

**Environmental Monitoring Plan
United States Department of Energy
Richland Operations Office**

November 9, 1994

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

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PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831;
prices available from (615) 576-8401. FTS 626-8401.

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Acronyms

AAMSR	Aggregate Area Management Study Reports
ALARA	As Low As Reasonably Achievable
ALE	Fitzner/Eberhardt Arid Land Ecology
Am	Americium
ANSI	American National Standards Institute
BHI	Bechtel Hanford, Inc.
CAR	Compliance Assessment Reports
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CIP	contaminant indicator parameter
Cm	Curium
CM	critical mean
COC	Chemicals of Concern
CPP	CERCLA Past-Practice
CPU	Central Processing Units
CRDL	contractually required detection limit
CSL	Chemical Sewer Line
DDCP	bidentate organophosphorus solvent
D&D	Demolition and Decommissioning
DOE	U.S. Department of Energy
DQO	Data Quality Objective
DST	double-shell tank
Ecology	Washington State Department of Ecology
EDE	Effective Dose Equivalent
EDP	Electronic Data Processing
EDTA	ethylene-diaminetetraacetic acetate
E&ETS	Earth and Environmental Technology Services
EM	Effluent Monitoring Group
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
ERA	Expedited Response Action
ERC	Environmental Restoration Contractor
ERPP	Environmental Radiological Protection Program
FEMP	Facility Effluent Monitoring Plan
FFTF	Fast Flux Test Facility
GC/MS	Gas Chromatography/Mass Spectrometry
GIS	Geographic Information System
HACMP	High Availability Clustered Multi-Processing
HEHF	Hanford Environmental Health Foundation
HEIS	Hanford Environmental Information System
HGP	Hanford Generating Plant
HI	Hazard Index
HMS	Hanford Meteorology Station
HP	Health Physics
HPGE	hyperpure germanium
HVAC	Heating, Ventilation, and Air Conditioning

HWMA	Hazardous Waste Management Act
HWVP	Hanford Waste Vitrification Plant
ICF KH	Kaiser Hanford Company
ICR	Incremental Cancer Risk
ICRP	International Commission on Radiological Protection
ISV	in situ vitrification
IT	International Technology Corporation
LEMIS	Liquid Effluent Monitoring Information System
LEPD	Low-Energy Proton Detector
LERF	Liquid Effluent Retention Facility
LFI	Limited Field Investigation
LLBG	Low-Level Burial Grounds
LLW	Low-Level Waste
LWDF	Liquid Waste Disposal Facility
M&TE	Measurement and Test Equipment
MDC	minimum detectable concentration
MDL	method detection limit
MEI	Maximally Exposed Individual
MEPAS	Multimedia Environmental Pollutant Assessment System
MSCM	Mobile Surface Contamination Monitor
MTCA	Model Toxic Control Act
NDA	Nondestructive Assessment
NASQAN	National Stream Quality Accounting Network
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Effluent System
NRA	not routinely analyzed
NRDWL	Nonradioactive Dangerous Waste Landfill
OEM	Operational Environmental Monitoring
OU	Operable Unit
PAC	portable alpha counter
PAM	portable alpha meter
PFP	Plutonium Finishing Plant
PIC	pressurized ionization chamber
PNL	Pacific Northwest Laboratory
PS	Process Sewer
Pu	Plutonium
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QRA	Qualitative Risk Assessments
QUEST	Quality Environmental Safety Tracking
RCRA	Resource Conservation and Recovery Act
REDOX	reduction/oxidation (plant)
RI/FS	Remedial Investigation/Feasibility Study
RL	DOE Richland Operations Office
RLWS	Radioactive Liquid Waste System
ROD	Record of Decision
RPP	RCRA Past-Practice
RPR	Radiological Problem Reports

RPS	Retention Process Sewer
RQ	Reportable Quantities
RSD	relative standard deviation
SAP	Sampling Analysis Plan
SESP	Surface Environmental Surveillance Project
SIU	Signal Interface Unit
SOW	Statement of Work
SS	Sanitary Sewer
SST	single-shell tank
SWL	solid waste landfill
TEDF	Treated Effluent Disposal Facility
TLD	Thermoluminescent dosimeters
TOX	total organic halogen
TPA	Tri-Party Agreement
TRU	transuranic
TSD	treatment, storage, and disposal
UNH	Uranyl Nitrate Hexahydrate
USGS	U.S. Geological Survey
UV	Ultraviolet
VOC	Volatile Organic Compound
WAC	Washington Administrative Code
WDOH	Washington State Department of Health
WESF	Waste Encapsulation and Storage Facility
WHC	Westinghouse Hanford Company
WIDS	Waste Information Data System
WMA	Waste Management Area
WP	water pollution
WPPSS	Washington Public Power Supply System
WQ	water quality

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Hanford Site Environmental Monitoring Plan

Section I. Introduction

As required by DOE Order 5400.1, U.S. Department of Energy (DOE), the Richland Operations Office (RL) prepared and issued an *Environmental Monitoring Plan* (EMP) on November 9, 1991. The EMP is to be revised every 3 years. This is the first edition. *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991) provides specific guidance regarding environmental monitoring activities.

According to DOE Order 5400.1, each DOE site, facility, or activity that uses, generates, releases, or manages significant quantities of hazardous materials shall provide a written *Environmental Monitoring Plan* covering two major activities: 1) effluent monitoring and 2) environmental surveillance. This Hanford Site plan addresses those activities.

This Hanford Site Environmental Monitoring Plan consists of Section I, Introduction; Section II.A, Facility Effluent Monitoring Plans; Section II.B, Operational Environmental Monitoring and its Appendixes A, B, and C; Section III.A, Surface Environmental Surveillance; Section III.B, Ground-Water Surveillance; and Section III.C, Meteorological Monitoring, and Section IV, Environmental Restoration Ground-Water Monitoring. Appendix A is a compilation of Area wells.

Effluent Monitoring

All 4 primary Hanford contractors at that time, Westinghouse Hanford Company (WHC), Pacific Northwest Laboratory (PNL), Bechtel Hanford, Inc. (BHI), and Hanford Environmental Health Foundation (HEHF) reviewed potential sources of contamination. Two of the 4, WHC and PNL, prepared facility effluent monitoring plans (FEMPs) in a uniform format following the Hanford FEMP guidance document (WHC-EP-0438-1). A FEMP was written for each facility with the potential to release significant quantities of hazardous materials, addressing both radiological and nonradiological effluent monitoring. The FEMPs contain the detailed rationale and design criteria for the effluent monitoring program, extent and frequency of monitoring and measurements, procedures for laboratory analyses, quality assurance requirements, and program implementation procedures.

Operational Environmental Monitoring (Section II.B) is an integral part of effluent monitoring activities conducted by WHC at all of their facilities and certain waste disposal sites. The facility-based program evaluates the adequacy of process effluent controls or stabilization efforts near a specific facility. The program focuses on facilities near and in the 100, 200, 300, 400, 600, and 1100 Areas. The program monitors radiation contamination in air, surface water, ground water, soil, sediment, vegetation, and biota. The description of these activities in Section II.B contains details or specific references to the rationale and design criteria for the extent and frequency of monitoring and measurements, procedures for laboratory analyses, quality assurance requirements, and program implementation procedures.

Environmental Surveillance

The PNL sitewide environmental surveillance program assesses onsite and offsite environmental impacts and offsite human health exposures. The program monitors air, surface water, sediment, agricultural products, vegetation, soil, and wildlife. Also, PNL conducts independent onsite surveillance to evaluate the effectiveness of Hanford Site effluent controls.

Section III.A, Surface Environmental Surveillance, contains the detailed rationale and design criteria for the environmental surveillance program, extent and frequency of monitoring and measurements, procedures for laboratory analyses, quality assurance requirements, and program implementation procedures. Where possible, existing documents are referenced to minimize duplication.

Section III also includes ground water, meteorology, and climatology monitoring. The ground-water portion (Section III.B) describes the ground-water monitoring design, location of wells, frequency of sampling, sampling procedures, analyses performed, and analysis of data; it also provides the rationale for the level of effort devoted to each element. Section III.C describes the rationale and design of the meteorology and climatology program, including the number and location of stations, instrumentation, forecasting capability, data management, diffusion modeling, and emergency response capability.

An annual report describing the environmental status of the Hanford Site and the surrounding area is prepared and distributed in accordance with DOE Order 5400.1 and applicable DOE-Headquarter's guidance. This report includes environmental data collected through environmental surveillance projects and also an evaluation of Hanford Site compliance with applicable environmental standards and regulations. In addition, detailed annual reports are prepared on ground-water surveillance, operational environmental monitoring, meteorology, and climatology.

Independent Data Verification

The Washington State Department of Health (WDOH) was awarded a grant beginning in March 1990 to conduct independent surveillance, oversight, and data verification at the Hanford Site. The grant provides funds to WDOH for sample collection, analysis, data compilation and interpretation, and report preparation. The WDOH provides the results of their independent surveillance, data verification, and oversight activities annually.

Other Sources of Effluents

In addition to the DOE facilities, private and public operations involving radioactive materials are present both on and near the Hanford Site. U.S. Ecology and Washington Public Power Supply System are the onsite operations; Siemens Nuclear Power Corporation, Battelle Memorial Institute, and the Allied Technology Group are the local offsite users of radioactive material. These operations are licensed by the U.S. Nuclear Regulatory Commission or the WDOH and are not subject to DOE environmental orders.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Monitoring

Monitoring at Hanford CERCLA operable units is conducted as part of Remedial Investigation/Feasibility Studies (RI/FS). These are detailed characterization of operable units that will be used as the basis for cleanup/environmental restoration. These studies are conducted by various contractors and are now under the management of BHI, the Hanford Environmental Restoration Management Contractor (ERMC). RI/FS monitoring is not included in this EMP.

RI/FS reports are prepared for each operable unit and they are readily available. Also, the design of the RI/FS studies and the format and content of the reports are defined by U.S. Environmental Protection Agency (EPA) CERCLA procedures.

Facility and operational monitoring conducted for BHI by WHC is included in the appropriate sections of the EMP.

Contractor Roles

This EMP describes the environmental monitoring conducted by all Hanford contractors. PNL conducts the environmental surveillance, Site-wide ground-water monitoring, meteorology and climatology, and effluent monitoring of its facilities. WHC conducts near-field environmental monitoring around facilities, tank farms, and waste burial sites; conducts RCRA ground-water monitoring, and near-field ground-water monitoring; and effluent monitoring on its facilities. BHI conducts CERCLA monitoring, effluent monitoring on its facilities and monitoring of optimization of design, conceptual model development, trending, point-of-compliance, and remediation performance evaluation activities. BHI began work as the Hanford Environmental Restoration Contractor (ERC) during FY 1994. It now has responsibility for environmental restoration and some environmental monitoring that was previously performed by WHC. BHI has made arrangements for WHC to provide near-field monitoring and reporting services. Where these arrangements have been made, the organization responsible for performing monitoring is identified in detailed descriptions in Sections II and III. Some of the responsibilities for environmental monitoring are still being identified. Also, WHC is reviewing its RCRA ground-water monitoring and is anticipating changes that will occur in 1995. PNL reviews its monitoring schedule annually, and changes are implemented at the beginning of the calendar year. BHI is reviewing monitoring responsibilities associated with its activities. The status of monitoring described in this EMP are current as of November 9, 1994. In January 1995, the team that prepared this plan will meet to review changes that will occur in Hanford environmental monitoring in 1995 and will document changes.

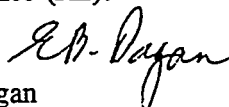
References

DOE/EH-0173T. 1991. *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*. U.S. Department of Energy, Washington, DC.

DOE Order 5400.1. *General Environmental Protection Program*.

WHC (Westinghouse Hanford Company) 1992. *A Guide for Preparing Hanford Site Facility Effluent Monitoring Plans*. WHC-EP-0438-1, Westinghouse Hanford Company, Richland, Washington.

**Hanford Site Environmental Monitoring Plan
Section II.A. Facility Effluent Monitoring Plans**

Prepared by:  R. E. Johnson	Date: 11/2/94	Concurrence (RL):  E. B. Dagan	Date: 10/28/94
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Introduction

This section of the Environmental Monitoring Plan (EMP) addresses facility effluent monitoring plans (FEMPs). To meet the overall requirements of DOE 5400.1 and DOE/EH-0173T, all operational FEMPs were completed and implemented by November 9, 1991. In addition, new or modified facilities will be evaluated to determine whether a FEMP is needed; if required, a FEMP will be completed before startup.

In accordance with the requirements of the U.S. Department of Energy (DOE) *Environmental Protection Implementation Plan*, DOE/RL 93-97, the Westinghouse Hanford Company (WHC) Environmental Services Function is responsible for preparing and maintaining a FEMP guidance document (WHC-EP-0438-1) for use by Hanford Site contractors in preparing their facility-specific FEMPs. A FEMP management plan, WHC-EP-0491, describes the relationship of the FEMP to the overall EMP and delineates required contents and DOE and contractor relationships.

Nonroutine monitoring for nonradioactive constituents (as defined by the Resource Conservation and Recovery Act [RCRA]) are covered in the Sampling Analysis Plans (SAPs); the routine effluent and emission monitoring activities are addressed by the FEMPs. Two activities associated with the FEMPs are the determination of the need for a FEMP and the preparation of the FEMP.

Sampling Analysis Plans

As part of the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement [TPA]), the DOE, with the concurrence of the Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA) made a commitment to (Ecology 1989):

- document liquid effluent discharge histories
- characterize liquid effluent discharges
- assess the potential for contamination in soils and ground water
- assess the extent of existing contamination in soils and ground water.

Actions taken to meet these commitments included the development of 22 SAPs. The purpose of the SAPs was to characterize liquid effluent discharges, account for variations in volumes and contaminant concentrations from operational practices, and consider all the parameters known or suspected to be associated with each liquid effluent stream, such as influence of operational practices, raw water characteristics, and process knowledge. The results collected during the SAP investigations are compared against WAC-173-200 "Ground Water Standards," to identify any exceedances and to ascertain compliance with regulations; results are also used to assess the potential for contamination in soils and ground water.

Sampling performed in accordance with the SAPs complements the routine environmental monitoring program at the Hanford Site and allows an analysis of the nonradioactive constituents in the waste stream that are not covered by any routine environmental monitoring sampling programs.

Initial results of the SAPs sampling efforts were compiled in the *Liquid Effluent Monitoring Information System* (LEMIS) and will continue to be compiled there.

FEMP Determination

The FEMP determinations were prepared for the individual Hanford Site facilities. In many cases facilities were grouped by area and the following information included in a FEMP Determination document:

- an introduction section that includes the present configuration and current status of each facility (active, inactive, standby, etc.)
- a facility information section that includes a brief facility/process description
- discussion section that includes source term identification and characterization, radiological/hazardous material inventories at risk, fugitive sources (where applicable), identification of release pathway and effluent point of discharge, and identification and characterization of source terms contributing to each effluent stream
- a section describing potential upset conditions (assuming single failure) that briefly describes each event, along with the type and amount of material involved, the pathway for potential release, and offsite dose calculations to be evaluated against the *Clean Air Act of 1977* (and as amended 1990), 40 CFR 61, and National Emission Standards for Hazardous Air Pollutants
- a summary section that includes an evaluation of the relevant data to determine whether the facility requires a FEMP
- Attachment 1, "Determination of FEMP Requirement" from WHC-EP-0438-1, the WHC guidance for preparing FEMPs.

Pursuant to the requirements of DOE/5400.1, a FEMP was prepared for those facilities with the potential to release quantities of airborne radioactive materials that could cause radiation doses in excess of 0.1 mrem/yr to the maximally exposed individual (MEI). A FEMP was also prepared for any facility with a liquid effluent that is regulated by the National Pollutant Discharge Elimination System (NPDES) and that contains sufficient radionuclides to cause an effective dose equivalent (EDE) greater than 4.0 mrem/yr in any person consuming that effluent. The release quantities are to be evaluated at the point of release, assuming no engineering controls are in place to mitigate the release. In this determination process, over 160 potential source terms were evaluated (WHC-EP-0498; PNL-10061).

Finally, a FEMP is prepared for those facilities with the potential to release large quantities of nonradioactive hazardous materials (e.g., exceeding the reportable quantities listed in 40 CFR 302.4), without engineering controls in place to mitigate the release. Dose calculation methods and a summary of many of the FEMP determinations are summarized in WHC-EP-0498. The FEMP determinations are grouped according to the Hanford areas and are found in six documents, WHC-EP-0439 through -0443 and PNL-10061.

FEMP Preparation

The FEMPs were prepared in the format specified in WHC-EP-0438-1. The sections of the FEMP are introduction, including purpose, scope, and discussion of constituents and applicable regulations; description of the facility, process, potential source terms, and release pathways; characterization of

effluent discharges (both airborne and liquid) that are monitored and the potential effluent concentrations; identification and characterization of the effluent points (both airborne and liquid) and a discussion of the design criteria and technical specifications pertaining to the effluent monitoring/sampling systems; discussion of alternative monitoring and assessment methods different from those specified by the EPA and the DOE 5400-series Orders; historic monitoring/sampling data (if available) and a comparison of data for normal and upset conditions; information regarding sample analysis, including laboratory procedures; notification and reporting requirements; interface with the operational environmental surveillance program; a discussion of quality assurance (QA); a discussion of internal and external reviews, approvals of changes, and annual reviews; a discussion of compliance with applicable DOE Orders and EPA regulations; conclusions, exceptions or exemptions and justifications, and required system upgrades; and applicable references.

Coordination

The Westinghouse Hanford Environmental Services Function coordinates FEMP activities for the Hanford Site contractors and communicates the results of the FEMP preparations to the DOE Richland Operations Office (RL). Within the Environmental Services Function, the Effluent Monitoring Group (EM) will summarize and document the results of the WHC FEMP determinations and transmit the information to RL for review.

WHC facilities are required to obtain EM's approval for all changes to the FEMPs, including those generated in the annual review and update. The FEMP determinations and the written FEMPs will be retained in the custody of EM. Further, RL will be informed in a timely manner of any changes to the FEMPs. Pacific Northwest Laboratories (PNL) Environmental Monitoring Program performs a similar function for the PNL facilities.

Quality Assurance

DOE/EH-0173T stipulates that a QA plan be prepared and included as a section in this EMP. The QA plan must cover the monitoring activities at the Hanford Site consistent with applicable elements of ASME NQA-1-1989 Edition and QAMS-005/80. To meet this requirement, a QA plan is included or referenced in each individual FEMP.

QA objectives for the monitoring of liquid effluents and air emissions are discussed in *Quality Assurance Project Plan for Facility Effluent Monitoring Plan Activities*, WHC-EP-0446-1. The QA objectives for compiling and reporting air emission monitoring are defined in *Quality Assurance Project Plan for Radioactive Airborne Emissions Data Compilation and Reporting*, WHC-EP-0528-1.

Environmental ALARA

10 CFR 834 Subpart II.D stipulates that all DOE activities will be managed in accordance with an Environmental Radiological Protection Program (ERPP). An Environmental ALARA^(a) Program is included in the ERPP and addresses the potential radiological impact of DOE operations on the public

(a) As Low As Reasonably Achievable.

and/or environment. An Environmental ALARA Program includes, as appropriate, 1) a statement of commitment to use the ALARA process, 2) a description of the means to be used to implement the ALARA program, 3) a process for documenting ALARA decisions, 4) a training program for the staff on implementation of the ALARA process, and 5) a listing and evaluation of specific factors considered in arriving at the ALARA position.

The Hanford Site will implement an integrated Environmental ALARA Program in accordance with DOE Order 5400.1 and 10 CFR 834. It will include 1) the management policy and statement of commitment to the ALARA philosophy, 2) the organizational responsibilities and authority and structure for implementation, 3) an evaluation of site operations identifying activities responsible for radioactive releases causing a radiation exposure to the public and/or environment, and 4) an overall procedure to be used to analyze existing and proposed operations and activities to ensure ALARA is practiced. The Environmental ALARA Program will be designed to identify general areas to be considered in environmental ALARA decisions (e.g., societal, technological, economic, and public policy). A checklist of evaluation factors, staff requirements, and required records, in addition to the programs already in place on the Hanford Site, will be developed. WHC, PNL, and Bechtel Hanford, Inc. (BHI), will each prepare an Environmental ALARA Program Plan.

Responsibilities

Table II.A-1 provides a complete listing of the facilities at the Hanford Site, the contractor responsible for the facility, and the determination of a need for a FEMP (WHC-EP-0498 and PNL-10061). Table II.A-2 provides a complete listing of the FEMPS and the supporting FEMP documents, with the issue dates and the revision status. Because it is not feasible to include each individual FEMP in this Environmental Monitoring Plan, an abstract from each applicable FEMP follows.

Table II.A-1. Facilities Determination Results

Facility	Westinghouse Hanford Operations			FEMP Required?		
100 Area						
KE/KW Fuel Storage Basins and Associated Facilities				yes		
200/600 Areas						
B Plant				yes		
PUREX				yes		
UO ₃				no ^(a)		
Plutonium Finishing Plant				yes		
T Plant				no ^(b)		
222-S Laboratory				yes		
2703-E Clinical Environmental Laboratory				no		
2711-E				no		
2724-W Protective Equipment Decontamination Facility				no ^(c)		
Grout Facilities				no		
224-T Transuranic Waste Storage and Assay Facility				no		
Solid Waste Facilities Compactor				no		
616 Non-Radioactive Dangerous Waste Storage Facility				no		
212-P Non-Radioactive PCB Storage Facility				no		
Low-Level Burial Grounds				no		
PWSF 600 Area				no		
213-J and 213-K Storage Vaults (600 Area)				no		
200 Area TEDF				no		
WSCF				no		
<i>Single-Shell Tank Farms</i>						
241-A	241-AX	241-B		no	no	no
241-BX	241-BY	241-C		no	no	yes
241-S	241-SX	241-TX		no	yes	no
241-TY	241-U			no	no	
<i>Double-Shell Tank Farms</i>						
241-AN	241-AP	241-AW		no	yes	yes
241-SY	244-A	244-TX		yes	yes	no
244-U	244-S	244-BX		yes	yes	yes
241-AY	241-AZ			yes	yes	
<i>Vaults</i>						
204-AR	244-AR	244-CR		no	no	yes
<i>Evaporators</i>						
242-A	242-S	242-T		yes	no	no
300 Area						
300 Area Treated Effluent Disposal Facility				no		
303-A, B, C, E, F, G, J, K				no		
303-M Oxide Facility				no		

Table II-A.1. (cont'd)

<u>Facility</u>	<u>FEMP Required?</u>
313 and 333 Fuels Fabrication Facilities	no ^(d)
334-A Spent Acid Storage	no
306-E Fabrication and Testing Laboratory	no
308 Fuels Laboratory	no ^(e)
321 Shutdown	no
335/335A Facility	no
340 Complex	yes
377 Facility	no
3703 Facility	no
3718-F Alkali Metal	no
3717-B Standards Laboratory	no
<u>400 Area</u>	
Fast Flux Test Facility	yes ^(f)
Maintenance and Storage Facility	no
Fuels and Materials Examination Facility	no
4713-B Maintenance	no
4831 Flammable Storage	no
4843 Alkali Metal Storage	no
<u>1100 Area</u>	
1154-A Radio Maintenance	no
1162 Flammable Storage	no
1164 Hazardous Material Storage	no

Bechtel Hanford Incorporated

<u>100 Area</u>	
N Reactor	yes ^(g)
Retired Reactors (B, C, D, DR, F, H)	no
<u>200/600 Area</u>	
U Plant	no
202-S (REDOX)	no
233-S	no

Hanford Environmental Health Foundation

747 Building	no
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Pacific Northwest Laboratory

<u>200 Area</u>	
242-B	no
2718-E	no

Table II-A.1. (cont'd)

<u>Facility</u>	<u>FEMP Required?</u>
<u>300 Area</u>	
300N	no
324 Facility	yes
325 Building	yes
327	yes
303-J	no
331-H	no
3720	yes
329	no
320	no
306-W	no
331 & 331-A	no
3708	no
3745	no
329 NMF	no
3730	no
331-C	no
326	no
314	no
331-G	no
323	no
3746-A	no
318/318-Tr4	no
303-C	no
3745-B	no
318 Trailer 5	no
305-B	no
<u>600 Area</u>	
ALE Reserve (6652)	no
622-D	no
622-R	no
622-S	no
<u>700 Area</u>	
747-A	no

ICF Kaiser Hanford Company

<u>100 Area</u>	
100-N Paint Shop	no
100-N Electrical Shop	no
<u>200/600 Areas</u>	
Batch Plant	no
200-E Electrical Shop	no
200-W Paint Shop	no

Table II-A.1. (cont'd)

<u>Facility</u>	<u>FEMP Required?</u>
200-E Darkroom	no
284-E and 294-W Powerplants	yes
2911-E	no
Fabrication Shops	no
General Area Services (200 Area)	no
PUREX Pipefitter Shop	no
<u>300 Area</u>	
300 Paint Shop	no
305 Hot Cell Verification	no
309 SP-100	no
312 Facility	no
315 Water Plant	no
328 Technical Shops	no
337 High-Temperature Sodium Facility	no
338 Maintenance	no
382 Facility	no
384 Powerhouse	no ^(b)
3621B/C/D Facility	no
3704 Facility	no
3705 Photo Laboratory	no
3706 Facility	no
3707 Facility	no
3709 Paint Shop	no
3717-B Standards Laboratory	no
3722 Facility	no
3732 Facility	no
3765 Facility	no
3790 Facility	no
<u>400 Area</u>	
FMEF	no
4722 B, C Maintenance	no
4734-B Maintenance	no
<u>1100 Area</u>	
1100 TCPC CAD Room	no
1100 TCPC Print Room	no
1171 Shop	no
1172-A Service Station	no
1176 Tire Station	no
1171-A Vehicle Wash	no
<u>3000 Area</u>	
1209	no
1235 Bottle Dock	no
1208	no
1212	no

Table II-A.1. (cont'd)

<u>Facility</u>	<u>FEMP Required?</u>
1226 Bay and Wash Down Pad	no
1240 Electrical and Fabricating Shops	no

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- (a) The UO₃ Facility will be turned over to BHI in Jan. 1995, with no further releases.
- (b) T Plant will no longer need a FEMP, redetermination approved June 1994.
- (c) The facility has been demolished and the area will be turned over to BHI in Jan. 1995.
A FEMP is no longer needed.
- (d) A FEMP is no longer needed.
- (e) A FEMP would be required for the 308-GL-EX stack but it is being shut down and blanked off in 1994.
- (f) FFTF will undergo a redetermination and will likely not need a FEMP.
- (g) N Reactor is undergoing a redetermination and will likely not need a FEMP.
- (h) The 284-E and 284-W Powerhouses have a FEMP. The 384 Powerhouse, which may return to coal usage, may require a new FEMP redetermination.

Table II.A-2. Listing of FEMPS and Supporting Documents

Document #	Title of Document	Issue Date	REV #	Status
WHC-EP-0438-1	<i>A Guide for Preparing Hanford Site Facility Effluent Monitoring Plans</i>	Jun. 1992	Rev 1	This is the current version of this document.
WHC-EP-0439	<i>Facility Effluent Monitoring Plan Determinations for the 100 Area Facilities</i>	Nov. 1991	Rev 0	This document will be revised on a section-by-section basis as determinations are added or redeterminations replace old determinations.
WHC-EP-0440 Volume 1	<i>Facility Effluent Monitoring Plan Determinations for the 200 Areas Facilities</i>	Nov. 1991	Rev 0	This document will be revised on a section-by-section basis as determinations are added or redeterminations replace old determinations.
WHC-EP-0440 Volume 2	<i>Facility Effluent Monitoring Plan Determinations for the 200 Areas Facilities</i>	Nov. 1991	Rev 0	This document will be revised on a section-by-section basis as determinations are added or redeterminations replace old determinations.
WHC-EP-0440, Rev. 0-A	<i>Facility Effluent Monitoring Plan Determination for the T Plant</i>	Jun. 1994	Rev 0-A	Redetermination completed May 1994. Facility no longer needs FEMP.
WHC-EP-0441	<i>Facility Effluent Monitoring Plan Determinations for the 300 Area Facilities</i>	Nov. 1991	Rev 0	This document will be revised on a section-by-section basis as determinations are added or redeterminations replace old determinations.
WHC-EP-0442	<i>Facility Effluent Monitoring Plan Determinations for the 400 Area Facilities</i>	Nov. 1991	Rev 0	This document will be revised on a section-by-section basis as determinations are added or redeterminations replace old determinations.
WHC-EP-0443	<i>Facility Effluent Monitoring Plan Determinations for the 600 Area Facilities</i>	Nov. 1991	Rev 0	This document will be revised on a section-by-section basis as determinations are added or redeterminations replace old determinations.
WHC-EP-0444	<i>Facility Effluent Monitoring Plan Determinations for the Operations Support Services Facilities (100, 200, 300, 400, and 1100 Areas)</i>	Nov. 1991	Rev 0	This document will be revised on a section-by-section basis as determinations are added or redeterminations replace old determinations.
WHC-EP-0446-2	<i>Quality Assurance Project Plan for Facility Effluent Monitoring Plan Activities</i>	Jun. 1992	Rev 1	Rev 2 will be released in Oct. 1994.
WHC-EP-0466-1	<i>Facility Effluent Monitoring Plan for the 242-A Evaporator</i>	Apr. 1993	Rev 1	Rev 2 is not due until Nov. 1996.
WHC-EP-0467	<i>Facility Effluent Monitoring Plan for the B-Plant</i>	Nov. 1991	Rev 0	Rev 1 is in final draft and will be released before Nov. 1994.

Table II-A.2. (cont'd)

Document #	Title of Document	Issue Date	REV #	Status
WHC-EP-0468-2	<i>Facility Effluent Monitoring Plan for the Plutonium-Uranium Extraction Facility</i>	Nov. 1993	Rev 2	Rev 3 is not due until Nov. 1996.
WHC-EP-0469-1	<i>Facility Effluent Monitoring Plan for the 340 Waste Handling Facility</i>	Nov. 1992	Rev 1	Rev 2 will be due Nov. 1995.
WHC-EP-0470-1	<i>Facility Effluent Monitoring Plan for the Uranium Trioxide Facility</i>	Nov. 1993	Rev 1	The facility will be turned over to Bechtel Hanford, Inc. for decontamination and decommissioning Jan. 1994.
WHC-EP-0471-1	<i>Facility Effluent Monitoring Plan for the 2724-W Protective Equipment Decontamination Facility</i>	Dec. 1992	Rev 1	Facility has been demolished and will be turned over to Bechtel Hanford, Inc. in Jan. 1995. A FEMP is no longer needed.
WHC-EP-0472-1	<i>Facility Effluent Monitoring Plan for the 284-E and 284-W Power Plants</i>	Nov. 1992	Rev 1	Rev 2 will be due Nov. 1995.
WHC-EP-0475-1	<i>Facility Effluent Monitoring Plan for the Fast Flux Test Facility</i>	Nov. 1992	Rev 1	Redetermination is in process. It is unlikely that a FEMP will be needed.
WHC-EP-0476-1	<i>Facility Effluent Monitoring Plan for the Plutonium Finishing Plant</i>	Nov. 1993	Rev 1	Rev 2 will not be due until Nov. 1996.
WHC-EP-0477	<i>Facility Effluent Monitoring Plan for the N Reactor</i>	Nov. 1991	Rev 0	Redetermination is in process. It is unlikely that a FEMP will be needed.
WHC-EP-0479	<i>Facility Effluent Monitoring Plan for Tank Farms</i>	Nov. 1991	Rev 0	Rev 1 is currently in draft and is due by Nov. 1994.
WHC-EP-0480-1	<i>Facility Effluent Monitoring Plan for the 222-S Laboratory</i>	Nov. 1992	Rev 1	Rev 2 is currently in draft and will be released before Nov. 1994.
WHC-EP-0491	<i>Management Plan for the Facility Effluent Monitoring Plan Activities</i>	Aug. 1991	Rev 0	This is the current version of this document.
WHC-EP-0497	<i>Facility Effluent Monitoring Plan for K Area Fuel Storage Basins</i>	Nov. 1991	Rev 0	Rev 1 is currently in draft and is due by Nov. 1994.
WHC-EP-0498	<i>Unit Dose Calculation Methods and Summary of Facility Effluent Monitoring Plan Determinations</i>	Nov. 1991	Rev 0	Document is being revised.
WHC-EP-0509	<i>Facility Effluent Monitoring Plan for the 300 Area Fuels Fabrication Facility</i>	Nov. 1991	Rev 0	Redetermination completed Jan. 1994. FEMP is no longer needed.
WHC-EP-0528-1	<i>Quality Assurance Project Plan for Radioactive Airborne Emissions Data Compilation and Reporting</i>	Feb. 1994	Rev 1	This is the current version of this document.

Table II-A.2. (cont'd)

Document #	Title of Document	Issue Date	REV #	Status
WHC-EP-0536-1	<i>Quality Assurance Program Plan for Radionuclide Airborne Emission Monitoring</i>	Jul. 1993	Rev 1	Rev 2 is currently in progress.
WHC-Internal Memo 12750-94-003	<i>Facility Effluent Monitoring Plan Determination for Waste Sampling Characterization Facility</i>	Jan. 1994	NA	FEMP is not required.
WHC-Internal Memo 88420-93-146	<i>Review and Approval of FEMP Determination for the 200 Area Effluent Treatment Facility</i>	Dec. 1993	NA	FEMP is not required.
WHC-Internal Memo 88420-94-003	<i>Review and Approval of FEMP Redetermination for the 300 Area Fuels Fabrication Facility</i>	Jan. 1993	NA	FEMP is not required.
Approved FEMP Determination Incorporated into 300 Area Determination Document	<i>300 Area Treated Effluent Disposal Facility, Facility Effluent Monitoring Plan Determination. Included in the FEMP Determinations for the 300 Area Facilities, WHC-EP-0441, Rev 0-A</i>	Approval date May 1994	NA	FEMP is not required.
PNL-MA-660	<i>Facility Monitoring Plan for the 324 Facility</i>	Nov. 1991	Rev 0	Rev 1 is currently in draft and is due by Nov. 1994.
PNL-MA-661	<i>Facility Monitoring Plan for the 325 Facility</i>	Nov. 1991	Rev 0	Rev 1 is currently in draft and is due by Nov. 1994.
PNL-MA-662	<i>Facility Monitoring Plan for the 327 Facility</i>	Nov. 1991	Rev 0	Rev 1 is currently in draft and is due by Nov. 1994.
PNL-MA-663	<i>Facility Monitoring Plan for the 3720 Facility</i>	Nov. 1991	Rev 0	Rev 1 is currently in draft and is due by Nov. 1994.
PNL-10061	<i>Pacific Northwest Laboratory Facilities Radionuclide Inventory Assessment CY 1992-1993</i>	1994	Rev. 0	This is a new document.

Facility Effluent Monitoring Plans Abstracts

FEMPs were prepared for all facilities that the FEMP determination process indicated required one. These FEMPs are summarized below.

KE and KW Fuel Storage Basins

The KE and KW Fuel Storage Basins are located in the 100-K Area, adjacent to the Columbia River on the Hanford Site. The KE and KW Reactors have been shut down, deactivated, and decommissioned. Most of the stored fuel was shipped to the 200-East Area reprocessing facilities. After initial laying away, the fuel storage basins located in the 105-KE and 105-KW Buildings were cleaned and modified for storing N Reactor irradiated fuel. The basin cooling systems were modified to a closed system, and a leak in the 105-KE Basin was repaired. Storage of N Reactor fuel in the basins started in 1975 and continues to the present, but shipments to the basins were ceased in 1989. Monitoring of the ground water adjacent to the basin for leak detection purposes is conducted under the Operational Environmental Monitoring Program (OEMP). In addition to the 105-KE and 105-KW Fuel Storage Basins, this FEMP covers 1706-KE and 1706-KER Engineering Laboratories, 1908-KE Outfall (a.k.a. NPDES Outfall 004), and 181-KE Filter Screen Backwash Discharge (a.k.a. NPDES Outfall 003). This last facility does not release hazardous materials in excess of EPA standards.

Airborne Effluents

Airborne effluent streams considered in this FEMP include those from the 105-KE Fuel Storage Basin, 105-KW Fuel Storage Basin, 1706-KE Environmental and Engineering Demonstration Laboratory, and 1706-KER Water Studies Recirculation Building. Radionuclides discharged to the air included ^{60}Co , ^{90}Sr , ^{134}Cs , ^{137}Cs , ^{238}Pu , ^{239}Pu , and ^{240}Pu .

Liquid Effluents

One liquid stream, which is located at the 1908-KE Outfall (a.k.a. NPDES Outfall 004) and is routinely sampled, was determined to have low-to-remote potential to exceed the Drinking Water Standard or contain radionuclide constituents specified in DOE 5400.5. Radionuclides including ^3H , ^{60}Co , ^{90}Sr , ^{137}Cs , ^{239}Pu , and ^{240}Pu were discharged to the Columbia River.

FEMP Determination

A FEMP is required for the KE/KW Basins because of the potential for liquid effluents from the 1908-KE Outfall to contain radionuclide constituents specified in DOE 5400.5 or to exceed Drinking Water Standards of 4 mrem/yr. A FEMP document has been prepared, WHC-EP-0497, Rev 0, *Facility Effluent Monitoring Plan for K Area Fuel Storage Basins*, issued November 1991. A revision to the FEMP is in process and is due November 1994.

N Reactor

The N Reactor is located in the 100-N Area, adjacent to the Columbia River on the Hanford Site. The reactor was designed to produce special nuclear materials for weapons production and by-product steam for electric power generation. The major components of N Reactor include the 105-N Reactor Building, 109-N Heat Exchange Building, Turbine Generator Building, 183-N Water Filtration Plant, 163-N Demineralization Plant, 184-N Plant Service Powerhouse, 107-N Basin Recirculation Facility, and 182-N High Lift Pumphouse. The facility was placed in standby mode in January 1987 and was declared in August 1991 to be shut down. N Reactor officially became a surplus facility in April 1994. N Reactor does not release hazardous materials in excess of EPA standards.

Airborne Effluents

Airborne effluent streams considered in this FEMP include the 116-N Main Stack, the 107-N Building, and the 14-foot Decon Facility, which have record samples. The 105-N Reactor Building and the 109-N Heat Exchange Building vents are no longer active. The vents have been shut off and closed, but have not been physically blanked off. Radionuclides discharged to the air include ^{60}Co , ^{90}Sr , ^{134}Cs , ^{137}Cs , ^{155}Eu , ^{238}Pu , and ^{239}Pu .

Liquid Effluents

Radionuclides are released to the Columbia River primarily through the NPDES 009 Outfall (102 in.) and N Springs, which are routinely sampled. The N Springs are not releasing radionuclides to the ground water, though both the 1301-N and 1325-N Liquid Waste Disposal Facility soil columns may still be releasing some radionuclides to the ground water as the result of rising and dropping ground water levels because of river level fluctuations (bank storage). Radionuclides sampled for liquid effluents include ^3H , ^{60}Co , ^{90}Sr , ^{125}Sb , ^{134}Cs , ^{137}Cs , ^{155}Eu , ^{238}Pu , and $^{239,240}\text{Pu}$.

FEMP Determination

A FEMP had been required for N Reactor because of the potential for radionuclides discharged in the liquid effluents from 100-N Area springs to exceed 0.1 mrem/yr exposure to the MEI. A FEMP document has been prepared, WHC-EP-0477, Rev 0, *Facility Effluent Monitoring Plan for the N Reactor*, issued November 1991. The 100 Area Surplus Facility management is currently in the process of redetermining the need for this facility to maintain a FEMP.

B Plant

B Plant is located in the 200-East Area of the Hanford Site. The plant was originally designed to chemically process spent nuclear fuels but was later modified to individually separate strontium and cesium from the PUREX fission product waste stream, encapsulate the strontium and cesium at the Waste Encapsulation and Storage Facility (WESF), and transfer the remaining waste to the tank farms. B Plant is an operating facility that is required to ensure safe storage and management of the WESF cesium and strontium capsules. There are currently no production activities at B Plant, but there are several operating systems required to accomplish the current mission. B Plant receives and stores various chemicals from commercial suppliers for treatment of low-level waste generated at WESF and B Plant and for conditioning of water used in heating, ventilation, and air conditioning (HVAC) units. A FEMP is required based on potential for release of both radionuclides and hazardous waste.

Airborne Effluents

Airborne effluent streams considered in this FEMP included those from the 291-B-1, 296-B-5, 296-B-10, and 296-B-13 Stacks; 296-B-21 through -27 Gallery Exhausters, 296-B-12 WESF Emergency Jet, bulk chemical storage tank vents, and aqueous makeup tank vents. The 291-B-1 Stack has a real-time monitor. Radionuclide and chemical constituents of interest include ^{90}Sr , ^{137}Ba , ^{137}Cs , $^{239,240}\text{Pu}$, and ^{241}Am .

Liquid Effluents

The liquid effluent streams considered in this FEMP include B Plant Steam Condensate (currently inactive), B Plant Process Condensate (currently inactive), B Plant Chemical Sewer, B Plant Combined Cooling Water, B Plant Sanitary Sewer Systems, and french drains. The chemical sewer and cooling water have real-time monitors. Radionuclides and chemical constituents of interest include ^{90}Sr , ^{137}Cs , $^{239,240}\text{Pu}$, lead, iron, potassium, sodium, nitrate, chloride, sulfate, and carbonate.

FEMP Determination

A FEMP is required for B Plant because of the potential for radionuclides in the airborne effluents from the 291-B-1 main stack to exceed 0.1 mrem/yr exposure to the MEL. A FEMP document has been prepared, WHC-EP-0467, Rev 0, *Facility Effluent Monitoring Plan for the B-Plant*, issued November 1991.

PUREX

The PUREX Plant is located in the 200-East Area of the Hanford Site. The plant is a collection of buildings and facilities for reprocessing spent nuclear fuel. The primary components of the PUREX Plant are the 202-A Building (main canyon building) in which fuels are reprocessed, 203-A Pumphouse and Tank Farm, 211-A Pumphouse and Tank Farm, 206-A Acid Fractionator Building, 293-A Building (backup facility), effluent monitoring buildings, railroad tunnel, and 291-AE Building. The facility is currently being deactivated, i.e., prepared for long-term, safe, unstaffed surveillance.

Airborne Effluents

The PUREX Plant has been the source of 11 principal airborne effluent streams (stacks). Ten of these 11 stacks discharged at any one time. PUREX also had six minor building ventilation gaseous effluent streams that have been permanently shut down. Gaseous effluents continue during the transition to deactivation to provide control of trace quantities of contamination. The 291-A-1 and 296-A-1 stacks have the potential to exceed EPA standards and will require selective air monitoring for $^{239,240}\text{Pu}$ and ^{241}Am . The other nine stacks will require periodic (four weeks per year) confirmatory sampling.

Liquid Effluents

Of the five liquid effluent streams that discharged during the operating history of PUREX, only the Chemical Sewer Line (CSL) remains. The CSL discharges to the 216-B-3 Pond and has a real-time monitor. By mid-1995, the CSL will be routed to the Treated Effluent Disposal Facility (TEDF).

FEMP Determination

A FEMP is required for the PUREX Plant because of the potential for radionuclides in the airborne effluents from the 291-A-1 main stack and the 296-A-1 (PR) stack to exceed 0.1 mrem/yr exposure to the MEI. A FEMP document has been prepared, WHC-EP-0468-2, Rev 2, *Facility Effluent Monitoring Plan for the Plutonium-Uranium Extraction Facility*, issued November 1993.

242-A Evaporator

The 242-A Evaporator complex is located in the 200-East Area of the Hanford Site and is the primary waste concentrator for Hanford Site wastes stored in underground double-shell tanks (DSTs). The principal components of the system are located in the 242-A Process Building and the 242-AB Control Room Building. Radionuclide constituents include mixed fission products and transuranics (TRUs). Nonradionuclide inventories at risk include ammonia, cyanide, lead, mercury, nickel, phosphorous, sodium, sodium fluoride, sodium hydroxide, sodium nitrite, and sodium phosphate.

Airborne Effluents

The two major airborne effluent streams for the 242-A Evaporator are the 296-A-22 Vessel Ventilation System and the 296-A-21 "Hot Area" Building Ventilation System, both of which have real-time monitors. A third, separate air system supplies the noncontaminated (cold) area and exhausts through miscellaneous dampers and vents. The 296-A-22 Vessel Ventilation System has a potential dose of greater than 0.1 mrem/yr to the MEI.

Liquid Effluents

Two primary liquid streams that discharge to the environment are associated with the 242-A Evaporator: cooling water or used raw water stream and the steam condensate stream. Both have real-time monitors. Other liquid streams leaving the facility are either not discharged to the environment or are exempt from monitoring requirements because no process wastewater enters the stream. The proposed waste stream designation for both the used raw water and steam condensate streams, based on sampling data and process knowledge, is that neither is a dangerous waste stream.

FEMP Determination

A FEMP is required for the 242-A Evaporator because of the potential for radionuclides in the airborne effluents from the 296-A-22 stack to exceed 0.1 mrem/yr exposure to the MEI. A FEMP document has been prepared, WHC-EP-0466-1, Rev 1, *Facility Effluent Monitoring Plan for the 242-A Evaporator*, issued April 1993.

Tank Farm Complex

The Tank Farm Complex is located within the 200-East and 200-West Areas of the Hanford Site. A total of 177 single-shell tanks (SSTs) and DSTs with transfer, receiving, and treatment facilities make up the complex. Major components evaluated for the FEMP include the DST farms, SST farms, 204-AR Unloading Station, 244-CR Vault, the Double-Contained Receiver Tanks, and Waste Transfer Lines. No upset scenarios considered for the transfer lines would produce a release requiring a FEMP. Chemical constituents include sodium aluminate, sodium hydroxide, sodium nitrate, sodium nitrite, sodium carbonate, sodium sulfate, sodium phosphate, iron (III) hydroxide, and various organic compounds. Radionuclide constituents include ^{14}C , ^{63}Ni , ^{90}Sr , ^{93}Zr , ^{99}Tc , ^{106}Ru , ^{126}Sn , ^{129}I , ^{135}Cs , ^{137}Cs , ^{151}Sm , ^{226}Ra , ^{230}Th , ^{233}U , ^{234}U , ^{235}U , ^{237}Np , ^{238}U , ^{238}Pu , ^{239}Pu , ^{240}Pu , ^{241}Pu , ^{241}Am , ^{243}Am , and ^{244}Cm .

Airborne Effluents

Sixteen stacks for SSTs or DSTs were identified in the National Emissions Standards for Hazardous Air Pollutants stack source assessment (Davis and Barnett 1994a, 1994b) as designated stacks, and will require a FEMP, based on the calculated EDE potential of more than 0.1 mrem (see Table II.A-3).

Liquid Effluents

The liquid effluents include those from 241-AY/AZ Tank Farm Steam Coil Condensate to 216-A-8 Crib, 241-A Tank Farm Surface Condenser Cooling Water (CA8) to 216-B-3 Pond, 241-SX Tank Farm Sludge Cooler to 216-S-25 Crib, and 244-AR Vault Coolant Water (CAR) to 216-B-3 Pond. These effluents are routinely sampled.

FEMP Determination

A FEMP is required for the Tank Farm Complex because of the potential for radionuclides in airborne effluents from the stacks to exceed 0.1 mrem/yr exposure to the MEL. A FEMP document has been prepared, WHC-EP-0479, Rev 0, *Facility Effluent Monitoring Plan for Tank Farms*, issued November 1991.

Table 11.A-3. Tank Farm Stacks, Descriptions, and Status

Stack	Description	Status
296-A-12	244-AR Vault	Nondesignated
296-A-13	244-AR Vault Canyon and Cell	Nondesignated
296-A-17	241-AY/AZ Tank Farm Primary	Designated
296-A-18	241-AY-101 Tank Annulus	Nondesignated
296-A-19	241-AY-102 Tank Annulus	Nondesignated
296-A-20	241-AZ Tank Farm Annulus	Nondesignated
296-A-21	242-A Evaporator Building	Nondesignated
296-A-22	242-A Evaporator Vessel	Designated
296-A-25	244-A DCRT & Annulus	Designated
296-A-26	204-AR Unloading Facility	Nondesignated
296-A-27	AW Tank Farm Primary	Designated
296-A-28	AW Tank Farm Annulus	Nondesignated
296-A-29	AN Tank Farm Primary	Designated
296-A-30	AN Tank Farm Annulus	Nondesignated
296-A-40	AP Tank Farm Primary	Designated
296-A-41	AP Tank Farm Annulus	Nondesignated
296-B-28	244-BX DCRT & Annulus	Designated
296-C-05	244-CR Vault	Designated
296-P-16	241-C-104/105/106 Portable	Designated
296-P-17	241-A-105/105/106	Nondesignated
296-P-22	241-SY Tank Farm Annulus	Nondesignated
296-P-23	241-SY Tank Farm Primary	Designated
296-P-26	241-AY/AZ Tank Farm Primary Backup	Designated ^(a)
296-P-28	241-SY Tank Farm Primary Backup	Designated ^(a)
296-P-31	209-E Critical Mass Laboratory	Nondesignated
296-S-15	241-SX Tank Farm	Designated
296-S-18	242-S Evaporator Building	Nondesignated
296-S-22	244-S DCRT and Annulus	Designated
296-T-17	242-T Evaporator Facility	Nondesignated
296-T-18	244-TX DCRT and Annulus	Designated
296-U-11	244-U DCRT and Annulus	Designated ^(a)

(a) Unregistered Stacks

284-E and 284-W Powerplants

The 284-E Powerplant, located in the 200-East Area of the Hanford Site, has three Erie City boilers and two Riley "RX" boilers in use, and a backup oil-fired packaged boiler that is no longer used. The 284-W Powerplant, located in the 200-West Area of the Hanford Site, uses four Erie City boilers. The powerplants are coal-fired and are used to generate steam. Major components include the baghouses, stacks, brine pit, ash disposal basin, ash handling system, chemical mixing room/equipment, and ion-exchange regeneration tanks. No radioactive materials are used or introduced into the powerhouse operations or facilities. Hazardous chemicals inventory at risk includes alum, brine (salt), coal, chlorine, dearborn [sodium hydroxide, ethylene-diaminetetraacetic acetate (EDTA), Tetra-sodium], lead, mercury, polyquest 683 (potassium hydroxide), and sulfuric acid.

Airborne Effluents

Flue gas from the boilers is normally routed through the baghouses to remove soot and fly ash from the flue gas. Flue gas from any boiler or any combination of boilers can be directed through ducting and dampers to any or all baghouses and then on to either or both stacks. The bags are periodically shaken to remove ash and soot buildup. The ash and soot are then removed from collection hoppers by use of the HVAC system and sent to the ash disposal basin. The air emissions are all regulated under the *Clean Air Act* and are routinely monitored for opacity. Source testing for NO_x and SO₂ is performed every 2 years.

Liquid Effluents

Liquid discharges include water softener regeneration solution, cooling water, and liquid from floor drains and boiler blowdown; all are routinely sampled. All streams are nonregulated.

FEMP Determination

A FEMP is required for the 284-E and 284-W Powerplants because of the potential for airborne effluents in the form of fugitive dust from the ash disposal basin to exceed reportable quantities (RQ) of hazardous materials. A FEMP document has been prepared, WHC-EP-0472-1, Rev 1, *Facility Effluent Monitoring Plan for the 284-E and 284-W Power Plants*, issued November 1992.

T Plant

T Plant is located in the 200-West Area of the Hanford Site. Its original mission was to extract plutonium for use in nuclear weapons; however, that was changed in 1957 to decontamination processes. The major components of T Plant include 221-T, 2706-T, 221-T Head End, 214-T, 271-T, 291-T, 221-TA, and 211-T. Potential radionuclide effluents include ^{90}Sr , ^{137}Cs , ^{239}Pu , and ^{241}Am . A hazardous chemical inventory performed in May of 1994 includes only two chemicals, potassium permanganate and sodium. Neither chemical has the potential to reach the environment through the canyon exhaust stacks.

Airborne Effluents

Airborne effluent streams at T Plant include the 291-T-1 Main Stack, 296-T-13 Roof Stack, and the 296-T-7 Stack. The 291-T-1 Main Stack and 296-T-13 Roof Stack were originally determined to require monitoring based on the FEMP determination document. These stacks were reassessed by the Nondestructive Assessment (NDA) method and were determined to not have the potential to exceed 0.1 mrem/yr dose to the MEI. Because these stacks are undesignated and do not meet the EPA criteria for continuous monitoring, they are record sampled only. The 296-T-7 Stack does not meet the criteria for which record sampling is required; instead, periodic confirmatory measurements are taken to assess the status of the emissions.

Liquid Effluents

The liquid effluent streams at T Plant include the 216-T-4 Chemical Sewer and Pond, T Plant Aqueous Waste Transfer Stream, and 216-T-1 Ditch, all of which are routinely sampled. Based on an evaluation of normal and upset operating conditions, there is no potential to exceed the reportable quantities for hazardous or radioactive contaminants. Therefore, continuous monitoring is not required for any of the liquid waste streams at T Plant.

FEMP Determination

A FEMP was originally required for T Plant because of the potential for liquid effluents from the 216-T-4 Chemical Sewer to exceed the RQ for hazardous materials. A FEMP Redetermination document, WHC-EP-0440, Rev 0-A, *Facility Effluent Monitoring Plan Determination for the T Plant*, was issued in May 1994. It was determined that a FEMP is not required for any of the radioactive or nonradioactive air and liquid waste streams at T Plant.

2724-W Protective Equipment Decontamination Facility (Laundry)

The 2724-W Protective Equipment Decontamination Facility has been demolished. The area will be turned over to BHI in January 1995.

Gaseous Effluents

All stacks have been dismantled and removed.

Liquid Effluents

No liquids are being discharged.

FEMP Determination

A FEMP was originally required for this facility because of the potential for radionuclides in liquid effluents to exceed the Drinking Water Standard of 4 mrem/yr. A FEMP document has been prepared, WHC-EP-0471-1, Rev 1, *Facility Effluent Monitoring Plan for the 2724-W Protective Equipment Decontamination Facility*, issued December 1992. As this facility no longer exists, a FEMP is no longer needed.

UO₃ Plant

The UO₃ Plant is located in the 200-West Area of the Hanford Site and consists of two primary processing buildings (224-U and 224-UA) and several ancillary facilities. The purpose of the plant was to receive uranyl nitrate hexahydrate (UNH) from PUREX, concentrate it, convert the UNH to uranium trioxide (UO₃) powder, and package it for offsite shipment. The plant is in shutdown mode in transition to becoming a surplus facility. The facility is scheduled to be turned over to BHI in January 1995 for decontamination and decommissioning.

Airborne Effluents

Of the three registered stacks, only one (the 296-U-4 Main Stack) is still active and has a real-time monitor. It and the 17 unregistered roof exhausters have been assessed for the potential to exceed 0.1-mrem/yr EDE to the MEI. Dose calculations do not indicate a FEMP is required for any airborne emission. Periodic confirmatory measurements (i.e., radiological surveys and near-facility monitoring in conjunction with operational environmental monitoring), will be taken to verify the emissions.

Liquid Effluents

There will be no wastewater discharge streams from the UO₃ Plant after the transition to the shutdown mode is complete. The Process Condensate Stream, which used to discharge to the 216-U-17 Crib, has been eliminated and physically blanked off. The UO₃/U Plant wastewater stream, which discharges to the 207-U Basin and subsequently to the 216-U-14 Ditch, is in the process of being eliminated. Stormwater runoff will continue to be routed to the 207-U Retention Basin, which will be isolated from the ditch and used as an evaporation basin.

FEMP Determination

A FEMP was required for the UO₃ Plant because of the potential (during upset conditions) for liquid effluents from the wastewater and process condensate streams to exceed the RQ for hazardous materials. A FEMP document has been prepared, WHC-EP-0470-1, Rev 1, *Facility Effluent Monitoring Plan for the Uranium Trioxide Facility*, issued November 1993. A FEMP redetermination is in process.

Plutonium Finishing Plant

The Plutonium Finishing Plant (PFP) is located in the 200-West Area of the Hanford Site. The complex consists of one primary processing facility and several ancillary facilities. The process and support buildings include 234-5Z, 236-Z, 231-Z, 232-Z, 241-Z, 242-Z, 243-Z, 270-Z, 291-Z, 2736-Z, 2736-ZA, and 2736-ZB. Hazardous material inventories include acetone, carbon tetrachloride, oxides of nitrogen, hydrogen chloride, hydrochloric acid, and nitric acid. Radionuclide inventories include ^{90}Sr , ^{137}Cs , ^{238}Pu , ^{239}Pu , ^{241}Pu , and ^{241}Am .

Airborne Effluents

One PFP complex gaseous effluent stream, the 291-Z-1 Main Stack, which has a real-time monitor, was determined to require a FEMP based on the calculated EDE exceeding 0.1 mrem/yr.

Liquid Effluents

One PFP complex liquid effluent stream, the 216-Z-20 Crib, was determined to require a FEMP because radionuclide constituents are being discharged in the liquid effluent stream.

FEMP Determination

A FEMP is required for the PFP because of the potential for radionuclides in airborne effluents from the 291-Z-1 Main Stack to exceed 0.1 mrem/yr exposure to the MEI. A FEMP document has been prepared, WHC-EP-0476-1, Rev 1, *Facility Effluent Monitoring Plan for the Plutonium Finishing Plant*, issued November 1993.

222-S Laboratory

The 222-S Laboratory complex is located in the 200-West Area of the Hanford Site. The laboratory complex provides analytical and radiological chemistry services for Hanford Site. The principal components include the 222-S Main Laboratory, 222-SA Laboratory (nonradioactive standards and "cold" process development), 2716-S Storage Facility, 222-S Annex, 207-SL Retention Basin, 219-S Waste Handling Facility, 222-SD Solid Waste Handling and Storage System, 222-SC Filter Building, 222-SB Filter Building, 218-W-7 Dry Waste Burial Vault, and 216-S-26 Crib. Because of the nature of the laboratory complex, the inventories of both radionuclides and hazardous materials are extensive.

Airborne Effluents

Calculations and real-time monitoring show no gaseous effluent streams that would exceed EPA standards.

Liquid Effluents

Three liquid effluent streams, all of which have real-time monitors, were identified as requiring a FEMP based on their potential for releasing hazardous waste under upset conditions. The facilities from which these streams originate include the 207-SL Retention Basin (part of 222-S), 222-SA Laboratory, and 219-S Waste Handling Facility.

FEMP Determination

A FEMP is required for the 222-S Laboratory because of the potential, during upset conditions, for liquid effluents from each of the three streams to exceed the RQ for hazardous materials. A FEMP document has been prepared, WHC-EP-0480-1, Rev 1, *Facility Effluent Monitoring Plan for the 222-S Laboratory*, issued November 1992. Revision 2 of the document is currently in progress and will be released before November 1994.

313 and 333 Fuels Fabrication Facilities

The 313 Building (N Fuels Fabrication Support Facility) houses the uranium laboratory, copper casting, waste-acid treatment facility, extrusion press, engineering development laboratory, training rooms, and staff offices. The building was used from 1944 to 1971 for fabricating uranium fuel elements for the eight retired, single-pass reactors in the 100 Areas. The function of the building changed when those reactors ceased operating. The building then was used as an N Fuels Fabrication Support Facility to treat uranium-bearing acid in the waste-acid treatment system. The recovered uranium sludge was recycled to form new uranium billets at Fernald, Ohio.

The waste-acid treatment is still active in treating uranium-bearing clean-up solutions in preparation for Resource Conservation and Recovery Act (RCRA) closure of the waste-acid treatment system. Engineering development laboratory work was terminated in 1991.

The primary N Reactor Fuels Fabrication activities were conducted in the 333 Building. The fuel fabrication operation produced N Reactor fuel from 1961 until 1987 when operations were stopped. The facility used a variety of mechanical, chemical, and electrical processes to convert uranium billets and assorted components into finished fuel assemblies for irradiation at N Reactor.

Airborne Effluents

There are no sources of powered airborne exhaust/ventilation in the WHC-managed portion of the 313 Facility. Continuous monitoring of airborne effluents were terminated in 1991.

Operations and resulting radionuclide air emissions in the 333 Building ceased in January 1987. Emission monitoring equipment was shut down at that time.

Liquid Effluents

Process liquid effluents are not discharged from the 313 Building. However, stormwater is discharged to the 300 Area Process Sewer system.

Process liquid effluents are not discharged from the 333 Building. However, steam condensate water, air conditioning water, and stormwater are discharged to the 300 Area Process Sewer (PS) system.

FEMP Determination

A FEMP redetermination showed that a FEMP is no longer needed for either facility.

340 Complex

The 340 Complex is located in the 300 Area, near the Columbia River. The complex was constructed and continues to collect, store, and transport radioactive liquid wastes. Buildings that can discharge waste directly into the 340 Complex include 324, 325, 326, 327, and 329. Wastes from other facilities can be transferred to the complex via 55-gal drums, carboys, or other containers to a floor sump in the 340 Building. Two waste streams are managed by the 340 Complex, the Radioactive Liquid Waste System (RLWS) and the Retention Process Sewer (RPS). Inventories of both radionuclides and hazardous materials are extensive and are itemized in the FEMP.

Airborne Effluents

The RLWS, which has real-time monitors, has the potential to release gaseous/particulate radioactive contaminants to the atmosphere. The RLWS receives wastes from several sources and stores the wastes in one of the two below ground 15,000-gal storage tanks. The stored waste is then transported quarterly to the 204-AR Unloading Facility in the 200-East Area for long-term storage/disposal.

Liquid Effluents

The RPS receives potentially radioactive liquid effluents and is discussed in the 340 Waste Handling Facility FEMP. The RPS liquid effluents are monitored for gross beta and gamma radiation with real-time monitoring instruments. If radiation is not detected, the waste stream is disposed to the soil column via an unlined trench. The disposal to the soil column will be eliminated by January 1995, and the waste stream will be diverted to the 300 Area TEDF. If radiation is detected, the waste stream is diverted to the RLWS.

FEMP Determination

A FEMP is required for the 340 Complex because of the potential for radionuclides in airborne emissions from the 340 Complex stacks to exceed 0.1 mrem/yr exposure to the MEI. A FEMP document has been prepared, WHC-EP-0469-1, Rev 1, *Facility Effluent Monitoring Plan for the 340 Waste Handling Facility*, issued November 1992.

Fast Flux Test Facility

The Fast Flux Test Facility (FFTF) is a 400-MW thermal sodium-cooled neutron flux reactor plant, designed specifically for irradiation testing of nuclear reactor fuels and materials for liquid metal fast breeder reactors. It is located in the 400 Area on the Hanford Site. The FFTF is a complex of buildings and equipment arranged around a reactor containment building. Radionuclide inventories of primary interest include tritium, ^{41}Ar , and ^{137}Cs . Hazardous materials inventories include sodium, PCBs, sulfuric acid, potassium hydroxide, freon, benzene, and ethylene glycol. The facility has been placed in transition to shutdown mode.

Airborne Effluents

The FFTF radioactive airborne emission source term includes ^{22}Na , ^3H , ^{54}Mn , ^{134}Cs , and ^{41}Ar . Airborne emission monitoring consists of a record gross alpha/beta particulate sampler, a continuous tritium monitor, a noble gas monitor, and an ^{131}I record sampler.

Liquid Effluents

There is no potential for release of liquid effluents in excess of EPA standards at this facility. The PS liquid effluents are continuously monitored for pH and composite sampling is performed for chemical constituents and gross alpha/beta activity.

FEMP Determination

A FEMP was originally required for the FFTF because of the potential for ^{41}Ar in airborne emissions from the radioactive argon processing system to exceed 0.1 mrem/yr exposure to the MEL. A FEMP document has been prepared, WHC-EP-0475-1, Rev 1, *Facility Effluent Monitoring Plan for the Fast Flux Test Facility*, issued November 1992. A redetermination is in process to determine the further need for a FEMP.

324 Facility

The 324 Facility in the 300 Area primarily supports the research and development of radioactive and nonradioactive waste vitrification technologies (i.e., ceramic melters, in situ vitrification [ISV], and Hanford Waste Vitrification Program design support), biological waste remediation technologies, spent nuclear fuel studies, waste mixing and transport studies, and tritium development programs. All of the above-mentioned programs deal with and have the potential to release hazardous and/or radioactive material. The potential for discharge would primarily result from 1) conduct of research activities using the hazardous materials, 2) storage of radionuclides and hazardous chemicals, 3) archive storage of programmatic samples, and 4) waste accumulation and storage. The following summarizes the airborne and liquid effluents and the results of the FEMP determination for the facility. The complete monitoring plan is contained in PNL-MA-660 and includes characterization of effluent streams, monitoring/sampling design criteria, a description of the monitoring systems and sample analysis, and QA requirements.

Airborne Effluents

Potential radioactive airborne effluents in the 324 Facility have been characterized, and all airborne release pathways have been verified. Stack monitors (samplers) were upgraded to meet 40 CFR 61 criteria. The primary stack at the 324 Facility (EP-324-01-S) is currently registered with the WDOH as required by WAC 246-247. Nonradioactive airborne effluents have not been characterized, but characterization efforts are planned and will proceed in the course of compliance with state air toxics regulations and as the *Clean Air Act Amendments* are fully implemented.

Liquid Effluents

The 324 Facility discharges to four sewer systems (radioactive liquid waste system [RLWS], retention process sewer [RPS], PS, and sanitary sewer [SS]). Liquid effluent releases in the 324 Facility are either administratively or physically controlled. Most connections to the PS that have the potential to release regulated effluent have been plugged. Floor and sump drains have been modified with stand pipes to prevent uncontrolled discharge. The remaining drains have been posted with labels stating the type of drain and liquid effluent disposal controls. These are primarily laboratory sink and hood drains. Selected floor drains in facility service tunnels that must remain open in case of main service line leaks or ruptures are also posted to control liquid effluent disposal. Verification of RLWS, RPS, and PS liquid effluent lines in the 324 Facility is proceeding as part of an ongoing program. Liquid effluent lines from the facility enter into the 300 Area liquid effluent system operated by WHC. WHC monitors effluents that are released into the environment and operates the 340 Complex, which transports RLWS to the 200 Area tank farms.

A sampling program for liquid effluents from the 324 Facility is under way. Liquid effluent monitoring equipment is being installed and includes a flow-proportional liquid sampler, on-line pH meter, and conductivity meter. Sampling of the liquid effluents will commence when the samplers are installed.

FEMP Determination

An inventory-based method was used to estimate the maximum potential offsite dose if airborne releases from the facility were unmitigated. The projected unmitigated dose met criteria (> 0.1 mrem/yr) for preparing a FEMP. A list of chemicals in the building was also obtained and chemicals in greater than reportable quantities were identified to characterize the potential for emissions of nonradioactive hazardous materials. A FEMP document has been prepared, PNL-MA-660, *Facility Monitoring Plan for the 324 Facility*, issued November 1991.

325 Building

The Applied Chemistry Laboratory (325 Building) houses radiochemistry research, radioanalytical service, radiochemical process development, and hazardous and mixed hazardous waste treatment activities. The laboratories and specialized facilities enable work ranging from that with nonradioactive materials to work with picogram to kilogram quantities of fissionable materials and up to megacurie quantities of other radionuclides. The special facilities include two shielded hot cell areas that provide for process development or analytical chemistry work with highly radioactive materials, and a waste treatment facility for processing hazardous, mixed, low-level, and TRU wastes generated by PNL.

Radioactive material storage and usage occur throughout the facility and include a large number of isotopes. This material is in several forms, including solid, liquid, particulate, and gas. Some of these materials are also heated during testing. The research activities have been assigned to the following activity designations: High-Level Hot Cell, Waste Packaging Facility, Waste Form Development, Special Testing Projects, Chemical Process Development, Analytical Hot Cell, and Analytical Chemistry. The following summarizes the airborne and liquid effluents and the results of the FEMP determination for the facility. The complete monitoring plan is contained in PNL-MA-661 and includes characterization of effluent streams, monitoring/sampling design criteria, a description of the monitoring systems and sample analysis, and QA requirements.

Airborne Effluents

Potential radioactive airborne effluents in the 325 Building have been characterized, and all airborne release pathways have been verified. Stack monitors (samplers) were upgraded to meet 40 CFR 61 criteria. The primary stack at the 325 Building (EP-325-01-S) is currently registered with the Washington State Department of Health (WDOH) as required by WAC 246-247. Nonradioactive airborne effluents have not been characterized, but characterization efforts are planned and will proceed in the course of compliance with state air toxics regulations and as the *Clean Air Act Amendments* are fully implemented.

Liquid Effluents

Liquid effluent release pathways in the 325 Building are either administratively or physically controlled. Most connections to the PS that have the potential to release regulated effluent have been plugged. The remaining drains have been posted with labels stating the type of drain and liquid effluent disposal controls. These are primarily laboratory sink and hood drains.

The 325 Building has three liquid effluent systems (RPS, RLWS, and SS). Because of the age of the facility and out-of-date drawings, some lines were found to be labeled (and used) inappropriately during liquid effluent line verification. Modifications were completed as soon as the lines were correctly identified. Liquid effluent lines from the facility enter into the 300 Area liquid effluent system operated by WHC. WHC monitors effluents that are released into the environment and operates the 340 Complex, which transports RLWS to the 200 Area tanks farms.

A sampling program for liquid effluents from the 325 Building is under way. Liquid effluent monitoring equipment is being installed and includes a flow-proportional liquid sampler, on-line pH meter, and conductivity meter. Sampling of the liquid effluents will commence when the samplers are installed.

FEMP Determination

An inventory-based method was used to estimate the maximum potential offsite dose if airborne releases from the building were unmitigated. The projected unmitigated dose met criteria (> 0.1 mrem/yr) for preparing a FEMP. A list of chemicals in the building was also obtained and chemicals in greater than reportable quantities were identified to characterize the potential for emissions of nonradioactive hazardous materials. A FEMP document has been prepared, PNL-MA-661, *Facility Monitoring Plan for the 325 Building*, issued November 1991.

327 Facility

The 327 Facility provides office and laboratory space for PNL scientific and engineering staff conducting multidisciplinary research in the areas of postirradiated fuels and structural materials. The building is designed to accommodate the use of radioactive and hazardous materials in the conduct of these activities. The following summarizes the airborne and liquid effluents and the results of the FEMP determination for the facility. The complete monitoring plan is contained in PNL-MA-662 and includes characterization of effluent streams, monitoring/sampling design criteria, a description of the monitoring systems and sample analysis, and QA requirements.

Airborne Effluents

Potential radioactive airborne effluents in the 327 Facility have been characterized, and all airborne release pathways have been verified. Stack monitors (samplers) were upgraded to meet 40 CFR 61 criteria. Two stacks at the 327 Facility (EP-327-01-S and EP-327-02V) are currently registered with the WDOH as required by WAC 246-247. Nonradioactive airborne effluents have not been characterized, but characterization efforts are planned and will proceed in the course of compliance with state air toxic regulations and as the *Clean Air Act Amendments* are fully implemented.

Liquid Effluents

The 327 Facility discharges access to four sewer systems (RLWS, RPS, PS, and SS). Liquid effluent releases in the 327 Facility are either administratively or physically controlled. Most connections to the PS that have the potential to release regulated effluent have been plugged. Floor and sump drains have been modified with stand pipes to prevent uncontrolled discharge. The remaining drains have been posted with labels identifying the type of drain and liquid effluent disposal instructions. These are primarily laboratory sink and hood drains. Selective floor drains in facility service tunnels that must remain open in case of main service line leaks or ruptures are also posted to control disposal of liquid effluents. Verification of the RLWS, RPS, and PS liquid effluent lines is nearing completion.

Liquid effluent lines from the facility enter into the 300 Area liquid effluent system operated by WHC. The RPS, PS, and SS are monitored by WHC before release to the environment. The RLWS is not released to the environment, but is transferred to the 340 Complex operated by WHC and then to the 200 Area tank farms. A program to characterize liquid effluents from the 327 Facility is under way. Liquid effluent monitoring equipment is being installed and includes a flow-proportional liquid sampler, on-line pH meter, and conductivity meter. Sampling the liquid effluents will commence when the samplers are installed.

FEMP Determination

An inventory-based method was used to estimate the maximum potential offsite dose if airborne releases from the building were unmitigated. The projected unmitigated dose met criteria (> 0.1 mrem/yr) for preparing a FEMP. A list of chemicals in the building was also obtained and chemicals in greater than reportable quantities were identified to characterize the potential for emissions of nonradioactive hazardous materials.

3720 Facility

The Materials Science Laboratory (3720 Facility) provides office and laboratory space for PNL scientific and engineering staff conducting multidisciplinary research in the areas of materials characterization and testing and waste management. The facility is designed to accommodate the use of radioactive and hazardous materials in the conduct of these activities.

Chemical storage and usage are well dispersed throughout the facility and consist of bulk materials (solvents, acids/bases), specimen materials used in materials characterization (e.g., beryllium alloys), substrate materials used in the conduct of laboratory experiments (e.g., chelating agents, nitrate, chromium and arsenic salts, inorganic oxides), and standards used for instrument calibration. A number of environmental or fabricated materials (i.e., grouts, coal, asphalts) are used in the conduct of leaching experiments or materials testing activities. The following summarizes the airborne and liquid effluents and the results of the FEMP determination for the facility. The complete monitoring plan is contained in PNL-MA-662 and includes characterization of effluent streams, monitoring/ sampling design criteria, a description of the monitoring systems and sample analysis, and QA requirements.

Airborne Effluents

Potential radioactive airborne effluents in the 3720 Facility have been characterized, and all airborne release pathways have been verified. Stack monitors (samplers) were upgraded to meet 40 CFR 61 criteria. The primary stack at the 3720 Facility (EP-3720-01-S) is currently registered with the WDOH as required by WAC 246-247. Nonradioactive airborne effluents have not been characterized, but characterization efforts are planned and will proceed in the course of compliance with state air toxic regulations and as the *Clean Air Act Amendments* are fully implemented.

Liquid Effluents

The 3720 Facility discharges to two sewer systems (PS and SS). Liquid effluent releases in the 3720 Facility are either administratively or physically controlled. Most connections to the PS that had the potential to release regulated effluent have been plugged. The remaining drains have been posted with labels stating the type of drain and liquid effluent disposal controls. These are primarily laboratory sink and hood drains. Verification of the PS lines in the facility is planned as part of an ongoing program to verify liquid effluent lines in major PNL facilities in the 300 Area.

Liquid effluent lines from the facility enter into the 300 Area liquid effluent system operated by WHC. The PS and SS are monitored by WHC before release to the environment. A program to characterize liquid effluents from the 3720 Facility is under way. Liquid effluent monitoring instruments are being installed and include a flow-proportional liquid sampler, on-line pH meter, and conductivity meter. Sampling of the liquid effluents will commence when the samplers are fully operational.

FEMP Determination

An inventory-based method was used to estimate the maximum potential offsite dose if airborne releases from the building were unmitigated. The projected unmitigated dose met criteria (> 0.1 mrem/yr) for preparing a FEMP. A list of chemicals in the building was also obtained and chemicals in greater than reportable quantities were identified to characterize the potential for emissions of nonradioactive hazardous materials. A FEMP has been prepared, PNL-MA-663, *Facility Monitoring Plan for the 3720 Building*, issued November 1991.

Potential Unmitigated Doses From Hanford Facilities

Table II.A-4 contains the source terms and potential radiation doses from airborne releases from WHC and BHI facilities. These dose calculations were used to determine whether the potential airborne releases could cause a radiation dose in excess of 0.1 mrem/yr to an MEI. A FEMP is needed for any facility that exceeds this dose level. For WHC and BHI facilities, the table includes the number of curies of each radionuclide released, the assessment method used, the dose factor from the CAP88, the treatment or release factor, and the potential dose in mrem/yr calculated by the CAP88 code. For PNL facilities, the potential dose for each facility is listed in Table II.A-5, calculated from a comprehensive inventory of radionuclides (PNL-10061 describes the method used).

The following decontamination treatment factors were used in Table II.A-4: HEPA filter efficiency is 99.97%, decontamination factor is 3000^n , where n = the number of stages in series; HEPA pre-filter efficiency is 80%, decontamination factor is 5; charcoal efficiency is 95%, decontamination factor is 20; and sand filter efficiency is 99.8%, decontamination factor is 500. Appendix D calculations (Davis and Barnett 1994a, 1994b) used release factors of 1.0 for gases, 0.001 for liquids, and 0.000001 for solids. CAP88 factors were taken from WHC-EP-0498. Since the NESHAPs compliance assessment for the registered stacks (Davis and Barnett 1994a) was due in December 1993, the data for the annual releases for 1992 were used to complete the assessments. The unregistered stack assessments (Davis and Barnett 1994b) were due in August 1994, but 1992 annual releases were used to establish a baseline and maintain consistency.

Table II.A-4. Dose Calculations for Hanford Potential Unmitigated Airborne Discharges Used in FEMP Determinations for WHC and BHI Facilities.

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ⁿ	Alternate
<u>Westinghouse Hanford Company</u>							
<u>PUREX</u>							
291-A-1*			(3000) ⁿ				
	90-Sr	3.3E-04		1.20E-02	2.7E+10	1.1E+05	
	129-I	2.7E-02		1.84E-01	1.0E+00	5.0E-03	
	137-Cs	1.6E-03		6.54E-03	2.7E+10	2.8E+05	
	147-Pm	1.7E-04		3.11E-04	2.7E+10	1.4E+03	
	212-Pb	2.7E-03		9.42E-04	2.7E+10	6.9E+04	
	220-Rn	3.4E+01		6.42E-21	1.0E+00	0.0E+00	
	238-Pu	1.3E-05		2.19E+00	2.7E+10	7.7E+05	
	239/240-Pu	2.2E-05		2.37E+00	2.7E+10	1.4E+06	
	241-Pu	4.7E-04		3.76E-02	2.7E+10	4.8E+05	
	241-Am	1.3E-04		3.59E+00	2.7E+10	1.3E+07	
					Total	1.6E+07	
296-A-1*			(3000) ⁿ				
	239/240-Pu	1.0E-06		2.37E+00	2.7E+10	6.4E+04	
	241-Pu	7.1E-06		3.76E-02	2.7E+10	7.2E+03	
	241-Am	3.5E-07		3.59E+00	2.7E+10	3.4E+04	
	Gr. Beta	<2.4E-06		1.20E-02	2.7E+10	<7.8E+02	
					Total	1.1E+05	
296-A-2*			(3000) ⁿ				
	Gr. Alpha	<3.1E-07		2.37E+00	3.0E+03	<2.2E-03	
	Gr. Beta	<2.4E-06		1.20E-02	3.0E+03	<8.6E-05	
					Total	<2.3E-03	

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ⁿ	Alternate
296-A-3*			(3000) ⁿ				
	Gr. Alpha	<1.8E-07		2.37E+00	3.0E+03	<1.3E-03	
	Gr. Beta	<1.4E-06		1.20E-02	3.0E+03	<5.0E-05	
					Total	<1.4E-03	
296-A-5A			(3000) ⁿ & App. D				
	239/240-Pu	6.4E-07		8.67E+00	3.0E+03	1.7E-02	
	Gr. Beta	<1.4E-05		4.38E-02	3.0E+03	<1.8E-03	
					Total	1.9E-02	
296-A-5B			(3000) ⁿ & App. D				
	239/240-Pu	6.4E-07		8.67E+00	3.0E+03	1.7E-02	
	Gr. Beta	<1.4E-05		4.38E-02	3.0E+03	<1.8E-03	
					Total	1.8E-04	
296-A-6*			(3000) ⁿ				
	Gr. Alpha	<1.0E-06		2.37E+00	3.0E+03	<7.1E-03	
	Gr. Beta	<8.0E-06		1.20E-02	3.0E+03	<2.9E-04	
					Total	<7.4E-03	
296-A-7*			(3000) ⁿ				
	Gr. Alpha	<1.4E-06		2.37E+00	3.0E+03	<1.0E-02	
	Gr. Beta	<1.1E-05		1.20E-02	3.0E+03	<4.0E-04	
					Total	<1.0E-02	
296-A-8*			(3000) ⁿ				
	Gr. Alpha	<7.0E-07		2.37E+00	3.0E+03	<5.0E-03	
	Gr. Beta	<5.6E-06		1.20E-02	3.0E+03	<2.0E-04	
					Total	<5.2E-03	
296-A-10			(3000) ⁿ				
	Gr. Alpha	<4.3E-07		8.67E+00	3.0E+03	<1.1E-02	
	Gr. Beta	<3.3E-06		4.38E-02	3.0E+03	<4.3E-04	
					Total	<1.1E-02	
296-A-14			(3000) ⁿ				
	Gr. Alpha	<3.6E-07		8.67E+00	3.0E+03	<9.4E-03	
	Gr. Beta	<2.8E-06		4.38E-02	3.0E+03	<3.7E-04	
					Total	<9.8E-03	
						PUREX Total	1.6E+07
B Plant							
291-B-1*			(3000) ⁿ				
	90-Sr	2.2E-05		1.20E-02	9.0E+06	2.4E+00	
	137-Cs	5.3E-04		6.54E-03	9.0E+06	3.1E+01	
	239/240-Pu	3.1E-06		2.37E+00	9.0E+06	6.6E+01	
					Total	9.9E+01	
296-B-5			(3000) ⁿ				
	Gr. Alpha	<3.6E-08		8.67E+00	3.0E+03	<9.4E-04	
	Gr. Beta	<3.4E-07		4.38E-02	3.0E+03	<4.5E-05	
					Total	<9.9E-04	
296-B-10*†			Appendix D				
	90-Sr	3.0E+04		1.20E-02	1.0E-06		3.6E-04
	137-Cs	4.3E+03		6.54E-03	1.0E-06		2.8E-05
						Total	3.9E-04

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ⁿ	Alternate
296-B-12			Appendix D				
	90-Sr	3.0E+04		4.38E-02	1.0E-06		1.3E-03
	137-Cs	4.3E+03		2.39E-02	1.0E-06		1.0E-04
						Total	1.4E-03
296-B-13			NDA				
	137-Cs	2.0E-06		2.39E-02			4.8E-08
						Total	4.8E-08
296-B-22			Upstream				
	Gr. Alpha	4.0E-06		8.67E+00			3.5E-05
	Gr. Beta	1.3E-05		4.38E-02			5.7E-07
						Total	3.6E-05
296-B-23			Upstream				
	Gr. Alpha	7.8E-06		8.67E+00			6.8E-05
	Gr. Beta	3.7E-05		4.38E-02			1.6E-06
						Total	7.0E-05
296-B-24			Upstream				
	Gr. Alpha	1.1E-05		8.67E+00			9.5E-05
	Gr. Beta	4.1E-05		4.38E-02			1.8E-06
						Total	9.7E-05
296-B-25			Upstream				
	Gr. Alpha	3.5E-06		8.67E+00			3.0E-05
	Gr. Beta	2.0E-05		4.38E-02			8.7E-07
						Total	3.1E-05
296-B-26			Upstream				
	Gr. Alpha	5.1E-06		8.67E+00			4.4E-05
	Gr. Beta	1.6E-05		4.38E-02			7.0E-07
						Total	4.5E-05
296-B-27			Upstream				
	Gr. Alpha	8.1E-06		8.67E+00			7.0E-05
	Gr. Beta	3.3E-05		4.38E-02			1.4E-06
						Total	7.1E-05
						B Plant Total	9.9E+01
Grout Facility							
296-G-1			NDA				
	54-Mn	1.8E-07		5.51E-03			9.9E-10
	60-Co	8.6E-07		2.90E-02			2.5E-08
	137-Cs	3.5E-07		2.39E-02			8.4E-09
						Total	3.4E-08
						Grout Total	3.4E-08
242-A Evaporator							
296-A-21			Appendix D				
	90-Sr	9.5E-03		4.38E-02	1.0E-03		4.2E-07
	90-Y	9.5E-03		3.77E-04	1.0E-03		3.6E-09
	241-Am	1.9E-04		1.31E+01	1.0E-03		2.5E-06
						Total	2.9E-06
296-A-22*†			Appendix D				
	90-Sr	2.8E+04		1.20E-02	1.0E-03		3.4E-01
	106-Ru/Rh	2.0E+03		5.71E-03	1.0E+00		1.1E+01
	137-Cs	1.9E+05		6.54E-03	1.0E-03		1.2E+00
	241-Am	1.3E+02		3.59E+00	1.0E-03		4.7E-01
						Total	1.3E+01
						242-A Evaporator Total	1.3E+01

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ^a	Alternate
200 Area Tank Farm Stack and Vent Emissions							
296-A-12*†			Appendix D				
	90-Sr	1.2E+03		1.20E-02	1.0E-03		1.4E-02
	137-Cs	9.5E+02		6.54E-03	1.0E-03		6.2E-03
	239/240-Pu	1.4E-01		2.37E+00	1.0E-03		3.3E-04
	241-Am	1.6E+00		3.59E+00	1.0E-03		5.7E-03
						Total	2.6E-02
296-A-13*†			Appendix D				
	90-Sr	1.1E-02		1.20E-02	1.0E-03		1.3E-07
	241-Am	2.1E-02		3.59E+00	1.0E-03		7.5E-05
						Total	7.5E-05
296-A-17			Appendix D				
	90-Sr	4.0E+04		4.38E-02	1.0E-03		1.8E+00
	137-Cs	9.2E+06		2.39E-02	1.0E-03		2.2E+02
	241-Am	1.5E+02		1.31E+01	1.0E-03		2.0E+00
						Total	2.2E+02
296-A-18			Appendix D				
	Zero Source	0.0E+00				Total	0.0E+00
296-A-19			Appendix D				
	Zero Source	0.0E+00				Total	0.0E+00
296-A-20			Appendix D				
	Zero Source	0.0E+00				Total	0.0E+00
296-A-25			Appendix D				
	137-Cs	1.7E+05		2.39E-02	1.0E-03		4.1E+00
	154-Eu	7.7E+02		4.38E-02	1.0E-03		3.4E-02
	238-Pu	7.8E+00		8.02E+00	1.0E-03		6.3E-02
	239/240-Pu	1.5E+02		8.67E+00	1.0E-03		1.3E+00
	241-Pu	3.2E+02		1.38E-01	1.0E-03		4.4E-02
	241-Am	1.2E+01		1.31E+01	1.0E-03		1.6E-01
						Total	5.7E+00
296-A-26			Appendix D				
	90-Sr	5.0E-03		4.38E-02	1.0E-03		2.2E-07
	90-Y	5.0E-03		3.77E-04	1.0E-03		1.9E-09
	241-Am	1.0E-04		1.31E+01	1.0E-03		1.3E-06
						Total	1.5E-06
296-A-27			Appendix D				
	90-Sr	1.6E+05		4.38E-02	1.0E-03		7.0E+00
	137-Cs	5.2E+06		2.39E-02	1.0E-03		1.2E+02
	241-Am	1.2E+03		1.31E+01	1.0E-03		1.6E+01
						Total	1.4E+02
296-A-28			Appendix D				
	Zero Source	0.00E+00				Total	0.0E+00
296-A-29			Appendix D				
	90-Sr	9.8E+05		4.38E-02	1.0E-03		4.3E+01
	137-Cs	9.4E+06		2.39E-02	1.0E-03		2.2E+02
	239/240-Pu	7.4E+02		8.67E+00	1.0E-03		6.4E+00
	241-Am	4.4E+04		1.31E+01	1.0E-03		5.8E+02
						Total	8.4E+02
296-A-30			Appendix D				
	Zero Source	0.0E+00				Total	0.0E+00

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ⁿ	Alternate
296-A-40			Appendix D				
	90-Sr	2.3E+01		4.38E-02	1.0E-03		1.0E-03
	129-I	2.7E-03		2.91E-01	1.0E+00		7.9E-04
	137-Cs	1.5E+01		2.39E-02	1.0E-03		3.6E-04
	237-Np	7.6E-02		1.19E+01	1.0E-03		9.0E-04
	239/240-Pu	7.1E-02		8.67E+00	1.0E-03		6.2E-04
	241-Am	5.7E+00		1.31E+01	1.0E-03		7.5E-02
	242/244Cm	1.2E-01		6.94E+00	1.0E-03		8.3E-04
						Total	8.0E-02
	(Radiological inventory data were available for 3 of the 8 tanks) Adjusted Total (Factor 8/3)						2.1E-01
296-A-41			Appendix D				
	Zero Source	0.0E+00				Total	0.0E+00
296-B-28			Appendix D				
	90-Sr	3.1E+01		4.38E-02	1.0E-03		1.4E-03
	137-Cs	2.0E+04		2.39E-02	1.0E-03		4.8E-01
						Total	4.8E-01
296-C-5			Appendix D				
	90-Sr	3.5E+06		4.38E-02	1.0E-03		1.5E+02
	90-Y	3.5E+06		3.77E-03	1.0E-03		1.3E+00
	137-Cs	1.2E+05		2.39E-02	1.0E-03		2.9E+00
	239/240-Pu	1.0E+03		8.67E+00	1.0E-03		8.9E+00
	241-Am	1.5E+03		1.31E+01	1.0E-03		2.0E+01
						Total	1.8E+02
296-P-16			Appendix D				
	90-Sr (a)	3.7E+02		4.38E-02	1.0E-03		1.6E-02
	90-Sr (b)	2.8E+06		4.38E-02	1.0E-06		1.2E-01
	129-I (c)	2.0E-01		2.91E+00	1.0E+00		5.8E-01
	137-Cs (a)	2.7E+04		2.39E-02	1.0E-03		6.5E-01
	137-Cs (b)	4.4E+05		2.39E-02	1.0E-06		1.1E-02
	238-U (b)	3.0E+03		2.84E+00	1.0E-06		8.5E-03
	239/240-Pu (a)	6.0E+01		8.67E+00	1.0E-03		5.2E-01
	239/240-Pu (b)	2.2E+04		8.67E+00	1.0E-06		1.9E-01
	241-Am (a)	1.1E+00		1.31E+01	1.0E-03		1.4E-02
	241-Am (b)	6.5E+03		1.31E+01	1.0E-06		8.5E-02
						Total	1.7E+00
296-P-17			Appendix D				
	90-Sr	3.8E+06		4.38E-02	1.0E-03		1.7E+02
	90-Y	3.8E+06		3.77E-04	1.0E-03		1.4E+00
	239/240-Pu	2.0E+03		8.67E+00	1.0E-03		1.7E+01
	241-Am	1.2E+03		1.31E+01	1.0E-03		1.6E+01
						Total	2.0E+02
296-P-22			Appendix D				
	Zero Source	0.0E+00				Total	0.0E+00
296-P-23			Appendix D				
	90-Sr	5.2E+03		2.60E-02	1.0E-03		1.4E-01
	137-Cs	7.3E+05		1.42E-02	1.0E-03		1.0E+01
						Total	1.0E+01
296-P-26			Appendix D				
	90-Sr	4.0E+04		4.38E-02	1.0E-03		1.8E+00
	137-Cs	9.2E+06		2.39E-02	1.0E-03		2.2E+02
	241-Am	1.5E+02		1.31E+01	1.0E-03		2.0E+00
						Total	2.2E+02

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ^a	Alternate
296-P-28			Appendix D				
	90-Sr	5.2E+03		2.60E-02	1.0E-03		1.4E-01
	137-Cs	7.3E+05		1.42E-02	1.0E-03		1.0E+01
						Total	1.0E+01
296-P-31			Appendix D				
	239/240-Pu	9.6E+01		8.67E+00	1.0E-06		8.3E-04
						Total	8.3E-04
296-S-15			Appendix D				
	90-Sr	6.7E+06		2.60E-02	1.0E-03		1.7E+02
	90-Y	6.7E+06		2.22E-04	1.0E-03		1.5E+00
	137-Cs	1.9E+06		1.42E-02	1.0E-03		2.7E+01
	239/240-Pu	2.3E+03		5.15E+00	1.0E-03		1.2E+01
	241-Am	7.0E+03		7.79E+00	1.0E-03		5.5E+01
						Total	2.7E+02
296-S-18			Appendix D				
	90-Sr	9.5E-03		2.60E-02	1.0E-03		2.5E-07
	241-Am	1.9E-04		7.79E+00	1.0E-03		1.5E-06
						Total	1.8E-06
296-S-22			Appendix D				
	90-Sr	2.7E+05		2.60E-02	1.0E-03		7.0E+00
	137-Cs	2.8E+05		1.42E-02	1.0E-03		4.0E+00
	239/240-Pu	6.9E+02		5.15E+00	1.0E-03		3.6E+00
						Total	1.5E+01
296-T-17			Appendix D				
	90-Sr	5.1E-03		2.60E-02	1.0E-03		1.3E-07
	241-Am	1.0E-04		7.79E+00	1.0E-03		7.8E-07
						Total	9.1E-07
296-T-18			Appendix D				
	90-Sr	4.6E+03		2.60E-02	1.0E-03		1.2E-01
	90-Y	4.6E+03		2.22E-04	1.0E-03		1.0E-03
	137-Cs	3.8E+03		1.42E-02	1.0E-03		5.4E-02
						Total	1.8E-01
296-U-11			Appendix D				
	90-Sr	3.5E+04		2.60E-02	1.0E-03		9.1E-01
	137-Cs	5.5E+04		1.42E-02	1.0E-03		7.8E-01
	238-Pu	2.0E+00		4.76E+00	1.0E-03		9.5E-03
	239/240-Pu	3.0E+01		5.15E+00	1.0E-03		1.5E-01
						Total	1.9E+00
						Tank Farm Total	2.2E+03
T Plant							
291-T-1*			NDA				
	90-Sr	1.6E-03		7.82E-03			1.3E-05
	137-Cs	1.7E-03		4.28E-03			7.3E-06
	239/240-Pu	2.1E-03		1.55E+00			3.3E-03
	241-Am	1.9E-04		2.35E+00			4.5E-04
						Total	3.8E-03
296-T-7			(3000) ^a				
	Gr. Beta	6.9E-07		2.60E-02	3.0E+03	5.4E-05	
					Total	5.4E-05	

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ⁿ	Alternate
296-T-13*			NDA				
	90-Sr	1.3E-04		7.82E-03			1.0E-06
	137-Cs	1.4E-04		4.28E-03			6.0E-07
	239/240-Pu	1.7E-04		1.55E+00			2.6E-04
	241-Am	1.5E-05		2.35E+00			3.5E-05
						Total	3.0E-04
						T Plant Total	4.0E-03
<u>UO₃ Plant</u>							
296-U-2*			(3000) ⁿ				
	Gr. Alpha	1.2E-07		5.70E+00	1.5E+04	1.0E-02	
	Gr. Beta	1.3E-07		7.82E-03	1.5E+04	1.5E-05	
					Total	1.0E-02	
295-U-4*			(3000) ⁿ				
	90-Sr	5.4E-08		7.82E-03	1.0E+00	4.2E-10	
	137-Cs	3.8E-07		4.28E-03	1.0E+00	1.6E-09	
	U, total	9.4E-07		5.70E+00	1.0E+00	5.4E-06	
	239/240-Pu	4.0E-08		1.55E+00	1.0E+00	6.2E-08	
					Total	5.5E-06	
296-U-13			(3000) ⁿ				
	Gr. Alpha	<2.1E-08		1.89E+00	1.5E+04	<6.0E-04	
	Gr. Beta	<1.7E-07		2.60E-02	1.5E+04	<6.6E-05	
					Total	<6.7E-04	
224-U-RE-1			Upstream				
	Gr. Alpha	0.0E+00		1.89E+00			0.0E-00
	Gr. Beta	7.8E-05		2.60E-02			2.0E-06
						Total	2.0E-06
224-U-RE-3			Upstream				
	Gr. Alpha	3.2E-06		1.89E+00			6.0E-06
	Gr. Beta	1.6E-05		2.60E-02			4.2E-07
						Total	6.4E-06
224-U-RE-4			Upstream				
	Gr. Alpha	3.2E-06		1.89E+00			6.0E-06
	Gr. Beta	1.6E-05		2.60E-02			4.2E-07
						Total	6.4E-06
224-U-RE-83			Upstream				
	Gr. Alpha	2.2E-06		1.89E+00			4.2E-06
	Gr. Beta	3.3E-05		2.60E-02			8.6E-07
						Total	5.1E-06
224-U-RE-84			Upstream				
	Gr. Alpha	0.0E+00		1.89E+00			0.0E+00
	Gr. Beta	4.5E-05		2.60E-02			1.2E-06
						Total	1.2E-06
224-U-RE-86			Upstream				
	Gr. Alpha	3.7E-06		1.89E+00			7.0E-06
	Gr. Beta	2.5E-05		2.60E-02			6.5E-07
						Total	7.7E-06
224-U-RE-87			Upstream				
	Gr. Alpha	7.5E-06		1.89E+00			1.4E-05
	Gr. Beta	1.9E-05		2.60E-02			4.9E-07
						Total	1.4E-05
224-U-RE-88			Upstream				
	Gr. Alpha	0.0E+00		1.89E+00			0.0E+00
	Gr. Beta	4.2E-05		2.60E-02			1.1E-06
						Total	1.1E-06

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ^a	Alternate
224-U-RE-91			Upstream				
	Gr. Alpha	2.3E-06		1.89E+00			4.3E-06
	Gr. Beta	4.9E-04		2.60E-02			1.3E-05
						Total	1.7E-05
224-RE-92			Upstream				
	Gr. Alpha	2.3E-06		1.89E+00			4.3E-06
	Gr. Beta	4.9E-04		2.60E-02			1.3E-05
						Total	1.7E-05
224-UA-RV-1			Upstream				
	Gr. Alpha	2.5E-06		1.89E+00			4.7E-06
	Gr. Beta	2.5E-05		2.60E-02			6.4E-07
						Total	5.3E-06
224-UA-RV-2			Upstream				
	Gr. Alpha	3.4E-06		1.89E+00			6.4E-06
	Gr. Beta	2.1E-05		2.60E-02			5.5E-07
						Total	7.0E-06
224-UA-RV-3			Upstream				
	Gr. Alpha	4.9E-06		1.89E+00			9.3E-06
	Gr. Beta	1.4E-05		2.60E-02			3.6E-07
						Total	9.7E-06
224-UA-RV-4			Upstream				
	Gr. Alpha	5.2E-06		1.89E+00			9.8E-06
	Gr. Beta	2.0E-05		2.60E-02			5.2E-07
						Total	1.0E-05
224-UA-RV-5			Upstream				
	Gr. Alpha	4.1E-06		1.89E+00			7.7E-06
	Gr. Beta	2.3E-05		2.60E-02			6.0E-07
						Total	8.3E-06
224-UA-RV-6			Upstream				
	Gr. Alpha	2.4E-06		1.89E+00			4.5E-06
	Gr. Beta	2.1E-05		2.60E-02			5.5E-07
						Total	5.1E-06
224-UA-RV-7			Upstream				
	Gr. Alpha	5.8E-06		1.89E+00			1.1E-05
	Gr. Beta	2.3E-05		2.60E-02			6.0E-07
						Total	1.2E-05
						UO ₃ Plant Total	1.1E-02
Plutonium Finishing Plant							
291-Z-1*			(3000) ^a				
	239/240-Pu	4.2E-04		1.55E+00	2.7E+10	1.8E+07	
	241-Pu	2.9E-03		2.46E-02	2.7E+10	1.9E+06	
	241-Am	7.2E-05		2.35E+00	2.7E+10	4.6E+06	
	Gr. Beta	3.4E-04		7.82E-03	2.7E+10	4.2E+03	
					Total	2.5E+07	
296-Z-3			HEPA Analysis				
	238-Pu	1.3E-04		6.69E+00			8.7E-04
	239-Pu	4.3E-03		7.47E+00			3.2E-02
	240-Pu	1.0E-03		7.46E+00			7.5E-03
	241-Pu	2.3E-02		1.50E-01			3.5E-03
	242-Pu	6.0E-08		7.11E+00			4.3E-07
	241-Am	5.8E-04		7.69E+00			4.5E-03
						Total	4.8E-02

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ⁿ	Alternate
296-Z-5							
			Spill Release				
	238-Pu	1.1E+01		4.76E+00	4.0E-05		2.1E-03
	239-Pu	4.3E+01		5.15E+00	4.0E-05		8.9E-03
	240-Pu	2.0E+01		5.14E+00	4.0E-05		4.1E-03
	241-Pu	1.1E+03		8.17E-02	4.0E-05		3.6E-03
	241-Am	3.7E+01		7.79E+00	4.0E-05		1.2E-02
						Total	3.1E-02
296-Z-6							
			Appendix D				
	238-Pu	1.3E+03		4.76E+00	1.0E-06		6.2E-03
	239-Pu	1.7E+03		5.15E+00	1.0E-06		8.8E-03
	240-Pu	1.4E+03		5.14E+00	1.0E-06		7.2E-03
	241-Pu	9.0E+04		8.17E-02	1.0E-06		7.4E-03
	241-Am	3.2E+03		7.79E+00	1.0E-06		2.5E-02
						Total	5.5E-02
296-Z-14							
			Appendix D				
	238-Pu	6.3E+00		4.76E+00	1.0E-06		3.0E-05
	239-Pu	2.5E+01		5.15E+00	1.0E-06		1.3E-04
	240-Pu	1.1E+01		5.14E+00	1.0E-06		5.7E-05
	241-Pu	6.1E+02		8.17E-02	1.0E-06		5.0E-05
	241-Am	2.1E+01		7.79E+00	1.0E-06		1.6E-04
						Total	4.3E-04
						Plutonium Finishing Plant Total	
							2.5E+07
222-S Laboratory							
296-S-16							
			NDA				
	137-Cs	9.7E-06		1.42E-02			1.4E-07
	Gr. Alpha	3.1E-07		5.15E+00			1.6E-06
	Gr. Beta	9.8E-06		2.60E-02			2.5E-07
						Total	2.0E-06
296-S-21							
			Appendix D				
	3-H	1.4E+00		1.38E-05	1.0E-03		1.9E-08
	14-C	4.5E-03		1.65E-03	1.0E-03		7.4E-09
	90-Sr	3.7E+02		2.60E-02	1.0E-03		9.5E-03
	90-Y	3.7E+02		2.22E-04	1.0E-03		8.1E-05
	99-Tc	5.8E-02		6.45E-04	1.0E-03		3.7E-08
	129-I	5.3E-01		1.14E-01	1.0E-03		6.0E-05
	137-Cs	8.1E+01		1.42E-02	1.0E-03		1.2E-03
	147-Pm	2.7E+00		6.75E-04	1.0E-03		1.8E-06
	235-U	5.8E-04		1.76E+00	1.0E-03		1.0E-06
	238-U	9.6E-03		1.69E+00	1.0E-03		1.6E-05
	238-Pu	4.1E-02		4.76E+00	1.0E-03		2.0E-04
	239/240-Pu	1.1E+01		5.15E+00	1.0E-03		5.7E-02
	241-Am	1.9E-01		7.79E+00	1.0E-03		1.5E-03
						Total	6.9E-02
296-S-23							
			NDA				
	137-Cs	6.3E-08		1.42E-02			8.9E-10
						Total	8.9E-10
						222-S Laboratory Total	
							6.9E-02
200 West Laundry Emissions							
296-W-1							
			Appendix D				
	Zero Source	0.0E+00				Total	0.0E+00
						200 West Laundry Total	
							0.0E+00

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ^a	Alternate
Solid Waste Operations							
296-T-11			Upstream				
	Gr. Alpha	2.3E-04		7.79E+00		1.8E-03	
	Gr. Beta	1.5E-05		2.60E-02		3.9E-07	
					Total	1.8E-03	
296-T-12			Upstream				
	Gr. Alpha	4.7E-05		7.79E+00		3.7E-04	
	Gr. Beta	3.3E-06		2.60E-02		8.6E-08	
					Total	3.7E-04	
296-W-3			NDA				
	137-Cs	1.1E-07		1.42E-02		1.6E-09	
					Total	1.6E-09	
					Solid Waste Operations Total		2.2E-03
K-Basins							
105-KE			(3000) ^a				
	60-Co	1.3E-06		4.28E-02	1.0E+00	5.6E-08	
	90-Sr	1.6E-04		6.45E-02	1.0E+00	1.0E-05	
	106-Ru	1.3E-05		3.08E-02	1.0E+00	4.0E-07	
	125-Sb	1.1E-05		6.13E-03	1.0E+00	6.7E-08	
	137-Cs	2.3E-04		3.53E-02	1.0E+00	8.1E-06	
	238-Pu	1.3E-06		1.18E+01	1.0E+00	1.5E-05	
	239/240-Pu	8.5E-06		1.28E+01	1.0E+00	1.1E-04	
	241-Pu	3.9E-05		2.03E-01	1.0E+00	7.9E-06	
	241-Am	5.1E-06		1.94E+01	1.0E+00	9.9E-05	
					Total	2.5E-04	
105-KW			(3000) ^a				
	60-Co	1.4E-06		4.28E-02	1.0E+00	6.0E-08	
	90-Sr	9.9E-07		6.45E-02	1.0E+00	6.4E-08	
	106-Ru	6.2E-06		3.08E-02	1.0E+00	1.9E-07	
	137-Cs	2.7E-05		3.53E-02	1.0E+00	9.5E-07	
	154-Eu	4.9E-06		2.69E-02	1.0E+00	1.3E-07	
	238-Pu	3.0E-08		1.18E+01	1.0E+00	3.5E-07	
	239/240-Pu	1.8E-07		1.28E+01	1.0E+00	2.3E-06	
			Total	4.0E-06			
1706-KE			(3000) ^a				
	90-Sr	1.0E-07		6.45E-02	3.0E+03	1.9E-05	
	106-Ru	6.2E-08		3.08E-02	3.0E+03	5.7E-06	
	238-Pu	4.5E-10		1.18E+01	3.0E+03	1.6E-05	
	239/240-Pu	2.5E-09		1.28E+01	3.0E+03	9.6E-05	
			Total	1.4E-04			
1706-KER			(3000) ^a				
	90-Sr	1.9E-08		6.45E-02	3.0E+03	3.7E-06	
	106-Ru	2.4E-06		3.08E-02	3.0E+03	2.2E-04	
	134-Cs	1.8E-07		4.62E-02	3.0E+03	2.5E-05	
	238-Pu	4.2E-10		1.18E+01	3.0E+03	1.5E-05	
	239/240-Pu	2.4E-09		1.28E+01	3.0E+03	9.2E-05	
			Total	3.6E-04			
1706-KEL			NDA				
	137-Cs	2.0E-07		3.53E-02			7.1E-09
					Total	7.0E-09	
					K-Basin Total		7.5E-04

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ⁿ	Alternate
300 Area Stack and Vent Emissions							
306-E-ULAB*†			(3000) ⁿ				
	90-Sr	1.8E-07		2.46E-01	3.0E+03	1.3E-04	
	238-U	4.2E-08		1.60E+01	3.0E+03	2.0E-03	
					Total	2.1E-03	
308-GL-EX			Appendix D				
	238-U	1.3E-03		5.66E+01	1.0E-03		7.4E-05
	238-Pu ^(a)	3.5E+00		1.60E+02	1.0E-03		5.6E-01
	238-Pu ^(b)	2.6E+00		1.60E+02	1.0E-06		4.2E-04
	239/240-Pu ^(a)	1.9E+01		1.73E+02	1.0E-03		3.3E+00
	239/240-Pu ^(b)	1.4E+01		1.73E+02	1.0E-06		2.4E-03
	241-Pu ^(a)	2.6E+01		2.74E+00	1.0E-03		7.1E-02
	241-Pu ^(b)	1.9E+01		2.74E+00	1.0E-06		5.2E-05
	241-Am ^(a)	1.4E+01		2.62E+02	1.0E-03		3.7E+00
	241-Am ^(b)	1.0E+01		2.62E+02	1.0E-06		2.6E-03
						Total	7.6E+00
308-ET-EX			NDA				
	54-Mn	1.9E-07		1.10E-01			2.1E-08
	137-Cs	9.3E-07		4.77E-01			4.4E-07
	Gr. Alpha	1.8E-07		1.73E+02			3.1E-05
	Gr. Beta	9.3E-07		8.72E-01			8.1E-07
						Total	3.2E-05
308-TRIGA			Appendix D				
	51-Cr	2.8E-13		1.26E-03	1.0E-06		3.5E-22
	54-Mn	4.8E+00		1.10E-01	1.0E-06		5.3E-07
	55-Fe	1.8E+02		3.86E-03	1.0E-06		6.9E-07
	58-Co	2.7E-04		6.43E-02	1.0E-06		1.7E-11
	59-Fe	9.1E-09		6.38E-02	1.0E-06		5.8E-16
	60-Co	3.9E-01		5.79E-01	1.0E-06		2.3E-07
	63-Ni	1.0E+01		4.05E-03	1.0E-06		4.1E-08
	65-Zn	1.2E+00		1.86E-01	1.0E-06		2.2E-07
						Total	1.7E-06
309-PR-TR*			(3000) ⁿ				
	90-Sr	1.5E-06		2.46E-01	3.0E+03	1.1E-03	
	239-Pu	2.7E-07		4.87E+01	3.0E+03	3.9E-02	
					Total	4.0E-02	
309-RTF-EX			NDA				
	137-Cs	1.9E-08		4.77E-01			9.1E-09
						Total	9.1E-09
340-NT-EX			(3000) ⁿ				
	90-Sr	8.9E-08		8.72E-01	4.5E+07	3.5E+00	
	239/240-Pu	2.1E-08		1.73E+02	4.5E+07	1.6E+02	
					Total	1.6E+02	
340-B-BLDG			NDA				
	90-Sr	1.8E-05		8.72E-01			1.6E-05
	137-Cs	6.7E-06		4.77E-01			3.2E-06
	239/240-Pu	3.8E-06		1.73E+02			6.6E-04
						Total	6.8E-04
340-DECON			NDA				
	90-Sr	1.6E-03		8.72E-01			1.4E-03
	137-Cs	5.9E-04		4.77E-01			2.8E-04
	239/240-Pu	3.4E-04		1.73E+02			5.9E-02
						Total	6.1E-02

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ⁿ	Alternate
377-GEL			Appendix D				
	3-H	1.2E-05		3.97E-04	1.0E+00		4.8E-09
	90-Sr	5.3E-03		8.72E-01	1.0E-03		4.6E-06
	239/240-Pu	5.3E-02		1.73E+02	1.0E-03		9.2E-03
						Total	9.2E-03
						300 Area Total	1.7E+02
400 Area							
FFTF-CB-EX			(3000) ⁿ				
	41-Ar	8.5E+00		1.65E-05	1.0E+00	1.4E-04	
	137-Cs	6.7E-06		3.17E-02	1.0E+00	2.1E-07	
	239/240-Pu	1.1E-06		1.15E+01	1.0E+00	1.3E-05	
					Total	1.5E-04	
FFTF-RE-SB			(3000) ⁿ				
	137-Cs	5.2E-06		3.17E-02	1.0E+00	1.6E-07	
	239/240-Pu	7.8E-07		1.15E+01	1.0E+00	9.0E-06	
					Total	9.2E-06	
FFTF-HT-TR			(3000) ⁿ				
	137-Cs	4.6E-07		3.17E-02	1.0E+00	1.5E-08	
	239/240-Pu	7.5E-08		1.15E+02	1.0E+00	8.6E-06	
					Total	8.6E-06	
437-MN&ST			NDA				
	54-Mn	2.0E-01		7.29E-03			1.5E-03
	60-Co	1.3E-04		3.85E-02			5.0E-06
	137-Cs	7.7E-05		3.17E-02			2.4E-06
	Gr. Alpha	2.0E-05		1.15E+01			2.3E-04
	Gr. Beta	7.8E-05		5.80E-02			4.5E-06
						Total	1.7E-03
437-1-61			NDA				
	137-Cs	5.6E-07		3.17E-02			1.8E-08
						Total	1.8E-08
						400 Area Total	1.9E-03
						Westinghouse Hanford Total	4.1E+07
Bechtel Hanford Incorporated							
S Plant							
291-S-1*			(3000) ⁿ				
	90-Sr	1.0E-08		7.82E-03	5.0E+02	3.9E-08	
	239/240-Pu	2.7E-07		1.55E+00	5.0E+02	2.1E-04	
					Total	2.1E-04	
296-S-2*†			NDA				
	137-CS	3.5E-06		4.38E-03			1.5E-08
	Gr. Alpha	2.1E-06		1.55E+00			3.3E-06
	Gr. Beta	3.5E-06		7.82E-03			2.7E-08
						Total	3.3E-06
296-S-4*†			(3000) ⁿ				
	Gr. Alpha	7.5E-10		1.55E+00	3.0E+03	3.5E-06	
	Gr. Beta	5.1E-07		7.82E-03	3.0E+03	1.2E-05	
					Total	1.6E-05	
296-S-6*†			(3000) ⁿ				
	Gr. Alpha	2.0E-07		1.55E+00	1.0E+00	3.1E-07	
	Gr. Beta	3.9E-06		7.82E-03	1.0E+00	3.0E-08	
					Total	3.4E-07	

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ⁿ	Alternate
Upstream							
296-S-7W	238-Pu	1.5E-06		4.76E+00			7.1E-06
	239-Pu	2.6E-05		5.15E+00			1.3E-04
	240-Pu	6.1E-06		5.14E+00			3.2E-05
	241-Pu	3.4E-04		8.17E-02			2.8E-05
	242-Pu	3.5E-10		5.15E+00			1.8E-09
	241-Am	3.9E-04		7.79E+00			3.0E-03
						Total	3.2E-03
U Plant							
291-U-1*			(3000) ⁿ				
	90-Sr	1.5E-05		7.82E-03	5.0E+02	5.9E-05	
	137-Cs	2.2E-04		4.28E-03	5.0E+02	4.7E-04	
	239/240-Pu	3.1E-07		1.55E+00	5.0E+02	2.4E-04	
					Total	7.7E-04	
					S Plant and U Plant Total	4.2E-03	
N Reactor							
105-N-14ft DR ^(d)			Appendix D				
				Total		<3.8E-03	
105-N-Tran Area			(3000) ⁿ				
	60-Co	2.3E-07		4.28E-02	1.0E+00	9.8E-09	
	90-Sr	1.0E-07		6.45E-02	1.0E+00	6.5E-09	
	106-Ru	7.6E-07		3.08E-02	1.0E+00	5.5E-08	
	125-Sb	5.4E-07		6.13E-03	1.0E+00	3.3E-09	
	155-Eu	3.3E-07		2.73E-03	1.0E+00	9.0E-10	
	239/240-Pu	1.4E-09		1.28E+01	1.0E+00	1.8E-08	
	241-Am	2.3E-09		1.94E+01	1.0E+00	4.5E-08	
					Total	1.4E-07	
107-N			Upstream ^(e)				
	Gross alpha	3.5E-04		1.94E+01	3.0E+03	6.7E-03	
	Gross beta	1.9E-02		6.45E-02	3.0E+03	1.2E-03	
					Total	7.9E-03	

Table II.A-4. (cont'd)

Stack No.	Radionuclide	1992 Curies	Assessment Method	mrem/Ci Dose Factor CAP88	Release or Treatment Factor	Potential Dose mrem/yr	
						(3000) ^a	Alternate
116-N*			(3000) ^a				
	60-Co	4.7E-07		1.29E-02	3.0E+03	1.8E-05	
	90-Sr	2.7E-06		1.94E-02	3.0E+03	1.6E-04	
	106-Ru	1.7E-05		9.26E-02	1.0E+00	1.6E-06	
	137-Cs	1.9E-04		1.06E-02	3.0E+03	6.0E-03	
	239/240-Pu	1.0E-08		3.85E+00	3.0E+03	1.2E-04	
				Total		8.2E-04	
						N Reactor Total	8.7E-03
						Bechtel Hanford Inc., Total	1.3E-02

* Stacks above 60 ft that use the 89 meter CAP88 dose factor.

† Stacks which used the 10 meter CAP88 dose factor instead of the 89 meter factor in the NESHAPs stack source assessment (David and Barnett 1994a, 1994b). This did not affect the outcome of the assessment.

(a) Source term is from liquid supernate.

(b) Source term is from solid sludge.

(c) Source term is combined from liquid supernate and solid sludge.

(d) The hypothetical inventory that would result in a potential dose of 0.1 mrem/yr to the MEI was projected from actual 1993 releases to estimate the external dose rate for waste drums as 1.3E+03 mrem/hr measured at 1 cm. Because the Administrative Control value for the external dose rate of a drum is <50 mrem/hr, the potential dose from the stack was calculated by applying a factor of (50/1300) to the 0.1 mrem/yr, resulting in a potential dose to the MEI of <3.8E-03 mrem/yr.

(e) The 107-N Stack was reassessed by an alternate method. An upstream sample was taken between the two HEPA filter stages. The potential dose to the MEI is less than 0.1 mrem/yr.

Table II.A-5. Potential Unmitigated Doses from Pacific Northwest Laboratory Facilities

Building	Dose ^(a) , mrem/yr
242-B/BL	< 1.0E-01
2718-E	0.0E+00
300N	0.0E+00
303-C	0.0E+00
303-J	0.0E+00
305-B	8.1E-04
306-W	2.0E-02
314	6.7E-05
318/318 Tr 4	2.5E-07
318 Tr 5	1.4E-07
320	7.3E-04
323	0.0E+00
324	8.0E+03
325	4.1E+00
326	1.6E-04
327	1.5E+02
329	2.1E-02
329-NMF	1.1E-06
331/331-A	3.0E-03
331-C	9.6E-05
331-G	2.2E-04
331-H	1.5E-11
3708	8.1E-05
3720	7.7E-01
3730	2.1E-04
3745	9.5E-05
3745-B	4.2E-08
3746-A	9.7E-05
622-D	0.0E+00
622-R	0.0E+00
622-S	0.0E+00
6652 (ALE)	1.1E-07
747-A	6.3E-09

(a) Assessments were made on 1994 data using an inventory-based method.

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Hanford Site Environmental Monitoring Plan

Section II.B Operational Environmental Monitoring

Prepared by:	Date:	Concurrence (RL):	Date:
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Preoperational Survey

Preoperational Environmental Surveys are required by DOE Order 5400.1, *General Environmental Protection Program*, Chapter IV, Page IV-2, Paragraph 3:

An environmental study shall be conducted prior to startup of a site, facility, or process which has the potential for significant adverse environmental impact. The preoperational study should begin not less than one year, and preferably two years before startup to evaluate seasonal changes. The study shall serve to: characterize existing physical, chemical, and biological conditions that could be affected; establish background levels of radioactive and chemical components; characterize pertinent environmental and ecologic parameters; and identify potential pathways for human exposure and environmental impact as a basis for determining the nature and extent of the subsequent routine operational and emergency effluent monitoring and environmental surveillance programs. Where time and circumstance do not allow for completion of preoperational monitoring prior to startup, it shall be conducted concurrent with work on the new site, facility, or process. The preoperational study shall be consistent with NEPA compliance activities. Where appropriate, activities and documentation conducted for NEPA compliance may substitute for compliance with this requirement.

General guidelines for conducting the preoperational environmental survey can be found in *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE/EH-0173T, Section 9.0, 9.2.1) and in *Low Level Waste Management Handbook Series Environmental Monitoring for Low Level Waste Disposal Sites* (DOE/LLW-13Tg, Rev 2, Vol. 1 of 2, Section 4.0, 4.2).

WHC-specific references for conducting the preoperational survey can also be found in *Environmental Compliance* (WHC-CM-7-5, Section 5.0, 5.4.2.1.b; Section 8.0, 8.5.1.7; and Section 9.0, 9.3.1.3), and in *Operational Environmental Monitoring* (WHC-CM-7-4, Section 13, 13.4.3). The requirements for preoperational surveys are implemented by Operational Environmental Monitoring (OEM).

Data Quality Objectives

The objectives of the preoperational environmental survey are to evaluate compliance with DOE, EPA, Ecology, WDOH, and internal WHC environmental radiation protection requirements and guides. The survey can provide data to:

- provide a baseline for monitoring performance of waste confinement systems
- determine trends in radioactive materials in the environment at and adjacent to treatment facilities and waste disposal sites
- provide a preoperational baseline for facility closure.

Specifically, the survey is developed to provide data for modifying existing OEM, which serves the following functions:

- monitor appropriate radiological and nonradiological hazards (DOE Order 5820.2A)

- determine the effectiveness of effluent treatment and controls in reducing effluents and emissions (DOE/EH-0173T, Page 1-1, Par. 1) (DOE/EV/1830-T5)
- detect and quantify unplanned releases (DOE/EH-0173T, Page 1-1, Par. 2) (40 CFR 302) (WAC 173-303-145) (DOE 5000.3A) (DOE 5400.1)
- monitor fugitive emissions and diffuse sources from contaminated areas for compliance with NESHAP (40 CFR 61) (DOE/EH-0173T, Pg. 3-4, 3.3.2), Toxic Air Emissions Inventory (40 CFR 265, Subparts AA and B13), State Operating Permit Program (40 CFR 70), and Source Registration (WAC 246-247)
- monitor new and existing sites, processes, and facilities for potential impacts and releases (DOE Order 5400.1 and DOE/EH-0173T)
- monitor and assess radioactive contamination and potential exposure to employees and the public (DOE Orders 5400.1 and 5400.5).

User Identification

There are four primary users of the preoperational environmental survey. These include:

- 1) the planning and construction organization (to demonstrate compliance with DOE Order 5400.1, *General Environmental Protection Program*, Chapter IV, Page IV-2, Paragraph 3)
- 2) the project operating organization (to show that containment systems for stored chemicals and wastes remain adequate in compliance with DOE Order 5400.1)
- 3) Operational Environmental Monitoring (to provide adequate data for determining the need to modify the existing program and to determine trends in future effluents and environmental conditions)
- 4) the Surface Environmental Surveillance Program (to adjust the program if needed).

Preoperational Survey Design

The preoperational survey shall be designed to monitor the media specified in the guidelines for conducting the preoperational environmental survey found in DOE/EH-0173T (*Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*) and in DOE/LLW-13Tg Rev 2, Vol. 1 of 2 (*Low Level Waste Management Handbook Series Environmental Monitoring for Low Level Waste Disposal Sites*). To assist in designing this survey, existing documents (e.g., Unplanned Release Reports, Occurrence Reports, Operational and Site Environmental Reports, historical photographs, Environmental Impact Statements, and Preliminary Safety Analysis Reports) will be reviewed.

Before initiating preoperational sampling of any new or modified facility or process, a Sampling and Analysis Plan shall be issued. The contents of this Sampling and Analysis Plan shall contain a project description, media to be sampled and analysis to be performed, and sampling design rationale.

Once preoperational monitoring is completed and analytical data are available, the results shall be included in the Final Preoperational Environmental Monitoring Report.

Operational Environmental Monitoring

The OEM provides facility-specific environmental monitoring to protect the environment adjacent to nuclear facilities and waste treatment, storage, and disposal sites, and ensure compliance with Hanford contractor requirements and local, state, and federal environmental regulations.

The OEM objectives are to evaluate:

- compliance with DOE, EPA, Ecology, WDOH, and internal company environmental radiation protection requirements and guides
- performance of radioactive waste confinement systems
- trends of radioactive materials in the environment at and adjacent to nuclear facilities and waste disposal sites.

Specifically, OEM is developed to:

- monitor all inactive, existing, and new low-level waste (LLW) disposal sites to assess both radiological and nonradiological hazards (DOE 5820.2A)
- determine the effectiveness of effluent treatment and controls in reducing effluents and emissions (DOE/EH-0173T, Page 1-1, Par. 1) (DOE/EV/1830-T5)
- detect and quantify unplanned releases (DOE/EH-0173T, Page 1-1, Par. 2) (40 CFR 302) (WAC 173-303-145) (DOE 5000.3A) (DOE 5484.1)
- monitor fugitive emissions and diffuse sources from contaminated areas for compliance with NESHAP (40 CFR 61) (DOE/EH-0173T, Pg. 3-4, 3.3.2), Toxic Air Emissions Inventory (40 CFR 265, Subparts AA and B13), State Operating Permit Program (40 CFR 70), and Source Registration (WAC 246-247)
- monitor all surplus facilities before decontaminating or decommissioning (DOE 5820.2A).
- Monitor new and existing sites, processes, and facilities for potential impacts and releases (DOE 5484.1 and DOE/EH-0173T)
- monitor and assess radioactive contamination and potential exposure to employees and the public (DOE 5400.1 and 5400.5).

Primary justifications for OEM include the following:

- The OEM provides a level of assurance that the effluent and contamination controls for the various facilities and waste sites are effective.
- The OEM monitors a diversity of operations, activities, and programs managed by several different organizations. Accordingly, the program direction and integration function performed by the OEM staff is needed to ensure program consistency, technical quality, and cost effectiveness.

- A secondary aspect of the OEM is additional assurance beyond that provided by the Occupational Health and Safety Program that it is safe to work onsite and for visitors to safely tour the site.

OEM staff are responsible for planning, directing, and executing an effective, technically sound, near-facility OEM for all media and to ensure that the requirements of the program are implemented. This responsibility includes establishing the program basis and scope, developing sample and survey schedules, and ensuring that schedules and procedures are followed by the performing organizations. The OEM staff serve as the primary contact within and outside of Hanford contractors in technical matters pertaining to near-facility OEM, and represent Hanford contractors at meetings with environmental regulators regarding this work.

Data obtained by the OEM will be used to identify areas of noncompliance with Hanford contractors policy regarding loss of contamination control. The program utilizes Radiological Problem Reports (RPR) and Compliance Assessment Reports (CAR) as formal mechanisms for documenting instances of noncompliance. Formal tracking of noncompliances is performed. OEM staff are integral to the process of developing compliance schedules for the noncompliant organization, which are then closely tracked to determine their effectiveness. These reports solidify the oversight function of the OEM and perform the critical function of formally identifying areas of concern regarding unacceptable environmental conditions.

Document Hierarchy

A list showing the governing document hierarchy pertaining to the OEM is included in Table II.B-1. The list includes the primary DOE Orders and regulations applicable to the program, and the Hanford Site and Hanford contractor implementation documentation.

Program Review

OEM shall be reviewed at least annually to ensure that the work complies with regulations, that appropriate effluents are being monitored, and that the monitoring locations are positioned to best determine and quantify potential releases.

OEM Media and Parameters

OEM consists of surface and subsurface components. Media for the surface component include external radiation dose, ambient air particulates, soil, surface water, and sediment and biota at or near active and inactive facilities and waste sites. Parameters include, as appropriate, radionuclides, radiation exposure, hazardous constituents, pH, and water temperature. Nonradiological ambient air quality conditions are also beginning to be addressed (e.g., carbon tetrachloride near the 200-West Expedited Response Action [ERA]).

Table II.B-1. Document Hierarchy**DOE Order 5400.1, "General Environmental Protection Program"**

- Chapter III, Environmental Protection Program Plans
- Chapter IV, Environmental Monitoring Requirements

DOE Order 5400.5, "Radiation Protection of the Public and the Environment"

- Chapter I, General Paragraph 8, Environmental Monitoring and Surveillance

DOE Order 5820.2A, "Radioactive Waste Management"**DOE Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements"****DOE Order 5000.3A, "Occurrence Reporting and Processing of Operational Information"****DOE/LLW-13Tg, *Low Level Waste Management Handbook Series, Environmental Monitoring for Low Level Waste Disposal Sites*****DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*****40 CFR 61, "National Emission Standards for Hazardous Air Pollutants"****40 CFR 70, "State Operating Permit Programs"****40 CFR 264, "Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"****40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"****40 CFR 302, "Designation, Reportable Quantities, and Notification"****WAC 173-303-145, "Dangerous Waste Regulations (Spills and Discharges into the Environment)"****WAC 246-247, "Radiation Protection - Air Emissions"****DOE/RL-94-127, Rev. 0, *U.S. Department of Energy/Richland Operations Office/Environmental Protection Implementation Plan, November 9, 1991 through November 9, 1992*****DOE/RL-91-50, Rev. 1, *Environmental Monitoring Plan*****WHC-CM-7-5, *Environmental Compliance Manual*****WHC-CM-7-4, *Operational Environmental Monitoring* and in DOE/RL 91-50, Rev. 1, *Environmental Monitoring Plan*****WHC-EP-0538-1, *Operational Environmental Monitoring Program Quality Assurance Project Plan***

Subsurface sample media consist of ground water and the soil column above the water table. Ground-water samples are analyzed for both radioactive and nonradioactive constituents. The soil column at treatment, storage, and disposal sites is monitored for gamma-emitting radionuclides with downhole logging methods. Details of the subsurface monitoring activity are described in the "Subsurface Monitoring" section.

Sampling Locations

Samples are collected from known or suspected effluent pathways (e.g., downwind of potential releases, in liquid streams, or near release points). To minimize duplication, OEM relies on existing sampling locations maintained by other Hanford contractors (e.g., 300 and 400 Area air samplers). Current sampling locations, frequency, and analytes are shown in Table II.B-2. Additional information regarding specific sampling locations can be found in WHC-CM-7-4.

Also, routine surface contamination surveys are conducted near and on liquid waste disposal sites (e.g., cribs, trenches, drains, retention basin perimeters, pond perimeters, and ditch banks), solid waste disposal sites (e.g., burial grounds and trenches), unplanned release sites, tank farm perimeters, stabilized waste disposal sites, roads, and firebreaks in the operations areas. There are 391 sites (100 in the 100 Areas, 273 in the 200/600 Areas, and 18 in the 300/400 Areas) where radiological surveys were conducted.

Sampler Design

Sampler design is reviewed to determine equipment efficiency and comply with current U.S. Environmental Protection Agency (EPA) and industry (e.g., American National Standards Institute [ANSI], American Society for Testing and Materials [ASTM]) standards.

Table II.B-2. OEM Sampling Media, Frequency, and Analytes

Sample Type ^(a)	Number of Samples	Collection Frequency/Analytes
Air	42	Biweekly/ total alpha and total beta; Semi-annual/Sr, Pu, U, Gamma
Soil	157	Annual/Sr Pu, U, Gamma
Vegetation	95	Annual/Sr, Pu, U, Gamma
TLD	107	Quarterly Exposure
Survey Points	182	Annual Exposure Readings
Liquid Surface Disposal (Pond and Ditch)	4	Weekly/pH; composited monthly for total alpha and total beta; Sr, Gamma
River Seepages ^(b)	22	Annual Sr, Gamma, ³ H
Sediment	11	Annual Sr, Pu, U, Gamma
Aquatic Vegetation	11	Annual Sr, Pu, U, Gamma

(a) Note: Animal samples are collected at or near facilities and/or waste sites when surveys indicate contamination, or the potential for contamination, potentially spread by biological vectors.

(b) The number of actual seepages sampled varies from year to year.

General OEM Design Requirements

Figure II.B-1 is a general schematic of the monitoring system provided by OEM. The following types of environmental media are monitored routinely in accordance with criteria stated in Sections III.A, III.B, and III.C of this Environmental Monitoring Plan:

- **ambient air** in the immediate vicinity of active and inactive waste sites and nuclear facilities when there is potential for measurable airborne releases
- **soil samples** in the immediate vicinity of active and inactive waste sites and nuclear facilities to indicate adequacy of contamination control
- **vegetation samples** in the immediate vicinity of active and inactive waste sites and nuclear facilities to indicate adequacy of contamination control
- **animal samples** (e.g., feces, nests, and carcasses) to indicate adequacy of contamination control
- **surface water, sediments, and aquatic vegetation samples** in springs, ponds, and ditches for constituents indicating the status of operational practices and effluent control
- **ground-water samples** from monitoring wells to ensure the physical integrity of nuclear facilities
- **background dose rate samples** near facilities (active sites, inactive sites, areas of employee or public access, waste-handling facilities, effluent discharge points, or other suspected pathways for radiation exposure) that potentially may expose people to radiation
- **radiation surveys** at facilities that may have the potential to spread radioactive contamination (e.g., roadways, railroad lines, operating facilities, active and inactive disposal sites, and storage areas like basins, tanks, and tank farms).

The OEM covers activities near the following facilities (Appendix A, Figures II.B-A.1 through II.B-A.14):

- active facilities and processes
- storage and transfer facilities
- active waste management facilities
- roadways and railroad lines
- inactive waste management facilities
- decommissioning of deactivated facilities
- unplanned release sites.

Table II.A-4 in Section II.A provides a comprehensive list of facility release points and the constituents released at those points that are of environmental significance. Appendix B provides a summary of waste sites and facilities as condensed from the Waste Information Data System (WIDS).

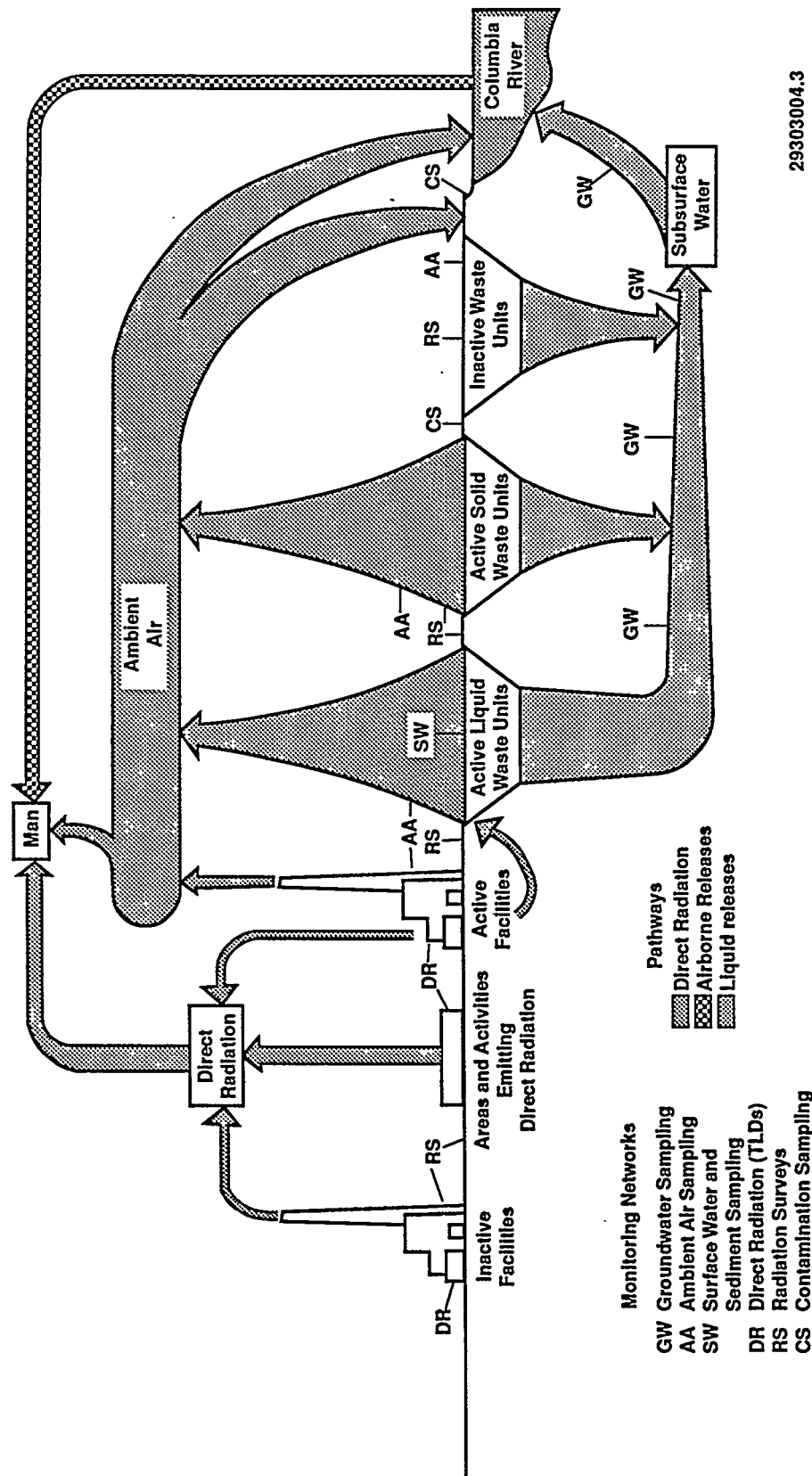


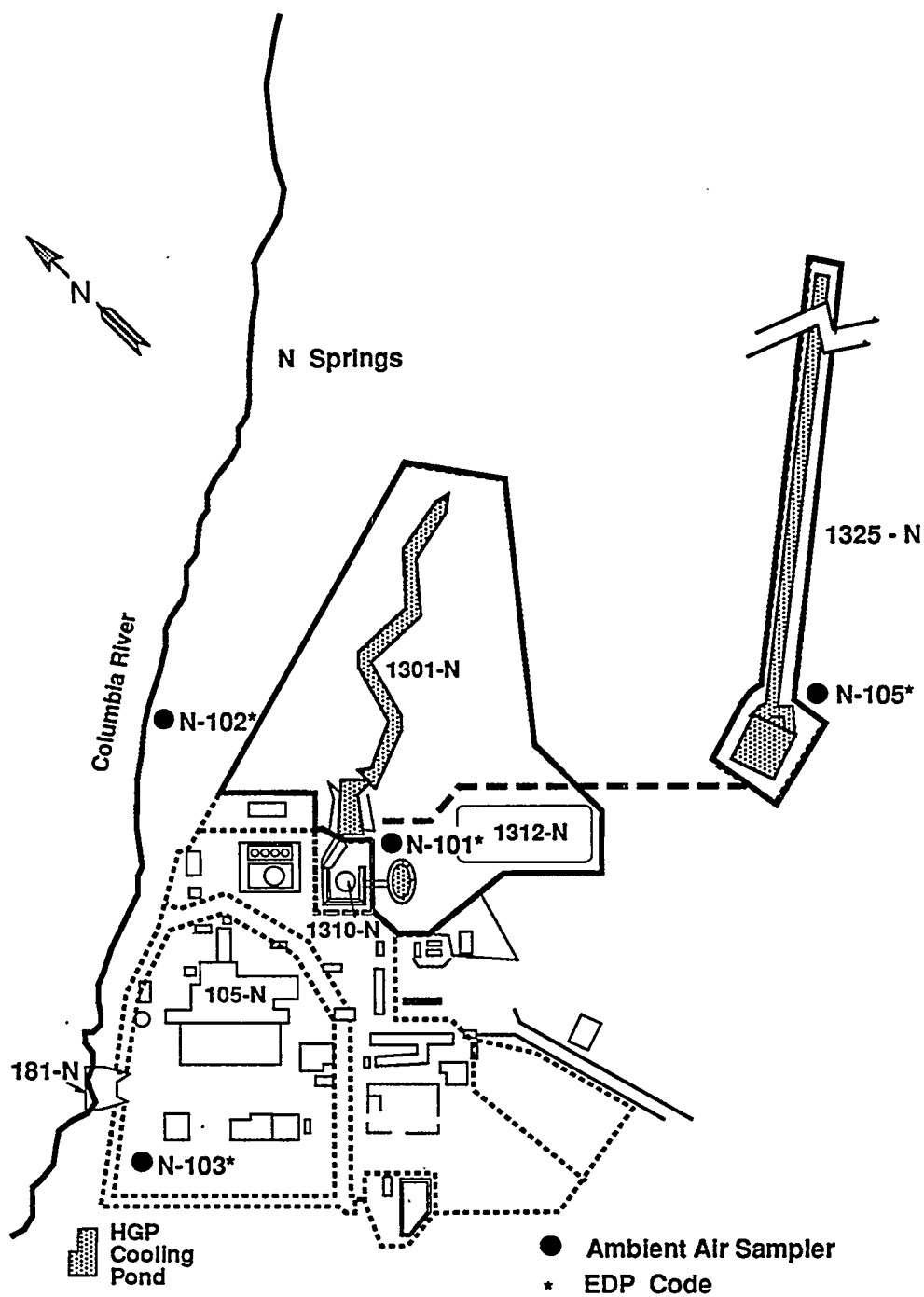
Figure II.B-1. OEM System

Monitoring Locations

Below are listed the criteria for establishing monitoring locations for each media type.

- **Ambient Air** - Locate at or near (≤ 500 m) sites and/or facilities with the potential for release. As a general rule, at least four monitoring/sampling locations should be provided surrounding the potential point or diffuse source. Unless documented site-specific evidence exists to justify otherwise, the sample(s) at each air sampling station should be collected at a height of 2 m above ground level and in a location free from unusual localized effects (near a large building, vehicular traffic, or trees) that could result in artificially high or low concentrations. Locations should be selected to avoid areas where large-particle, fugitive dust could dominate the sample (DOE/EH-0173T). Figures II.B-2 through II.B-8 show ambient air monitoring locations for the OEM.
- **Soil** - Locate downwind and within a few meters of a source. Unless documented site-specific evidence exists to justify otherwise, the sample(s) should be collected in a location free from unusual localized effects or other conditions (near a large building, vehicular traffic, or trees) that could result in artificially high or low concentrations. Figures II.B-9 through II.B-14 show soil sampling locations for the OEM.
- **Vegetation** - Locate on or near sites and/or facilities with the potential for biological intrusion. Figures II.B-15 through II.B-20 show vegetation sampling locations for the OEM.
- **Animal** - Collect feces, nests, and carcasses on or near sites and/or facilities with the potential for biological intrusion. Animals are sampled opportunistically.
- **Surface Water, Sediments, and Aquatic Vegetation** - Locate at ponds or ditches used for disposal of, or potentially impacted by, liquid effluents from operating facilities. Figures II.B-21 through II.B-23 show where these samples are taken for OEM.
- **Ground Water** - Collect from wells drilled specifically for monitoring operational impacts on the underground aquifer. OEM ground-water monitoring is discussed further in II.B, "Subsurface Monitoring."
- **Background Dose Rate** - Locate at or near facilities that may cause elevated dose rates, including active sites, inactive sites, areas of employee or public access, waste-handling facilities, effluent discharge points, and other suspected pathways for radiation exposure. Figures II.B-24 through II.B-30 show OEM dosimeter locations.
- **Radiation Surveys** - Routine radiation surveys are part of the near-facility operational environmental monitoring that monitors and helps direct the reduction of the radiologically controlled areas at the Hanford Site. The surveys included in this program consist of inactive waste sites; outdoor radiological control areas; tank farm perimeters and associated diversion boxes, lift stations, and vent stations; perimeters of active or uncovered waste sites such as retention basins, ponds, process trenches, and ditches; and road and rail surfaces.

A routine operational monitoring schedule is developed by OEM and reviewed and approved by WHC and BHI. WHC reviews the radiological survey reports and files a copy for historical purposes and reference. Radiological conditions are tracked and trends noted. All sites are surveyed at least once each year. The survey frequencies for particular sites are based on site history, radiological conditions, and general maintenance. Special surveys may be conducted at



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Figure II.B-2. OEM Ambient Air Sampling Locations at the 100-N Area

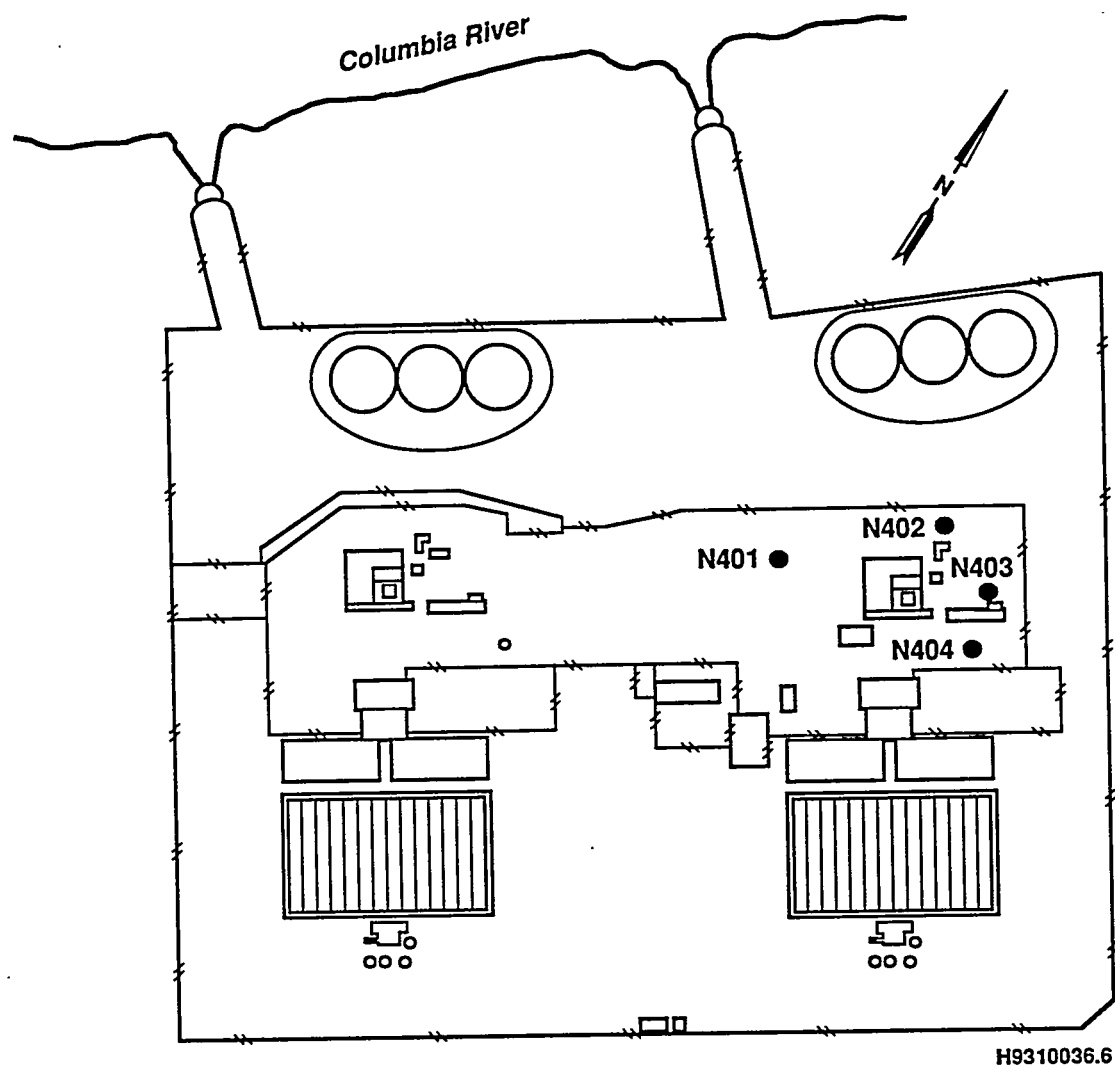
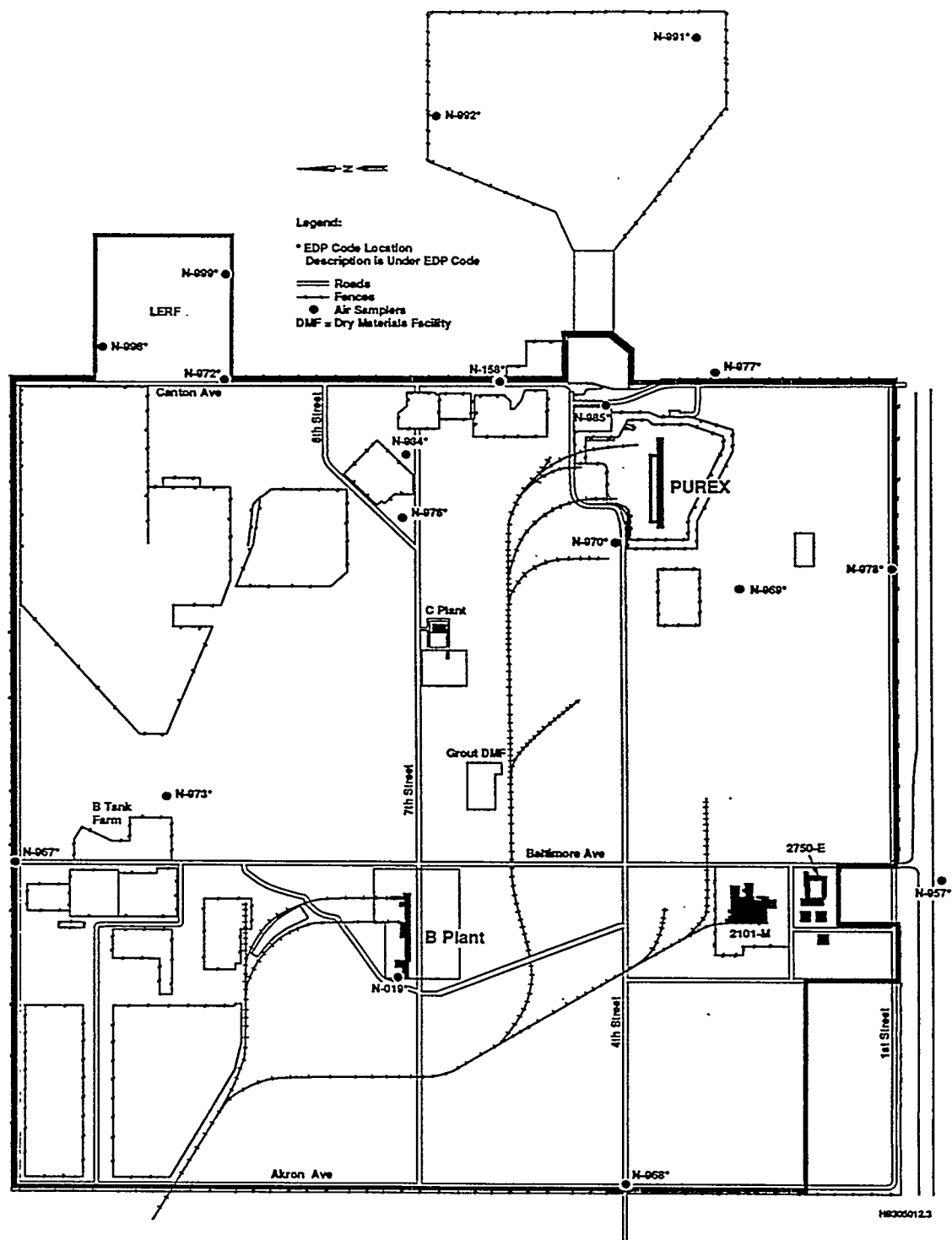


Figure II.B-3. OEM Ambient Air Sampling Locations at the 100-K Area



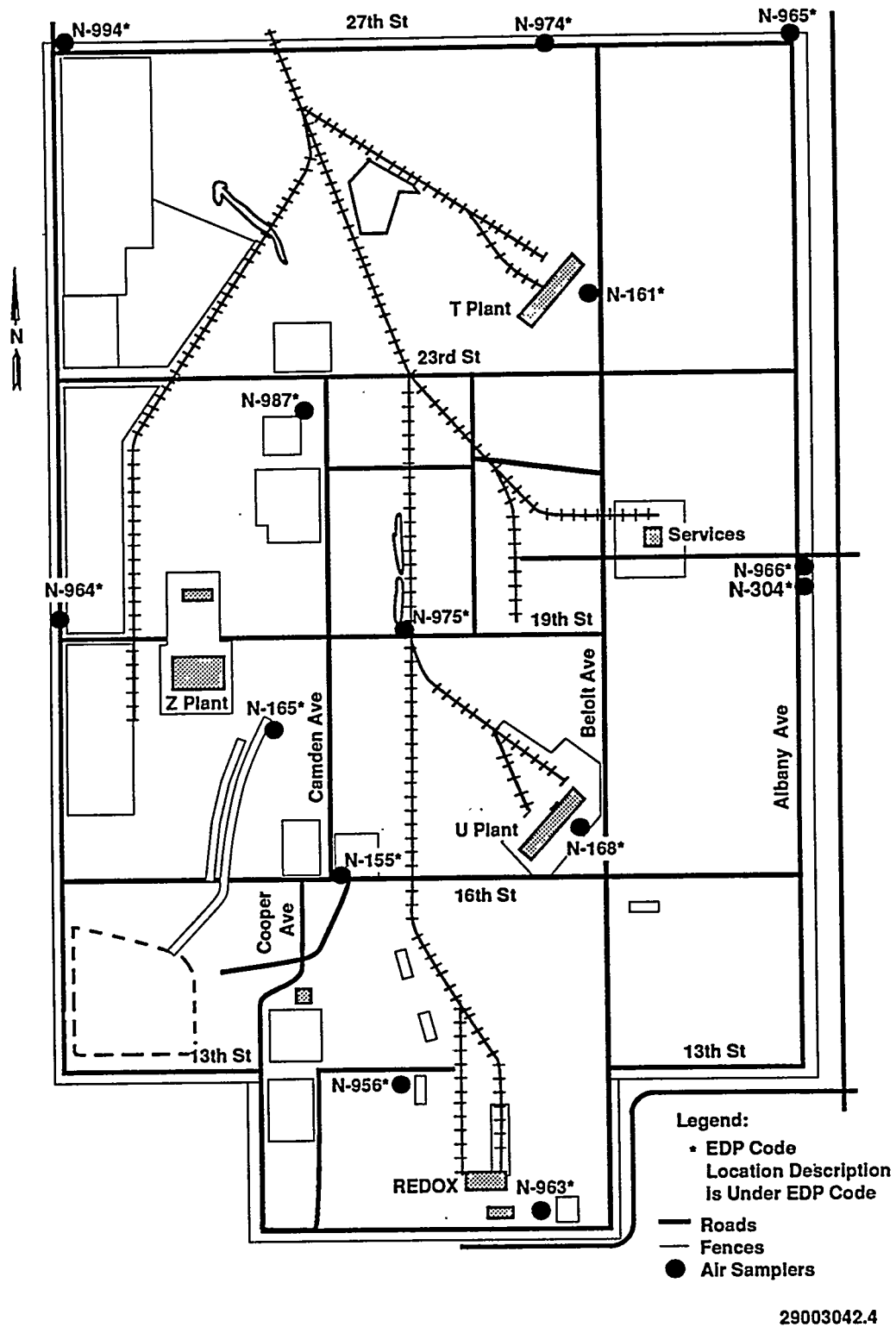


Figure II.B-5. OEM Ambient Air Sampling Locations at the 200-West Area

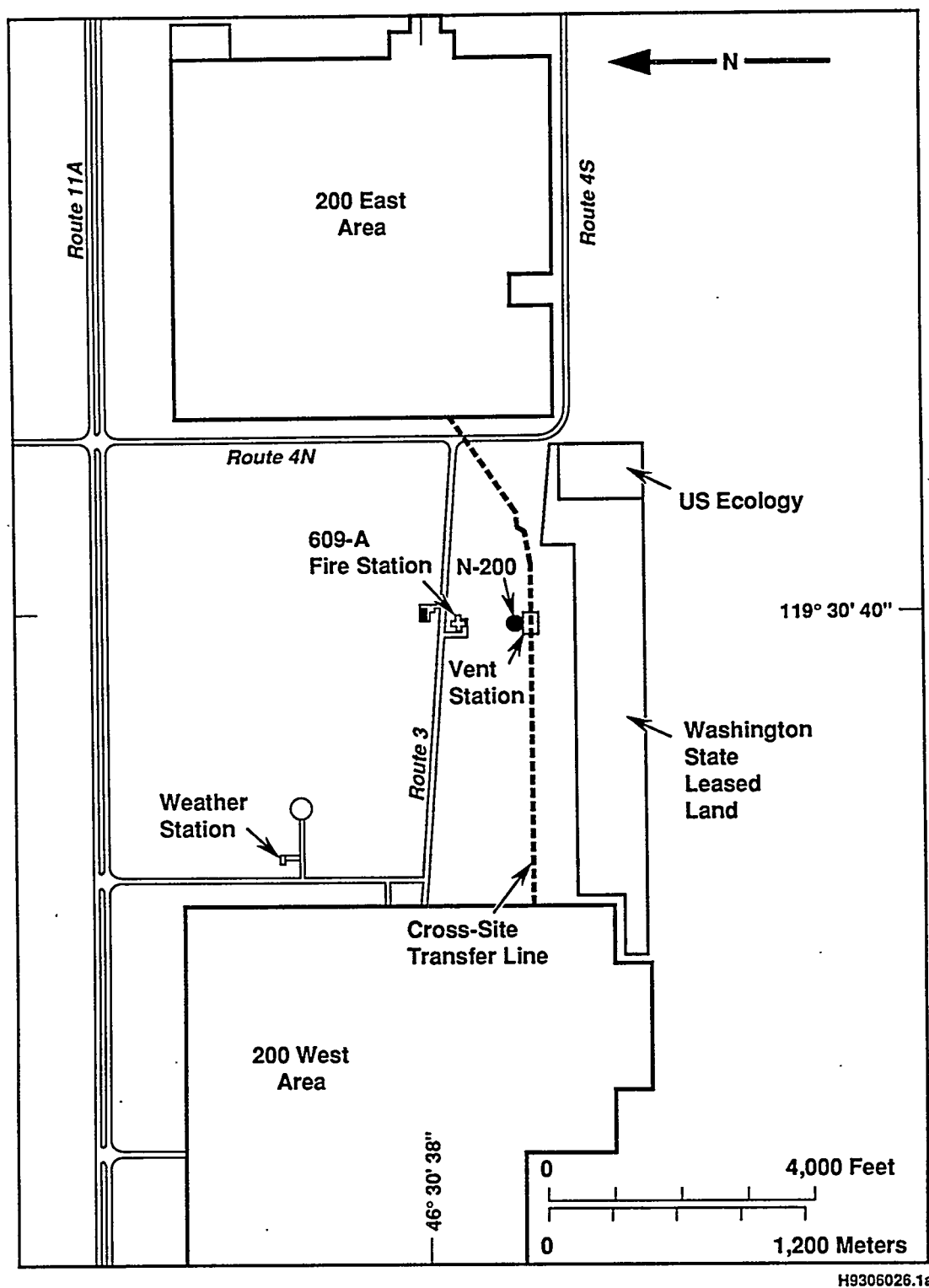


Figure II.B-6. OEM Ambient Air Sampling Locations at the 200 Areas Vent Stations

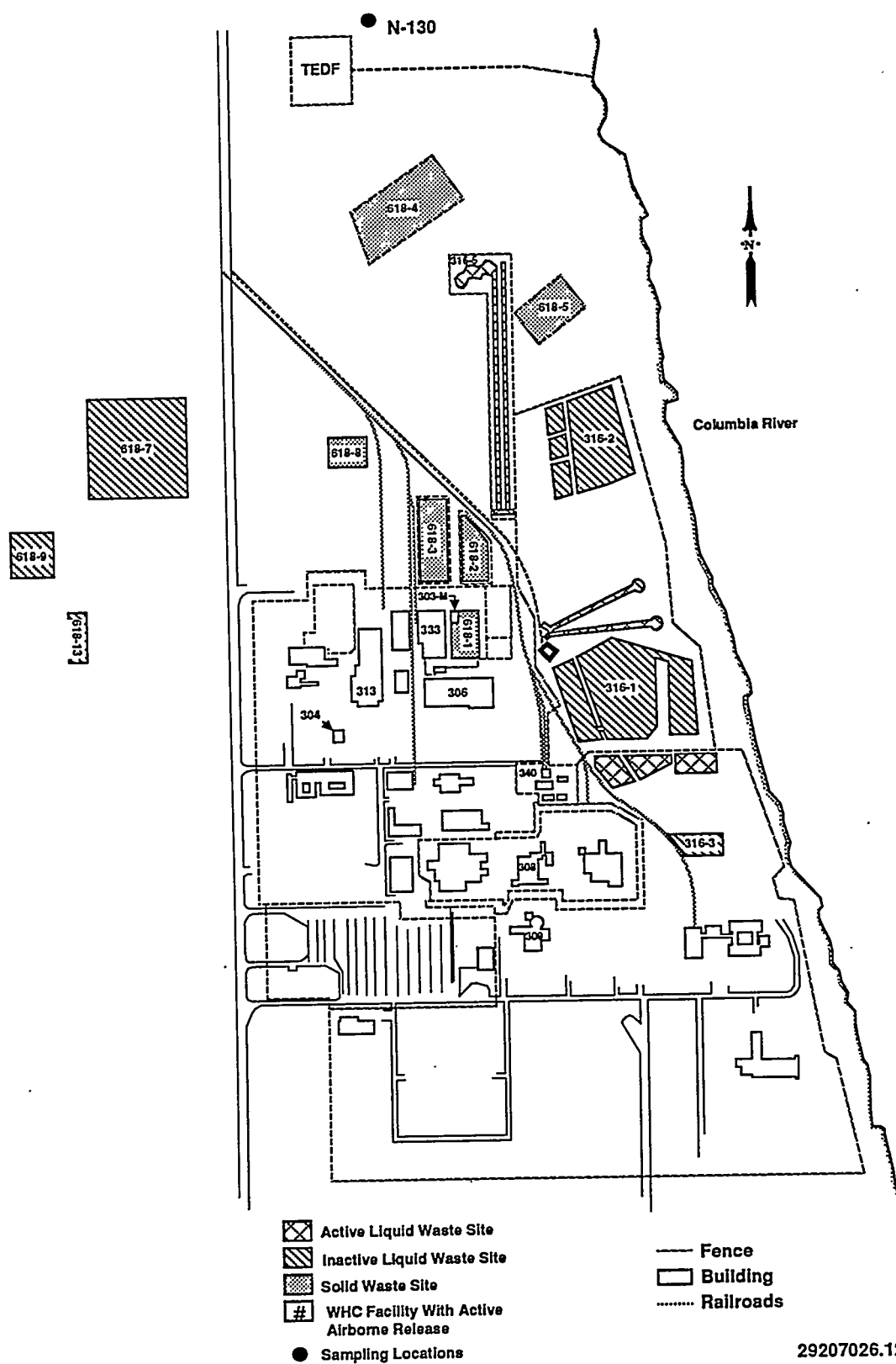
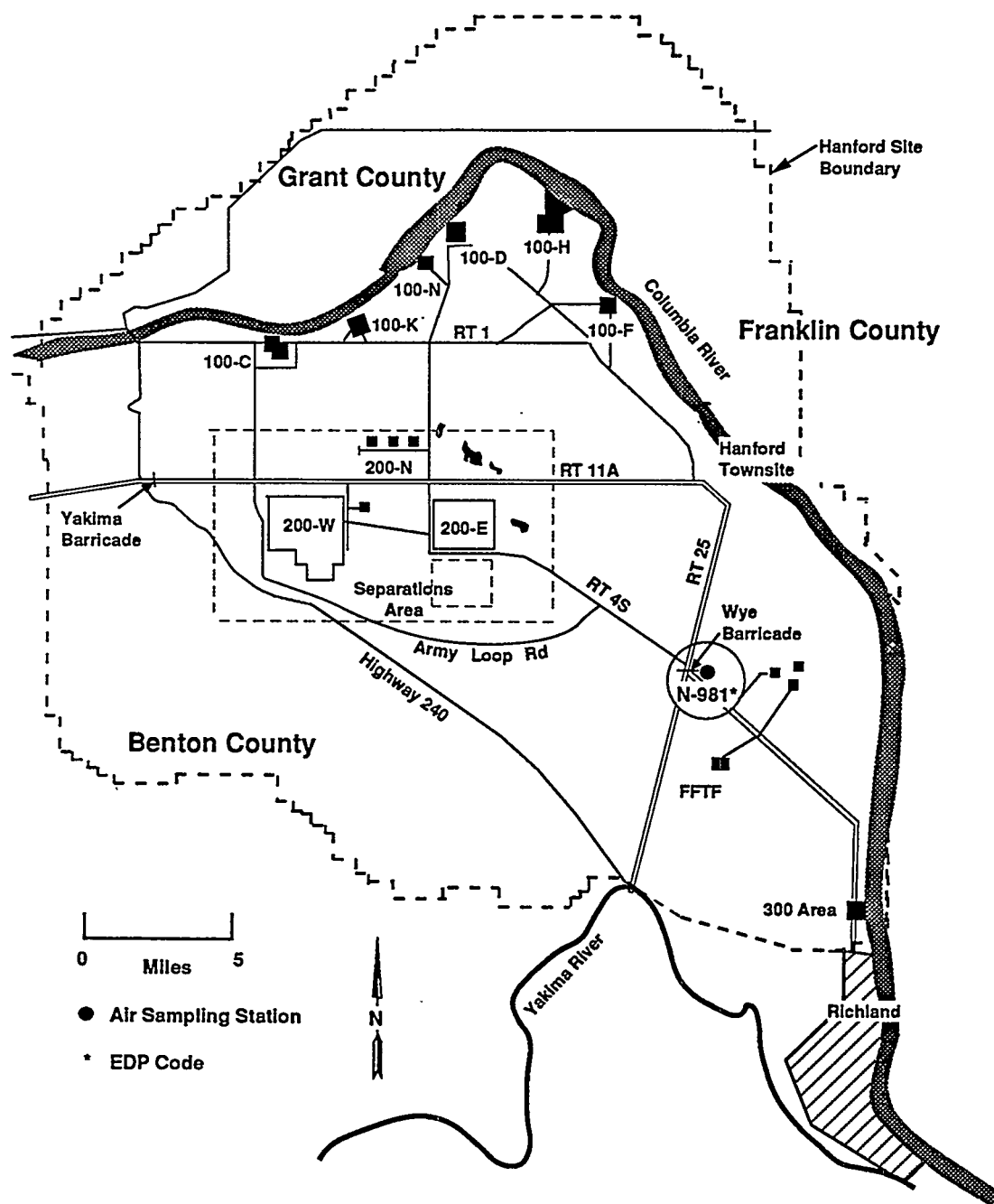


Figure II.B-7. OEM Ambient Air Sampling Locations at the 300 Area Treated Effluent Disposal Facility



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Figure II.B-8. Ambient Air Sampling Locations at the 600 Area

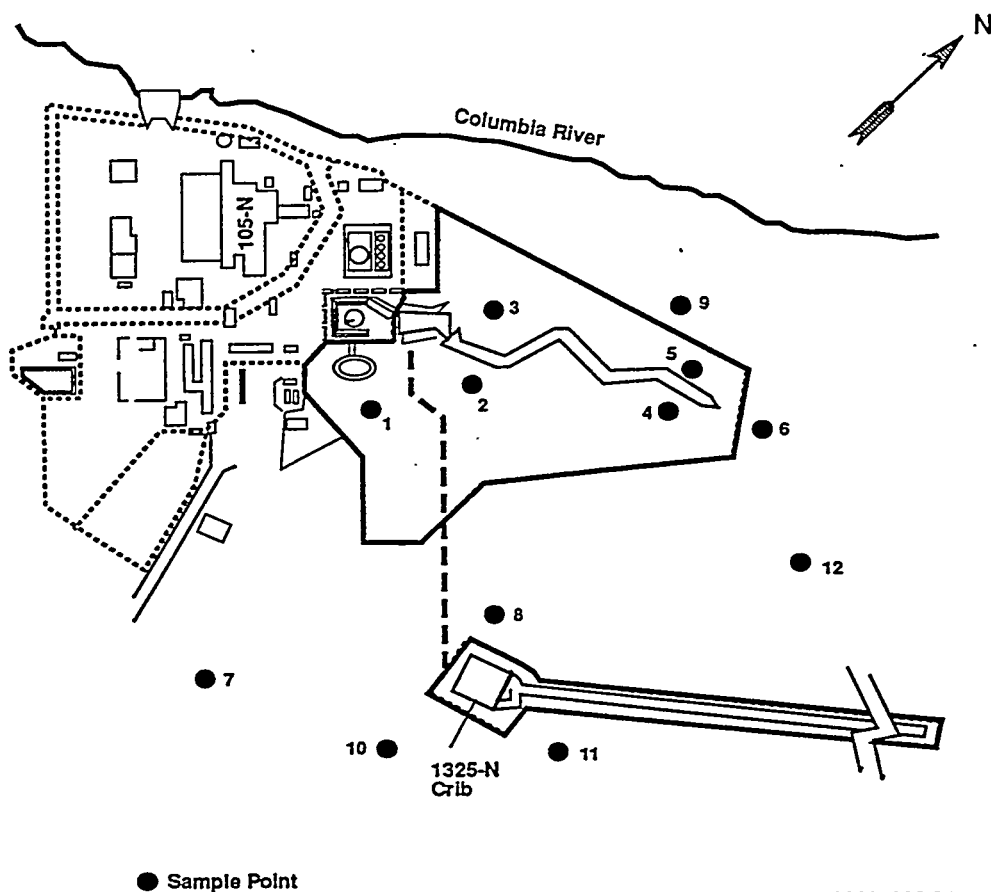


Figure II.B-9. OEM 100-N Area Soil Sampling Locations

irregular frequencies if conditions warrant (e.g., growth of deep-rooted vegetation is noted at a waste site). Radiological surveys are conducted to detect surface contamination and document changes in vegetation growth, biological intrusion, erosion, and general site maintenance conditions. Survey data are compared with standards identified in WHC-CM-7-5, *Environmental Compliance*, as well as previous surveys to recognize possible trends, assess environmental impacts, and help determine where corrective actions are needed. Figures II.B-31 through II.B-35 show OEM survey points.

Sampler Design

- **Ambient Air** - Air sampling stations collect samples at a height of 2 m above ground level and use a vacuum pump to provide air flow of 2 cfm or 120 scfh. A timer and flowrate meter are used to determine time and flow of the sampler. Samples are collected bi-weekly to prevent dust loading on the sample filter.
- **Soil** - Soil sampling equipment are one of three types: 1) a garden spade, 2) a core sampler (split

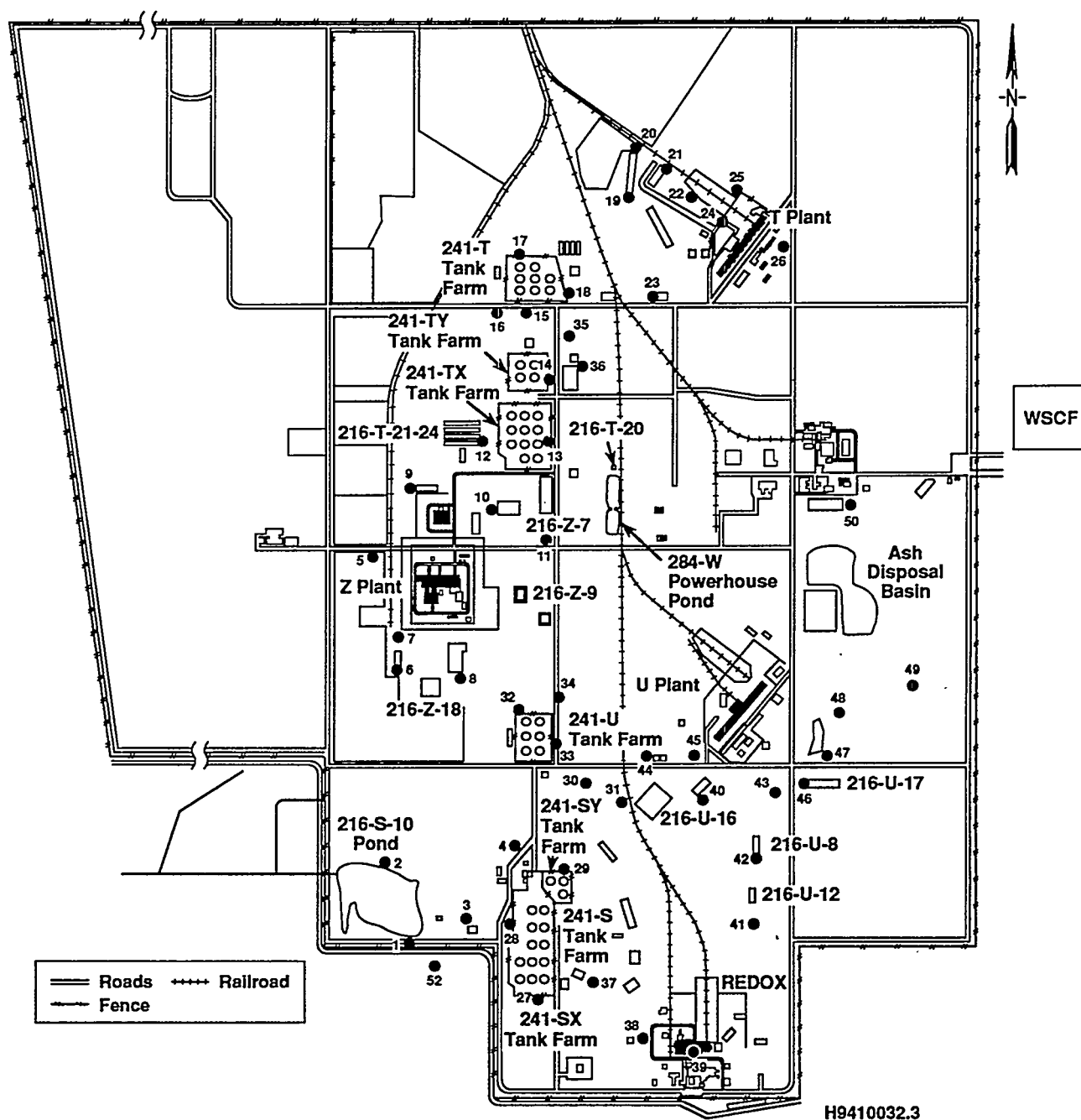
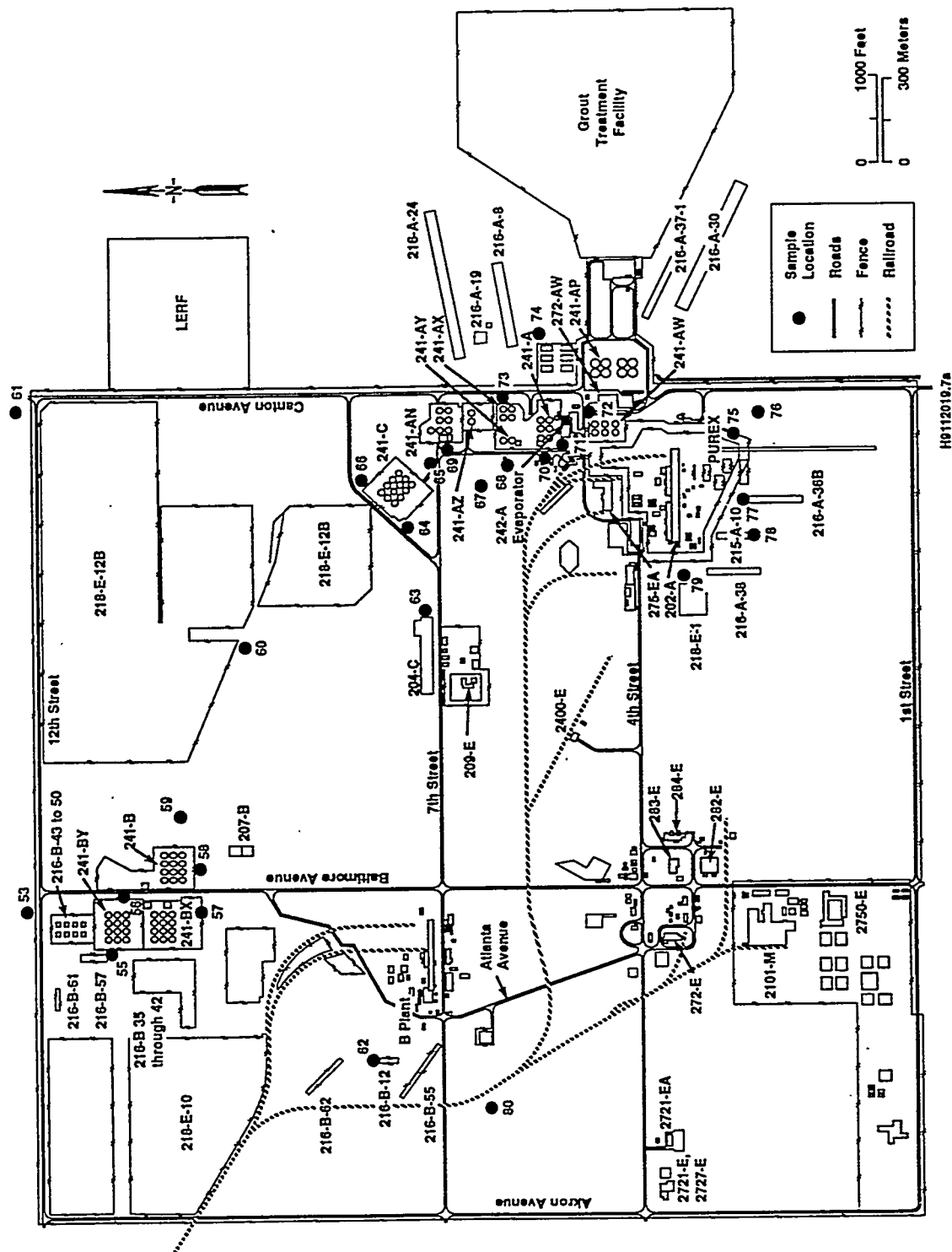


Figure II.B-10. OEM 200-West Area Soil Sampling Locations



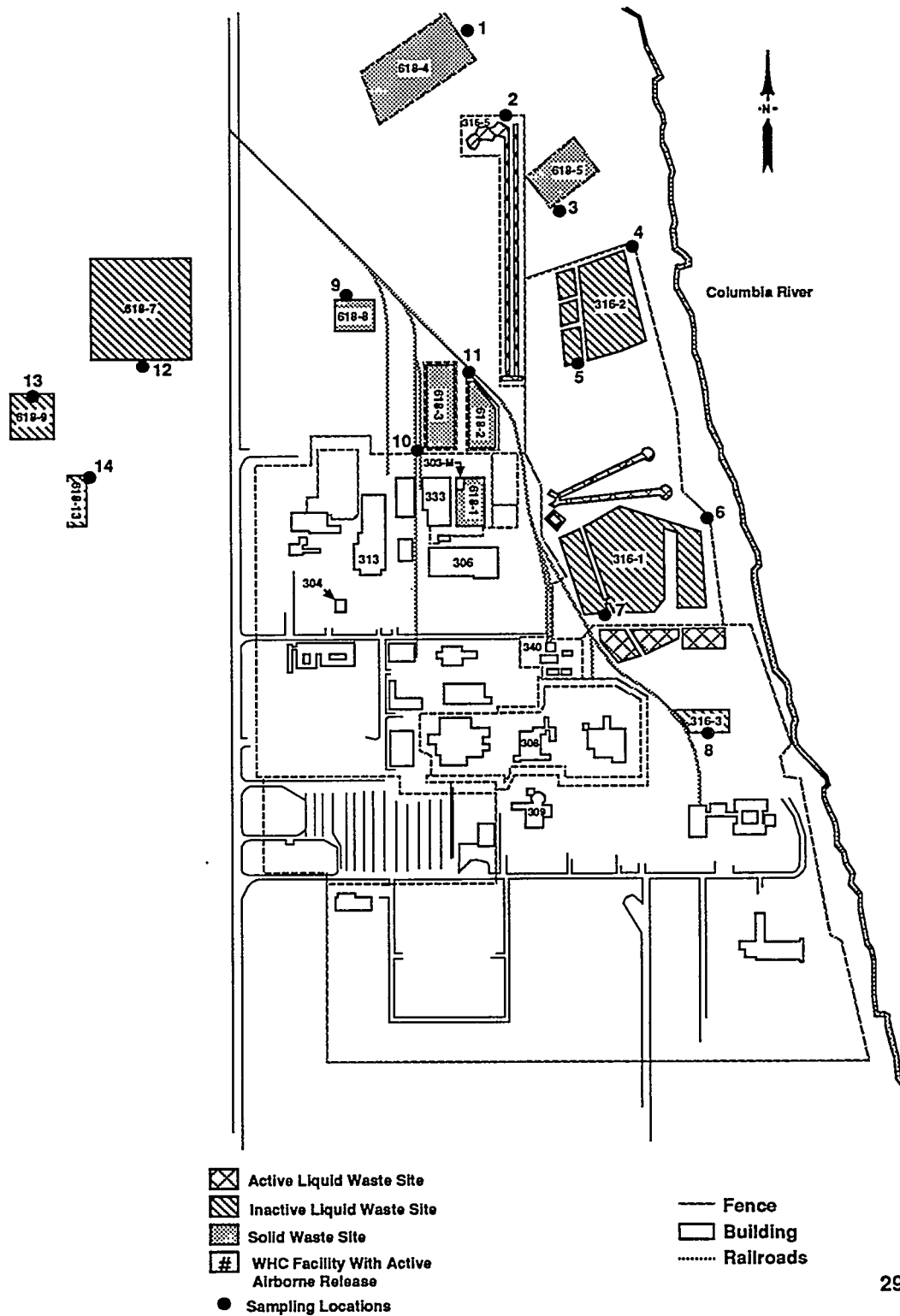
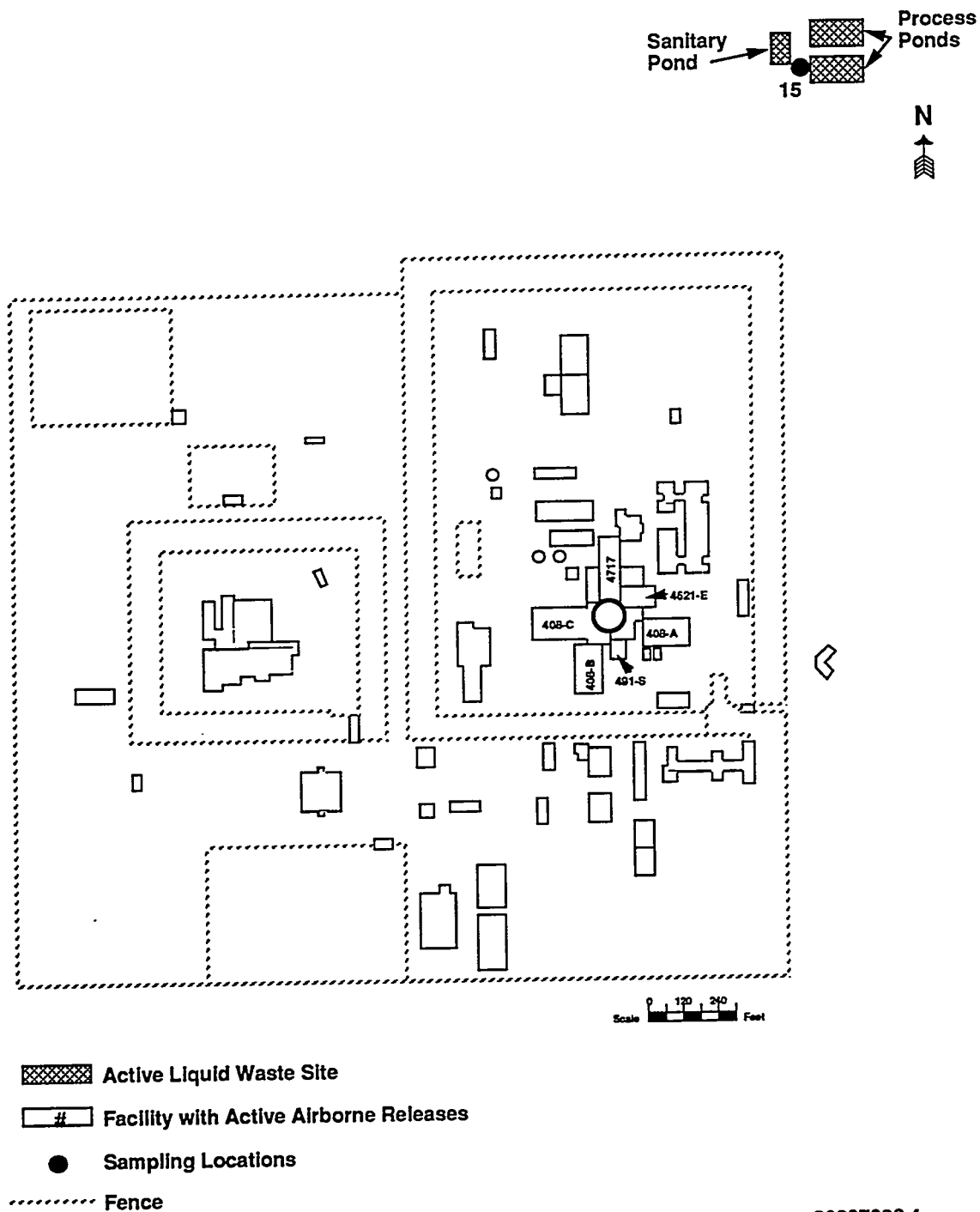
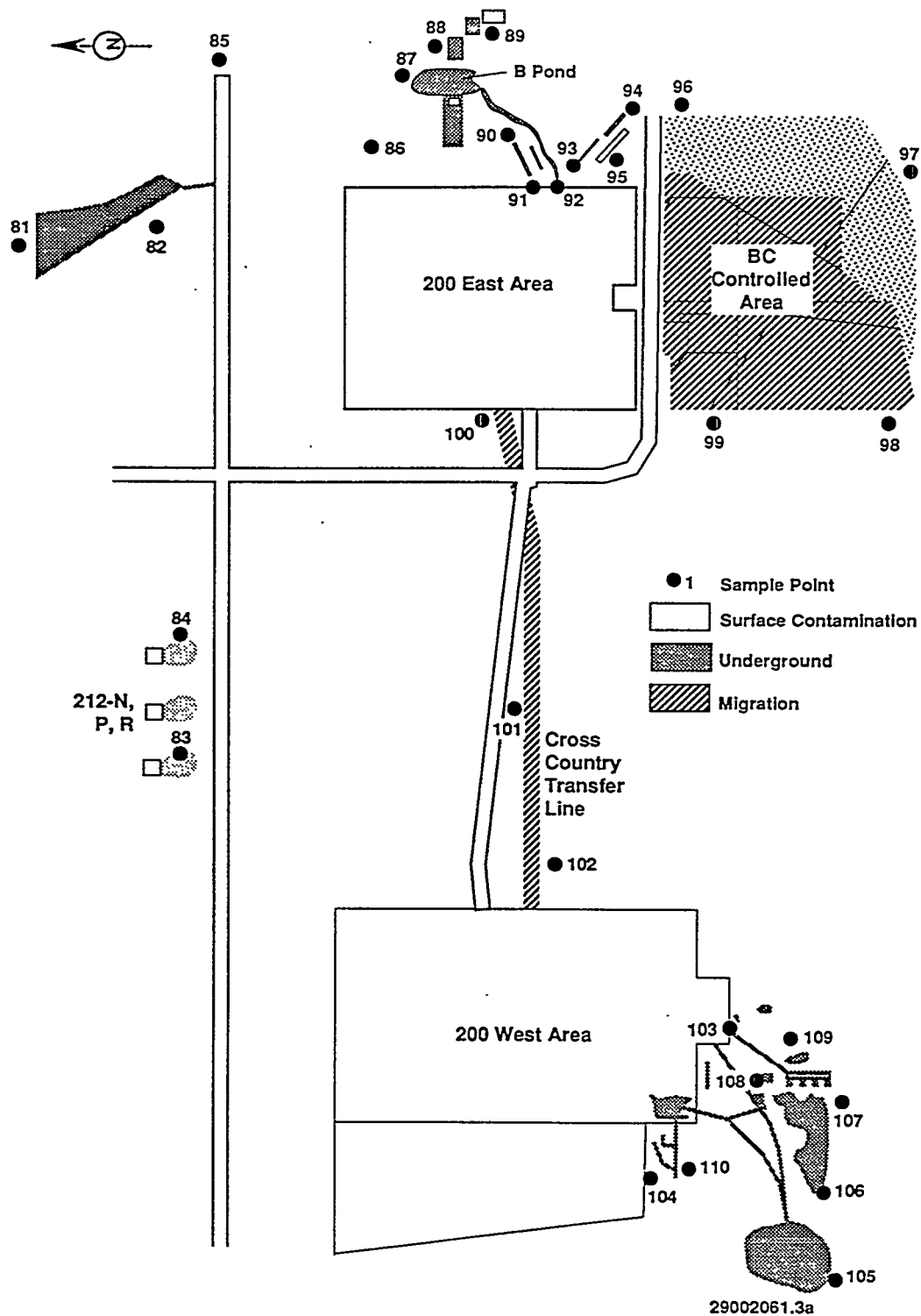


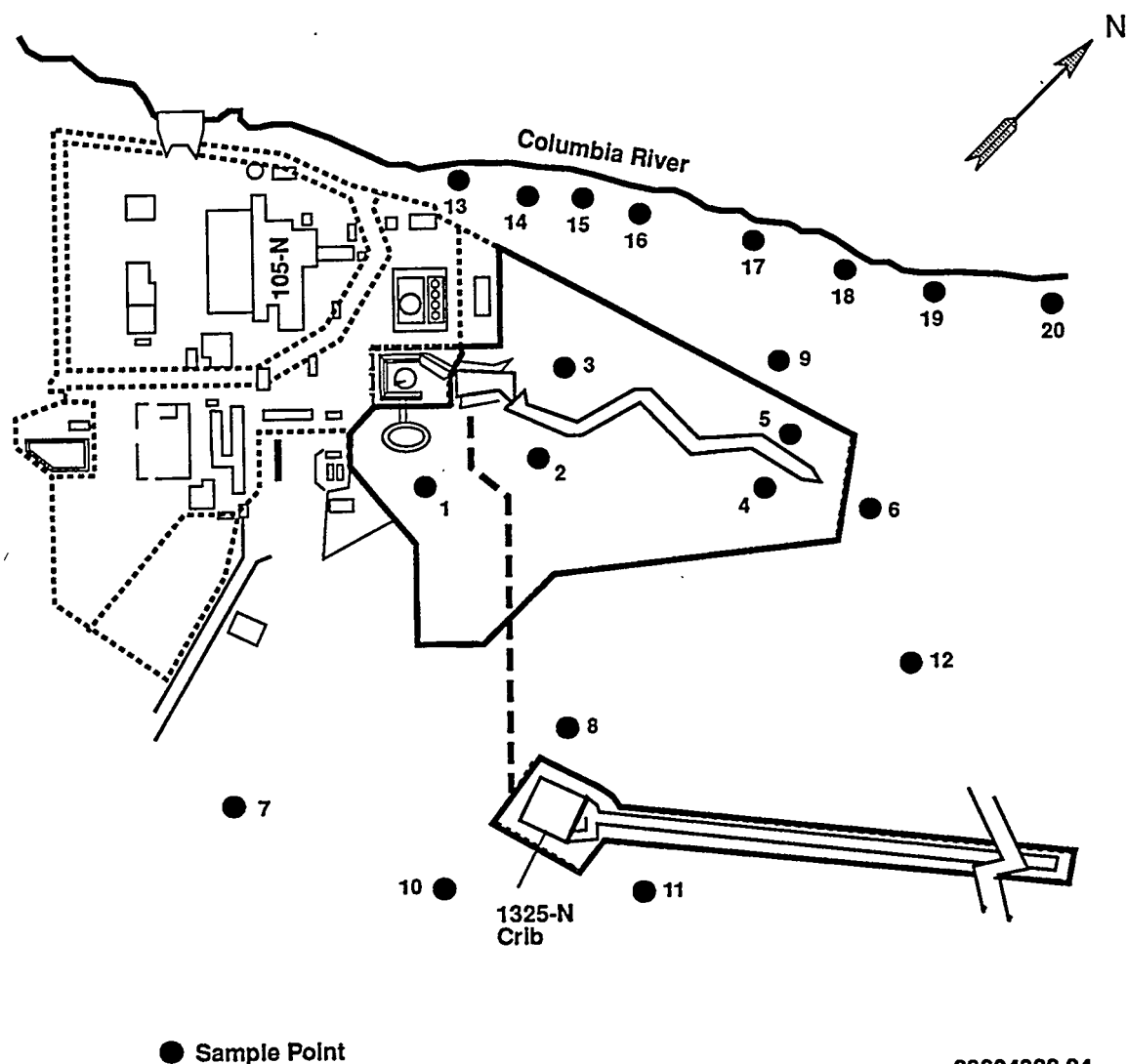
Figure II.B-12. OEM 300 Area Soil Sampling Locations



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Figure II.B-13. OEM 400 Area Soil Sampling Locations

**Figure II.B-14. OEM 600 Area Soil Sampling Locations**



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Figure II.B-15. OEM 100-N Area Vegetation Sampling Locations

spoon) for special soil sampling, or 3) a plug (cookie cutter) sampler for routine samples. All equipment is easily decontaminated or disposable. Samples are placed in a sealable plastic bag or other approved container and then placed in an approved shipping container.

- **Vegetation** - Vegetation sampling equipment consists of pruning shears, loppers, saws, core drill, or machete. Samples are cut to length, placed in a plastic bag, and placed in an approved shipping container.
- **Animal** (feces, nests, or carcasses) - OEM animal samples are usually collected by pest control. The animals are checked for radioactive contamination by Radiation Control (RC), and those animals found to be contaminated may be kept for analysis. These animal samples are put in a plastic bag and placed in an approved shipping container.

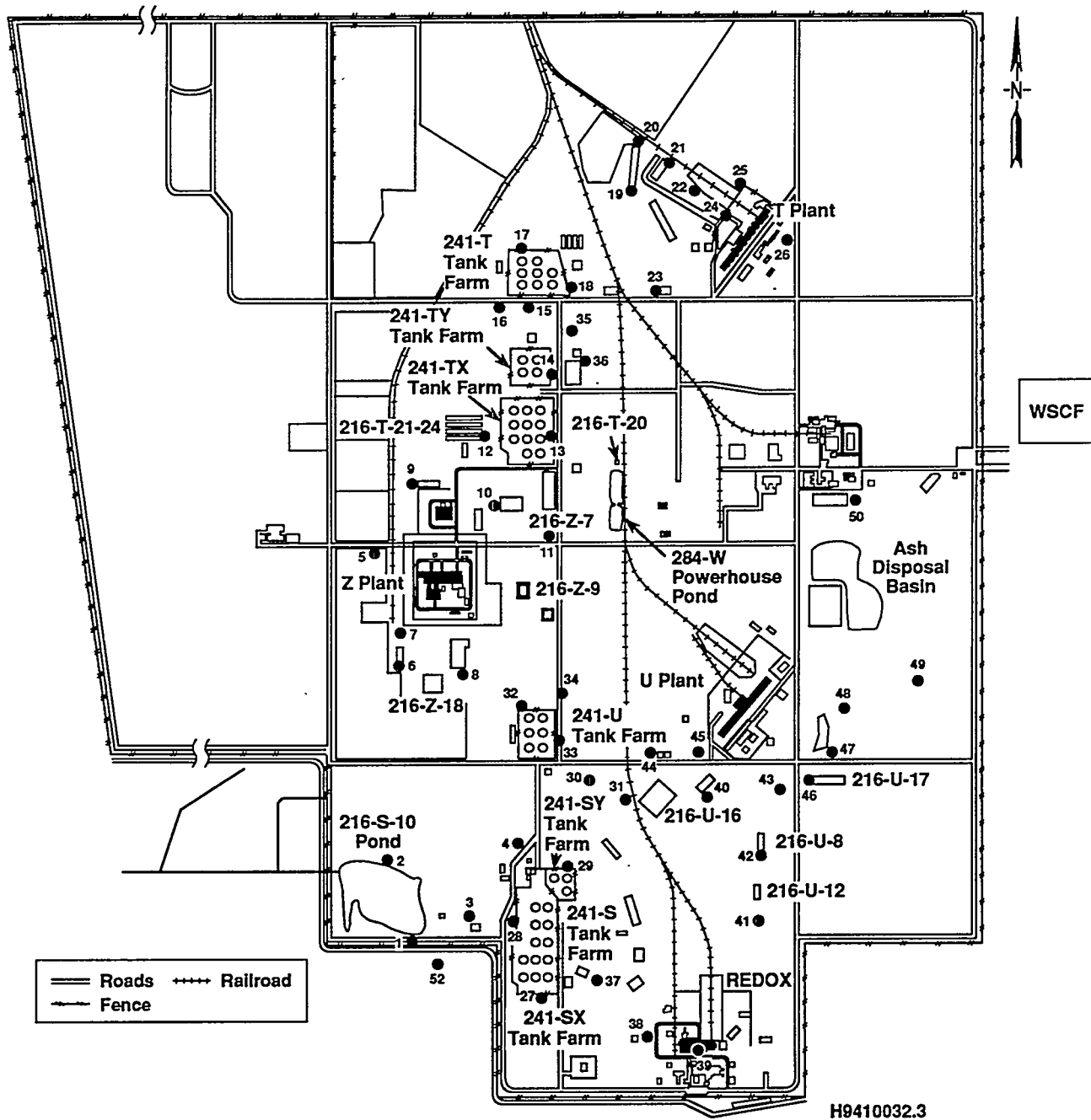
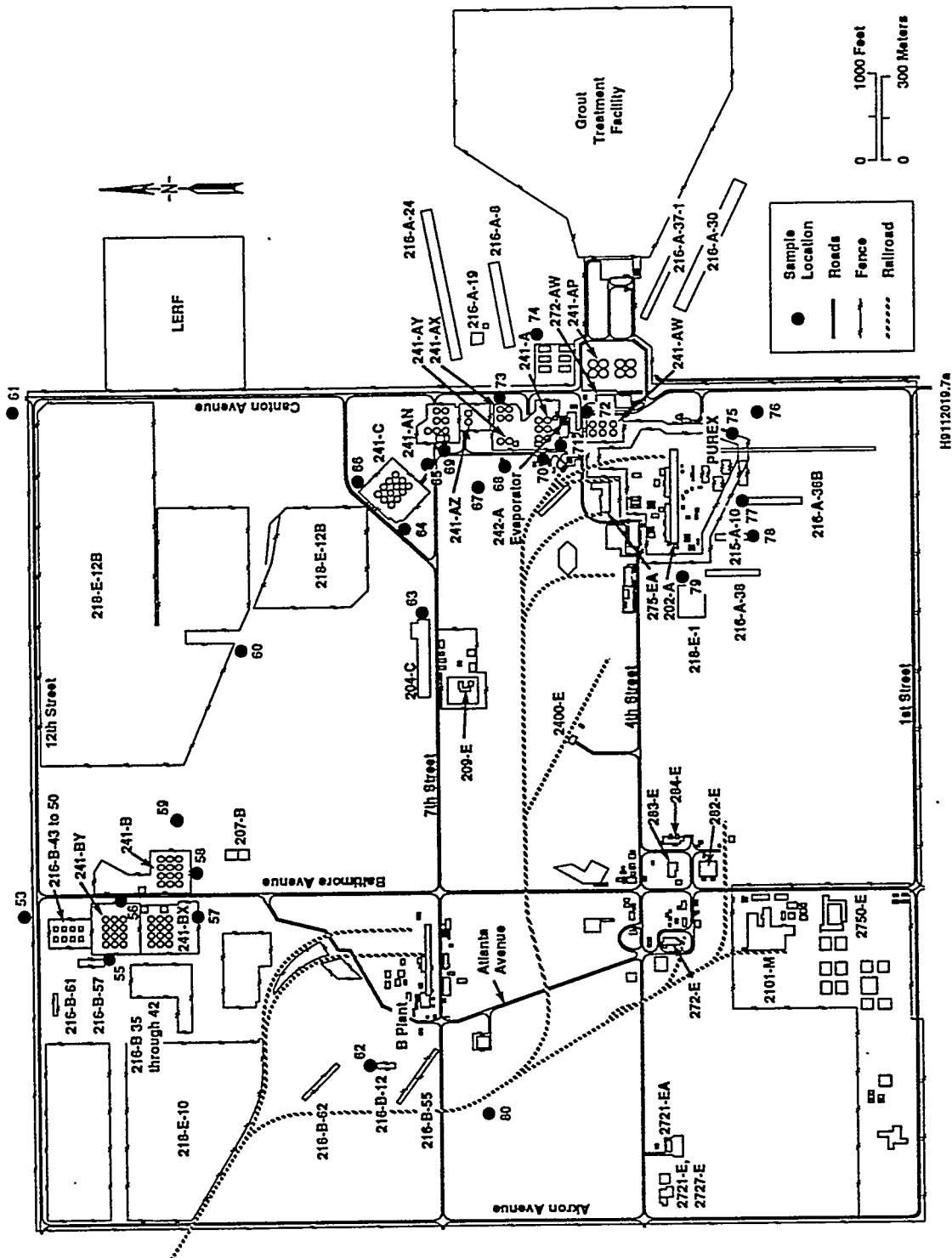


Figure II.B-16. OEM 200-West Area Vegetation Sampling Locations



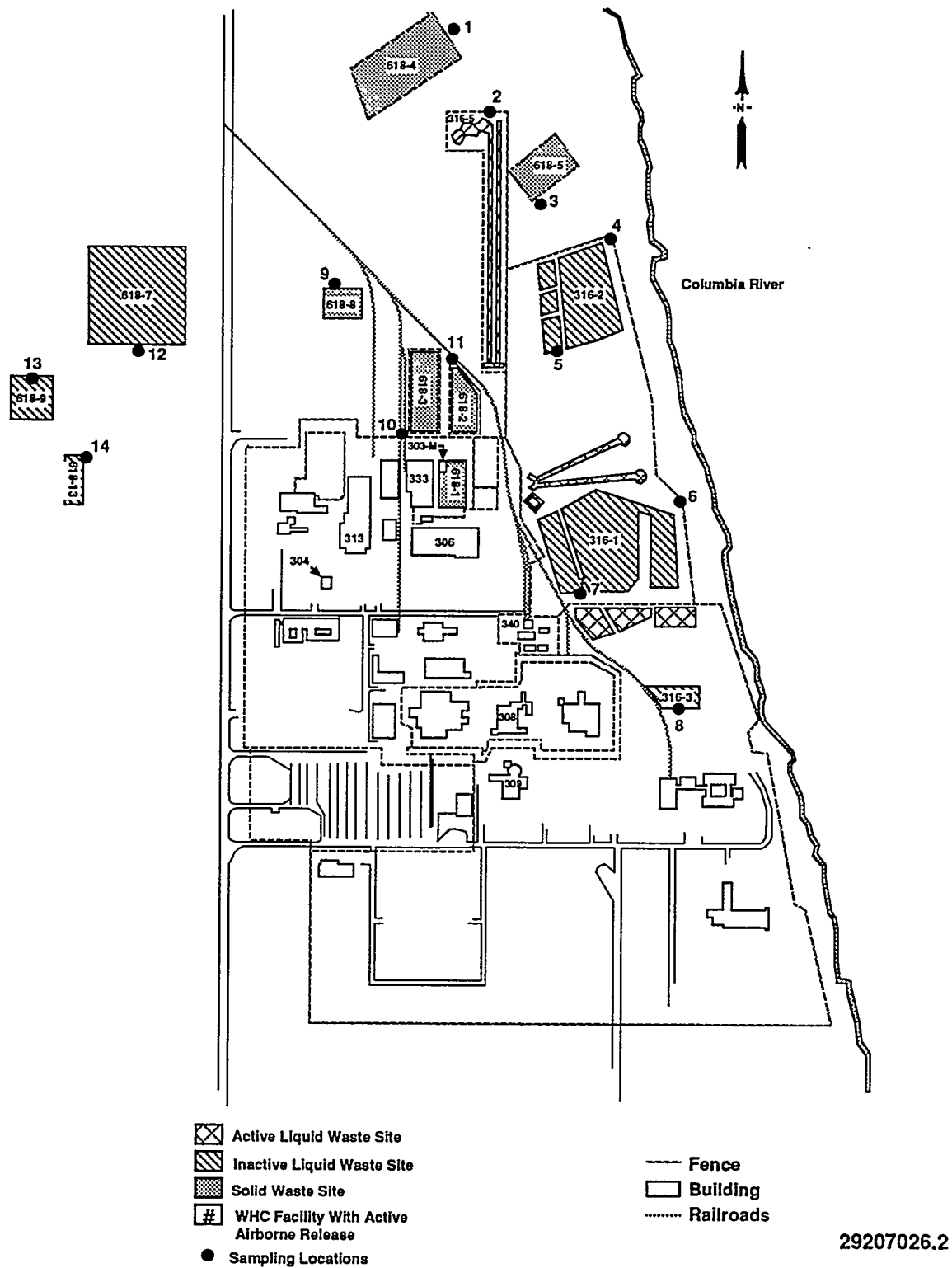
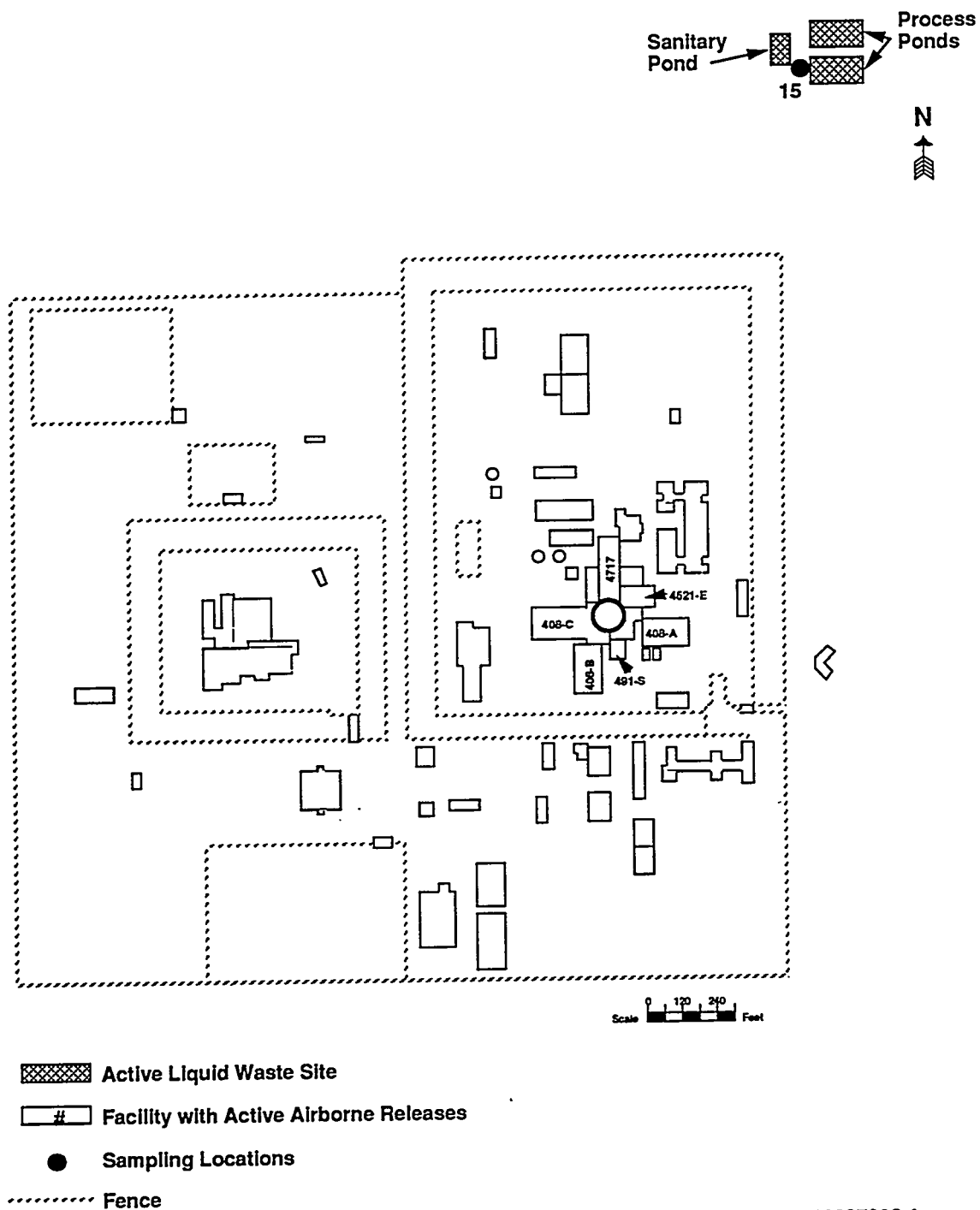


Figure II.B-18. OEM 300 Area Vegetation Sampling Locations



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Figure II.B-19. OEM 400 Area Vegetation Sampling Locations

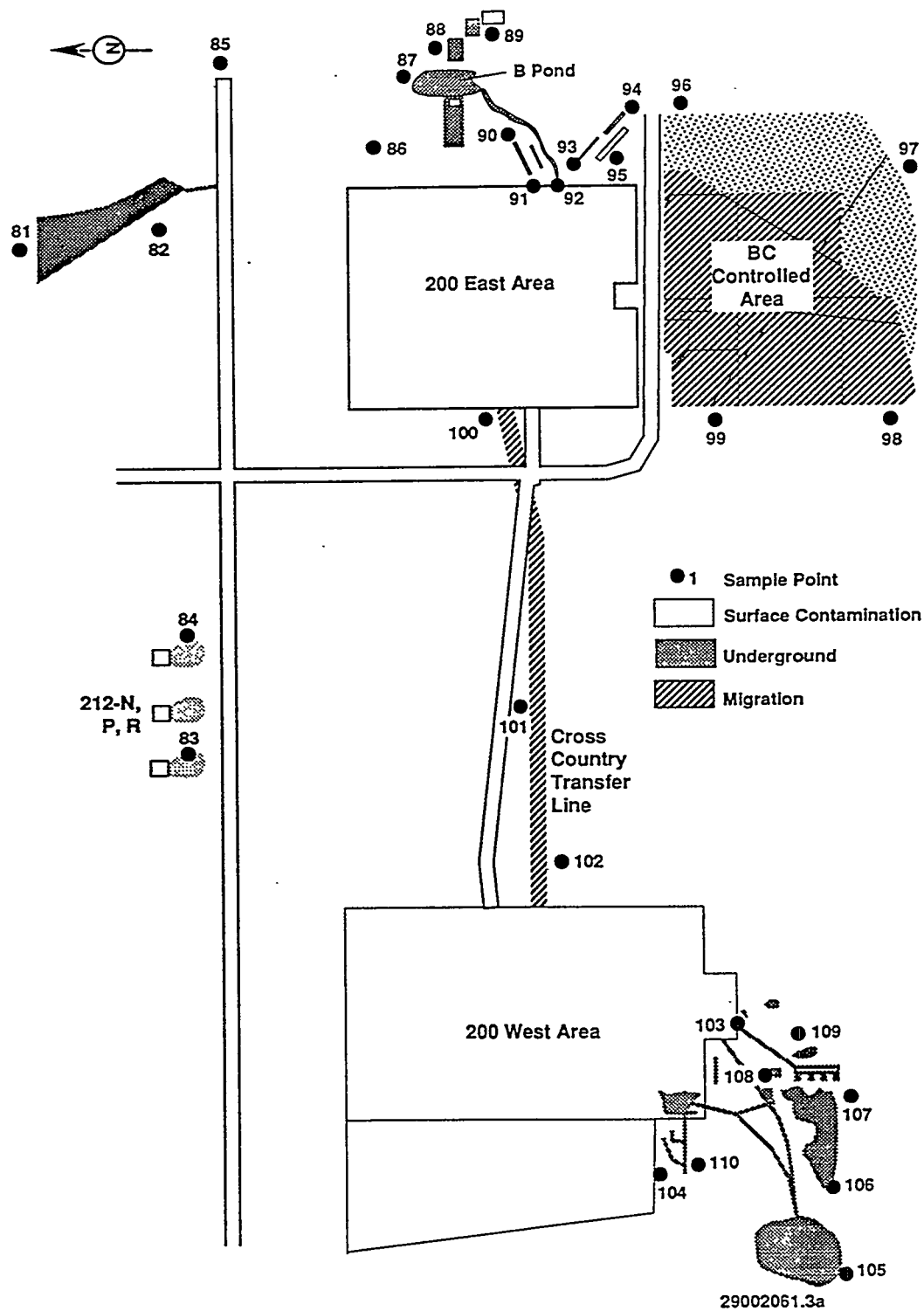


Figure II.B-20. OEM 600 Area Vegetation Sampling Locations

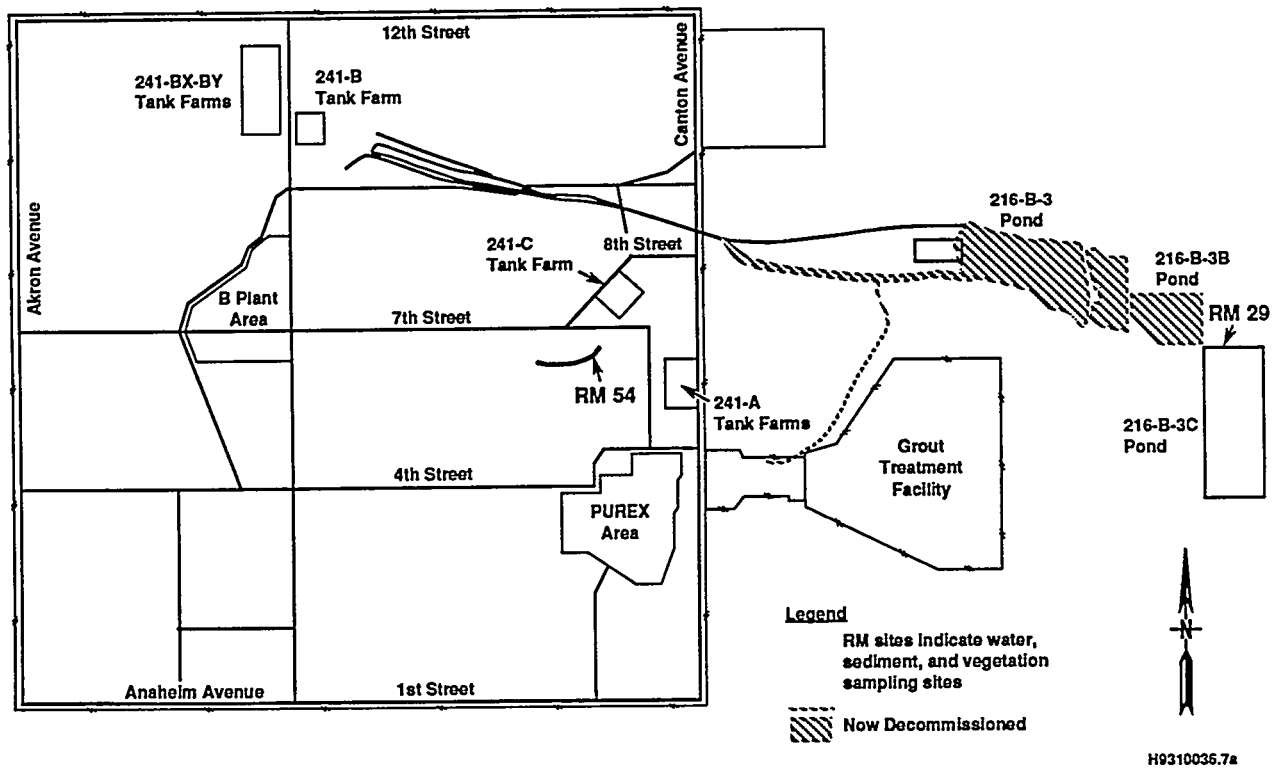
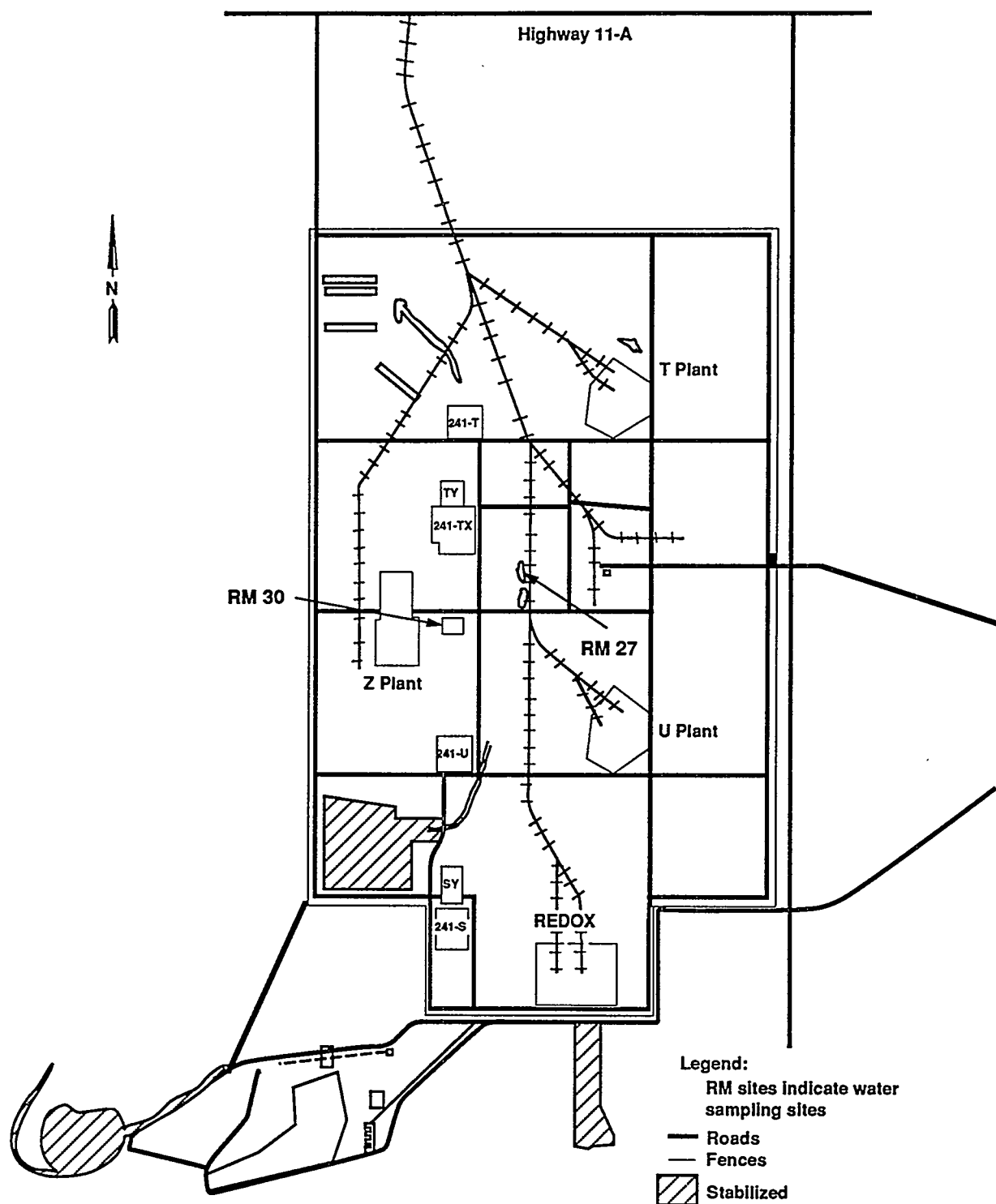
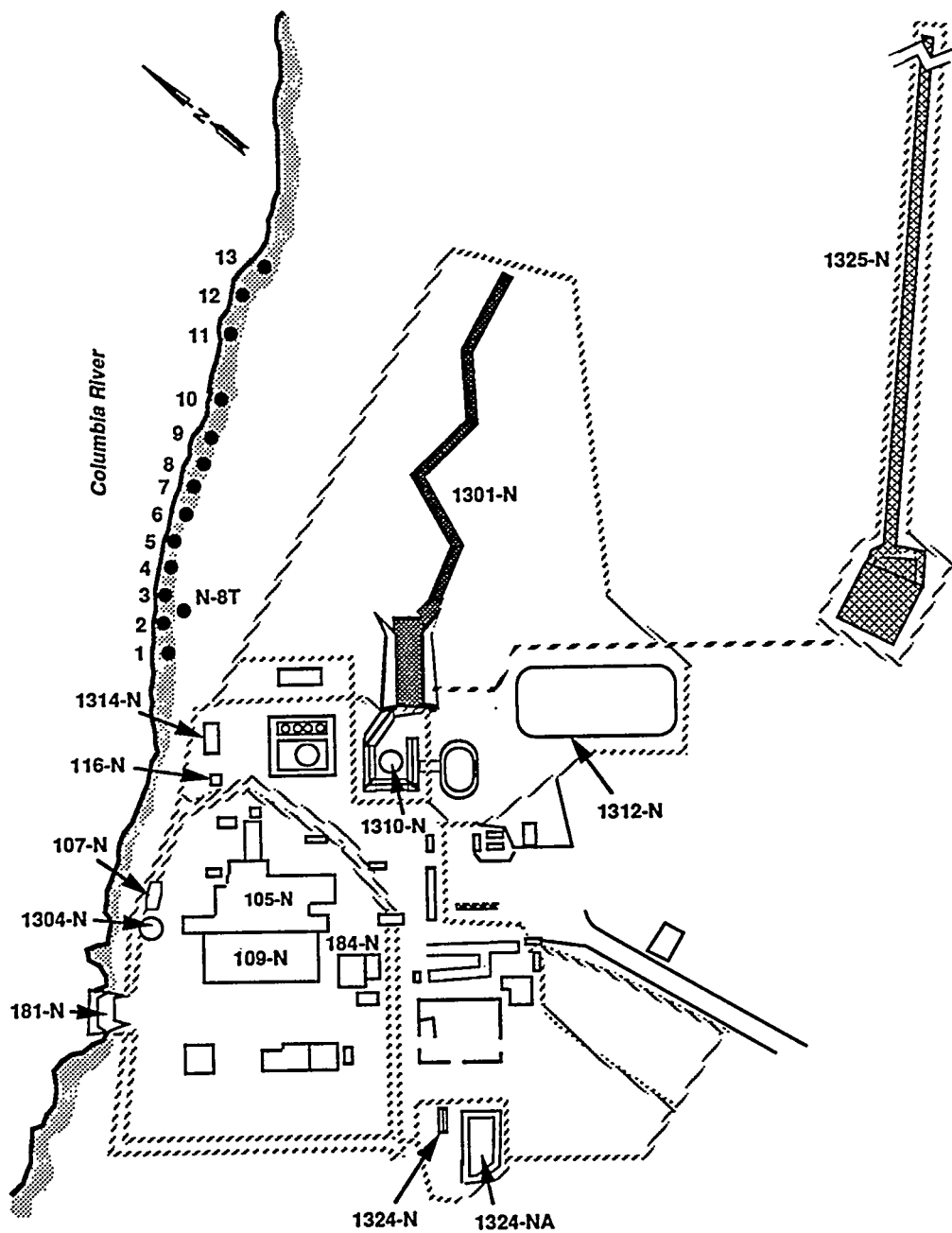


Figure II.B-21. OEM 200-East Area Pond and Ditch Sample Sites



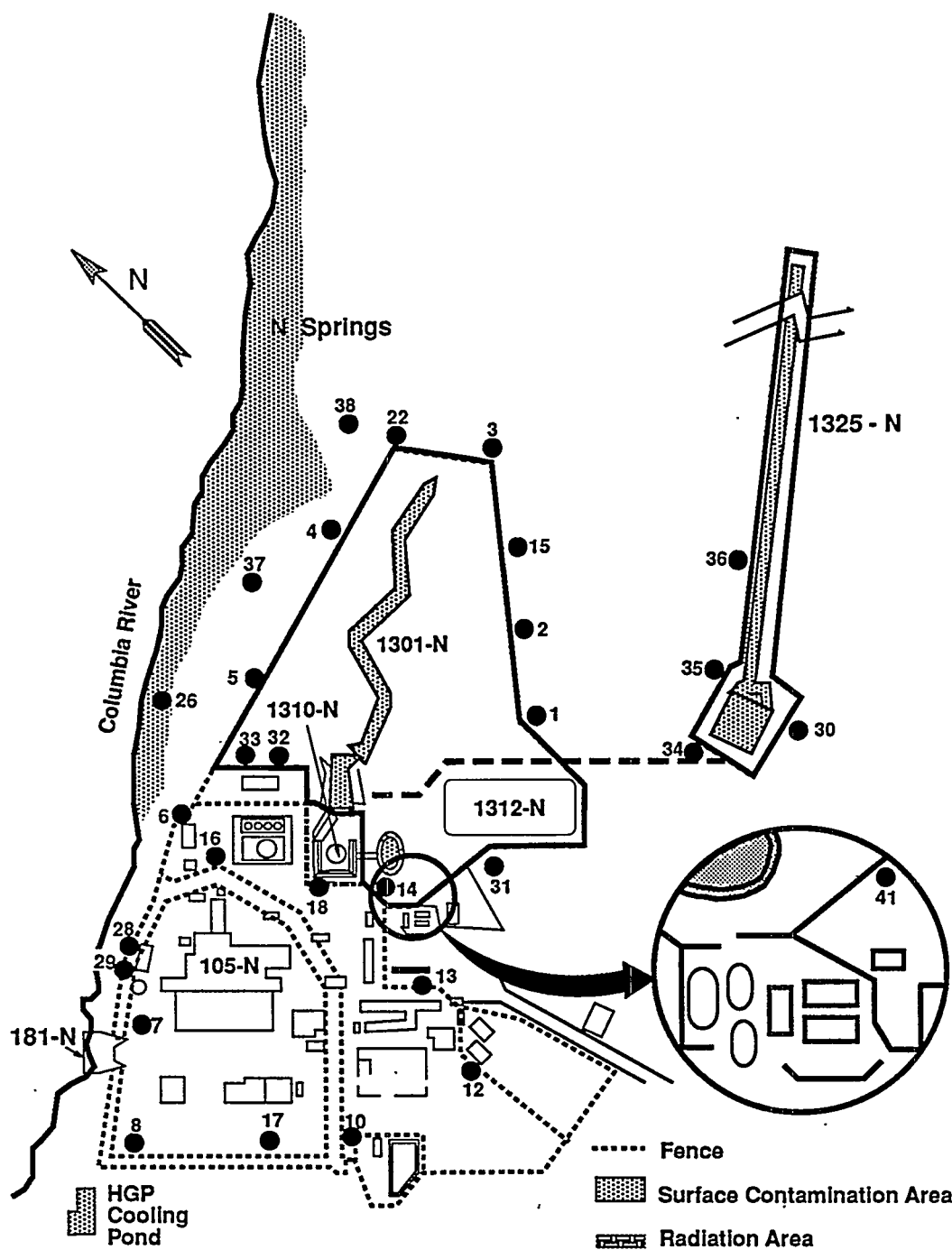
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Figure II.B-22. OEM 200-West Area Pond and Ditch Sample Sites



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Figure II.B-23. OEM 100-N Seeps Sample Sites (N-Springs Sampling Well Locations)



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Figure II.B-24. Location of OEM Environmental Dosimeters at the 100-N Area

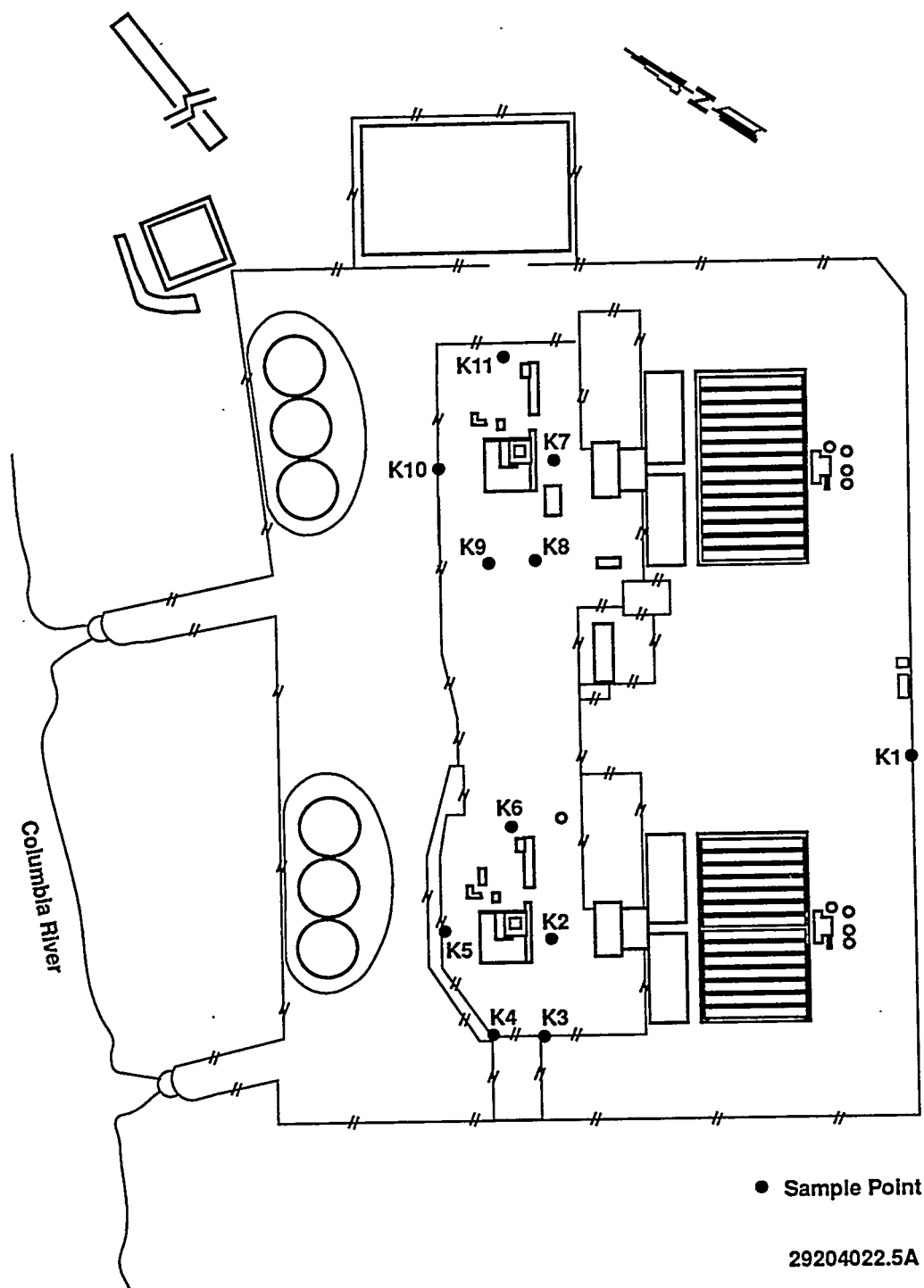


Figure II.B-25. Location of OEM Environmental Dosimeters at the 100-K Area

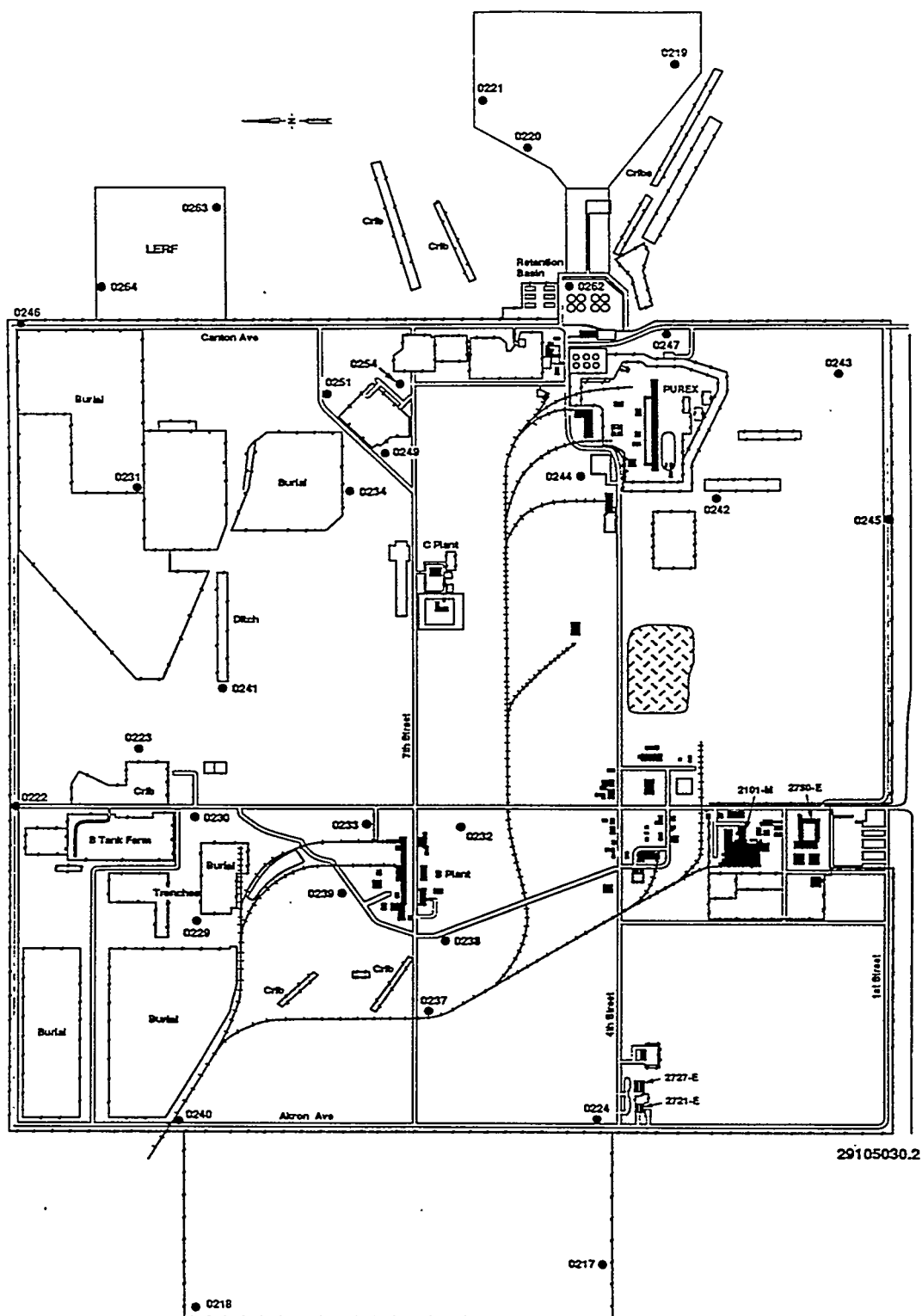
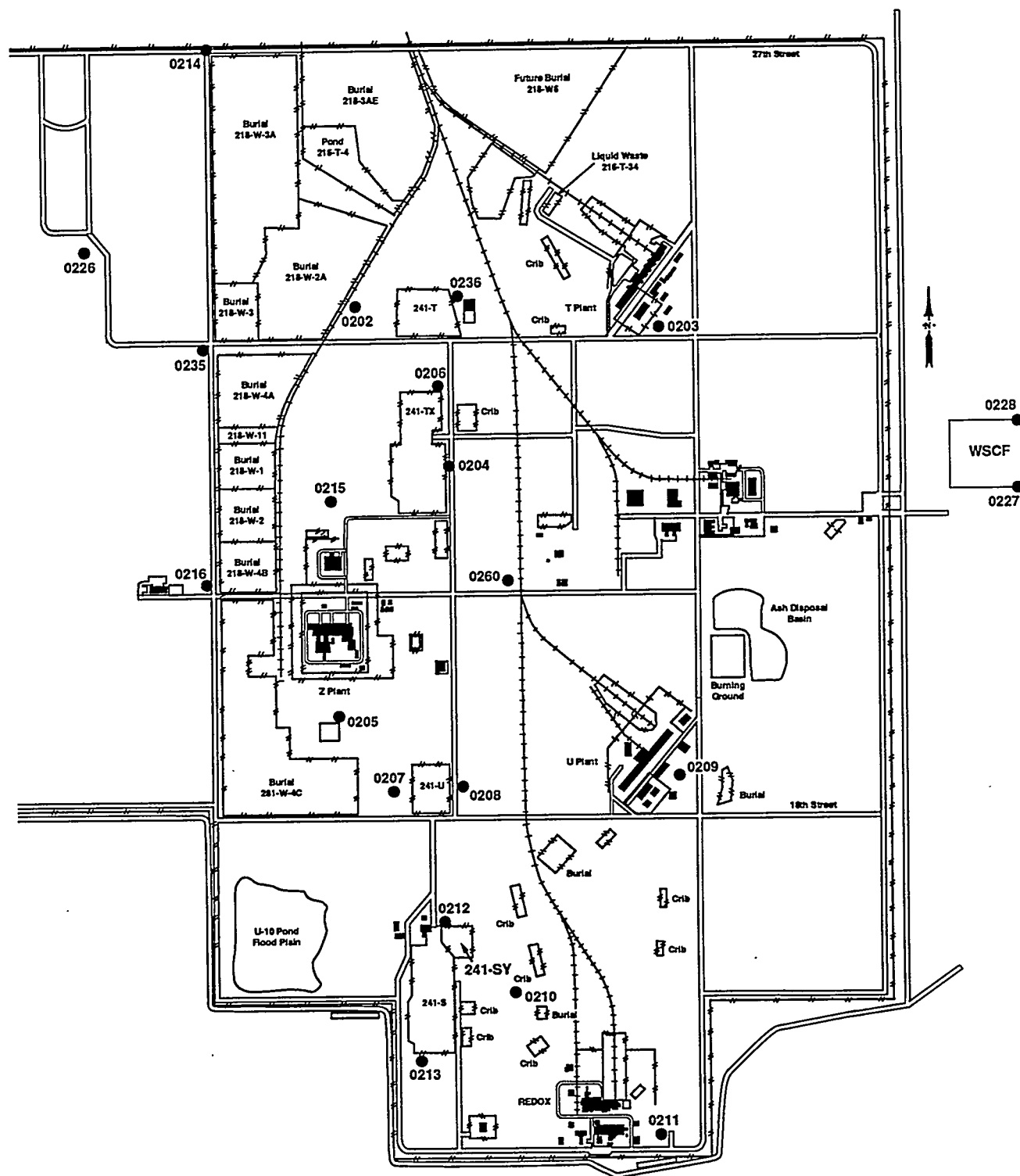


Figure II.B-26. 200-East Area OEM Thermoluminescent Dosimeter Locations



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Figure II.B-27. 200-West Area OEM Thermoluminescent Dosimeter Locations

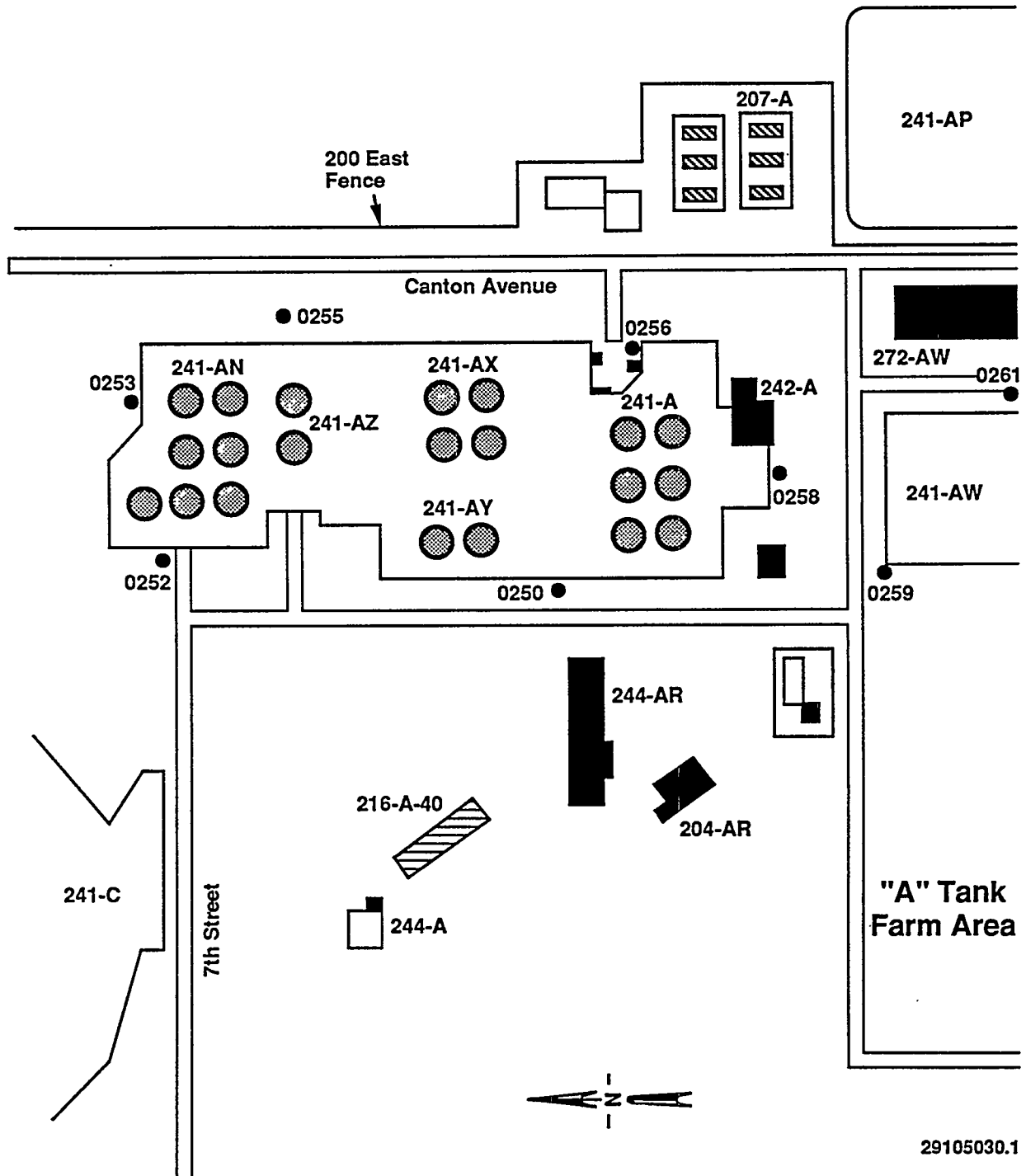


Figure II.B-28. OEM Thermoluminescent Dosimetry Locations in the "A" Tank Farm Area

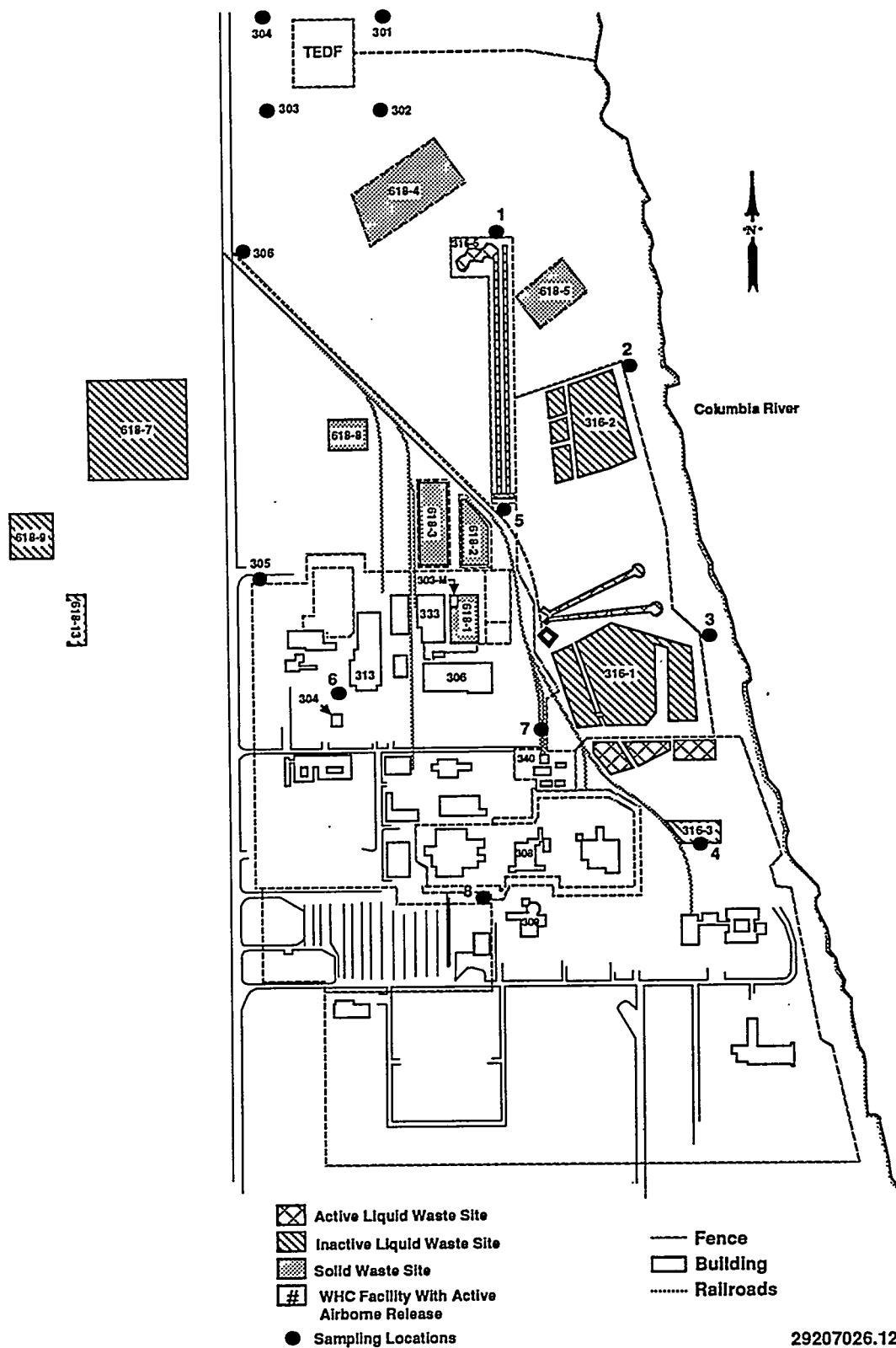


Figure II.B-29. 300 Area OEM Thermoluminescent Dosimeter Locations

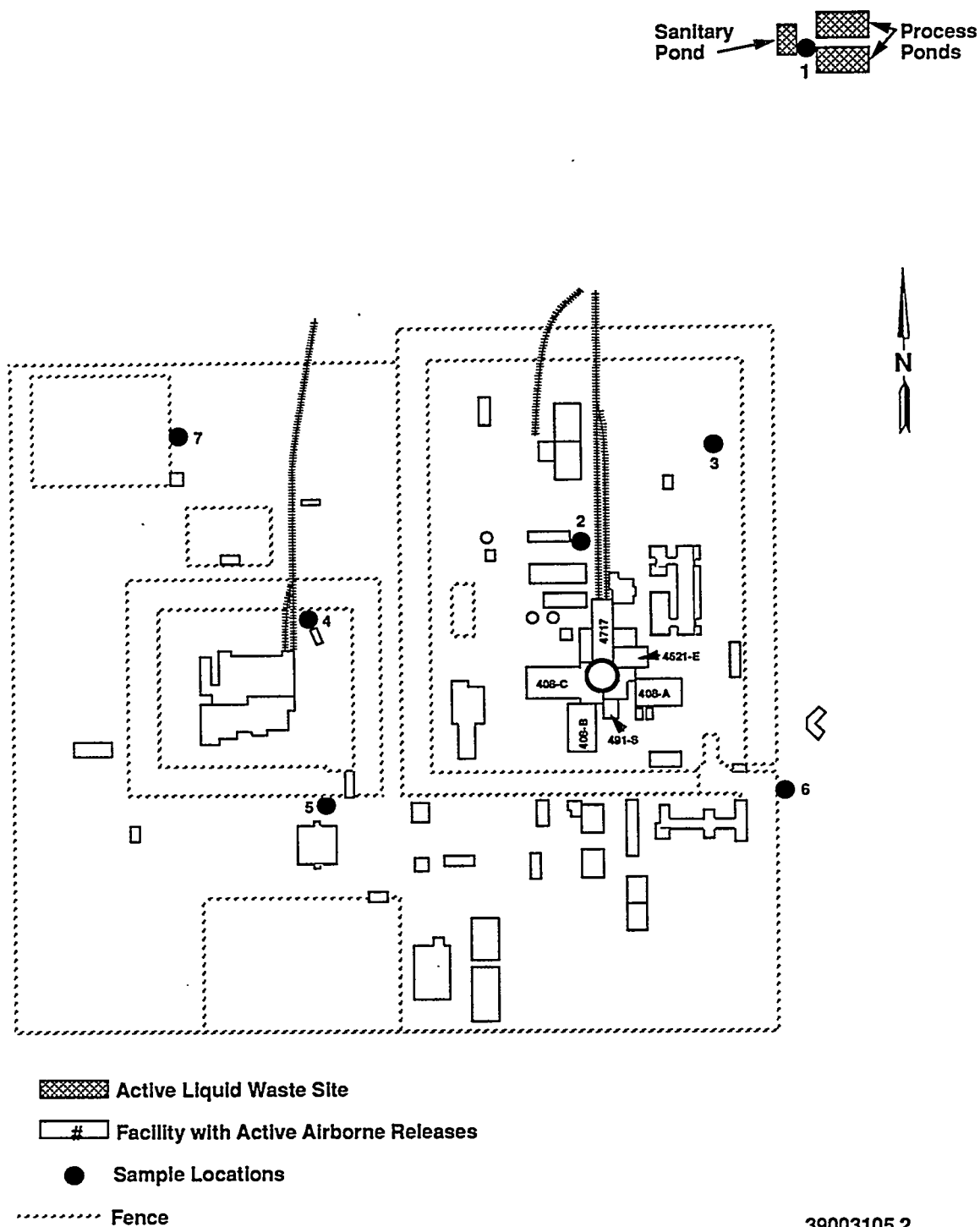


Figure II.B-30. 400 Area OEM Thermoluminescent Dosimeter Locations

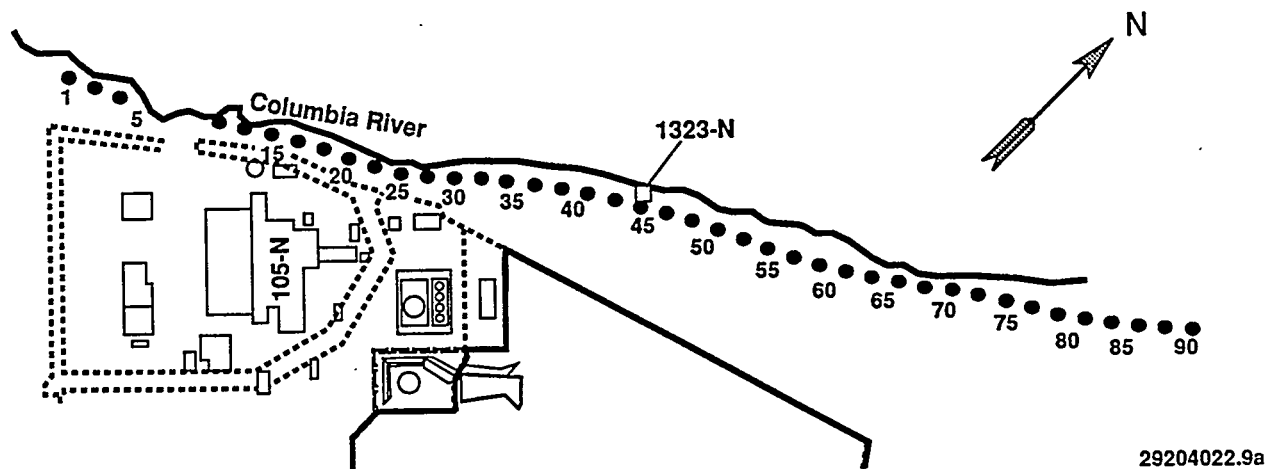


Figure II.B-31. OEM 100-N Area Environmental Dose Rate Survey Points Along the Columbia River Shoreline

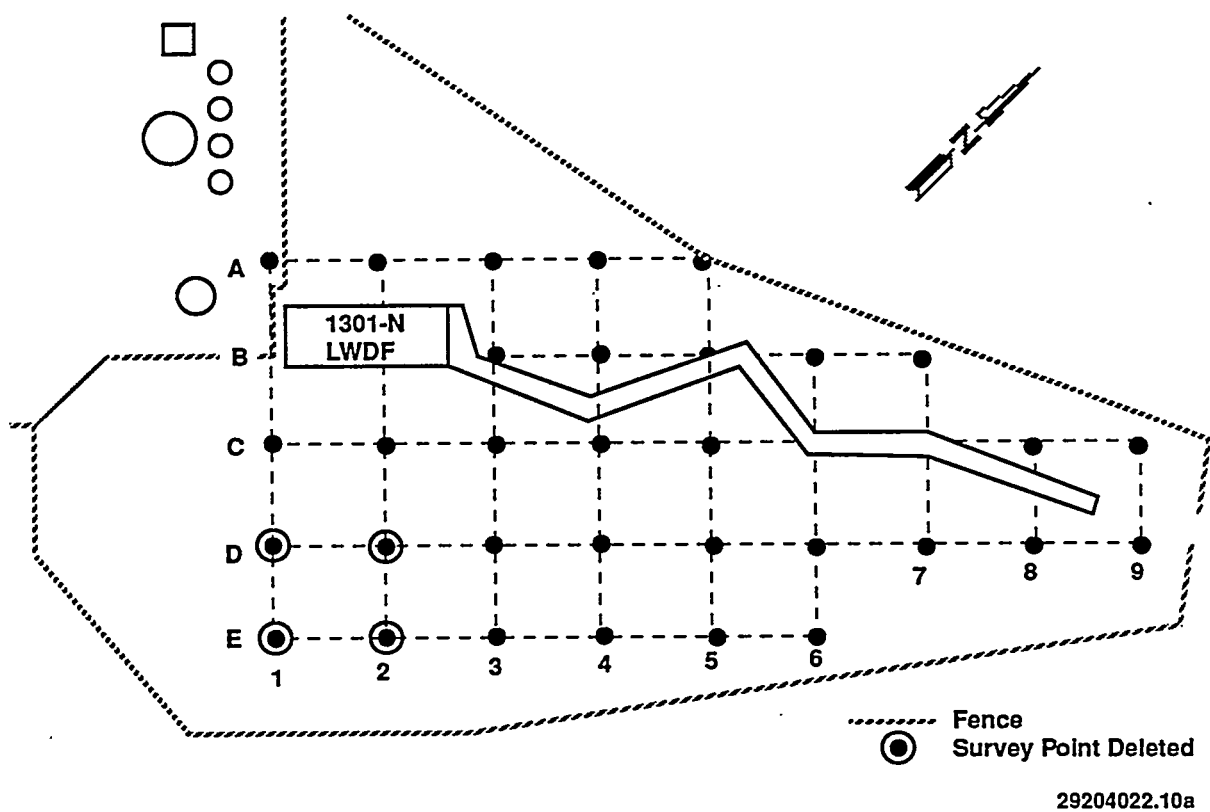


Figure II.B-32. OEM 100-N Area Environmental Dose Rate Survey Points Around the 1301-N Liquid Waste Disposal Facility

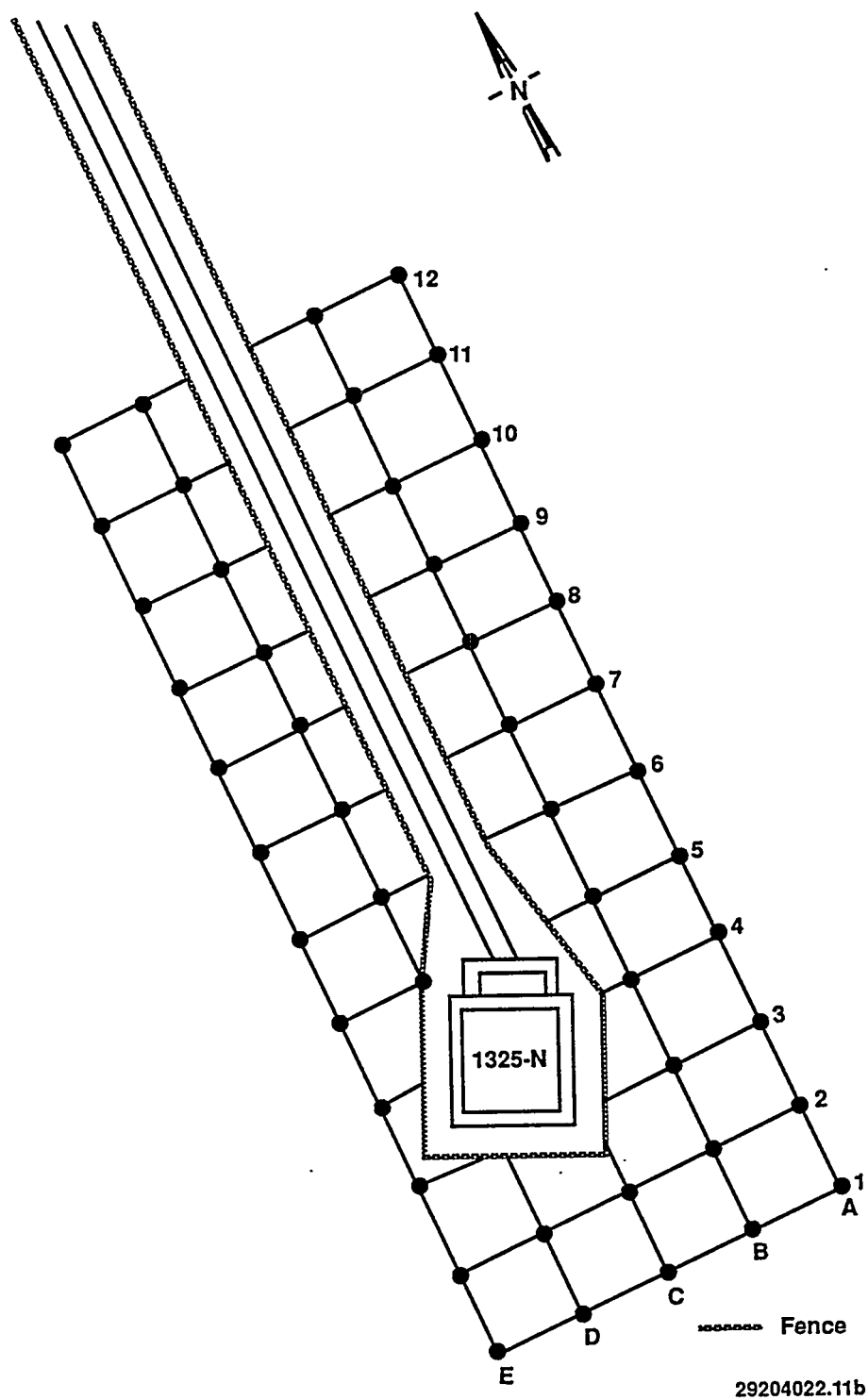


Figure II.B-33. OEM 100-N Area Environmental Dose Rate Survey Points Around the 1325-N Liquid Waste Disposal Facility

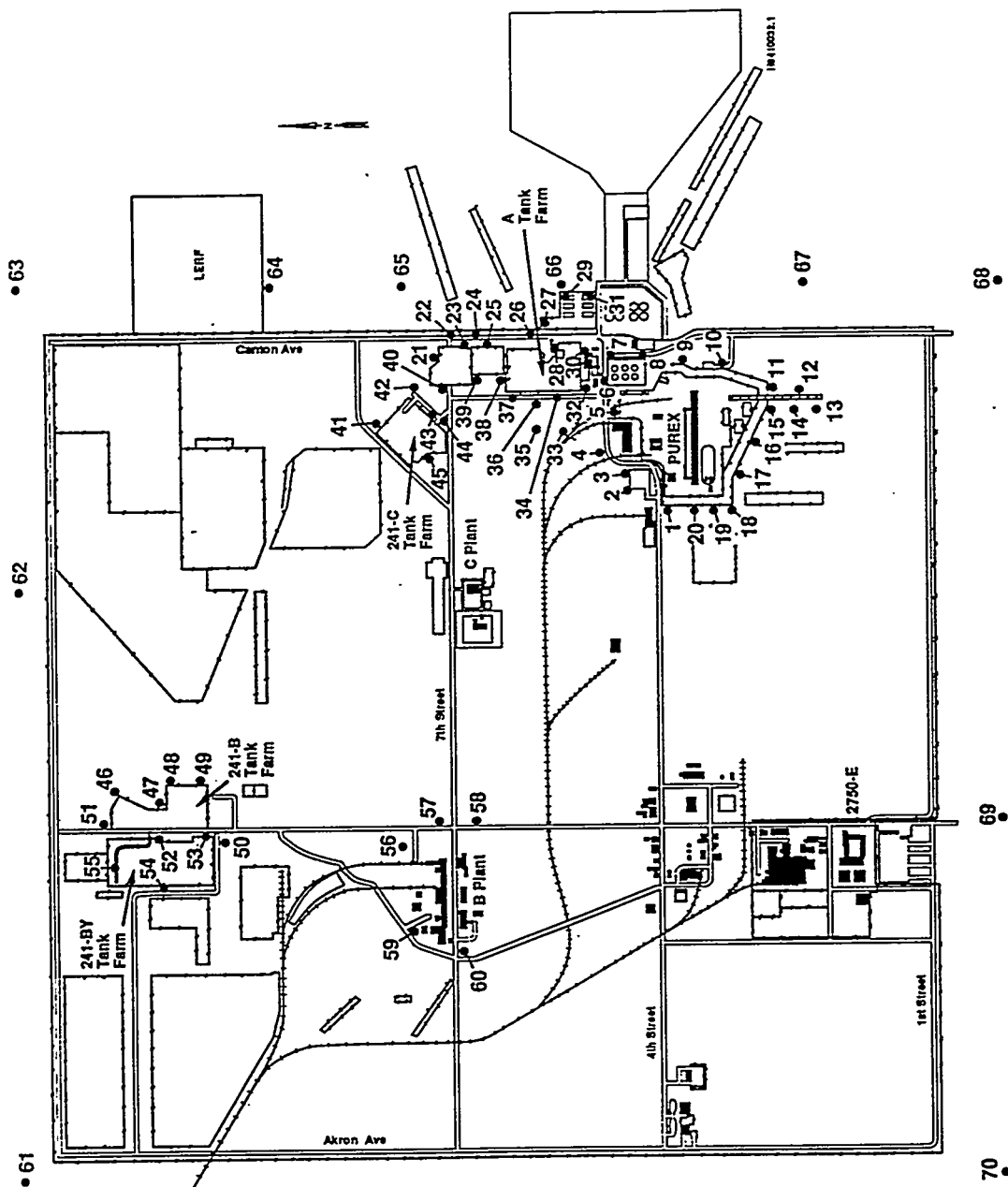


Figure II.B-34. OEM 200-East Area Environmental Dose Rate Survey Points

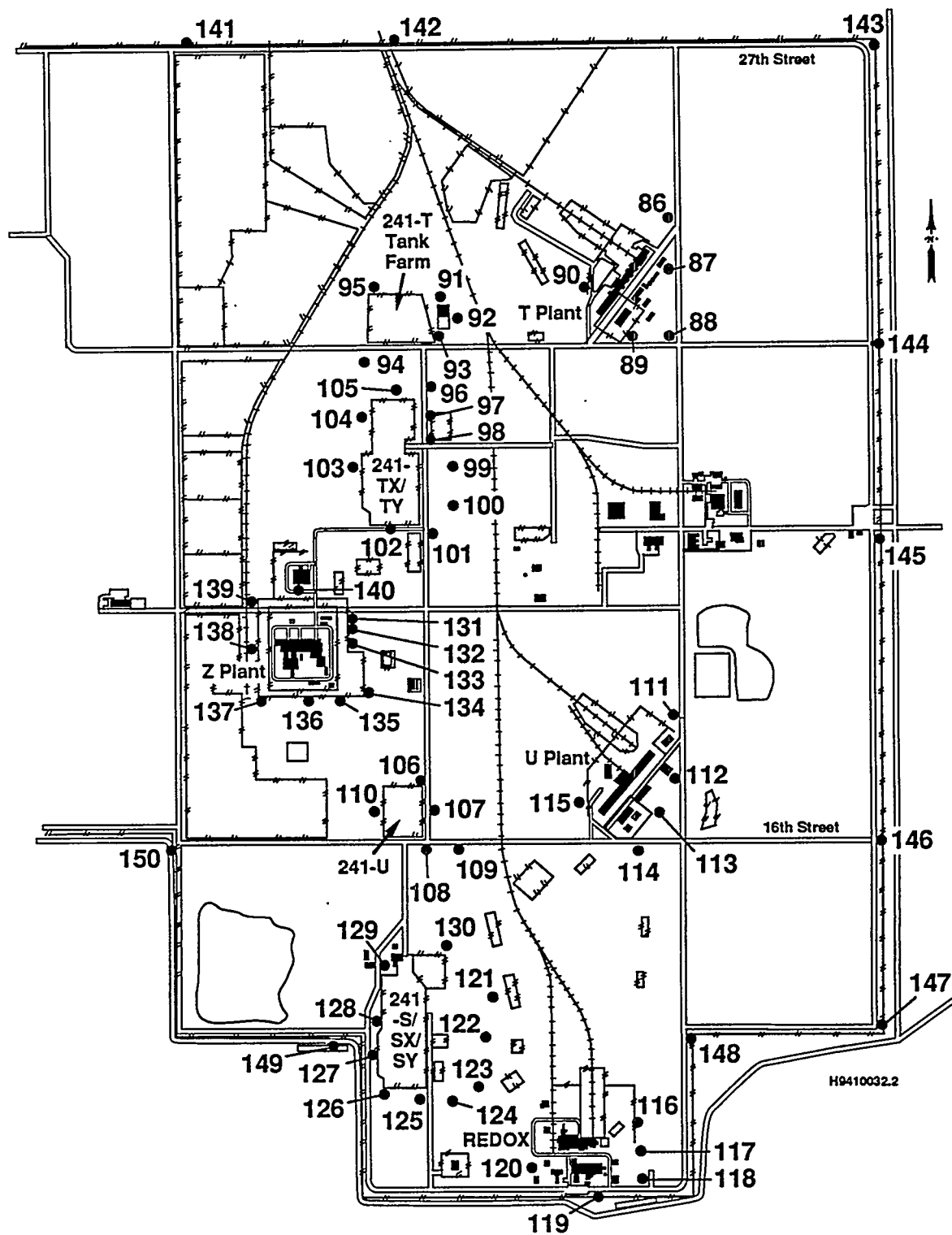


Figure II.B-35. OEM 200-West Area Environmental Dose Rate Survey Points

- **Surface Water** - Surface water collection sampling equipment consists of a clean cup (approximately 1 L) attached to the end of a sampling pole. The sample is taken at the designated sampling location by dipping the sampling cup into the surface water (being careful not to disturb the sediments). The sample is then poured into a larger sample container, and the process repeated until the sample container is full. One additional full cup of sample is then taken from the surface water, and a field reading is taken of the pH. This sample is then returned to the surface water.
- **Aquatic Sediment Sampling** - Aquatic sediment samples are collected using two methods. Sediment core sampling requires the use of a soil core sampler equipped with a sample liner. The core sampler is forced into the sediment to a depth of 30 cm. The liner is withdrawn from the sampler, and the retained sediment is placed into a watertight plastic jar, sealed, and labeled appropriately for delivery to the designated laboratory for analyses.

Surface sediment sampling utilizes a flat-bladed shovel and cookie cutter/spatula-type sampler. The sample is collected by skimming an approximate 2.54-cm-deep portion of sediment into the shovel and removing it carefully from the water. The cookie cutter is forced into the sediment. Excess sediment is removed by scraping it away with the spatula. The spatula is then cautiously placed under the cookie cutter, trapping the sample. The sample is placed in a watertight plastic jar, sealed, and labeled appropriately for delivery to the designated laboratory for analyses.

- **Aquatic Vegetation Sampling** - Aquatic vegetation samples are collected using various tools, such as shears, pruners, and loppers. Vegetation is collected either directly from the water source or bank in 500-g samples and placed in a plastic bag. The sample is double-bagged and labeled appropriately for delivery to the designated laboratory for analyses.
- **Ground Water** - Ground-water sampling is discussed later in this section.
- **Background Dose Rate** - Background dose rates are taken by two methods, thermoluminescent dosimeters (TLDs) and micro-R meters. The TLDs consist of four LiF (TLD-700) and one $\text{CaF}_2\text{:Dy}$ (TLD-200) chips in a plastic card supplied by PNL. Three TLDs are placed at each sampling location on a post at 1 m from the surface. Micro-R meters are calibrated by PNL and used by RC to measure relative background dose rates.
- **Radiation Surveys** - Radiation surveys include road/railroad surfaces, cribs, stabilized burial grounds, covered ponds and ditches, tank farm perimeters, active burial ground perimeters, unplanned release sites and other radiation areas. Methods and procedures for these surveys can be found in WHC-CM-7-4, *Operational Environmental Monitoring*; WHC-CM-1-6, *WHC Radiation Control Manual*; HSRM-1, *Hanford Site Radiological Control Manual*; and WHC-IP-0718, *Health Physics Procedures*.

Road and Rail Surveys - Road surveys are performed with a Mobile Surface Contamination Monitor (MSCM) Tractor or a vehicle equipped with sodium iodide detectors or plastic scintillators. Railroad surveys are conducted with a vehicle equipped with "high railers," which allows the truck to travel both on the roads or railroads, and sodium iodide detectors. The detector height is adjustable in all cases, and the average survey height is 1 ft.

The vehicles are driven at less than 5 mph per hour. When activity is detected, the vehicle is stopped and a thorough survey is made with an Eberline Model BNW-1 portable survey instrument equipped with a P-11 probe to identify the extent of the contamination. Appropriate management is notified when road contamination is identified and corrective actions are initiated.

Waste Sites and Other Radiation Area Surveys - Surveys at waste sites and other radiation areas may be conducted with vehicles equipped with radiation detection instruments or with hand-held field instruments. Field instrument survey results are reported in disintegrations per minute (using a conversion factor of 10 dpm/cpm) as detected by using a Geiger-Mueller detector for beta/gamma radiation. Alpha survey results are reported in disintegrations per minute as measured with a portable alpha meter (PAM) or a portable alpha counter (PAC-6). Surveys include the perimeter and portions of the ground surface of radiation areas. Wherever possible, smear surveys are made on the surface of exposed equipment within a radiation area. Vegetation, animal burrows, and animal feces are also monitored to detect biological transport. Detailed survey practices and procedures are described in WHC-CM-7-4, *Operational Environmental Monitoring*; WHC-CM-1-6, *WHC Radiation Control Manual*; HSRCM-1, *Hanford Site Radiological Control Manual*; and WHC-IP-0718, *Health Physics Procedures*.

Parameters Monitored

Parameters vary by media.

- **Ambient Air** - analyzed for isotopic or total gamma, strontium, plutonium, and uranium (tritium at selected locations).
- **Soil** - analyzed for isotopic or total gamma, strontium, and plutonium (uranium also in the 200 and 300 Areas).
- **Vegetation** - analyzed for isotopic or total gamma, strontium, and plutonium (uranium also in the 200 and 300 Areas).
- **Animal** - (feces, nests, and carcasses) at a minimum, analyzed for isotopic or total gamma, strontium, and plutonium (uranium also in the 200 and 300 Areas).
- **Surface Water, Sediments, and Aquatic Vegetation** - Surface water is analyzed for isotopic or total gamma, strontium, tritium, plutonium (uranium also in the 200 and 300 Areas), nitrates, and pH. Sediments and aquatic vegetation are analyzed for the same constituents except tritium, nitrates, and pH.
- **Ground Water** - analyzed for isotopic or total gamma, strontium, tritium, and plutonium (uranium also in the 200 and 300 Areas).
- **Background Dose Rate** - the external radiation in the area where samples are taken to identify any increasing or decreasing trends in background radiation that may affect the environment, workers, or public exposure.
- **Radiation Surveys** - measure the surface and background radiation in the area in which the measurement is taken.

Samples are, at a minimum, analyzed for the constituents listed in Table II.A-4 in Section II.A for the facility of concern. Initial sampling site locations are situated in known or suspected pathways, avoid barriers or diversions, and are close enough to monitor the operating environment.

Current Program Status (1994)

The following section identifies and discusses the status of the OEM during calendar year 1994. Updates to status program changes to the OEM will be provided in annual schedules issued every January for the following year of sampling and monitoring.

Nonradiological Ambient Air Monitoring

At the present time, the OEM does not conduct any environmental nonradiological air quality monitoring; however, the OEM staff are acquiring the capability so as to ensure compliance with environmental regulations. This approach will actively address diffuse/fugitive emission concerns raised by environmental regulators. Nonradiological ambient air quality measurements for parameters such as volatile organics or ammonia generally fall under the dual categories of effluent and contamination control as well as worker assurance. There appears to be a possibility of avoiding duplication of monitoring by having the various user groups share data from monitoring and sampling. Sometimes this monitoring is outside the immediate work place; however, it is conducted to address regulators' concerns that effluent and contamination controls are adequate to demonstrate compliance with established standards.

Currently, OEM's primary involvement is to characterize diffuse/fugitive hazardous chemical emissions. Better quantification of these sources is becoming necessary to address WDOH Source Registration, NESHAP, Toxic Air Emissions Inventory, and OEM. Existing reports, studies, and data, already collected by various Hanford programs, has been reviewed. A technically justifiable and cost-effective monitoring program will be recommended based on this review and after some initial field screening activities.

Radiological Ambient Air Monitoring

Radiological ambient air quality measurements for parameters such as gross alpha and gross beta, as well as gamma energy analysis, uranium, plutonium and strontium on composited filters, are performed at 45 stations (Table II.B-4). With the exception of the one background station, all of the air stations are located near waste sites or facilities. In most instances a single air station (or group of stations) monitors several facilities and waste sites simultaneously. Biweekly gross alpha and gross beta analyses are performed as a screening for contamination before offsite shipment, as well as an early indication of "trouble" upwind of the sampler. All other analyses are conducted by International Technology (IT) Corporation - Richland Laboratory.

In addition to the routine air particulate monitoring, OEM is performed in the vicinity of ERAs, Treatability Studies, demolition and decontamination of retired facilities, and pre-operational monitoring of new or modified facilities for other Hanford contractors.

Soil

Soil samples are collected from 157 sites (Table II.B-5) located near waste sites. Typically the monitoring results are used to identify trends of buildup of radionuclides. In most instances a single soil site or group of sites monitor several waste sites simultaneously.

Table II.B-4. OEM Ambient Air Sample Locations, 1994

EDP Code	Area	Location
N019	200-East	West of B-Plant
N101	100-N	1301-N Liquid waste disposal facility
N102	100-N	N-Springs
N103	100-N	Northwest of 105N
N105	100-N	1325-N Liquid waste disposal facility
N130	300	300 Area Treated Effluent Disposal Facility
N401	100-K	West of 105-KE
N402	100-K	North of 105-KE
N403	100-K	East of 105-KE
N404	100-K	South of 105-KE
N155	200-West	U Tank Farm
N158	200-East	AX Tank Farm
N161	200-West	T Stack
N165	200-West	216-Z-19 Ditch
N168	200-West	U-Stack
N200	600	North of E/W Vent Station
N304	200-West	200 West Main Gate
N956	200-West	East of S/SX Tank Farm
N957	600	BC Crib Area
N962	200-West	Southeast of 218-W-4B Burial Ground
N963	200-West	Southeast of Redox
N964	200-West	East of 218-W-4B Burial Ground
N965	200-West	Northeast Corner 200-West Area
N966	200-West	200-West Main Gate
N967	200-East	North of B/BX Tank Farm
N968	200-East	200-East West Gate
N969	200-East	Southwest of PUREX
N970	200-East	Northwest of PUREX
N972	200-East	Northeast of C Tank Farm
N973	200-East	East of B Tank Farm
N974	200-West	North of T Plant
N975	200-West	East of Z Plant
N976	200-East	West of C Tank Farm
N977	200-East	Southeast of PUREX
N978	200-East	Southwest of PUREX
N981	600	Wye Barricade
N984	200-East	Southeast of C Tank Farm
N985	200-East	West of 272-AW
N987	200-West	Northeast of TY Tank Farm
N994	200-West	Gate 609
N998	200-East	North of Liquid effluent retention facility
N999	200-East	South of Liquid effluent retention facility

Vegetation

Vegetation samples are collected from 95 sites (Table II.B-6) located near waste sites. In most instances a single vegetation site or group of sites monitor several waste sites simultaneously.

Animals

Animal samples (usually small mammals, mammal or bird feces, birds, or bird nests) are collected at or near facilities and/or waste sites when surveys indicate contamination, or the potential for contamination and spread by biological vectors. If surveys of other media indicate the presence of contamination, further isotope-specific characterization is performed to establish the source of the contamination. When contamination is identified, investigations are conducted and documented in accordance with the RPR and CAR systems.

Surface Water

Weekly samples are collected at five liquid surface disposal (pond and ditch) locations (Table II.B-7) and analyzed for pH, and composited monthly for total alpha, total beta, strontium-90, and gamma energy analysis. In addition, samples are collected quarterly for nitrates and tritium. The surface water samples serve as a check on liquid effluents and trends are evaluated against normal operating conditions. Anomalous values trigger immediate review to determine cause and implement appropriate corrective action.

River Seepages

Annual samples can be collected from as many as 22 river seepages along N-Springs and analyzed for strontium-90, gamma-emitting radionuclides, and tritium. Sampling is conducted to determine trends in hydrologic contaminant balance across the entire seepage zone. The OEM seep samples constitute a check on effluents emanating from the 1301-N and 1325-N LWDFs.

Table II.B-5. Soil Sample Locations, 1994

Sample Point	Area	Location
	100-N	
1		1301-N Liquid Waste Disposal Facility
2		1301-N Liquid Waste Disposal Facility
3		1301-N Liquid Waste Disposal Facility
4		1301-N Liquid Waste Disposal Facility
5		1301-N Liquid Waste Disposal Facility
6		N-Area
7		N-Area
8		1325-N Liquid Waste Disposal Facility
9		N-Area
10		1325-N Liquid Waste Disposal Facility
11		1325-N Liquid Waste Disposal Facility
12		1325-N Liquid Waste Disposal Facility
	200-East/West	
	Even Number Sampled in 1994 & 1996; Odd Number Sampled in 1995 & 1997	
1		U-Pond South
2		U-Pond North
3		216-S-21 Crib
4		U-14 Ditch Southwest
5		218-W-4B South
6		216-Z-12 South
7		216-Z-12 North
8		216-Z-19 Ditch
9		216-Z-16 Crib
10		216-Z-7 Crib
11		216-T-19 Crib
12		TX Farm West
13		TX Farm East
14		TY Farm East
15		216-T-36 East
16		216-T-36 West
17		T Farm North
18		207 T Basin, Southwest
19		216-T-35 Crib, South

Table II.B-5. (cont'd)

Sample Point	Area	Location
	Even Number Sampled in 1994 & 1996; Odd Number Sampled in 1995 & 1997	
20		216-T-35 Crib, North
21		216-T-33 Crib, Northeast
22		T- Unloading Station
23		216-T-6 Crib
24		2706-T, North
25		T-1 Ditch, Headend
26		291-T Stack Area
	200-East/West	
27		SX Farm South
28		S Farm, West
29		SY Farm, North
30		U-14 Ditch, Active-Southwest
31		UN-216-W-30, Northeast
32		U Farm, NW
33		U Farm, East
34		UN-216-W-35
35		216-T-26-28, North
36		216-T-26-28, Southeast
37		Un-216-W-24, Southeast
38		211-S Tanks, West
39		291-S Stack Area
40		216-U-16 Crib
41		218-U-12 Crib
42		216-U-8 Crib
43		UN-216-W-33, East
44		216-U-1 & 2, West
45		216-U-1 & 2, East
46		216-U-17 Crib
47		Old Burial Site
48		C.C. Transfer Line
49		C.C. Transfer Line
50		Laundry Waste Crib
51		216-S-26 Crib
52		216-S-25 Crib
53		East Area Fenceline, North
54		BY Farm, North
55		BY Farm, Northwest
56		BY Farm, East
57		BX Farm, South
58		B Farm, South
59		B-63 Ditch

Table II.B-5. (cont'd)

Sample Point	Area	Location
	200-East/West	
	Even Number Sampled in 1994 & 1996;	
	Odd Number Sampled in 1995 & 1997	
60		216-B-2-2 Ditch
61		Fenceline, Northeast
62		216-B-64 Basin
63		218-C-9 Trench, East
64		C-Farm, Southwest
65		C-Farm, East
66		C-Farm, North
67		244-A Lift Station
68		216-A-40 Basin
69		AN Farm, West
70		AZ Farm, West
71		A Farm, South
72		AW Farm, North
73		A Farm, East
74		AP Farm, Northeast
75		PUREX, Southeast
76		PUREX, Southeast
77		216-A-36 Crib, North
78		216-A-10 Crib, South
79		218-E-1 Burial, East
80		C.C. Transfer Line
81		Gable Pond, North
82		Gable Pond, South
83		216-N-1 Pond
84		216-N-6 Pond
85		Un-216-E-31, North
86		UN-216-E-31, Southwest
87		216-B-3 Pond, North
88		216-B-3 Pond, Overflow
89		216-B-3 Pond, 3rd Overflow
90		216-A-24 Crib, East
91		Outside East Fenceline
92		216-A-29 Ditch, Headend
93		216-A-37-1 Crib
94		216-A-37-2 Crib
95		216-A-30 Crib
96		BC Controlled Area, Northeast
97		BC Controlled Area, Southeast
98		BC Controlled Area, Southwest
99		BC Controlled Area, Northwest

Table II.B-5. (cont'd)

Sample Point	Area	Location
200-East/West		
Even Number Sampled in 1994 & 1996; Odd Number Sampled in 1995 & 1997		
100		C.C. Transfer Line
101		Vent Station
102		C.C. Transfer Line
103		216-S-10 Ditch
104		216-U-11 North
105		216-S-16 Pond
106		216-S-17 Pond
107		216-S-10 Pond
108		216-S-16 Crib
109		216-S-19 Pond
110		216-U-11, South
300 Area		
1		Northeast side of 618-4
2		North side of 316-5
3		South side of 618-5
4		Northeast side of 316-2
5		South side of 316-2
6		Northeast corner of 316-1
7		South side of 316-1
8		South side of 316-3
9		Northwest corner of 618-8
10		Southwest corner 618-3
11		North side of 618-2
12		South side of 618-7
13		North end of 618-9
14		North end of 618-13
400 Area		
15		400 Area Process Pond

Table II.B-6. OEM Vegetation Sample Locations, 1994

Sample Point	Area	Location
	100-N	
1		1301-N Liquid Waste Disposal Facility
2		1301-N Liquid Waste Disposal Facility
3		1301-N Liquid Waste Disposal Facility
4		1301-N Liquid Waste Disposal Facility
5		1301-N Liquid Waste Disposal Facility
6		N-Area
7		N-Area
8		1325-N Liquid Waste Disposal Facility
9		N-Area
10		1325-N Liquid Waste Disposal Facility
11		1325-N Liquid Waste Disposal Facility
12		1325-N Liquid Waste Disposal Facility
13		N-Springs
14		N-SPRINGS
15		N-Springs
16		N-SPRINGS
17		N-Springs
18		N-SPRINGS
19		N-Springs
20		N-SPRINGS
	200-East/West	
2		U-Pond North
7		216-Z-12 North
9		216-Z-16 Crib
25		T-1 Ditch, Headend
32		U Farm, Northwest
34		UN-216-W-35
37		Un-216-W-24, Southeast
41		218-U-12 Crib
43		UN-216-W-33, East
44		216-U-1 & 2, West
48		C.C. Transfer Line
50		Laundry Waste Crib
55		BY Farm, Northwest
59		B-63 Ditch
67		244-A Lift Station
78		216-A-10 Crib, South

Table II.B-6. (cont'd)

Sample Point	Area	Location
	200-East/West	
79		218-E-1 Burial, East
80		C.C. Transfer Line
81		Gable Pond, North
82		Gable Pond, South
83		216-N-1 Pond
84		216-N-6 Pond
85		U-216-E-31, North
88		216-B-3 Pond, Overflow
90		216-A-24 Crib, East
92		216-A-29 Ditch, Headend
94		216-A-37-2 Crib
95		216-A-30 Crib
96		BC Controlled Area, Northeast
97		BC Controlled Area, Southeast
98		BC Controlled Area, Southwest
99		BC Controlled Area, Northwest
100		C.C. Transfer Line
101		Vent Station
102		C.C. Transfer Line
104		216-U-11 North
105		216-S-16 Pond
106		216-S-17 Pond
110		216-U-11, South
	300 Area	
1		Northeast side of 618-4
2		North side of 316-5
3		South side of 618-5
4		Northeast corner of 316-2
5		South side of 316-2
6		Northeast corner of 316-1
7		South side of 316-1
8		South side of 316-e
9		Northwest corner 618-8
10		Southwest corner 618-3
11		North 618-2
12		South of 618-7
13		North of 618-13
14		North of 618-13
15	400 Area	400 Area Process Pond

Table II.B-6. OEM Surface Water Sample Locations, 200-East/West Areas, 1994

<u>ID Number</u>	<u>Location</u>	<u>Area</u>
RM27	West Powerhouse Pond	200-West
RM29	216-B-3C	200-East
RM30	216-Z-21 Basin	200-West
RM54	East Powerhouse Ditch	200-East

Sediment and Aquatic Vegetation

Monitoring of five locations for sediment and aquatic vegetation is performed annually at active ponds and ditches. Samples are analyzed for strontium-90, plutonium, uranium, and gamma emitters. Data trends monitor the effectiveness of effluent and contamination control at the active ponds and ditches primarily as a check on operations.

External Radiation Dose

External radiation measurements are conducted using handheld instruments and TLDs at 289 locations (182 annual survey points and 107 quarterly TLDs; Table II.B-7) near facilities (e.g., tank farms, evaporator, and fuel storage basins) and waste sites. These measurements are used to assess the exposure rate or contamination spread near the facilities and waste sites to monitor the effectiveness of effluent and waste management controls (e.g., 1301-N Crib skyshine and pending corrective action). Data are plotted to determine trends and anomalous values are investigated to determine cause and appropriate corrective action.

Waste Site Surveys

Waste sites are surveyed to comply with DOE Orders regarding the spread of contamination and is an extremely important aspect of OEM. These surveys help identify physical transport of radioactive materials as well as biological intrusion of waste sites and is one mechanism to demonstrate compliance with NESHAP (40 CFR 61, Subpart H). Anomalous readings are investigated and documented in accordance with the RPR and CAR systems. Typically, the monitoring results are used to identify trends of uptake of radionuclides. Special samples (e.g., soil, vegetation, and animal feces) are taken where physical transport problems are identified. The purpose of these special samples is to ensure effluent and waste management control at the waste sites.

Table II.B-7. OEM Thermoluminescent Dosimeter and Survey Point Locations, 1994

Sample Point	Area	Location
	100-N	
001		1301-N East Fenceline
002		1301-N 60 feet Northeast of 001
003		1301-N Northeast
004		1301-N Gate 24 North
005		1301-N Gate 24 South
006		1314-N Fence
007		1908-N Fence
008		182-N Tank Farm
010		Gate #22
012		MO-054 Fenceline
013		Gate #2
014		MO-536 Fenceline
015		1301-N 60 feet Northeast of 002
016		Stack Fenceline
017		163-N Wastepad
018		1310-N Fenceline
022		1301-N West
026		N Springs
028		107-N North
029		107-N South
030		1325-N East
031		1301-N Fenceline
032		1723-N Northeast
033		1723-N Lunch Room
034		1325-N Southwest
035		1325-N Northwest
036		1325 Trench
037		River Road West
038		River Road East
041		North of 1515-N
	100-K	
009		100-K South Gate
011		105-KW Southwest
019		105-KW Northwest
020		105-KW North
021		105-KW East
023		105-KW South
024		105-KE Southwest
025		105-KE Northwest

Table II.B-7. (cont'd)

Sample Point	Area	Location
027		105-KE North
039		105-KE East
040		105-KE South
	200-East/West	
0202		218-W-2A
0203		221-T East
0204		241-TX East
0205		216-Z-20
0206		241-TX North
0207		241-U West
0208		241-U East
0209		221-U Southeast
0210		241-SY
0211		202-S Southeast
0212		241-SY North
0213		241-S South
0214		200-West Northwest (Gate 609)
0215		234-5Z North
0216		234-5Z West
0217		HWVP Southwest
0218		HWVP Northwest
0219		218-E-16 (Grout) South
0220		218-E-16 (Grout) Northwest
0221		218-E-16 (Grout) North
0222		241-BX/BY North
0223		241-B East
0224		HWVP Southeast (Gate 814)
0226		218-W-5 West
0227		WSCF South
0228		WSCF North
0229		218-E-10 East
0230		241-BX South
0231		218-E-12
0232		221-B Southeast
0233		221-B Northeast
0234		241-C West
0235		218-W-5 South
0236		241-T East
0237		HWVP East
0238		221-B Southwest
0239		221-B North
0240		HWVP Northeast

Table II.B-7. (cont'd)

Sample Point	Area	Location
0241		216-B-63
0242		202-A Southwest
0243		202-A South
0244		202-A Northwest
0245		200-East South
0246		200-East Northeast
0247		202-A Southeast
0249		241-C Southwest
0250		241-AY West
0251		241-C North
0252		241-AN West
0253		241-AN North
0254		241-C Southwest
0255		241-AZ East
0256		241-AX East
0258		241-A South
0259		241-AW Northwest
0260		234-5Z East
0261		241-AW Southeast
0262		241-AP Northeast
0263		LERF Southeast
	300 Area	
001		Process Trench North
002		North Process Pond
003		South Process Pond
004		316-3 Trench
005		Process Trench South
006		303-K Mixed TSDF
007		340 Facility Gate
008		3701-U Gate
401		Northeast Perimeter TEDF
402		Southeast Perimeter TEDF
403		Southwest Perimeter TEDF
404		Northwest Perimeter TEDF
405		TEDF In-Line 1
406		TEDF In-Line 2
	400 Area	
009		Process Ponds
010		4717 North End
011		Cask Laydown Pad
012		427 North End
013		FMEF Main Gate

Table II.B-7. (cont'd)

Sample Point	Area	Location
014		FFTF Main Gate
015		4843 Sodium TSDF
	100-North	
1		1301-N Liquid Waste Disposal Facility
2		1325-N Liquid Waste Disposal Facility
3		N-Springs (Columbia River shoreline)
	200-East	
4		200-East
	200-West	
5		200-West

Subsurface Monitoring

The subsurface monitoring portion of OEM is currently conducted by Hanford Technical Services (WHC) and RUST-Geotech through a subcontract with WHC, Tank Waste Remediation System (TWRS) project. Subsurface monitoring at treatment, storage, and disposal (TSD) sites in WHC-operated areas consists of two primary components: 1) borehole radionuclide logging of the soil column (vadose zone) above the water table and 2) ground-water monitoring of the uppermost aquifer.

Vadose Zone Monitoring

Contaminants in the soil column beneath liquid waste disposal sites, underground storage tanks, and or spill sites are potential sources of ground-water contamination. The status, and control, if necessary, of vertical contaminant movement is therefore an essential element of ground-water protection (DOE/RL 1994; DOE Order 5820.2A). The purpose of vadose monitoring is to provide an "early warning" of any unusual movement of existing contamination, to monitor any movement of vadose contaminants, and/or to assist as a secondary system to detect leakage from liquid waste storage tanks, and to provide empirical data for risk and performance assessment modeling.

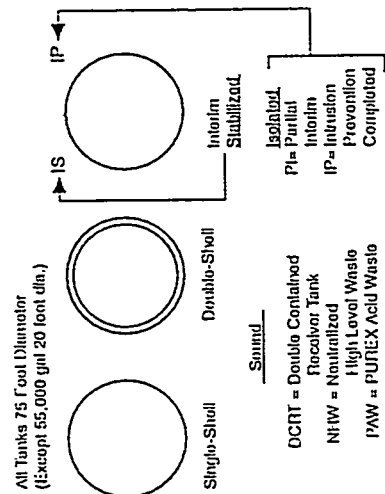
Vadose zone monitoring activities are conducted in two major areas: 1) tank farms and 2) liquid waste disposal sites. The tank farm monitoring network consists of over 700 "dry wells" or vertical boreholes located immediately adjacent to single-shell tanks (SST) in the 200-East and 200-West Areas (Figures II.B-36 and II.B-37). Some tanks are also equipped with horizontal leak detection systems located beneath the tanks. Additional details are described *Technical Baseline for Leak Detection Surveillance at the Tank Farms* (WHC-SD-WM-EI-573, Rev 0). Borehole logs are generally run annually and reported in company summary reports and in special project reports. Spectral gamma logging (by gamma energy analysis) for the tank farms is conducted under contract with RUST-Geotech, Grand Junction, Colorado. The primary radionuclides of interest that are detectable by downhole gamma energy analysis include ^{60}Co , ^{137}Cs , ^{154}Eu , and ^{241}Am .

Changes in status of the depth and lateral distribution of radioactive wastes in the soil column beneath liquid waste disposal sites are also evaluated using spectral gamma-ray logging or monitoring. To date, over 25% of the 800 existing ground-water monitoring wells and/or vadose monitoring wells

200 East

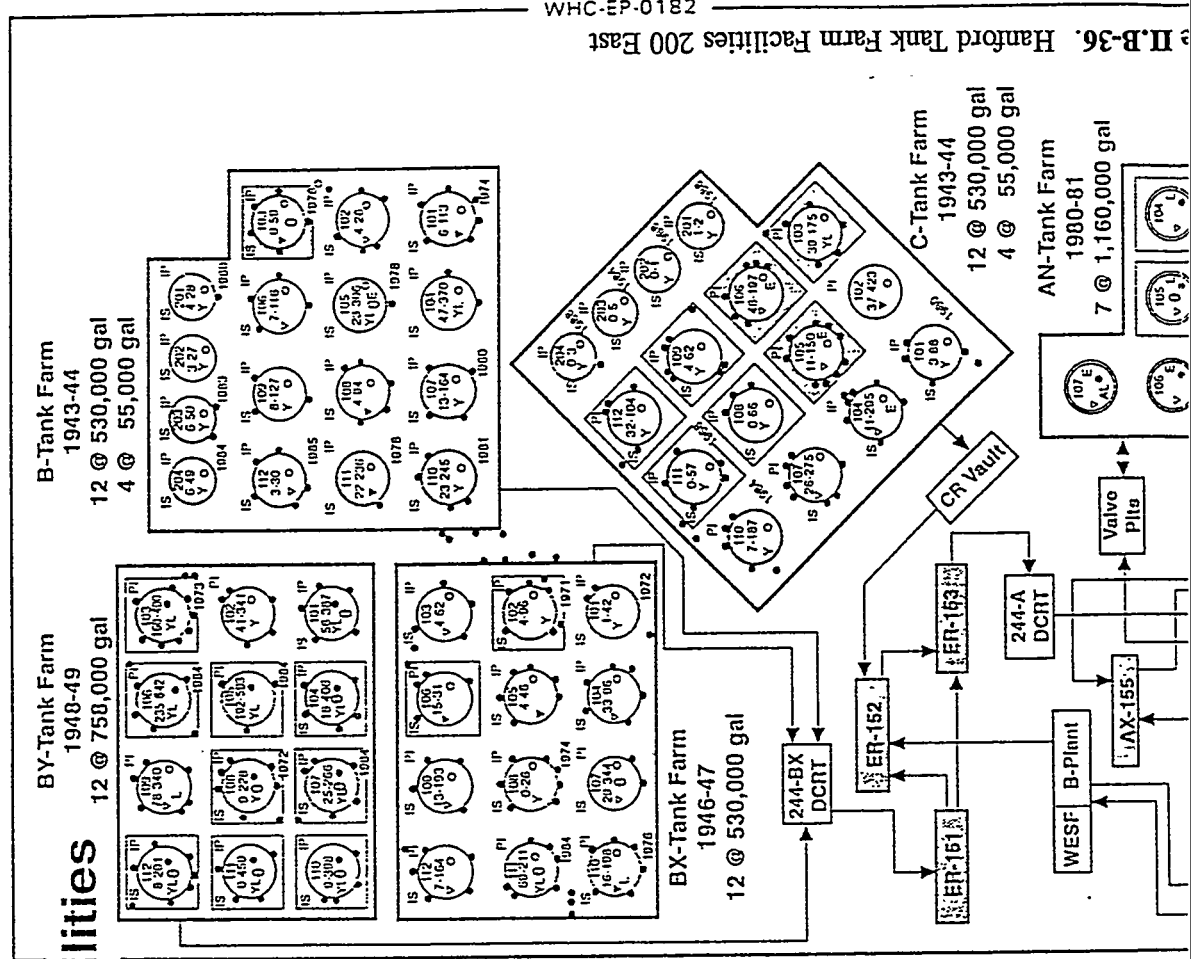
Note: All single-shell tanks were removed from service (not allowed to receive waste) on or before November 21, 1980

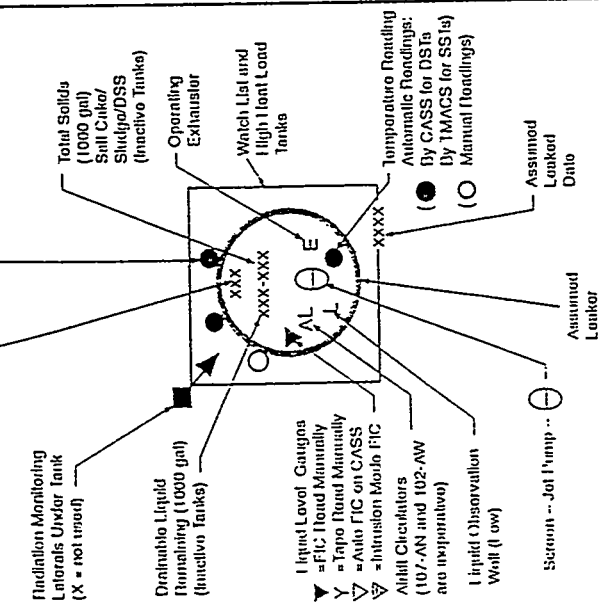
Single Wallod Pipe Direct Buried



Index

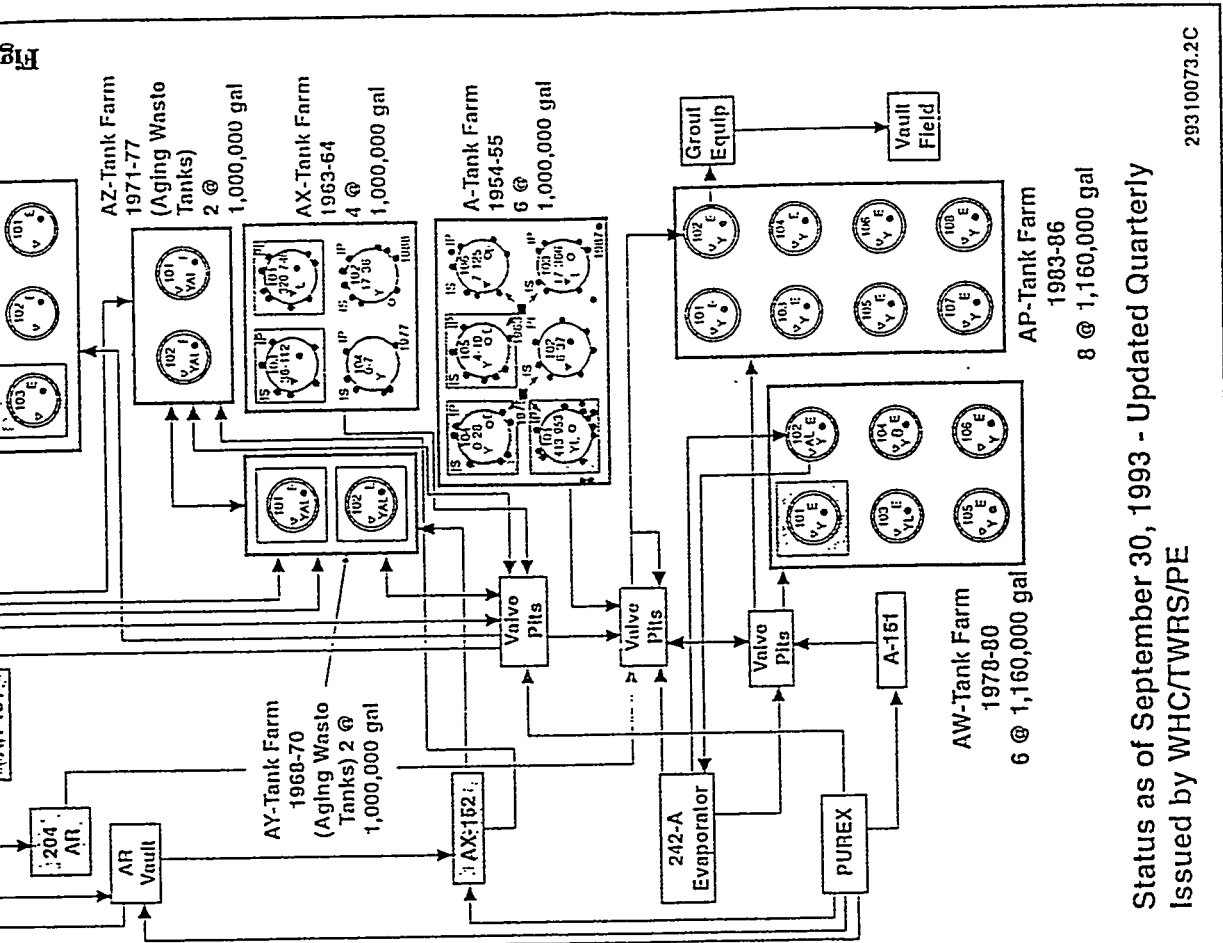
Dry Wall -- Approx Location





Watch List Tanks

- ☐ Ferrocyanide
- ☐ H₂/Flammable gases (109-SX has potential only-other tanks vent thru it)
- ☐ Organics
- ☐ High Heat - 106-C only on Watch List (cooling water added)



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Note: All single-shell tanks were removed from service (not allowed to receive waste) on or before November 21, 1980

Double Watlud Pipe	Single Watlud Pipe (Direct Buried)
	

WHC-EP-0182

Hanford Tank Farm Facilities 200 West

(☐ = Active; ○ = Inactive)

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National Monitor

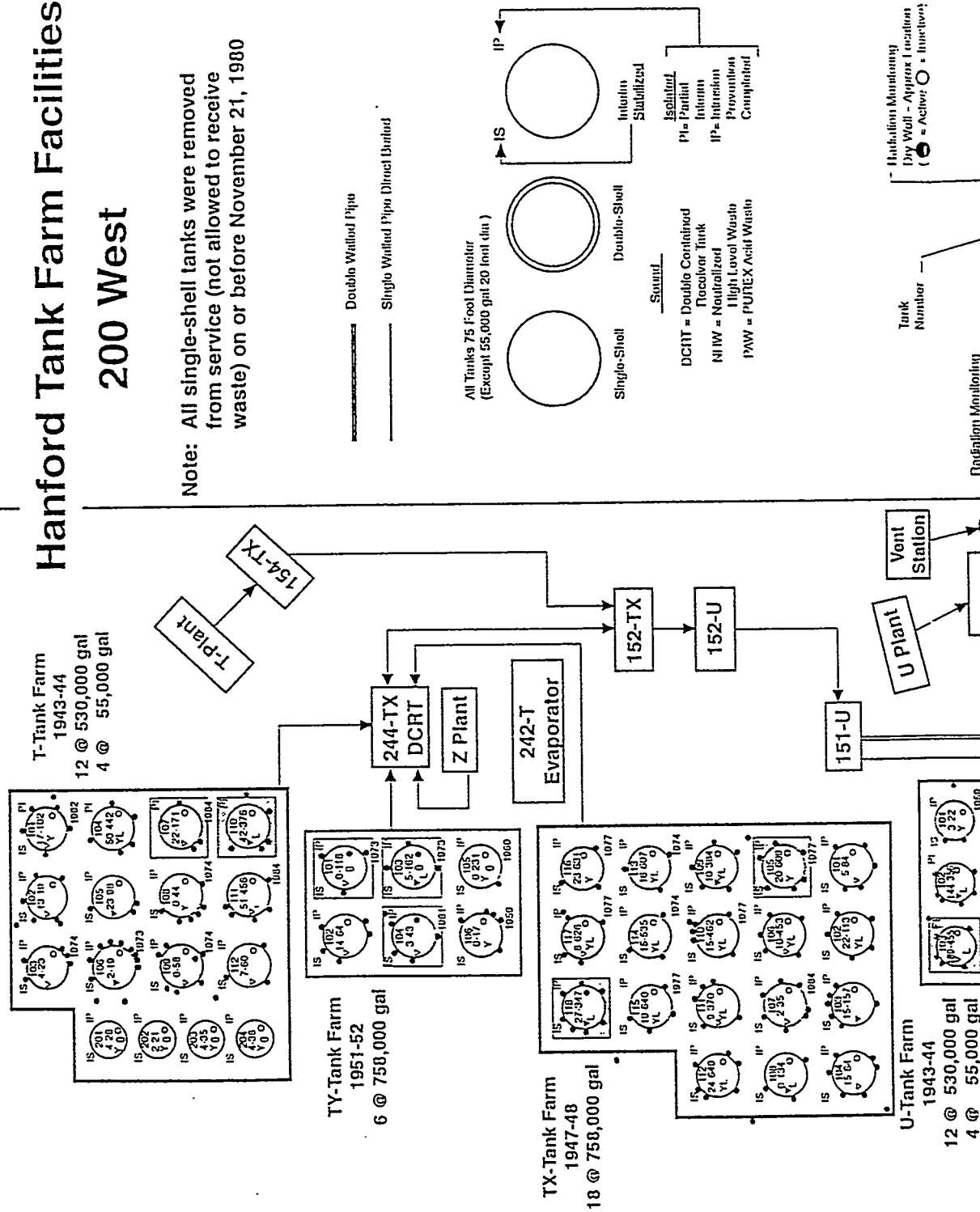
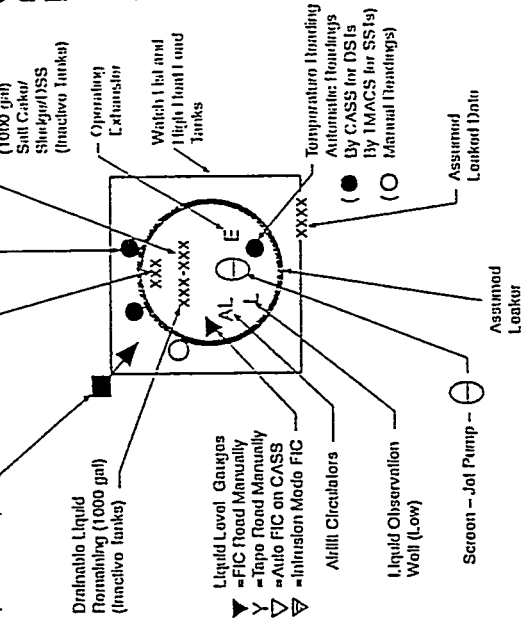


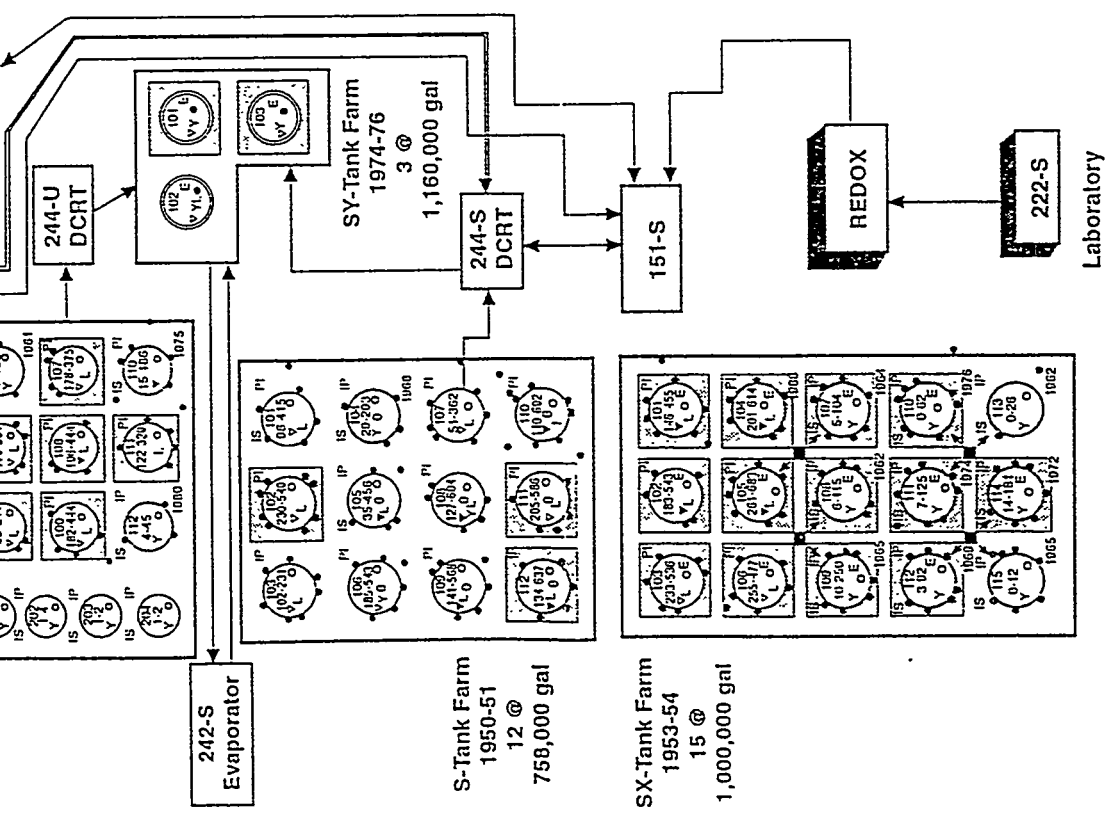
Figure II.B-3



Watch List Tanks	
☐	Ferrocyanide
☐	H2/Flammable gases (109-SX has potential only-other tanks vent thru it)
☐	Organics
☐	High Heat - 106-C only on Watch List (cooling water added)

Status as of September 30, 1993 - Updated Quarterly
Issued by WHC/TWRS/PE

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immediately adjacent to liquid waste disposal sites (both active or inactive) have been logged to establish baseline conditions. After the baseline of a facility is established, a monitoring schedule is determined and the data are collected with a faster, less costly but lower-resolution sodium iodide spectral gamma-ray logging system. The activities for the liquid waste disposal sites are performed by the technical services organization of the operating contractor. A sampling and analysis plan and quality assurance plan for this activity are currently in preparation.

Fluctuating moisture regimes in the vadose zone may be an important contributor to any detected movement of contaminants. Therefore, various methods of measuring in situ, lithologic moisture surrounding the steel-cased boreholes are being investigated, and such surveys will be conducted as deemed necessary. Advanced developments in other technologies are monitored to assess if any may be useful for the monitoring effort. If any are identified, they will be incorporated into the vadose zone monitoring program.

Ground-Water Monitoring

Ground-water monitoring is conducted at both RCRA (Resource Conservation and Recovery Act) and non-RCRA sites. The primary purposes of RCRA/operational ground-water monitoring are: 1) to comply with interim and final status state and federal RCRA requirements, 2) to assess potential impact on ground-water quality, and 3) to provide an early warning of unusual occurrences and trends (WHC-CM-7-4, WHC-CM-7-5).

The RCRA sites include both liquid and solid waste TSD facilities. Those sites with potential for contaminating ground water require ground-water monitoring as prescribed in 40 CFR 265 and WAC 173-303-400 (interim status) and WAC 173-303-645 (final status). The non-RCRA sites are controlled under DOE Orders and by Tri Party Agreement (TPA) milestones (Ecology et al. 1992). The latter are primarily associated with soil column disposal facilities for chemical and radioactive liquid wastes that were associated with nuclear fuel processing refining and waste treatment activities. A schedule was established for terminating all such discharges to the ground by no later than June 1995 (Ecology et al. 1992). During the interim, detailed evaluation of the impact of certain non-RCRA regulated facilities on ground-water quality was required (TPA milestone M17-13; Ecology et al. 1992). In addition, an agreement was reached in December 1991 to include all miscellaneous waste streams and/or any new waste streams discharged to the ground under the State of Washington waste discharge permit program (WAC 173-216). Some of the "216 permit" sites also require ground-water monitoring.

Those aspects of the RCRA and non-RCRA ground-water monitoring activities that are common are discussed collectively following the separate descriptions of each program. Sampling schedules, constituent lists, and well location maps are presented in Appendix C.

RCRA Ground-Water Monitoring Projects

The overall RCRA program involves application for permits to operate regulated TSD units, detection/assessment monitoring of ground water to detect and assess possible contamination from TSD units, and corrective measures including closure plans and cleanup actions. Ground-water monitoring at a TSD facility is designed to detect changes in upgradient ground-water quality from conditions downgradient of the TSD. Over 330 wells are sampled quarterly or semi-annually for a total of 900 sampling events (FY95 schedule). The formal sampling results are supplemented with data collected for other programs to assess the impact of adjacent contaminant plumes.

Construction and Maintenance of Wells

All RCRA monitoring wells are installed so as to maintain the integrity of the monitoring well borehole. The casing and screen allow collection of representative ground-water samples from the aquifer. In general, all wells meet the requirements set forth in Parts 1 and 3 of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells."

Sampling and Analysis

In accordance with 40 CFR 265 and WAC 173-303-400 the RCRA projects are monitored under one of three prescribed sampling protocols: 1) background monitoring, 2) indicator parameter evaluation, and 3) ground-water quality assessment.

The constituent lists for laboratory analyses are established in accordance with the requirements of 40 CFR 265.92. The contamination indicator parameters are specified in 40 CFR 265.92(b)(3). The parameters establishing ground-water quality are specified in 40 CFR 265.92(b)(2). The drinking water standards are required by 40 CFR 265.92(b)(1) and are specified in Appendix III of that chapter. Site-specific parameters (including radionuclides) are determined from evaluation of the waste stream (or source) associated with the facility. Additional site-specific constituents may be included to aid in tracking ground-water movement and the influence of other facilities. In some cases, an Appendix IX list of constituents (40 CFR 264) is analyzed to establish a baseline for future comparisons and analyses.

Ground-water samples from all RCRA monitoring wells must be obtained and analyzed quarterly for 1 year to establish background concentrations. The water level at each monitoring well must be determined each time a ground-water sample is obtained. Most of the RCRA sites at Hanford have completed their initial background monitoring programs.

After background is established, the indicator parameter evaluation program commences. Samples collected to indicate ground-water contamination are taken semi-annually. Data obtained through the indicator parameter evaluation program are compared with background data. If a significant statistical change over background has occurred in a downgradient well, Ecology must be notified and a ground-water quality assessment plan must be prepared and implemented. Table II.B-8 lists the RCRA facilities and waste management units managed by the operating contractor and their monitoring program status. Figure 11.B-38 is an index map for locating all the RCRA facilities on the Hanford Site. An abbreviated list of constituents analyzed for in the RCRA monitoring projects is shown in Table II.B-9.

Final Status Monitoring

Final status for Hanford RCRA facilities became effective on September 28, 1994 and will remain in effect until September 28, 2004. Implementation of this decision will be accomplished on a unit by unit basis during a transition period. Unit-specific monitoring conditions (e.g., analyte lists) will be negotiated and included in the permit for each unit.

In compliance with final status regulations (40 CFR 264 Subpart F and WAC 173-303-645), all wells will be sampled at least semiannually during detection monitoring and during the active and postclosure period of each TSD unit. During each sampling event, a sequence of four independent

Table II.B-8. Status of Hanford Site RCRA Interim-Status Ground-Water Monitoring Projects Managed by the Operating Contractor as of June 1994

Project (date initiated)	Program Status		Ground-Water Quality Assessment ^(a)	Regulatory Requirements
	Background Monitoring	Indicator Parameter Evaluation		
216-B-63 Trench (8/91)		X		40 CFR 265.93(b) WAC 173-303-400
LERF ^(b) (7/91)		X		40 CFR 265.93(b) WAC 173-303-400
2101-M Pond (8/88)		X		40 CFR 265.93(b) WAC 173-303-400
LLBG ^(c)				
LLWMA 1 (1/94)				40 CFR 265.93(b) WAC 173-303-400
LLWMA 2 (9/88)		X		40 CFR 265.93(b) WAC 173-303-400
LLWMA 3 (1/94)	X			40 CFR 265.92(c)
LLWMA 4 (10/88)		X		40 CFR 265.93(b) WAC 173-303-400
LLWMA 5 (3/92)		X		40 CFR 265.93(b) WAC 173-303-400
SST ^(d)				
WMA-A-AX (2/90)		X		40 CFR 265.93(b) WAC 173-303-400
WMA-B-BX-BY (2/90)		X		40 CFR 265.93(b) WAC 173-303-400
WMA-S-SX (10/91)		X		40 CFR 265.93(b) WAC 173-303-400
WMA-T (2/90)			X (7/93) Spe cond	40 CFR 265.93(d) WAC 173-303-400
WMA-TX-TY (9-10/91)			X (7/93) Spe cond	40 CFR 265.93(d) WAC 173-303-400

Table II.B-8. (cont'd)

Project (date initiated)	Program Status		Regulatory Requirements
	Background Monitoring	Indicator Parameter Evaluation	
WMA-U (10/9)		X	40 CFR 265.93(b) WAC 173-303-400
300 Area Process Trenches (6/85)			X (6/85) <i>Consent Agreement and Compliance Order^(e)</i>

(a) An X and date in the fourth column indicates the following: 1) the date that the assessment was initiated and 2) the indicator parameter that triggered assessment monitoring. Spe cond = specific conductance. TOX = total organic halogen.

(b) LERF = Liquid Effluent Retention Facility.

(c) LLBG = Low-Level Burial Grounds; WMA = Waste Management Area.

(d) SST = single-shell tanks.

(e) Ecology and EPA 1986.

samples will be taken from each well [40 CFR 264.97(g)(1) and WAC 173-303-645(8)(g)(i)]. These four samples will be taken at an interval that ensures, to the greatest extent technically feasible, that an independent sample is obtained. This requirement could be accomplished by reference to the uppermost aquifer's effective porosity, hydraulic conductivity, and hydraulic gradient, and the fate and transport characteristics of the potential contaminants. In hydrogeologic environments where the ground-water velocity prohibits one from obtaining four independent samples on semiannual basis, an alternate sampling procedure approved by Ecology may be used. Specific sampling intervals will be presented in unit-specific applications.

The Solid Waste Landfill (SWL) is a solid waste disposal facility. It is not a RCRA site and is not addressed under the *Hanford Federal Facility Agreement and Consent Order* (TPA) (Ecology et al. 1992). The current operations of the SWL fall under the regulations of WAC 173-304, and a permit application for the facility under this regulation has been prepared (DOE-RL 1993).

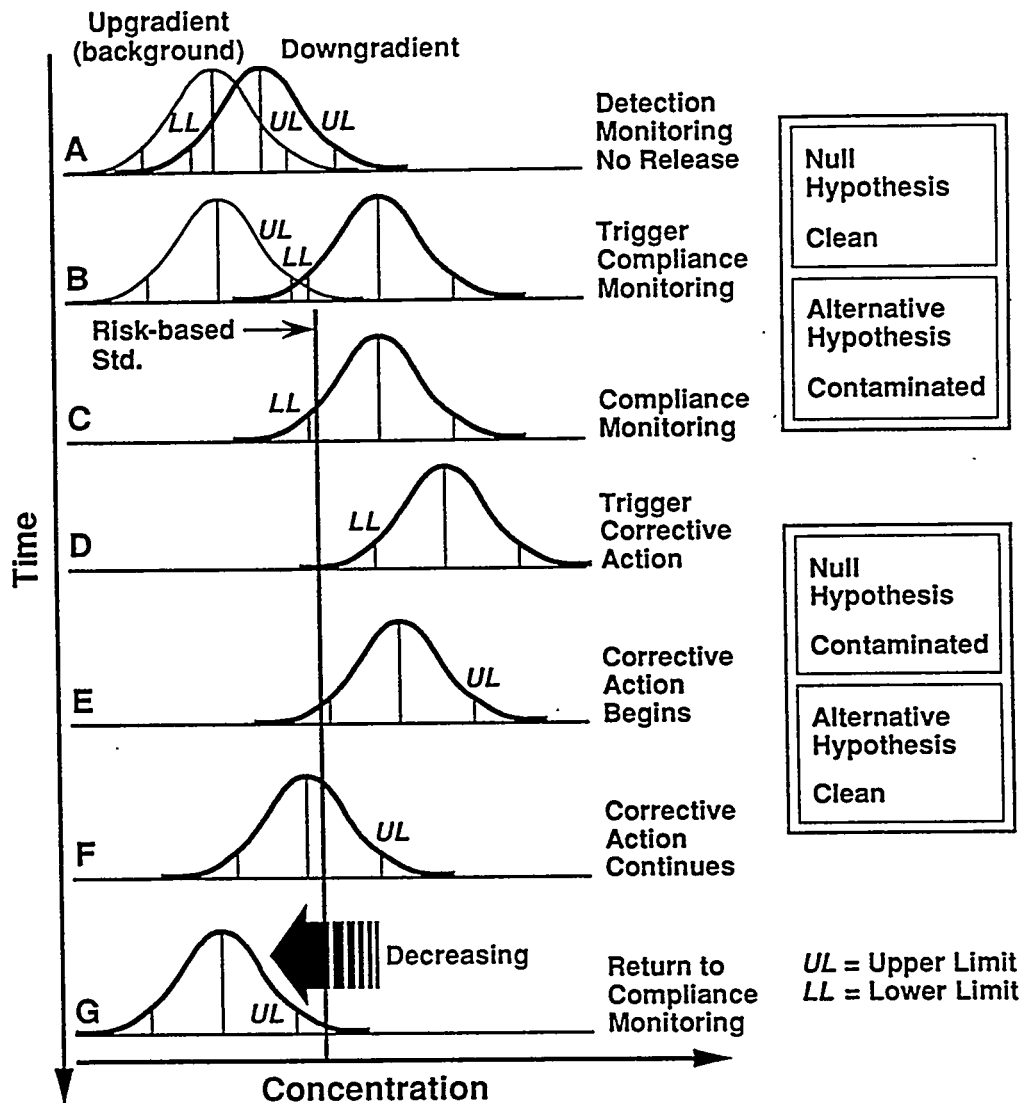
Regulatory Drivers

The RCRA-related ground-water monitoring projects comply with the following WAC regulations: 1) "Dangerous Waste Regulations," WAC 173-303, for hazardous waste; and 2) "Minimum Functional Standards for Solid Waste Handling," WAC 173-304, for nonhazardous waste. The projects meet the federal requirements for "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," 40 CFR 265, Subpart F; and "Criteria for Classification of Solid Waste Disposal Facilities and Practices," 40 CFR 257, for nonhazardous waste.

Reporting

40 CFR Part 265.94, "Recordkeeping and Reporting," requires that for ground-water monitoring projects, concentrations and any changes in measured parameters for each ground-water monitoring

A Statistical Perspective of the Sequence of Groundwater Monitoring Requirements Under RCRA



(Notice that until contamination above a risk standard is documented (D) the null hypothesis is that the facility is clean. Once the facility has been proven to be in exceedance of a health criteria then the null hypothesis is that the facility is contaminated until proven otherwise (G).

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Figure II.B-38. A Statistical Perspective of the Sequence of Ground-Water Monitoring Requirements Under RCRA Hanford Site

Table II.B-9. Typical Constituent List for RCRA Projects^(a)**Contamination Indicator Parameters**

pH	Total organic carbon
Specific conductance	Total organic halogen

Ground-Water Quality Parameters

Chloride	Manganese	Sodium
Iron	Phenols	Sulfate

Drinking Water Parameters

Arsenic	Endrin	Lindane	Selenium
Barium	Fluoride	Mercury	Silver
Cadmium	Gross alpha	Methoxychlor	Toxaphene
Chromium	Gross beta	Nitrate	Turbidity
Coliform	Lead	Radium	2,4,5T
			2,4-D

Site-Specific Parameters^(b)

Carbon tetrachloride	Chloroform	Cyanide	Strontium-90
Cesium-137	Chromium (VI)	Iodine-129	Technetium-99
			Tritium

(a) Under final status, individual or "tailored" constituent lists will be negotiated as a permit condition for each RCRA unit.

(b) Varies for each project.

well must be reported. Any significant differences from the initial background found in the upgradient well(s) must be separately identified in the report (265.94[a][2]). For assessment-level monitoring, a report of the results of the ground-water quality assessment program must be submitted annually (DOE 1994). The report must include the calculated (or measured) rate of migration of hazardous waste or hazardous waste constituents in the ground water (40 CFR 265.94[b][2]). An annual report for solid waste landfills is required under WAC 173-304. In addition to the above, quarterly data summary reports are prepared and submitted to Ecology.

The annual reports discuss results by geographical area and include an overview of Hanford Site hydrogeology. A summary description of the quality control program for sample analysis and a summary of the year's activities together with the required statistical evaluations are appended to the annual report. A complete description of the quality control/quality assurance and program management plan, are found in the annual statement of work (SOW) governing sampling and analysis. The annual report also includes a complete listing of all RCRA reports previously published.

Non-RCRA Ground-Water Monitoring

As noted previously, the impacts of non-RCRA sites on ground-water quality are assessed in accordance with TPA milestone M 17-13 and DOE Orders 5400.1 and 5400.5. Locations of major wastewater disposal sites, including those designated as RCRA sites, are shown in Figure II.B-39. Table II.B-10 lists the waste streams discharged to each disposal facility and their current use status. Miscellaneous waste streams and disposal sites requiring WAC 173-216 Discharge Permits are shown in Table II.B-11.

Primary emphasis for ground-water monitoring at non-RCRA sites is on liquid waste disposal facilities. These sites generally involve several wells located immediately adjacent to the disposal facility, which were intended to detect breakthrough of contaminants from the soil column directly beneath the disposal structure.

Approximately 50 wells associated with active or recently active liquid waste disposal facilities are currently included in the network. Up to about 100 additional wells have been sampled annually (CY 1993-1994) to supplement available data for defining near-field plume distribution patterns. The latter sampling will decline significantly as CERCLA ground-water pump and treat sampling expands (DOE/RL 94-95).

Monitoring wells are sampled for site-specific chemical and radiological constituents, as well as general indicator parameters. Water-table elevations in selected wells are used to determine the direction of ground-water movement near waste disposal and storage sites. As noted above, most of the monitoring wells are located immediately adjacent to the monitored facility, but others are located farther away to aid in defining plume boundaries. Where possible, data from upgradient or local area background wells are used for comparison with those from downgradient wells to assess the impact from a specific facility. The direction of ground-water movement is determined from water table elevation maps that are based on area-wide and facility-specific water-level measurements.

Well Condition

A mix of both older wells and new wells built to RCRA standards are used for the operational monitoring network. A fitness-for-use evaluation of existing or older wells has been conducted, and appropriate limitations of the well have been designated. Wells with limitations are either used for a limited set of constituents or are used for water-level measurements for water table maps.

Water Levels

For water-level measurements, existing wells evenly spaced over as much of the area of interest as possible are chosen. The older wells are most often completed at the top of the unconfined aquifer; however, a few are completed in the uppermost confined aquifer to evaluate vertical gradients. To be representative of ambient water-level conditions, wells are used that are located away from the localized influence of liquid disposal facilities.

Well Maintenance

Ground-water monitoring wells require periodic maintenance to ensure that the well is providing representative samples. Wells used for the operational monitoring program are scheduled for routine inspection and maintenance every 3 to 5 years. A surface check is used to evaluate the condition of

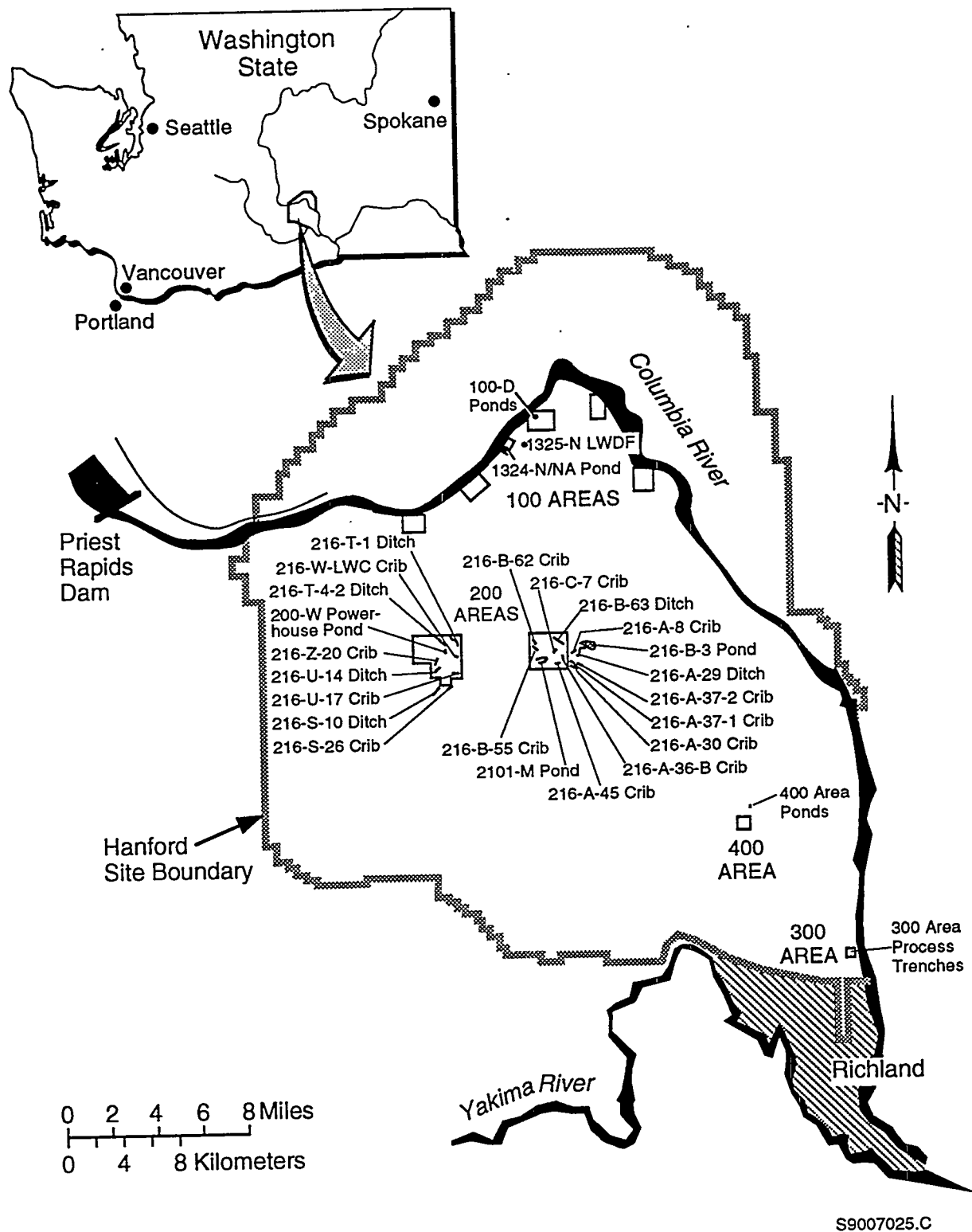


Figure II.B-39. Locations of Active or Recently Active Liquid Waste Disposal Sites

Table II.B-10. Liquid Effluent Streams and Receiving Site Status as of June 1994

Receiving Site		Associated Effluent Stream	Receiving Site Status
1	100-D Ponds	R 183-D Filter backwash wastewater	Inactive
2	1324N/NA Pond	R 163N Demineralization Plant wastewater	Inactive
3	1325N LWDF Crib	R N Reactor effluent	Inactive
4	216-A-8 Crib	241-A&/AZ Tank Farm steam condensate	Inactive
5	216-A-29 Ditch	R PUREX Plant chemical sewer	Inactive
6	216-A-30 Crib	PUREX Plant steam condensate	Inactive
7	216-A-36B Crib	R PUREX Plant ammonia scrubber condensate	Inactive
8	216-A-37-1 Crib	242-A Evaporator process condensate	Inactive
9	216-A-37-2 Crib	PUREX Plant steam condensate	Inactive
10	216-A-45 Crib	PUREX Plant process condensate	Inactive
11	216-B-3 Pond System	R PUREX Plant chemical sewer	Active
11	216-B-3 Pond System	R PUREX Plant cooling water	Active
11	216-B-3 Pond System	R 242-A Evaporator cooling water	Active
11	216-B-3 Pond System	R B Plant cooling water	Active
11	216-B-3 Pond System	R 241-A Tank Farm cooling water	Active
11	216-B-3 Pond System	R 284-E Powerplant wastewater	Active
11	216-B-3 Pond System	R 244-AR Vault cooling water	Active
11	216-B-3 Pond System	R 242-A Evaporator steam condensate	Active
12	216-B-55 Crib	B Plant steam condensate	Inactive
13	216-B-62 Crib	B Plant process condensate	Inactive
14	216-B-63 Trench	R B Plant chemical sewer	Inactive
15	216-C-7 Crib	209-E Laboratory reflector water	Active
16	216-S-10 Facility	R S Plant wastewater	Active
17	216-S-26 Crib	222-S Laboratory wastewater	Active
18	216-T-1 Ditch	T Plant laboratory wastewater	Active
19	216-T-4-2 Ditch	T Plant wastewater	Active

Table II.B-10. (cont'd)

Receiving Site		Associated Effluent Stream	Receiving Site Status
20 216-U-14 Ditch		UO ₃ /U Plant wastewater	Active
20 216-U-14 Ditch		242-S Evaporator steam condensate	Active
21 216-U-17 Crib		UO ₃ Plant process condensate	Active
22 216-W-LC Crib		2724-W Laundry wastewater	Active
23 216-Z-20 Crib		Plutonium Finishing Plant wastewater	Active
24 200-W Powerhouse Pond		284-W Powerplant wastewater	Active
25 2101-M Pond	R	2101-M Laboratory wastewater	Inactive
26 300 Area Process Trenches	R	300 Area process wastewater	Active
27 400 Area Ponds		400 Area secondary cooling water	Active

R = RCRA site.

the well cap, surface seal, survey point, well identification label, and protective barrier posts (WHC-CM-7-7). Following the surface check, the pump is pulled and inspected. With the pump removed, a downhole video camera survey is performed to identify corrosion or encrustation problems and to observe any debris that may have collected at the bottom of the well. The inside of the casing is then brushed to remove deposits that may block the well screen or affect water quality. Any sediment or debris that blocks the screened interval or access to it is removed from the well by pumping or bailing. Finally, the pump is replaced and tested.

Nonroutine well maintenance may be scheduled when a problem is identified during sampling. Some or all of the routine maintenance activities may be performed to bring the well back into working order.

Sampling and Analysis

The extent or number of analytical constituents monitored and the sampling frequency are dependent on the disposal or storage site operating conditions. All samples are analyzed for a standard suite of indicator constituents, including conductivity, pH, tritium, nitrate, gross alpha, and gross beta. If the concentration of a constituent from the standard suite becomes elevated or shows a trend, additional constituents may be analyzed.

Selection of site-specific analytes is guided either by the history of the disposal structure (soil column inventory) and current effluent composition or by the waste composition of stored waste (e.g., underground tanks or liquid storage tanks and basins). A survey of all major waste streams and disposal sites during 1989-1990 (WHC-EP-0367) included analysis of the complete Appendix IX (40 CFR 264) list of analytes, as well as site-specific constituents. Key effluent constituents were

Table II.B-11. Liquid Effluent Receiving Sites Requiring a Ground-Water Impact Assessment and WAC 173-216 SWD Permit

Tri-Party Agreement Milestone M-17-06E (only ground-water impact assessment)

300 Area Process Trenches - Project L-045H

Interim Compliance Wastestreams:

Tri-Party Agreement Milestone M-17-13A (only ground-water impact assessments)

216-U-14 Ditch

1325-N LWDF

216-W-LC Crib

216-Z-20 Crib

216-U-17 Crib

216-S-26 Crib

216-T-1 Crib

216-T-1 Ditch

216-T-4-2 Ditch

284 West Powerhouse Pond

2101-M Pond

Other Phase II Waste Streams:

Tri-Party Agreement Milestone M-17-13A and WAC 173-216 State Waste Discharge Permit

400 Area Ponds

100-D Ponds

216-B-3 Pond System

Miscellaneous Waste Streams:

WAC 173-216 State Waste Discharge Permit

216-C-9 Pond

400 Area Septic System

200-W Powerhouse Ash Pit

200-E Powerhouse Ash Pit

300 Area Powerhouse Ash Pit

300 Area Sanitary Sewer

100-N Sewage Lagoon

300 Area Backwash Pond

216-Z-21 Seepage Basin (207-Z Retention Basin)

200-E Chemical Drain Field

183-N Backwash Discharge Pond

Unidentified Waste Streams--to be determined

Planned Waste Streams:

WAC 173-216 State Waste Discharge Permit

Project C-018H Treated Effluent Disposal Site

Project W-049H Treated Effluent Disposal Site

identified for each waste stream (i.e., constituents with mean concentrations that exceeded a maximum contaminant level or equivalent standard over the period of record). Results of this study are used in conjunction with data from ongoing effluent monitoring to establish an appropriate list of analytes or site-specific parameters in addition to a basic indicator group. These lists are updated annually and are included in the SOW for the annual renewal of the analytical services contract.

Sampling frequency depends on the expected rate of change at a specific disposal site. In general, quarterly sampling is conducted at active liquid waste disposal sites or at wells with increasing levels of a contaminant. Monthly or weekly sampling is conducted in special cases where short-term changes are suspected (e.g., leak from KE-Basin; WHC-SD-EN-174). All other wells are sampled annually. The sampling schedule is modified as required. In addition, results not consistent with concentration trends are verified by resampling.

Area-Specific Conditions (Non-RCRA Sites)

The major operational areas are grouped by either geographic location or common source types. Major features, as related to facility ground-water monitoring, are discussed by area.

100 Areas

Of the six 100 Areas (Figure II.B-39), none are currently discharging radioactive liquid effluent to the ground, although disposal, storage, and treatment of contaminated liquids and solids have occurred in all of the 100 Areas. The types of waste discharged to the ground are relatively consistent for the 100 Area facilities (Dorian and Richards 1978). Cribs, trenches, and burial grounds were used to dispose of waste related to nuclear reactor operations. Much of the radioactive waste consisted of short-lived fission products that decayed below detectable levels. Radionuclides that may remain include ^3H , ^{14}C , ^{60}Co , ^{63}Ni , ^{90}Sr , ^{137}Cs , and ^{152}Eu . Many of these contaminants were introduced to the ground when coolant water, contaminated as a result of fuel cladding failures, was discharged to cribs and trenches. Process chemicals included chromic acid and sodium dichromate associated with decontamination and cooling water treatment. Assessment of past-practice contaminant plumes from these sources is addressed under the CERCLA program, which will also integrate ground-water investigations for all past-practice units within the 100 Areas. Current or operational contributions to ground-water contamination arise primarily from leakage of water from the 100-KE nuclear fuel storage basin to the ground. Monitoring of ground water adjacent to these facilities will be conducted for leak detection purposes until the aging nuclear fuel is encapsulated and transferred to a more permanent storage location.

Discharge of ^{90}Sr to the Columbia River from past N Reactor effluent soil column disposal activities is monitored as part of the effluent monitoring program (see Section II.A). Additional ground-water sampling for operational monitoring purposes includes selected wells in the 100-K and 100-N Areas. Only the water-filled basins in the 100-N and 100-K Areas have the potential for ground-water contamination. Monitoring wells at these basins are sampled monthly to track trends in tritium and gamma-emitting radionuclides, the major radioactive constituents found in the storage basin water. Ground-water remediation activities for the environmental restoration program will include a ground-water monitoring network that will reduce the need for RCRA operational monitoring.

200 Areas

The 200 Areas contain the majority of the ground-water monitoring wells sampled for either RCRA or other operational purposes. There are eight remaining active liquid waste disposal sites and several hundred inactive waste disposal and storage sites (Stenner et al. 1988) in the 200 Areas that are potential ground-water contamination sources.

Liquid waste disposal sites in the 200 Areas that are not currently designated as RCRA sites are shown in Table II.B-10 (i.e., all sites with a 216 prefix and without the "R" designator). These sites are monitored with existing wells that have carbon-steel casings, and, as indicated previously, were installed to monitor ground water directly beneath the disposal facility. The original purpose of this type of well was to monitor breakthrough of contaminants from the soil column.

Other non-RCRA sites (see Figure II.B-39) that receive liquid waste but for which there are no existing monitoring wells include the 216-C-7 Cribs and the 200-W Powerhouse Pond.

Results from all operational and related sampling programs, and any site-wide surveillance monitoring data, are used in combination with supplemental sampling at active liquid waste disposal sites (from old or existing wells) to evaluate near-field impacts of active waste disposal sites in the 200 Areas.

300 Area

The 300 Area was constructed, in part, as a fabrication facility for nuclear fuel used in the 100 Area reactors. The RCRA monitoring network for the 300 Area Process Trenches (DOE/RL 91-03) covers the entire 300 Area, so no additional operational monitoring is performed.

400 Area

Only small quantities of uncontaminated cooling and sump water have been discharged to the ground in the 400 Area. Several deep wells located within the 400 Area supply sanitary and drinking water for use by the facilities and their personnel. The area is monitored by the PNL Ground-Water Monitoring Project (see Section III.B). HEHF also collects samples from drinking water sources supplied from ground water. One operational monitoring well is used in this area to assess impact on ground water from nonradioactive discharges to a disposal pond.

Reporting

An annual ground-water report (e.g., WHC-EP-0595) covering all operational ground-water activities is published for general distribution. The operational contractor(s) and DOE/RL management are informed by letter of unusual occurrences. Operations management is notified when ground-water concentrations approach or exceed internal control limits (WHC-CM-7-5) beneath active waste facilities or if other pertinent information is found.

The semiannual water table maps are also published as external documents. These documents include a map of contoured water table elevations, a plot of depth to water for all measured wells, and

a contour map of the potentiometric surface of the Rattlesnake Ridge confined aquifer. Data used to produce the maps are tabulated and a short descriptive text is included.

Summaries of radiological ground-water monitoring results are also included in the annual OEM report.

Special project reports are issued periodically that include ground-water impact assessments (WHC-SD-EN-EV-008), data evaluation reports, and presentations at professional society meetings.

Implementation

The ground-water protection plan (DOE/RL 89-12) and the environmental program implementation plan (DOE/RL 89-18) define the general policy, program scope, and responsibilities for the RCRA and non-RCRA monitoring. Administrative implementation is accomplished through the WHC Waste Management Program Office and WHC-CM-7-5 (Environmental Compliance). The operations contractor assigns personnel and budgets the work in accordance with the cost account plan from the program office. Implementation of sampling and analysis aspects of the program is accomplished through the annual RCRA and operational ground-water monitoring SOW. The SOW specifies well location, analyte list, sampling frequency, quality assurance, and analytical and sampling procedures.

Program Oversight

The Complete Assessment Group provides oversight of the operations-related ground-water monitoring for Environmental Monitoring. The OEM assesses the impact of past and present operations in the 100, 200, 300 and 600 Areas.

Data Management and Interpretation

Data for the RCRA as well as non-RCRA sites are managed on computer data bases and hard copy files. Water-level and analytical data are currently stored in the HEIS computer data base. Well logs, effluent data, hydraulic parameters, field/sampling records, hard copy analytical results, and other related information are assembled and stored in project files.

Sampling results from wells that monitor active waste disposal facilities are reviewed for compliance with internal or company regulations (e.g., WHC-CM-7-5). This manual specifies the administrative controls on the discharge of waste to the ground at Hanford and specifies the control standards (maximum contaminant levels or appropriate equivalent ground-water quality standards).

If the concentration of a constituent in the ground water beneath an active waste facility exceeds a control standard, an investigation is initiated to determine the source of the contamination and to evaluate whether continued disposal will degrade the aquifer.

Interpretation of sample analysis data is necessary to determine the impact of a waste facility on ground-water quality and contaminant dispersal in the aquifer. This is accomplished by observing trends in contaminant concentrations in individual wells and by mapping contaminant plumes in the vicinity of the facility.

Project Management

Sampling and analysis for the RCRA/operational ground-water projects are conducted under one umbrella SOW and associated quality control procedures. The RCRA projects are conducted under individual ground-water monitoring plans for each waste site, which conform to 40 CFR 265 requirements. A project scientist is assigned to each site or logical grouping of sites and is responsible for ensuring execution of the plan. A similar project plan requirement has recently been included for the non-RCRA sites (WHC-CM-7-5). Under the umbrella SOW for sampling and analysis, both RCRA and non-RCRA sites are covered by the same quality assurance and quality control procedures.

Data Quality Evaluation and Objectives

Five basic data quality criteria are applied: precision, accuracy, representativeness, completeness, and comparability, along with applicable program-specific quality parameters to evaluate the data and the laboratories analyzing the samples. Target values for precision and accuracy (generally relative standard deviation [RSD] = 25%) are specified in *Quality Assurance Project Plan (QAPP) for RCRA Ground-Water Monitoring Activities* (WHC 1992). An RSD of 5% of the minimum contaminant level (MCL) for analytical purposes is desired. However, the latter is not always achievable, especially in those cases where the criterion or MCL is near or below the analytical detection limit. Thus, as an analytical data quality objective (DQO), an RSD of 5% should be regarded only as a goal.

Evaluation of the sampling and analysis results for the RCRA and non-RCRA projects with respect to the five basic data quality criteria noted above are summarized as follows:

1. Precision is evaluated using data results from laboratory duplicates, matrix spike duplicates, field duplicates, and blind samples.
2. Accuracy is evaluated using data results from laboratory matrix spikes; laboratory control samples; EPA Water Pollution, Water Supply, and Interlaboratory Performance Evaluation Programs and by blind samples.
3. Representativeness expresses the degree to which facility ground-water monitoring data represent the real composition of the ground water in the aquifer. Goals for data representativeness for ground-water monitoring programs are addressed qualitatively by the specification of well construction, sampling locations, sampling intervals, and sampling and analysis techniques in the ground-water monitoring plan for each RCRA facility.
4. Completeness is defined as the percentage of measurements made that are judged to be valid. Completeness is determined by the number of data unflagged during validation divided by the total number of data validated multiplied by 100. The calculated percentages used in reporting completeness are conservative figures and are based on the data flags P, F, Q, and/or H.
5. Comparability is used to ensure that samples analyzed by different laboratories or by the same laboratory over different time periods are comparable. Samples were analyzed in accordance with *Test Methods for Evaluating Solid Waste* (EPA 1986b) and other applicable approved methods. Comparability of field measurements is determined by following approved sampling procedures that ensure consistency among sampling events.

External Quality Control Program

The external quality control program uses three kinds of quality control samples to evaluate quality in the field and laboratory. These are field duplicates, field blanks, and blind samples. The quality control analytical results are judged to be acceptable if the following evaluation criteria are met:

- Field duplicates--Results of field duplicate pairs must have precision as measured by RPD within $\pm 25\%$.
- Blanks--Four kinds of blanks are used to check for contamination resulting from field activities and/or bottle preparation. These are full trip blanks, daily trip blanks, field transfer blanks, and bottle blanks. Except for common laboratory contaminants, results above the limit of two times the method detection limit (MDL) are identified as suspected contamination. For common laboratory contaminants, such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, sample results less than five times the MDL are qualified as nondetects.
- Blind samples--Results must fall within 2.0 standard deviations from the mean recovery of the known concentration of samples submitted to the laboratory.

Samples associated with duplicate or blank analytes that exceeded the quality control limits are discussed below and are flagged with a 'Q' in the data base and data tables.

Internal Quality Control Program

The internal quality control program uses four types of quality control data to establish and monitor performance in the laboratory. These data are laboratory blanks, matrix spikes, matrix duplicates, and EPA studies.

Every quarter the contracted laboratories each supply their own quality control report, which includes data quality information on matrix spikes, matrix duplicates, and blanks in the form of precision and accuracy. The contracted laboratories also supply a report of their results on EPA's studies on a quarterly basis. The results of EPA studies independently verify the continuation of laboratory performance and are expressed as the percentage of EPA-accepted results. Each half year the contracted laboratories also supply an MDL/minimum detectable concentration (MDC) report. The MDLs and MDCs are required to be below the contractually required detection limit (CRDL). It is intended to be the lowest analyte concentration in a given matrix that a laboratory can be expected to detect consistently. The CRDL is agreed upon under the contractual SOW. A laboratory nonconformance report is issued when the MDL is greater than the CRDL.

Statistical Evaluations

Interim Status. For the RCRA indicator parameter sampling phase, the quadruplicate sampling results are averaged and summary statistics are developed using data collected from the quarterly sampling events during the first year of monitoring. These summary statistics (mean, standard deviation, coefficient of variation) describe the background data. Once the background summary statistics have been developed for each RCRA facility, the averaged-replicate t-test is used to calculate the test statistic (EPA 1986) for each contaminant indicator parameter (CIP).

The test statistic is reformulated in such a way that a critical mean (CM) for each CIP can be obtained. These CMs have been adjusted to control the overall facility false positive rate at 1 %, which is consistent with the performance standard required for RCRA facilities operated under interim status (see 40 CFR 265.93[b]).

Final Status. Three levels of ground-water monitoring are required under final status regulations (40 CFR 264 Subpart F and WAC 173-303-645): detection monitoring, compliance monitoring, and corrective action (Figure II.B-38).

In a *detection level* ground-water monitoring program, ground-water parameter data (pH, specific conductance, TOC, TOX, or heavy metals, waste constituents, or reaction products) from down-gradient compliance point wells will be compared with those from background wells (area) semi-annually to determine whether there is a statistically significant increase (or decrease for the case of pH) over background concentrations. Statistical methods appropriate for a final status detection monitoring program will include analysis of variance, tolerance intervals, prediction intervals, control charts, test of proportions, or other statistical methods approved by Ecology. The distribution(s) of monitoring parameters, the nature of the data, the proportions of nondetects, and seasonal, temporal, and spatial variations are important factors to consider when selecting appropriate statistical methods. The statistical evaluation procedures chosen will be based on the EPA guidance documents, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Interim Final Guidance* (EPA 1989) and *Addendum to Interim Final Guidance* (EPA 1992). Specifics will be addressed in the unit-specific permit applications.

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

Maximum concentration limits will be identified for each of the ground-water monitoring parameters listed in Table 1 of WAC 173-303-645. Alternate concentration limits will be proposed after considering the observed concentrations of chemical constituents in the ground water that might originate from the regulated unit in question. The area background, natural background, and other standards that are applicable, relevant, and appropriate requirements will be evaluated when proposing an alternate concentration limit.

If, during compliance level monitoring, the referenced concentration limit(s) for a given ground-water parameter or parameters are significantly exceeded, a *corrective action* program will be developed and implemented to protect human health and environment. Details for the corrective action program will be specified in the unit-specific permit applications. Additionally, a ground-water monitoring plan that will be used to assess the effectiveness of the corrective action measures will be submitted. This monitoring plan will be similar in scope to the compliance level ground-water monitoring program and will include all relevant information pertaining to the location and description of monitoring wells, monitoring network, well construction and development, sampling and analysis plans, statistical methods, and quality assurance and quality control procedures.

Ground-Water Monitoring Project Reports

Reports resulting from ground-water monitoring and assessment activities at the operations contractor operated facilities since 1990 are listed as follows. These reports should be consulted for more detail about specific sites or for additional information about the program.

RCRA Reports

Both quarterly and annual reports are produced for the RCRA ground-water monitoring projects. However, only the annual reports are included in the following listing. Report numbers for the quarterly reports are included in each annual report for the respective report year. The quarterly reports are primarily data reports while the annual report includes interpretive analysis of the data.

Chou, C. J., and R. L. Jackson. 1992. *RCRA Groundwater Data Analysis Protocol for the Hanford Site, Washington*. WHC-SA-1451-FP, Westinghouse Hanford Company, Richland, Washington.

DOE/RL. 1991. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1990*. DOE/RL-91-03, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL. 1992. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1991*. DOE/RL-92-03, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL. 1993. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1992*. DOE/RL-93-09, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL. 1994. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993*. DOE/RL-93-88, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Non-RCRA/Operational Reports

Ground-water monitoring at non-RCRA sites intensified beginning in 1989 and resulted in several site-specific monitoring and assessment project reports as well as the routine or annual reports. All operational ground-water monitoring and related reports generated from 1990 to present are listed in chronological order as follows:

WHC. 1990. *Liquid Effluent Study: Groundwater Characterization Report*. WHC-EP-0366. V. G. Johnson and B. F. Ford, authors. Westinghouse Hanford Company, Richland Washington.

WHC. 1990. *Liquid Effluent Study Final Project Report*. WHC-EP-0367. V. J. Rohay, V. G. Johnson, A. G. Law, B. H. Ford, and K. R. Fecht, authors. Westinghouse Hanford Company, Richland, Washington.

Tyler, D. K. 1991. *A Methodology for Assessing Impacts to Groundwater from Disposal of Liquid Effluent to the Soil at the Hanford Site*. WHC-SD-EN-EV-008, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Tyler, D. K. 1992. *Assessment of Potential Environmental Impacts from Continued Discharge to the 300 Area Process Trenches at Hanford*. WHC-SD-WM-EE-005, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Tyler, D. K. 1992. *Groundwater Impact Assessment Report for the 400 Area Ponds*. WHC-EP-0587, Westinghouse Hanford Company, Richland, Washington.
- Alexander, D. J. 1993. *Groundwater Impact Assessment Report for the 100-D Ponds*. WHC-EP-0666, Westinghouse Hanford Company, Richland, Washington.
- Alexander, D. J., and V. G. Johnson. 1993. *Groundwater Impact Assessment Report for the 1325-N Liquid Waste Disposal Facility*. WHC-EP-0675, Westinghouse Hanford Company, Richland, Washington.
- Alexander, D. J., V. G. Johnson, and K. A. Lindsey. 1993. *Groundwater Impact Assessment Report for the 284-WB Powerplant Ponds*. WHC-EP-0679, Westinghouse Hanford Company, Richland, Washington.
- Chou, C. J., V. G. Johnson, and F. N. Hodges. 1993. *Statistical Application of Groundwater Monitoring Data at the Hanford Site*. WHC-SA-1792-FP, Westinghouse Hanford Company, Richland, Washington.
- Johnson, V. G. 1993. *Groundwater Impact Assessment Report for the 216-Z-20 Crib, 200 West Area*. WHC-EP-0674, Westinghouse Hanford Company, Richland, Washington.
- Johnson, V. G. 1993. *Westinghouse Hanford Company Operational Groundwater Status Report*. WHC-EP-0595, Richland, Washington [updated annually].
- Lindberg, J. W., S. D. Evelo, and D. J. Alexander. 1993. *Groundwater Impact Assessment Report for the 216-S-26 Crib*. WHC-EP-0690, Westinghouse Hanford Company, Richland, Washington.
- Lindsey, K. A., and V. G. Johnson. 1993. *Hydrogeologic Characterization Plan: I. Principal Recharge Zone for the Hanford Site 200 Areas Waste Storage and Disposal Sites, Cold Creek Valley Area, Western Hanford Site*. WHC-SD-EN-AP-133, Westinghouse Hanford Company, Richland, Washington.
- Reidel, S. P., V. G. Johnson, and N. W. Kline. 1993. *Groundwater Impact Assessment Report for the 216-U-17 Crib, 200 West Area*. WHC-EP-0664, Westinghouse Hanford Company, Richland, Washington.
- Johnson, V. G. 1994. *Westinghouse Hanford Company Groundwater Status Report for 1993*. [In preparation], Westinghouse Hanford Company, Richland, Washington.
- Johnson, V. G., C. J. Chou, and F. N. Hodges. 1994. *Some Statistical Aspects of Background Based Groundwater Standards at an Arid Hazardous Waste Site*. WHC-SA-2358-FP; also to be published in proceedings of the Institute of Materials Management Annual Mtg., July 1994, Naples, Florida.
- Kasza, G. L., M. J. Hartman, W. A. Jordon, and D. C. Weeks. 1994. *Groundwater Maps of the Hanford Site, June 1993*. WHC-EP-0394-7, Westinghouse Hanford Company, Richland, Washington [updated semi-annually].

Singleton, K. M., and K. A. Lindsey. 1994. *Groundwater Impact Assessment Report for the 216-U-14 Ditch*. WHC-EP-0698, Westinghouse Hanford Company, Richland, Washington.

Williams, B. A., and R. E. Peterson. 1994. *Installation of Groundwater Monitoring Wells in Support of the 100-K Area Fuel Storage Basins*. WHC-SD-EN-AP-153, Rev 1, Westinghouse Hanford Company, Richland, Washington.

References Cited

DOE-RL. 1993. *Hanford Site Solid Waste Landfill Permit Application*. DOE/RL-90-38, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 1993. *Hanford Site Groundwater Protection Management Program*. DOE/RL-89-12, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 1994. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993*. DOE/RL-93-88, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL. 1994. *Hanford Sitewide Groundwater Remediation Strategy*. DOE/RL-94-95, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE. 1992. *Hanford Federal Facility Agreement and Consent Order*. 2 vols., as amended, Washington State Department of Ecology, Olympia, Washington, U.S. Environmental Protection Agency, and U.S. Department of Energy, Washington, D.C.

EPA. 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document, OSWER-9950.1*. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1989. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Interim Final Guidance*, PB 89-151047, U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1992. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Addendum to Interim Final Guidance (Draft)*, EPA/530-R-93-003, U.S. Environmental Protection Agency, Washington, D.C.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." *Washington Administrative Code*, as amended.

WAC 173-216, "State Discharge Permit Program." *Washington Administrative Code*, as amended.

WAC 173-303, "Dangerous Waste Regulations." *Washington Administrative Code*, as amended.

WAC 173-304, "Minimum Functional Standards for Solid Waste Handling." *Washington Administrative Code*, as amended.

WHC-SD-EN-EV-008. 1991. *A Methodology for Assessing Impacts to Groundwater from Disposal of Liquid Effluent to the Soil at the Hanford Site*. Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-EV-174. 1992. *Groundwater and Monitoring Assessment Plan for the 100K Area Facility Site Baseline*. Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-QAPP-001. 1992. *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities*. Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0595. 1993. *Westinghouse Hanford Company Operational Groundwater Status Report, 1990-1992*. Westinghouse Hanford Company, Richland, Washington.

WHC-CM-7-5. 1994. *Environmental Compliance Manual*. Section 8, "Water Quality," Westinghouse Hanford Company, Richland, Washington.

40 CFR 257. "Criteria for Classification of Solid Waste Disposal Facilities and Practices." *Code of Federal Regulations*, as amended.

40 CFR 265. "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities." *Code of Federal Regulations*, as amended.

Hanford Site Environmental Monitoring Plan

Section II.B - Appendix A

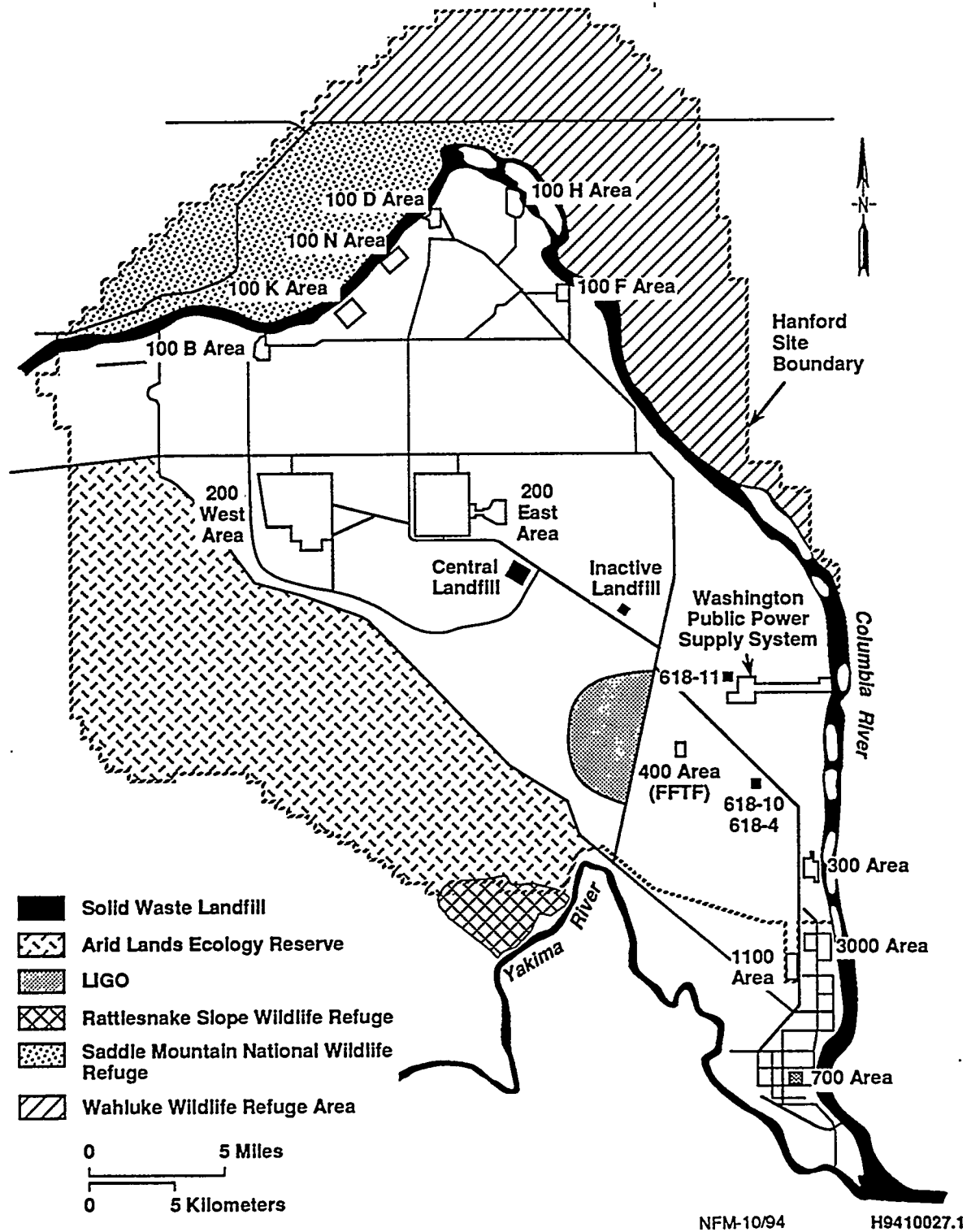


Figure II.B-A.1. Hanford Operations

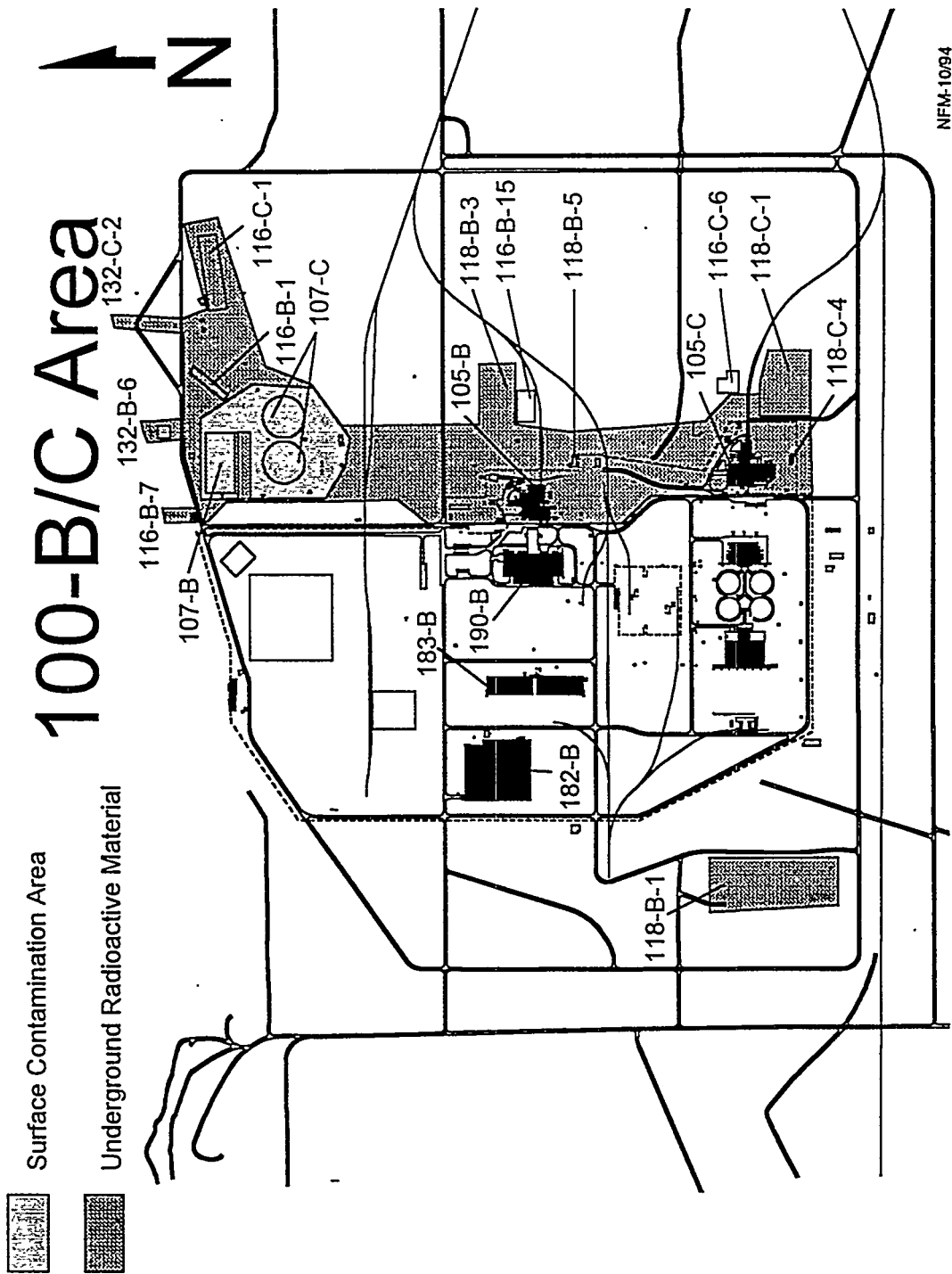


Figure II.B-A.2. Inactive, Radioactive, and Mixed Waste Sites at the 100-B and 100-C Areas

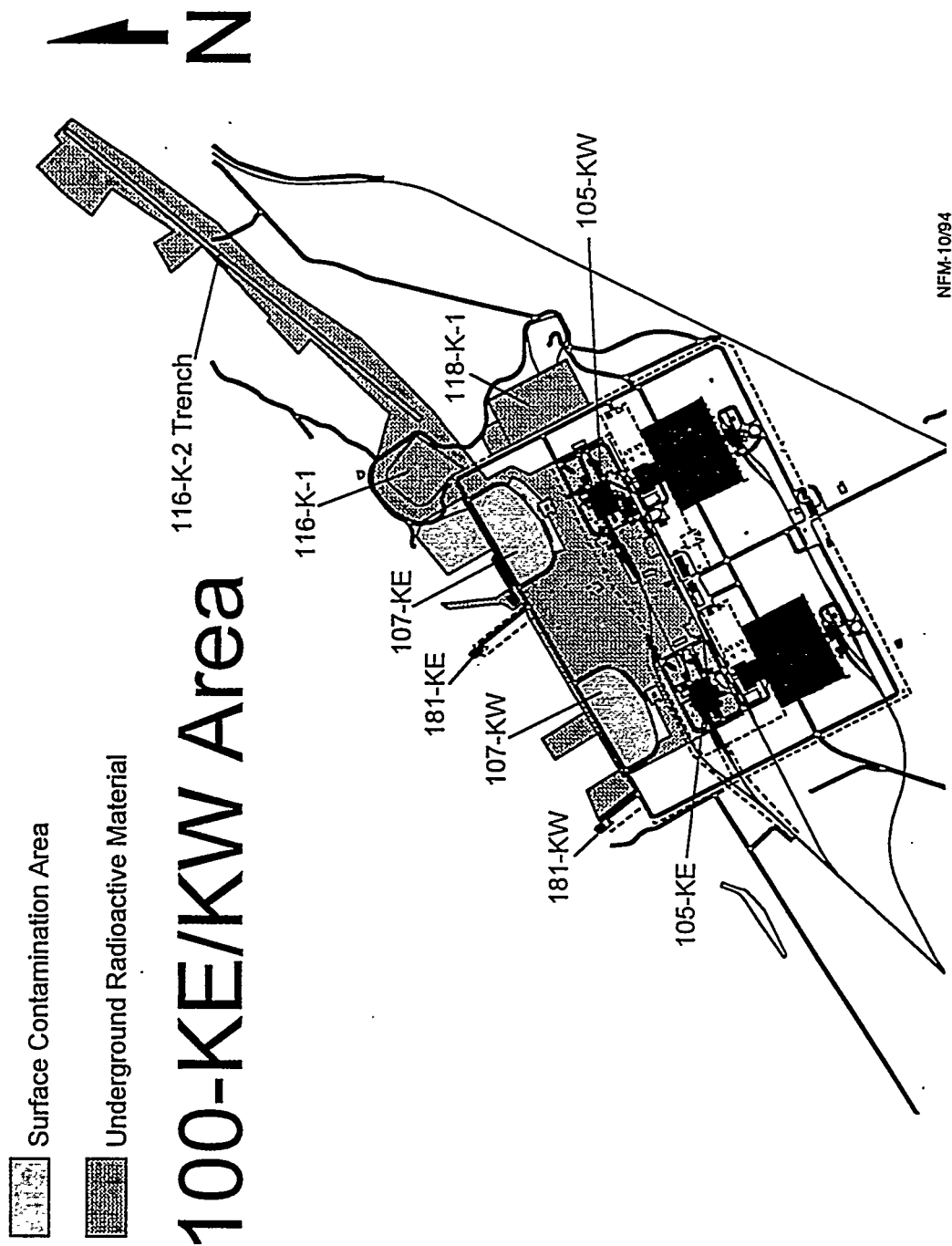


Figure II.B-A.3. 100-K Area Release Points and Waste Sites

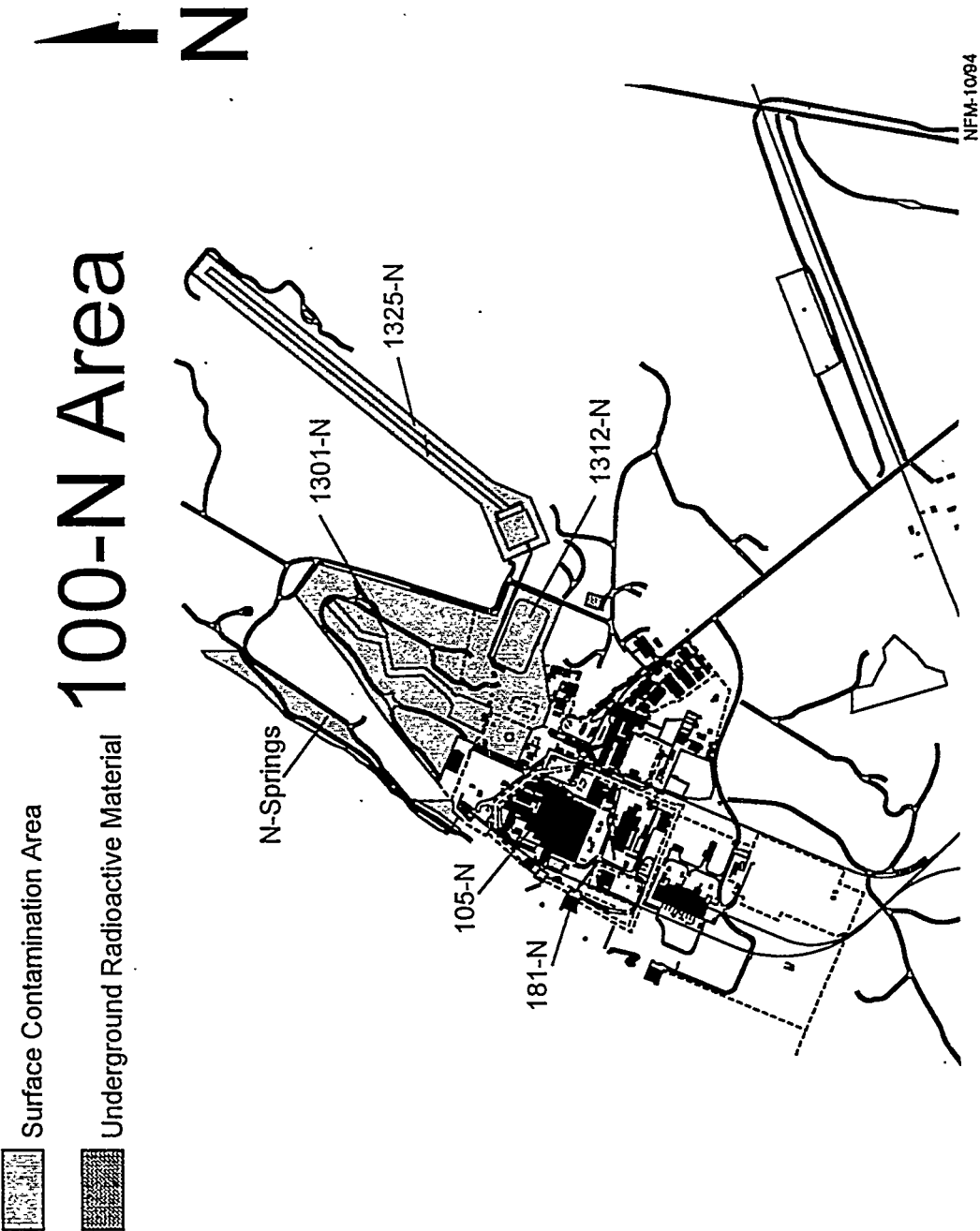


Figure II.B-A.4. 100-N Area

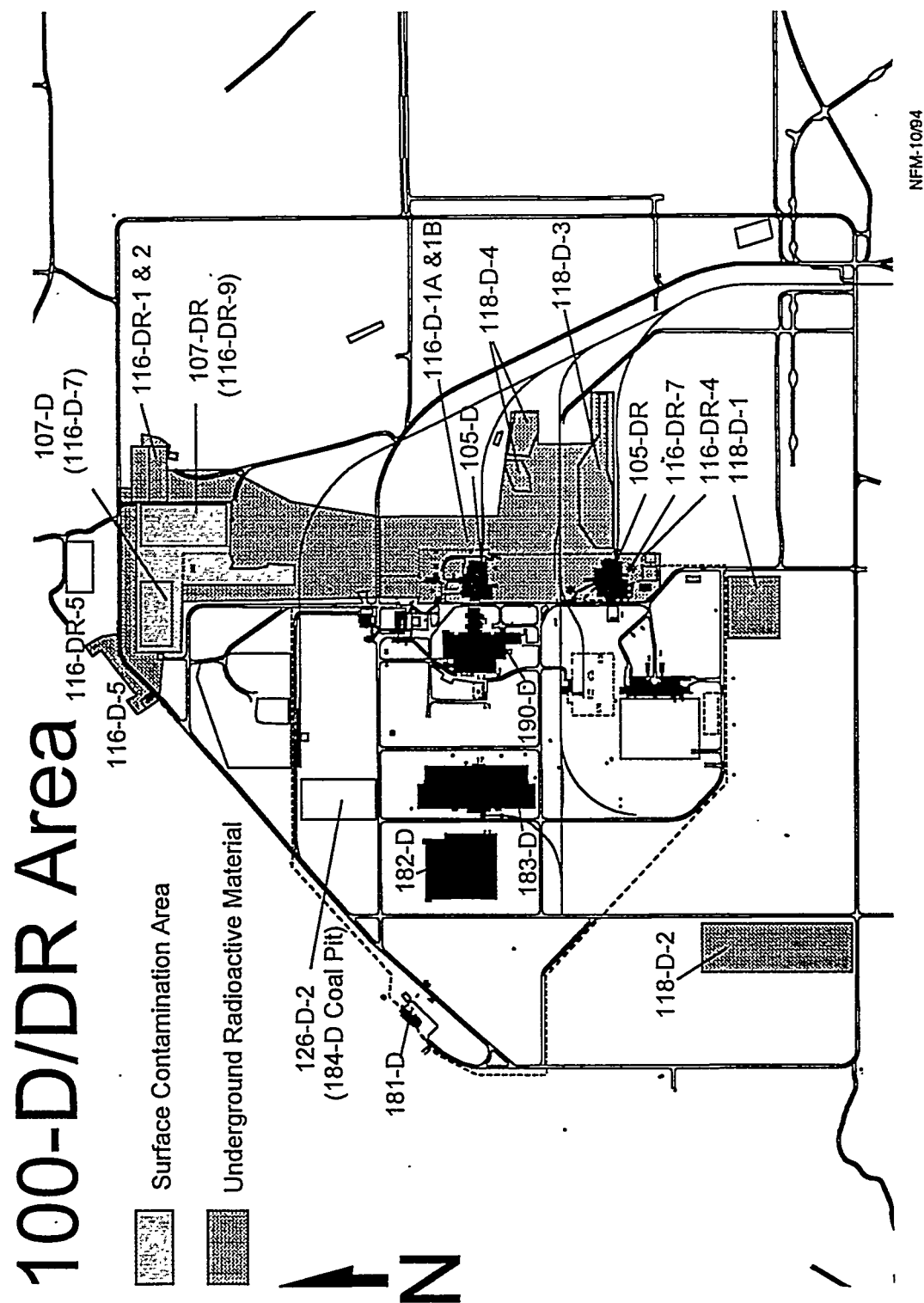


Figure II.B-A.5. 100-D/DR Area Release Points and Waste Sites

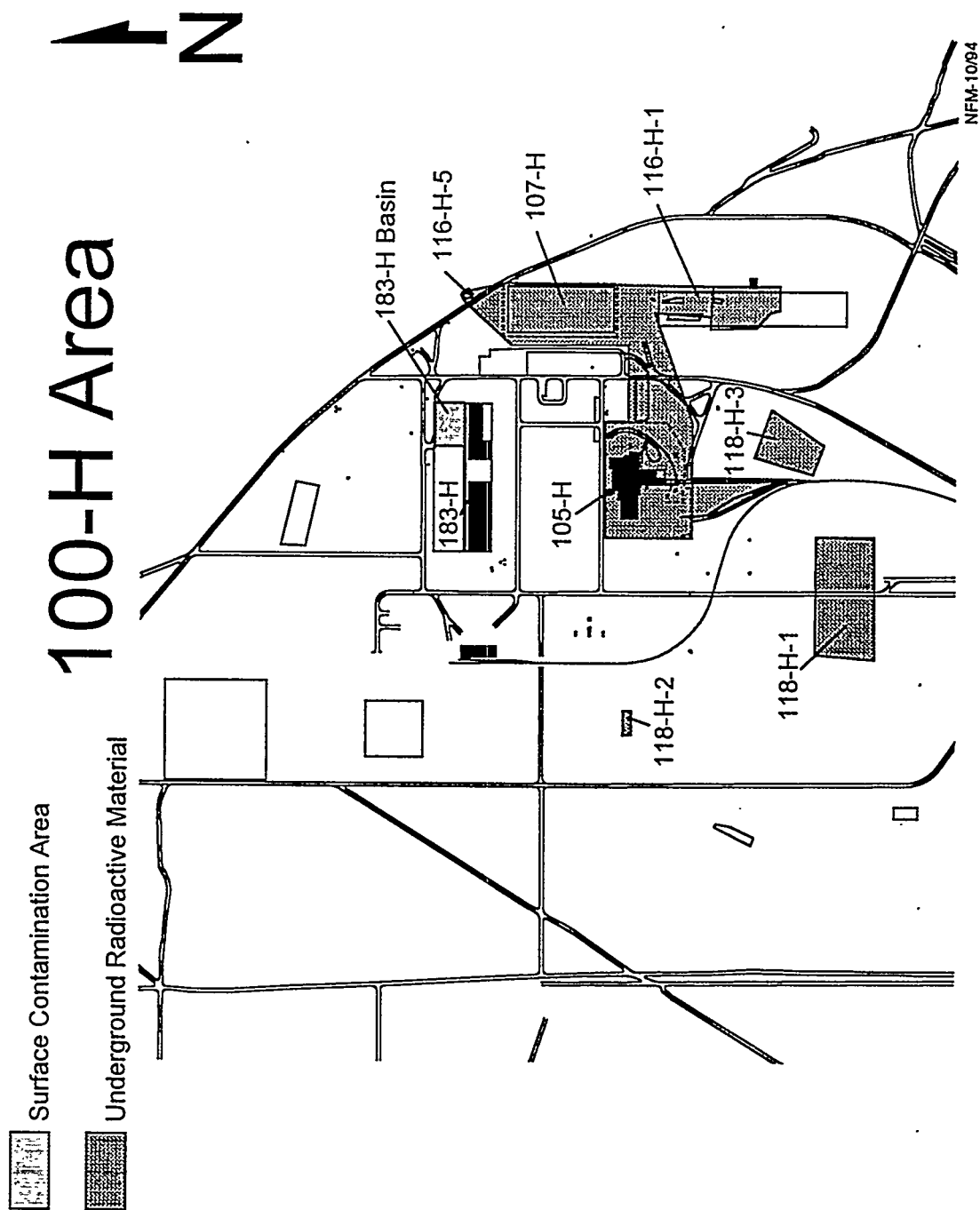


Figure II.B-A.6. 100-H Area Waste Sites

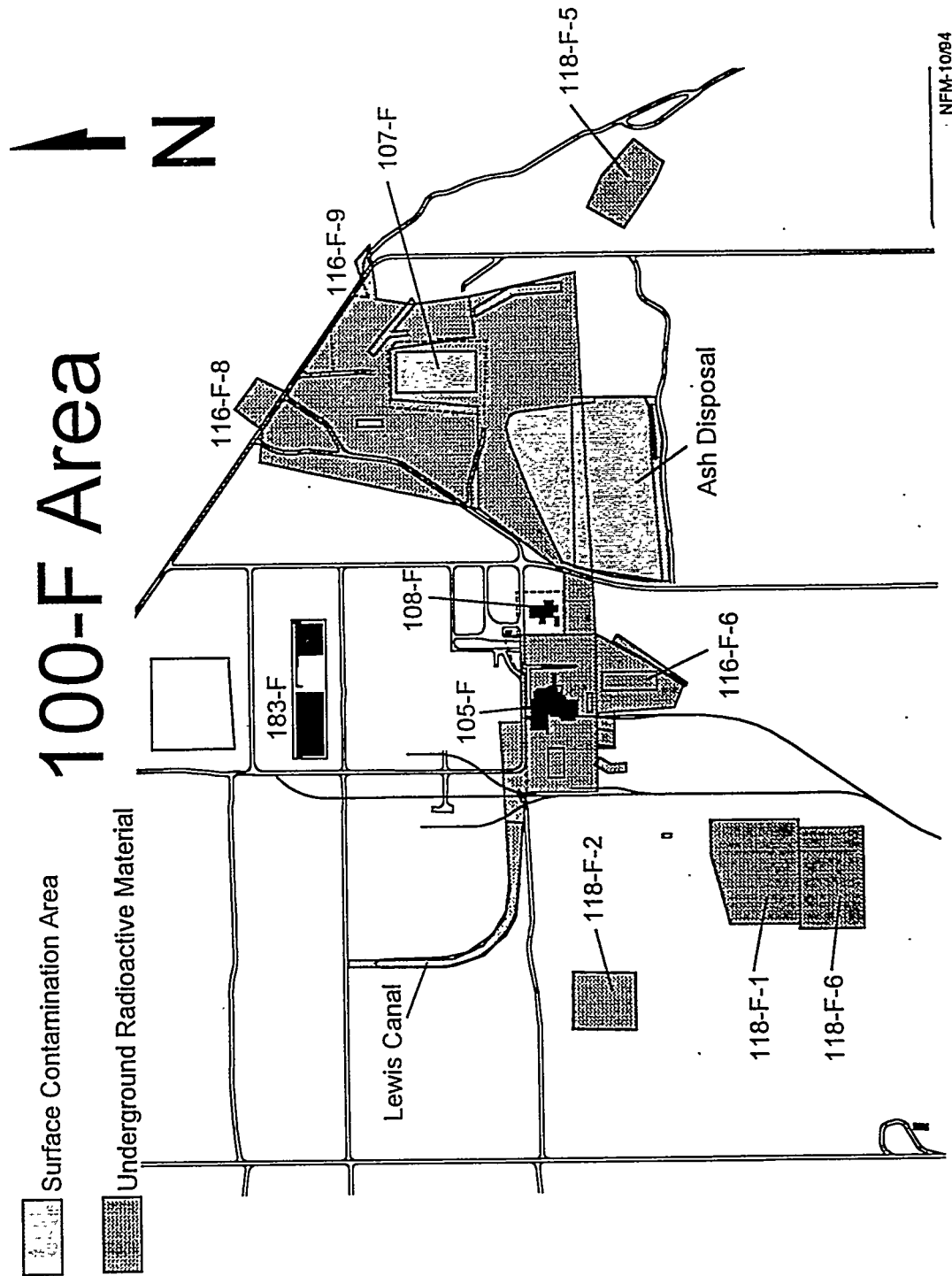


Figure II.B-A.7. 100-F Area Waste Sites

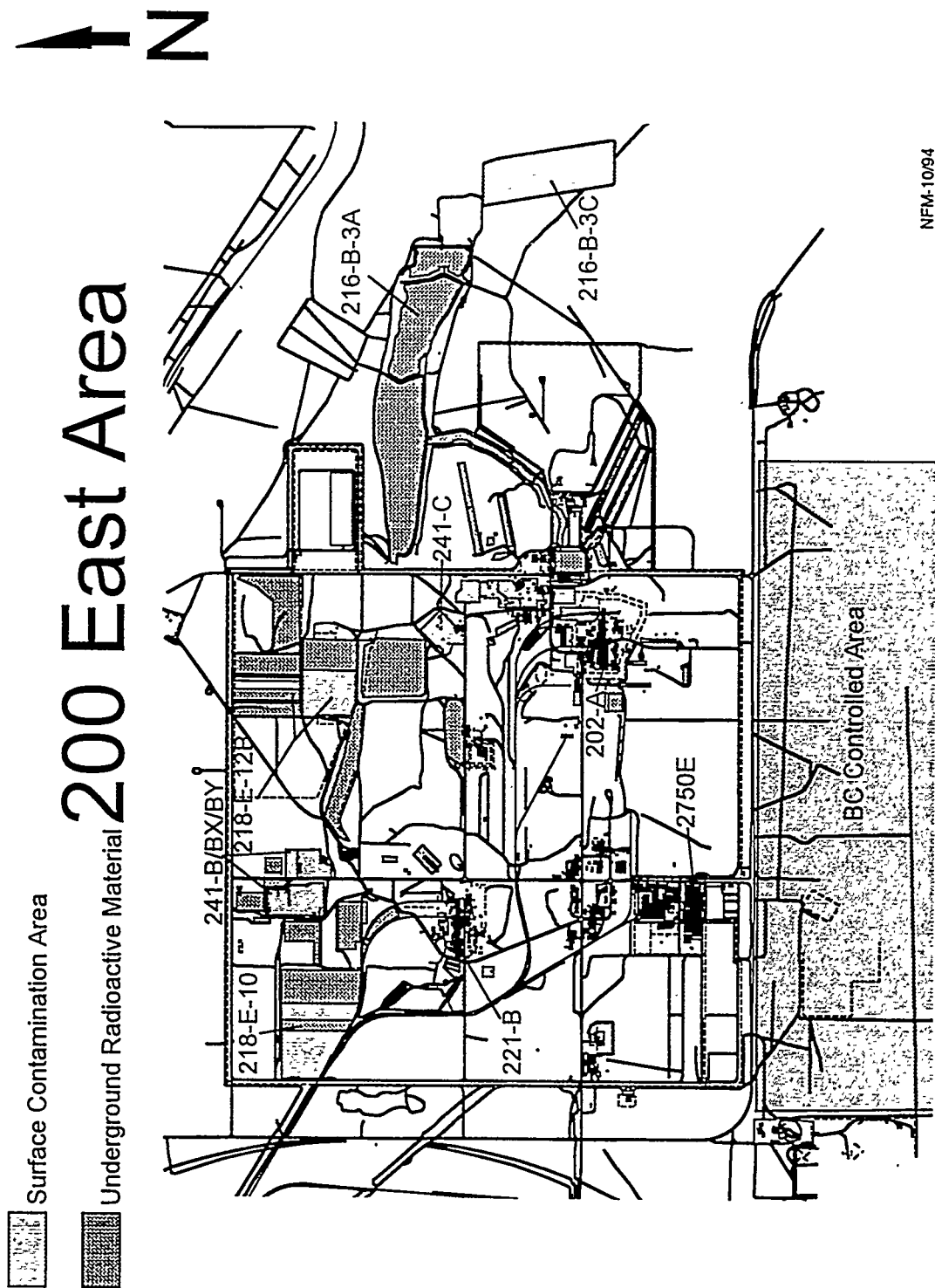


Figure II.B-A.8. 200-East Area Release Points and Waste Sites

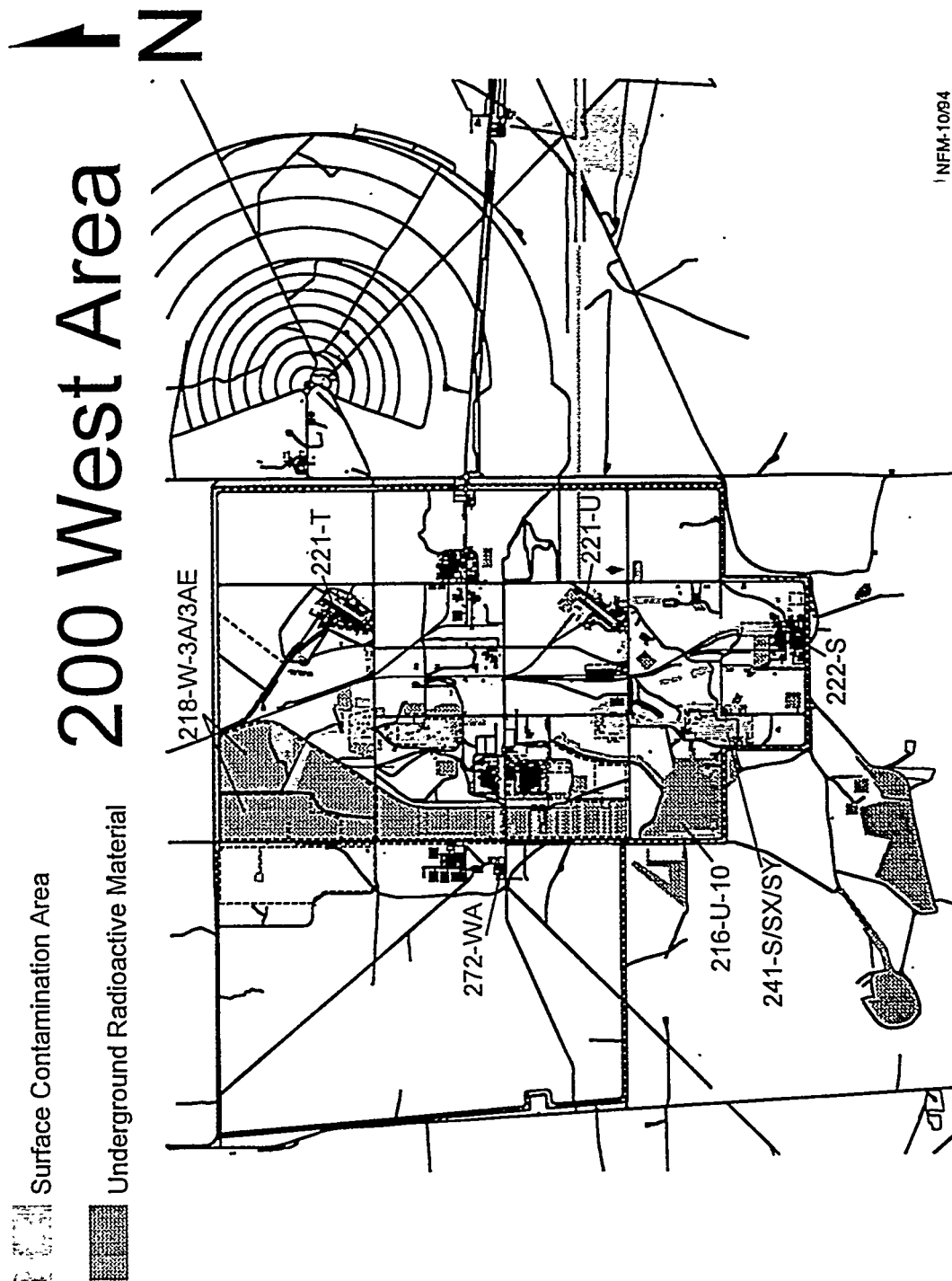


Figure II.B-A.9. 200-West Area Release Points and Waste Sites

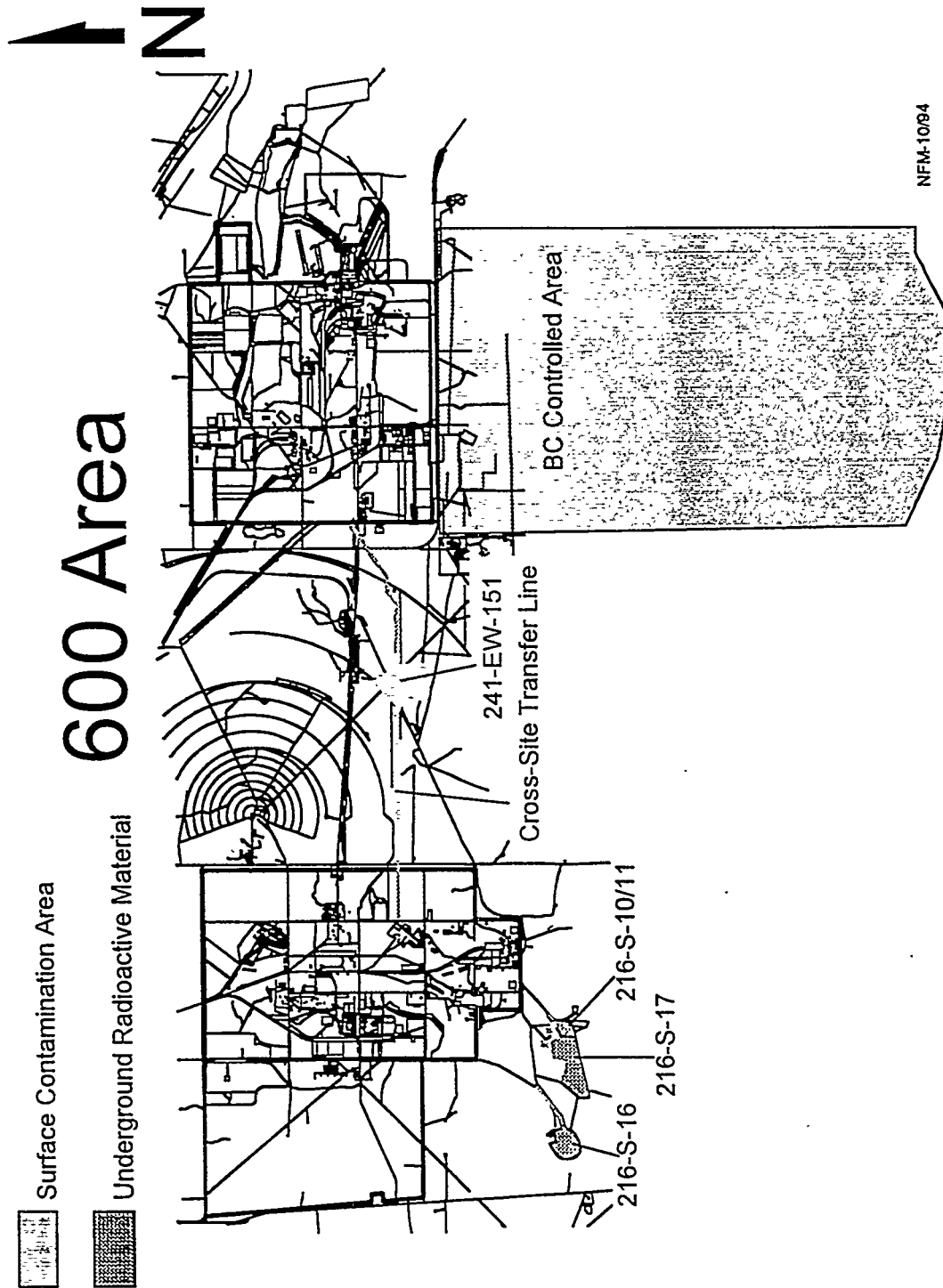


Figure II.B-A.10. 600 Area Waste Sites

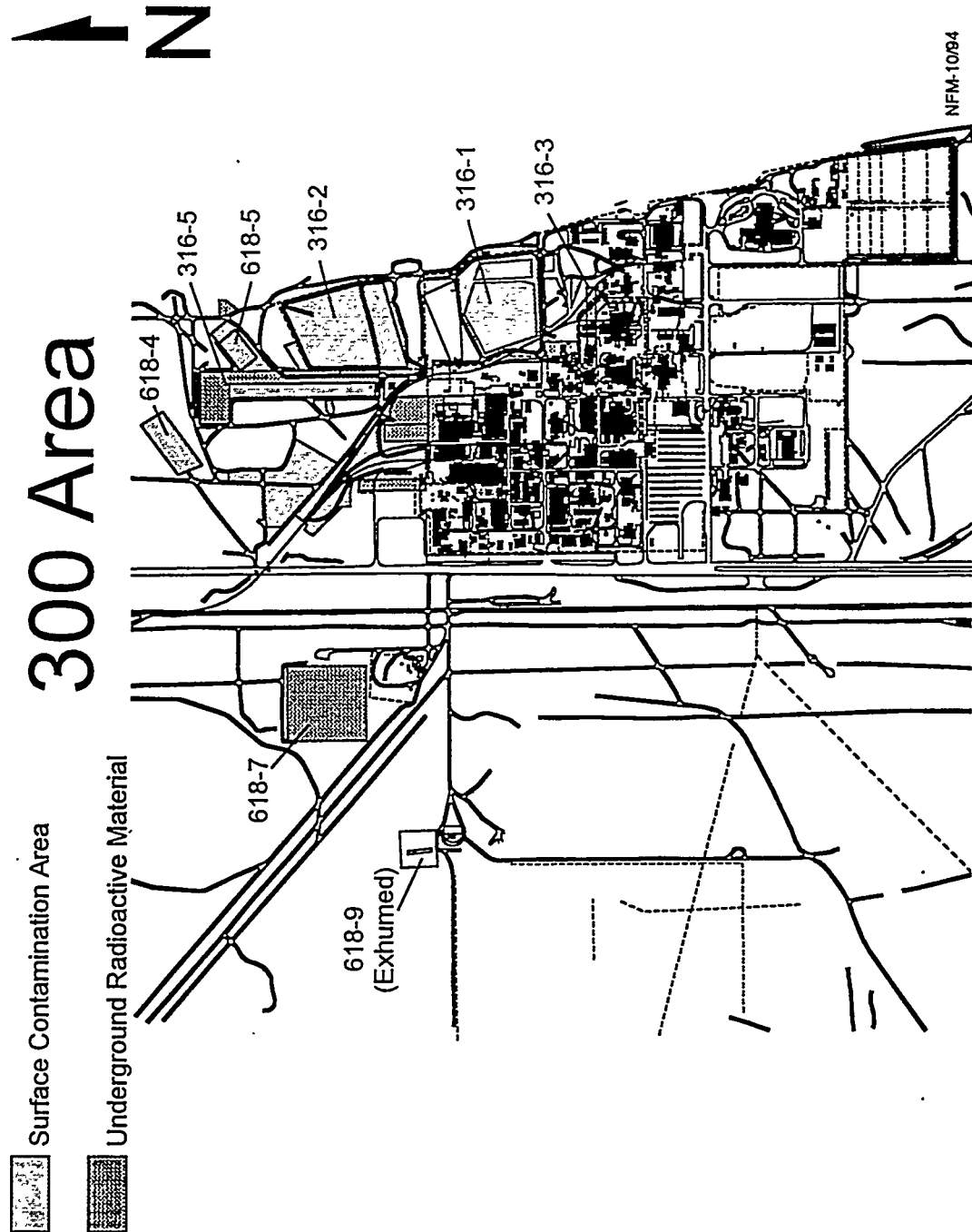


Figure II.B-A.11. 300 Area Release Points and Waste Sites



400 Area

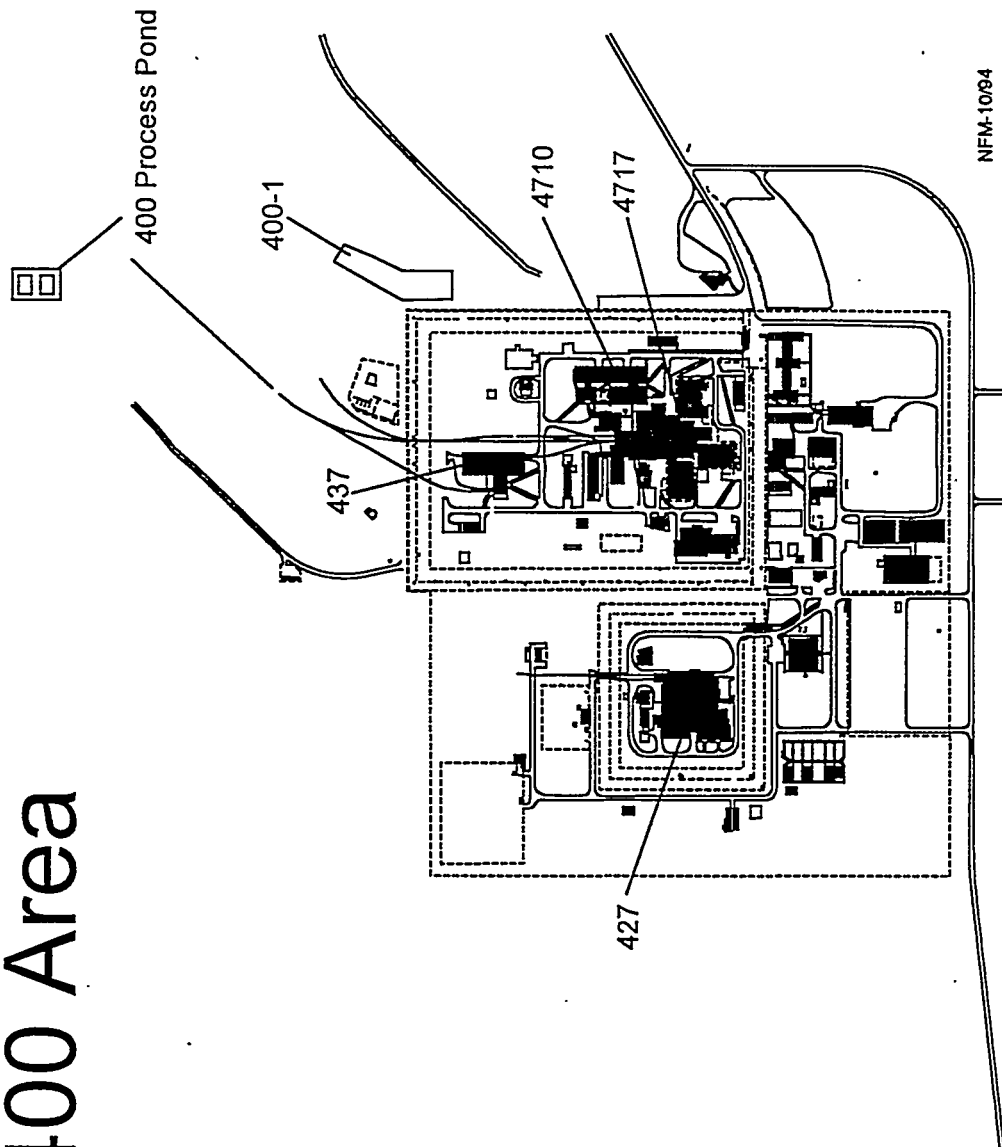


Figure II.B-A.12. 400 Area Release Points

Hanford Site Environmental Monitoring Plan

Section II.B - Appendix B

Table II.B-B.1. Number of Active and Inactive Waste Sites^(a)

Ponds	Cribs ^(b)	Ditches	Trenches ^(b)	Retention Basins	Diversion Boxes	Valve Pits	French Drains	Reverse Wells	Tanks	Burial Grounds
29	119	23	96	17	87	11	44	4	151	42

(a) These numbers reflect the best data available on the Paradox Waste Identification Data System database. Research is continuing to identify a more accurate record of the facilities.

(b) Cribs and trenches such as those within the BC Cribs and Trenches Area were recorded as one site, rather than individual cribs and trenches.

Table II.B-B.2.

Area	Surface Contamination (hectare)	Underground Radioactive Material (hectare)
100 B/C	8.0	38.9
100 KE/KW	10.7	52.2
100 N	29.4	0.3
100 D/DR	6.1	32.9
100 H	0.4	13.4
100 F	8.0	30.1
200 East ^(a)	2,269.5	138.9
200 West	222.2	656.0
300	21.2	12.5
400	0	0
600	0	5.8
Total	2,575.50	981.00

(a) Includes BC Radiological Control Area

Hanford Site Environmental Monitoring Plan

Section II.B - Appendix C Operating Contractor RCRA and NON-RCRA Ground-Water Monitoring Schedules and Well Location Maps

The FY94 detailed sampling schedules and well location maps for the RCRA and non-RCRA sites are grouped separately in this appendix. Schedules are subject to change during the year as environmental conditions and/or budget constraints dictate.

RCRA Site Format. Discussions for each of the individual RCRA sites begin with a well location map followed by a sampling schedule and an analyte or constituent list. The constituent lists are letter coded to each schedule. Column header abbreviations used in the sampling schedules are as follows:

- Well:** well identification number used for Hanford wells; the first digit indicates the area; i.e., 1 for 100 Area, 2 for 200 Area, 3 for 300 Area, 4 for 400 Area, and 6 for 600 Area. Well numbers on the location maps do not include the area designator.
- UP:** a "U" entry in this column indicates the well is an upgradient well.
- WMA:** refers to a specific waste management area; a number 1 through 5 appears in this column only for the low-level burial ground sites.
- Reps:** a "Y" or "N" is used to designate whether replicate samples are taken at a sampling event
- List:** a letter code in this column refers to the analyte list used for that well and or sampling event. The analyte list and corresponding letter code are different for each site.
- COSAMP:** entries in this column indicate cases where there is shared sampling with another project (i.e., where two or more projects may use the same well and results to avoid duplication.) Letter codes in this column refer to the specific project by name (e.g., 216-A-36B Crib would be entered as A-36B, etc.).

Constituent list column heading explanations are as follows:

- List:** the letter code in this column corresponds to the letter code entered in the "List" column of the sampling schedule.
- Group:** the analytical constituent group or individual constituent analyzed. Specific codes and breakdown of analyte groups are included in the annual statement of work.
- Filtered:** indicates the constituent or analyte group sample is filtered (F) or unfiltered (U); a blank entry in this column is understood to be unfiltered.

Non-RCRA Site Format. Discussions for each individual site, or logical grouping of sites, begin with a sampling schedule/matrix table showing the well and month in which the sampling event takes place. A letter code indicates the constituent list, which is shown immediately beneath the well/month matrix table. A monitoring objective statement is also included for the individual site or grouping of sites. Well numbers are listed in the matrix table without the area prefix; however, the well code or name shown on the location maps may include the full prefix (e.g., 299- for 200 Area wells, 199- for 100 Area wells, etc.). The three-digit prefix may also be shortened to just the first digit in some cases; e.g., 299- would be 2- and so on).

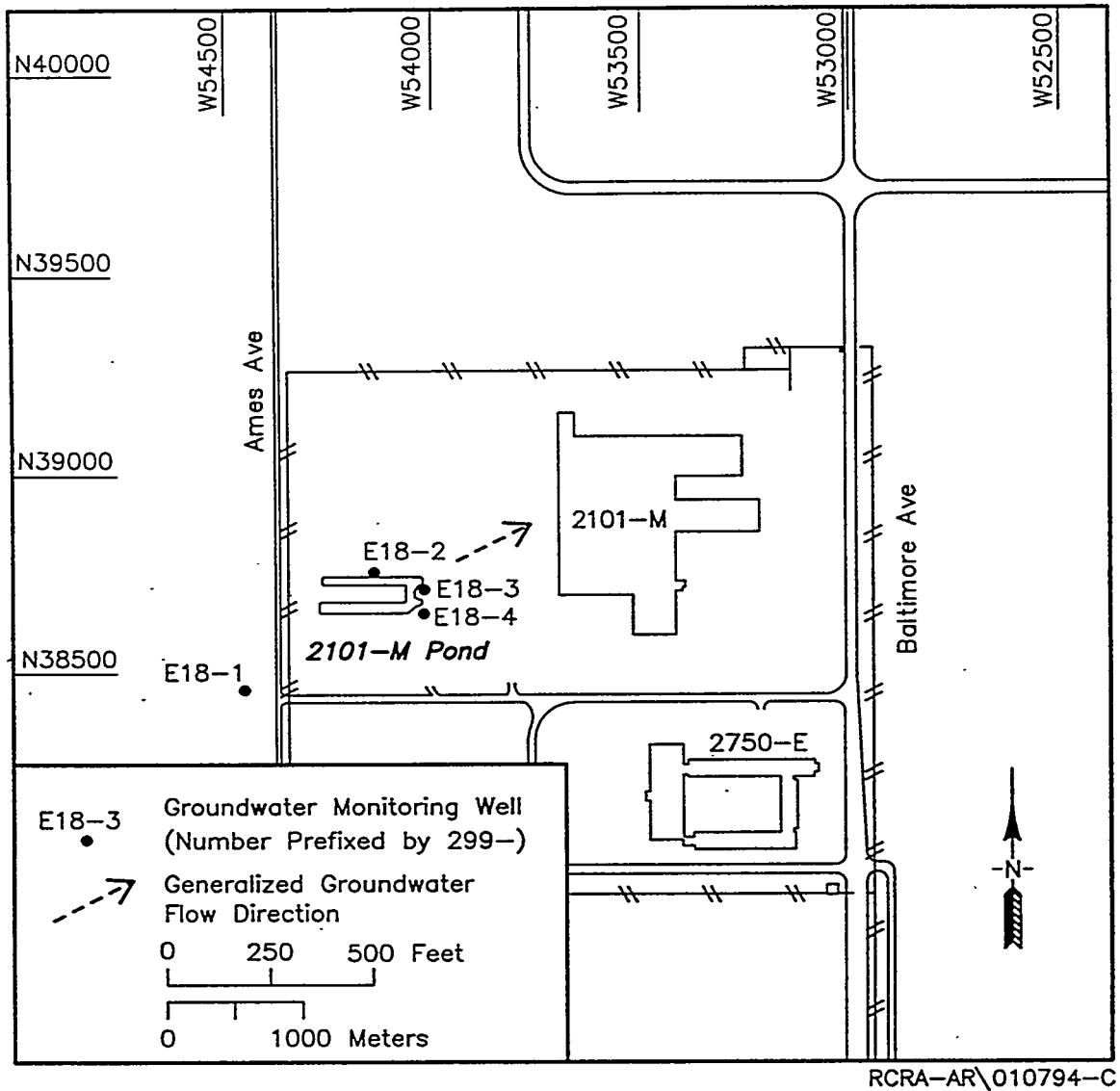


Figure II.B-C.1. RCRA Monitoring Well Locations for 2101-M Pond

2101-M Pond 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
2-E18-1	U		Y	A	December		B Pond
2-E18-1	U		Y	SA	June		B Pond
2-E18-2			Y	A	December		
2-E18-2			Y	SA	June		
2-E18-3			Y	A	December		
2-E18-3			Y	SA	June		
2-E18-4			Y	A	December		
2-E18-4			Y	SA	June		

2101-M Well Constituent List

<u>List</u>	<u>Group</u>	<u>Filtered</u>	<u>Other W. O.</u>	<u>Change Date</u>
A	Alpha, Beta, Uranium			
A	Anions			
A	Coliform			
A	Conductivity-Lab			
A	ICP, Arsenic, Selenium	F		
A	ICP, Arsenic, Selenium	U		
A	pH-Lab			
A	Phenols			
A	TOC			
A	TOX (Weston)			
A	Turbidity			
SA	Alpha, Beta			
SA	Anions			
SA	Coliform			
SA	Conductivity-Lab			
SA	ICP, Arsenic, Selenium	F		
SA	ICP, Arsenic, Selenium	U		
SA	pH-Lab			
SA	TOC			
SA	TOX (Weston)			
SA	Turbidity			

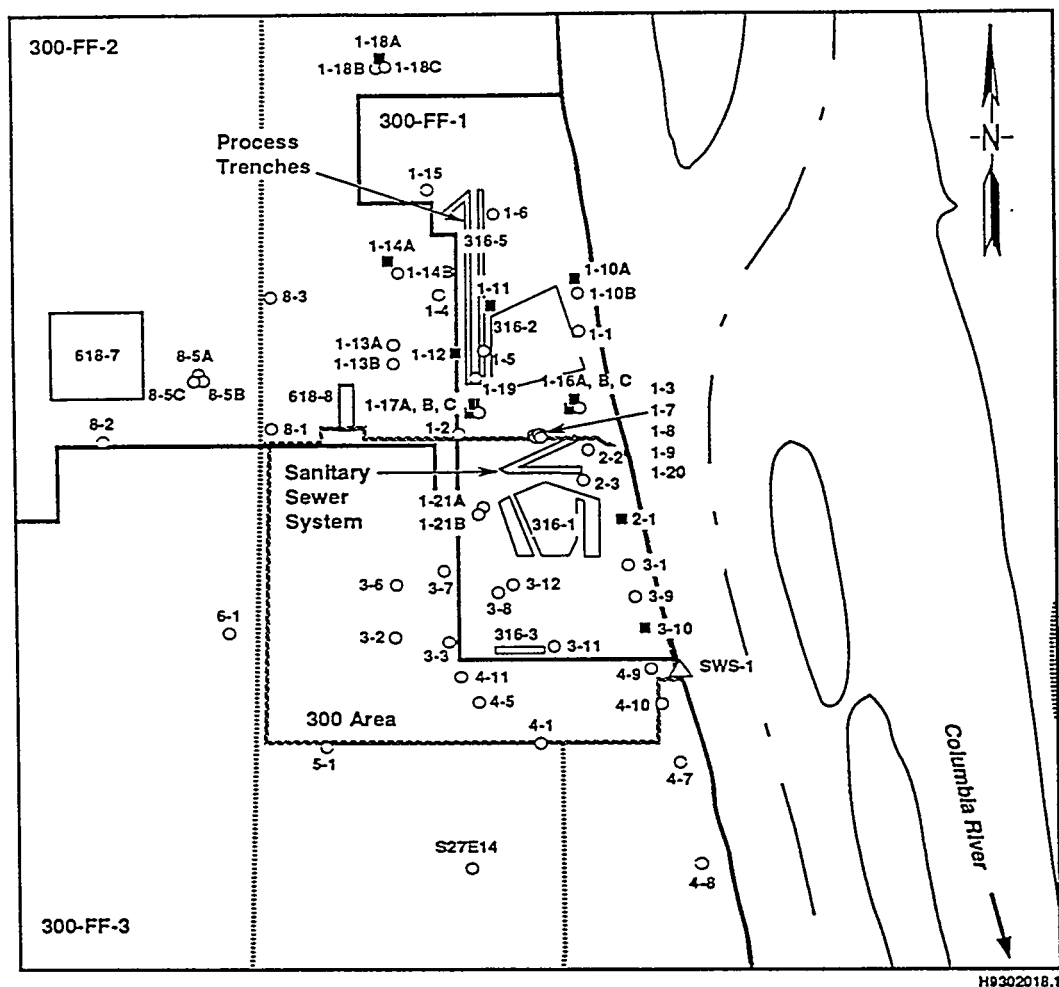


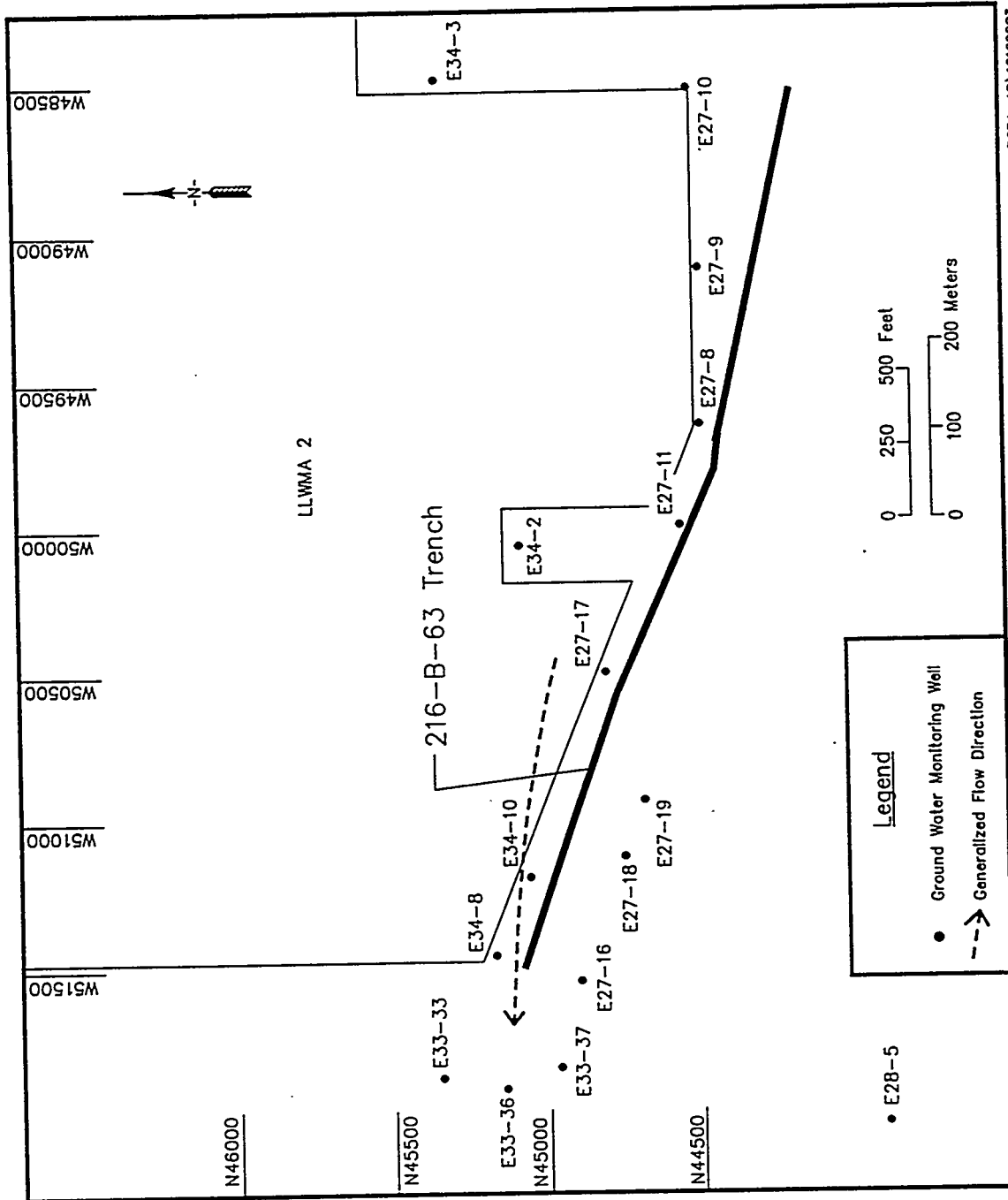
Figure II.B-C.2. RCRA Monitoring Well Locations for the 300 Area Process Trenches

300 Area Process Trenches 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
3-1-10A				SA	June		
3-1-10A				SA	October		
3-1-11				SA	June		
3-1-11				SA	October		
3-1-12				SA	June		
3-1-12				SA	October		
3-1-14A	U			SA	June		
3-1-14A	U			SA	October		
3-1-16A				SA	June		
3-1-16A				SA	October		
3-1-16B				SA	June		
3-1-16B				SA	October		
3-1-17A			Y	Q	April		
3-1-17A			Y	Q	December		
3-1-17A			Y	SA	June		
3-1-17A			Y	SA	October		
3-1-17B				SA	June		
3-1-17B				SA	October		
3-1-18A	U			SA	June		
3-1-18A	U			SA	October		
3-2-1				SA	June		
3-2-1				SA	October		
3-3-10				SA	June		
3-3-10				SA	October		

300 Area Process Trenches Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
Q	Anions			
Q	Conductivity-Lab			
Q	Gamma Scan			
Q	pH-Lab			
Q	Strontium-90			
Q	TOC			
Q	TOX (Weston)			
Q	U-ISO			
Q	Uranium			
Q	VOA (GC)			
SA	Alkalinity			
SA	Alpha, Beta, Uranium			
SA	Coliform			
SA	Conductivity-Lab			
SA	ICP, Arsenic, Selenium, Lead	F		
SA	ICP, Arsenic, Selenium, Lead	U		
SA	Mercury	F		
SA	Mercury	U		
SA	pH-Lab			
SA	Radium			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			
SA	VOA (GC)			



RCRA-AR\121092C3

Figure II.B-C.3. RCRA Monitoring Well Locations for the 216-B-63 Trench

216-B-63 Trench 1994 Well Sampling Schedule

Well	UP	Reps	List	Month	Change	COSAMP
2-E27-11	U	Y	A	November		LLBG
2-E27-11	U	Y	SA	May		LLBG
2-E27-16		Y	A	November		
2-E27-16		Y	SA	May		
2-E27-17	U	Y	A	November		LLBG
2-E27-17	U	Y	SA	May		LLBG
2-E27-18		Y	A	November		
2-E27-18		Y	SA	May		
2-E27-19		Y	A	November		
2-E27-19		Y	SA	May		
2-E27-8	U	Y	A	November		LLBG
2-E27-8	U	Y	SA	May		LLBG
2-E27-9	U	Y	A	November		LLBG
2-E27-9	U	Y	SA	May		LLBG
2-E33-33		Y	A	November		
2-E33-33		Y	SA	May		
2-E33-36		Y	A	November		
2-E33-36		Y	SA	May		
2-E33-37		Y	A	November		EAST
2-E33-37		Y	SA	May		
2-E34-10	U	Y	A	November		LLBG
2-E34-10	U	Y	SA	May		LLBG
2-E34-8		Y	A	November		EAST
2-E34-8		Y	SA	May		

216-B-63 Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Anions			
A	Conductivity-Lab			
A	ICP Metals	U		
A	Iodine-129			
A	Phenols			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	U-ISO			
A	VOA (GC)			
SA	Conductivity-Lab			
SA	ICP Metals	U		
SA	Iodine-129			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			
SA	U-ISO			
SA	VOA (GC)			

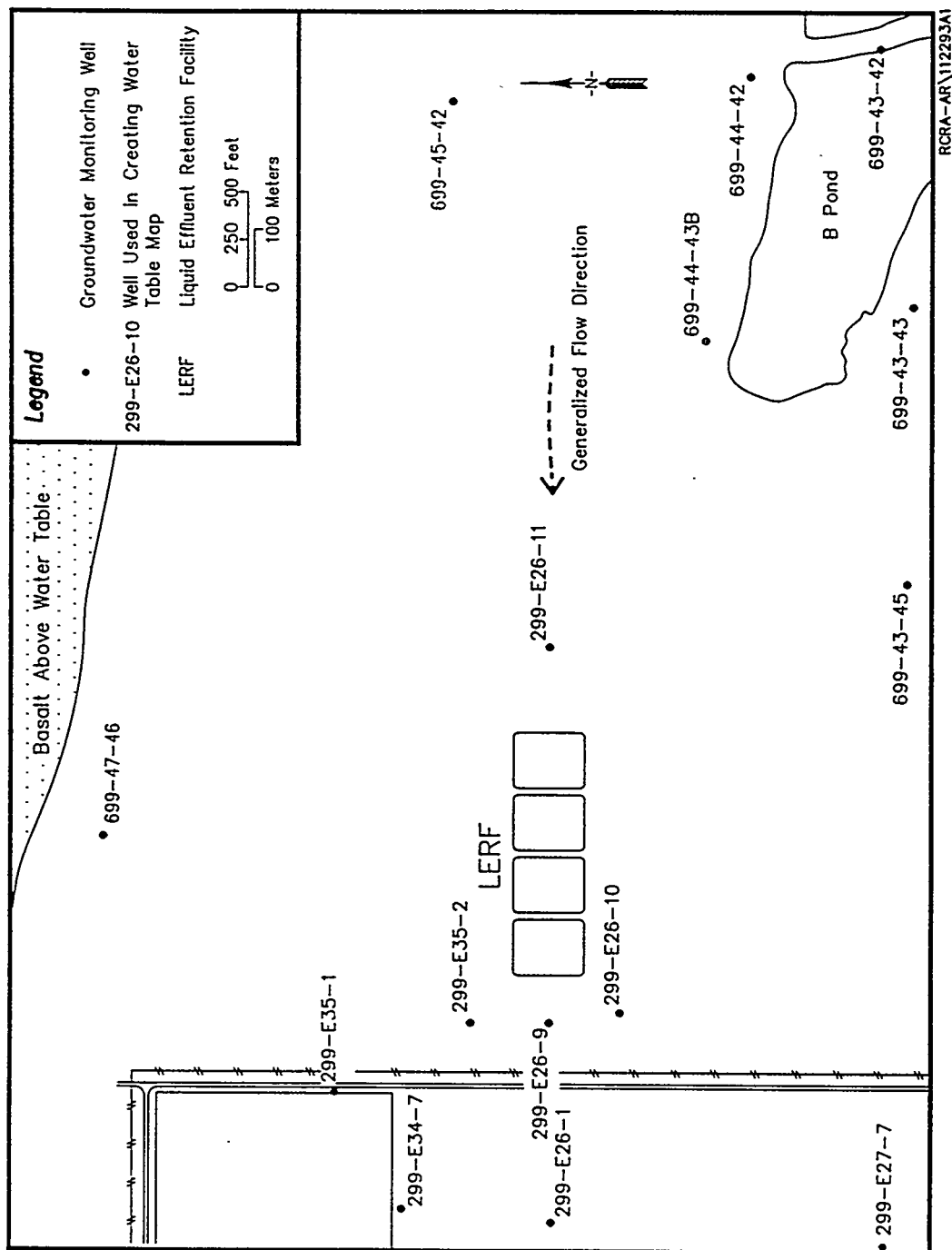


Figure II.B-C.4. RCRA Monitoring Well Locations for the LERF

LERF 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
2-E26-10			Y	A	January		
2-E26-10			Y	SA	July		
2-E26-11	U		Y	A	January		EAST
2-E26-11	U		Y	SA	July		
2-E26-9			Y	A	January		EAST
2-E26-9			Y	SA	July		
2-E35-2			Y	A	January		
2-E35-2			Y	SA	July		

LERF Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alkalinity			
A	Ammonium			
A	Anions			
A	Conductivity-Lab			
A	ICP Metals	F		
A	ICP Metals	U		
A	pH-Lab			
A	Phenols			
A	TDS			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	VOA (GC)			
SA	Ammonium			
SA	Conductivity-Lab			
SA	pH-Lab			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			
SA	VOA (GC)			

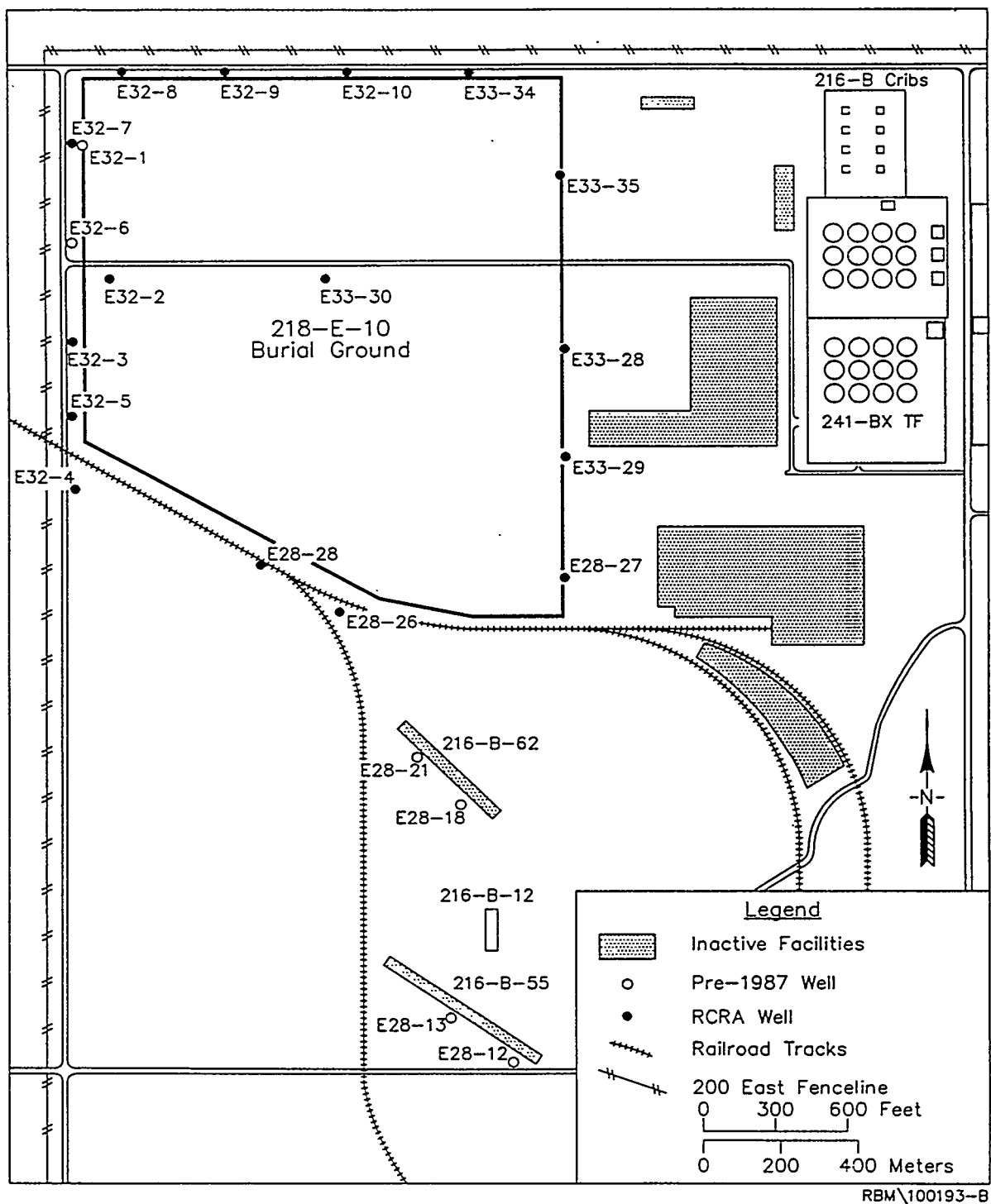


Figure II.B-C.5. RCRA Monitoring Well Locations for LLBG WMA 1

LLBG WMA1 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
2-E28-26	U	1	Y	A	June		
2-E28-26	U	1	Y	S	December		
2-E28-27	U	1	Y	A	June		
2-E28-27	U	1	Y	S	December		
2-E28-28	U	1	Y	A	June		
2-E28-28	U	1	Y	S	December		
2-E32-10		1	Y	A	June		
2-E32-10		1	Y	S	December		
2-E32-2		1	Y	A	June		
2-E32-2		1	Y	S	December		
2-E32-3		1	Y	A	June		
2-E32-3		1	Y	S	December		
2-E32-4	U	1	Y	A	June		
2-E32-4	U	1	Y	S	December		
2-E32-5		1	Y	A	June		
2-E32-5		1	Y	S	December		East
2-E32-6		1	Y	A	June		
2-E32-6		1	Y	S	December		
2-E32-7		1	Y	A	June		
2-E32-7		1	Y	S	December		
2-E32-8		1	Y	A	June		
2-E32-8		1	Y	S	December		
2-E32-9		1	Y	A	June		
2-E32-9		1	Y	S	December		
2-E33-28	U	1	Y	A	June		
2-E33-28	U	1	Y	S	December		
2-E33-29	U	1	Y	A	June		
2-E33-29	U	1	Y	S	December		
2-E33-30	1	Y	A		June		
2-E33-30	1	Y	S		December		
2-E33-34	1	Y	A		June		
2-E33-34	1	Y	S		December		
2-E33-35	U	1	Y	A	June		
2-E33-35	U	1	Y	S	December		

LLBG WMA1 Well Constituent List

<u>List</u>	<u>Group</u>	<u>Filtered</u>	<u>Other W. O.</u>	<u>Change Date</u>
A	Alpha, Beta, Uranium			
A	Anions			
A	Cyanide			
A	ICP Metals, Lead	F		
A	ICP Metals, Lead	U		
A	Mercury	F		
A	Mercury	U		
A	pH-Lab			
A	Phenols			
A	Radium			
A	Semi-VOA			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
A	VOA (GC)			
S	Alpha, Beta, Uranium			
S	Anions			
S	Cyanide			
S	ICP Metals, Lead	F		
S	ICP Metals, Lead	U		
S	Mercury	F		
S	Mercury	U		
S	pH-Lab			
S	Radium			
S	Semi-VOA			
S	TOC			
S	TOX (Weston)			
S	Tritium			
S	Turbidity			
S	VOA (GC)			

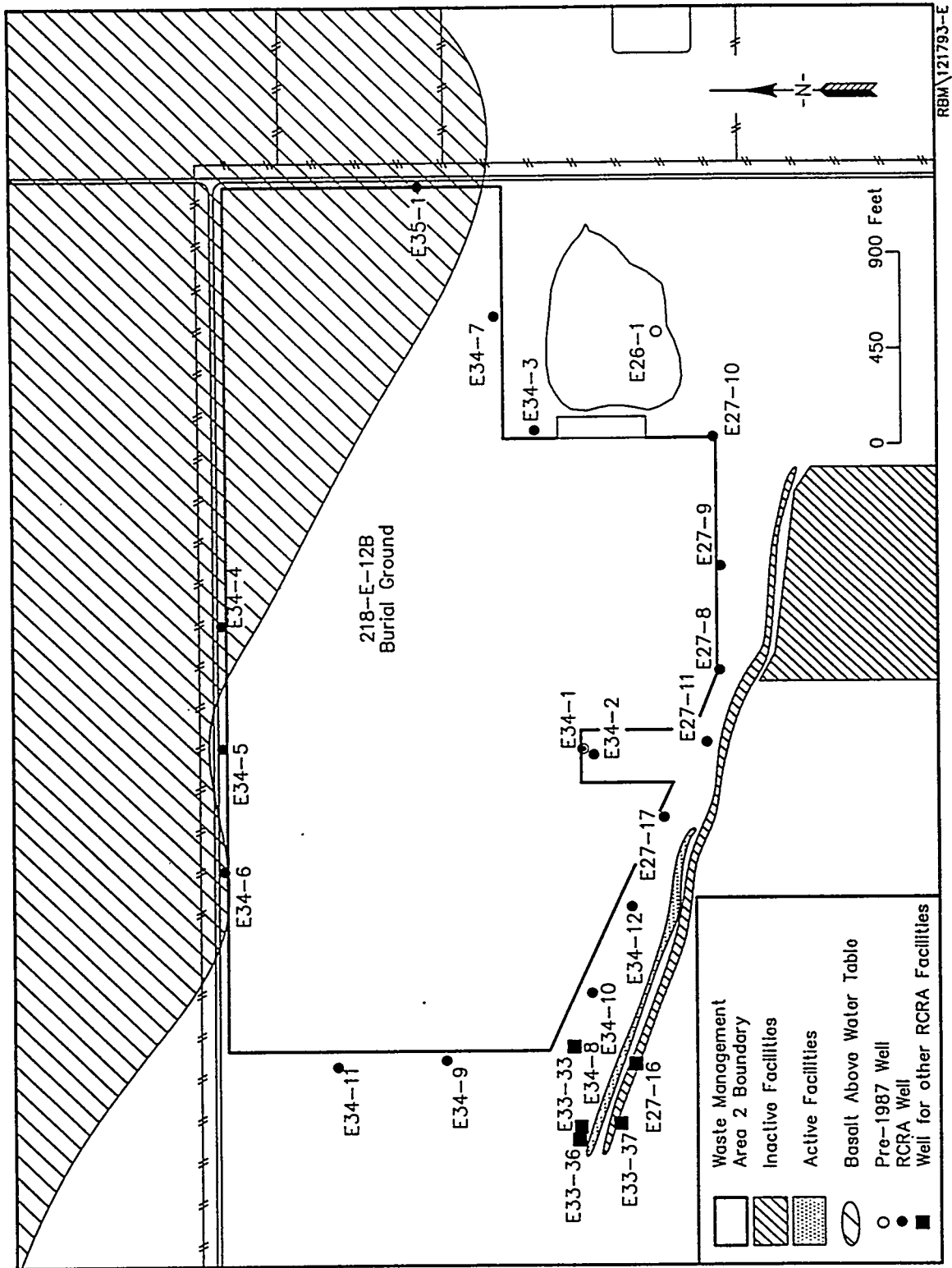


Figure II.B-C.6. RCRA Monitoring Well Locations for LLBG WMA 2

LLBG WMA2 1994 Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
2-E27-10	U	2	Y	A1	November		
2-E27-10	U	2	Y	S2	May		
2-E27-11		2	Y	A1	November		B-63
2-E27-11		2	Y	S2	May		B-63
2-E27-17		2	Y	A1	November		B-63
2-E27-17		2	Y	S2	May		B-63
2-E27-8		2	Y	A1	November		B-63
2-E27-8		2	Y	S2	May		B-63
2-E27-9		2	Y	A1	November		B-63
2-E27-9		2	Y	S2	May		B-63
2-E34-10		2	Y	A1	November		B-63
2-E34-10		2	Y	S2	May		B-63
2-E34-11		2	Y	A1	November		
2-E34-11		2	Y	S2	May		
2-E34-12		2	Y	A1	November		
2-E34-12		2	Y	S2	May		
2-E34-2		2	Y	A1	November		
2-E34-2		2	Y	S2	May		
2-E34-3	U	2	Y	A1	November		
2-E34-3	U	2	Y	S2	May		
2-E34-5	U	2	Y	A1	November		
2-E34-5	U	2	Y	S2	May		
2-E34-7	U	2	Y	A1	November		EAST
2-E34-7	U	2	Y	S2	May		
2-E34-9		2	Y	A1	November		
2-E34-9		2	Y	S2	May		

LLBG WMA2 Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A1	Alpha, Beta, Uranium			
A1	Anions			
A1	Cyanide			
A1	ICP Metals, Lead	F		
A1	ICP Metals, Lead	U		
A1	Mercury	F		
A1	Mercury	U		
A1	PCB			
A1	pH-Lab			
A1	Phenols			
A1	Radium			
A1	Semi-VOA			
A1	TOC			
A1	TOX (Weston)			
A1	Tritium			
A1	Turbidity			
A1	VOA (GC)			
S2	Alpha, Beta, Uranium			
S2	Anions			
S2	Cyanide			
S2	ICP Metals, Lead	F		
S2	ICP Metals, Lead	U		
S2	Mercury	F		
S2	Mercury	U		
S2	PCB			
S2	pH-Lab			
S2	Radium			
S2	Semi-VOA			
S2	TOC			
S2	TOX (Weston)			
S2	Tritium			
S2	Turbidity			
S2	VOA (GC)			

LLBG WMA3 1994 Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
2-W10-13	U	3	Y	A	March		
2-W10-13	U	3	Y	Q	December		
2-W10-13	U	3	Y	Q	June		
2-W10-13	U	3	Y	S	September		
2-W10-14	U	3	Y	A	March		
2-W10-14	U	3	Y	S	September		
2-W10-19	U	3	Y	A	March		SST
2-W10-19	U	3	Y	Q	December		SST
2-W10-19	U	3	Y	Q	June		SST
2-W10-19	U	3	Y	S	September		SST
2-W10-20	U	3	Y	A	March		SST
2-W10-20	U	3	Y	Q	June		SST
2-W10-20	U	3	Y	Q1	December		SST
2-W10-20	U	3	Y	S	September		SST
2-W10-21	U	3	Y	A	March		SST
2-W10-21	U	3	Y	Q	December		
2-W10-21	U	3	Y	Q	June		SST
2-W10-21	U	3	Y	S	September		SST
2-W6-2		3	Y	A	March		LLBG-5
2-W6-2		3	Y	A	March		SST
2-W6-2		3	Y	A	March		WEST
2-W6-2		3	Y	S	September		LLBG-5
2-W6-2		3	Y	S	September		
2-W7-1		3	Y	A	March		
2-W7-1		3	Y	S	September		
2-W7-10		3	Y	A	March		LLBG-5
2-W7-10		3	Y	S	September		LLBG-5
2-W7-11		3	Y	A	March		
2-W7-11		3	Y	S	September		
2-W7-12		3	Y	A	March		
2-W7-12		3	Y	S	September		
2-W7-2		3	Y	A	March		
2-W7-2		3	Y	S	September		
2-W7-3		3	Y	A	March		
2-W7-3		3	Y	S	September		
2-W7-4		3	Y	A	March		

LLBG WMA3 1994 Sampling Schedule (cont'd)

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
2-W7-4		3	Y	S	September		
2-W7-5		3	Y	A	March		
2-W7-5		3	Y	S	September		
2-W7-6		3	Y	A	March		WEST
2-W7-6		3	Y	S	September		
2-W7-7		3	Y	A	March		
2-W7-7		3	Y	S	September		
2-W7-8		3	Y	A	March		
2-W7-8		3	Y	S	September		
2-W7-9		3	Y	A	March		
2-W7-9		3	Y	S	September		
2-W8-1		3	Y	A	March		
2-W8-1		3	Y	A	September		
2-W9-1	U	3	Y	A	March		
2-W9-1	U	3	Y	Q	December		
2-W9-1	U	3	Y	Q	June		
2-W9-1	U	3	Y	S	September		

LLBG WMA3 Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta, Uranium			
A	Anions			
A	Cyanide			
A	ICP Metals, Lead	F		
A	ICP Metals, Lead	U		
A	Mercury	F		
A	Mercury	U		
A	pH-Lab			
A	Phenols			
A	Radium			
A	Semi-VOA			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
A	VOA (GC)			
Q	TOC			
Q	TOX (Weston)			
Q1	Alpha, Beta			
Q1	Anions			
Q1	Coliform			
Q1	Herbicides, Pesticides, Phenols			
Q1	ICP, Arsenic, Selenium, Lead	F		
Q1	ICP, Arsenic, Selenium, Lead	U		
Q1	Mercury	F		
Q1	Mercury	U		
Q1	Radium			
Q1	TOC			
Q1	TOX (Weston)			
Q1	Tritium			
Q1	Turbidity			
Q1	VOA (GC)			
S	Alpha, Beta, Uranium			
S	Anions			
S	Cyanide			
S	ICP Metals, Lead	F		

LLBG WMA3 Well Constituent List (cont'd)

<u>List</u>	<u>Group</u>	<u>Filtered</u>	<u>Other W. O.</u>	<u>Change Date</u>
S	ICP Metals, Lead	U		
S	Mercury	F		
S	Mercury	U		
S	pH-Lab			
S	Radium			
S	Semi-VOA			
S	TOC			
S	TOX (Weston)			
S	Tritium			
S	Turbidity			
S	VOA (GC)			

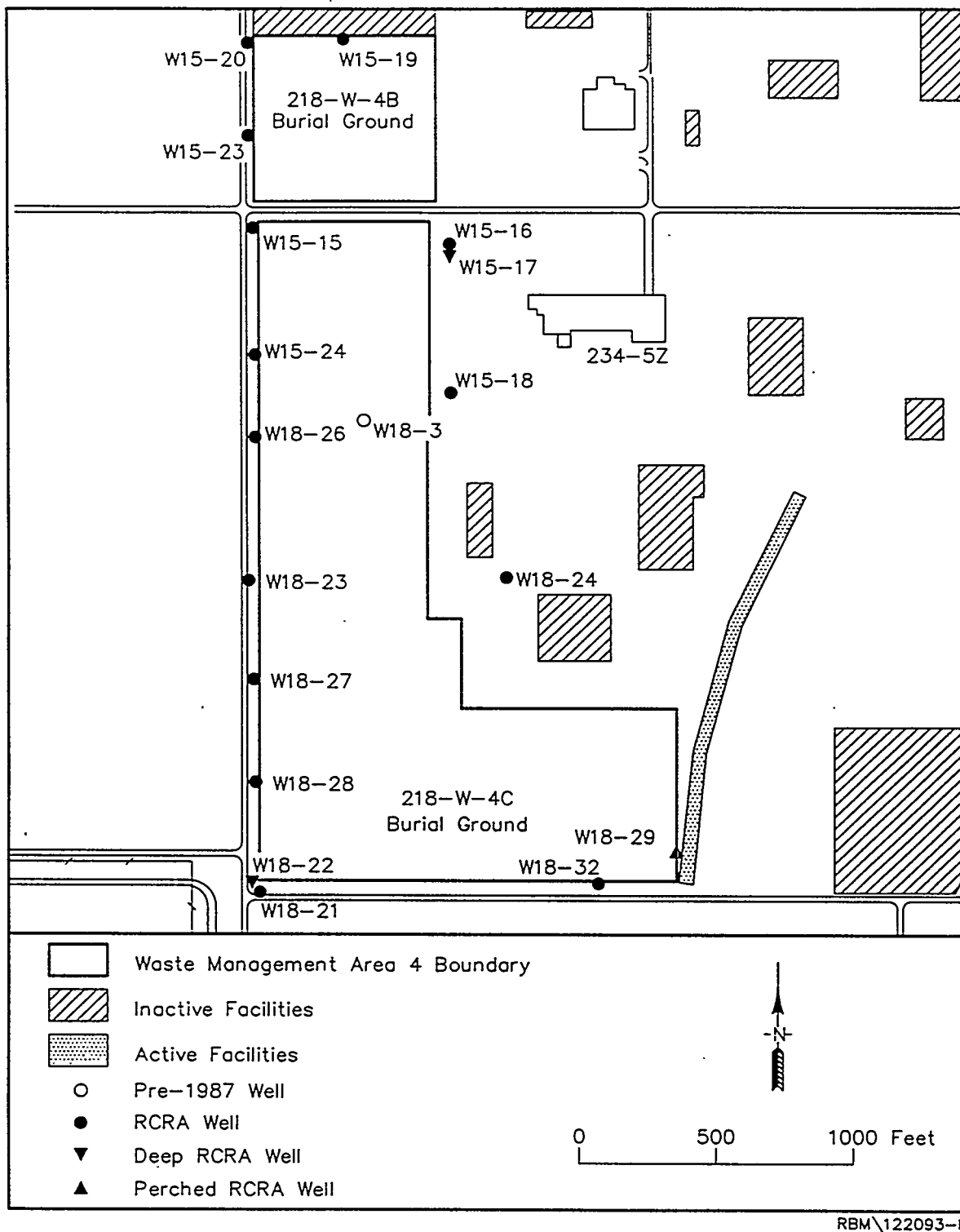


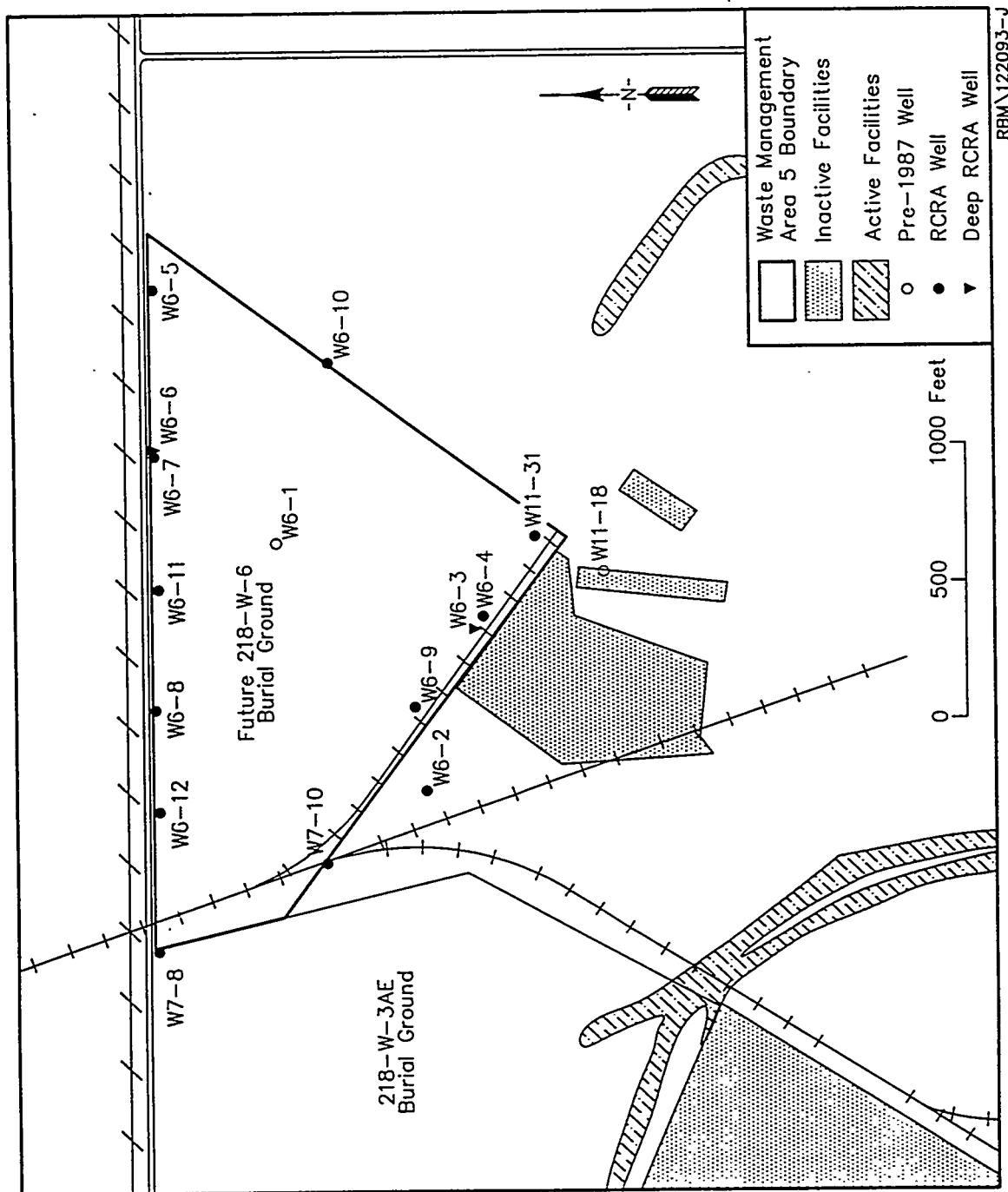
Figure II.B-C.7. RCRA Monitoring Well Locations for LLBG WMA 4

LLBG WMA4 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
2-W15-15		4	Y	A	November		
2-W15-15		4	Y	S	May		
2-W15-16	U	4	Y	A	November		
2-W15-16	U	4	Y	S	May		
2-W15-17	U	4	Y	A	November		
2-W15-17	U	4	Y	S	May		
2-W15-18	U	4	Y	A	November		
2-W15-18	U	4	Y	S	May		
2-W15-19		4	Y	A	November		WEST
2-W15-19		4	Y	S	May		
2-W15-20		4	Y	A	November		
2-W15-20		4	Y	S	May		
2-W15-23		4	Y	A	November		
2-W15-23		4	Y	S	May		
2-W15-24		4	Y	A	November		WEST
2-W15-24		4	Y	S	May		
2-W18-21		4	Y	A	November		
2-W18-21		4	Y	S	May		
2-W18-22		4	Y	A	November		WEST
2-W18-22		4	Y	S	May		
2-W18-23		4	Y	A	November		
2-W18-23		4	Y	S	May		
2-W18-24	U	4	Y	A	November		
2-W18-24	U	4	Y	S	May		
2-W18-26		4	Y	A	November		
2-W18-26		4	Y	S	May		
2-W18-27		4	Y	A	November		
2-W18-27		4	Y	S	May		
2-W18-28		4	Y	A	November		
2-W18-28		4	Y	S	May		
2-W18-32	U	4	Y	A	November		
2-W18-32	U	4	Y	S	May		

LLBG WMA4 Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta, Uranium			
A	Anions			
A	Cyanide			
A	ICP Metals, Lead	F		
A	ICP Metals, Lead	U		
A	Mercury	F		
A	Mercury	U		
A	pH-Lab			
A	Phenols			
A	Radium			
A	Semi-VOA			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
A	VOA (GC)			
S	Alpha, Beta, Uranium			
S	Anions			
S	Cyanide			
S	ICP Metals, Lead	F		
S	ICP Metals, Lead	U		
S	Mercury	F		
S	Mercury	U		
S	pH-Lab			
S	Radium			
S	Semi-VOA			
S	TOC			
S	TOX (Weston)			
S	Tritium			
S	Turbidity			
S	VOA (GC)			



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Figure II.B-C.8. RCRA Monitoring Well Locations LLBG WMA 5

LLBG WMA5 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
2-W11-31	U	5	Y	A	March		SST
2-W11-31	U	5	Y	S	September		SST
2-W6-10	U	5	Y	A	March		SST
2-W6-10	U	5	Y	S	September		SST
2-W6-11		5	Y	A	March		
2-W6-11		5	Y	S	September		
2-W6-12		5	Y	A	March		
2-W6-12		5	Y	S	September		
2-W6-2	U	5	Y	A	March		LLBG-3
2-W6-2	U	5	Y	A	March		SST
2-W6-2	U	5	Y	A	March		WEST
2-W6-2	U	5	Y	S	September		LLBG-3
2-W6-2	U	5	Y	S	September		SST
2-W6-3	U	5	Y	A	March		
2-W6-3	U	5	Y	S	September		
2-W6-4	U	5	Y	A	March		SST
2-W6-4	U	5	Y	S	September		SST
2-W6-5		5	Y	A	March		
2-W6-5		5	Y	S	September		
2-W6-6		5	Y	A	March		
2-W6-6		5	Y	S	September		
2-W6-7		5	Y	A	March		
2-W6-7		5	Y	S	September		
2-W6-8		5	Y	A	March		
2-W6-8		5	Y	S	September		
2-W6-9	U	5	Y	A	March		SST
2-W6-9	U	5	Y	S	September		SST
2-W7-10	U	5	Y	A	March		LLBG-3
2-W7-10	U	5	Y	S	September		LLBG-3

LLBG WMA5 Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta, Uranium			
A	Anions			
A	Cyanide			
A	ICP Metals, Lead	F		
A	ICP Metals, Lead	U		
A	Mercury	F		
A	Mercury	U		
A	pH-Lab			
A	Phenols			
A	Radium			
A	Semi-VOA			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
A	VOA (GC)			
S	Alpha, Beta, Uranium			
S	Anions			
S	Cyanide			
S	ICP Metals, Lead	F		
S	ICP Metals, Lead	U		
S	Mercury	F		
S	Mercury	U		
S	pH-Lab			
S	Radium			
S	Semi-VOA			
S	TOC			
S	TOX (Weston)			
S	Tritium			
S	Turbidity			
S	VOA (GC)			

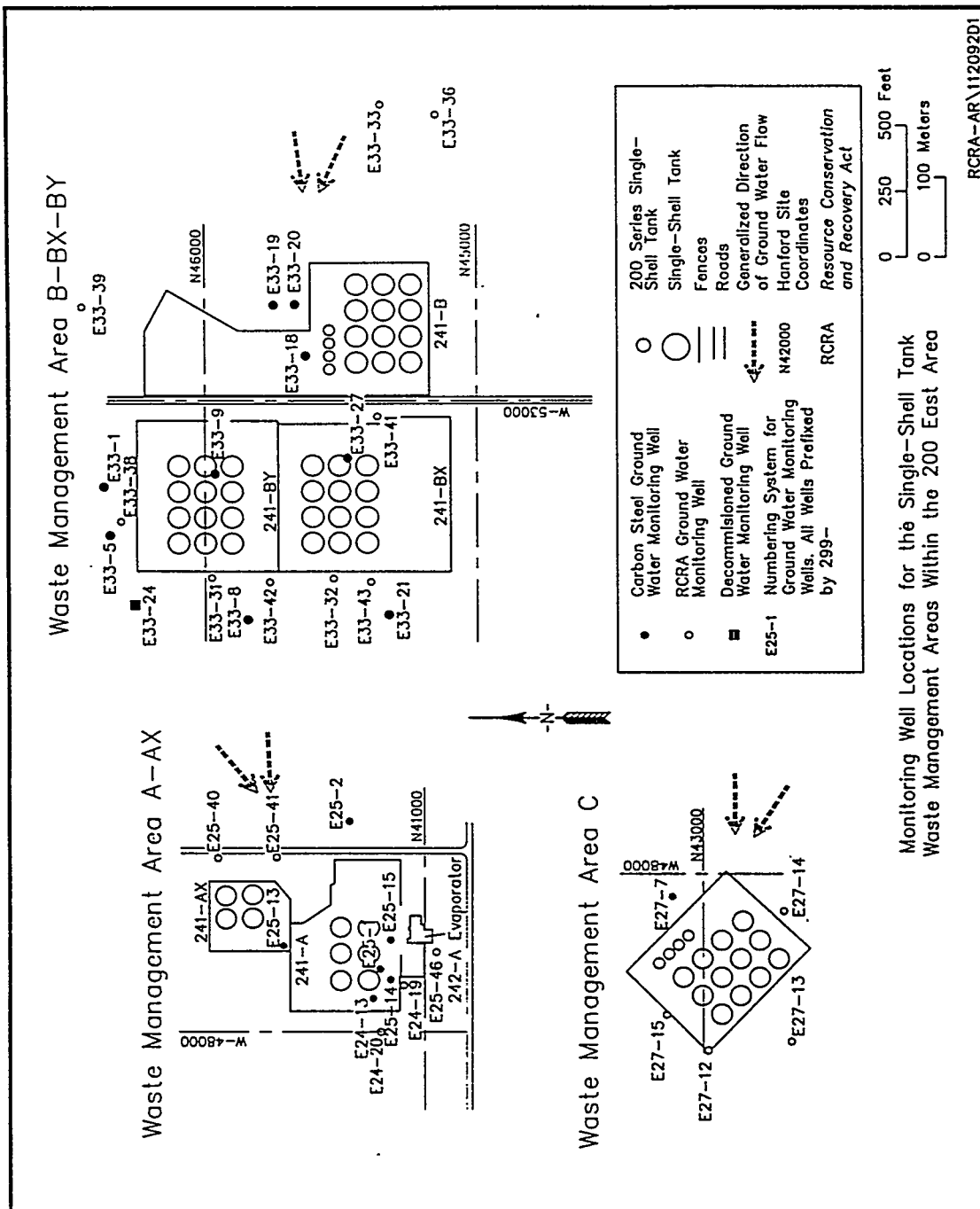


Figure II.B-C.9. RCRA Monitoring Well Locations for the SST A-AX, B-BX-BY, and C Waste Management Areas

SST A-AX 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
2-E24-19		A	Y	A	February		EAST
2-E24-19		A	Y	SA	August		
2-E24-20		A	Y	A	February		
2-E24-20		A	Y	SA	August		
2-E25-40	U	A	Y	A	February		
2-E25-40	U	A	Y	SA	August		
2-E25-41	U	A	Y	A	February		EAST
2-E25-41	U	A	Y	SA	August		
2-E25-46		A	Y	A	February		
2-E25-46		A	Y	SA	August		

SST A-AX Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta, Uranium			
A	Anions			
A	Conductivity-Lab			
A	Gamma Scan-Low Level			
A	ICP Metals	F		
A	ICP Metals	U		
A	Iodine-129			
A	pH-Lab			
A	Phenols			
A	Pu-ISO			
A	Strontium-90			
A	TDS			
A	Technetium-99			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
SA	Alpha, Beta			
SA	Conductivity-Lab			
SA	Gamma Scan-Low Level			
SA	Iodine-129			
SA	pH-Lab			
SA	Pu-ISO			
SA	Strontium-90			
SA	TDS			
SA	Technetium-99			
SA	TOC			
SA	TOX			
SA	TOX (WESTERN)			
SA	Tritium			
SA	Turbidity			

SST B-BX-BY 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
2-E33-31		B	Y	A	February		
2-E33-31		B	Y	SA	August		
2-E33-32		B	Y	A	February		
2-E33-32		B	Y	SA	August		
2-E33-33	U	B	Y	A	February		
2-E33-33	U	B	Y	SA	August		
2-E33-36	U	B	Y	A	February		
2-E33-36	U	B	Y	SA	August		
2-E33-41		B	Y	A	February		
2-E33-41		B	Y	SA	August		
2-E33-42		B	Y	A	February		
2-E33-42		B	Y	SA	August		
2-E33-43		B	Y	A	February		
2-E33-43		B	Y	SA	August		

SST B-BX-BY Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta, Uranium			
A	Anions			
A	Conductivity-Lab			
A	Gamma Scan-Low Level			
A	ICP Metals	F		
A	ICP Metals	U		
A	Iodine-129			
A	pH-Lab			
A	Phenols			
A	Pu-ISO			
A	Strontium-90			
A	TDS			
A	Technetium-99			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
SA	Alpha, Beta			
SA	Conductivity-Lab			
SA	Gamma Scan-Low Level			
SA	Iodine-129			
SA	pH-Lab			
SA	Pu-ISO			
SA	Strontium-90			
SA	TDS			
SA	Technetium-99			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			
SA	Turbidity			

SST C 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
2-E27-12		C	Y	A	February		
2-E27-12		C	Y	SA	August		
2-E27-13		C	Y	A	February		
2-E27-13		C	Y	SA	August		
2-E27-14	U	C	Y	A	February		EAST
2-E27-14	U	C	Y	SA	August		
2-E27-15		C	Y	A	February		EAST
2-E27-15		C	Y	SA	August		
2-E27-7	U	C	Y	A	February		
2-E27-7	U	C	Y	SA	August		

SST C Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta, Uranium			
A	Anions			
A	Conductivity-Lab			
A	Gamma Scan-Low Level			
A	ICP Metals	F		
A	ICP Metals	U		
A	Iodine-129			
A	pH-Lab			
A	Phenols			
A	Pu-ISO			
A	Strontium-90			
A	TDS			
A	Technetium-99			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
SA	Alpha, Beta			
SA	Conductivity-Lab			
SA	Gamma Scan-Low Level			
SA	Iodine-129			
SA	pH-Lab			
SA	Pu-ISO			
SA	Strontium-90			
SA	TDS			
SA	Technetium-99			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			
SA	Turbidity			

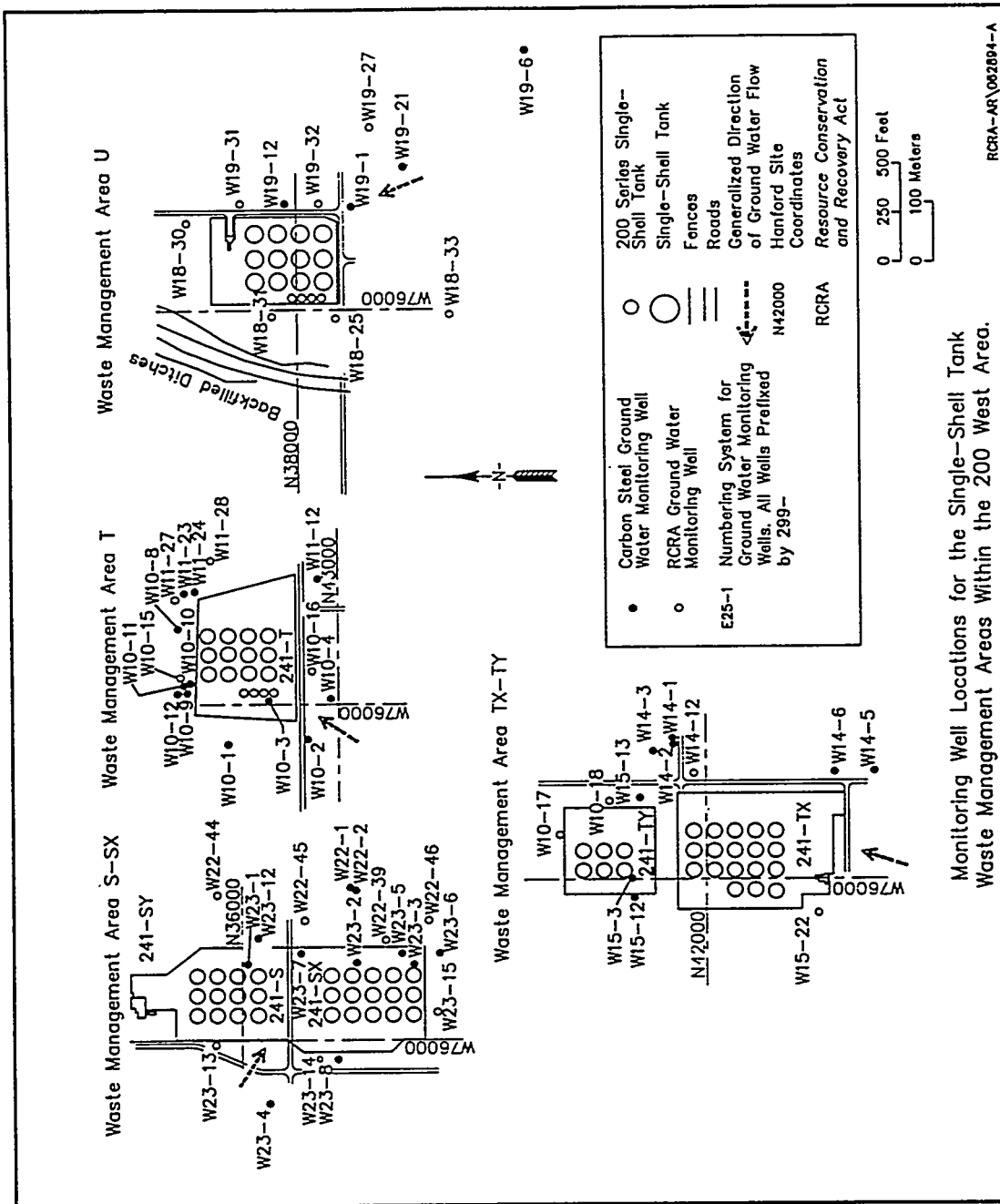


Figure II.B-C.10. RCRA Monitoring Well Locations for the SST S-SX, U, T, 7X-7Y Waste Management Areas

SST S-SX 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	COSAMP
2-W22-39		S	Y	A	February	WEST
2-W22-39		S	Y	SA	August	
2-W22-44		S	Y	A	February	
2-W22-44		S	Y	SA	August	
2-W22-45		S	Y	A	February	
2-W22-45		S	Y	SA	August	
2-W22-46		S	Y	A	February	
2-W22-46		S	Y	SA	August	
2-W23-13	U	S	Y	A	February	WEST
2-W23-13	U	S	Y	SA	August	
2-W23-14	U	S	Y	A	February	
2-W23-14	U	S	Y	SA	August	
2-W23-15		S	Y	A	February	
2-W23-15		S	Y	SA	August	

SST S-SX Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta, Uranium			
A	Anions			
A	Conductivity-Lab			
A	Gamma Scan-Low Level			
A	ICP Metals	F		
A	ICP Metals	U		
A	Iodine-129			
A	pH-Lab			
A	Phenols			
A	Pu-ISO			
A	Strontium-90			
A	TDS			
A	Technetium-99			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
SA	Alpha, Beta			
SA	Conductivity-Lab			
SA	Gamma Scan-Low Level			
SA	Iodine-129			
SA	pH-Lab			
SA	Pu-ISO			
SA	Strontium-90			
SA	TDS			
SA	Technetium-99			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			
SA	Turbidity			

SST T 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
2-W10-15		T		Q2	August		
2-W10-15		T		Q2	February		
2-W10-15		T		Q2	May		
2-W10-15		T		Q2	November		
2-W10-16	U	T		Q2	August		
2-W10-16	U	T		Q2	February		
2-W10-16	U	T		Q2	May		
2-W10-16	U	T		Q2	November		WEST
2-W10-19		T		Q1	December		LLBG
2-W10-19		T		Q1	June		LLBG
2-W10-19		T		Q1	March		LLBG
2-W10-19		T		Q1	September		LLBG
2-W10-20		T		Q1	December		LLBG
2-W10-20		T		Q1	June		LLBG
2-W10-20		T		Q1	March		LLBG
2-W10-20		T		Q1	September		LLBG
2-W10-21		T		Q1	December		LLBG
2-W10-21		T		Q1	June		LLBG
2-W10-21		T		Q1	March		LLBG
2-W10-21		T		Q1	September		LLBG
2-W11-27		T		Q2	August		
2-W11-27		T		Q2	February		
2-W11-27		T		Q2	May		
2-W11-27		T		Q2	November		
2-W11-28		T		Q2	August		
2-W11-28		T		Q2	February		
2-W11-28		T		Q2	May		
2-W11-28		T		Q2	November		
2-W11-31		T		Q1	December		
2-W11-31		T		Q1	June		
2-W11-31		T		Q1	March		LLBG
2-W11-31		T		Q1	September		LLBG
2-W6-10		T		Q1	December		
2-W6-10		T		Q1	June		
2-W6-10		T		Q1	March		LLBG
2-W6-10		T		Q1	September		LLBG
2-W6-2		T		Q1	December		
2-W6-2		T		Q1	June		
2-W6-2		T		Q1	March		LLBG
2-W6-2		T		Q1	September		LLBG

SST T 1994 Well Sampling Schedule (cont'd)

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
2-W6-4		T		Q1	December		
2-W6-4		T		Q1	June		
2-W6-4		T		Q1	March		LLBG
2-W6-4		T		Q1	September		LLBG
2-W6-9		T		Q1	December		
2-W6-9		T		Q1	June		
2-W6-9		T		Q1	March		
2-W6-9		T		Q1	September		LLBG

SST T Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
Q1	Anions			
Q1	Gamma Scan-Low Level			
Q1	Iodine-129			
Q1	Strontium-90			
Q1	TDS			
Q1	Technetium-99			
Q1	TOC			
Q1	TOX (Weston)			
Q1	Tritium			
Q2	Alkalinity			
Q2	Alpha, Beta, Uranium			
Q2	Anions			
Q2	Conductivity-Lab			
Q2	Gamma Scan-Low Level			
Q2	ICP, Arsenic, Selenium, Lead, Thallium	F		
Q2	ICP, Arsenic, Selenium, Lead, Thallium	U		
Q2	Iodine-129			
Q2	Mercury	F		
Q2	Mercury	U		
Q2	pH-Lab			
Q2	Pu-ISO			
Q2	Strontium-90			
Q2	TDS			
Q2	Technetium-99			
Q2	TOC			
Q2	TOX (Weston)			
Q2	Tritium			
Q2	Turbidity			

SST TX-TY 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
2-W10-17		TX-TY		Q2	August		
2-W10-17		TX-TY		Q2	February		
2-W10-17		TX-TY		Q2	May		
2-W10-17		TX-TY		Q2	November		
2-W10-18		TX-TY		Q2	August		
2-W10-18		TX-TY		Q2	February		
2-W10-18		TX-TY		Q2	May		
2-W10-18		TX-TY		Q2	November		
2-W14-12		TX-TY		Q2	August		
2-W14-12		TX-TY		Q2	February		
2-W14-12		TX-TY		Q2	May		
2-W14-12		TX-TY		Q2	November		
2-W15-22	U	TX-TY		Q2	August		
2-W15-22	U	TX-TY		Q2	February		
2-W15-22	U	TX-TY		Q2	May		
2-W15-22	U	TX-TY		Q2	November		WEST

SST TX-TY Well Constituent List

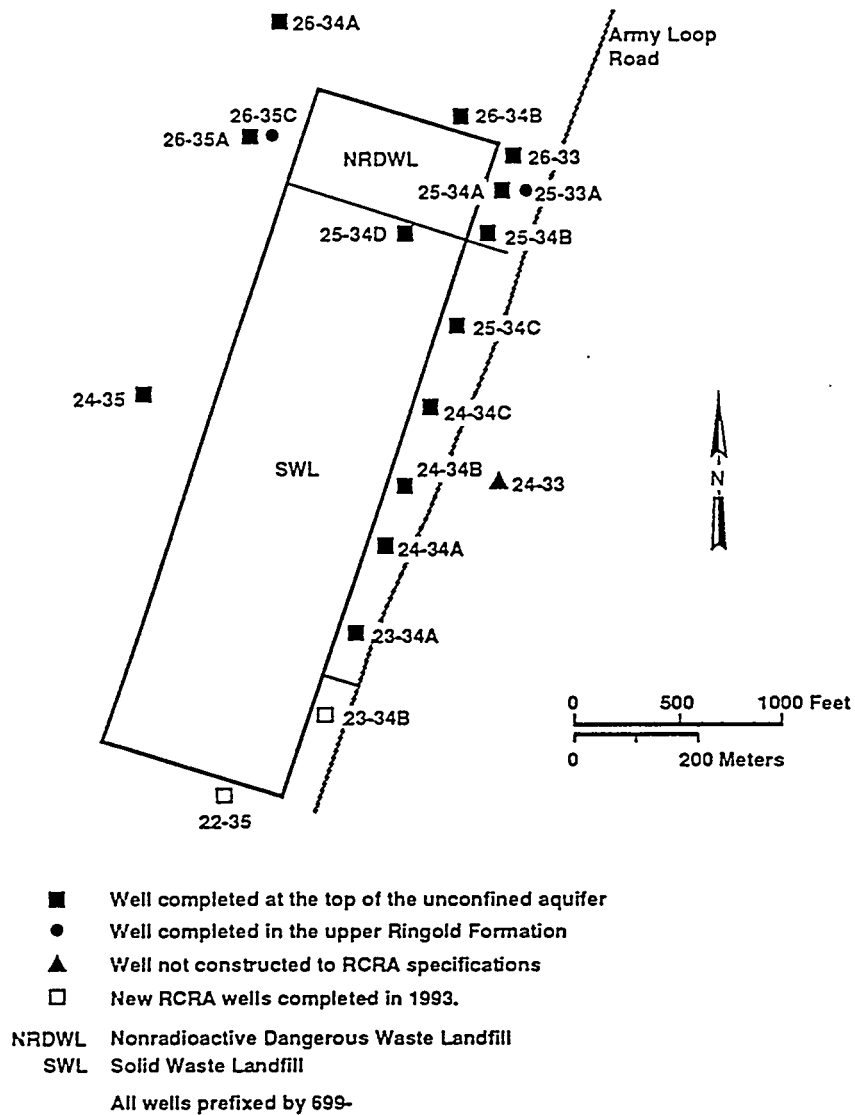
List	Group	Filtered	Other W. O.	Change Date
Q2	Alkalinity			
Q2	Alpha, Beta, Uranium			
Q2	Anions			
Q2	Conductivity-Lab			
Q2	Gamma Scan-Low Level			
Q2	ICP, Arsenic, Selenium, Lead, Thallium	F		
Q2	ICP, Arsenic, Selenium, Lead, Thallium	U		
Q2	Iodine-129			
Q2	Mercury	F		
Q2	Mercury	U		
Q2	pH-Lab			
Q2	Pu-ISO			
Q2	Strontium-90			
Q2	TDS			
Q2	Technetium-99			
Q2	TOC			
Q2	TOX (Weston)			
Q2	Tritium			
Q2	Turbidity			

SST U 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
2-W18-25		U	Y	A	February		WEST
2-W18-25		U	Y	S	August		
2-W18-30		U	Y	A	February		
2-W18-30		U	Y	S	August		
2-W18-31		U	Y	A	February		
2-W18-31		U	Y	S	August		
2-W19-31	U	U	Y	A	February		WEST
2-W19-31	U	U	Y	S	August		
2-W19-32	U	U	Y	A	February		U-14
2-W19-32	U	U	Y	S	August		U-14

SST U Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta, Uranium			
A	Anions			
A	Conductivity-Lab			
A	Gamma Scan-Low Level			
A	ICP Metals	F		
A	ICP Metals	U		
A	Iodine-129			
A	pH-Lab			
A	Phenols			
A	Pu-ISO			
A	Strontium-90			
A	TDS			
A	Technetium-99			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
S	Alpha, Beta, Uranium			
S	Anions			
S	Conductivity-Lab			
S	Gamma Scan-Low Level			
S	Iodine-129			
S	pH-Lab			
S	Pu-ISO			
S	Strontium-90			
S	TDS			
S	Technetium-99			
S	TOC			
S	TOX (Weston)			
S	Tritium			
S	Turbidity			



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Figure II.B-C.11. Monitoring Well Locations for the SWL

SWL 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
6-22-35			Y	L	November		
6-22-35			Y	Q	August		
6-22-35			Y	Q	February		
6-22-35			Y	Q	May		
6-23-34A			Y	Q	August		
6-23-34A			Y	Q	February		
6-23-34A			Y	Q	May		
6-23-34A			Y	Q	November		
6-23-34B			Y	Q	August		
6-23-34B			Y	Q	February		
6-23-34B			Y	Q	May		
6-23-34B			Y	Q	November		
6-24-33			Y	Q	August		
6-24-33			Y	Q	February		
6-24-33			Y	Q	May		
6-24-33			Y	Q	November		
6-24-34A			Y	Q	August		
6-24-34A			Y	Q	February		
6-24-34A			Y	Q	May		
6-24-34A			Y	Q	November		
6-24-34B			Y	Q	August		
6-24-34B			Y	Q	February		
6-24-34B			Y	Q	May		
6-24-34B			Y	Q	November		
6-24-34C			Y	Q	August		
6-24-34C			Y	Q	February		
6-24-34C			Y	Q	May		
6-24-34C			Y	Q	November		
6-24-35	U		Y	Q	August		
6-24-35	U		Y	Q	February		
6-24-35	U		Y	Q	May		
6-24-35	U		Y	Q	November		
6-25-34C			Y	Q	August		
6-25-34C			Y	Q	February		
6-25-34C			Y	Q	May		
6-25-34C			Y	Q	November		
6-26-35A	U		Y	Q	August		NRDW
6-26-35A	U		Y	Q	February		NRDW
6-26-35A	U		Y	Q	May		
6-26-35A	U		Y	Q	November		

SWL Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
L	Alkalinity			
L	Alpha, Beta			
L	Ammonium			
L	Anions			
L	COD			
L	Coliform			
L	Conductivity-Lab			
L	D&D			
L	ICP Metals, Thallium	F		
L	Pesticides Organic			
L	pH-Lab			
L	Semi-VOA APPX IX			
L	Sulfide			
L	TC			
L	TDS			
L	TOC			
L	TOX (Weston)			
L	Tritium			
L	Turbidity			
L	VOA (GC/MS) APPX IX			
Q	Alkalinity			
Q	Alpha, Beta			
Q	Ammonium			
Q	Anions			
Q	COD			
Q	Coliform			
Q	Conductivity-Lab			
Q	ICP Metals	F		
Q	pH-Lab			
Q	TC			
Q	TDS			
Q	TOC			
Q	TOX (Weston)			
Q	Tritium			
Q	Turbidity			
Q	VOA (GC)			

100-K Area Operational Environmental Monitoring Well Sampling and Analysis Schedule for FY 1994

Well	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
K-13	A	A	A	A	A	A	A	A	A	A	A	A
K-18	A	A	A	A	A	A	A	A	A	A	A	A
K-27	X ^(a)	A	A	X ^(a)	A	A	X ^(a)	A	A	X ^(a)	A	A
K-28	X	A	A	X	A	A	X	A	A	X	A	A
K-29	X	A	A	X	A	A	X	A	A	X	A	A
K-30	X ^(a)	A	A	X ^(a)	A	A	X ^(a)	A	A	X ^(a)	A	A
K-32A	X	A	A	X	A	A	X	A	A	X	A	A
K-34	X	A	A	X	A	A	X	A	A	X	A	A
K-106A	X		X				X		X			
K-107A	X		X				X		X			
K-108A	X		X				X		X			
K-109A	X ^(b)	A	A	X	A	A	X	A	A	X	A	A
K-110A	X	A	A	X	A	A	X	A	A	X	A	A
K-111A	X		X				X		X			

(a) "X" list excluding turbidity (lab).

(b) Priority sampling requested.

"X" list:

Gross alpha and gross beta
Anions (IC)
Carbon-14
Conductivity (field)
Conductivity (lab)

Gamma scan
ICP metals (filtered)
pH (field)
Tritium
Turbidity (lab)

"A" list*:

Tritium screening

Notes:

*Starting October 1, *field screening* for tritium will replace the "A" sampling list. Weekly tritium will be done at K-27, K-28, K-29, and K-30. The monthly and weekly results will not be included in HEIS. They will be reported biweekly to K Basin Project and included in quarterly report of monitoring results.

Monitoring Objective. The primary objective is to detect leaks at the 100-KW and 100-KE fuel storage basins. The spatial array of new and existing wells was designed to distinguish upgradient sources from basin leakage and to track known or potential contaminant plumes (primarily tritium) from the basins toward the river. The general direction of ground-water movement is from south to north. The sampling schedule is coordinated with CERCLA ground-water characterization and monitoring activities. The latter network includes the additional monitoring wells at past practice disposal sites near the river. Adjustment in the balance between waste management/operational monitoring and CERCLA monitoring are expected as remediation efforts of the new environmental restoration contractor develop.

Additional details concerning the monitoring well network and DQOs for this project are included in the monitoring well installation plan (WHC-SD-EN-AP-153) and the site-specific sampling and analysis plan (WHC-SD-EN-AP-174) for the 100-K Area fuel storage basins.

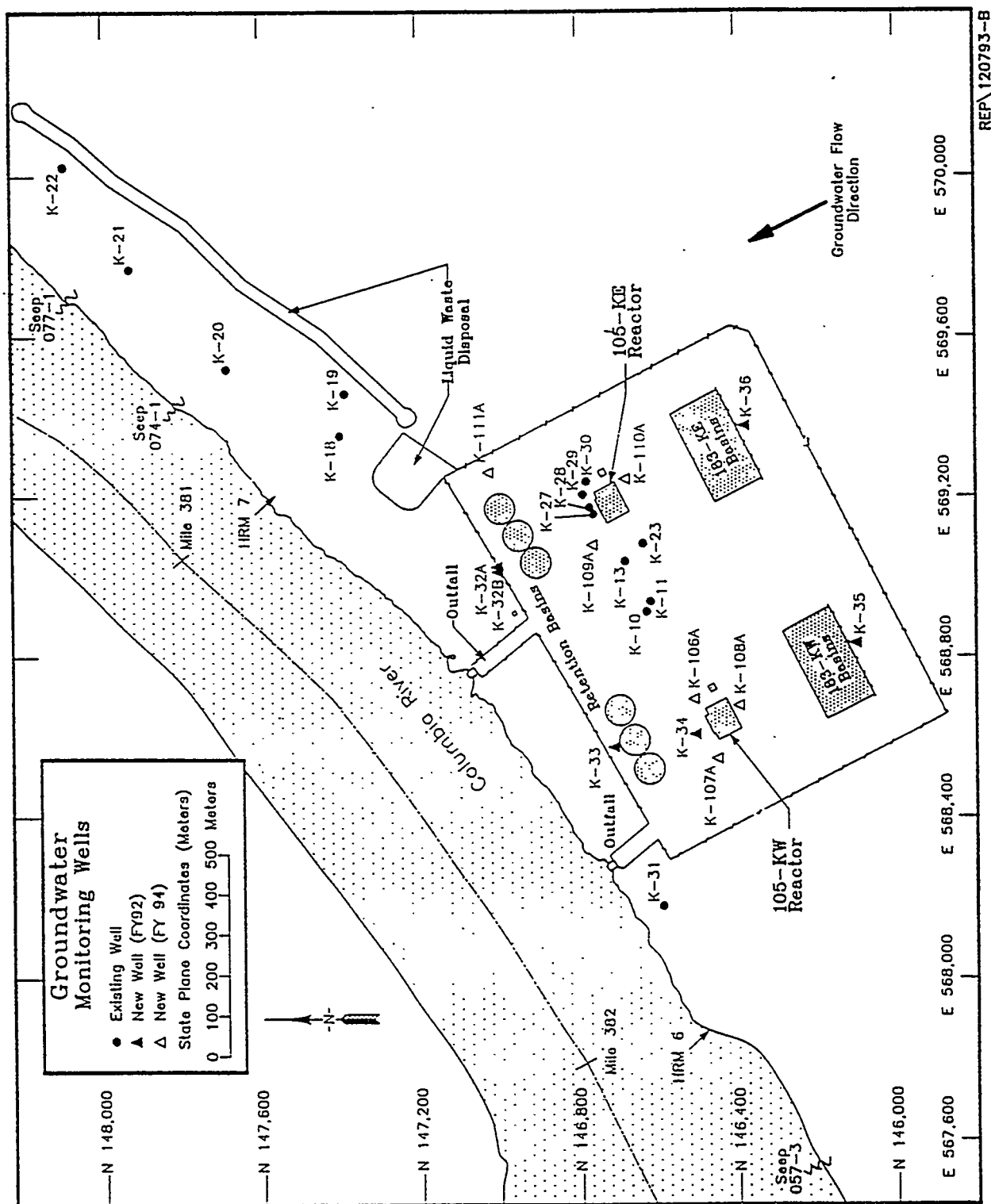


Figure II.B-C.12. Operational Environmental Monitoring Well Locations for the 100-K Area

**222-S Laboratory Operational Environmental Monitoring Well Sampling and Analysis
Schedule for FY 1994**

<u>Well</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
2-W27-1	X			X				X		X		

"X" list:

Gross alpha, gross beta, and uranium
 Conductivity (field)
 gamma scan
 pH (field)
 selenium (unfiltered)
 TOC
 Tritium

Anions
 Conductivity (lab)
 ICP metals, selenium (filtered)
 pH (lab)
 Strontium-90
 TOX (Weston)
 VOA (GC)

Monitoring Objective. The 222-S Laboratory discharges liquid waste to the 216-S-26 Crib. The monitoring objective is to determine compliance with appropriate ground-water quality standards and to monitor for breakthrough of contaminants stored in the soil column. After termination of all liquid discharges (June 1995), this and other similar facilities will be monitored on a reduced schedule to track return to ambient or local area ground-water conditions.

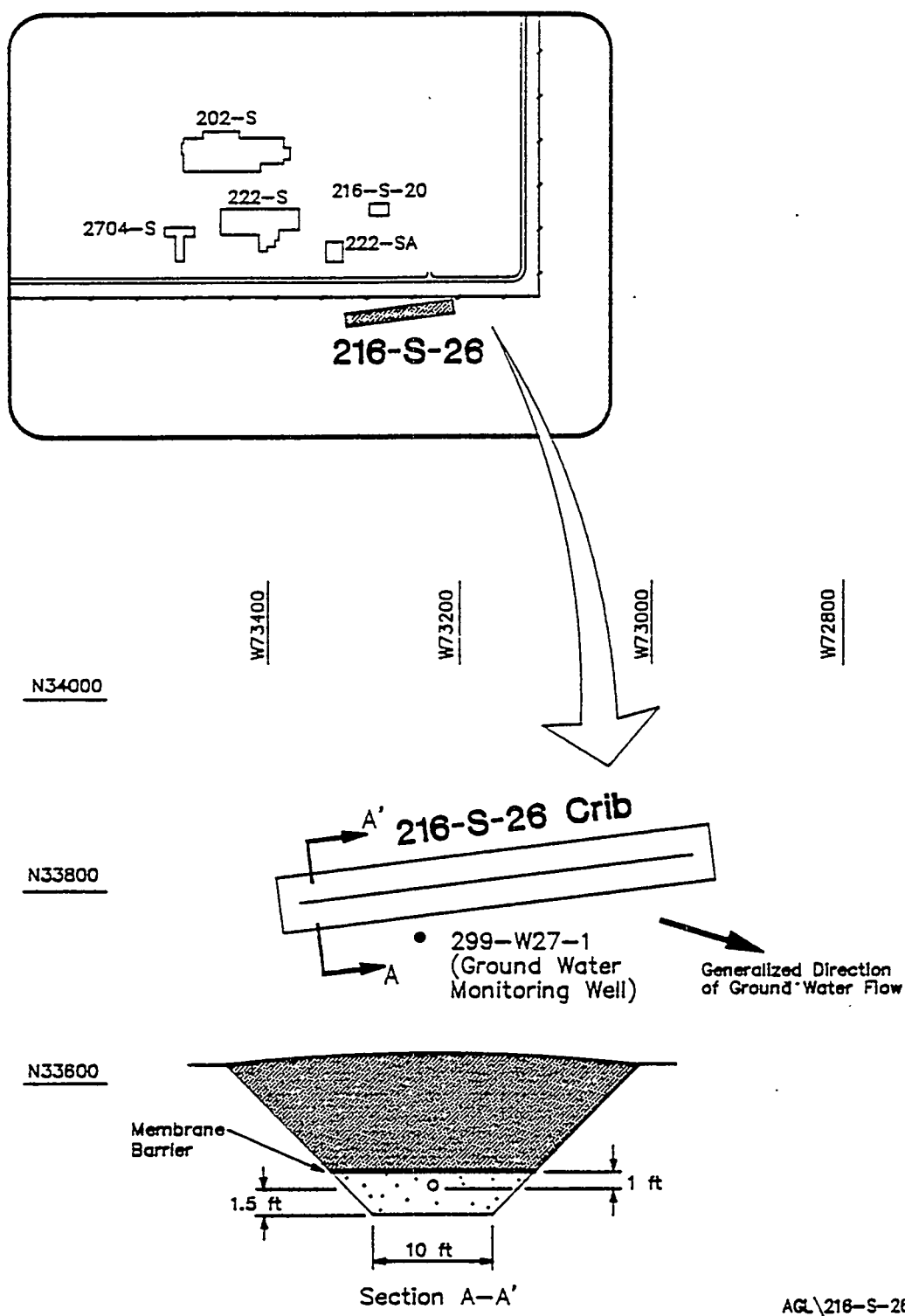


Figure II.B-C.13. Operational Environmental Monitoring Well Locations for the 216-S-26 Crib

400 Area Ponds Operational Environmental Monitoring Well Sampling and Analysis Schedule for FY 1994

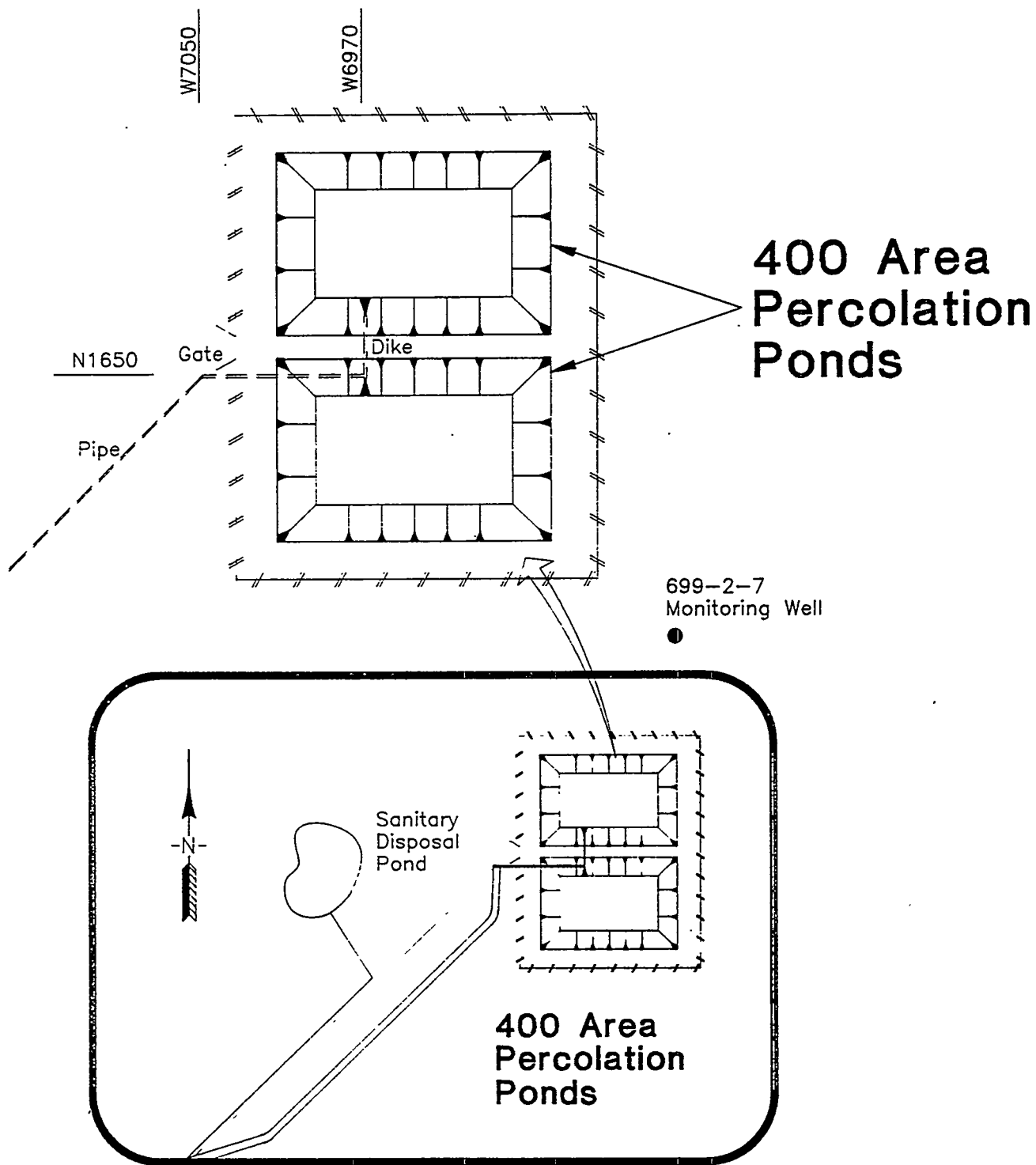
<u>Well</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
6-1-18			X			X			X			X
6-2-3			X			X			X			X
6-2-7			X			X			X			X

"X" list:

Gross alpha and beta
Conductivity (field)
ICP metals (filtered)
pH (lab)
TOC
TOX (Weston)

Anions
Conductivity (lab)
pH (field)
Tritium

Monitoring Objective. The 400 Area Ponds receive nonradioactive liquid waste from 400 Area facilities. The monitoring objective is to determine compliance with appropriate ground-water quality standards and to monitor for breakthrough of contaminants stored in the soil column from past discharges. Two upgradient wells (6-2-3 and 6-1-18) are included for comparison with the single monitoring well (6-2-7) adjacent to the ponds. A detailed evaluation of contaminant sources and occurrences in the 400 Area was conducted for the ground-water impact assessment for this disposal facility (WHC-EP-0587) as part of TPA milestone M17-13.



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Figure II.B-C.14. Operational Environmental Monitoring Wells for the 400 Area Ponds

600 Area Operational Environmental Monitoring Well Sampling and Analysis Schedule for FY 1994

Well	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
6-32-62	X											
6-34-42	X											
6-35-70	X											
6-36-61A	X											
6-37-43	X											
6-37-82A	X											
6-38-70	X											
6-39-79	X											
6-40-62	X											
6-42-42A	X											
6-44-64	X											
6-45-42	X											
6-45-69A	X											
6-48-71							X					
6-49-79							X					
6-52-46A							X					
6-53-48A							X					
6-53-50							X					
6-54-45B							X					
6-54-48							X					
6-55-60A							X					
6-56-43							X					
6-56-53							X					
6-59-55							X					
6-59-58							X					

"X" list:

Gross alpha and beta
Conductivity (field)
Tritium

Anions
Conductivity (lab)

Monitoring Objective. Wells are sampled for a minimum number of indicator parameters on an annual basis to provide spatial coverage for contaminant plume tracking in the 200 Areas. Adjustments and or reductions in this schedule are anticipated as CERCLA ground-water remediation and related monitoring efforts are extended. Sampling schedules are coordinated among the various programs, including CERCLA, to ensure adequate spatial coverage for delineating plume distribution patterns. The scheduled dates are staggered to accommodate availability of sampling crews and cosampling.

**B-Plant Area Operational Environmental Monitoring Well Sampling and Analysis Schedule
for FY 1994 (216-B-62 Crib)**

<u>Well</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
2-E28-18				X								
2-E28-21				X								

"X" list:

Gross alpha, gross beta, and uranium
 Conductivity (field)
 gamma scan
 pH (field)
 Strontium-90
 TOX (Weston)

Anions
 Conductivity (lab)
 ICP metals (filtered)
 pH (lab)
 TOC
 Tritium

Monitoring Objective. Wells are monitored to determine the time to return to ambient ground-water conditions following termination of liquid waste input to the disposal facility and to provide additional spatial coverage for tracking contaminant plumes in the vicinity of RCRA and waste management TSD sites. Sampling frequency may shift to biannual in the future.

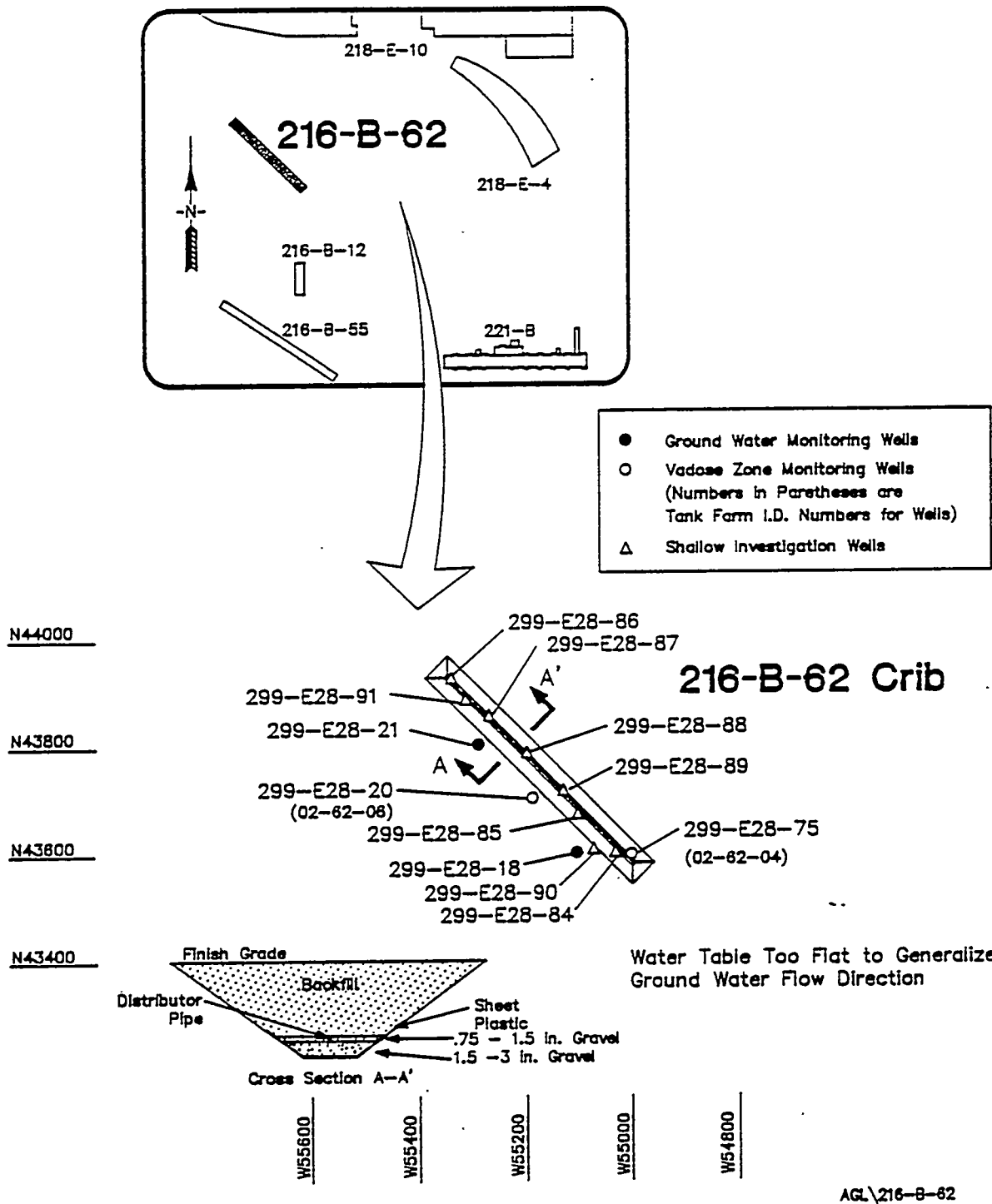


Figure II.B-C.15. Operational Environmental Monitoring Well Locations for the 216-B-62 Crib

200-East Area Operational Environmental Monitoring Well Sampling and Analysis Schedule for FY 1994

Well	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2-E16-1								X				
2-E23-1								X				
2-E24-19					X							
2-E24-4								X				
2-E24-5								X				
2-E24-7								X				
2-E25-17								X				
2-E25-33								X				
2-E25-37								X				
2-E25-39								X				
2-E25-41					X							
2-E26-11				X								
2-E26-2			X									
2-E26-8			X									
2-E26-9				X								
2-E27-14					X							
2-E27-15					X							
2-E28-1			X									
2-E28-12			X									
2-E28-2			X									
2-E28-5			X									
2-E28-6			X									
2-E28-9			X									
2-E32-5			X									
2-E33-37		X										
2-E34-7		X										
2-E34-8		X										

"X" list:

Gross alpha and beta
Conductivity (field)

Anions
Tritium Conductivity (lab)

Monitoring Objective. Wells are sampled for a minimum number of indicator parameters on an annual basis to provide spatial coverage for contaminant plume tracking near RCRA and other operational sites in the 200-East Area. Adjustments and/or reductions in this schedule are anticipated as CERCLA ground-water remediation and related monitoring efforts are extended. Sampling schedules are coordinated among the various programs, including CERCLA, to ensure adequate spatial coverage for delineating plume distribution patterns. The scheduled dates are staggered to accommodate availability of sampling crews and cosampling.

**Gable Mountain Area Operational Environmental Monitoring Well Sampling and Analysis
Schedule for FY 1994**

<u>Well</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
6-53-47B	X											
6-53-48B	X											
6-54-49	X											
6-55-50C	X											

"X" list:

Gross alpha and beta
Conductivity (field)
ICP metals (filtered)
pH (lab)
TOX (Weston)

Anions

Conductivity (lab)
pH (field)
Strontium-90
Tritium

**PUREX Operational Environmental Monitoring Well Sampling and Analysis Schedule
for FY 1994**

<u>Well</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
2-E16-2												X
2-E17-12						Y ^(b)						
2-E17-13						Y						
2-E25-11												X
2-E25-22						X						
2-E25-24						X						
2-E25-6						X ^(a)						
2-E25-9												X ^(a)
2-E26-6	Y						Y					

(a) "X" list plus VOA (GC).

(b) "Y" list plus iodine-129.

"X" list:

Gross alpha, gross beta, and uranium
Conductivity (field)
gamma scan
pH (field)
Strontium-90
TOX (Weston)

Anions
Conductivity (lab)
ICP metals (filtered)
pH (lab)
TOC
Tritium

"Y" list:

Gross alpha and beta
Conductivity (field)
ICP metals (filtered)
pH (lab)
TOX (Weston)

Anions
Conductivity (lab)
pH (field)
TOC
Tritium

Monitoring Objective. Wells are monitored to determine the time to return to ambient ground-water conditions following termination of liquid waste input to the PUREX liquid waste disposal facilities (see Figures II.B-C.27 through C.31) and to provide additional spatial coverage for tracking contaminant plumes near RCRA and other waste management TSD sites. Sampling frequency may shift to biannual in the future.

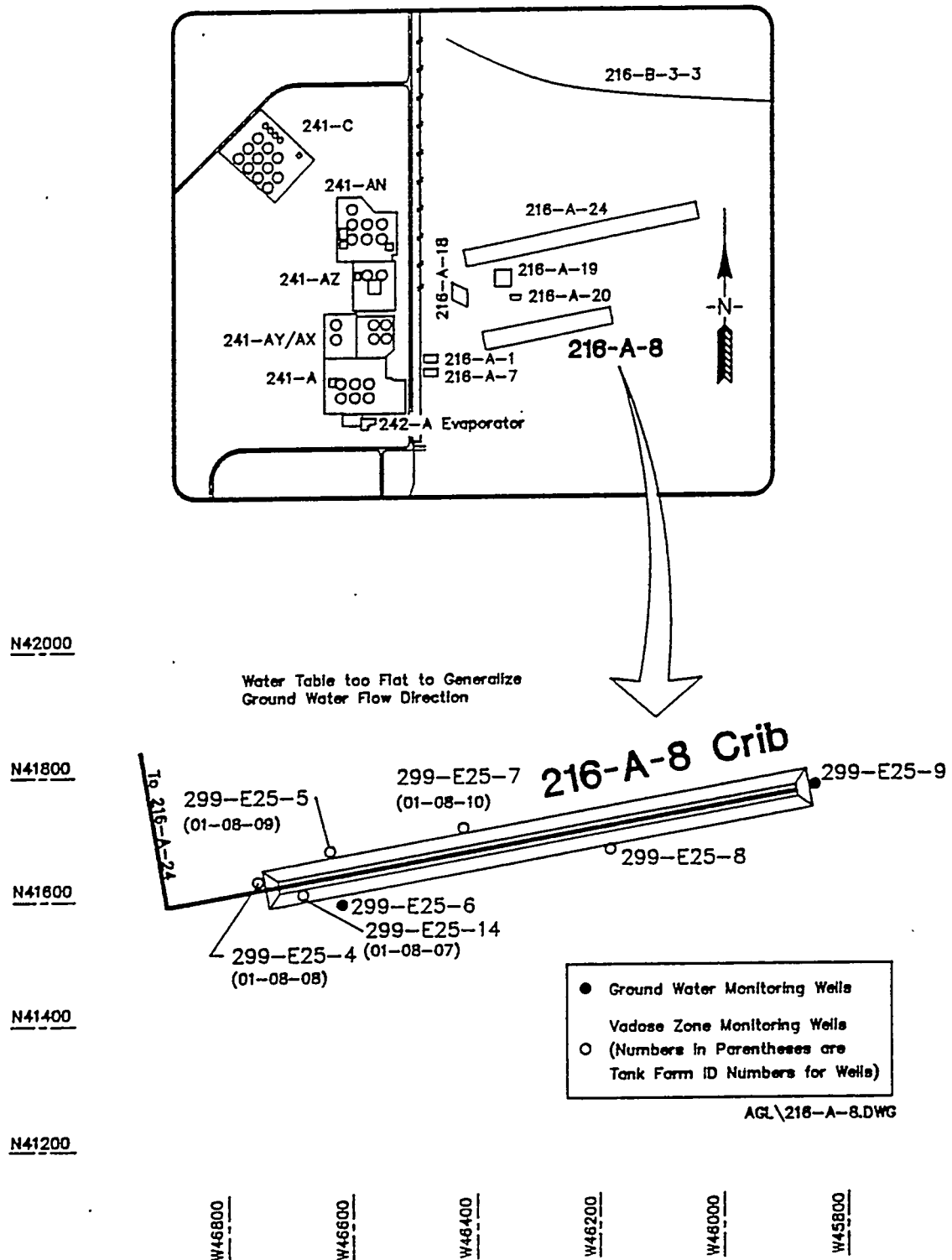


Figure II.B-C.16. Operational Environmental Monitoring Well Locations for the 216-A-8 Crib

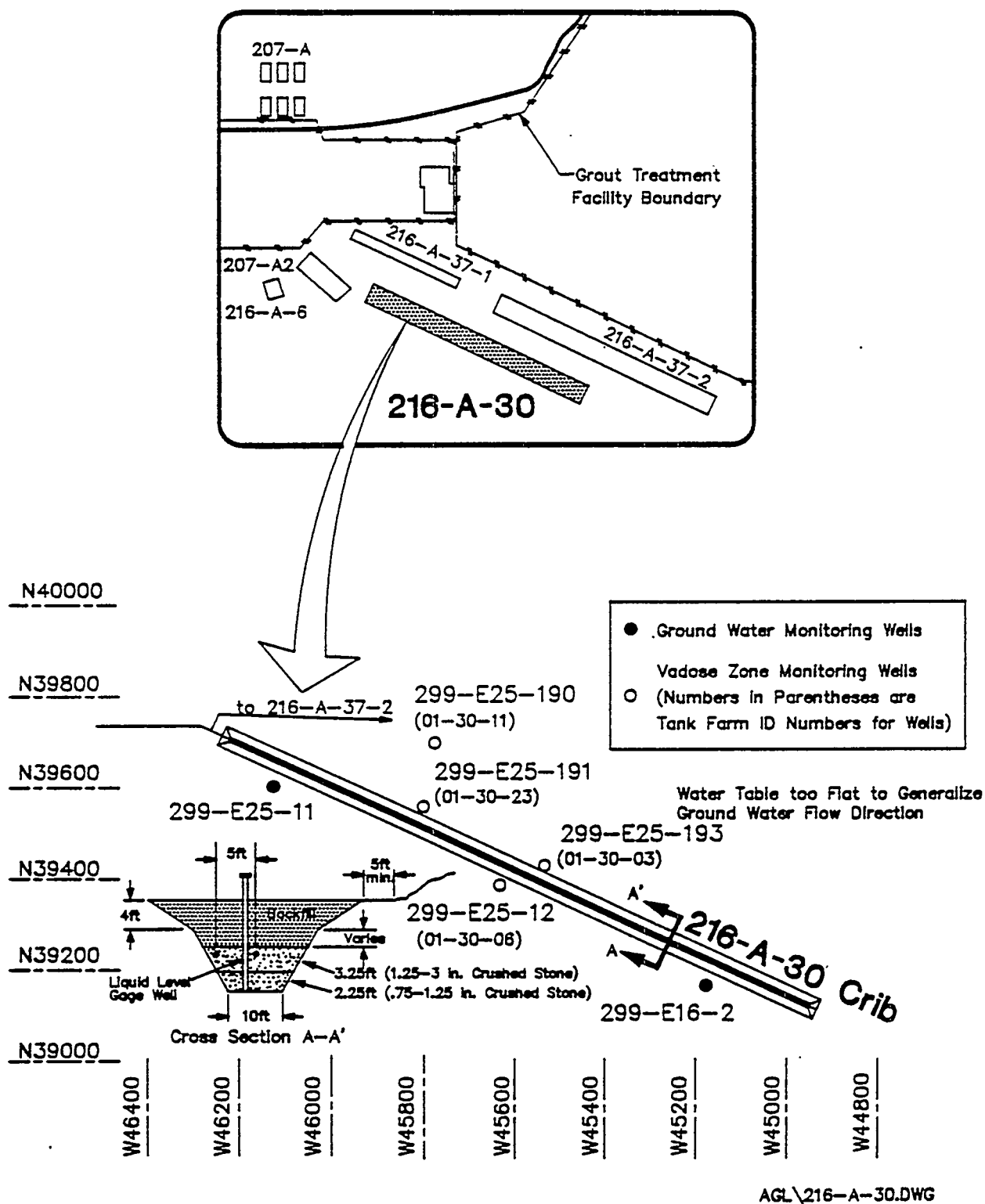


Figure II.B-C.17. Operational Environmental Monitoring Well Locations for the 216-A-30 Crib

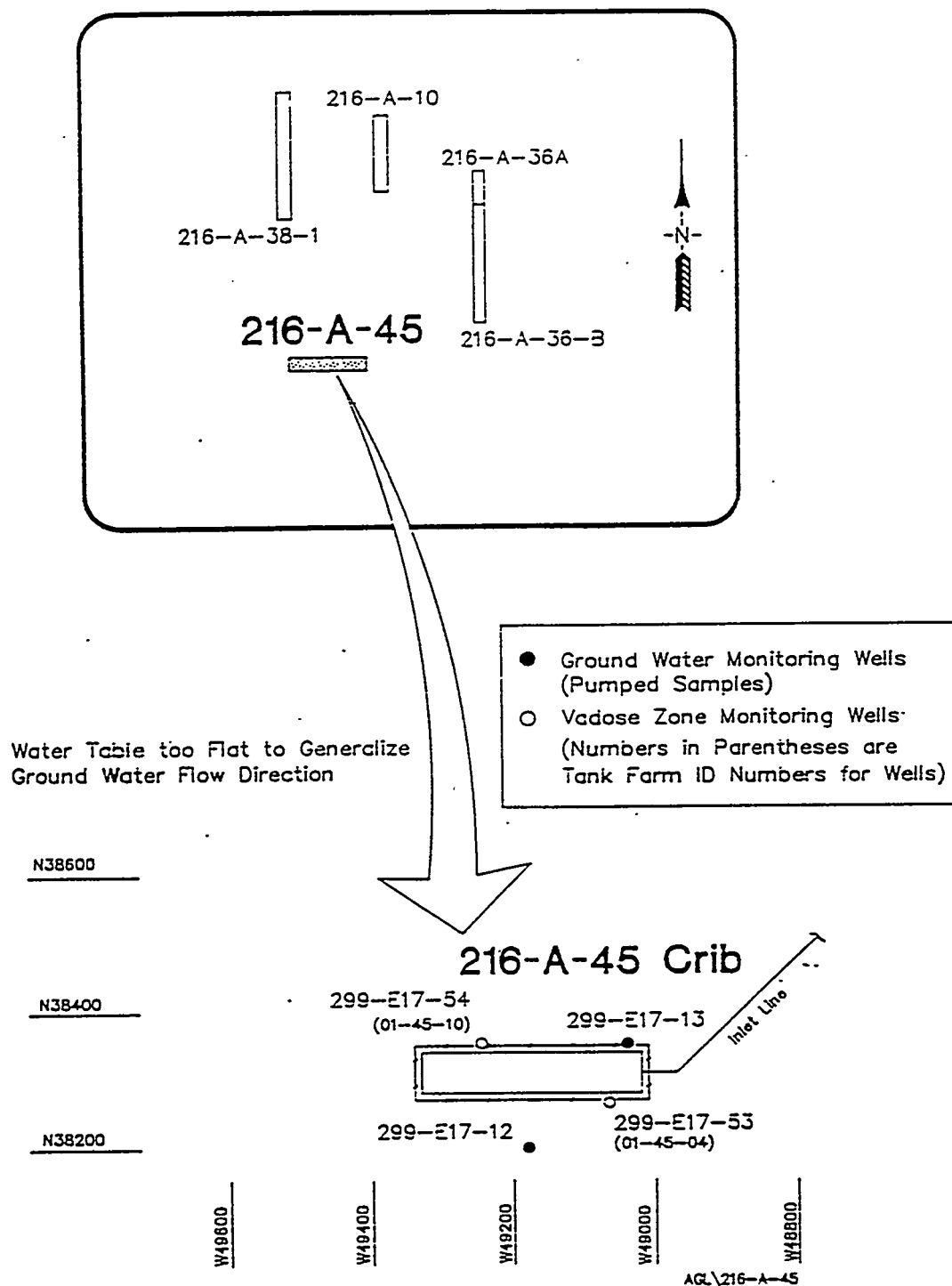


Figure II.B-C.18. Operational Environmental Monitoring Well Locations for the 216-A-45 Crib

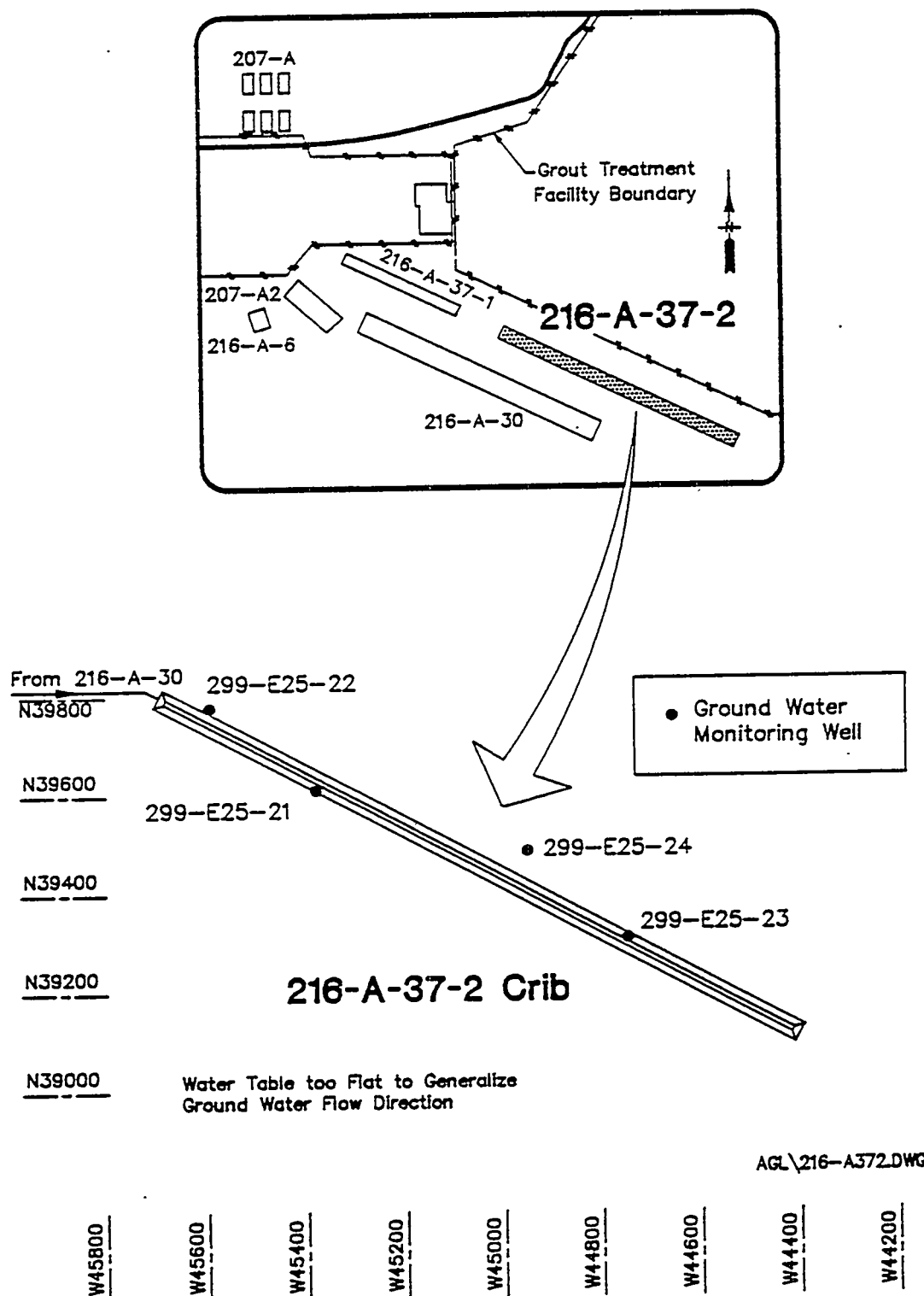


Figure II.B-C.19. Operational Environmental Monitoring Well Locations for the 216-A-37-2 Crib

**U-1 and U-2 Operational Environmental Monitoring Well Sampling and Analysis Schedule
for FY 1994**

<u>Well</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
2-W19-10	X											
2-W19-11	X											
2-W19-15	X											
2-W19-16	X											
2-W19-17	X											
2-W19-18	X											
2-W19-9	X											

"X" list:

Gross alpha, gross beta, and uranium
 Conductivity (field)
 ICP metals (filtered)
 pH (lab)
 TOX (Weston)
 VOA (GC)

Anions
 Conductivity (lab)
 pH (field)
 TOC
 Tritium

Monitoring Objective. Wells are monitored to determine the time to return to ambient ground-water conditions following termination of input of UO₃ Plant process condensates and to provide additional spatial coverage for tracking contaminant plumes near RCRA and other waste management TSD sites. Sampling near this facility will be reduced as CERCLA sampling for ground-water remediation projects expands in the future.

U-14 Ditch Operational Environmental Monitoring Well Sampling and Analysis Schedule for FY 1994

<u>Well</u>	<u>Oct</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
2-W18-33				X						X	
2-W19-21				X						X	
2-W19-27				X						X	
2-W19-32				X						X	
2-W19-91				X*						X*	
2-W19-92				X						X	

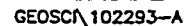
* Sample to be collected using a bailer.

"X" list:

Gross alpha, gross beta, and uranium
Gamma scan
TOC
Tritium

Anions
ICP metals, arsenic (unfiltered)
TOX (Weston)
VOA (GC)

Monitoring Objective. The monitoring objective at this currently active wastewater disposal facility is to determine compliance with appropriate ground-water quality standards and to monitor for breakthrough of contaminants stored in the soil column. After termination of all liquid discharges (June 1995), this and other similar facilities will be monitored on a reduced schedule to track return to ambient or local area ground-water conditions.



Issued: 11-9-94

**U-17 Crib Operational Environmental Monitoring Well Sampling and Analysis Schedule
for FY 1994**

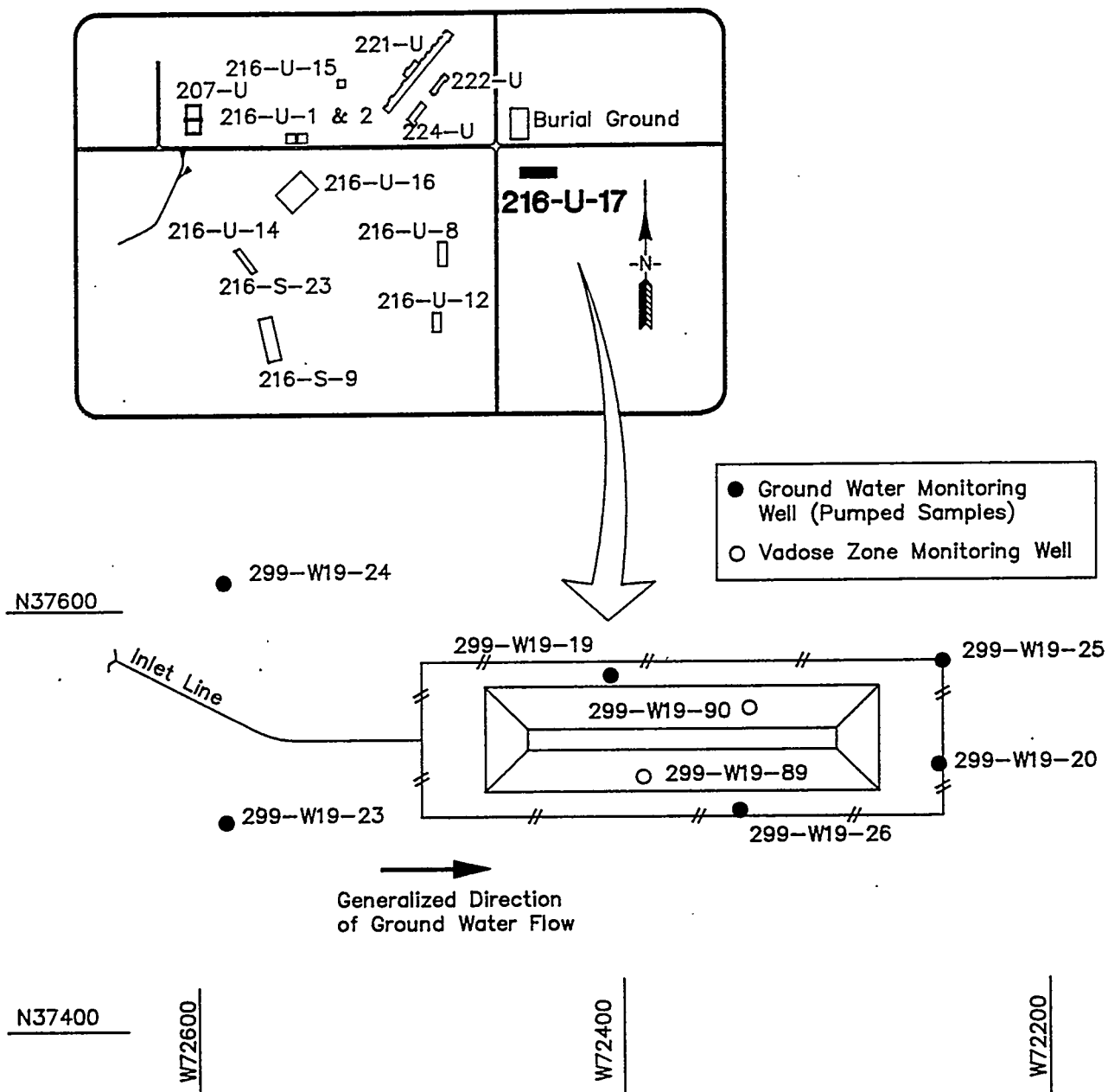
<u>Well</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
2-W19-19					X						X	
2-W19-20					X						X	
2-W19-23					X						X	
2-W19-24					X						X	
2-W19-25					X						X	
2-W19-26					X						X	

"X" list:

Gross alpha, gross beta, and uranium
 Conductivity (field)
 ICP metals (filtered)
 pH (field)
 TOC
 Tritium

Anions
 Conductivity (lab)
 ICP metals (unfiltered)
 pH (lab)
 TOX (Weston)
 VOA (GC)

Monitoring Objective. The monitoring objective at this currently active wastewater disposal facility is to determine compliance with appropriate ground-water quality standards and to monitor for breakthrough of contaminants stored in the soil column. After termination of all liquid discharges (June 1995), this and other similar facilities will be monitored on a reduced schedule to track return to ambient or local area ground-water conditions. Upgradient monitoring wells are used to distinguish upgradient sources from the crib. Expanding ground-water monitoring for the ground-water remediation demonstration in this area (UP-1 Operable Unit) may reduce or replace the need for monitoring at this site, especially after June 1995, as noted above.



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Figure II.B-C.21. Operational Environmental Monitoring Well Locations for the 216-U-17 Crib

**U-8 Crib Operational Environmental Monitoring Well Sampling and Analysis Schedule
for FY 1994**

Well	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

2-W19-2	X											
---------	---	--	--	--	--	--	--	--	--	--	--	--

"X" list:

Gross alpha, gross beta, and uranium
Conductivity (field)
ICP metals (filtered)
pH (lab)
TOX (Weston)
VOA (GC)

Anions
Conductivity (lab)
pH (field)
TOC
Tritium

Monitoring Objective. Wells are monitored to determine the time to return to ambient ground-water conditions following termination of discharges of UO₃ Plant process condensates and provide additional spatial coverage for tracking contaminant plumes near RCRA and other waste management TSD sites. Sampling near this facility will be reduced as CERCLA sampling for ground-water remediation projects expands in the future.

**U Plant Area Operational Environmental Monitoring Well Sampling and Analysis Schedule
for FY 1994**

Well	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

2-W19-28	X ^(a)											
----------	------------------	--	--	--	--	--	--	--	--	--	--	--

2-W19-29												
----------	--	--	--	--	--	--	--	--	--	--	--	--

	X ^(a)											
--	------------------	--	--	--	--	--	--	--	--	--	--	--

2-W19-3	X											
---------	---	--	--	--	--	--	--	--	--	--	--	--

(a) "X" list plus technetium-99.

"X" list:

Gross alpha, gross beta, and uranium
Conductivity (field)
ICP metals (filtered)
pH (lab)
TOX (Weston)
VOA (GC)

Anions
Conductivity (lab)
pH (field)
TOC
Tritium

Monitoring Objective. Wells are monitored to determine the time to return to ambient ground-water conditions following terminated use of a suspected leaking transfer line previously connected to various U cribs and to provide additional spatial coverage for tracking contaminant plumes near RCRA and other waste management TSD sites in the 200-West Area.

**200-West Area Operational Environmental Monitoring Well Sampling and Analysis Schedule
for FY 1994**

<u>Well</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>
2-W10-1					X							
2-W10-16	X											
2-W10-4					X							
2-W10-5					X							
2-W11-10			X									
2-W11-14			X ^(a)									
2-W11-18			X									
2-W11-23			X									
2-W11-3			X									
2-W11-6			X									
2-W11-7			X									
2-W12-1									X			
2-W14-2									X			
2-W14-6									X			
2-W15-12					X							
2-W15-19	X											
2-W15-2					X							
2-W15-22	X											
2-W15-24	X											
2-W15-4					X							
2-W15-7					X							
2-W18-15									X			
2-W18-22	X											
2-W18-25					X							
2-W19-12									X			
2-W19-31					X							
2-W19-4									X			
2-W22-12							X					
2-W22-20							X					
2-W22-21							X					
2-W22-39					X							
2-W22-40			X									
2-W22-9							X					
2-W23-11							X					
2-W23-14					X							
2-W23-9							X					
2-W26-6									X			
2-W6-1									X			
2-W6-2					X							
2-W7-6					X							

(a) "X" list plus uranium and technetium-99.

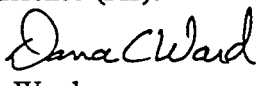
"X" list:

Gross alpha and beta
Conductivity (field)
Tritium

Anions
Conductivity (lab)
VOA (GC)

Monitoring Objective. Wells are sampled for a minimum number of indicator parameters on an annual basis to provide spatial coverage for contaminant plume tracking near RCRA and other sites in the 200-West Area. Adjustments and/or reductions in this schedule are anticipated as CERCLA ground-water remediation and related monitoring efforts are extended. Sampling schedules are coordinated among the various programs, including CERCLA, to ensure adequate spatial coverage for delineating plume distribution patterns. The scheduled dates are staggered to accommodate availability of sampling crews and cosampling.

Hanford Site Environmental Monitoring Plan
Section III.A. Surface Environmental Surveillance

Prepared by:  R. L. Dirkes	Date: 10-21-94	Concurrence (RL):  D. C. Ward	Date: 10/28/94
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Introduction

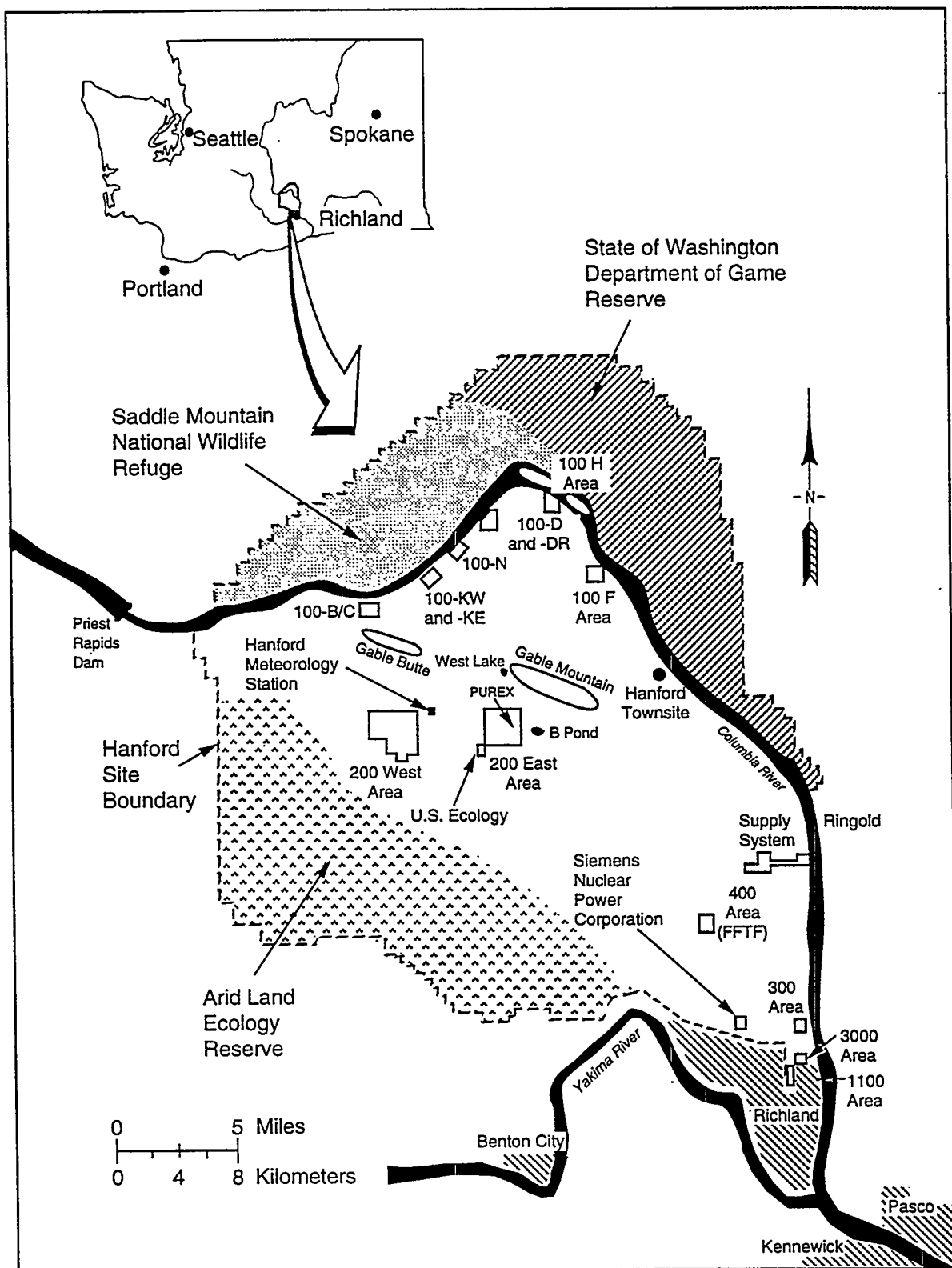
This section describes the Hanford Site (Figure III.A-1.1) plan for surface environmental surveillance. Environmental surveillance includes all components of the surface environment. Ground-water surveillance is discussed in Section III.B. This plan is prospective, in that it describes the objectives, criteria, program, and management processes to be implemented in calendar year 1995 rather than current status.

The purpose of this section is to describe how the surveillance requirements of DOE Orders 5400.1 and 5400.5 and the guidance of DOE/EH-0173T are to be met for the Hanford Site.

Although the scope of the environmental surveillance project has expanded significantly during recent years to include hazardous chemical surveillance, this plan focuses on radiological surveillance in response to DOE requirements. This plan is written to comply with all *should** statements in DOE/EH-0173T unless noted otherwise in the Exceptions discussions. *Should* statements are described in DOE/EH-0173T as flexible guidance; this guidance has been considered in the development of this plan and incorporated where determined appropriate. However, lack of incorporation of such statements has not been noted in the Exceptions discussions.

This section (III.A) of the plan is related to other sections in several respects. The sampling design described is based on a pathway analysis that utilizes the source data obtained under the effluent monitoring program described in Section II. The pathway analysis and dose assessment conducted for this plan and the dose assessments reported in the annual *Hanford Site Environmental Report* (e.g., Dirkes et al. 1994) use the dispersion data provided by the Meteorological and Climatological Services Program described in Section III.C. The pathway analysis and dose assessment conducted for this section include the contribution to dose from the ground-water pathway discussed in Section III.B.

The environmental pathways carrying contaminants to humans and the significance of the media and contaminants to total dose are strongly influenced by the environmental setting. The Hanford Site's environmental setting is summarized by Cushing (1990) and will not be described here.



S9108047.15

Figure III.A-1.1. The Hanford Site

Requirements and Objectives

The general requirements and objectives for environmental surveillance are contained in DOE Orders 5400.1 and 5400.5. The broad objectives (DOE Order 5400.1) are to demonstrate compliance with legal and regulatory requirements, to confirm adherence to DOE environmental protection policies, and to support environmental management decisions. These requirements are embodied in the surveillance objectives stated in the Orders and DOE/EH-0173T and include the following:

- determine compliance with applicable environmental quality standards and public exposure limits and applicable laws and regulations; the requirements of DOE Orders 5400.1 and 5400.5; and the environmental commitments made in environmental impact statements, environmental assessments, safety analysis reports, or other official DOE documents. Additional objectives that derive from the Orders and this primary objective include the following:
 - conduct preoperational assessments
 - assess radiological doses to the public and aquatic biota from Site operations
 - assess doses from other local sources
 - report alarm levels and potential doses exceeding reporting limits (DOE Order 5400.5, Chapter II, Section 7)
 - prepare an annual Site environmental report
 - maintain an environmental monitoring plan
- determine background levels and Site contributions of contaminants in the environment
- determine long-term accumulation of Site-related contaminants in the environment and predict trends; characterize and define trends in the physical, chemical, and biological condition of environmental media
- determine effectiveness of effluent treatment and controls in reducing effluents and emissions
- determine validity and effectiveness of models to predict the concentrations of pollutants in the environment
- detect and quantify unplanned releases
- identify and quantify new or existing environmental quality problems.

DOE/EH-0173T indicates that subsidiary objectives for surveillance should be considered. Subsidiary objectives applicable to the Site include the following:

- obtain data and maintain the capability to assess the consequence of accidents
- provide public assurance; address issues of concern to the public, business, and regulators

- enhance public understanding of Site environmental impacts, primarily through public involvement and by providing public information
- provide environmental data and assessments to assist DOE-RL in environmental management of the Site.

The Orders require that the content of surveillance programs be determined on a site-specific basis by RL. The surveillance programs must reflect facility characteristics; applicable regulations; hazard potential; quantities and concentrations of materials released; extent and use of affected air, land, and water; and specific local public interest and concern.

The subsection that follows contains a site-specific pathway analysis that estimates the radiological hazard based on routine facility operating characteristics and the associated source terms and on maximal estimates of public use of the affected environment. This pathway analysis is one of the sources of information that serves as the basis for the content and design of the surveillance project.

Pathway Analysis Summary

A chemical pathway analysis was conducted to ensure that the selection of surveillance parameters such as environmental media, sampling location, and chemical constituents were chosen in a manner that is scientifically sound and cost efficient. A pathway analysis was performed for both radionuclides and nonradioactive chemicals (hereinafter referred to as chemicals).

The radionuclide pathway analysis is based on 1993 source-term data and on the comprehensive pathway and dose assessment methodology included in the GENII computer code (Napier et al. 1988a, 1988b, 1988c) used for estimating the radiation doses to the public from Hanford operations. The doses are reported in the annual *Hanford Site Environmental Report* (e.g., Dirkes et al. 1994). The pathway analysis is also based on the CRITR computer code (Baker and Soldat 1992) used to calculate doses to animals, and on hand calculations for those doses not addressed in the computer codes.

The chemical pathway analysis is based upon source-term data reported in the literature through February 1, 1994, and the use of the Multimedia Environmental Pollutant Assessment System (MEPAS) code, version 3.0 (Droppo et al. 1993). This is the first time that a nonradiological chemical pathway analysis has been performed by the Surface Environmental Surveillance Project (SESP). A fully detailed discussion of the results of the chemical pathway analysis can be found in an upcoming report by Blanton and Cooper.

Section 1.1 briefly describes past and current operations at Hanford and the nature of the materials that have been released to the environment, methods of waste disposal, and descriptions of chemicals of concern. A discussion of the potential pathways by which these releases could impact humans is provided for both radionuclides and chemical contaminants. This is followed by a discussion on the potential human health risks from exposure to radionuclides and chemicals. An assessment of potential impact to the environment and biota from exposure to released radionuclides is also provided in this section. A similar discussion has yet to be developed for wildlife exposure to chemicals.

Historically, there is a better understanding of the releases and environmental behavior of radionuclides than there is of chemical contaminants, because of the nature of past operations and the focus of past monitoring programs. As a result, the following discussion of chemical contaminants is more detailed to clarify what we do know about these contaminants and identify those areas where gaps may exist, either in the data or our understanding of the contaminants in the environment.

Hanford Site Past and Current Practices and Sources of Radionuclide and Chemical Contamination

The goal of this section is to provide a brief summary of the primary operations occurring at facilities located in the 100, 200-East, 200-West, 300, 400, and 1100 Areas. Only radiological concerns are addressed for the 400 Area and only chemical concerns are addressed for the 1100 Area. This discussion is divided into four topics.

- regulated waste sites at Hanford
- past practices and associated sources of contamination
- current operations and sources of contamination
- radionuclides and Chemicals of Concern (COC).

Regulated Waste Sites at Hanford

The Hanford Site has approximately 1400 inactive waste disposal and unplanned release sites that are regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Thompson 1991). There are also approximately 64 Resource Conservation and Recovery Act (RCRA) treatment, storage, or disposal units (Thompson 1991). Other regulated environmental pollution releases fall under the National Pollution Discharge Elimination System (NPDES) and National Emission Standards for Hazardous Air Pollutants (NESHAP) that result from current powerhouse air stacks and wastewater treatment plant effluent releases.

Past Practices and Associated Sources of Contamination

100 Areas. The 100 aggregate areas contain nine reactors that were used in the production of plutonium. They are B, C, D, DR, F, H, KW, KE, and N. Numerous support facilities are associated with the reactors, including water treatment plants, water storage tanks, raw water intake structures, process sewers, underground sewage-disposal systems, and powerhouses (oil or coal-fired) (Stenner et al. 1988). All of the reactors, except the N Reactor, which used oil-fired boilers, utilized coal-fired boilers and had large areas for coal storage and fly ash/clinker disposal (Stenner et al. 1988).

The 100-N Reactor was a dual-purpose reactor. It was used not only in the production of plutonium but also to feed steam to the 860-MWe Hanford Generating Plant nearby run by the Washington Public Power Supply System (WPPSS). The N Reactor cooling water was designed to be recycled after its use. The single-purpose production reactors (B, C, D, DR, F, H, KW, KE) were operated by "once-through" cooling. Water drawn from the Columbia River was treated with alum, sulfuric acid, and chlorine before entering the reactor core as a coolant to remove heat, film buildup and scale from the fuel elements (Becker 1990; Gray and Becker 1993; Stenner et al. 1988). To prevent corrosion of the piping and the aluminum surfaces of the fuel elements, sodium dichromate was also added to the water (Becker 1990; Gray and Becker 1993; Stenner et al. 1988). Other chemicals used during production included:

- copper sulfate and chlorine to control algae growth in retention basins and settling ponds
- oxalic acid, nitric acid, and chromic acid to decontaminate the "dummy" fuel elements that were used as spacers
- sulfuric acid to keep water at a desired pH level (Gray and Becker 1993; Becker 1990; Stenner et al. 1988)

The 100 Areas contain 22 Operable Units (OU), which can be categorized into the following four groups: 1) source units, 2) cooling water treatment units, 3) buried and solid waste units, and 4) ground-water units (Gray and Becker 1993; Stenner et al. 1988). Source units and cooling water treatment units comprise areas that received liquid effluent from reactors such as reactor coolants, decontaminated waste streams, effluents from ruptured fuel storage areas, and areas that received waste-water effluents from water treatment plants located at the 100-N and 100-K Areas (Gray and Becker 1993). Radiologically contaminated liquid wastes were discharged to engineered waste disposal facilities, such as ponds, french drains, cribs, ditches, trenches, and reverse wells (Gray and Becker 1993; Stenner et al. 1988).

Buried and solid waste units are areas that received radioactive solid waste, failed reactor wastes, and contaminated equipment. Solid waste was buried underground in trenches, caissons, and tunnels or retrievable storage on concrete pads (Gray and Becker 1993). Trenches primarily contained failed pieces of equipment placed in storage containers (concrete, wooden, or metal). "Dry" waste consisted of contaminated paper, rags, filters, soil, disposable supplies, small pieces of equipment, etc., placed in boxes and backfilled with approximately 2.4 m (8 ft) of soil (Gray and Becker 1993; Stenner et al. 1988). Groundwater units are found beneath "Source Units," where liquid waste discharged to the surface or below the surface has migrated to the water table, resulting in a contaminated ground-water plume.

The 200-East and 200-West Areas. These areas were used for chemical separations and waste management; the original separations plants B, T and U are located in the 200 Areas. Facilities located in the 200-East Area include the Plutonium Uranium Extraction (PUREX) Plant, B Plant, and the Semiworks Plant. The principal chemical processing plants in the 200-West area include the U, S, T, and reduction/oxidation (REDOX) plants and Finishing Plant (Z).

200-East Area. Processes that occurred at the PUREX Plant included the separation of uranium, plutonium, and neptunium from irradiated uranium fuel. This was accomplished by first removing the fuel cladding with an ammonium fluoride-ammonium nitrate solution (Becker 1990; Gray and Becker 1993; Stenner et al. 1988). The fuel was dissolved in nitric acid (Becker 1990; Gray and Becker 1993; Stenner et al. 1988). Uranium, plutonium, and neptunium was separated from the fuel with an organic solvent called tributyl phosphate (in a kerosene dilutant). B Plant also separated plutonium from irradiated uranium fuel and used a bismuth phosphate process (Stenner et al. 1988) where the aluminum fuel jacket was dissolved in a solution of sodium hydroxide-sodium nitrate solution (Stenner et al. 1988). Once the protective jacket was removed, the fuel elements were dissolved in nitric acid. The plutonium was then recovered after a series of chemical extractions and ion exchanges using various chemicals such as sodium bismuthate, sodium nitrate, sodium dichromate, oxalic acid, hydrofluoric acid, ammonium nitrate, potassium hydroxide, hydrogen peroxide, and ammonium sulfate (Stenner et al. 1988). The Semiworks Plant was first a pilot plant for the REDOX process and then later used as a pilot plant for the PUREX process. The Semiworks Plant was also used in the recovery of ^{90}Sr and ^{137}Cs for shipment to Oak Ridge National Laboratory. It has since been decommissioned (Stenner et al. 1988).

200-West Area. U Plant was one of the first fuel separation facilities built at Hanford, but it was never used for that purpose. It was converted to recover uranium from stored radioactive waste by dissolving the waste in a nitric acid solution and removing the uranium with an organic solvent (tributyl phosphate in a kerosene dilutant) (Stenner et al. 1988). Operations at T Plant were similar to those at B Plant. T Plant is now used to repair and decontaminate equipment (Gray and Becker 1993; Stenner et al. 1988). Z Plant, or Plutonium Finishing Plant (PFP), included a plutonium laboratory (231-Z), a finishing operations facility, and facilities for the processing of scrap plutonium materials and preparation of plutonium products (Stenner et al. 1988). Plutonium was recovered from scrap using a process called recouplex to form a plutonium nitrate solution (Stenner et al. 1988). This was achieved by dissolving solids in a nitric acid and hydrofluoric acid solution and extracting plutonium with a tributyl phosphate-carbon tetrachloride solvent (Stenner et al. 1988). Other chemicals were also used in the recovery of the purified plutonium nitrate solution, which included aluminum nitrate and aluminum fluoroxide nitrate (Stenner et al. 1988).

The 200-East and -West Areas contain 43 OUs grouped into one of four categories:

tank farms - Highly radioactive and hazardous chemical byproducts were stored underground in single-shell tanks (SSTs) or double-shell tanks (DSTs).

process liquids - Radioactive and hazardous liquid waste was disposed to the ground in cribs, ditches, trenches, and ponds. In addition, some process liquid was discharged into reverse injection wells that were drilled down to or very near the groundwater table. (These disposal practices have resulted in surface soil contamination and groundwater contamination.)

buried wastes - Radioactive dry wastes, contaminated drums, equipment, and limited amounts of liquid wastes were placed in numerous burial grounds.

support services - Sites contaminated from byproducts of coal burning, laundry, and maintenance facility operations are in this category (Becker 1990; Gray and Becker 1993; Stenner et al. 1988),

Releases from the separation processes fall into five categories: 1) high-activity aqueous solutions; 2) low-activity aqueous solutions; 3) non-aqueous solutions; 4) gaseous effluents, including particulate material; and 5) solids (Gray and Becker 1993; Stenner et al. 1988). Most of the nonaqueous liquid waste was usually disposed of by trenching and backfilling. Solid wastes (decontamination rags and failed equipment) were boxed and buried in trenches (Gray and Becker 1993). Gaseous effluents were vented to the atmosphere, usually following various forms of treatment and filtration. Disposal of aqueous waste was dependent on the level of the contamination. Highly contaminated liquid waste was stored in underground SSTs or DSTs. There are 149 SSTs and 28 DSTs buried in the 200 aggregate areas (Gray and Becker 1993; Becker 1990). Less contaminated liquid waste was disposed of to the ground in cribs and allowed to seep through the soil column. Some of the pollutants sorbed onto soil particles while others migrated to the groundwater table. Most of the cooling water and steam condensate was discharged to engineered artificial ponds and permitted to seep downward through the soil column to the unconfined aquifer.

300 Area. This area is located approximately 5 miles north of Richland and covers an area of approximately 1.5 km² (370 acres). Facilities in the 300 Area were used to support the fabrication of reactor fuel (Stenner et al. 1988). A process called "coextrusion" was used to fabricate the fuel elements for the 100-N reactor (Stenner et al. 1988). The process bonded zirconium cladding and the uranium-silicon fuel core together in one extrusion process (Stenner et al. 1988). Chemicals used in this process included trichloroethylene, which was used to remove lubricants, and nitric acid, which was used to dissolve the copper jacket after fuel elements were extruded into "bullets" (Stenner et al. 1988). A zirconium end cap was brazed onto the fuel bundle with beryllium (Stenner et al. 1988). Other chemicals used in the milling process included nitric acid, sulfuric acid, and copper sulfate (Becker 1990; Gray and Becker 1993; Stenner et al. 1988). Forms of waste were predominately liquid in nature and primarily consisted of cooling water, dilute caustics, and pickling rinses (Becker 1990).

Up until 1971, waste from fabrication of fuels used in single-purpose reactors containing low concentrations of uranium were discharged to two settling ponds a few hundred feet from the Columbia River (Foster et al. 1961). Waste from nearby research laboratories containing chemical solutions and

low-level radioactive liquids were also disposed of to these ponds (Becker 1990). Liquid waste was permitted to seep through the soil column to the shallow unconfined aquifer below. These ponds also received low-level radioactive liquids and chemical solutions used in research laboratories located in the 300 Area (Becker 1990).

The 300 Area contains five operable units that can be grouped into one of the following categories:

- process liquid-liquid waste disposals from fuel fabrications operations
- buried and solid waste (Gray and Becker 1993; Stenner et al. 1988).

400 Area: The Fast Flux Test Facility (FFTF) is located in the 400 Area. This facility was constructed to test fuels and materials for advanced nuclear technology. The facility is unique in that it is cooled by recirculating liquid sodium metal (Becker 1990; Gray and Becker 1993). The 400 Area also contains septic tanks and hazardous-materials-handling facilities.

1100 Area: This area was used as a central warehouse, vehicle maintenance, and transportation distribution center. Chemicals disposed at the 1100 Area included, but are not limited to, paints, antifreeze, battery acid, pesticides, and organic solvents (DOE/RL 1990). There are four operable units located in the 1100 Area that can be grouped into one of the following two categories:

- voluntary and involuntary liquid waste releases
- voluntary and involuntary solid waste releases.

Hanford Site Groundwater. As previously mentioned, many of the OUs found in the above areas function as sources that contribute to ground-water contamination beneath the Site. It has been estimated that from 1944 to 1989, approximately 444 billion gallons of liquid were discharged to the ground through disposal trenches, cribs, and ponds (Freshley and Thome 1992). The primary pollutants found in the numerous plumes located onsite include fluoride, chromium, cyanide, carbon tetrachloride, chloroform, trichloroethylene, nitrate, ^3H , ^{60}Co , ^{90}Sr , ^{99}Tc , ^{129}I , ^{137}Cs , and uranium. Following is a brief summary of the sources of these contaminants.

Nitrate contamination can be attributed to process-condensate liquid wastes and the use of nitric acid in the decontamination and chemical reprocessing operations that were discharged to the ground (Dresel et al. 1992). The fluoride contamination is primarily due to the use of aluminum fluoride nitrate in the 200 Areas that was subsequently disposed of in trenches and cribs (Dresel et al. 1992).

Chromium contamination can be attributed primarily to the use of sodium dichromate in the 100 Areas (Dresel et al. 1992). Cyanide contamination results primarily from the use of ferrocyanide disposed of in the BY cribs located in the 200 Areas (Dresel et al. 1992). Carbon tetrachloride contamination is due primarily to the extensive use of this substance for Z plant operations and its subsequent disposal to the ground. Chloroform contamination appears to be associated with the carbon tetrachloride plume found in the 200 areas and may be a result of biodegradation of carbon tetrachloride (Dresel et al. 1992). Trichloroethylene was a common industrial solvent used as a degreasing compound. This chemical can be detected in the 100, 200, 300, and 600 aggregate areas (Dresel et al. 1992).

All of the above-mentioned radionuclides can be attributed to Hanford's plutonium production process where uranium and many other chemicals used in the process became irradiated.

Detailed descriptions of each of the engineered disposal systems described above for the operational areas (100, 200, 300, 400, and 1100) can be found in the *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford* (Stenner et al. 1988).

Current Operations and Sources of Contamination

Westinghouse Hanford Company (WHC) and Pacific Northwest Laboratory (PNL) quantify and document the amounts of radioactive and nonradioactive liquids, gases, and solids released to or disposed of in the environment from operations. The release points include effluent stacks and vents in the 100, 200, 300, and 400 Areas; direct releases to the Columbia River; riverbank seepage; liquid effluents discharged to engineered ground disposal facilities at the 100, 200, and 300 Areas; and solid wastes disposed of to the engineered ground disposal facilities. The principal gaseous and liquid effluent streams are monitored either continuously or periodically by collecting samples for laboratory analysis. These results are evaluated for compliance with limits for releases of radioactive materials to the environment.

Air Emissions

100 Areas: There are 14 points of airborne emission of radionuclides located in the 100 Areas, all at facilities operated by WHC. There are no "major" stacks, as defined by the U.S. Environmental Protection Agency (EPA), in the 100 Areas. The 14 points include the N Reactor, eight inactive production reactors, and associated support facilities. Although the N Reactor has just recently been placed in permanent shutdown status, it is the main source of emissions of radionuclides to the atmosphere from the 100 Areas. There are minor contributions from several ventilation systems at support facilities.

200 Areas: The facilities located in the 200 Areas include the chemical separations and processing facilities and the waste handling and disposal facilities operated by WHC. Sources of radioactive gaseous emissions include PUREX, Uranium Oxide (UO₃) Plant, PFP, B Plant, REDOX, 222-S Laboratory, 2724-W laundry facility, underground storage tanks, waste evaporators, and tank farms. There are 59 airborne emission sources in the 200 Areas (Dirkes et al. 1993), four of which were classified as major stacks, based on release data collected in 1989. The major stacks are 291-A-01, 291-B-01, 291-Z-01, and 296-A-40.

300 Area: The 300 Area consists primarily of laboratories and research facilities. In 1993 there are 38 active airborne emission sources in the 300 Area (Dirkes et al. 1993), including six major stacks and vents: 324-01-S, 325-01-S, 327-01-S, 327-02-V, 3720-01-S, and 340-NT-EX.

400 Area: The facilities located in the 400 Area are the FFTF, the Maintenance and Storage Facility, and the Fuels and Materials Examination Facility (FMEF). There are four sources of airborne emissions in the 400 Area, none of which are classified as major.

Liquid Effluents

Liquid effluents are generated at facilities in all of the operating areas of the Hanford Site. The effluent streams are discharged to the Columbia River or to soil columns through ditches, ponds, or cribs. A few of the radionuclides in some of the streams eventually reach the Columbia River through the ground water.

100 Areas: The N Reactor has been placed in permanent shutdown status, and the fuel has been removed and is stored in the 100-K storage basins. The 100-K fuel storage basins do not have discharge paths to the river. Because the 100-N storage basin has not yet been decontaminated, it is kept filled with water for contamination control. A small amount of water overflows the basin into a sump that is periodically pumped out and discharged into the 1325-N trench. This trench prolongs the travel time for the seepage water to reach the river and provides more soil for adsorption of radionuclides than did the previous trench.

When the reactor was operating, the 1325-N trench was used for disposal of reactor cooling water, and seepage from the 1301-N trench was the source of contaminated springs along the Columbia River shoreline at 100-N. The operating contractor monitored seepage by collecting samples from a well drilled in the path of the underground flow between the trench and the river. A small area along the shoreline is currently contaminated with radionuclides deposited from past spring-water flow.

Radionuclides entering the Columbia River with the groundwater at the 100-N Area have been estimated by the operating contractor from sampling both of the liquid effluent into the trench and the shoreline springs. The reported values for the 100 Areas also included small contributions to the river from the 100-K Area. The results were reported as radionuclides put into the river from 100-N, as though they were from a single point source. Because the 100-K Area release point is upstream of the 100-N Area, the assumption that all of these materials are released from 100-N is conservative in terms of dilution and travel time in the river before reaching the point of potential exposure.

200 Areas: Low-level radioactive liquid effluents are discharged to the ground through ditches, ponds, or cribs in the 200 Areas. Few of the radionuclides present in these effluents reach the groundwater because they either are firmly held in the soil or have their movement retarded enough so that radioactive decay effectively eliminates them. A few long-lived soluble radionuclides do reach the ground water and are detectable downgradient. These include ^3H , U, ^{99}Tc , and ^{129}I , which eventually travel with the ground water to the Columbia River.

The amount of radionuclides entering the river from disposal of liquid effluents in the 200 Areas has been estimated by PNL from the differences between concentrations in river-water samples collected upstream and downstream of the Hanford Site, corrected for the reported contributions from 100-K and 100-N effluents. Surface ponds containing radionuclides are a potential source of contamination to waterfowl that may inhabit or visit the ponds.

300 Area: Liquid effluents containing 53 mc. of uranium were disposed to the ground in engineered disposal facilities at the 300 Area in 1993. Because the soil between the disposal site and the river is relatively porous, the uranium is likely to eventually travel to the river with the groundwater. The amount of uranium added to the river is small compared to the several kilocuries of natural uranium in the river water flowing past the 300 Area every year.

*** Note:** *All radionuclides disposed to the ground at the 300 Area are assumed, for purposes of dose calculation, to reach the river in the year of disposal. This is a conservative assumption, in that no holding in soil and no radioactive decay is assumed to have occurred.*

400 Area: At the FFTF in the 400 Area, well water is used for drinking and sanitary and equipment cooling systems. The used water is monitored and disposed of to the FFTF Pond. In 1993, this well water contained approximately 7,000 pCi/L of ^3H , which is present in the ground water as a result of past disposal of liquid effluents in the 200 Areas. Analysis of the water in the FFTF Pond indicates

that it contains no radionuclides other than those present in the well water. The pond can be a source of airborne tritiated water vapor, thus an air sampler, operated downwind, collects samples for this constituent.

Radiolonuclides and Chemicals of Concern

The topics to be covered in this discussion include the following:

- insufficient characterization of chemicals occurring at Hanford
- sources of data used in modeling the fate and transport pathways for radionuclides and chemicals to offsite receptors.
- types of radionuclides and chemicals occurring onsite.
- the radionuclides contributing the most to radiation dose and the chemicals considered to be chemicals of concern (COC)
- summary of the methodology used in the assessment of impacts.

Source-Term Data

Chemicals: Information concerning source-term concentrations and geographical distribution of nonradiological chemicals at the Hanford Site is very limited. Historical information concerning concentrations and volumes of nonradiological contaminants used and disposed of at the Hanford Site is very limited and incomplete. Process information (as described in the previous section) and purchase order records are useful in developing "laundry" lists of contaminants used onsite. A full listing of such chemicals can be found in Klem (1990). Other documents that provide similar listings of contaminants found on the Hanford Site include Fowler et al. (1993) and Riley et. al. (1992). A summary of the types of chemical contaminants occurring at the Hanford Site is provided in Table III.A-3.1. This table is based upon data obtained from three representative OUs, 100-BC, 200-Z, and 300-FF-1, taken from the following reports: "100 Area Feasibility Study, Phases I & II" (DOE/RL-92-11), "Z Plant Aggregate Area Management Study Report" (DOE/RL-91-58), and "Phase I Remedial Investigation Report for the 300-FF-1 Operable Unit" (DOE/RL-92-43).

The list provided in Table III.A-3.1 is not intended to be a comprehensive list of every chemical used at Hanford. Table III.A-3.1 is only intended to be representative of the types of chemicals most often encountered onsite at the 100, 200 and 300 Areas. More detailed information can be obtained from the previously mentioned reports. However, those reports do not provide a significant amount of chemical source-term data. The most reliable source-term data comes from Limited Field Investigation (LFI) reports, Qualitative Risk Assessments (QRA), and Remedial Investigation and Feasibility Study RI/FS reports. However, many of the OUs occurring onsite have not had LFI studies performed. For example, no LFI reports have been completed for any of the 200 Areas OUs at the time of this writing.

Table III.A-3.1. Representative Types of Chemicals Found at the Hanford Site

Chemicals	Aggregate Area		
	100 Area	200 Area	300 Area
Organics			
Acetone		•	
Benzene		•	
Benzo(a)pyrene			•
Bis(2 ethylhexyl)phthalate			•
Carbon tetrachloride		•	
Chlorobenzene		•	
Chloroform		•	
Chrysene			•
Dibutyl phosphate		•	
1,2-Dichloroethane		•	•
cis/trans-1,2 Dichloroethene		•	
Ethylbenzene		•	
Methylene chloride		•	
Methyl isobutyl ketone		•	
Pentachlorophenol			•
Polychlorinated biphenyls	•		
Tetrachloroethene		•	
Toluene		•	
Tributylphosphate		•	
Trichloroethane		•	
Vinyl Chloride			•
Xylenes		•	
Diesel oil	•		
Inorganic Compounds			
Antimony			•
Arsenic	•		•
Asbestos	•	•	
Barium	•	•	•
Beryllium		•	•
Boron	•	•	
Cadium	•	•	•
Chloride	•		
Chromium	•	•	•
Copper		•	•
Cyanide		•	
Fluoride	•	•	
Lead	•	•	
Manganese			•
Mercury	•	•	•
Nickel	•	•	•
Nitrate	•	•	
Nitrite		•	
Silver		•	•
Sulfate	•	•	
Vanadium			•
Zinc	•	•	•

Chemicals of Concern

Chemicals: A list of COC for the Hanford Site was developed based upon conservative onsite human health risk assessments reported in the literature. Some of the primary sources of this information comes from LFI, QRA, RI/FS and Aggregate Area Management Study Reports (AAMSR). Source-term data input to the MEPAS code is derived from these same sources. The risk assessments reported in the literature (i.e., QRA) are very conservative and utilize the maximum ground water and soil concentrations encountered during limited field investigations, regardless of the depth at which the concentration occurred, as did this report (i.e., some of the maximum soil concentrations were encountered at a soil depth greater than 12 ft). A description of the methodology used and the assumptions made in calculating human health risk can be found in Hanford Site Baseline Risk Assessment Methodology (HSBRAM; DOE/RL 1992).

A chemical was placed on the list of COC if it had a $1.0E-6$ Incremental Cancer Risk (ICR) or a 1.0 Hazard Index (HI) or greater health risk from onsite exposure. This selection criteria was chosen based upon the following assumption: a chemical detected onsite and not posing a significant health risk from a residential use onsite exposure scenario would not pose a significant human health risk to offsite receptors because concentrations of the chemical would be reduced during transport offsite. A listing of the COC for the Hanford Site can be found in Table III.A-3.2, along with the associated source-term concentrations and onsite health risk estimates reported in the literature. These data (Table III.A-3.2) were used as input into the MEPAS code.

When selecting chemical source terms for the 200 Areas, special allowances were made because of lack of suitable data and insufficient onsite risk assessments/characterization. For the 200 Areas suspect chemicals that had source-term data available were chosen based upon degree of toxicity and professional judgment.

Radionuclides: Table III.A-3.3 is a list of radionuclides that commonly occur at the Hanford Site as a result of past practices.

In 1993, the following radionuclides made up over 95% of the dose to the MEI listed in descending order of contribution: ^{212}Pb , ^3H , ^{238}U , ^{234}U , ^{99}Tc , ^{239}Pu , ^{90}Sr , and ^{129}I (Dirkes et al. 1994). This list of eight radionuclides are the primary radionuclides of concern for the Hanford Site.

Tables III.A-3.4, III.A-3.5, and III.A-3.6 contain a listing of the radionuclides discharged to the atmosphere, in liquid effluents discharged to ground disposal facilities, and the Columbia River in 1993, respectively. Data presented in these tables were used as input to the GENII code.

Table III.A-3.2. List of Chemicals of Concern and Associated Onsite Risk Information

	Soil Max, mg/kg	GW Max, mg/L	Onsite Risk - Frequent-Use Scenario ICR ^(a)				Onsite Risk - Frequent-Use Scenario HQ ^(a)			
			Soil Ingestion	Dust Inhalation	G.W. Ingestion	G.W. Inhalation	Soil Ingestion	G.W. Ingestion	G.W. Inhalation	Soil Ingestion
100 Area										
Arsenic	47 ^(b)	0.01 ^(e)	1.00E-04	1.00E-05	2.16E-04	(NA)	(NA)	(NA)	(NA)	2
Benzo(a)Pyrene	0.81 ^(b)	NA	2.00E-06	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Beryllium	4.7 ^(b)	NA	3.00E-05	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Chromium	610 ^(b)	2.09 ^(e)	(NA)	2.00E-04	(NA)	(NA)	30	(NA)	(NA)	2
PCBs	0.13 ^(b)	NA	2.00E-06	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Ammonia	NA	0.75 ^(e)	(NA)	(NA)	(NA)	(NA)	3	(NA)	(NA)	(NA)
Bis(2-ethylhexyl)phthalate	NA	0.011 ^(e)	(NA)	(NA)	2.00E-06	(NA)	(NA)	(NA)	(NA)	(NA)
Chloroform	NA	0.053 ^(e)	(NA)	(NA)	4.00E-06	(NA)	1	(NA)	(NA)	(NA)
Fluoride	NA	1.3 ^(e)	(NA)	(NA)	(NA)	(NA)	2	(NA)	(NA)	(NA)
Manganese	NA	0.18 ^(e)	(NA)	(NA)	(NA)	(NA)	7	(NA)	(NA)	(NA)
Nitrate	NA	170 ^(e)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Trichloroethene	NA	0.0199 ^(e)	(NA)	(NA)	2.56E-06	(NA)	(NA)	(NA)	(NA)	(NA)
200 Area										
Carbon Tetrachloride	52.27 ^(b)	7 ^(b)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Nitrates	1136.36 ^(b)	450 ^(b)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Nitric Acid	128.97 ^(b)	NA	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Chloroform	NA	1 ^(b)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
300 Area										
Arsenic	23.3 ^(b)	NA	1.00E-06	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Benzo(a)Pyrene	27 ^(b)	NA	4.00E-06	(NA)	2.00E-06	(NA)	(NA)	2.00E-06	(NA)	(NA)
Beryllium	3.3 ^(b)	NA	(NA)	(NA)	1.00E-05	(NA)	(NA)	1.00E-05	(NA)	(NA)
Chromium	960 ^(b)	NA	(NA)	2.00E-05	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Chrysene	43 ^(b)	NA	5.00E-06	(NA)	1.00E-05	(NA)	(NA)	1.00E-05	(NA)	(NA)
PCBs	19.5 ^(b)	NA	7.00E-06	(NA)	9.00E-06	(NA)	(NA)	9.00E-06	(NA)	(NA)
Tetrachloroethene (1,1,1)	1.1 ^(b)	NA	(NA)	4.00E-06	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
Trichloroethene	0.39 ^(b)	NA	(NA)	7.00E-06	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)
1100 Area										
PCBs	65.29 ⁽¹⁾	NA	2.00E-06	(NA)	2.00E-06	(NA)	(NA)	2.00E-06	(NA)	(NA)
Bis(2-ethylhexyl)phthalate	25.046 ⁽¹⁾	NA	3.00E-06	(NA)	1.00E-06	(NA)	(NA)	1.00E-06	(NA)	(NA)

NA = not applicable.

(a) Risk values were obtained from document referenced for source-term valve.

(b) QRA 100-HR-1, WHC-SD-EN-RA-004

(c) QRA 100-KR-4, WHC-SD-EN-RA-010

(d) QRA 100-BC-1, WHC-SD-EN-RA-003

(e) QRA 100-HR-3, WHC-SD-EN-RA-007

(f) QRA 100-DR-1, WHC-SD-EN-RA-005

(g) QRA 100-BC-5, WHC-SD-EN-RA-006

(h) Northwest Area Environmental Restoration Performance Based Requirements Draft - September 1993

(i) Phase I Remedial Investigation Report for the 300-PF-1 Operable Unit DOE/RL-92-43

(j) Phase I Remedial Investigation Report for the Hanford Site 1100-EM-1 Operable Unit DOE/RL-90-18

Table III.A-3.3. Select Hanford-Derived Radionuclides and Their Respective Half-Lives.

Radionuclide	Half-life
Sodium-24	15 h
Barium-140	12.7 d
Scandium-46	83.9 d
Chromium-51	27.8 d
Manganese-56	2.6 h
Copper-64	12.9 h
Zinc-65	243 d
Zirconium-95	65 d
Niobium-95	35.1 d
Iodine-131	8 d
Cesium-137	30 y
Neptunium-239	2.4 d
Hydrogen-3	12.35 y
Phosphorus-32	14.3 d
Strontium-90	21.1 y
Radium-222	37 sec.
Plutonium-239	24,360 y
Uranium-234	2.48×10^5 y
Uranium-238	4.5×10^9 y
Americium-241	432 y

Potential Pathways of Exposure

Exposure is defined as the interaction of an organism with a physical or chemical agent of interest. Thus, exposure can be quantified as the amount of chemical or physical agent available for absorption at the organism's exchange boundaries (i.e., dermal contact, lungs, gut, etc.). An exposure pathway is identified based upon 1) examination of the types, location, and sources (contaminated soil, raw effluent, etc.) of contaminants occurring onsite; 2) the principal release mechanisms; 3) the probable environmental fate and transport (including persistence, partitioning, and intermediate transfer) of contaminants of interest; and, most importantly, 4) the location and activities of the potentially exposed populations. Mechanisms that influence the fate and transport of a chemical through the environment and that are the determining factor influencing the amount of exposure one might receive at various receptor locations are listed below.

Table III.A-3.4. Radionuclides Discharged to the Atmosphere, 1993

Radionuclide	Half-Life	Release, Ci ^(a)				
		100 Area	200-East Area	200-West Area	300 Area	400 Area
³ H (as HTO) ^(b)	12.3 y	NM	NM	NM	11	2.1
³ H (as HT) ^(c)	12.3 y	NM	NM	NM	10	NM
⁶⁰ Co	5.3 y	5.2 x 10 ⁻⁶	ND	ND	1.4 x 10 ⁻⁸	NM
⁹⁰ Sr ^(d)	21.1 y	5.4 x 10 ⁻⁴	1.4 x 10 ⁻⁴	1.3 x 10 ⁻⁴	4.3 x 10 ⁻⁵	NM
¹⁰⁶ Ru	368 d	1.3 x 10 ⁻⁵	ND	4.0 x 10 ⁻⁶	ND	NM
¹²⁵ Sb	2.8 y	6.0 x 10 ⁻⁶	ND	ND	1.5 x 10 ⁻⁵	NM
¹²⁹ I	1.6 x 10 ⁷ y	NM	4.8 x 10 ⁻³	NM	NM	NM
¹³⁴ Cs	2.1 y	8.9 x 10 ⁻⁸	ND	ND	3.3 x 10 ⁻⁷	NM
¹³⁷ Cs ^(e)	30 y	1.6 x 10 ⁻⁴	1.5 x 10 ⁻³	2.3 x 10 ⁻⁴	9.3 x 10 ⁻⁷	8.2 x 10 ⁻⁶
¹⁴⁷ Pm	2.6 y	ND	1.1 x 10 ⁻⁴	ND	ND	NM
¹⁵⁴ Eu	8.8 y	6.3 x 10 ⁻⁶	ND	ND	1.5 x 10 ⁻⁶	NM
¹⁵⁵ Eu	5 y	2.8 x 10 ⁻⁶	ND	ND	2.6 x 10 ⁻⁸	NM
²¹² Pb	10.6 h	NM	9.7 x 10 ⁻⁴	NM	NM	NM
²²⁰ Rn	56 s	NM	12(f)	NM	85	NM
²²² Rn	3.8 d	NM	NM	NM	1.5	NM
Uranium total		NM	NM	1.7 x 10 ⁻⁵	3.6 x 10 ^{-8(g)}	NM
²³⁴ U	2.4 x 10 ⁶ y	NM	NM	NM	5.9 x 10 ⁻⁹	NM
²³⁵ U	7 x 10 ⁸ y	NM	NM	NM	6.2 x 10 ⁻¹⁰	NM
²³⁸ U	4.5 x 10 ⁹ y	NM	NM	NM	5.9 x 10 ⁻⁹	NM
²³⁸ Pu	87.7 y	1.0 x 10 ⁻⁶	3.2 x 10 ⁻⁶	ND	NM	NM
^{239,240} Pu ^(h)	2.4 x 10 ⁴ y	8.2 x 10 ⁻⁶	1.1 x 10 ⁻⁵	5.5 x 10 ⁻⁴	7.0 x 10 ⁻⁶	2.4 x 10 ⁻⁶
²⁴¹ Pu	14.4 y	NM	3.3 x 10 ⁻⁵	3.4 x 10 ⁻³	NM	NM
²⁴¹ Am	432 y	5.4 x 10 ⁻⁶	2.8 x 10 ⁻⁵	9.9 x 10 ⁻⁵	5.5 x 10 ⁻⁸	NM

(a) Ci = 3.7 x 10¹⁰ Bq; NM = not measured; ND = none detected.

(b) HTO is tritiated water vapor.

(c) HT is elemental tritium gas.

(d) ⁹⁰Sr values in the 200 and 300 ⁹⁰Sr. Also factored into this value was a small total beta release from a single emission point in the 600 Area.(e) ¹³⁷Cs value for the 400 Area is derived fully from total beta measurements.(f) ²²⁰Rn value is calculated from ²¹²Pb measurements.

(g) Uranium value is derived fully from total alpha measurements for facilities at which processes involving plutonium have not occurred and analysis for uranium have not been done.

(h) Results of total alpha measurements were assumed to be ²³⁹Pu, ²⁴⁰Pu. Also factored into this value was a small total alpha release from a single emission point in the 600 Area.

Once a radionuclide or chemical is released into the environment it may be:

- transported (e.g., migrate downstream in solution or on suspended sediment, or travel through the atmosphere)
- physically or chemically transformed (e.g., deposition, precipitation, volatilization, photolysis, oxidation, reduction, hydrolysis; if radionuclide it may decay).
- biologically transformed (e.g., biodegradation)
- accumulated in the receiving media (e.g., an environmental sink, such as a chemical sorbed strongly in the soil column)

Table III.A-3.5. Radionuclides in Liquid Effluents Discharged to Ground Disposal Facilities in 1993

Radionuclide	Half-Life	Release, Ci ^(a)	
		200 Areas	300 Areas
³ H	12.3 y	15	NM
⁹⁰ Sr	29.1 y	0.071	0.022 ^(b)
⁹⁹ Tc	2.1 x 10 ⁵ y	0.048	NM
¹³⁷ Cs	30 y	0.22	NM
Uranium, total		0.0017	0.052 ^(c)
²³⁸ Pu	87.7 y	0.0014	NM
^{239,240} Pu	2.4 x 10 ⁴ y	0.1	NM
²⁴¹ Pu	14.4 y	0.024	NM
²⁴¹ Am	432 y	0.14	NM

(a) 1 Ci = 3.7x10¹⁰ Bq; NM = not measured.

(b) Reported as total beta; assumed to be ⁹⁰Sr for dose calculations.

(c) Reported as total alpha; assumed to be uranium, total for dose calculations.

**Table III.A-3.6. Radionuclides in Liquid Effluents Discharged to the Columbia River
From the 100 Areas, 1993**

Radionuclide	Half-Life	Release, Ci ^(a)
³ H	12.3 y	0.38
⁶⁰ Co	5.3 yr	0.0036
⁹⁰ Sr	29.1 y	0.11
¹⁰⁶ Ru	368 d	0.0016
¹²⁵ Sb	2.8 y	0.00013
¹³⁴ Cs	2.1 y	0.000047
¹³⁷ Cs	30 y	0.00044
^{239,240} Pu	2.4 x 10 ⁴ y	1.4 x 10 ⁻⁷

(a) 1 Ci = 3.7 x 10¹⁰ Bq

The potential pathways of exposure for both radionuclides and chemical contaminants to humans and biota are illustrated in Figures III.A-3.1 and III.A-3.2, respectively. The following summarizes the human exposure pathways:

- direct contact with contaminated air plume resulting in possible dermal adsorption of contaminants; dust and air inhalation of contaminated plume; ingestion of fugitive dust
- fugitive dust deposition offsite onto crops, livestock, and wildlife used as food
- consumption of crops and livestock that have been irrigated or drinking water that is contaminated; consumption of fish, ducks, mussels and other aquatic or terrestrial wildlife that frequent the river
- consumption of wildlife that migrate on and off the Hanford Site
- the use of ground water for bathing, showers, drinking, cooking, etc., possibly leading to ingestion of contaminants, or adsorption of contaminants through mucus membranes and dermal contact
- direct irradiation from external exposure to radionuclide contaminants (from the above activities)
- internal irradiation from ingestion of radionuclide contaminants (from the above activities).

Types of Radionuclide Exposure Pathways Modeled for Radionuclides: The following pathways are currently included in the dose estimates for the MEI and the general population near the Hanford Site. Those associated with releases of radionuclides to the atmosphere at the 100, 200, 300, and 400 Areas include the following:

- external doses from submersion in the radioactive plume and standing on contaminated ground
- internal doses from direct inhalation from the plume and from eating crops and animal products contaminated following deposition of radionuclides from the air.

The pathways associated with releases of radionuclides to the Columbia River directly or indirectly (with groundwater from the 100, 200, 300, and 600 Areas) include the following:

- external doses from swimming, boating, standing on the river shore, and standing in an irrigated field
- internal doses from ingestion of drinking water and fish from the river and from eating crops and animal products contaminated by irrigation water drawn from the river.

Some potential exposure pathways are addressed separately from the dose to the MEI or to the collective population. These include waterfowl using the Columbia River or open onsite waste ditches and ponds. Ducks and geese that inhabit the waste ponds and open areas on the Hanford Site might migrate offsite. Upland game birds, on the other hand, usually do not travel great distances; however, there is the possibility that they could be harvested offsite. Another potential pathway is consumption

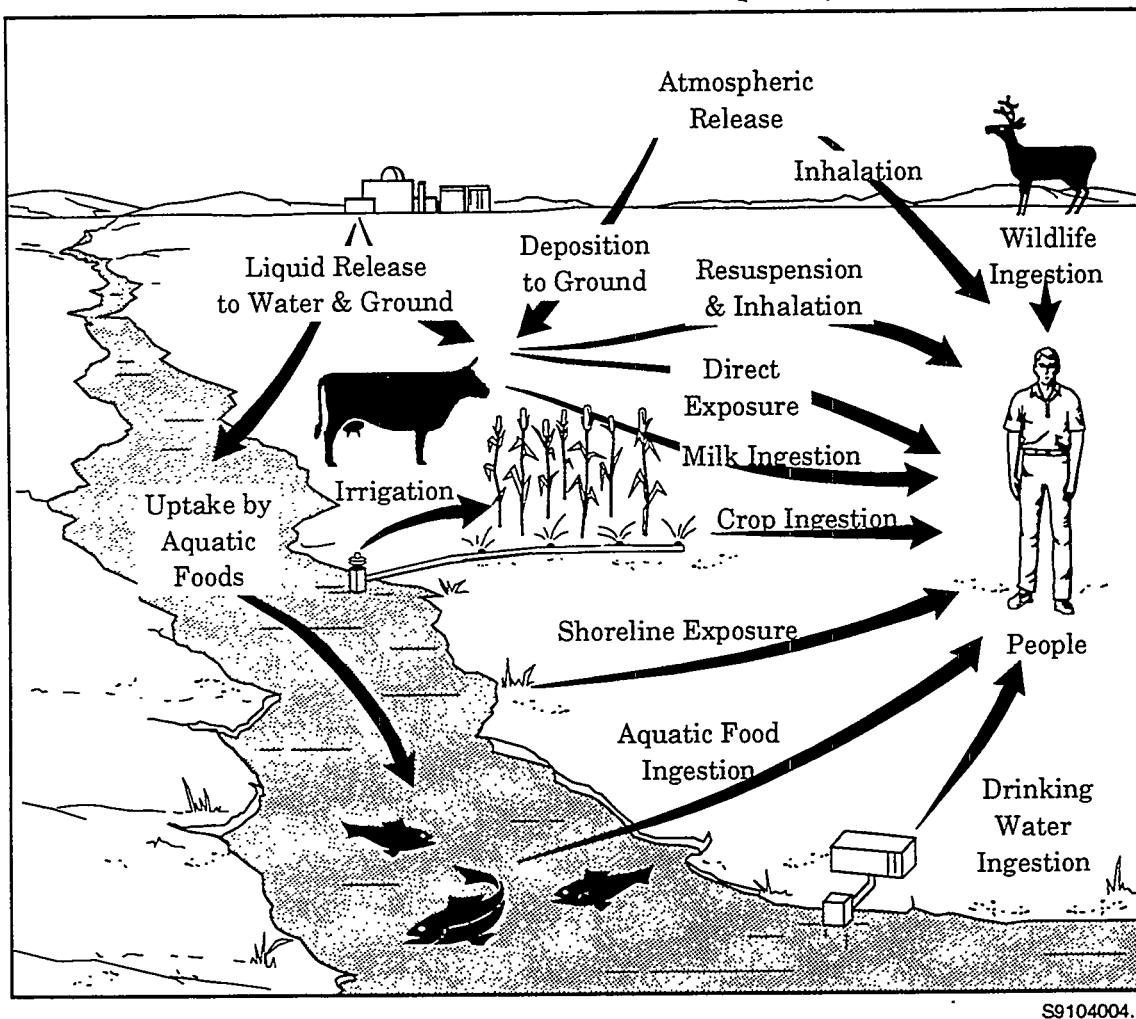
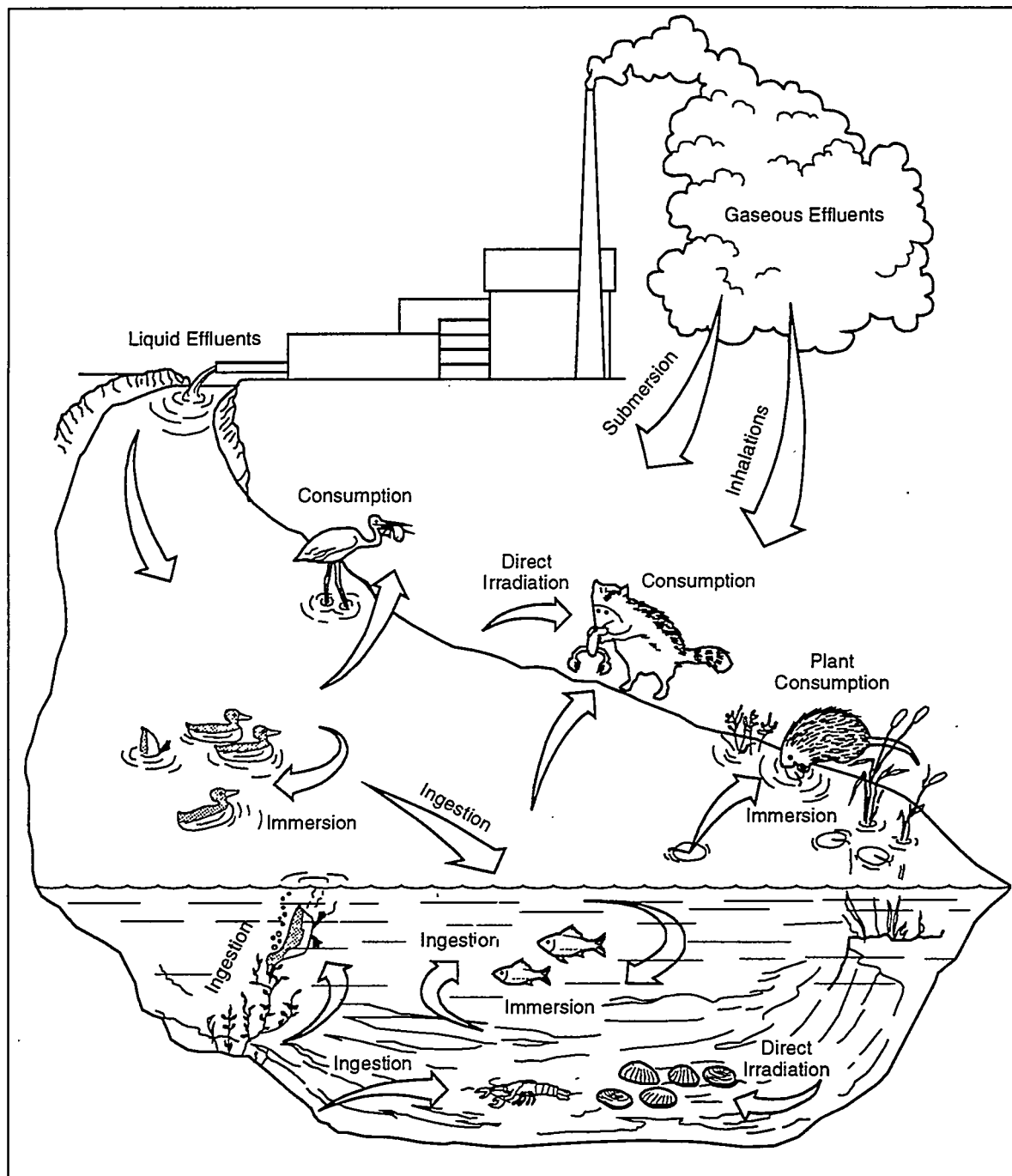


Figure III.A-3.1. Radiation and Chemical Exposure Pathways to Humans

of clams and crayfish from the Columbia River. The presence, in the Tri-Cities, of ethnic groups that may include these items in their diet make consideration of these foods worthwhile. Another potential pathway is the resuspension of contaminated soil, because such soil is present in most of the operating areas on the Hanford Site.

Types of Exposure Pathways Modeled for Chemicals: The fate and transport of COCs were modeled using available source-term data as input to the MEPAS code (Table III.A-3.1). The MEPAS code modeled the transport of COCs from the 100, 200, 300, and 1100 Areas to offsite receptor points. The transport of these chemicals offsite was modeled and human health risks were generated from the predicted offsite concentrations. Criteria used to evaluate human health risks included calculations of Cancer Incidence (CI) and Hazard Index (HI) for the MEI.



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Figure III.A-3.2. Radiation and Chemical Exposure Pathways to Biota

COCs located in the 100, 200, 300, and 1100 Areas were modeled to various offsite receptors. A detailed discussion of the results of the chemical pathway analysis can be found in a report to be published by Blanton and Cooper in the near future. The following transport pathways and exposure mediums were used in the MEPAS code.

Chemicals that were found to occur only in the soil were modeled using the following pathways:

- vadose zone to ground water
- vadose zone to surface water
- volatilization to air
- suspension to air.

Chemicals that were found to occur in the ground water only were modeled using the following pathways.

- saturated zone to ground water
- saturated zone to surface water.

Chemicals that were found occurring in both media were modeled using all the above pathways.

The pathways were used in conjunction with the following offsite exposure scenarios:

- air inhalation -- exposure to fugitive dust and volatilization of chemicals from Hanford Site
- aquatic food consumption -- eating fish and shell fish from the Columbia River that have been exposed to chemicals derived from the Hanford Site
- agriculture -- eating farm products grown or raised in Benton County that have been exposed to chemicals derived from the Hanford Site through irrigation or atmospheric deposition
- surface water -- exposure to chemicals that have migrated to the river
- ground water -- exposure to chemicals that have migrated to offsite ground-water wells (there is no evidence that this pathway occurs).

Because of the limited rainfall, and the geologic conditions occurring at the Hanford Site, and relative distance from Site sources to offsite exposure point receptors, the potential pathway of overland flow to surface water was not evaluated.

Pathway Analysis Results Summary

The GENII and MEPAS codes were used to evaluate the potential exposure of persons living near the Hanford Site to radionuclides and chemicals of Hanford origin, respectively. The results of these evaluations indicated that any exposures potentially received from these sources were well below any exposure limits given in applicable regulations, standards, or guidelines.

The conservative estimate of offsite CI obtained for the MEI to chemicals is $2.1 \text{ E-}09$, three orders of magnitude below the EPA action level of $1 \text{ E-}06$. The surface-water exposure pathway contributed

the highest fraction of the total chemical exposure; the chemical contributing the most to this pathway was arsenic. Although arsenic occurs on the Hanford Site, it was not directly used in the production process; however, arsenic contamination may have occurred from the use of coal-fired generation plants at the Site. Little information is currently available regarding this issue.

The total offsite radiation dose to the MEI from Hanford operations in 1993 was 0.03 mrem. The current DOE radiation limit for a member of the public is 100 mrem/yr. During 1993 the MEI potentially received 0.03% of the DOE dose limit and 0.01% of the average natural background dose. Inhalation of airborne radionuclides was the pathway contributing the most to this dose. The radionuclide contributing the most to this pathway is the ^{212}Pb decay product of the ^{220}Rn released from the 300 Area (50%). The results from the radionuclide pathway analysis can be found in Dirkes et al. (1994). Further discussions of the radionuclide and chemical pathway analyses are provided below.

Pathway Results of the Radionuclide Analysis

Radiation doses were calculated for effluent releases reported by the operating contractors and radionuclide measurements in environmental media, using Version 1.485 of the GENII code (Napier et al. 1988a, 1988b, 1988c), and site-specific parameters for food pathways, diet, and recreational activity used for the dose calculations are contained in Appendix D of Dirkes et al. (1994) and in Bisping (1994). Unless stated otherwise, the term "dose" in this section is the "effective dose equivalent," or EDE.

Potential Radiation Doses to the MEI: The MEI is a hypothetical person living at a particular location who has a postulated lifestyle conducive to receiving higher radiation doses than other members of the public would be likely to receive. This hypothetical individual's characteristics were chosen to maximize the combined doses from all realistic environmental pathways of exposure to radionuclides in Hanford effluents. In reality, such a combination of maximized parameters is unlikely to apply to any single individual.

The MEI for 1993 was postulated to be an individual who:

- was a resident of the closest farm, 1.5 km (1 mi) across the Columbia River from the 300 Area
- consumed foodstuffs irrigated with Columbia River water grown in the Riverview Irrigation District
- used the Columbia River extensively for boating, swimming, and fishing; consumed the fish caught
- drank well water that did not contain radionuclides of Hanford origin
- was exposed to the low levels of ^{220}Rn and ^{222}Rn released from the 300 Area in October, November, and December 1993.

Radiation doses to the MEI were calculated using the effluent data in Tables III.A-3.4, III.A-3.5, and III.A-3.6. The calculated doses for the MEI are summarized in Table III.A-3.7. These values include the potential doses received from exposure to liquid and airborne effluents during 1993, as well as the future dose from radionuclides that were deposited in the body during 1993 via inhalation and ingestion.

Table III.A-3.7. Doses to the Hypothetical Maximally Exposed Individual from Hanford Operations, 1993

Effluent	Pathway	Operating Area Contribution to Doses, mrem ^{(a)(b)}			400 Area	Pathway
		100	200	300		
Air	External ^(c)	4×10^{-8}	2×10^{-6}	3×10^{-4}	3×10^{-8}	3×10^{-4}
	Inhalation	8×10^{-6}	0.001	0.01	2×10^{-5}	0.01
	Foods ^(d)	4×10^{-7}	6×10^{-4}	2×10^{-4}	2×10^{-5}	8×10^{-4}
Water	Recreation ^(e)	2×10^{-6}	5×10^{-5}	6×10^{-7}	(f)	6×10^{-5}
	Foods ^(g)	4×10^{-4}	0.008	1×10^{-4}		0.008
	Fish ^(h)	4×10^{-4}	0.004	1×10^{-4}		0.004
	Total	8×10^{-4}	0.01	0.01	4×10^{-5}	0.03

(a) to convert these dose values to mSv, divide them by 100

(b) values rounded after adding

(c) includes air submersion and exposure to ground-deposition from the air

(d) includes consumption of all foodstuffs contaminated via deposition from the air

(e) external exposure during river recreation plus inadvertent ingestion of water while swimming

(f) there are no releases to the river from the 400 Area

(g) includes consumption of all foodstuffs contaminated via irrigation water

(h) consumption of fish taken from the Columbia River.

The radiation dose limit for any member of the public from all routine DOE operations is 100 mrem/yr (1 mSv/y). The dose calculated for the MEI was 0.03 % of the DOE limit.

From 1989 through 1992, the MEI was located at either Ringold or Riverview, whichever location represented the maximum hypothetical dose. For 1993, the hypothetical MEI was located across the Columbia River from the 300 Area. The potential dose to the MEI in 1993 from Hanford operations was 0.03 mrem (3×10^{-4} mSv) compared to 0.02 mrem (2×10^{-4} mSv) reported for 1992. The primary pathways contributing to this dose as determined by the computer calculations were:

- inhalation of airborne radionuclides, principally the ^{212}Pb decay product of the ^{220}Rn released from the 300 Area (50 %)
- consumption of food irrigated with Columbia River water containing radionuclides, principally ^3H and ^{99}Tc (29 %)
- consumption of fish containing radionuclides, principally isotopes of uranium, from the Columbia River (15 %).

The small additional dose to the MEI in 1993 was a result of new experimental work initiated in the 300 Area during September 1993. This work entailed the release of radon isotopes (85 Ci of ^{220}Rn and 1.5 Ci of ^{222}Rn) to the atmosphere from the 327 Building ventilation system (see Table III.A-3.4). As a result, the MEI location was changed to a point 1.5 km (1 mi) across the river from the 300 Area. The calculated potential dose from these releases to the MEI was 0.01 mrem (1×10^{-4} mSv). The calculated potential dose to the population within 80 km (50 mi) of the Hanford Site was 0.06 person-rem (6×10^{-4} person-Sv). Inhalation of the ^{212}Pb decay product of the ^{220}Rn accounted for over 90% of these doses. These doses are included in the air pathway doses listed in Tables III.A-3.7 and III.A-3.8. The radiation dose limit for any member of the public from all routine DOE operations is 100 mrem/yr (1 mSv/yr). The total dose of 0.03 mrem calculated for the MEI was 0.03% of the DOE limit.

Table III.A-3.8. Population Doses from Hanford Operations, 1993

Effluent	Pathway	Operating Area Contribution Doses, mrem ^{(a)(b)}				Pathway Total
		100 Area	200 Area	300 Area	400 Area	
Air	External ^(c)	8×10^{-6}	2×10^{-4}	0.003	1×10^{-6}	0.002
	Inhalation	0.002	0.1	0.06	0.001	0.2
	Foods ^(d)	1×10^{-4}	0.07	0.01	0.001	0.09
Water	Recreation ^(e)	9×10^{-6}	3×10^{-4}	3×10^{-6}	(f)	3×10^{-4}
	Foods ^(g)	4×10^{-4}	0.008	1×10^{-4}		0.009
	Fish ^(h)	1×10^{-4}	0.001	4×10^{-5}		0.002
	Drinking Water	0.001	0.1	6×10^{-4}		0.014
	Total	0.004	0.3	0.07	0.003	0.4

(a) to convert these dose values to person-Sv, divide them by 100

(b) values rounded after adding

(c) includes air submersion and exposure to ground-deposition from the air

(d) includes consumption of all foodstuffs contaminated via deposition from the air

(e) external exposure during river recreation plus inadvertent ingestion of water while swimming

(f) there are no releases to the river from the 400 Area

(g) includes consumption of all foodstuffs contaminated via irrigation water and external exposure to ground contaminated via irrigation

(h) consumption of fish taken from the Columbia River.

Potential Radiation Doses To The Population: Pathways of exposure to the population from releases of radionuclides to the atmosphere include inhalation, air submersion, exposure to contaminated ground, and consumption of contaminated food. Pathways of exposure associated with Hanford-generated radionuclides present in the Columbia River include consumption of drinking water, fish, and irrigated foods, and external exposure during aquatic recreation. The regional population dose from 1993 Hanford operations was estimated by calculating the radiation dose to the population residing within an 80-km (50-mi) radius of the onsite operating areas. Results of the dose calculations are shown in Table III.A-3.8. Food pathway, dietary, residency, and recreational activity assumptions for these calculations are given in Appendix D of Dirkes et al. (1994).

The potential dose to the local population of 380,000 persons (Beck et al. 1991) from 1993 operations was 0.4 person-rem (0.004 person-Sv), compared to 0.8 person-rem (0.008 person-Sv) reported for 1992. The 1993 average dose to the population was 0.001 mrem (1×10^{-5} mSv) per person. The current DOE radiation limit for an individual member of the public is 100 mrem/yr (1 mSv/yr), and the national average dose from natural sources is 300 mrem/yr (3 mSv/yr). During 1993, the MEI potentially received 0.03% of the DOE dose limit and 0.01% of the natural background average dose. The average individual potentially received 0.001% of the standard and $3 \times 10^{-4}\%$ of the 300 mrem/yr received from typical natural sources. Primary pathways contributing to the 1993 dose to the population were:

- inhalation of radionuclides (principally $^{239,240}\text{Pu}$ and ^{241}Am) that were released to the air from the PUREX Plant stack (43%)
- consumption of drinking water contaminated with radionuclides (principally ^3H) released to the Columbia River at Hanford (32%)
- consumption of foodstuffs contaminated with radionuclides (principally ^{129}I) released with gaseous effluents primarily from the PUREX Plant stack (20%).

Sportsman Dose: Listed below are examples of the estimated radiation doses that could have resulted if wildlife containing the maximum concentrations measured in onsite wildlife in 1993 migrated offsite, were hunted, and were consumed. These are very low doses and qualitative observations suggest that the significance of this pathway is further reduced because of the relatively low migration offsite and the inaccessibility of onsite wildlife to hunters. Not all of the maximum values were observed in the same animal of each species sampled. However, the maximum values were compounded to arrive at an upper limit to the potential concentrations. These doses would be in addition to the MEI dose.

- The dose from eating 1 kg of meat containing the maximum concentration of ^{137}Cs measured in a deer collected onsite is estimated to be 0.02 mrem (2×10^{-4} mSv).
- The dose from eating 1 kg of meat containing the maximum concentration of ^{137}Cs measured in any duck collected onsite is estimated to be 0.05 mrem (5×10^{-4} mSv).
- The dose from eating 1 kg of meat containing the maximum concentration of ^{60}Co and ^{137}Cs measured in any pheasant collected onsite is estimated to be 1×10^{-3} mrem (1×10^{-5} mSv).
- The dose from eating 1 kg of meat containing the maximum concentration of ^{137}Cs measured in a rabbit collected onsite is estimated to be 0.02 mrem (2×10^{-4} mSv).

- The dose from eating 1 kg of meat containing the maximum concentration of ^{137}Cs measured in a carp collected from the Hanford Reach of the Columbia River is estimated to be 1×10^{-3} mrem (1×10^{-5} mSv).

The methodology for calculating doses from consumption of wildlife are addressed in more detail in Soldat et al. (1990).

Potential Radiation Doses Via Resuspension: Another potential source is resuspension of contaminated surface soil that might be carried offsite. Most such contaminated soil is located within the 200 Areas, well away from the Hanford Site boundary. However, some soil contamination exists in the 300 Area, relatively close to the Site boundary. Areas of contamination above background levels have been described by Poston (1990), Teel and Olsen (1990) and annual reports by WHC (e.g. Schmidt et al. 1994).

Although the GENII code has equations for calculating concentrations of resuspended material in air at the point of resuspension, it does not include a model for transporting and dispersing the resuspended material downwind. The best estimate of air concentrations resulting from resuspension of contaminated onsite soil would be obtained from air concentrations measured at the offsite point of exposure, corrected for background (upwind) concentrations, and for known releases from stacks and vents.

The annual average air concentration of uranium at background locations in 1993 was 53 aCi/m³. The average onsite concentration was 93 aCi/m³, and that at the downwind perimeter stations averaged 100 aCi/m³. The existence of surface contamination in the 300 Area and these results suggest an offsite impact from resuspension. Removing background from the downwind perimeter concentration (100 minus 53) results in a residual of 47 aCi/m³. This increment corresponds to an inhalation dose of approximately 90 μrem EDE. This is likely to be an overestimate of the incremental offsite effect from resuspension because it is known that the geologic strata outcropping in the bluffs downwind of the 300 Area contain elevated natural uranium. Air concentrations remain about the same as one moves northward from a point on the eastern shore of the river across the river from the 300 Area; there is no measurable gradient.

Radiation Dose Rates to Biota: Conservative (upper) estimates have been made of the potential radiation dose to "native aquatic animal organisms," in accordance with a DOE Order 5400.5 interim requirement for management and control of liquid discharges. Potential radiation dose rates during 1993 were calculated for several possible exposure modes, including exposure to water entering the Columbia River from springs near the 100-N Area, and internally deposited radionuclides measured in samples of animals collected from the Columbia River and onsite.

Because the volumetric flow of the springs at the 100-N Area is so low, no aquatic animal can live directly in this seep water. Exposure to the radionuclides from the springs cannot occur until the seep water has been noticeably diluted in the Columbia River. The unlikely assumption was made that a few aquatic animals might be exposed to the maximum concentration of radionuclides measured in the seep water after dilution at only 10 to 1 by the river. Radiation doses were calculated for several different types of aquatic animals, using highly conservative assumptions and the computer code CRITR2 (Baker and Soldat 1992). The animal receiving the highest potential dose was calculated to be a duck consuming aquatic plants. However, even if such a duck spent 100% of its time in the one-tenth

seep water consuming only plants growing there, it would only receive a radiation dose rate of 0.08 rad/d. This dose rate is 8% of the limit of 1 rad/d given for native aquatic animal organisms in DOE Order 5400.5.

Doses were also estimated for clams, fish, and waterfowl exposed to Columbia River water containing a mixture of all the radionuclides reaching the Columbia River from Hanford sources during 1993. The highest potential dose was 1×10^{-5} rad/d for a plant-eating duck.

Dose estimates based on the maximum concentrations of ^{60}Co and ^{137}Cs measured in muscle of animals collected onsite ranged from 5×10^{-7} rad/d for game birds to 2×10^{-5} rad/d for the maximally exposed duck. A low concentration (0.026 pCi/g) of ^{90}Sr was detected in only one of five samples of carp muscle. The ^{90}Sr was probably from a small piece of bone that could have been present in this sample. Even if the ^{90}Sr was actually a constituent of the muscle, the radiation dose to the muscle would have been only 2×10^{-6} rad/d.

Results of the Pathway Analysis for Chemicals of Concern

The estimated human health risk from chemicals of Hanford origin, transported to the MEI, is $2.09\text{E-}10$ for CI and $2.40\text{E-}04$ for HI. Arsenic was the largest contributor to the CI value, contributing 84%, followed by carbon tetrachloride (10%) and bis-(2-ethylhexyl)phthalate (6%). These three chemicals made up over 99% of the cancer risk to the MEI, while the remaining eight COCs comprised the remainder. As previously noted, arsenic was not known to be utilized during production at the Hanford Site, but may be attributed to fly ash generated from coal-burning power plants.

The largest percent contribution to the HI value was chromium (assumed to be Cr VI), which contributed 62% to the HI total, followed by nitric acid (32%), and nitrate (6%). The remaining four COCs contributed less than 1% of the total HI value. Based upon this risk assessment, the CI and HI values indicate that health risks from offsite exposure to Hanford-derived COCs is relatively small. The values are less than the EPA action level of $1.0\text{E-}6$ CI and 1.0 HI. The total offsite risk along with the contributions from each chemical and pathway is provided in Tables III.A-3.9 and III.A-3.10 for CI and HI, respectively.

Hydrogeological investigations performed by Dresel et al. (1993) and three-dimensional modeling studies done by Wurstner and Devary (1993) demonstrate that the southward migration of flow from the Hanford Site (200-East Area tritium plume) is diverted eastward and discharges into the Columbia River before reaching wells located in the city of Richland. The ground water exposure pathway was therefore not a viable route of exposure to the MEI, and so was not included. A hypothetical test was conducted, however, using the MEPAS code for receptors exposed to chemicals from ground water. The health risk values from this exercise were also below the EPA health risk action levels.

A forensic modeling exercise was also performed during this chemical pathway analysis. The MEPAS code was used to estimate the onsite soil concentrations necessary to reach a $1.0\text{E-}6$ cancer risk at the same offsite receptor locations previously described (in the discussion of Potential Pathways of Exposure). The same list of COCs was used in this exercise, in addition to many of the chemicals found in Table III.A-3.1. Results showed that only three chemicals: arsenic, bis-(2-ethylhexyl)phthalate, and chloroform—could reach onsite soil concentrations high enough to cause an offsite health risk problem (i.e., $1.0\text{E-}06$). The small number of chemicals for which it was theoretically possible to reach the EPA risk action level required that exceedingly high concentrations be present. Also during the pathway analysis human health risk estimations used the Model Toxic Control Act (MTCA)

method-B cleanup standards as source-term data for the Hanford Site. Thus, the report Chemical Pathway Analysis provides a bounding type of risk analysis in which health risks from current onsite source-term data can be compared to risks from MTCA method-B cleanup levels and the concentrations required for each chemical onsite to pose a 1E-06 cancer risk offsite (final report in preparation).

In conclusion, the results of the chemical pathway analysis, with limitations previously discussed, suggest that chemical contaminants known to occur on the Hanford Site do not currently pose an offsite human health risk. Characterization of chemical contaminants present on much of the Hanford Site has not been completed. Such characterization is necessary to further ensure that these contaminants do not pose a significant health risk. As restoration activities continue at Hanford, COCs should be monitored to ensure that the cleanup process will not increase offsite exposure and human health risk. It should also be noted that an ecological risk assessment of Hanford-derived chemicals was not part of this study and may be warranted for onsite flora and fauna.

Table III.A-3.9. The Cancer Incidence (CI) to the Offsite MEI by Chemical and Pathway^{(a),(b),(c)}

Chemical ^(b)	Air Exposure	Aquatic Foods	Agriculture	Surface Water	Risk Summed
1,1,1 Tetrachloroethane	1.90E-22	(d)	(d)	1.34E-14	1.34E-14
Arsenic	3.30E-17	6.04E-11	1.22E-11	1.03E-10	1.76E-10
Benzo(a)pyrene	3.86E-16	0.00E+00	2.30E-17	0.00E+00	4.09E-16
Beryllium	8.66E-18	0.00E+00	8.81E-19	0.00E+00	9.54E-18
Bis2(ethyhexl)phthalate	6.93E-16	6.91E-15	1.31E-11	1.24E-14	1.31E-11
Carbon tetrachloride	1.97E-19	1.19E-11	2.19E-13	8.37E-12	2.05E-11
Chloroform	(e)	1.38E-17	3.40E-17	2.31E-16	2.79E-16
Chromium VI	3.27E-15	(d)	(d)	(d)	3.27E-15
Chrysene	6.15E-16	0.00E+00	2.62E-17	0.00E+00	6.42E-16
PCB(1260)	1.78E-16	0.00E+00	7.46E-17	0.00E+00	2.53E-16
Trichloroethene	8.50E-21	4.17E-15	2.43E-15	1.07E-13	1.14E-13
Total Offsite Cancer Risk	5.19E-15	7.24E-11	2.55E-11	1.11E-10	2.09E-10

(a) As previously mentioned, a hypothetical ground-water pathway was investigated and found to be below the EPA Action level of 1.0 E-06; it is not reported here because it is not a viable pathway. See discussion under Potential Pathways of Exposure for clarification.

(b) COCs that are not listed in this table are not considered to be carcinogens; therefore, they would appear in Table III.A-3.10, Hazard Index.

(c) **Bolded** value represents the total offsite CI risk to the MEI from exposure to all viable COCs.

(d) This chemical is not considered to be a carcinogen through this pathway.

(e) The source-term data used for this chemical occurred in the ground water only; thus, this chemical would not be exposed to the receptor through this pathway.

Table III.A-3.10. The Hazard Index (HI) to the offsite MEI by chemical and pathway. The Hazard Index (summed Hazard Quotients) values are also provided for individual chemical and pathway and for the total of all pathways combined^{(a),(b),(c)}

Chemical	Air Exposure	Aquatic Foods	Agriculture	Surface Water	Hazard Index
1,1,1 Tetrachloroethane	1.06E-13	2.43E-07	1.54E-08	5.08E-07	7.66E-07
Chromium VI	1.04E-08	5.79E-05	9.58E-06	8.05E-05	1.48E-04
Fluoride	(d)	7.32E-13	6.09E-12	2.27E-11	2.95E-11
Iron	0.00E+00	7.79E-11	2.46E-12	2.41E-12	8.28E-11
Manganese	(d)	2.69E-10	3.35E-11	1.04E-10	4.07E-10
Nitrate	2.29E-18	1.46E-05	1.32E-07	3.72E-09	1.48E-05
Nitric Acid	1.19E-17	7.57E-05	6.61E-07	1.87E-08	7.63E-05
Hazard Quotient	1.04E-08	1.48E-04	1.04E-05	8.10E-05	2.40E-04

- (a) As previously mentioned, a hypothetical ground-water pathway was investigated and found to be below the EPA Action level of 1.0 E-06; it is not reported here because it is not a viable pathway. See discussion under Potential Pathways of Exposure for clarification.
- (b) COCs that are not listed in this table are considered to be carcinogens; therefore, they would appear in Table III.A-3.9, Cancer Incidence.
- (c) **Bolded** value represents the total offsite HQ to the MEI from exposure to all viable COCs.
- (d) The source-term data used for this chemical occurred in the ground water only; thus, this chemical would not be exposed to the receptor through this pathway.

Surveillance Project Design

The surveillance project design has both management and technical aspects. The management aspect is defined by the processes used to control the design and implement sampling, analysis, interpretation, and reporting activities. These processes are discussed in a subsequent subsection. The technical aspect is defined by the sampling design and technical methods. This subsection discusses the design rationale and criteria that apply to most elements of the project. The media-focused subsections (air, water, etc.) describe the technical aspects of the surveillance strategy applicable to each.

Project Rationale and Design Criteria

The rationale and criteria for environmental surveillance are based on the following:

- DOE Orders 5400.1 and 5400.5
- DOE/EH-0173T
- surveillance objectives
- results of the pathway analysis
- other site commitments.

The minimum objective criteria for determining the content of surveillance projects are contained in Tables 5-1 and 5-2 of DOE/EH-0173T, and Table 4 of Section 7 of Watson (1980).

The 1993 dose to the MEI was 0.03 mrem EDE and the population dose was 0.4 person-rem (Dirkes et al. 1994). Based on these doses and the above-referenced objective criteria alone, no routine environmental surveillance sampling is required, but periodic surveillance measurements are required a minimum of every 5 years to confirm that the doses are below the objective criteria. The minimum number of sampling locations and surveillance measurement frequencies based on these objective criteria are summarized in Table III.A-4.1.

However, conducting only confirmatory surveillance measurements every 5 years at the Site and in the surrounding region would not fully meet the primary surveillance objectives (Subsection 2), satisfy the subsidiary objectives. The rationale and criteria for additional sampling in each medium will be discussed in the subsections that follow. First, there are some general considerations that will be factors in decisions about the content of the surveillance design.

The application of objective criteria from DOE/EH-0173T to the pathway analysis results addresses only surveillance for routine releases and does not consider the inventory potentially available for release. As indicated in the Pathway Analysis Summary subsection, the potential inventory of activity disposed of to the ground is very large (5.6 million Ci). In addition, it is estimated that there are 209 million Ci in waste storage tanks, 174 million Ci (cesium and strontium) in capsule storage, 63 million Ci in irradiated fuel, 651 thousand Ci in stored solids, and 16 million Ci in isotopic heat sources. Likewise, the inventory of hazardous chemicals onsite, while not well quantified or documented, is believed to be of considerable magnitude.

Table III.A-4.1. Minimum Number of Sampling Locations^(a) as a Function of Calculated Annual Maximally Exposed Individual Dose

Frequency	Annual MEI Dose, mrem (EDE)		
	Routinely	At Least Annually	At Least Every 5 Years
Dose Range	1 to 10	0.1 to 1	<0.1
Number of Locations ^(a)			
Air and External Radiation			
Offsite	10	3	1
Each Onsite Operating Area	4	4	1
Foodstuffs (Crops, milk, fish)	5	2	1
Columbia River			
Upstream	1	1	1
End of Mixing Zone(s)	1	1	1
Nearest Public Use	1	1	1

(a) In addition to a background location.

The need for routine surveillance independent of the operating contractor is reinforced by the recognition that expedited cleanup actions under the Hanford Site's Tri-Party Agreement (TPA 1989) have begun and that cleanup actions will increase and continue over the next few decades. This activity, in some cases applying cleanup technologies that have never been used before, increases the potential for the release to and migration within the environment of materials that are currently well contained. The design for routine surveillance must address the need to establish baselines to measure the integrated effects of various cleanup actions across the Site and to monitor the trends that may result from these operations.

Design rationale and criteria that apply to most media are summarized below.

Media Selection

Highest priority is to be given to sampling media that are directly ingested or inhaled by the public. Additional media are selected based on their sensitivity as indicators of loss of control, for their ability to predict accumulations and trends, or as indicators of environmental quality.

Sampling Locations

Background sampling locations are to be established for all media-contaminant combinations routinely sampled or that would likely have to be sampled to assess the effects of unusual or accidental releases. Sampling locations are selected near potential sources to maximize the probability of detect-

ing losses of containment, to establish baselines, and to assess the effects of releases. Sampling stations are positioned at the Site perimeter (near or just inside the Site boundary) to estimate conditions at the nearest points at which members of the public reside or could reside. Exposures at these locations are typically the maximum that any member of the public could receive. Finally, sampling is conducted in the community locations where the highest potential chronic impacts are expected to occur, both to provide measurements where the most people are potentially exposed and to provide assurance to the communities that levels are well below standards established to protect public health. Supplemental sampling locations are maintained where needed to meet the requirements of the Emergency Management Project for emergency preparedness and response data. Supplemental routine air sampling for emergency response is required for each operating area with a potential to cause a Site emergency (50-mrem offsite dose).

Sampling and Analysis Frequencies

Sampling frequency selection is based on the rate at which significant changes are expected and the need to obtain time-representative samples. In general, sampling near onsite effluents will be the most frequent, sampling at the perimeter will be less frequent, and sampling at distant offsite locations will be the least frequent. The exposure or sample integration period may be up to 1 year but no more than twice the radionuclide half-life. The minimum exposure period must be constrained to the operating limits (flow, breakthrough, etc.) of the sampling medium necessary to obtain a sample representative of the exposure period. Periodic samples are composited for longer-lived radionuclides to increase time representativeness and to lower detection limits.

Detection and Precision Criteria

The general surveillance criterion is to use the lowest level of detection practical utilizing standard analytical procedures and considering practical sampling strategy tradeoffs (e.g., time and location compositing versus discrete samples and practical sampling trains). Where technically feasible and practical, the minimum objective for a given medium-radionuclide combination is to detect concentrations at or below the concentration that would result in a dose to humans of 1 mrem/yr if that concentration were sustained for a year. This dose estimate assumes that the radionuclide is being transported to subsequent compartments of the pathway, and that the individual is exposed to all subsequent compartments. For example, the limit for air assumes not only inhalation but also exposure from deposition, vegetation uptake, consumption, etc. One millirem is selected as the minimum criterion because it is 10% of the level at which potential doses to the public must be reported to DOE-HQ, as well as being 10% of the dose limit (40 CFR 61) for the air pathway, thereby providing a high level of assurance that these requirements will be met.

The current detection criteria (by radionuclide and medium) are contained in the Laboratory Procedures subsection. Except for ^{14}C in air, these detection limits are well below the 1-mrem level and are driven by the goal of obtaining the lowest practical level of detection using standard methods. Analytical precision criteria are contained in the Quality Assurance and Quality Control subsection.

The rationale, design criteria, and plan for surveillance measurements to meet the primary and subsidiary objectives are described in the media-specific subsections.

Dose Assessment

Pathway and dose assessments are conducted:

- annually to assess compliance with DOE Order 5400.5 public limit and the 40 CFR 61 standard
- annually to determine the minimum needs for environmental surveillance as defined in DOE/EH-0173T
- at least every 5 years to assess compliance with DOE Order 5400.5 interim aquatic biota limit or when exposure conditions have changed significantly, at the discretion of the Surface Environmental Surveillance Project manager.

Pathway modeling results are compared to measurable surveillance results to assess model performance, and the results of the comparison documented. When measured results exceed model results, the measured results are used to adjust the dose results.

Site Commitments

Other commitments that affect the design of surveillance sampling include the FFTF environmental specifications (HEDL 1981).

Air Surveillance

Radioactive particles and gases are released from point sources (site stacks and vents) during routine operations in the 100, 200, 300, and 400 Areas. Diffuse sources consist primarily of contaminated soil in the 100, 200, 300, and 600 Areas that can be resuspended by wind. These materials are diluted to low concentrations as they are transported offsite where people may be directly exposed to radionuclides through inhalation or by deposition onto crops, a primary product of the region.

The pathway analysis (Table III.A-3.1) indicated that the site dose to the MEI in 1993 was 0.03 mrem, well below the level at which routine surveillance is recommended. The air pathway contributed 0.012 mrem to the MEI (across the Columbia River from the 300 Area), or 40% of the total Site dose. The predominant pathways were the air inhalation pathway (predominant source was ^{220}Rn from the 300 Area) and the air-food pathway (predominant source was ^{129}I from the 200 Areas). The next highest contributors to dose were ^{60}Co , ^{134}Cs , and ^{137}Cs from the 100 Areas and ^{212}Pb from the 200 Areas; each of these radionuclides contributed between 1% and 2% of the total Site dose.

These estimates do not include the effects of resuspension from contaminated surfaces. Fission product and transuranic (TRU) surface contamination exists in the 200 Areas, and uranium surface contamination exists in and around the 300 Area. As indicated in Table III.A-3.2; there is also a large inventory of buried wastes in the 100, 200, and 300 Areas that represents a potential source not addressed in the pathway dose assessment. Past monitoring data indicate that these sources currently do not represent significant sources for the air pathway. However, because of the large inventory, the potential for biointrusion, and the desire to provide a high level of public assurance, continued routine air surveillance of these source areas is considered necessary to provide an early indication of any loss of control. Each of these areas also contains *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) operable units at which buried wastes will potentially be treated or removed in the future. Air surveillance in the margins of these operable units will provide baseline data before restoration actions (preoperational data) are taken, as well as data to assess the effects of restoration activities.

A review of worst-case scenarios from available safety analysis reports indicates that each of the four operating areas has the potential to initiate a Site Emergency. Under that designation, there is a potential for an offsite dose of 50 to 1,000 mrem (whole-body dose commitment). At this level, there exists a need for near-facility air data to assess impacts resulting from potential accidents and unusual occurrences. To meet these special sampling needs, air samplers must be operated continuously.

Public assurance is an essential element of surveillance at the Hanford Site. Although pathway modeling using operating facility source-term data is a useful tool, the public inherently has more confidence in actual environmental measurements. Sampling near the Site perimeter, especially in the downwind sectors, provides data that are compared to background data to estimate the effect of the Site at the closest point of actual or potential public residence, as well as to evaluate the pathway models and to estimate doses directly. Measurements in nearby communities provide assurance at those locations where the greatest number of people reside. In many cases, the environmental levels are below analytical detection limits. Exposures at the detection limits would result in doses that are a very small fraction of the dose standards.

Objectives

The objectives of air surveillance are to:

- obtain air concentration measurements at locations of actual and potential public residence to verify that doses to the public through the air pathway from DOE operations remain low relative to standards
- provide early detection of potential increases in public exposures and contamination of the environment through measurements of actual and potential emissions to the air from facilities and areas with surface contamination and buried wastes
- obtain preoperational baseline data and environmental surveillance data for areas near waste units scheduled for treatment and/or restoration to assess the integrated effects of individual Site actions and over time
- obtain measurements at the Site perimeter and in nearby communities to provide public assurance that the degree of contamination from DOE operations is known
- sample air onsite and offsite continuously to assess the environmental effects and doses from unusual releases
- provide data to evaluate and improve pathway models used to predict and assess public dose compliance and environmental contamination
- conduct surveillance for FFTF technical specifications (HEDL 1981).

Plan Rationale and Criteria

The criteria for air sampling consist of those identified as *should** statements in DOE/EH-0173T. Any exceptions to those criteria are identified in Exceptions, below. The minimum level of surveillance for the Site, adapted from the objective criteria in DOE/EH-0173T, are described in Table III.A-4.1. The level of surveillance and specific criteria to meet the Site objectives are described below.

The locations, media, sampling frequencies, temporal and spatial compositing, analyses, and analysis frequencies to meet air surveillance objectives and criteria are summarized in Table III.A-5.1 and Figure III.A-5.1. The rationale and any additional specific criteria for these selections are discussed below.

Media Selection

Air is sampled with consideration given to the primary form in which the radionuclides occur. Most of the potential radionuclides of interest occur in particulate form at the Site. Past measurements indicate that iodine occurs predominantly as a gas and tritium as water vapor.

Table III.A-5.1. Air Surveillance

Air - Particulate Filter

Location	Individual Samples			Composited Sample		
	Location Number ^(a)	Frequency	Analyses	Composite Group	Frequency	Analyses
Onsite						
100-K Area	1	BW	Beta, Alpha	100 Areas	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b)
100-N 1325 Crib	2	BW	Beta, Alpha		A	
100-D Area	3	BW	Beta, Alpha			
N of 200-E	4	BW	NRA	200 E Area	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c) , ²⁴¹ Am
N of 200-E No. 2	4	BW	NRA		A	
E of 200-E	5	BW	Beta, Alpha			
200-ESE	6	BW	Beta, Alpha	B Pond	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c)
S of 200-E	7	BW	Beta, Alpha		A	
B Pond	8	BW	Beta, Alpha	200 W South and East	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c)
B Pond No. 2	8	BW	Comp. Only		A	
Army Loop Camp	9	BW	Beta, Alpha	200 West	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c)
200 Tel. Exchange	10	BW	Beta, Alpha		A	
200-W SE	11	BW	Beta, Alpha	300 Area	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c)
200-W SE No. 2	11	BW	Comp. Only		A	
300 Water Intake	12	BW	Beta, Alpha	300 NE	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c)
300 South Gate	13	BW	Beta, Alpha		A	
300 Trench	14	BW	Beta, Alpha	400 Area	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b)
300 NE	15	BW	Beta, Alpha		A	
400-E	16	BW	Beta, Alpha			
400-W	17	BW	Beta, Alpha			
400-S	18	BW	Beta, Alpha	Wye Barricade	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c) , ²⁴¹ Am
400-N	19	BW	Beta, Alpha		A	
Wye Barricade	20	BW	Beta, Alpha	Wye Barricade	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c) , ²⁴¹ Am
Wye Barricade No. 2	20	BW	Comp. Only		A	
Perimeter						
Berg Ranch	21	BW	NRA	Ringold Met Tower	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b)
Ringold Met Tower	22	BW	Beta, Alpha		A	
W End of Fir Rd	23	BW	Beta, Alpha	W. End of Fir Road	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c) , ²⁴¹ Am
W End of Fir Rd No. 2	23	BW	Comp. Only		A	
Dogwood Met Tower	24	BW	Beta, Alpha	Dogwood Met Tower	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c) , ²⁴¹ Am
Dogwood Met Tower No. 2	24	BW	Comp. Only		A	
Perimeter						
Byers Landing	25	BW	Beta, Alpha	Byers Landing	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c) , ²⁴¹ Am
Battelle Complex	26	BW	NRA	Prosser Barricade	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c)
Horn Rapids Substation	27	BW	Beta, Alpha		A	
Prosser Barricade	28	BW	Comp. Only	Yakima Barricade	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b)
Yakima Barricade	29	BW	Beta, Alpha		A	
Yakima Barricade No. 2	29	BW	Comp. Only	Wahluke Slope	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b)
Wahluke Slope	30	BW	Beta, Alpha		A	
Wahluke Slope No. 2	30	BW	Comp. Only	Basin City School	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c)
Community						
Basin City School ^(d)	31	BW	Beta, Alpha	Basin City School	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c)
Basin City No. 2 ^(d)	31	BW	Comp. Only		A	
Leslie Groves-Richland ^(d)	32	BW	Beta, Alpha	Leslie Groves-Richland	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c)
Leslie Groves-Richland No. 2 ^(d)	32	BW	Comp. Only		A	
Pasco	33	BW	Beta, Alpha	Tri-Cities	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b)
Kennewick-Ely Street	34	BW	Beta, Alpha		A	
Benton City	35	BW	NRA	Edwin Markham School	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c) , ²⁴¹ Am
Benton City No. 2	35	BW	NRA		A	
Edwin Markham School ^(d)	36	BW	Beta, Alpha	Mattawa	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c) , ²⁴¹ Am
Community						
Mattawa	37	BW	NRA	Mattawa	Q	Gamma Scan ⁹⁰ Sr, Pu ^(b) , U ^(c) , ²⁴¹ Am
Mattawa No. 2	37	BW	NRA		A	

Table III.A-5.1. (cont'd)

Air - Particulate Filter

Location	Individual Samples			Composited Sample		
	Location Number ^(a)	Frequency	Analyses	Composite Group	Frequency	Analyses
Distant						
Sunnyside	38	BW	Beta, Alpha	Sunnyside	Q	Gamma Scan ^(b) , U ^(c)
Sunnyside No. 2	38	BW	Comp. Only		A	
Yakima	39	BW	Beta, Alpha	Yakima	Q	Gamma Scan ^(b) , U ^(c) , ²⁴¹ Am

(a) Refer to Figure III.A-5.1, Air Sampling Locations.

(b) Isotopic plutonium.

(c) Isotopic uranium.

(d) Community-Operated Environmental Surveillance Station

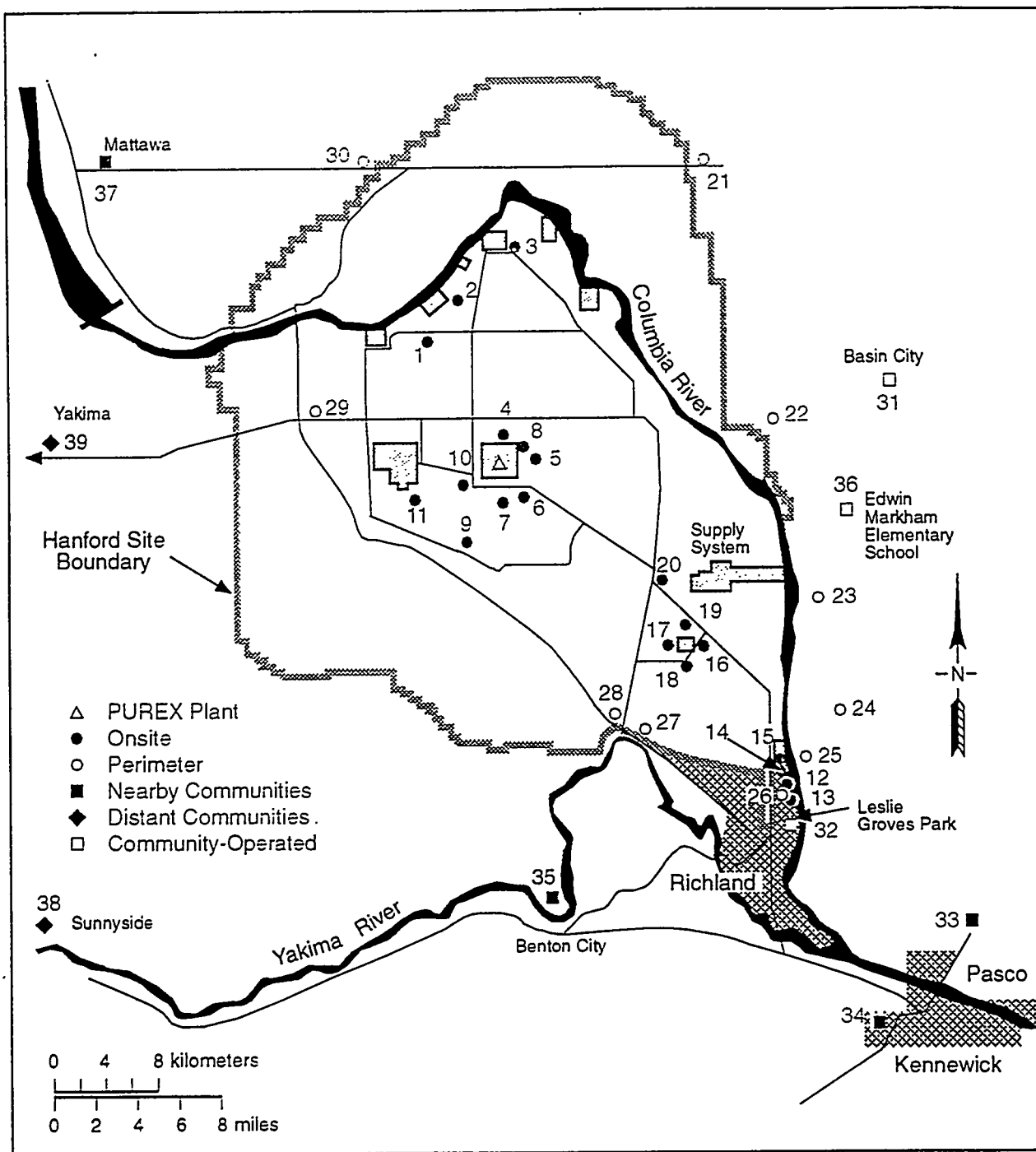
Air - Gases and Vapor

Location	Location Number ^(a)	Frequency	Analyses	Frequency ^(b)	Analyses	Frequency	Analyses
Onsite							
100-K Area	1					M	³ H (as HTO)
100-N 1325 Crib	2					M	³ H (as HTO)
200-ESE	6			Q Comp	¹²⁹ I	M	³ H (as HTO)
200 Tel. Exchange	10					M	³ H (as HTO)
300 South Gate	13					M	³ H (as HTO)
300 Trench	14					M	³ H (as HTO)
300-NE	15					M	³ H (as HTO)
400-E	16					M	³ H (as HTO)
Perimeter							
Ringold Met. Tower	22	BW	¹³¹ I	Q Comp	¹²⁹ I	M	³ H (as HTO)
Dogwood Rd Met. Tower	24					M	³ H (as HTO)
Byers Landing	25	BW	¹³¹ I	Q Comp	¹²⁹ I	M	³ H (as HTO)
Prosser Barricade	28					M	³ H (as HTO)
Wahluke Slope	30					M	³ H (as HTO)
Community							
Basin City School ^(c)	31					M	³ H (as HTO)
Leslie Groves-Richland ^(c)	32					M	³ H (as HTO)
Edwin Markham School ^(c)	36	BW	¹³¹ I			M	³ H (as HTO)
Distant							
Sunnyside	38					M	³ H (as HTO)
Yakima	39	BW	¹³¹ I	Q Comp	¹²⁹ I	M	³ H (as HTO)

(a) Refer to Figure III.A-5.1, Air Sampling Locations.

(b) Samples are collected monthly and composited for quarterly analyses.

(c) Community-Operated Environmental Surveillance Station.



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Figure III.A-5.1. Surface Environmental Surveillance Air Sampling Locations

Analyte Selection

Onsite. The onsite surveillance samples collected downwind near each operating area are field surveyed for alpha and beta-gamma radioactivity with hand-held instruments to verify normal conditions or detect unusual conditions should they occur. These samples are routinely analyzed for gross alpha and beta activity after natural activity has decayed to provide an indication of the levels of contaminants present. These samples are also analyzed for those radionuclides routinely released in measurable quantities as indicated by facility emissions data, for those with potential to be released under plausible abnormal conditions, for those calculated to be contributing more than 10% of the MEI dose, and for those of special public or agency interest. These criteria encompass those radionuclides considered necessary to meet technical and public assurance objectives. Screening and compositing techniques may be used to improve detection levels and reduce analysis requirements where screening provides adequate surveillance.

Additional sampling units, near the next highest occurrence downwind sectors, are used to assess operational control and effects of unusual events. The samples from these units are field-surveyed and laboratory-analyzed for gross alpha and beta-gamma under normal conditions and, generally, are composited with the downwind samples to enhance detection sensitivity for gamma scans and radiochemical analyses.

Offsite. Samples from the historical MEI location are analyzed for measurable radionuclides, those contributing more than 10% of the MEI dose, and those of special public or agency interest. Radionuclides meeting those criteria are also analyzed for selected downwind perimeter and community locations. At a few locations samples are collected, field-surveyed for radioactivity and archived, but not submitted for laboratory analysis unless an unusual event occurs.

Sampling and Analysis Frequency

Sample locations are visited every 14 days. Site experience indicates that particulate filters must be collected at this frequency to avoid excess particle buildup on the filters. Particulates are analyzed for gross alpha and beta every 2 weeks to provide early indication of any loss of control that may require expedited analysis of samples and/or additional or special sampling. Gamma scans are analyzed quarterly to track trends that are not likely to be detectable in gross activity measurements. Radiochemical analyses of filters are performed at least annually to provide data to estimate or bound the human annual dose standards.

Iodine-131 charcoal cartridge samples for routine analysis are collected and analyzed every 14 days. This sampling and analysis frequency is dictated by the half-life of ^{131}I and the goal of sampling at an interval that is less than two half-lives. Iodine-129 charcoal cartridges and tritium silica gel columns are collected every 28 days. This is an operationally practical sampling period and has been observed to be short enough to preclude significant breakthrough and loss of sample. Iodine-129 is the leading contributor to dose through the air pathway. Samples are analyzed quarterly near the source (200-East Area) and at the background location to track shorter-term trends. Perimeter samples are analyzed annually to directly estimate the annual dose and to provide data to validate the pathway model.

Background locations are sampled for a given constituent at the highest frequency the constituent is sampled onsite or offsite so that data can be compared and analyzed on the same time scale.

Table III-A.5.1 summarizes the analysis frequencies by location and radionuclide.

Sampling Location Selection

Onsite. Downwind of each operating area with significant inventories of nuclear materials, a sampler is located as near the climatologically predicted maximum impact area as is practical (considering access, power availability, and costs). Additional samplers are located around those areas to increase the likelihood of detecting an unusual occurrence. These additional samplers are distributed azimuthally by wind direction sector, balancing considerations of wind direction frequencies, geometric distribution, and practicality. Radial placement is based on the predicted distance of maximum ground-level impact for Class E atmospheric stability (slightly stable) (from Turner 1970, Figure 3-9) to the extent practical. The goal of placing samplers at the Class E stability maximum ground-level impact distance is a compromise between the desire to sample at the point of maximum ground-level concentration for all stabilities; the desire to be far enough away that an elevated plume will reach the ground at the sampler under all conditions; and the practical recognition that, in general, power is available near the facilities and much less available at increasing distance from the facilities.

Samplers are located with the goal of providing measurements representative of the integrated effects of the areas being monitored, a goal that may require a tradeoff with the goal of measuring the maximum effects.

Offsite. Offsite samplers are located near the MEI location to attempt to verify MEI exposures; in the nearest downwind population center, the Tri-Cities, to bound the maximum exposures at the nearest population center; at additional perimeter stations located to reflect the distribution of source areas across the Site; and at the highest frequency wind-direction sectors. In addition, samplers are located in a few selected downwind communities to provide means for public involvement, education, and assurance.

At least one background location a minimum of 20 km from the Site in a predominantly upwind direction is sampled for each radionuclide, form, and species sampled onsite or offsite.

Proximity to Obstructions. Samplers are located to obtain concentration measurements representative of open areas (i.e., avoiding significant local effects on the radionuclide concentrations of interest such as those caused by building wake entrainment and vegetation filtration). This approach is expected to provide better comparability of data between locations.

Samplers are placed outside building wake zones where aerodynamic effects could significantly affect the observed concentrations. This can occur when elevated plumes pass over structures and are entrained and mixed into the wake, or when plumes are of the same order or size as the structures they impinge upon. In the latter case, plumes will have a strong concentration gradient, and mixing by a wake can significantly change the concentrations that would otherwise have been observed. After elevated plumes have contacted the ground and at distances where the lateral dimensions of the plume are large compared to structures, the effects of the structures on air concentrations about the structures can be expected to be small, because the concentration gradients in the air approaching the structure are small. To implement this qualitative model, samplers are located at a distance that is at least three times the height of the building away from the nearest building unless:

- the sampling point is farther from the source than the predicted distance for the ground-level maximum concentration for the applicable effective stack height under Class F atmospheric stability (from Turner 1970, Figure 3-9)

- the lateral plume width ($4 \times \sigma_y$ from Turner 1970, Figure 3-2) under Class F atmospheric stability (moderately stable) conditions is at least 10 times L, where L is the largest dimension of the building.

Samplers near trees or other elevated vegetation can be influenced by the same effects. Isolated trees can be expected to cause less flow obstruction but can represent greater sinks for some radionuclides. Based on these considerations, samplers are placed at a distance at least 2 times the height of isolated trees and at 3 times the height of rows or stands of trees at all locations.

Application of these criteria is necessarily constrained by accessibility and the cost of providing electrical power. At some locations, it may not be practical to meet the desired criteria.

Sampling inlets are located 2 m aboveground to provide measurements representative of radionuclide concentrations inhaled by humans.

Sampling or Measurement Method Selection

Particle sampling is accomplished with glass fiber filters with manufacturer's documentation of a sampling efficiency of at least 99% for 0.3-micron dioctyl phthalate particles at the flow rate being used (2.6 to 5.2 m³/h).

Iodine-131 is collected on activated charcoal with manufacturer-documented collection efficiencies for the flow rate (2.6 m³/h), bed depth (2.5 cm), and exposure periods used (14 days). Iodine-129 is collected on petroleum-based (low-background) charcoal specially prepared by PNL; the collection efficiency is verified; and the flow rates are 2.6 m³/h, with a bed depth of 2.5 cm, and exposure period of 28 days. Both types of iodine sample traps are preceded in the sampling train by a disposable filter to remove particles.

Tritium is collected by silica gel for identifying the tritiated water in air component. Flow rates (0.014 m³/h), media volumes, and exposure periods (28 days) are such that the media will not be saturated during the sampling period. This is accomplished using a color-change indicator, which is useful in diagnosing sampling problems.

Flow rates for air samples are measured at the beginning and end of each sampling period with a device with a documented accuracy of 20% or better.

Sample Handling/Treatment Methods

Air samples are collected in a manner that avoids loss of sample mass, cross-contamination, or misidentification. This is accomplished by exchanging whole sample collection media containers rather than handling the collection media in the field, and by physically sealing and labeling each sample as it is collected in the field. Sample collection and handling procedures are described in PNL-MA-580.

Analytical Methods

Analytical methods are selected to meet the minimum goal of detecting levels equivalent to a dose of 1 mrem if that concentration were sustained for a year. An additional goal is to achieve the lowest detection levels available using standard state-of-the-art analytical methods. These goals are summarized in the Laboratory Procedures Subsection.

Analytical methods are also summarized in the Laboratory Procedures Subsection and are detailed in procedures of the International Technology Corporation Analytical Services Division laboratory (IT 1990).

Quality Control Methods

Air surveillance is controlled under the overall project quality assurance and analytical control program described in the Quality Assurance and Quality Control Subsection.

Reporting/Alarm Levels

Anomalous results are flagged by computer screening of reported data as they are entered into the project database. Levels for reporting to DOE-RL have been established and are listed in the Records Management and Reporting Subsection. Reporting levels are equivalent to the concentration that might lead to an MEI dose of 1 mrem (EDE) if it were sustained for a year. This reporting level provides early indication of conditions that might eventually require reporting to DOE-HQ, as required by DOE Order 5400.5.

Exceptions

No exceptions have been taken to *should** statements in DOE/EH-0173T.

Surface Water Surveillance

The Columbia River flows through the northern edge of the Hanford Site and forms part of the Site's eastern boundary. The Hanford Reach of the Columbia River extends from Priest Rapids Dam to the head of Lake Wallula (the impoundment created by McNary Dam). Priest Rapids Dam is the nearest dam upstream of the Site and McNary Dam is the nearest downstream.

In addition to the Columbia River, other surface waters exist at the Hanford Site. These include a naturally occurring pond (West Lake), Rattlesnake Springs, and two intermittently flowing streams (Dry and Cold creeks), as well as other small springs on the Fitzner/Eberhardt Arid Land Ecology (ALE) Reserve. Riverbank springs (ground-water discharge) occur along the Hanford Reach of the Columbia River as well. Other surface waters include several artificial waste disposal ponds and a series of ditches also associated with waste disposal practices at the Hanford Site.

The Columbia River has been developed extensively for hydroelectric power, flood control, navigation, irrigation, and industrial water supplies. The river is used as a source of drinking water at onsite facilities as well as at communities located downstream of the Site. In addition, the river and its shoreline are used for a variety of recreational activities, including hunting, fishing, boating, water skiing, wind surfing, picnicking, and swimming.

Pollutants resulting from past and current operations at the Hanford Site, both radiological and nonradiological, are known to enter the Columbia River along the Site boundary. In addition to a limited number of direct discharges of liquid effluents from onsite facilities, contaminants from past waste disposal practices seep into the river through riverbank springs and subsurface ground-water discharges.

The surface water pathway (Columbia River) has consistently been one of the primary contributors to the potential dose received by the public as a result of operations at the Hanford Site. The pathway analysis indicated the water pathway contributed approximately 44% of the 1993 0.03-mrem EDE to the theoretical maximally exposed individual (MEI). Table III.A-3.1 lists the total water pathway dose to the MEI as 0.012 mrem, well below the level requiring routine surveillance. This level is, however, within the range calling for periodic monitoring to confirm the low calculated levels.

Discharges to the Columbia River and onsite waste disposal ponds are monitored by the operating contractor. Requirements of DOE/EH-0173T identify the need for monitoring two media in the pathway of concern (one of which can be the effluent) as part of the routine surveillance program. As such, periodic sampling of the onsite waste disposal ponds is conducted as part of the surface surveillance conducted by PNL. Such sampling also provides a means of verifying existing effluent control and effluent monitoring systems. Unplanned releases may also be detected through routine sampling of these media.

Site-specific surveillance identified the need to maintain elements of the surveillance program to evaluate long-term trends and to detect change in environmental conditions as a result of Hanford Site operations. In addition, it is essential that the location and concentrations of contaminants entering the Columbia River be known. Periodic sampling of riverbank springs verifies the levels of contaminants identified in the local ground water and confirms the discharge of certain constituents into the river. Past Surface Environmental Surveillance Project activities, designed to provide these capabilities, will be maintained as appropriate.

The State of Washington classified the stretch of the Columbia River from Grand Coulee Dam to the Washington-Oregon border, which includes the Hanford Reach, as Class A, Excellent. Water quality criteria and water use were established in conjunction with this designation. Water quality monitoring is necessary to determine compliance with these criteria.

The Columbia River and the potential impact of Hanford Site operations on the quality of river water have received increasing public scrutiny and concern during recent years. Public interest groups conducted surveillance along the Hanford Reach and raised many questions and concerns. Surface water surveillance activities initiated in the past to address such public concerns and provide public reassurance will be continued.

Objectives

The objectives of the surface water surveillance activities include the following:

- assess impacts of Hanford Site operations on the water quality of the Columbia River
- identify significant changes in the concentrations of contaminants (radiological and chemical) in surface water
- verify adequacy of effluent monitoring and controls
- characterize contaminants in the surface water environment
- determine status of compliance with applicable water quality standards
- provide public reassurance that risks associated with the use of the Columbia River are low and are being evaluated on a continuous basis.

Plan Rationale and Criteria

The basis for the design of the surface water surveillance program is discussed in DOE/EH-0173T. In addition, other environmental monitoring guides and references were considered in the development of the Hanford Site's surface water surveillance program. Similarly, references and guidance specific to water quality monitoring and water sample collection were used in sampling protocols.

The surface water sampling plan is summarized annually in the *Environmental Surveillance Master Sampling Schedule* (Bisping 1994). The media, locations, sample type, frequency, and analyses are included in the sampling schedule. Tables III.A-6.1 through III.A-6.4 summarize current surface water surveillance activities, including Columbia River water (radiological and nonradiological), riverbank spring water, onsite pond water, and offsite water (drinking and irrigation).

All surface water samples are collected in accordance with documented, reviewed, and approved collection procedures. Applicable sample collection procedures are described in PNL-MA-580.

Table III.A-6.1. Water - Columbia River

Location ^(a)	Sample Type	Frequency	Analyses
Priest Rapids Dam	Cumulative	M Comp ^(b)	Alpha, beta, Lo ³ H, gamma scan, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c) , DOH ^(d)
	Particulate (filter)	M Comp ^(e) Q Comp	Gamma scan Pu ^(f)
	Soluble (resin)	M Comp ^(e) Q Comp	Gamma scan ¹²⁹ I, Pu ^(f)
Vernita	Grab	Q	WQ-NASQAN ^(g) : temp, DO, turbidity, pH, fecal coliform, SS, DS, cond, hardness as CaCO ₃ , P, Cr, N-Kjeldahl, TOC, Fe, NH ₃ -N
	Grab (Transect) ^(h)	Q	Lo ³ H, ⁹⁰ Sr, U ^(c) , volatile organics, ICP-u, anions
100-N	Grab (Transect) ⁽ⁱ⁾	A	Alpha, beta, Lo ³ H, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c) , gamma scan, volatile organics, ICP-u, anions, DOH ^(d)
100-F	Grab (Transect) ⁽ⁱ⁾	A	Lo ³ H, ⁹⁰ Sr, U ^(c) , volatile organics, ICP-u, anions
Hanford Townsite	Grab (Transect) ⁽ⁱ⁾	A	Lo ³ H, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c) , volatile organics, ICP-u, anions
300 Area	Grab (Transect) ⁽ⁱ⁾	A	Lo ³ H, ⁹⁰ Sr, U ^(c) , volatile organics, ICP-u, anions
Richland Pumphouse	Cumulative	W	Alpha, beta
	Cumulative	M Comp ^(b)	Alpha, beta, Lo ³ H, gamma scan, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c)
	Particulate (filter)	M Comp ^(e) Q Comp	Gamma scan Pu ^(f)
	Soluble (resin)	M Comp ^(e) Q Comp	Gamma scan ¹²⁹ I, Pu ^(f)
	Grab (Transect) ⁽ⁱ⁾	Q	Lo ³ H, ⁹⁰ Sr, U ^(c) , volatile organics, ICP-u, anions
	Grab	Q	WQ-NASQAN ^(g) : temp, DO, turbidity, pH, fecal coliform, SS, DS, cond, hardness as CaCO ₃ , P, Cr, N-Kjeldahl, TOC, Fe, NH ₃ -N

(a) Refer to Figure III.A-6.1, Surface Water and Drinking Water Sampling Locations.

(b) Composite of weekly samples.

(c) Isotopic uranium.

(d) Duplicate samples with the Washington State Department of Health (January and June only).

(e) Composite of biweekly sample.

(f) Isotopic plutonium.

(g) Numerous water quality (WQ) analyses are performed by the United States Geological Survey (USGS) in conjunction with the National Stream Quality Accounting Network (NASQAN) Program.

(h) 4 samples collected along cross-section.

(i) 10 samples collected along cross-section.

(j) Duplicate samples with the Washington State Department of Health collected at three sample sites along transect.

Media Selection

As previously discussed, contaminants are known to enter the Columbia River as a result of past and current operations at the Hanford Site. Consumption of water or biota from the Columbia River or foodstuffs produced on land irrigated with river water could expose the public to radioactivity from the

Table III.A-6.2. Water - Onsite Ponds

Location ^(a)	Sample Type	Frequency ^(b)	Analyses
West Lake	Grab	Q	Alpha, beta, ³ H, ⁹⁰ Sr, ⁹⁹ Tc, U ^(b) , gamma scan
B Pond North Side	Grab	Q	Alpha, beta, ³ H, ⁹⁰ Sr, ⁹⁹ Tc, gamma scan
FFTF Pond	Grab	Q	Alpha, beta, ³ H, gamma scan, DOH ^(c)

(a) Refer to Figure III.A-6.1, Surface Water and Drinking Water Sampling Locations.

(b) Isotopic uranium.

(c) Duplicate samples with the Washington State Department of Health.

Table III.A-6.3. Water - Offsite

Location ^(a)	Sample Type	Frequency	Analyses
Ringold Hatchery	Grab	A	Alpha, beta, ³ H, U ^(b) , gamma scan
Mathews Corner	Grab	A	Alpha, beta, ³ H, U ^(b) , gamma scan
White Bluffs Shallow	Grab	A	Alpha, beta, ³ H, U ^(b) , gamma scan
White Bluffs Deep	Grab	A	Alpha, beta, ³ H, U ^(b) , gamma scan
Alexander Farm	Grab	A	Alpha, beta, ³ H, U ^(b) , gamma scan
Riverview Canal	Grab	3 (May-Sept)	Alpha, beta, ³ H, ⁹⁰ Sr, U ^(b) , gamma scan, DOH ^(c)

(a) Refer to Figure III.A-6.1, Surface Water and Drinking Water Sampling Locations.

(b) Isotopic uranium.

(c) Duplicate samples with the Washington State Department of Health.

Table III.A-6.4. Water - Riverbank Springs

Location ^(a)	Sample Type	Frequency ^(b)	Analyses
100-B Spring	Grab	2 (Aug-Sept)	Alpha, beta, ³ H, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c) , gamma xcan, volatile organics, ICP-u, anions
100-K Spring	Grab	2 (Aug-Sept)	Alpha, beta, ³ H, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c) , gamma scan, volatile organics, ICP-u, anions
100-N Spring 8-13	Grab	2 (Aug-Sept)	Alpha, beta, ³ H, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c) , gamma scan, volatile organics, ICP-u, anions, DOH ^(d)
100-D Spring	Grab	2 (Aug-Sept)	Alpha, beta, ³ H, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c) , gamma scan, volatile organics, ICP-u, anions
100-H Spring	Grab	2 (Aug-Sept)	Alpha, beta, ³ H, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c) , gamma scan, volatile organics, ICP-u, anions
100-F Spring	Grab	2 (Aug-Sept)	Alpha, beta, ³ H, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c) , gamma scan, volatile organics, ICP-u, anions
Hanford Spring 28-2	Grab	2 (Aug-Sept)	Alpha, beta, ³ H, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c) , ¹²⁹ I, gamma scan, volatile organics, ICP-u, anions
300 Area Spring 42-2	Grab	2 (Aug-Sept)	Alpha, beta, ³ H, ⁹⁰ Sr, ⁹⁹ Tc, U ^(c) , ¹²⁹ I, gamma scan, volatile organics, ICP-u, anions

(a) Refer to Figure III.A-6.1, Surface Water and Drinking Water Sampling Locations.

(b) Collected twice a year during low river flow season.

(c) Isotopic uranium.

(d) Duplicate sample with the Washington State Department of Health.

Hanford Site. Similarly, public exposure could occur by direct exposure from water recreation. The Columbia River is routinely monitored to measure the potential exposure from these pathways.

Riverbank springs (ground-water discharge) containing elevated levels of contaminants enter the river along the Hanford Reach. The springs are monitored periodically to document the locations and levels of contaminants entering the river. Such monitoring also confirms the findings of the Ground-Water Monitoring Project relative to the extent of the contaminated ground-water plumes at the Hanford Site.

Onsite ponds, while not directly accessible to the public, are used by migratory waterfowl and wildlife that could migrate offsite and be harvested and consumed by the public. Onsite ponds are monitored to determine the potential for exposure to the public from this pathway.

Offsite water sources (drinking and irrigation) may be impacted by Site operations. Public concerns with respect to the quality of their water systems and the potential for degradation as a result of Site activities have been expressed. Periodic monitoring of offsite water sources provides reassurance that the quality of the water is not impacted by Hanford Site operations.

The following paragraphs provide a description of the monitoring activities specific to each medium identified above.

Columbia River

Analyte Selection -- Columbia River water samples are analyzed for those constituents that, as determined by pathway analyses, represent a significant fraction of the potential dose from the water pathway. In addition, contaminants of public concern are included in the analyses. In general, analyses include those contaminants known or suspected to be present in the river water as a result of past or current Hanford Site operations. In those cases where constituents have been documented to be consistently below measurable levels, they have been removed from the sampling plan.

Radiological analyses on water samples include gross alpha, gross beta, gamma scan, ^3H , ^{90}Sr , ^{99}Tc , ^{129}I , $^{239,240}\text{Pu}$, and isotopic uranium. Gross alpha and gross beta measurements provide a general indication of the radioactive contamination. Gamma scans provide the ability to monitor for numerous specific gamma radiation-emitting radionuclides, including ^{60}Co , ^{106}Ru , ^{125}Sb , ^{137}Cs , and ^{154}Eu , as well as others. Highly sophisticated radiochemical analytical techniques and, in some cases, special sampling techniques are used to determine the concentrations of ^3H , ^{90}Sr , ^{99}Tc , ^{129}I , ^{234}U , ^{235}U , ^{238}U , and $^{239,240}\text{Pu}$ in river water. Radionuclides of interest are selected based on their importance in determining water quality, in verifying effluent control and effluent monitoring systems, and in determining compliance with applicable standards. Where warranted, the half-lives of specific radionuclides are considered in determining sampling and analysis frequencies.

Chemical contaminants analyzed for in water samples include volatile organic compounds, metals, and anions. In addition to monitoring conducted by PNL, water quality measurements are also performed by the U.S. Geological Survey (USGS). The USGS samples are analyzed for numerous physical, biological, and chemical constituents including temperature, pH, turbidity, dissolved oxygen, fecal coliform and strep, suspended solids, dissolved solids, conductivity, hardness, phosphorus, chromium, iron, and nitrate.

Sampling Location Selection -- Routine Columbia River water sample collection locations are identified on Figure III.A-6.1. Samples are collected upstream of Hanford facilities at Priest Rapids Dam and near the Vernita Bridge to provide background data from locations unaffected by Site operations. Samples are collected from the 300 Area water intake and the Richland Pumphouse to identify any increase in contaminant concentrations at these locations caused by Site operations. Both the 300 Area and the Richland Pumphouse sample locations are at drinking water supply system intakes. The 300 Area intake supplies water for facilities in the 300 Area on the Hanford Site. The Richland Pumphouse is the first downstream point of river water withdrawal for a public drinking

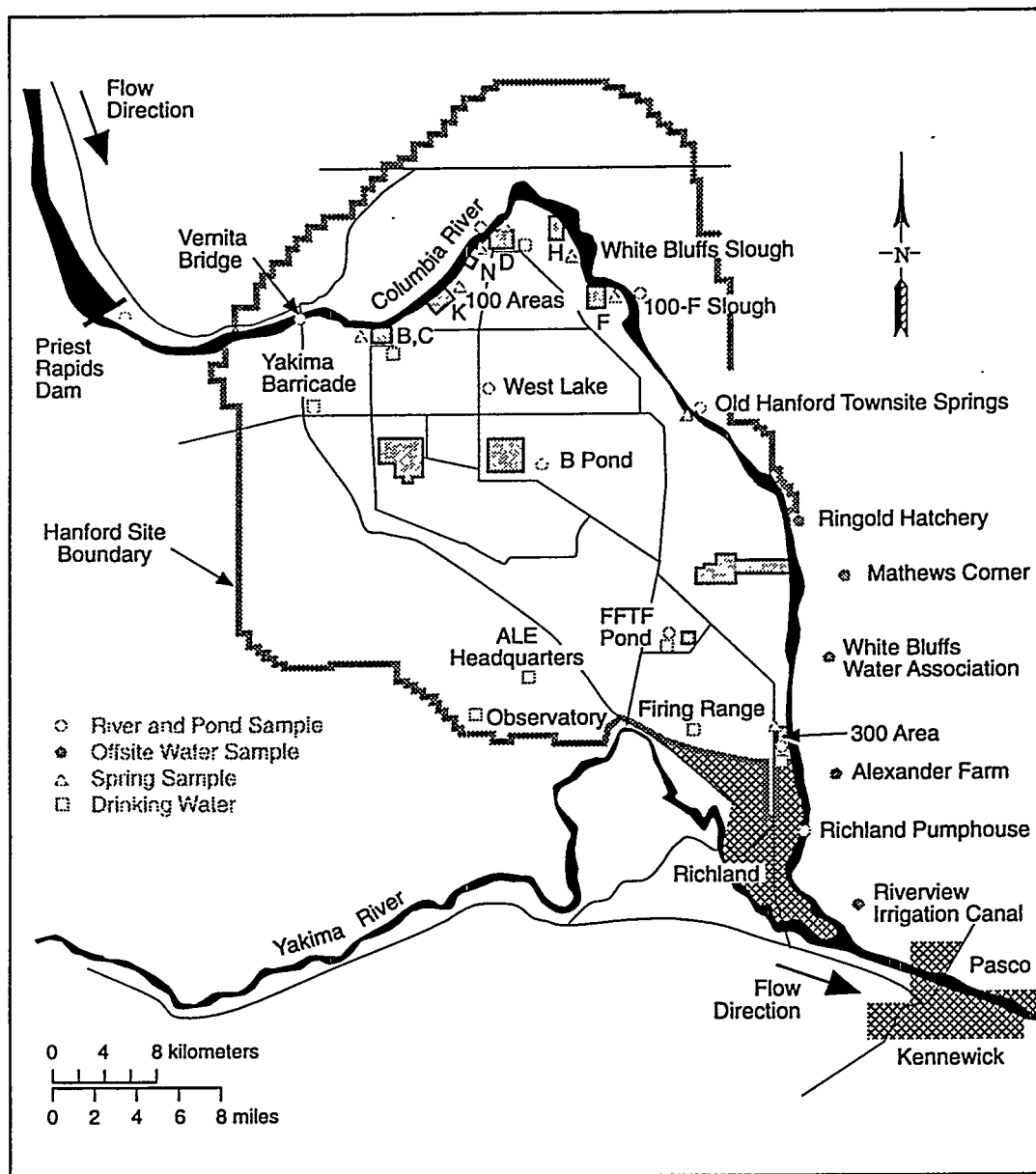


Figure III.A-6.1. Surface Water and Drinking Water Sampling Locations

water supply. As such, these locations provide an upper estimate of the amount of radioactive material in the water supply (drinking or irrigation) of the potentially affected population group(s) downstream of the Hanford Site.

Priest Rapids Dam is located approximately 8 km upstream of the Site boundary and 20 km upstream of the 100-B Area. The water sampler at Priest Rapids Dam is positioned approximately midstream within the dam and collects water from the reservoir behind the dam. The Vernita Bridge sampling location is approximately 6 km upstream of the 100-B Area. Samples are collected from the Benton County shoreline near the bridge for analysis of nonradiological constituents.

The 300 Area water intake is near the southern boundary of the Hanford Site, at the point of withdrawal for the 300 Area sanitary water supply. This is a source of onsite drinking water and provides a valuable historic database for certain constituents, as it has been in existence since the early days of Hanford Site operations. The sample intake is located in the water supply system intake structure on the Benton County shoreline of the river. Concentrations observed here are influenced by seepage of local ground water known to contain elevated levels of ^3H and uranium.

The Richland Pumphouse is located approximately 3 km downstream of the Site boundary and approximately 5 km downstream of the effluent discharge farthest downstream. The water sampling intake is located with the city of Richland drinking water supply intake on the Benton County shoreline, approximately 9 m into the river. Historical environmental monitoring reports indicate this to be the drinking water supply having the maximum radionuclide concentrations downstream of the Hanford Site (Corley 1970, 1973; Corley and Woolridge 1969; Fisher and Wilson 1970; Foster 1966; Foster and Wilson 1964, 1965; Honstead 1967). Past sampling along transects near this location indicated the distribution of gross beta activity to be slightly elevated near the Benton County shoreline (Soldat 1962).

Transect sampling is conducted near the Vernita Bridge, 100-N Area, 100-F, Old Hanford Townsite, 300 Area, and Richland Pumphouse. Transect sampling is performed to determine the distribution of contaminants across the river at these locations. In addition, transect sampling is used to determine the localized zone of influence near known discharges of contaminated ground water via riverbank springs. The representativeness of single-point-intake sampling systems located at the 300 Area and the Richland Pumphouse is also evaluated using results of the transect sampling. Samples along the transects are collected at approximately mid-depth and at several points (up to 10) across the river. Transect sampling will identify those contaminants that are measurable in the river and which may be influenced by proximity to the contaminated ground-water plume.

Sampling or Measurement Methods Selection -- The sample types, collection method, sample size, and sample and analysis frequency are discussed below. The selection of sampling methods and equipment depends on the potential for fluctuations in contaminant concentrations, variability in the effluent release into the receiving water, potential for significant environmental or human impact, and characteristics of the contaminant of interest.

Two types of water sampling systems are used to collect radiological samples: 1) a composite system that collects a fixed volume of water at set intervals at each location during each sample period and 2) a specially designed system that continuously collects waterborne radionuclides from the river on a series of filters and mixed-bed ion-exchange resin. Flow proportional sampling is desired; however, because of the extremely large size of the Columbia River, such a system is not practical.

Manual composites are collected in those cases where the use of automatic units is not feasible and to cover periods of equipment downtime. Sample size is determined by the requirements of the analytical method to be used and the required levels of sensitivity.

Composite sampling systems are operated at Priest Rapids Dam, 300 Area water intake, and the Richland Pumphouse. The composite samplers at Priest Rapids Dam and the Richland Pumphouse consist of timer-activated units that periodically collect water from a continuously flowing substream of Columbia River water into a 10-L container. The sample sequence includes a pre- and post-subsample air purge to avoid cross contamination between the individual sample aliquots. The cycle is repeated throughout a 1-week sample period at Priest Rapids Dam and Richland Pumphouse, such that approximately 55 mL of water are collected every hour. The 10-L sample container is changed every week, and the sample is taken to the laboratory, where water from each location is composited over a 4-week period, resulting in a total sample size of approximately 40 L. The system at the 300 Area is similar, except that sample aliquots are collected approximately every 4 h, and samples are removed monthly and composited for quarterly analysis. Gross alpha, gross beta, gamma scan, ^3H , ^{90}Sr , ^{99}Tc , ^{234}U , ^{235}U , and ^{238}U analyses are performed on these samples. In addition, weekly alpha and beta analyses are performed on an aliquot of the composite sample from the Richland Pumphouse.

Continuous sampling systems are located at Priest Rapids Dam, 300 Area water intake, and Richland Pumphouse. A special, continuously flowing system is used to separate radionuclides from the river water before analysis. A large volume of water is required to allow the extremely small concentrations of these radionuclides to be detected. River water is pumped through the collection system at a rate of approximately 50 mL/min, resulting in a total sample volume of approximately 1,000 L during each 2-week sampling period. Suspended particulates greater than $0.45\ \mu\text{m}$ in diameter are removed on a series of filters. Soluble radionuclides, except ^3H , are collected on a mixed-bed, ion-exchange resin column. The filters and ion-exchange resin are changed every 2 weeks, composited by location, and analyzed for gamma-emitting radionuclides. The filters and resin from each location are then composited on a quarterly basis for analyses of ^{129}I , ^{238}Pu , and $^{239,240}\text{Pu}$.

Grab samples of Columbia River water are collected quarterly or annually along cross-sections at transect Sites near the Vernita Bridge, 100-N Area, 100-F Area, Old Hanford Townsite, 300 Area, and Richland Pumphouse for analyses of various radiological and nonradiological water quality parameters. The requirement for minimum holding and transport times prohibits the use of composite systems for these analyses. Special care is taken to obtain water from a flowing portion of the river, avoiding stagnant backwater areas. Surface debris and bottom sediment are also avoided during sampling by collecting the samples from approximately mid-depth. Samples are delivered to the laboratory, where processing is initiated promptly to ensure sample integrity.

In addition to monitoring conducted by PNL, water quality measurements are also performed by the USGS at Vernita Bridge and Richland. The USGS samples are collected every other month at Vernita Bridge and quarterly at Richland. Numerous physical, biological, and chemical constituents are analyzed for the USGS laboratory in Denver, Colorado.

In addition to sampling, the USGS provides flow rate measurements at the Priest Rapids Dam gage station, near the upstream boundary of the Site.

Sample Handling/Transport Methods -- Surface water samples are collected in such a manner as to ensure that the sample is representative of the body of water being sampled. Steps are incorporated in the sampling procedure to avoid misidentification and cross-contamination of the samples being

collected. Quality assurance is established and implemented by PNL-MA-70. Chain-of-custody procedures, to ensure the integrity of the sample throughout the collection-transport-analysis process, are detailed in PNL-MA-70 and PNL-MA-580.

Analytical Methods — Analytical methods are selected to meet the minimum goal of detecting levels equivalent to a dose of 1 mrem if that concentration were sustained for a year. An additional goal is to achieve the lower detection levels available using standard state-of-the-art analytical methods. These goals are summarized in the Laboratory Procedures Subsection. In some cases, special techniques have been developed and are used to measure specific contaminants known to be discharged into the surface waters. Analytical methods are summarized in the Laboratory Procedures Subsection and are detailed in laboratory procedures of the International Technology Corporation Analytical Services Division (IT 1990).

Riverbank Springs

Routine riverbank spring sample locations are illustrated in Figure III.A-6.1. Samples are collected annually along the shoreline of the 100-B Area, 100-K Area, 100-N Area, 100-D Area, 100-H Area, 100-F Area, downstream of the Old Hanford Townsite, and at the 300 Area. Ground Water enters the Columbia River at these locations, with contaminant levels significantly higher than background.

Water samples collected at these locations are analyzed for those constituents known or suspected to be present in the local ground water. The primary radionuclides of concern include ^3H , ^{60}Co , ^{90}Sr , ^{99}Tc , ^{129}I , and uranium. Chemical contaminants of concern include metals (primarily chromium), volatile organic compounds (VOCs), and anions.

Samples are typically collected using a siphon pump directly in an improved discharge zone to avoid agitation of the sediments. The sampling zone of the riverbank spring is improved by scooping the sediment away from the discharge area and allowing the disturbed sediments to settle before the siphon pump is used. Riverbank spring samples are handled and transported in a manner similar to the river water samples discussed above.

Onsite Ponds

Sampling Locations — Three onsite ponds (see Figure III.A-6.1), located near operating areas, are routinely sampled. B Pond, located near the 200-East Area, was excavated in the mid-1950s for disposal of process cooling water and other liquid wastes occasionally containing low levels of radionuclides. West Lake, located north of the 200-East Area, is recharged from the ground water (Gephart et al. 1976). This lake has not received direct effluent discharges from Site facilities. Radionuclide concentrations in West Lake are influenced by the local ground water. The FFTF Pond, located near the 400 Area, was excavated in 1978 for the disposal of wastewater from various facilities in the 400 Area. The volume of water present in all of the onsite ponds has been decreased significantly during recent years as a result of changes in liquid effluent disposal practices. In addition, Site plans call for the elimination of discharges of liquid effluents to the ground in the near future. As such, sampling of these ponds is becoming more difficult with time and the need for continued monitoring may be diminished, if not eliminated.

Westinghouse Hanford Company (WHC) is responsible for monitoring effluents discharged to the ponds and for operational surveillance of the ponds (Coony et al. 1988). Although the ponds are

inaccessible to the public and do not constitute a direct offsite environmental impact, they are accessible to migratory waterfowl, creating a potential biological pathway for the dispersion of contaminants. Periodic sampling of the ponds provides an independent check on effluent control and monitoring systems as well.

Sample Collection and Analysis -- Ten-liter grab samples are collected quarterly from each pond. Care is taken to avoid surface debris and resuspension and inadvertent collection of bottom sediments. Unfiltered aliquots of the samples are analyzed for gross alpha and gross beta activities, gamma-emitting radionuclides, ^3H , and ^{90}Sr . Sodium-22 analyses are included on FFTF Pond samples to provide indications of process failure.

Offsite Water Sources (Drinking and Irrigation)

Water samples are collected from four drinking water systems directly east of and across the Columbia River from the Hanford Site (see Figure III.A-6.1). Samples are also collected from an irrigation canal that obtains water from the Columbia River downstream of Hanford. Sampling was initiated to document the levels of radionuclides in the water used by the public and as a result of public concerns about the potential for Hanford Site-associated contaminants being present in offsite water. Consumption of food irrigated with Columbia River water from downstream of the Site was identified as one of the primary pathways contributing to the potential dose to the hypothetical MEI in 1993 (Dirkes et al. 1994).

Water is collected from four offsite domestic water systems (see Figure III.A-6.1). Grab samples are collected quarterly according to PNL-MA-580 procedures. The analyses performed on these samples include total alpha, total beta, gamma scan, ^3H , ^{129}I , ^{234}U , ^{235}U , and ^{238}U .

The Riverview Irrigation Canal is sampled three times during the irrigation season. These samples are analyzed for total alpha, total beta, gamma emitters, ^3H , ^{90}Sr , ^{234}U , ^{235}U , and ^{238}U . Strontium-90 is the primary radionuclide of concern, because it was identified as one of the primary contributors to the calculated hypothetical dose to the public via the water pathway (Jaquish and Mitchell 1988).

Quality Control Methods

Surface water surveillance is controlled under the overall project quality assurance and analytical control program that is described in the Quality Assurance and Quality Control subsection.

Reporting/Alarm Levels

Anomalous results are flagged by computer screening of reported data as they are entered into the project database. Levels for reporting to DOE-RL have been established and are listed in the Records Management and Reporting subsection. Reporting levels are equivalent to the concentration that might lead to an MEI dose of 1 mrem (EDE) if it were sustained for a year. This reporting level provides early indication of conditions that might eventually require reporting to DOE-Headquarters, as required by DOE Order 5400.5.

Exceptions

No exceptions have been taken to *should** statements in DOE/EH-0173T.

Sediment Surveillance

As a result of operations at the Hanford Site, large quantities of radioactive materials were discharged to the Columbia River. On release to the river, the radioactive materials were dispersed rapidly, sorbed onto inorganic particles and detritus, incorporated into aquatic biota, and/or deposited on the riverbed as sediment. Fluctuations in the river flow rate, as a result of the operation of hydroelectric dams, annual spring freshets, and occasional floods, has resulted in the resuspension, relocation, and redeposition of the contaminated sediments.

Since the shutdown of the original single-pass cooling reactors, the radionuclide burden in the surface sediments has been decreasing as a result of radioactive decay and subsequent deposition of uncontaminated material. However, discharges of some radionuclides to the Columbia River still occur through the seepage of contaminated ground water into the river. It is expected that some of this material either is deposited directly or is sorbed onto the sediment material and deposited on the river bottom.

The accumulation of radioactive materials in sediment can lead to exposure of humans through ingestion of aquatic species, through sediment resuspension into drinking water supplies, or as an external radiation source irradiating people fishing, wading, sunbathing, or participating in other recreational activities associated with the river and/or the shoreline.

Public exposures are well below the level at which routine surveillance of the sediments is required. However, periodic sampling is necessary to confirm the low levels and to ensure that no significant changes have occurred over time that may increase the potential exposure to the public through this pathway.

Sampling on a routine basis is necessary to meet site-specific surveillance requirements. It is imperative that the whereabouts and fate of the contaminants known to enter the river along the Hanford Reach be understood. Because the source of radionuclides entering the river is predominantly the seepage of contaminated ground water, sampling of the sediments and river water near the discharge zones provides an indication of the levels entering the river and also confirms findings of the routine ground-water monitoring program conducted at the Hanford Site.

Public concern about the levels of contamination in the river sediments and the potential for these contaminants to be resuspended and relocated, perhaps in areas of public use, is evident in the Hanford Site area. Routine sampling of the sediment material provides the public a degree of assurance that both the potential problem (resuspension and redistribution of contaminated sediment) and their concerns are being considered and addressed appropriately.

Objectives

The objectives of the sediment surveillance activities, consistent with overall surface environmental surveillance, include the following:

- verify that doses caused by Hanford Site operations through this pathway remain low, by means of periodic river system evaluation, sampling, and analysis
- provide an indication of changes in environmental conditions with potential for increases in public exposures
- provide public assurance in the credibility of Site surveillance and that the radiological conditions and potential exposure pathways are understood and receive appropriate attention.

Plan Rationale and Criteria

The basis for sampling sediments from surface waters is discussed in Section 5.12 of DOE/EH-0173T. In addition, other environmental monitoring guides and references have been considered in the development of the sediment sampling plan. The locations, sampling frequency, and analyses performed routinely on sediment samples are summarized annually in the *Environmental Surveillance Master Sampling Schedule* (Bisping 1994). Additional rationale and specific criteria are described below.

Media Selection

Sediments along the Hanford Reach are known to contain elevated concentrations of radionuclides and produce higher than normal levels of external radiation. Contaminants in sediments may lead to public exposure through the ingestion of aquatic species, through sediment resuspension into drinking water systems, and as an external radiation source. Sediment sampling and the measurement of external radiation emanating from the sediments provide indications of the potential for human exposure from this pathway. Sediments are sometimes more sensitive indicators of waterborne contaminants than water or aquatic biota because some contaminants may accumulate in sediments.

The plan for sediment sampling in the Columbia River is summarized and documented annually in the *Environmental Surveillance Master Sampling Schedule*. Table III.A-7.1 provides a summary of the current sediment sampling plan. All sediment samples are collected in accordance with documented, reviewed, and approved collection procedures contained in PNL-MA-580. Analytical methods are summarized in the Laboratory Procedures subsection.

Analyte Selection

Sediment samples are analyzed for those contaminants known or suspected to be present as a result of past or current operations at the Hanford Site. Effluent discharge reports are reviewed to identify contaminants currently entering the river. Ground-water monitoring reports identify those contaminants near the river and potentially entering the river that must be considered in the sampling plan. Historic reports, documenting past releases and/or sediment contaminant concentrations, must be reviewed to determine contaminants of concern as a result of past operations.

Table III-A.7.1. Sediment Sampling

Location ^(a)	Frequency	Analyses
River		
McNary Dam		
Oregon Shore	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u, DOH ^(d)
1/3 from Oregon Shore	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u, DOH ^(d)
2/3 from Oregon Shore	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u, DOH ^(d)
Washington Shore	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u, DOH ^(d)
Priest Rapids Dam		
Grant County Shore	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u, DOH ^(d)
1/3 from Grant County Shore	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u, DOH ^(d)
2/3 from Grant County Shore	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u, DOH ^(d)
Yakima County Shore	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u, DOH ^(d)
Sloughs		
White Bluffs Slough	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u
100-F Slough	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u
Hanford Slough	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u
Richland	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , Pu ^(c) , ICP-u
Springs		
100-N Spring 8-13	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , ICP-u, DOH ^(d)
Hanford Spring 28-2	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , ICP-u
300 Area Spring 42-2	A	Gamma Scan, ⁹⁰ Sr, U ^(b) , ICP-u

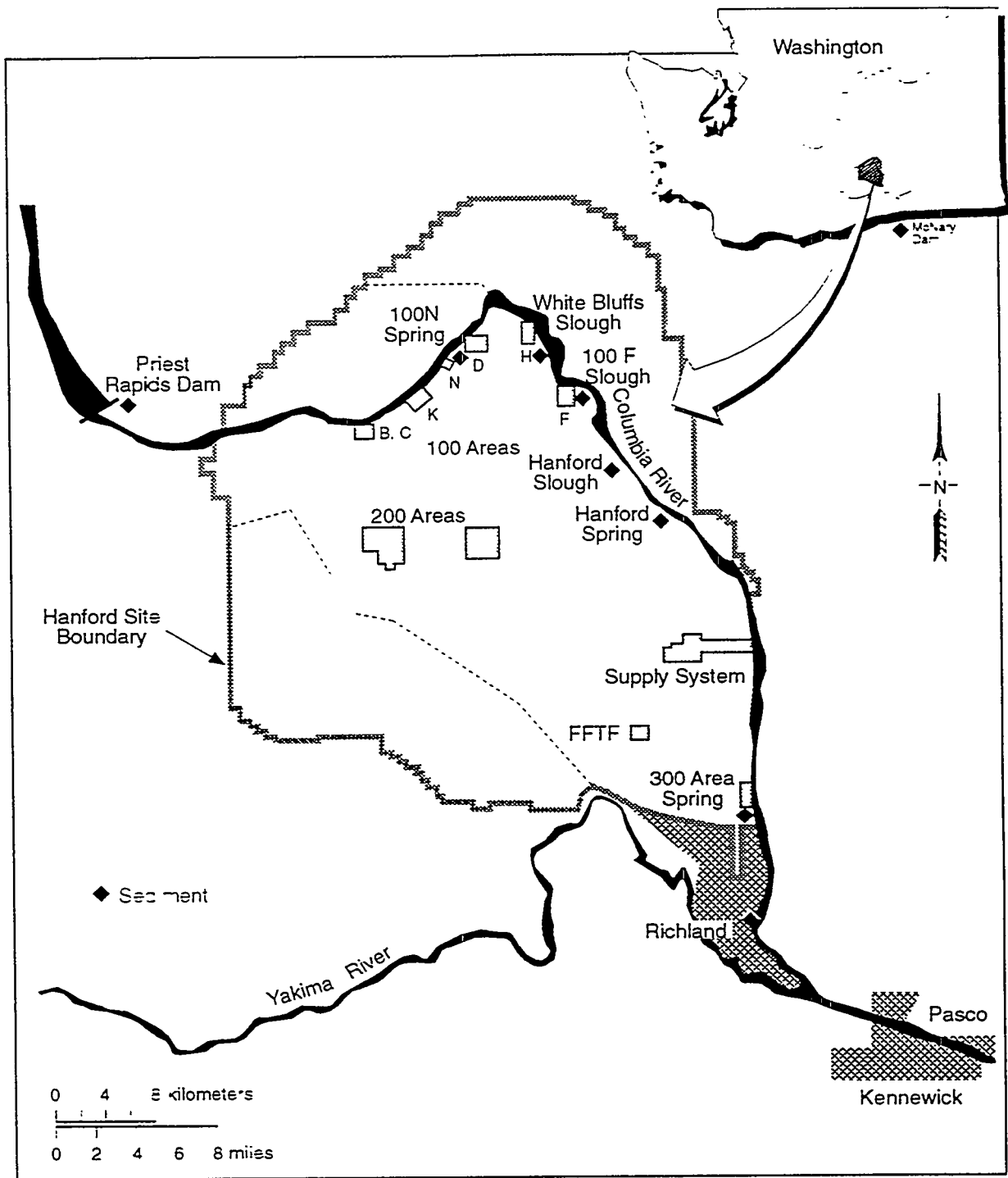
(a) Refer to Figure III.A-7.1, Sediment Sampling Locations.

(b) ²³⁵U-LEP, ²³⁸U-LEP.

(c) Isotopic plutonium.

(d) Duplicate samples with the Washington State Department of Health.

Sediment samples are routinely analyzed for gamma-emitting radionuclides (gamma scan), ⁹⁰Sr, ²³⁵U, ²³⁸U, ²³⁸Pu, and ^{239,240}Pu. Such analyses are consistent with past and current releases and historical data relative to contaminants in the sediments. In addition, sediment samples are routinely analyzed for metals.



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Figure III.A-7.1 Sediment Sampling Locations

Sampling Frequency

Sampling of sediments is conducted on an annual basis. This is deemed satisfactory because the sediments are not in a critical exposure pathway to the public. Sampling is conducted consistent with spring freshets (i.e., sampling occurs after the spring high water to provide a consistent and more easily interpreted information base).

Core samples, to determine the fate and buildup of contaminants in the sediment over time, are collected periodically, commensurate with findings of past core sampling activities and in consideration of future activities that may resuspend and redistribute the sediment.

Sample Location Selection

Samples of Columbia River sediment are collected at the locations shown in Figure III.A-7.1. Samples are collected upstream of the Hanford Site (outside the influence of Hanford Site facilities) behind Priest Rapids Dam (the nearest upstream impoundment). Samples are collected downstream of the Hanford Site at the City of Richland and behind McNary Dam (the nearest downstream impoundment). Four samples are collected behind each of the dams at approximately equal distances along a sample transect. This provides additional information relative to the distribution of contaminants in the sediments across the river. In addition, samples are collected along the Hanford Reach, at locations nearer the discharges (past and/or current), in areas where material is known to be deposited, and in areas commonly used by the public. These locations include the sloughs known as White Bluffs, 100-F, and Hanford.

In addition to the routine sediment sampling activities, core samples are collected periodically from the upstream and downstream impoundments to determine the distribution and fate of the contaminants present as a result of past Hanford operations. The frequency of this sampling is dependent on the findings of past sampling activities and in consideration of future river and/or downstream impoundment activities. For example, plans currently call for an extensive core sediment sampling study before construction of additional turbine facilities at McNary Dam. This study will include some dredging of the material deposited behind the dam. Other factors that warrant consideration include flow-control activities associated with salmon migration that may impact existing sediment deposits.

Sample Collection Methods

Because of the depth and swiftness of the river at some of the sediment sampling locations, samples are collected using a dredge-type mechanical sampler. In some cases, primarily in the shallow-water sloughs along the Hanford Reach, the dredge is used manually to better control the sample depth.

Surface sediments are sampled routinely to determine the levels of contaminants present in the most recently deposited sediments. Core samples may be collected periodically to determine the profile of the historical deposits and to determine trends and the fate of the contaminants once they are bound in the sediment material.

Analytical Methods

Analytical methods are selected to meet the minimum goal of detecting levels equivalent to a dose of 1 mrem if that concentration were sustained for a year. An additional goal is to achieve the lower detection levels available using standard state-of-the-art analytical methods. These goals are summarized in the Laboratory Procedures Subsection.

Analysis methods are also summarized in the Laboratory Procedures Subsection and are detailed in laboratory procedures of the International Technology Corporation Analytical Services Division (IT 1990).

Quality Control Methods

Sediment surveillance is controlled under the overall project quality assurance and analytical control program, described in the Quality Assurance and Quality Control Subsection.

Reporting/Alarm Levels

Anomalous results are flagged by computer screening of reported data as they are entered into the project database. Levels for reporting to the DOE Richland Operations Office have been established and are listed in the Records Management and Reporting Subsection. Reporting levels are equivalent to the concentration that might lead to an MEI dose of 1 mrem (EDE) if it were sustained for a year. This reporting level provides early indication of conditions that might eventually require reporting to DOE, Headquarters, as specified by DOE 5400.5.

Exceptions

No exceptions have been taken to should* statements in DOE/EH-0173T.

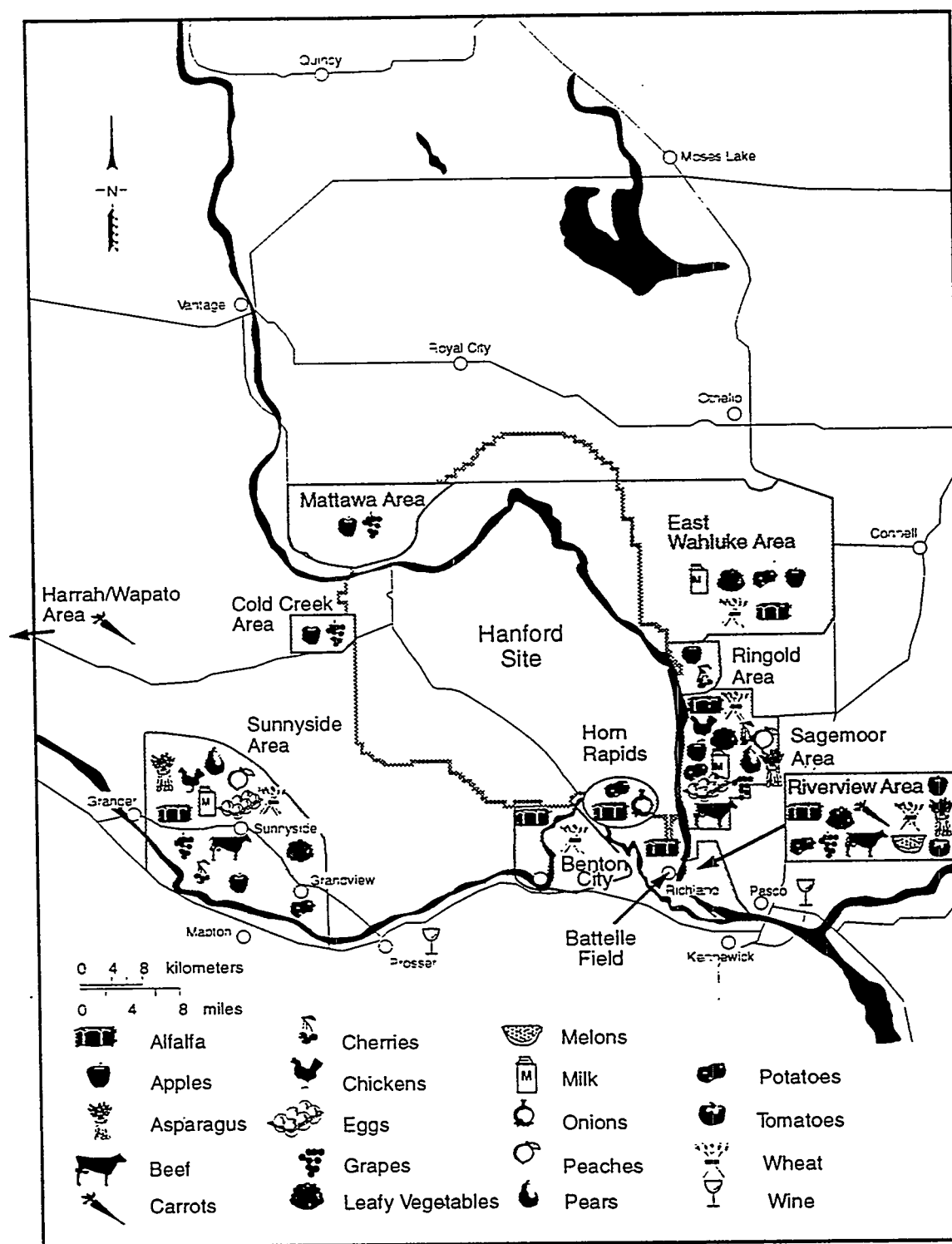
Agricultural Products Surveillance

Agriculture is a major factor in the economy of the Columbia Basin (Figure III.A-8.1). The Hanford Site is surrounded by large tracts of agricultural land, and surveillance of agricultural products for radioactive materials of potential Hanford Site origin is an important element of surface environmental surveillance. Radioactivity of Hanford Site origin could reach agricultural areas by two pathways: atmospheric dispersion and application of irrigation water from the Columbia River. Historically, the Riverview area has been the first location downstream of the Site that uses Columbia River water for irrigation. Recently, a potato farm, located closer to the Site, south of Horn Rapids Road, has begun to use Columbia River water for irrigation. Agricultural products are also grown in downwind areas around the Site perimeter and in more distant locations, and these products are potentially affected by atmospheric dispersion and deposition of effluents.

The air-food and water-food pathways continue to contribute to the 1993 MEI's estimated dose of 0.03-mrem, contributing 0.0008-mrem and 0.008-mrem, respectively (see Table III.A-3.1). These values are below the guidance levels (see Table III.A-5.1) for required routine sampling; however, confirmatory resampling is required at least every 5 years. These estimated doses do not include resuspended soil, which could increase the potential levels of radionuclide contamination. While the potential for contamination from resuspended soil is small, it could increase as cleanup activities proceed at the Site and buried waste is remediated. Surveillance of agricultural products from around the Hanford Site will provide needed assurances that cleanup activities are not significantly affecting agricultural products.

In the event of an unplanned release, it is critical to DOE's interests to be able to document whether agricultural products have become contaminated. This requires maintenance of baseline and background databases in association with air, meteorology, and river water monitoring. Maintaining an environmental database to support emergency response effects assessment is a continuing need as long as accident scenarios indicate the potential for significant contamination of offsite agricultural products. Agricultural data are maintained in a comprehensive database that allows data to be compared with previously collected data from the same location or from locations that are designated control Sites. These data are reviewed for unusual results as they are reported by the analytical laboratory and in the Annual *Hanford Site Environmental Report* (e.g., Dirkes et al. 1994). That report, along with Antonio (1994), compare trends in the monitoring data over the previous 5 years. The information is then used on an annual basis to re-evaluate sample Site selection, media, and radionuclides that require monitoring.

In most cases, current levels of key radionuclides are at or below detection limits, and there is no discernible difference between offsite control samples and downwind or downstream irrigated agricultural products. Assurance that regional agricultural products are not contaminated is vital to the public, the region's agribusinesses, and DOE's public and political acceptance. Therefore, periodic sampling more frequently than every 5 years is essential, and must be done in a manner that provides the ability to estimate the contribution from Site operations as opposed to other sources, including background. Where feasible, sampling of agricultural products in areas adjacent to the Hanford Site will be coordinated through the Community-Operated Environmental Surveillance Program.



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Figure III.A-8.1. Food and Farm Product Surveillance Locations

Objectives

The objectives of this activity are the following:

- verify that doses, (through the agricultural products pathway) caused by Hanford Site operations remain low through periodic sampling as required by DOE/EH-0173T
- provide assurance to producers and consumers of agricultural products that the degree of contamination caused by Site operations is known and documented in the Annual **Hanford Site Environmental Report** and special reports as required
- provide data to quantify the incremental effects of any accidental releases that may result from Site operations
- conduct surveillance to meet FFTF technical specifications (HEDL 1981).

Plan Rationale and Criteria

Pathway analysis indicates that effluents of Hanford origin could reach agricultural products by atmospheric dispersion and deposition downwind and through irrigation with Columbia River water. Specific agricultural pathways target a wide variety of local, representative products that are identified in DOE/EH-0173T and are emphasized to address concern for public assurance. The data are also used to support offsite dose estimates based on effluent monitoring. Procedures are designed to ensure that sample collection is performed in an unbiased manner (see PNL-MA-580 for sample collection procedures).

Media Selection

Selection of specific media is based on the significance of the pathway to dose. The products listed below and in Table III.A-8.1 are selected because they are potentially exposed to atmospheric deposition, irrigated with Columbia River or ground water, consumed by farmers or sold commercially, and known to contribute to the total potential dose through a specific pathway (e.g., ^{129}I in milk).

Milk. Historically, the milk pathway has been a major contributor of radioiodine to humans. Milk is collected from control sites (generally upwind and distant from the Hanford Site) and from dairies closer and downwind of the Site. The milk database documents the trends in radioiodine levels in milk that would be necessary to establish the presence of contamination in the event of an emergency response involving radioiodine releases. Approximately 70 samples are collected on a quarterly or semiannual basis. Radiochemical analyses include gamma scans, ^3H , ^{90}Sr , and ^{129}I .

Table III.A-8.1. Sample Location, Frequency, and Radionuclide Analytes for Agricultural Media

Whole Milk

Location ^(a)	Sample Type	Frequency	Collection Period	Analyses
East Wahluke Area Composite ^(b)		Q		³ H, ⁹⁰ Sr, gamma scan
Sagemoor Area Composite ^(b)		SA		¹²⁹ I
		M		³ H, gamma scan
		Q		⁹⁰ Sr
		SA		¹²⁹ I
Sunnyside Area		Q		³ H, ⁹⁰ Sr, gamma scan
		SA		¹²⁹ I

(a) Refer to Figure III.A-8.1, Food and Farm Product Sampling Locations.

(b) Sample composited from three sources in each area.

Poultry and Eggs

Location ^(a)	Sample Type	Frequency	Collection Period	Analyses
Sagemoor Area	Chicken	A		⁹⁰ Sr, gamma scan
	Eggs	A		⁹⁰ Sr, gamma scan, DOH ^(b)
Sunnyside Area	Chicken	A		⁹⁰ Sr, gamma scan
	Eggs	A		⁹⁰ Sr, gamma scan, DOH ^(b)

(a) Refer to Figure III.A-8.1, Food and Farm Product Sampling Locations.

(b) Duplicate samples with the Washington State Department of Health.

Beef

Location ^(a)	Sample Type	Frequency	Collection Period	Analyses
Sagemoor Area		A		⁹⁰ Sr, gamma scan
Riverview Area		A		⁹⁰ Sr, gamma scan
Sunnyside Area		A		⁹⁰ Sr, gamma scan

(a) Refer to Figure III.A-8.1, Food and Farm Product Sampling Locations.

Table III.A-8.1. (cont'd)

Leafy Vegetables

Location ^(a)	Sample Type	Frequency ^(b)	Collection Period	Analyses
East Wahluke Area		BA		⁹⁰ Sr, gamma scan
Sagemoor Area		A		⁹⁰ Sr, gamma scan, ¹²⁹ I-LEP
Riverview Area		A		⁹⁰ Sr, ⁹⁹ Tc, gamma scan, FDA ^(c)
Sunnyside Area		A		⁹⁰ Sr, gamma scan, FDA ^(c)

(a) Refer to Figure III.A-8.1, Food and Farm Product Sampling Locations.

(b) Three samples collected within each area. Biannual samples will next be collected in 1994.

(c) Duplicate samples sent to U.S. Food and Drug Administration.

Vegetables

Location ^(a)	Sample Type	Frequency ^(b)	Collection Period	Analyses
Riverview Area	Potatoes	A		⁹⁰ Sr, gamma scan, FDA ^(c)
	Tomatoes	A		³ H, ⁹⁰ Sr, gamma scan
	Carrots	A		⁹⁰ Sr, gamma scan, DOH ^(d)
	Asparagus	A		⁹⁰ Sr, Pu ^(e) , U ^(f) , gamma scan
Horn Rapids	Potatoes	A		⁹⁰ Sr, ⁹⁹ Tc, Pu ^(f) , U ^(f) , gamma scan, DOH ^(d)
	Onions (if available)	A		⁹⁰ Sr, ⁹⁹ Tc, Pu ^(f) , U ^(f) , gamma scan, DOH ^(d)
Sagemoor Area	Potatoes	A		⁹⁰ Sr, Pu ^(e) , gamma scan, FDA ^(c)
	Asparagus	A		⁹⁰ Sr, Pu ^(e) , U ^(f) , gamma scan, DOH ^(d)
Sunnyside Area	Potatoes	A		⁹⁰ Sr, Pu ^(e) , U ^(f) , ⁹⁹ Tc, gamma scan, FDA ^(c)
	Asparagus	A		⁹⁰ Sr, Pu ^(e) , U ^(f) , gamma scan, DOH ^(h)
Harrah/Wapato Area	Carrots	A		³ H, ⁹⁰ Sr, gamma scan, DOH ^(h)
East Wahluke Area	Potatoes	BA		⁹⁰ Sr, gamma scan

(a) Refer to Figure III.A-8.1, Food and Farm Product Sampling Locations.

(b) Three samples of each type collected within each area. Biannual samples will next be collected in 1994.

(c) Duplicate samples sent to U.S. Food and Drug Administration.

(d) Duplicate samples with the Washington State Department of Health.

(e) Isotopic plutonium.

(f) Isotopic uranium.

(g) If potatoes are unavailable, collect duplicate onion samples for the Washington State Department of Health.

(h) Samples provided to PNL by Washington State Department of Health.

Table III.A-8.1. (cont'd)

Fruit		Frequency ^(b)	Collection Period	Analyses
Location ^(a)	Sample Type			
Sagemoor Area	Apples	A	September	³ H, ⁹⁰ Sr, Pu ^(c) , gamma scan, FDA ^(d)
	Cherries	A	June	³ H, ⁹⁰ Sr, gamma scan
	Concord	A	September	³ H, ⁹⁰ Sr, gamma scan, ¹²⁹ I-LEP
	Grapes ^(e)			
	Peaches or Pears	A	August	³ H, ⁹⁰ Sr, gamma scan, DOH ^(f)
Cold Creek Area	Apples	BA	September	³ H, ⁹⁰ Sr, gamma scan
	Concord	BA	September	³ H, ⁹⁰ Sr, gamma scan
	Grapes ^(e)			
Sunnyside Area	Apples	A	September	³ H, ⁹⁰ Sr, Pu ^(c) , gamma scan, DOH ^(g)
	Cherries	A	June	³ H, ⁹⁰ Sr, gamma scan
	Concord	A	September	³ H, ⁹⁰ Sr, gamma scan, ¹²⁹ I-LEP
	Grapes ^(e)			
	Peaches or Pears	A	August	³ H, ⁹⁰ Sr, gamma scan, DOH ^(g)

Table III.A-8.1. (cont'd)

Location ^(a)	Sample Type	Frequency ^(b)	Collection Period	Analyses
Riverview Area	Apples	A	September	³ H, ⁹⁰ Sr, gamma scan, FDA ^(d)
	Concord	A	September	³ H, ⁹⁰ Sr, gamma scan
	Grapes ^(e)			
	Melons	A	August	³ H, ⁹⁰ Sr, gamma scan
Ringold Area	Apples	A	September	³ H, ⁹⁰ Sr, Pu ^(c) , gamma scan, DOH ^(f)
	Cherries	A	June	³ H, ⁹⁰ Sr, gamma scan
Mattawa Area	Apples	BA	September	³ H, ⁹⁰ Sr, gamma scan
	Concord	BA	September	³ H, ⁹⁰ Sr, gamma scan
	Grapes ^(e)			
East Wahluke Area	Apples	BA	September	³ H, ⁹⁰ Sr, gamma scan, FDA ^(d)

(a) Refer to Figure III.A-8.1, Food and Farm Product Sampling Locations.

(b) Three samples of each type collected within each area. Biannual samples will next be collected in 1996.

(c) Isotopic plutonium.

(d) Duplicate samples sent to the U.S. Food and Drug Administration.

(e) Concord grapes preferred; table grapes acceptable if concord grapes are unavailable.

(f) Duplicate samples with the Washington State Department of Health.

(g) Samples provided to PNL by Washington State Department of Health.

Wine

Location ^(a)	Sample Type	Frequency ^(b)	Collection Period	Analyses
Columbia Basin	White	A	December	³ H, gamma scan, DOH ^(c)
	Red	A	December	³ H, gamma scan, DOH ^(c)
Yakima Valley	White	A	December	³ H, gamma scan, DOH ^(c)
	Red	A	December	³ H, gamma scan, DOH ^(c)

(a) Refer to Figure III.A-8.1, Food and Farm Product Sampling Locations.

(b) Three samples of each type collected within each area.

(c) Duplicate samples with the Washington State Department of Health.

Wheat and Alfalfa

Location ^(a)	Sample Type	Frequency ^(b)	Collection Period	Analyses
East Wahluke Area	Wheat	BA	July	⁹⁰ Sr, gamma scan
	Alfalfa	BA	May	⁹⁰ Sr, gamma scan
Sage Moor Area	Wheat	A	July	⁹⁰ Sr, Pu ^(c) , gamma scan, FDA ^(d)
	Alfalfa	A	May	⁹⁰ Sr, gamma scan
Riverview Area	Wheat	A	July	⁹⁰ Sr, gamma scan
	Alfalfa	A	May	⁹⁰ Sr, gamma scan
Benton City Area	Wheat	A	July	⁹⁰ Sr, gamma scan
	Alfalfa	A	May	⁹⁰ Sr, gamma scan, DOH ^(e)
Sunnyside Area	Wheat	A	July	⁹⁰ Sr, Pu ^(c) , gamma scan
	Alfalfa	A	May	⁹⁰ Sr, gamma scan, DOH ^(e)

Table III.A-8.1. (cont'd)

Location ^(a)	Sample Type	Frequency ^(b)	Collection Period	Analyses
Battelle Field	Alfalfa	A	May	⁹⁰ Sr, gamma scan
Horn Rapids	Alfalfa	A	May	⁹⁰ Sr, gamma scan

(a) Refer to Figure III.A-8.1, Food and Farm Product Sampling Locations.

(b) Three samples of each type collected within each area. Biannual samples will next be collected in 1996.

(c) Isotopic plutonium.

(d) Duplicate samples sent to the U.S. Food and Drug Administration.

(e) Duplicate samples with the Washington State Department of Health.

Beef, Eggs, and Poultry. Beef, eggs, and poultry are collected from control and downwind areas annually to comply with FFTF technical specifications (HEDL 1981) and for public assurance. The Sagemoor beef collection site is the downwind site, and the Riverview site monitors beef fed on crops potentially irrigated with Columbia River water. Eggs and poultry are collected from one control area and from one downwind area. Samples are analyzed for ⁹⁰Sr and gamma-emitting radionuclides.

Farm Produce. Surveillance of farm produce involves the collection of 28 samples distributed among various fruits and vegetables. This media group includes fruit (apples, grapes, cherries), vegetables (melons, tomatoes, carrots, potatoes), and leafy vegetables. Specific foodstuffs are collected by site and not all sites yield the same types of produce (see Figure III.A-8.1). Certain sites are designated as upwind control or background sampling sites, and others have been selected as downwind sites to help quantify the contribution of radioactivity in produce attributable to Hanford Site activities. Sample analysis include gamma scan, ³H, ⁹⁰Sr, ⁹⁹Tc, ¹²⁹I, uranium, and plutonium.

Wheat and Alfalfa. Wheat and alfalfa samples are collected from two upwind control sites and five sites adjacent to the Hanford Site. All samples are analyzed for gamma-emitting radionuclides and ⁹⁰Sr. Samples collected from Sagemoor and Sunnyside are also analyzed for ²³⁸Pu and ^{239,240}Pu.

Wine. Wine samples are collected from upwind and downwind locations. Only wines that have been prepared from grapes grown in the immediate area are analyzed. Wines are analyzed for ³H and gamma-emitting radionuclides annually.

Analyte Selection

Radionuclides are selected based on monitored effluent releases, the degree to which the radionuclide contributes to the dose associated with the pathway, and public and agribusiness concern (see DOE/EH-0173T). Radionuclides of concern include plutonium, ³H, ⁹⁰Sr, ⁹⁹Tc, ¹²⁹I, and ¹³⁷Cs (and other gamma emitters). These radionuclides are important because of their biological activity: ¹²⁹I may concentrate in the thyroid, ¹³⁷Cs concentrates in muscle, ⁹⁰Sr and plutonium are bone seekers, and ³H is usually incorporated into meat or plant material as tritiated water. Tritium is monitored in all fruits because of their high liquid content. Principal radionuclides associated with atmospheric fallout are monitored to partition Hanford-related impacts from background and fallout. Generally, fallout radionuclides include plutonium, ⁹⁰Sr, and ¹³⁷Cs. Last, radionuclides must have a sufficiently long half-life to pose a realistic hazard by the foodchain pathway.

Sampling and Analysis Frequency

Sampling locations that represent the potential for the highest environmental dose from Hanford Site effluents are sampled more frequently than others. Only milk is sampled on a continuing routine basis year-round. Other agricultural products collected annually during the harvest season best represent the products consumed by the public.

Sampling Location Selection

Sampling locations are selected to provide samples for agricultural products that are likely to contain the maximum offsite concentrations of radionuclides from exposure to Hanford Site atmospheric and liquid effluents (see DOE/EH-0173T). Control or background sites are located generally upwind or upstream of the Hanford Reach or are independent of the Hanford Reach and known patterns of ground-water flow. The Riverview area and the Horn Rapids farm area are sampled because they are the first agricultural areas located downstream of the Hanford Site that use Columbia River water for irrigation. The remaining agricultural sites are located primarily on the Site perimeter in downwind locations.

Sampling or Measurement Methods Selection

Produce is collected in a manner to ensure adequate amounts of sample to meet detection goals. Care is taken to ensure that the produce is not contaminated with soil. All samples are double bagged to further guard against possible contamination. The methods used for sample collection are found in PNL-MA-580.

Sample Handling/Treatment Methods

Perishable samples, such as milk, are stored in ice chests when collected and during transport to the analytical laboratory (see PNL-MA-580).

Analytical Methods

Analytical methods are selected to meet the minimum goal of detecting levels equivalent to a dose of 1 mrem if that concentration were sustained for a year. An additional goal is to achieve the lower detection levels available using standard state-of-the-art analytical methods. These goals are summarized in the Laboratory Procedures subsection.

Analysis methods are also summarized in the Laboratory Procedures subsection and are detailed in laboratory procedures of the International Technology Corporation Analytical Services Division (IT 1990).

Quality Control Methods

Agricultural products surveillance is controlled under the overall project quality assurance and analytical control program that is described in the Quality Assurance and Quality Control subsection.

Duplicate samples are collected for selected produce and sent to the State of Washington Department of Health and/or the U.S. Food and Drug Administration for comparative analysis. All

samples undergo a gamma scan and ^{90}Sr analysis. Selected duplicate samples are analyzed for plutonium isotopes, ^3H (all fruit), uranium isotopes, ^{99}Tc , and ^{129}I , depending on the location of the sample sites.

Reporting/Alarm Levels

Anomalous results are flagged by computer screening of reported data as they are entered into the project database. Levels for reporting to DOE-RL have been established and are listed in the Records Management and Reporting subsection. Reporting levels are equivalent to the concentration that might lead to an MEI dose of 1 mrem (EDE) if it were sustained for a year. This reporting level provides early indication of conditions that might eventually require reporting to DOE-Headquarters, as required by DOE Order 5400.5.

Exceptions

No exceptions have been taken to *should** statements in DOE/EH-0173T.

Vegetation and Soil Surveillance

Assurance that natural vegetation and soils on the publicly accessible borders and downwind of the Hanford Site are not significantly contaminated is important to the DOE, the local agribusiness, and the public. Soil and natural vegetation have historically been sampled since the first efforts were made to monitor the accumulation of long-lived radionuclides in the area of the Hanford Site.

Soil and vegetation surveillance is designed to monitor atmospheric deposition in offsite areas not influenced by agriculture and onsite locations adjacent to potential sources of environmental radioactivity. Atmospheric data and modeling indicate that effluents resulting from Hanford Site operations can be carried offsite and deposited onto the land, where there is then the potential for accumulation. Airborne radioactivity can be either gaseous or particulate and can originate from site stacks and vents or from resuspension of contaminated soil by wind. Soils and vegetation on portions of the potentially accessible shoreline also are known, or have the potential, to contain elevated radionuclide concentrations.

The surveillance project provides data on the long-term accumulation of radioactivity onsite and at offsite nonagricultural locations. Sampling at locations adjacent to operating areas documents the levels of contamination available to wildlife and provides an early indication of degradation of controls. Sampling of shoreline areas also provides data to assess potential public exposures from contaminated soils and from the consumption of edible natural vegetation.

Soil and vegetation data are compared to historical data to evaluate trends. The project is conducted to maintain continuity in the environmental database in support of any possible emergency response and to provide reassurance to the public that releases of radioactivity in Hanford Site effluents do not pose a threat to public health. Soil and natural vegetation data are maintained in a comprehensive database that allows data to be compared with historical data from the same location or from locations that are designated control sites. These data are reviewed initially following analysis and collectively in the Annual *Hanford Environmental Report* (e.g., Dirkes et al. 1994). This report compares trends in the monitoring data over the previous 5 years. The information is used to re-evaluate sample site selection, media, and radionuclides that require monitoring.

In many cases, current levels of key radionuclides are at or below detection limits and there is little difference between onsite samples and upwind or downwind offsite samples. Some sample locations near industrialized areas may have slightly elevated concentration. The dose contribution to the hypothetical MEI from external exposure to contaminated vegetation and soil is negligible. Selected shoreline areas are known to have elevated concentrations in vegetation and soil; however, they do not result in significant public dose. Soil and vegetation data provide assurance to the public on environmental levels of radioactivity and contribute to the historical database for assessing unplanned releases and trends.

Objectives

The objectives of this activity are to:

- monitor the long-term buildup and inventory of long-lived radionuclides (^{90}Sr , ^{137}Cs , uranium, plutonium, and for special sites, ^{99}Tc) onsite and offsite from deposition of airborne releases, from either stacks, vents, or resuspended dust from clean-up activities
- monitor contaminated, or potentially contaminated, areas along the Columbia River shoreline
- provide assurance to the public that the degree of contamination from Hanford Site operations is known and quantified
- provide baseline data to quantify any incremental effects of unexpected releases of radioactivity and long-term buildup of radioactivity
- conduct surveillance to meet FFTF technical specifications (HEDL 1981).

Plan Rationale and Criteria

The current soil and vegetation surveillance criteria are based in part on *should** statements found in DOE/EH-0173T. The current effort is designed to meet the minimum sampling necessary to maintain public assurance for documentation of environmental radioactivity on and near the Hanford Site.

Media Selection

Vegetation sampling in recent years has been reduced because concentrations of radionuclides routinely analyzed have decreased below the detection limit. Moreover, concentrations of these radionuclides are more readily measured in soil samples than vegetation samples. Consequently, monitoring of radioactivity in vegetation samples has been focused on those areas onsite that have indicated potentially elevated concentrations, perimeter locations located downwind, and an upwind location. Future vegetation sampling onsite will focus on special studies and will emphasize sample collection along the Columbia River shoreline and aquatic vegetation in the river, selected terrestrial location sites associated with clean-up activities, and special interests.

Vegetation samples are to be made up of the prevalent natural plants, usually rabbit brush and sagebrush, at the sampling location. Shoreline plants consist of usable and edible natural plant materials to better characterize concentrations in plants that might be collected by the public. Plants of potential cultural significance will also be sampled on an as-needed basis. Sample collection and handling procedures are contained in PNL-MA-580.

Soil and vegetation sampling provides a direct measurement in support of air monitoring efforts to document fugitive radioactive effluents that settle on the ground. Additionally, special sampling will be conducted as needed to address Site clean-up actions, decommissioning, and transfer of property to other federal, state, or regional agencies.

Analyte Selection

Soil samples are to be analyzed for the radionuclides common to Hanford Site operations. All soil samples are analyzed for gamma emitters, ^{90}Sr , ^{235}U , ^{238}U , $^{239,240}\text{Pu}$, and, for selected samples, ^{241}Am . Vegetation samples are analyzed for gamma emitters, ^{90}Sr , $^{239,240}\text{Pu}$, and uranium. Vegetation samples at the Old Hanford Townsite are also analyzed for ^{99}Tc because of its presence in springs. These

radionuclides are selected because they persist in the environment, given their long half-lives, and because they are indicative of past Site operations. Americium-241 is analyzed in selected samples because of its long half-life and presence in fuel reprocessing activities. Additional radionuclides may be added if Site operations produce additional sources of radioactivity.

Sampling and Analysis Frequency Selection

Soil and vegetation samples are collected annually from onsite locations. Annual sampling is consistent with the primary purpose of sampling these media to detect long-term trends in environmental radioactivity. Additionally, for the industrialized areas of the site, annual monitoring provides a check on fugitive emissions. Perimeter and onsite locations distant from potential sources of radioactive deposition on soil are sampled once every 3 years. Distant control stations are sampled once every 5 years and will be sampled in 1995, as planned. The routine schedule for 1995 will be adjusted to a 5-year schedule with sampling next scheduled for 2000 pending evaluations of monitoring needs at that time and results of special studies. The current sampling plan entails a 5-year cycle that will be completed in 1995 (Table III.A-9.1).

The following groups of sample locations will be sampled annually for onsite comparisons of soil.

- 200 Area Plateau
- 100-N Area
- 300-400 Areas
- 600 Area

Table III.A-9.1. Projected Schedule for Soil and Vegetation Samples to be Collected in 1995

General Location	Number	Frequency ^(a)	Analytes
Soil			
Onsite			
100-N Area	5	A	⁹⁰ Sr, gamma scan, U, Pu
200 Areas	7	A	⁹⁰ Sr, ²⁴¹ Am, gamma scan, U, Pu
300 Area	2	A	⁹⁰ Sr, gamma scan, U, Pu
400 Area	2	A	⁹⁰ Sr, gamma scan, U, Pu
Old Hanford Townsite	1	3 yr	⁹⁰ Sr, gamma scan, U, Pu
Non-Area Specific	7	A to 3 yr	⁹⁰ Sr, gamma scan, U, Pu
Offsite			
Close	11	A to 3 yr	⁹⁰ Sr, ²⁴¹ Am, gamma scan, U, Pu
Distant	6	A or 5 yr	⁹⁰ Sr, gamma scan, U, Pu
Vegetation			
Onsite			
100-N Area	4	A	⁹⁰ Sr, gamma scan, U, Pu
200 Areas	1	A	⁹⁰ Sr, gamma scan, U, Pu
300 Area	1	A	⁹⁰ Sr, gamma scan, U, Pu
Old Hanford Townsite	1	A	⁹⁰ Sr, ⁹⁹ Tc, gamma scan, U, Pu
Non-Area Specific	1	A	⁹⁰ Sr, gamma scan, U, Pu
Offsite	6	A	⁹⁰ Sr, gamma scan, U, Pu

(a) = annually; 3-year samples to be collected next in 1996, 5-year samples to be collected next in 1995.

This sampling schedule is consistent with DOE/EH-0173T requirements and the change in the Site mission from production to cleanup. The soil and vegetation monitoring schedule will be reviewed annually. A more intensive sampling effort is not needed because of the low dose to the hypothetical MEI (see DOE/EH-0173T). Another contributing factor to less frequent sampling is the rather extensive database that has accumulated over time, coupled with decreased onsite production activities. Sampling frequency may be intensified in conjunction with site cleanup activities or in the event of an accidental release.

Sampling Location Selection

Sample sites are located in undisturbed areas to facilitate monitoring of long-term accumulation (Figure III.A-9.1). Generally, vegetation and soil samples are collected near air and external radiation sampling locations to facilitate interpretation of results (see DOE/ET-0173T). Soil and vegetation sample locations are selected to provide close-in monitoring of facilities that could release radioactive materials onsite. These include the 100, 200, 300, and 400 Areas. Many onsite locations appear to be relatively unimpacted by Hanford operations and the concentrations of radionuclides are comparable to what has been observed at background locations. In comparison, some onsite locations adjacent to industrialized areas clearly indicate elevated concentrations over background levels. Sampling locations along the Columbia River shoreline are selected to monitor potential public exposures to contaminated vegetation. Other onsite locations are sampled less frequently because they are not associated with any known point sources of radioactivity. Additional sample locations may be added in conjunction with Hanford cleanup activities as needed.

Offsite sampling locations are selected to characterize conditions near the MEI at selected perimeter locations around the Site. The preponderance of sample locations are downwind of the Site (to the east). Collectively, these locations provide information for downwind deposition and upwind control, and provide data, with the historical database, to establish background levels to ascertain the magnitude of contamination resulting from Hanford Site operations and cleanup.

Sampling or Measurement Methods Selection

Soil sampling and vegetation collection methods are described in PNL-MA-580. Vegetation samples consist of the current year's growth. Amounts of each shrub species present are collected in proportion to their estimated abundance at the sample site. Soils are sampled to a depth of 2.5 cm and a diameter of 10 cm. Five composited subsamples are taken from an area of approximately 1,000 ft². These methods meet the general DOE/ET-0173T requirements because of the arid climate and historical and extensive soil and vegetation sampling database.

Sample Handling/Treatment Methods

Samples are double-bagged when collected to minimize the potential for cross-contamination. Some samples are processed with a riffle splitter and are sent to different analytical facilities as part of a cooperative sampling program with the State of Washington Department of Health.

Analytical Methods

Analytical methods are selected to meet the minimum goal of detecting levels equivalent to a dose of 1 mrem if that concentration were sustained for a year. An additional goal is to achieve the lower detection levels available using standard state-of-the-art analytical methods. These goals are summarized in the Laboratory Procedures subsection.

Analysis methods are also summarized in the Laboratory Procedures subsection and are detailed in laboratory procedures of the International Technology Corporation Analytical Services Division (IT 1990).

Quality Control Methods

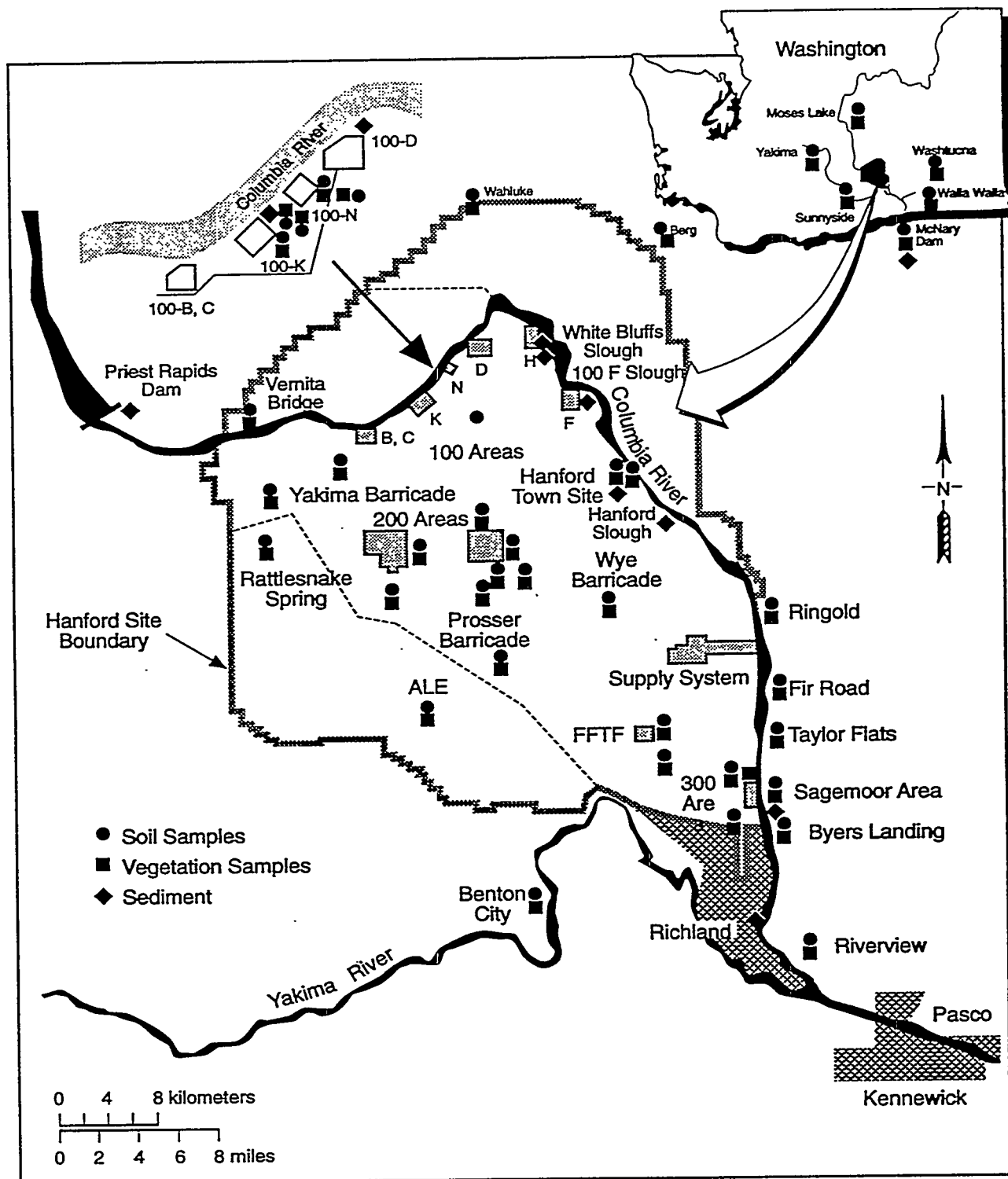
Vegetation and soil surveillance is controlled under the overall project quality assurance and analytical control program that is described in the Quality Assurance and Quality Control subsection.

Reporting/Alarm Levels

Anomalous results are flagged by computer screening of reported data as they are entered into the HEIS database. Levels for reporting to the DOE-RL have been established and are listed in the Records Management and Reporting Procedures subsection. Reporting levels are equivalent to the concentration that might lead to an MEI dose of 1 mrem (EDE) if it were sustained for a year. Exceptions are ^{90}Sr and ^{137}Cs in soil. Reporting levels for these radionuclides are nominally equivalent to a dose of 10 mrem if sustained for 1 year, because the large natural variability in such samples makes it impractical to detect a 1-mrem difference. This reporting level provides early indication of conditions that might eventually require reporting to DOE-Headquarters, as required by DOE Order 5400.5.

Exceptions

No exceptions have been taken to *should** statements in DOE/EH-0173T.



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Figure III.A-9.1. Soil and Vegetation Surveillance Locations

Fish and Wildlife Surveillance

Fish in the Columbia River and local wildlife are valued natural and recreational resources. Fish in the Columbia River and game that cross or are found on islands in the Columbia River may be harvested by the public for consumption. It is important, therefore, that fish and wildlife be sampled to document levels of radioactivity in the edible portions. All collections of fish and wildlife are conducted under permit with the State of Washington Department of Wildlife, the U.S. Fish and Wildlife Service, and PNL's animal care committee, which oversees all PNL activities dealing with vertebrate animals.

Hanford Site fish and wildlife may be exposed to radioactive materials from a number of sources. Waterfowl may nest and feed on low-level onsite waste or cooling water ponds. Fish and other aquatic life are exposed to low levels of radionuclides that enter the Columbia River from springs emanating from the Site (i.e., 100-N, Old Hanford Townsite, and 300 Area). Exposure to Hanford effluents and unplanned releases of radioactive material may lead to low-level contamination of edible portions of fish and game.

Moreover, rabbits located on the Site may enter radiation areas and pick up residual activity. Although rabbits cannot swim across the Columbia River, waterfowl, upland game birds, and deer can cross the river and are subject to hunting. Also, fishing for resident fish is a popular outdoor activity. Consequently, consumption of edible portions of fish and game is an important pathway for evaluating potential human exposure to Hanford Site radioactivity. Exposure of wildlife may increase as Hanford cleanup activities commence. A large inventory of waste is found in the 100, 200, 300, and 600 Areas, and there is a potential for biointrusion at these sites. Collection of species with small home ranges adjacent to operating areas assists in the verification of facility controls.

The calculated 1993 total Site MEI dose is 0.03 mrem (see Table III.A-3.1). The standard MEI scenario includes consumption of fish, but not other game. Fish have constituted as much as 14% of the dose to the MEI at Ringold. The estimated dose is below 0.1 mrem, indicating that, based on DOE/EH-0173T requirements, confirmatory measurements are required at least every 5 years. Consumption of other game may contribute to the offsite dose, though those species with the highest concentrations appear to have home ranges that keep them generally on the Site. Those that might tend to migrate farther (i.e., deer) have relatively lower concentrations. As shown in the Pathway Analysis subsection, the additional doses from wildlife consumption are likely to be substantially below the 5-mrem level suggested for routine surveillance. However, because of the potential for contamination and offsite migration, continued annual surveillance is considered necessary to provide reassurance to the hunting and fishing public. Samples are collected from background locations to estimate the contribution of Hanford-related radionuclides in wildlife.

Objectives

The objectives of fish and wildlife surveillance are to:

- evaluate radionuclides in fish, edible aquatic invertebrates, and wildlife and determine their potential influence on dose to human consumers
- evaluate radionuclides in wildlife near industrialized areas as indicators of biointrusion

- provide assurance to the public that the degree of contamination from Hanford Site operations in fish and wildlife is known and quantified
- provide baseline data to quantify any incremental effects of unexpected releases of radioactivity or long-term buildup of radioactivity in fish and wildlife.

Plan Rationale and Criteria

Consideration of species and selection of radionuclides for monitoring is summarized below.

Media Selection

The species of fish, location, and radionuclide analytes are summarized in Table III.A-10.1. Whitefish have historically been sampled because of their high propensity to accumulate radionuclides; however, carp and bass are also sampled. The species selected for sampling are found in sufficient abundance that sampling will not affect population stability. Species that may possibly be consumed as harvestable game or fish are preferred; however, consideration is also given to species that have a high potential for exposure to Site effluents or that may intrude on waste sites. Special consideration is given to species that may be specifically consumed by ethnic groups.

Game species collected (Table III.A-10.2) include deer, rabbits, waterfowl, and upland game birds (usually pheasants, but samples may include chukars). Changes to the sampling program involve waterfowl. Geese will be added to sampling on the Hanford Reach and will replace the sample collection location for ducks at the 100-N Area. B Pond (216 B-3) was decommissioned in 1994 and duck sampling will be eliminated because of insufficient habitat on Site. Duck sampling from West Lake will be discontinued because the lake is shrinking due to reduced ground-water discharges in the 200 Areas; it does not maintain a viable population of waterfowl.

Table III.A-10.1. Onsite and Offsite Sampling of Fish, 1995-1997

Species	Locations	Frequency	Analytes
Onsite			
Carp	2 (100-N to 100-D, 300)	Once every 2 yrs (1996)	⁹⁰ Sr, gamma ⁹⁰ Sr, gamma, U-Iso
Whitefish	2 (100-N to 100-D, 300)	Once every 2 yrs (1995, 97)	⁹⁰ Sr, gamma ⁹⁰ Sr, gamma, U-Iso
Bass	2 (100F / Hanford Slough)	5 times in 3 yrs (1996)	⁹⁰ Sr, gamma ⁹⁰ Sr, gamma, U-Iso
Offsite			
Carp	Vantage	Once every 3 yrs (1998)	⁹⁰ Sr, gamma ⁹⁰ Sr, gamma, U-Iso
Whitefish	Rocky Reach	Once every 3 yrs (1995)	⁹⁰ Sr, gamma ⁹⁰ Sr, gamma, U-Iso
Bass	Vantage	Once every 3 yrs (1996)	⁹⁰ Sr, gamma ⁹⁰ Sr, gamma, U-Iso

Table III.A-10.2. Onsite and Offsite Sampling of Wildlife

Species	Locations	Number	Frequency ^(a)	Analyte
Onsite				
Deer	3 ^(b)	2	A	
Muscle				Gamma scan
Liver				Pu
Bone				⁹⁰ Sr
Jackrabbit	2	4	A	
Muscle				Gamma scan
Liver				Pu
Bone				⁹⁰ Sr
Cottontail	2	4	A	
Muscle				Gamma scan
Liver				Pu
Bone				⁹⁰ Sr
Geese	2	5	A	
Muscle				⁹⁰ Sr, gamma scan, U
Liver ^(d)				⁹⁹ Tc ^(c)
Bone				
Pheasant or Chukar	3	3 to 6	A	
Muscle				⁹⁰ Sr, gamma scan, U
Liver ^(d)				
Bone	3	3 to 6	A	⁹⁰ Sr
Offsite				
Deer	1	4	5 yr	
Muscle				Gamma scan
Liver				Pu
Bone				⁹⁰ Sr
Jackrabbit	1	10	5 yr	
Muscle				Gamma scan
Liver				Pu
Bone				⁹⁰ Sr
Cottontail	1	10	5 yr	
Muscle				Gamma scan
Liver				Pu
Bone				⁹⁰ Sr
Geese	1	10	5 yr	
Muscle				⁹⁰ Sr, gamma scan, U
Liver ^(d)				⁹⁹ Tc ^(c)
Bone				Pu
Liver ^(d)				⁹⁰ Sr
Pheasant	1	10	5 yr	
Muscle				⁹⁰ Sr, gamma scan, U
Liver ^(d)				Pu
Bone				⁹⁰ Sr

(a) A = annually; otherwise the value indicates the yearly sample cycle.

(b) Includes 6 road-kill deer;

(c) Not all samples are analyzed for ⁹⁹Tc.

(d) Not routinely analyzed.

Analyte Selection

The persistent radionuclides ^{90}Sr and ^{137}Cs are routinely monitored in all fish and wildlife common to Hanford Site operations. Elevated levels of ^{137}Cs will be used to trigger additional analyses for plutonium in liver from waterfowl and game birds. Plutonium in liver and ^{90}Sr in bone are routinely analyzed for in control geese, control upland game birds, rabbits, and deer.

Sampling and Analysis Frequency

Fish and wildlife are collected annually from onsite locations. This schedule exceeds the minimum requirements of DOE/EH-0173T; however, the current level of effort is consistent with meeting DOE concern for public reassurance relative to contamination levels in game and fish in the region, emphasis on clean-up activities on the Site, and recent proposals regarding the fate of the Columbia River.

Fish will be collected on a rotating schedule beginning in 1995. Whitefish and carp are collected on alternating years from the Hanford Reach locations (in particular, the 100-N to 100-D section of the river) and at background locations every 3 years. Alternating years for carp and whitefish is justified because both species are bottom-feeding omnivores and are prone to absorption of radionuclides associated with benthic foodchains. Bass are sampled from the 100-F Hanford Sloughs because of potential harvest by fishers and the opening up of the Reach as Site restoration proceeds.

Offsite control wildlife are collected on a 5-year schedule; fish have been placed on a 2-to-3 year rotating schedule, including sample collection at background locations.

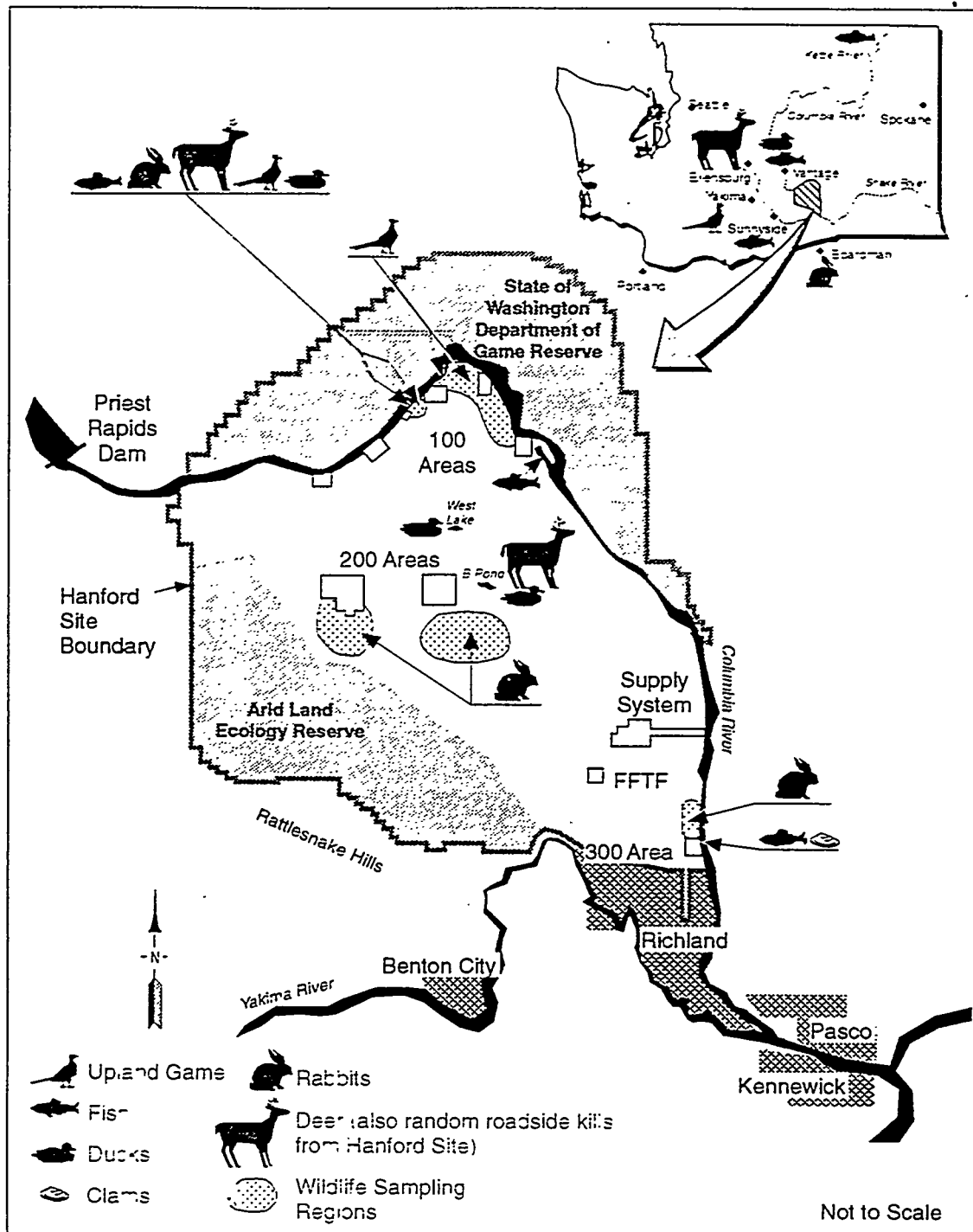
Sample Location Selection

Samples of fish are collected immediately adjacent to and downstream of locations where spring water that is potentially contaminated by radioactivity is known to enter the river. Locations are selected to monitor onsite facilities, nonpoint sources (diffuse), and several offsite control sample sites (Figure III.A-10.1). Moreover, locations are selected to collect fish with the highest potential exposure to Hanford Site radioactive effluents (100-N springs area). Upland game birds and deer are sampled from the 100 Areas because of their potential access to contaminated areas; it is possible for these game species to cross the river and be harvested.

Control samples are collected from areas expected to receive approximately the same contribution of fallout radioactivity as is found on the Hanford Site. For fish, these controls are distant upstream resident fish that have a low probability of passing over dams. Control sites for game species are distant sites, generally considered upwind of Hanford (e.g., Boardman, Oregon, for rabbits and remote arid locations for deer).

Sampling or Measurement Methods Selection

The methods used for fish and wildlife collection are found in PNL-MA-580. That document also addresses sample preparation and forms the basis for annual required training of field personnel. Fish and wildlife are collected by trapping, hunting, and several methods of fishing, including rod and reel, electroshocking, and seining. Disposal of animal waste is performed in accordance with state regulatory agencies and PNL waste management guidance.



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Figure III.A-10.1. Wildlife Surveillance Locations

Sample Handling/Treatment Methods

Samples of fish and wildlife are processed to represent edible portions. Target tissues (liver and bone) are sampled for organ-seeking radionuclides when the tissue levels exceed established criteria. Special care is taken to ensure that flesh and organs are not contaminated by the skin or hair or by piercing the gastrointestinal tract when cleaning the animal. Whenever possible, a sample mass adequate to meet the minimum detectable concentration is collected; however, at times, sample masses are less than the required amount and the minimum detectable concentration increases proportionally. Tissue samples must also be kept free of dirt, as background levels in the soil could lead to erroneously high values.

Analytical Methods

Analytical methods are selected to meet the minimum goal of detecting contaminant levels equivalent to a dose of 1 mrem if that concentration were sustained for a year. An additional goal is to achieve the lower detection levels available using standard state-of-the-art analytical methods. These goals are summarized in the Laboratory Procedures Subsection.

Analytical methods are also summarized in the Laboratory Procedures Subsection and are detailed in laboratory procedures of the International Technology Corporation Analytical Services Division (IT 1990).

Quality Control Methods

Fish and wildlife surveillance is controlled under the overall project quality assurance and analytical control program, described in the Quality Assurance and Quality Control Subsection.

Reporting/Alarm Levels

Anomalous results are flagged by computer screening of reported data as they are entered into the project database. Levels for reporting to the DOE Richland Operations Office have been established and are listed in the Records Management and Reporting Subsection. Reporting levels are equivalent to the concentration that might lead to an MEI dose of 1 mrem (EDE) if it were sustained for a year. This reporting level provides early indication of conditions that might eventually require reporting to DOE-Headquarters, as required by DOE Order 5400.5.

Exceptions

No exceptions have been taken to *should** statements in DOE/EH-0173T.

External Radiation Surveillance

External radiation exposure can be produced by various sources on and around the Hanford Site. The environmental pathways through air and surface water can transport radionuclides from effluent sources (point or diffuse) to locations near the public and biota. Many of these released radionuclides produce penetrating particles and photons (i.e., beta, gamma) during decay processes in media external to an organism. These media include cloud passage, surface water, soil, sediment, and vegetation. Other actual or potential sources of external radiation on the Hanford Site include radioactive waste handling, storage, and processing facilities; and radiation-generating facilities and equipment. Any of these external radiation sources can potentially produce significant exposures and doses to the public and/or biota.

The pathway analysis (see Table III.A-3.7) indicated that the total external radiation dose to the MEI from the Site operations in 1993 was less than 0.03 mrem (30 μ Sv), well below the level at which routine surveillance is recommended. This dose from external exposure was not measured directly; it was determined using calculational models and effluent data for the year. Because of the limitations of detection sensitivities for various external exposure measuring devices, it can be inferred that there is little potential for directly detecting increased external radiation from routine releases.

Several actual or potential sources could lead to external radiation exposure of the public or onsite biota from radiation or radioactive materials. These sources include nuclear operations, waste process streams, waste sites, diffuse sources, and onsite transport of sources or wastes. Various radiological emergency scenarios may result in significant levels of external radiation in the environment. Because of continuing changes in Site mission, production objectives, and land use, the significance of each of these pathways continues to vary.

The pathway analysis, based on effluent data, does not address existing and potential external radiation from sources such as contaminated surface sediments and soil and waste sites. However, background and elevated levels of external radiation have been studied extensively in the Hanford Site environment (Cooper and Woodruff 1993; Rathbun 1989; Sula 1980), with detection of measurable increases caused by Hanford Site operations at various onsite locations and on the Hanford Reach of the Columbia River. A recent aerial survey study (EG&G 1990; Snyder, Atlanto and Ikenberry 1994) confirmed most of these findings, indicating several onsite locations and locations along the Hanford Reach that have above-background gamma levels. These elevated terrestrial exposure locations are mainly to the south and west of the Columbia River (onsite operational areas) and are generally not accessible to the public for extended periods of time. The elevated radiation locations along the river, islands, and state/federal wildlife land of the Hanford Site are areas with access restrictions; however, the public occasionally occupies these areas for varying lengths of time. The highest exposure rate at a publicly accessible location occurs near the 100-N shoreline. At this location, exposure levels are approximately two to three times the natural terrestrial background for the area. These studies and other data indicate that Hanford operations, in recent history, have not caused detectable increased levels of offsite external radiation.

Generally, it can be expected that increases in offsite external exposure rates from current routine releases will be difficult if not impossible to detect above background using cost-effective conventional monitoring (thermoluminescent dosimeters [TLDs], survey meters, etc.).

Objectives

The objectives of external radiation monitoring are to:

- obtain external exposure measurements for actual and potential external radiation levels at locations of actual and potential public access to support the verification that doses to the public through all potential pathways from Hanford Site operations remain low relative to standards
- provide confirmatory measurements of actual or potential increases in exposures of the public or biota to radiation or radioactive materials from nuclear operations, waste process streams, waste sites, diffuse sources, or onsite transport of sources or waste
- obtain preoperational baseline data and environmental data near waste units scheduled for treatment and/or restoration, to assess the integrated effects of individual operations
- obtain measurements at the Site perimeter and in nearby communities to provide public assurance that the degree of external radiation exposure from Site operations is known
- measure onsite and offsite external radiation exposure for emergency response to accidents and to provide measurements to assess the environmental effects and doses from unusual releases
- support the evaluation of the effectiveness of Hanford Site effluent controls and models for predicting the concentrations of pollutants in the environment
- conduct surveillance to meet FFTF technical specifications (HEDL 1981).

Plan Rationale and Criteria

The criteria for external radiation monitoring consist of those identified as the *should** statements in DOE/EH-0173T. Any exceptions to those criteria are identified in the Exceptions discussion below. The minimum level of surveillance for the Hanford Site, adapted from the objective criteria in DOE/EH-0173T, are described in Table III.A-4.1. The level of surveillance and the specific criteria to meet the above objectives are described below.

The monitoring locations, measurements, methods, and frequencies for meeting external radiation surveillance objectives and criteria are summarized in Tables III.A-11.1 through III.A-11.3 and Figures III.A-11.1 through III.A-11.3. The rationale and any specific criteria for these selections are discussed below.

Table III.A-11.1. Terrestrial Locations - Stationary Dose Measurements

Location	Location Number	Frequency	Measurement	Instrument
Onsite^(a)				
100-K ^(b)	1	Q	Ambient dose	
100-N (WPPSS)	2	Q	Ambient dose	
100-D ^(b)	3	Q	Ambient dose	
N of 200-E ^(b)	4	Q	Ambient dose, DOH ^(c)	
200 Tel. Exchange ^(b)	5	Q	Ambient dose, DOH ^(c)	
200 W SE ^(b)	6	Q	Ambient dose	
S of 200-E ^(b)	7	Q	Ambient dose, DOH ^(c)	
B Pond ^(b)	8	Q	Ambient dose	
E of 200-E ^(b)	9	Q	Ambient dose, DOH ^(c)	
200-ESE ^(b)	10	Q	Ambient dose, DOH ^(c)	
3705 Building	11	Q	Ambient dose	
300 Water Intake ^(b)	12	Q	Ambient dose	
300 Southwest Gate	13	Q	Ambient dose	
300 South Gate ^(b)	14	Q	Ambient dose	
300 Trench ^(b)	15	Q	Ambient dose	
300 NE ^(b)	16	Q	Ambient dose	
400-E ^(b)	17	Q	Ambient dose	
400-W ^(b)	18	Q	Ambient dose	
400-S ^(b)	19	Q	Ambient dose	
400-N ^(b)	20	Q	Ambient dose	
Wye Barricade ^(b)	21	Q	Ambient dose, DOH ^(c)	
US Ecology NE Corner	22	Q	Ambient dose, DOH ^(c)	
US Ecology SE Corner	23	Q	Ambient dose, DOH ^(c)	
US Ecology NW Corner	24	Q	Ambient dose, DOH ^(c)	
US Ecology SW Corner	25	Q	Ambient dose, DOH ^(c)	
WPPSS 1 S of WNP 2	26	Q	Ambient dose, DOH ^(c)	
Perimeter^(d)				
Ringold Met. Tower ^(b)	1	Q	Ambient dose	
Byers Landing ^(b)	2	Q	Ambient dose	
Battelle Complex ^(b)	3	Q	Ambient dose	
WPPSS 4 WPPSS Warehouse	4	Q	Ambient dose, DOH ^(c)	
WPPSS 8 Fir Road	5	Q	Ambient dose, DOH ^(c)	
Community^(d)				
Basin City ^{(b)(e)}	6	Q	Ambient dose	PIC ^(f)
Pasco ^(b)	7	Q	Ambient dose	
Kennewick ^(b)	8	Q	Ambient dose	
Benton City ^(b)	9	Q	Ambient dose	
Mattawa ^(b)	10	Q	Ambient dose	
Edwin Markham ^{(b)(e)}	11	Q	Ambient dose	PIC ^(f)
Richland (LGP) ^{(b)(e)}	12	Q	Ambient dose	PIC ^(f)
Distant^(d)				
Sunnyside ^(b)	13	Q	Ambient dose, DOH ^(c)	
Yakima ^(b)	14	Q	Ambient dose, DOH ^(c)	

(a) Refer to Figure III.A-11.1, Thermoluminescent Dosimeter (TLD) Locations on the Hanford Site.

(b) Located at air sampling station.

(c) Washington State Department of Health TLDs also at these locations.

(d) Refer to Figure III.A-11.2, Thermoluminescent Dosimeter (TLD) Locations for Perimeter and Community Sites.

(e) Community-Operated Environmental Surveillance Station.

(f) PIC data (in mR/H) collected monthly.

Table III.A-11.2. Columbia River Shoreline Stationary Dose Measurements

Location ^(a)	Location Number	Frequency	Measurement
Above 100-B Area	1	Q	Ambient dose
Below 100-B Retention Basin	2	Q	Ambient dose
Above 100-K Boat Ramp	3	Q	Ambient dose
Below 100-N Outfall	4	M	Ambient dose
Below 100-N Stack	5	M	Ambient dose
Above Tip 100-N Berm	6	M	Ambient dose
100-N Trench Spring	7	M	Ambient dose
Below 100-D Area	8	Q	Ambient dose
Below Opposite 100-D	9	Q	Ambient dose
Lower End Locke Island	10	Q	Ambient dose
White Bluffs Ferry Landing	11	Q	Ambient dose
White Bluffs Slough	12	Q	Ambient dose
100-F Floodplain	13	Q	Ambient dose
Below 100-F	14	Q	Ambient dose
Hanford Slough	15	Q	Ambient dose
Hanford Powerline Crossing	16	Q	Ambient dose
Hanford Ferry Landing	17	Q	Ambient dose
Hanford RR Track	18	Q	Ambient dose
Savage Island Slough	19	Q	Ambient dose
Ringold Island	20	Q	Ambient dose
Powerline Crossing	21	Q	Ambient dose
N End Wooded Island	22	Q	Ambient dose
S End Wooded Island	23	Q	Ambient dose
Island Near 300 Area	24	Q	Ambient dose
Island DS Bateman Island	25	Q	Ambient dose
Port of Benton	26	Q	Ambient dose
100-D Island	27	Q	Ambient dose
Island Above 300 Area	28	Q	Ambient dose

(a) Refer to Figure III.A-11.1, Thermoluminescent Dosimeter (TLD) Locations on the Hanford Reach of the Columbia River.

Media Selection

External radiation exposures are measured with consideration for the types and levels of exposure expected from the various pathway transport media and other direct radiation sources. Some of the critical environmental media or sources causing potential external radiation exposure are airborne cloud passage, immersion in surface water, vegetation (i.e., contaminated tumbleweeds), shoreline sediments, and waste handling sites.

Most of the types of radiation causing external exposures are gamma photons and beta particles. External neutron and alpha particle exposures to the public have negligible potential. Historical data support the approach of designing the measurement methods mainly for photon sources, but there is the possibility that pure beta emitters exist in the environment unaccompanied by gamma emitters. Exposure levels at publicly accessible locations are typically in a range from the natural background level to possibly five times greater than the natural terrestrial background.

Table III.A-11.3. Columbia River Shoreline Radiation Surveys

Location ^(a)	Location Number	Frequency	Measurement	Instrument
Above 100-K Boat Ramp	3	Q	Exposure, Surface contamination	BICRON, GM
Below 100-N Outfall	4	M	Exposure, Surface contamination	BICRON, GM
Below 100-N Stack	5	M	Exposure, Surface contamination	BICRON, GM
Above Tip 100-N Berm	6	M	Exposure, Surface contamination	BICRON, GM
100-N Trench Springs	7	M	Exposure, Surface contamination	BICRON, GM
Below Opposite 100-D	9	Q	Exposure, Surface contamination	BICRON, GM
Lower End Locke Island	10	Q	Exposure, Surface contamination	BICRON, GM
White Bluffs Ferry Landing	11	Q	Exposure, Surface contamination	BICRON, GM
Below 100-F	14	Q	Exposure, Surface contamination	BICRON, GM
Hanford Powerline Crossing	16	Q	Exposure, Surface contamination	BICRON, GM
Hanford Ferry Landing	17	Q	Exposure, Surface contamination	BICRON, GM
Hanford RR Track	18	Q	Exposure, Surface contamination	BICRON, GM
Ringold Island	20	Q	Exposure, Surface contamination	BICRON, GM
Powerline Crossing	21	Q	Exposure, Surface contamination	BICRON, GM
100-D Island	27	Q	Exposure, Surface contamination	BICRON, GM
Island Above 300 Area	28	Q	Exposure, Surface contamination	BICRON, GM

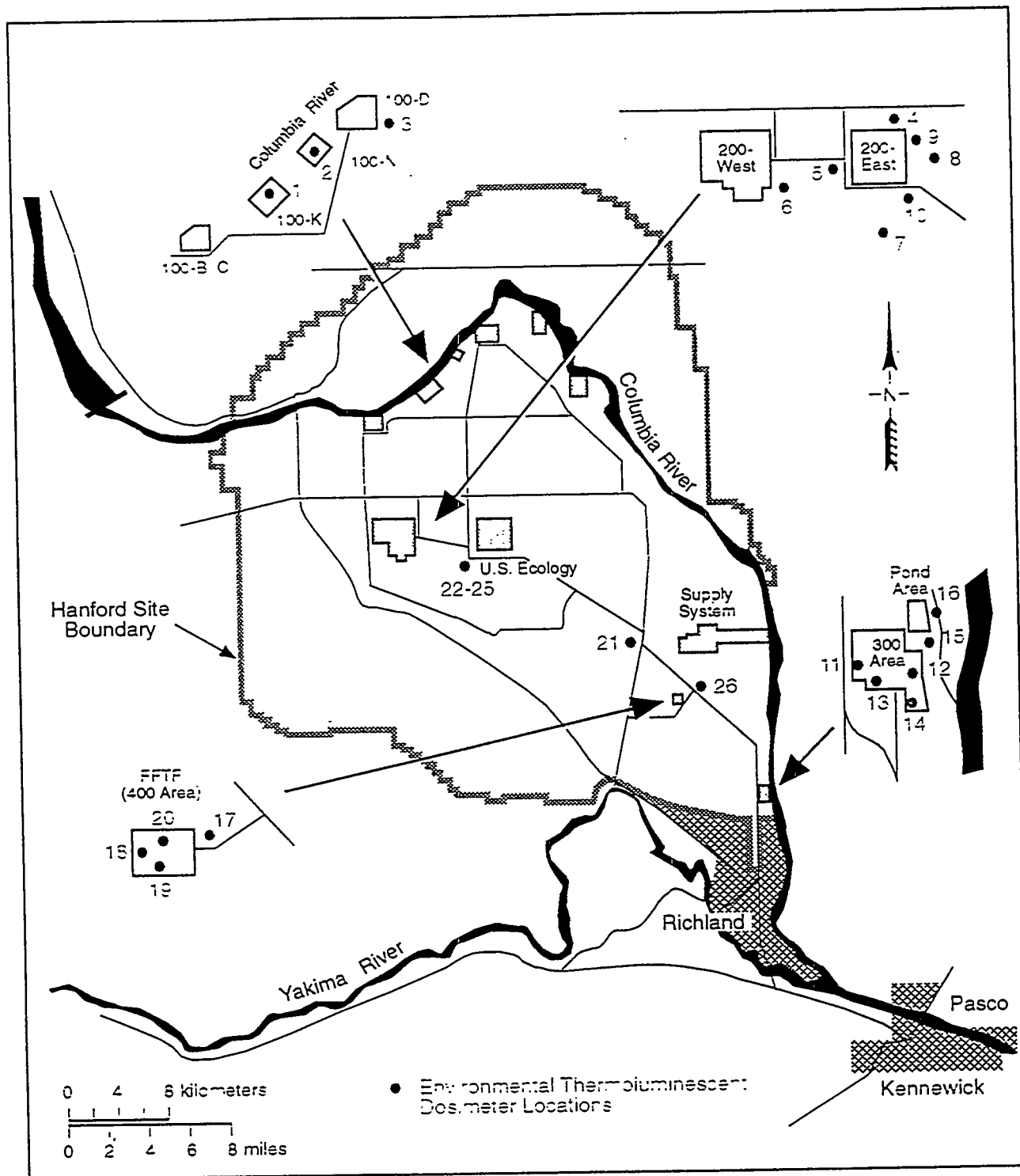
(a) Refer to Figure III.A-11.1, Thermoluminescent Dosimeter (TLD) Locations on the Hanford Reach of the Columbia River.

Analyte Selection

Whole-body and skin doses from external radiation fields caused by gamma (i.e., ^{137}Cs) and "hard" beta emitters (i.e., ^{90}Sr) are estimated using a variety of methods.

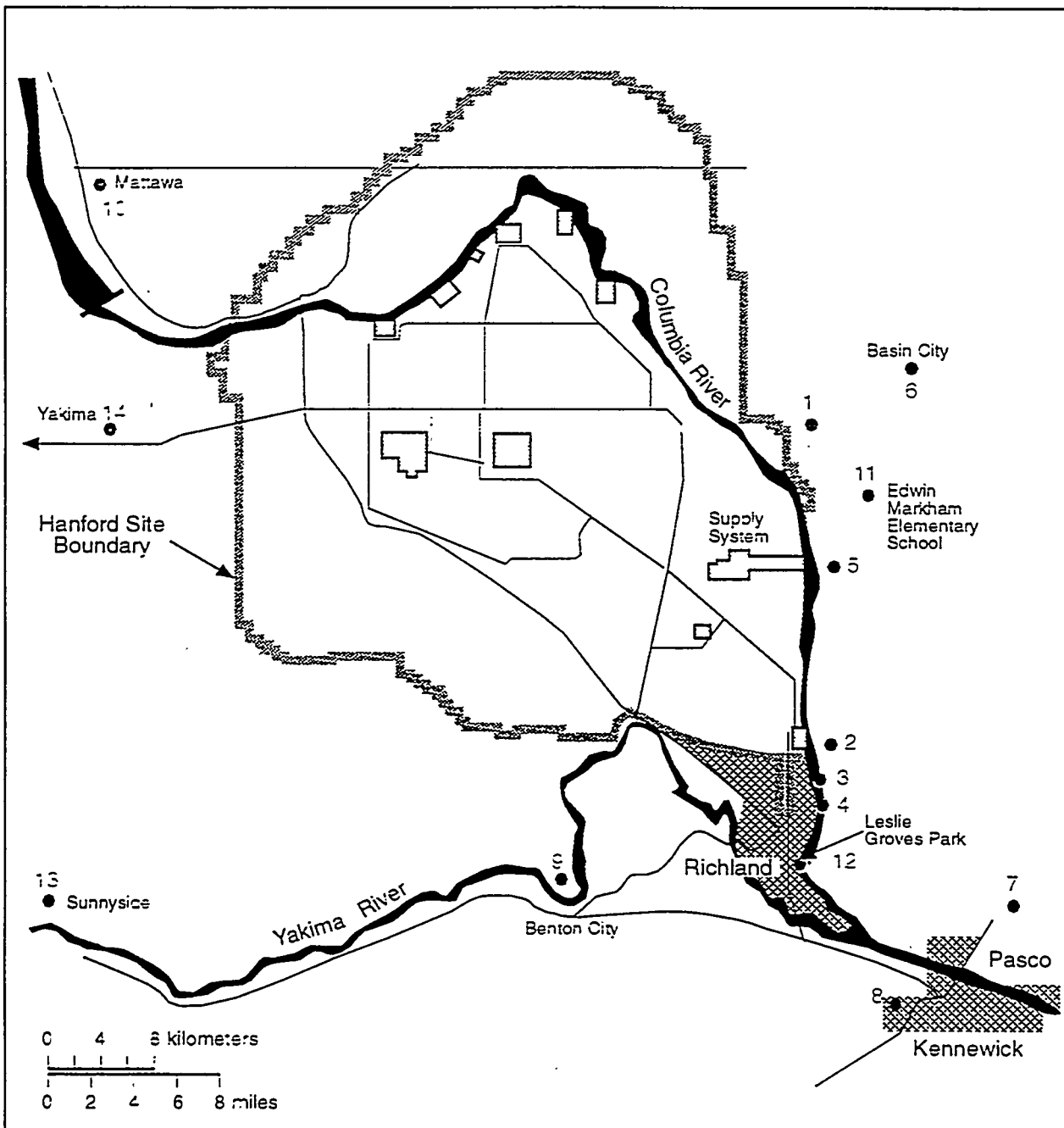
Sampling and Analysis Frequency

Sampling frequencies are determined based on the potentials for detecting elevated external radiation levels and for public exposure. Equipment limitations can be important, as in the case of the widely used TLD. The minimum detectable integrated exposure of the currently used TLD-700 system is approximately 6 mR, and exposure times that produce at least 15 to 20 mR are recommended for the desirable "2 σ " (95% confidence level) values. Therefore, TLDs may have variable exchange frequencies, depending on the exposure levels expected in the sampling location. The potential for



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Figure III.A-11.1. Environmental Dosimeter Locations on the Hanford Site



SS212076.1a

Figure III.A-11.2. Environmental Dosimeter Locations at the Site Perimeter and Community Sites

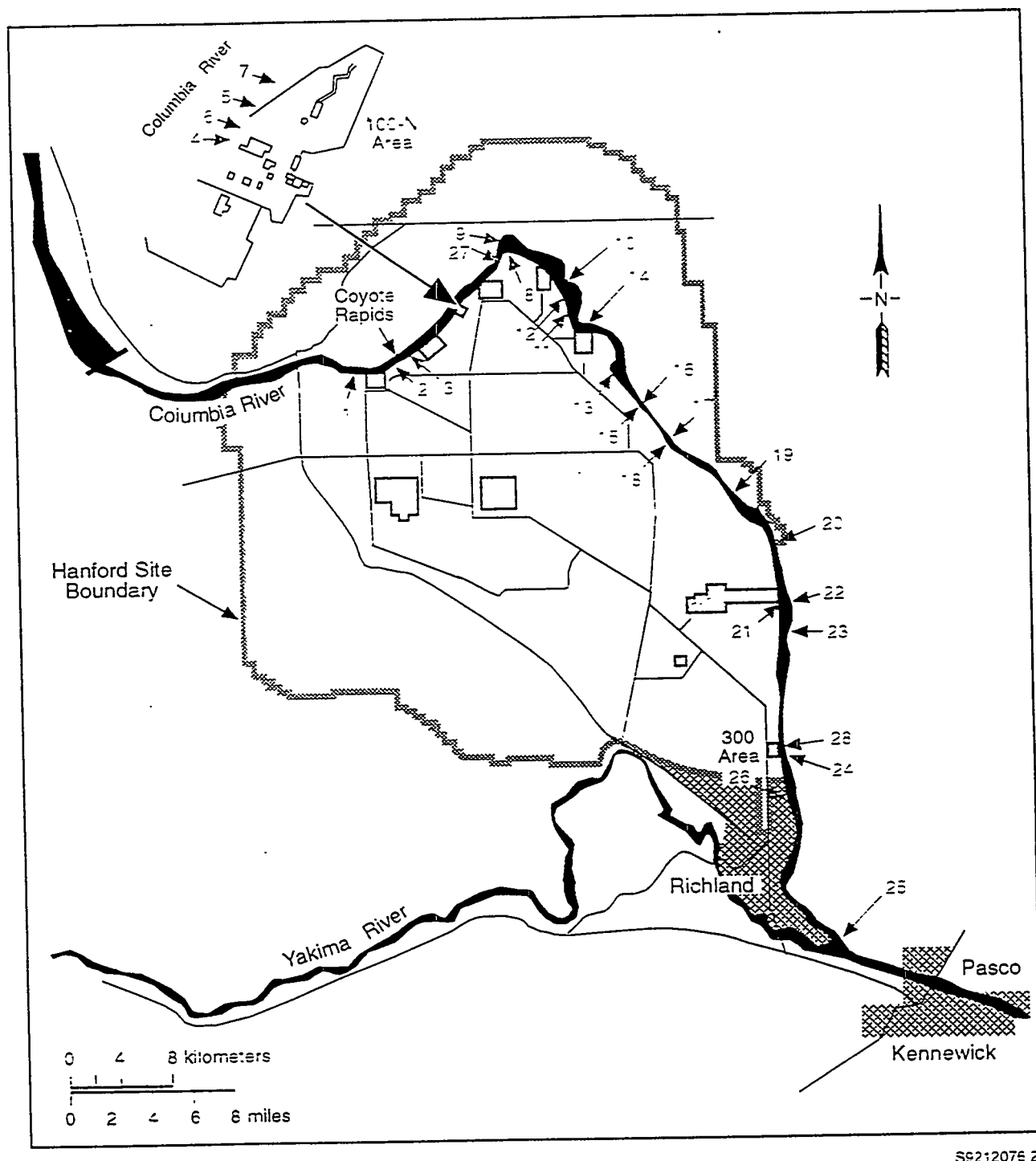


Figure III.A-11.3. Environmental Dosimeter Locations Along the Hanford Reach of the Columbia River

detecting external radiation levels caused by current onsite operations is insignificant at most offsite locations, as opposed to onsite locations that have variable and greater potential. Sampling frequencies for onsite surveys and TLDs require adjustments that reflect changes (such as potential for loss of control of radiation and modifications in operations or transportation of radiation sources). If intermittent or sporadic operations have significant potential for elevating environmental exposures, survey frequencies are adjusted. Established communication channels with WHC are used to acquire current operational information.

The exchange frequency for most TLDs is quarterly because approximately this much exposure time is needed to generate statistically confident results well above the limit of detection. Frequencies for TLDs in significantly elevated exposure areas (such as the 100-N shoreline) are monthly because this exposure period is long enough to provide statistically confident results and because this is an area of significance for detecting potential public exposures. The frequency can be changed to improve the statistical confidence (longer exposures) or the expedience of data gathering (shorter exposures), but these approaches have opposing effects and must be taken into account when adjusting sampling frequencies. If sampling periods shorter than 1 month are needed, pressurized ionization chambers (PICs) or exposure meter measurements will be considered.

The PIC measurements are continuously taken at prevailing downwind offsite locations. "Running" average exposure rates are displayed on a liquid crystal display, and averages are transferred to a removable data cartridge. The exposure rate data on the cartridge are collected monthly and transferred to a spreadsheet file for evaluation by PNL staff. The data are plotted and posted at community-operated environmental surveillance stations for public information.

Frequencies for instrument surveys vary and are set to be approximately proportional with the potential for detecting elevated exposure to the public. Some onsite surveys are performed by WHC (such as all waste site, road, and rail surveys), and will be considered in establishing frequencies. Shoreline surveys are performed either quarterly or monthly to coincide with TLD exchange dates for efficiency.

Sampling Location Selection

External radiation sampling locations are to be selected to accomplish the surveillance objectives. Several sources of information are used to help determine the potential for detecting or preventing increased exposures to the public. Some important factors that influence the determination of sampling locations are the radiation source characteristics, meteorology, geography, hydrology and sedimentation, population distribution, and recreational activities or lifestyles.

Although it appears that for public dose assessment there is little need to perform distant offsite external radiation monitoring for effects from airborne routine effluents or diffuse sources, selected sampling sites are maintained and concentrated around the local communities. There is a continual need for emergency preparedness dosimetry, confirmation of effluent controls, dose modeling, public assurance, and background monitoring. To fulfill these needs requires placement in strategic offsite locations that are generally upwind for the background location(s) and in population centers weighted toward prevailing wind directions (Waite 1973a, 1973b). Because of the size of the Hanford Site, maximum predicted concentrations from airborne effluents are typically onsite, and sampling at these locations should continue even though the data do not indicate public exposures.

The effects of the river transport pathway on external radiation levels have been studied because of the significant amount of radionuclides released into the Columbia River from past operations (Sula 1980). Liquid effluents from wastewater treatment, ground water, and contaminated springs have generally continued to decrease, causing lower levels of external exposure-producing radionuclides in the Columbia River. At the same time, most of the elevated exposure areas on the shoreline and islands from radionuclides that have accumulated in the sediment have decreased because of physical decay. Although significant external exposure potential at accessible locations along the river appears to be decreasing, it is assumed that elevated radiation levels to which the public could be exposed will be detectable for many years. Because of extensive river usage by local inhabitants, exposure monitoring will continue with emphasis on characterizing potential radiation fields that may expose the public. The 100-N Area shoreline has the greatest potential for the detection of increased external exposure levels from onsite operations. A technical consideration in selecting associated sampling locations along the river is the fact that the shoreline levels change significantly with water-level fluctuations. This creates a variable when estimating a dose, based on stationary sampling points, to someone standing at the shoreline. This is addressed by intermittent exposure surveys (survey meter, PIC, etc.) during seasons of recreational use. Selecting sampling locations is coordinated with water and sediment sampling locations for data comparability and support to the extent possible.

Before starting a new TLD sampling location, an initial survey is performed and documented to determine the natural radiation levels. Gamma spectroscopy, PIC measurements, micro-rem meters, and/or soil sample analyses are considered in initial survey characterizations. A study by Rathbun (1989) confirmed the importance of characterizing the radionuclides contributing external dose at sample locations. That study determined that naturally occurring higher concentrations of ^{40}K and thorium caused some perimeter TLD results to be consistently higher than typical onsite or offsite samples.

Sampling locations for PIC systems are not near large structures, in valleys, near atypical geologic strata, or at an unrepresentative altitude unless it is determined that such characteristics do not jeopardize the surveillance objective for that location.

Sampling or Measurement Methods Selection

Ambient whole-body external radiation dose integrations are typically performed using the environmental dosimeter, consisting of four TLD-700 chips and one TLD-200 chip (reserved for emergencies). The TLD-700 chips are preferred over others because of their relatively energy-independent response, tissue equivalence atomic mass, and minimal fade when deployed for extended periods.

The PIC is used at various offsite and onsite locations to accurately measure instantaneous whole-body exposure rates from gamma photons or X rays with energies greater than 70 keV. The PIC has computer memory capability to record average exposure rates over varying lengths of time and to integrate total exposures. The manufacturer-published accuracy for the PIC is $\pm 5\%$ at background levels, and the PIC has a range extending to 100 mR/h.

Routine external exposure rate surveys along the Columbia River are performed using micro-rem meters. The Bicon micro-rem meter detector utilizes a tissue-equivalent organic scintillator to measure dose rate. The energy response of the micro-rem meter is approximately flat for photon energies above 40 keV.

Routine contamination surveys by hand-held instruments are performed using the Geiger-Müller survey meter. Geiger-Müller meters are used for measuring surface contamination levels for beta or gamma emitters; results are reported in counts per minute and used to interpret compliance with regulatory limits. Although alpha-emitting radionuclides typically do not pose significant external radiation problems, the use of portable alpha survey equipment (such as an alpha scintillation probe/meter) is required when there is a concern about isolated alpha-emitter contamination.

Sample Handling/Treatment Methods

The TLDs are collected in a manner to ensure accurate exposures by appropriately shielding them in lead containers before and after deployment. The TLDs are handled in transport with consideration for keeping them unexposed to significant external radiation fields that would generate false positive data. Comments describing any unusual handling of TLDs or any findings that may affect TLD results are to be recorded on the Environmental Monitoring Trip Log.

Sample collection and handling procedures are contained in PNL-MA-580.

Analytical Methods

Ambient dose is measured at TLD sampling stations, which consist of three environmental dosimeters, each containing four lithium fluoride (TLD-700) chips and one calcium fluoride dysprosium (TLD-200) chip in a green Noryl plastic card contained inside a plastic holder. The three TLDs are mounted on a plastic pipe attached to a metal post at approximately 1 m above the ground. The 12 TLD-700 chips at each site are read and averaged to determine the routine exposure (or dose). The three TLD-200 chips are read and reported only as necessary following emergency conditions.

Quality Control Methods

The most important quality control features in this task are the calibration, maintenance, and audits of the TLD reading/recording system; calibration and maintenance of survey instruments; anomalous data tracking system; Radiation Protection Technologist training; and procedures and records maintenance. The quality control for TLDs is established pursuant to PNL-MA-70. Intercomparison studies have been conducted to determine and document TLD processing performance. Some stations are co-located with state of Washington TLDs for intercomparison of results. Survey instruments are calibrated to applicable standards of the American National Standards Institute (ANSI-N323) using radiation sources and standards traceable to the National Institute of Standards and Technology (NIST). Check source tests of detecting equipment are routinely performed before, during, and after (when required) surveys. The PICs are returned to the factory for calibration and maintenance periodically. The anomalous data tracking system in the environmental database is used to perform initial screening of TLD data (see Quality Assurance and Quality Control subsection).

Reporting/Alarm Levels

Anomalous TLD results are flagged by computer screening of reported data as they are entered into the project database. Investigation into an anomalous result includes, as necessary, verification of the quality of the result (sampling and analytical aspects), questioning the operators of facilities near the location with anomalous results about unusual situations, reviewing nearby air sampling results, and possibly following up with immediate portable instrument measurements and/or gamma spectroscopy. Reporting levels for TLDs and PICs have not been set because these instruments are not capable of

reliably detecting an annual incremental dose of 1 mrem above background, and measurements of environmental media are more capable of detecting events that could lead to a 1-mrem incremental external dose.

Exceptions

Neutron dose detection currently is not of concern in environmental measurements because no significant potential sources for public exposure have been identified. Facility construction, security, and distances to public access points eliminate the potential for any public exposure to significant neutron fields.

Potential submersion skin doses to members of the public are estimated from effluent data and are included in dose calculations for the EDE to members of the public. Although TLDs do perform some beta detection, potential skin dose to the public is currently not considered significant and is not reported in TLD results.

Onsite or offsite continuous gamma spectroscopy has not been used to detect environmental exposures because the cost has not been justified by current operations and effluent levels. Gamma spectroscopy has been used and is available for the characterization of photon-emitting radionuclides at various onsite and offsite locations.

Shoreline exposure measurement locations are not typically established at key water sampling locations at the Site boundary (along the Columbia River), because concentrations of radionuclides in water are routinely low enough not to cause any significant external exposure. If water sampling is performed in areas where the concentration levels are suspected to be high enough to cause external exposures, exposure measurements are made.

Dose Assessment Methods

The radiation dose that the public could potentially receive during a calendar year from Hanford operations is calculated in terms of the "effective dose equivalent" (EDE). These dose quantities are given in units of millirem (mrem) [milli-sievert (mSv)] for individuals and in units of person-rem (person-Sv) for the collective dose received by the total population within an 80-km (50 mi) radius of the Site. These quantities provide a way to uniformly express the radiation dose, regardless of the type or source of radiation or the means by which it is delivered. This subsection describes how the doses are calculated.

Releases of radionuclides from the Hanford Site activities are usually too low to be measured in offsite air, drinking water, and food crops. Therefore, in most cases, the dose calculations are based on measurements made at the point of release (stacks and effluent streams), and environmental concentrations are estimated from these effluent measurements by environmental transport models.

The transport of radionuclides from the environment to the point of exposure is predicted by empirical models of exposure pathways. These models calculate concentrations of radionuclides in air, water, and foods. Radionuclides taken into the body by inhalation or ingestion may be distributed among different organs and retained for various times. In addition, long-lived radionuclides deposited on the ground become possible sources for long-term external exposure and uptake by agricultural products. Dietary and exposure parameters are applied to calculate radionuclide intakes and radiation doses to the public. Standardized computer programs are used to perform the calculations. These programs contain internally consistent mathematical models that use Site-specific dispersion and uptake parameters. These programs are incorporated in a master code, GENII (Napier et al. 1988a, 1988b, 1988c), which employs the dosimetry methodology described in International Commission on Radiological Protection (ICRP) Reports (1979a, 1979b, 1980, 1981a, 1981b, 1982a, 1982b, 1988). The assumptions and input data used in these calculations are described below.

Types of Dose Calculations Performed

Calculations of radiation doses to the public from radionuclides released into the environment are performed to demonstrate compliance with applicable standards and regulations.

The DOE requires that estimates of radiation exposure to the general public be in terms of the EDE. The EDE represents the total risk of potential health effects from radiation exposure. The adoption and use of the EDE was previously recommended by the ICRP (1977). In addition to implementing the EDE requirement for offsite population dose calculations, the DOE has also adopted the biokinetic models and metabolic parameters for radionuclides given by the ICRP in 1977 for estimating radiation dose. As in the past, when concentrations of radionuclides in the environment are too low to measure, DOE specifies that the doses are to be calculated from effluent data using environmental transport and dosimetry models.

The calculation of the EDE takes into account the long-term (50-year) internal exposure from radionuclides taken into the body during the current year. The EDE is the sum of individual committed (50-year) organ doses multiplied by weighting factors that represent the proportion of the total health-effect risk that each organ would receive from uniform irradiation of the whole body. Internal organs may also be irradiated from external sources of radiation. The external exposure

received during the current year is added to the committed internal dose to obtain the total EDE. The EDE is frequently expressed in rem (or millirem), with the corresponding value in sievert (or millisievert) in parentheses. The numerous transfer factors used for pathway and dose calculations have been documented in GENII (Napier et al. 1988a, 1988b, 1988c) and by Schreckhise et al. (1993).

The following types of radiation doses are estimated:

1. **"Boundary" Dose Rate (mrem/h and mrem/yr)** The external radiation dose rates during the year in areas accessible by the general public are determined from measurements obtained near operating facilities.
2. **"Maximally Exposed Individual" Dose (mrem).** The MEI is a hypothetical person living at a particular location who has a postulated lifestyle conducive to receiving higher radiation doses than other members of the public would be likely to receive. All potentially significant exposure pathways to this hypothetical individual are considered, including:
 - inhalation of airborne radionuclides
 - submersion in airborne radionuclides
 - ingestion of foodstuffs contaminated by radionuclides deposited on vegetation and the ground by both airborne deposition and irrigation water drawn from the Columbia River downstream of Hanford discharges
 - exposure to ground contaminated by both airborne deposition and irrigation water
 - ingestion of fish taken from the Columbia River
 - recreation along the Columbia River, including boating, swimming, and shoreline activities.
3. **80-km Population Doses (person-rem).** Regulatory limits have not been established for population doses. However, evaluation of the collective population doses to all residents within an 80-km (50-mi) radius of the Hanford Site is required by DOE Order 5400.5. The 80-km (50-mi) population dose represents the summed products of the individual doses for the number of individuals involved for all potential exposure pathways.

The pathways assigned the MEI are assumed to be applicable to the offsite population. Consideration is given, however, to the fraction of the offsite population actually affected by each pathway. The exposure pathways for the population are as follows:

- **Drinking Water.** The cities of Richland and Pasco obtain their municipal water directly, and Kennewick indirectly, from the Columbia River downstream from the Hanford Site. A total population of approximately 70,000 in the three cities drinks water derived from the Columbia River.
- **Irrigated Food.** Columbia River water is withdrawn for irrigation of small vegetable gardens and farms in the Riverview district of Pasco in Franklin County. Enough food is grown in this district to feed an estimated 2,000 people. Commercial crops are also irrigated by Columbia River water in the Horn Rapids area of Benton County.

- **River Recreation.** These activities include swimming, boating, and shoreline recreation. An estimated 125,000 people who reside within 80 km (50 mi) of the Hanford Site are assumed to be affected by these pathways.
- **Fish Consumption.** Population doses from the consumption of fish obtained locally from the Columbia River were calculated from an estimated total annual catch of 15,000 kg/yr (without reference to a specified human group of consumers).

Data

The data that are needed to perform dose calculations based on measured effluent releases include information on initial transport through the atmosphere or river, transfer or accumulation in terrestrial and aquatic pathways, and public exposure. By comparison, radiation dose calculations based on measured concentrations of radionuclides in food require data describing only dietary and recreational activities and exposure times. These data are discussed in the following sections.

Population Distribution and Atmospheric Dispersion

Geographic distributions of the population residing within an 80-km (50-mi) radius of the four Hanford Site operating areas are shown in the *Hanford Site Environmental Data for Calendar Year 1993—Surface and Columbia River* (Bisping 1994). These distributions are based on 1990 Bureau of Census data (Beck et al. 1991). These data influence the population dose by providing estimates of the number of people exposed to radioactive effluents and their proximity to the points of release.

Atmospheric dispersion data are also shown in the *Hanford Site Environmental Data for Calendar Year 1993—Surface and Columbia River* (Bisping 1994). These data describe the transport and dilution of airborne radioactive material, which influences the amounts of radionuclides being transported through the air to specific locations.

Terrestrial and Aquatic Pathways

Important parameters affecting the movement of radionuclides within potential exposure pathways, such as irrigation rates, growing periods, and holdup periods, are listed in Table III.A-12.1. Certain parameters are specific to the lifestyles of either “maximally exposed” or “average” individuals.

Public Exposure

The potential offsite radiation dose is related to the extent of external exposure to or intake of radionuclides released from Hanford Site operations. Tables III.A-12.2 through III.A-12.4 give the parameters describing the diet, residency, and river recreation assumed for “maximally exposed” and “average” individuals.

Table III.A-12.1. Food Pathway Parameters Used in Dose Calculations, 1993

	Holdup, days ^(a)		Growing Period, days	Yield, kg/m	Irrigation Rate, L/m ² /month
	Maximally Exposed Individual	Average Individual			
Leafy vegetables	1	14	90	1.5	150
Other vegetables	5	14	90	4	170
Fruit	5	14	90	2	150
Cereal	180	180	90	0.8	0
Eggs	1	18	90	0.8	0
Milk	1	4			
Hay	(100) ^(b)	(100)	45	2	200
Pasture	(0)	(0)	30	1.5	200
Red meat	15	34			
Hay	(100)	(100)	45	2	200
Grain	(180)	(180)	90	0.8	0
Poultry	1	34	90	0.8	0
Fish	1	1	---	---	---
Drinking water	1	1	---	---	---

(a) Holdup is the time between harvest and consumption.

(b) Values in () are the holdup in days between harvest and consumption by farm animals.

Table III.A-12.2. Dietary Parameters Used in Dose Calculations, 1993

	Consumption, kg/yr	
	Maximally Exposed Individual	Average Individual
Leafy vegetables	30	15
Other vegetables	220	140
Fruit	330	64
Grain	80	72
Eggs	30	20
Milk ^(a)	270	230
Red meat	80	70
Poultry	18	8.5
Fish	40	--- ^(b)
Drinking water ^(a)	730	440

(a) Units L/yr.

(b) Average individual consumption not identified; radiation doses were calculated based on estimated total annual catch of 15,000 kg.

Table III.A-12.3. Residency Parameters Used in Dose Calculations, 1993

	Exposure, h/yr	
	Maximally Exposed Individual	Average Individual
Ground contamination	4,383	2,920
Air submersion	8,766	8,766
Inhalation ^(a)	8,766	8,766

(a) Inhalation rates: Adult 270 cm³/s.

Table III.A-12.4. Recreational Parameters Used in Dose Calculations, 1993

Parameter	Exposure, h/yr ^(a)	
	Maximally Exposed Individual	Average Individual
Shoreline	500	17
Boating	100	5
Swimming	100	10

(a) Assumed river water travel times from 100-N to the point of aquatic recreation were 8 h for the maximally exposed individual and 13 h for the average individual. Correspondingly lesser times were used for other locations.

Dose Calculation Documentation

The Hanford Dose Overview Panel has the responsibility for defining standard, documented computer codes and input parameters to be used for radiation dose calculations for the public near the Hanford Site. Only those procedures, models, and parameters previously defined by the Hanford Dose Overview Panel are used to calculate the radiation doses (Schreckhise et al. 1993). The calculations are then reviewed by the Dose Overview Panel. Summaries of dose calculation documentation for this report are shown in Tables III.A-12.5 through III.A-12.9 and *Hanford Site Environmental Data for Calendar Year 1993—Surface and Columbia River* (Bisping 1994).

Table III.A-12.5. Documentation of 100-N Area Airborne Release Dose Calculations, 1993

Facility name	100-N Area
Releases	See Table III.A-3.1
Meteorological conditions	1993 annual average, calculated from data collected at the 100-N Area and the Hanford Meteorology Station from January 1993 through December 1993, using the computer code HANCHI
X/Q'	Maximally Exposed Individual at residence, 5.9×10^{-9} at 41 km SE; Maximally Exposed Individual at food source, 3.8×10^{-9} at 53 km SSE; 80-km population, 1.7×10^{-3} person-s/m ³
Release height	89-m effective stack height
Population distribution	375,000 (see Table D-1, Bisping (1994))
Computer code	GENII, Version 1.485, 12-3-90
Doses calculated	Chronic, 1-year exposure, 50-year committed internal dose equivalent, and annual effective dose equivalent to individual and population
Pathways considered	External exposure to plume and ground deposits Inhalation Ingestion of locally produced foods
Files addressed	Radionuclide Library, Rev. 7-1-92 Food Transfer Library, Rev. 8-29-88 External Dose Factor Library, Rev. 5-9-88 Internal Dose Factor Library, Rev. 12-3-90

Table III.A-12.6. Documentation of 100-N Area Liquid Release Dose Calculations, 1993

Facility name	100-N Area
Releases	See Table III.A-3.4
Mean river flow	91,200 cfs (2,580 m ³ /s)
Shore-width factor	0.2
Population distribution	70,000 for drinking water pathway 125,000 for aquatic recreation 2,000 for consumption of irrigated foodstuffs 15,000 kg/yr total harvest of Columbia River fish
Computer code	GENII, Version 1.485, 12-3-90
Doses calculated	Chronic, 1-year exposure, 50-year committed internal dose equivalent, and annual effective dose equivalent to individual and population
Pathways considered	External exposure to irrigated soil, to river water, and to shoreline sediments Ingestion of aquatic foods, and irrigated farm products
Files addressed	Radionuclide Library, Rev. 7-1-92 Food Transfer Library, Rev. 8-29-88 External Dose Factor Library, Rev. 5-9-88 Internal Dose Factor Library, Rev. 12-3-90 Bioaccumulation Factor Library, Rev. 10-26-92

Table III.A-12.7. Documentation of 200 Area Airborne Release Dose Calculations, 1993

Facility name	200 Areas
Releases	See Table III.A-3.1
Meteorological conditions	1993 annual average, calculated from data collected at the Hanford Meteorology Station from January 1993 through December 1993, using the computer code HANCHI
X/Q'	Maximally Exposed Individual at residence, 1.4×10^{-8} at 34 km SE; Maximally Exposed Individual at food source, 1.1×10^{-8} at 43 km SE; 80-km population, 2.0×10^{-3} person-s/m ³
Release height	89-m effective stack height
Population distribution	376,000 [see Table D-2, Bisping (1994)]
Computer code	GENII, Version 1.485, 12-3-90
Doses calculated	Chronic, 1-year exposure, 50-year committed internal dose equivalent, and annual effective dose equivalent to individual and population
Pathways considered	External exposure to plume and ground deposits Inhalation Ingestion of locally produced foods
Files address	Radionuclide Library, Rev. 7-1-92 Food Transfer Library, Rev. 8-29-88 External Dose Factor Library, Rev. 5-9-88 Internal Dose Factor Library, Rev. 12-3-90

Table III.A-12.8. Documentation of 300 Area Airborne Release Dose Calculations, 1993

Facility name	300 Area
Releases	See Table III.A-3.1.
Meteorological conditions	1993 annual average, calculated from data collected at the 300 Area and the Hanford Meteorology Station from January 1993 through December 1993, using the computer code HANCHI
X/Q'	Maximally Exposed Individual at residence, 1.2×10^{-6} at 1.5 km E; Maximally Exposed Individual at food source, 9.4×10^{-8} at 13 km SSE; 80-km population, 7.6×10^{-3} person-s/m ³
Release height	10 m
Population distribution	282,000 [see Table D-3, Bisping (1994)]
Computer code	GENII, Version 1.485, 12-3-90
Doses calculated	Chronic, 1-year exposure, 50-year committed internal dose equivalent, and annual effective dose equivalent to individual and population
Pathways considered	External exposure to plume and ground deposits Inhalation Ingestion of locally produced foods
Files addressed	Radionuclide Library, Rev 7-1-92 Food Transfer Library, Rev. 8-29-88 External Dose Factor Library, Rev. 5-9-88 Internal Dose Factor Library, Rev. 12-3-90

Table III.A-12.9. Documentation of 400 Area Airborne Release Dose Calculations, 1993

Facility name	400 Area
Releases	See Table III.A-3.1
Meteorological conditions	1993 annual average, calculated from data collected at the 400 Area and the Hanford Meteorology Station from January 1993 through December 1993, using the computer code HANCHI
X/Q'	Maximally Exposed Individual at residence, 8.7×10^{-8} at 11 km SE; Maximally Exposed Individual at food source, 3.1×10^{-8} at 22 km SE; 80-km population, 4.9×10^{-3} person-s/m ³
Release height	10 m
Population distribution	283,000 [see Table D-4, Bisping (1994)]
Computer code	GENII, Version 1.485, 12-3-90
Doses calculated	Chronic, 1-year exposure, 50-year committed internal dose equivalent, and annual effective dose equivalent to individual and population
Pathways considered	External exposure to plume and ground deposits Inhalation Ingestion of locally produced foods
Files addressed	Radionuclide Library, Rev 7-1-92 Food Transfer Library, Rev. 8-29-88 External Dose Factor Library, Rev. 5-9-88 Internal Dose Factor Library, Rev. 12-3-90

Data Management, Analysis, and Statistical Treatment

Described herein are the objectives for data management, analysis, and statistical treatment. These objectives are primarily achieved through the Hanford Environmental Information System (HEIS). This database system is used to manage the information generated by ongoing collection and analyzing numerous environmental data from on and around the Hanford Site.

Objectives

Good data management, data analysis, and statistical treatment practices are essential for the production of auditable and quality results. The objectives of these activities are to:

- manage data in a manner that ensures their timely collection, analysis, reporting, and validation in accordance with the *Environmental Surveillance Master Sampling Schedule* (e.g., Bisping 1994), and the traceability of results from scheduling to archiving in the database
- estimate radionuclide concentrations at each sampling and/or measurement point for each sampling and/or measurement time; estimate accuracy and precision
- compare the estimated radionuclide concentrations at each sampling and/or measurement point to prior concentration assessments at that point to recognize changes or inconsistencies in concentration levels
- compare the estimated radionuclide concentration at each sampling and/or measurement point to reporting limits
- compare the estimated radionuclide concentrations at a single sampling and/or measurement point to those at control or other points and evaluate the credibility of those comparisons.

The Data Management Overview

The surface environmental surveillance data are maintained on HEIS. HEIS is a consolidated set of automated resources that effectively manage the data gathered during environmental monitoring and restoration of the Hanford Site. HEIS includes an integrated database and is intended to provide consistent and current data to all users; it promotes sharing of data by the entire user community.

HEIS is an operational system specifically designed and implemented for environmental data. The major components are a database and a geographic information system (GIS). HEIS is implemented using current industry standards including a UNIX operating system, Oracle as the database management system, C as the major programming language (when required), and SQL as the database query language. Other commercially available products used by HEIS include Uniface as the database user interface for screens, SQR for reporting, and Arc/In as the GIS engine. The HEIS computer system is managed by PNL; the database is managed by BHI.

Most samples for environmental surveillance are collected on a routine basis. A revised schedule for collecting samples is established in HEIS at the beginning of each calendar year. Sample identification labels and chain-of-custody forms are generated weekly to facilitate sample collection. The database also generates laboratory composite sheets that identify individual samples to be combined to form a composite sample. Results are reported by diskette and hard copy and entered into the database either electronically or manually. HEIS is also designed to produce various status and result reports to ensure a smooth and accurate flow of information and the prompt identification of unusual results. Finally, results are stored in a database and are retrievable for review and preparation of special reports and the Annual *Hanford Environmental Report* (e.g., Dirkes et al. 1994).

Sample Scheduling

The Surface Environmental Surveillance Project Manager and staff revise the calendar year sampling schedule to meet surveillance needs for the year. The sample locations, types, analyses, and frequencies of collection are identified and documented in the *Environmental Surveillance Master Sampling Schedule* (e.g., Bisping 1994).

Weekly, biweekly, monthly, and quarterly scheduling are accomplished automatically as the scheduling program interrogates itself to determine when a sample must be collected. The scheduled dates are automatically recalculated, based on the collection frequency, and are updated in the computer each week as the sample labels and chain-of-custody forms are generated.

When a new scheduled event is added to HEIS, collection and analysis are scheduled and provided with the appropriate scheduling identification.

Sample Collection

The computer generates a set of sample labels and chain-of-custody forms the week before the scheduled collection date. The sample label identifies the task code (i.e., air, water, biota, soil/sediment TLDs), HEIS sample identification number, collection date, and analyses required. Once the sample is collected, the sample label is attached to the sampling container and both are delivered to the analytical laboratory. The chain-of-custody form lists the samples to be collected on a given day and also identifies the task code, HEIS sample identification number, sampling location, and date of collection. The chain-of-custody form accompanies the samples to the analytical laboratory, where the samples are relinquished into the custody of the laboratory. The laboratory retains one copy of the signed chain-of-custody form, and the other copy is returned to the project and becomes a permanent record that verifies sample collection, delivery, and receipt by the laboratory. Sample collection and handling procedures are contained in PNL-MA-580.

Certain samples collected weekly or biweekly are composited at the laboratory to form monthly, quarterly, or annual samples for analysis. Each month the computer generates composite sheets that list the specific samples to be composited. To verify correct compositing, the laboratory technician returns the completed sheet, indicating the size of the aliquot used and the appropriate laboratory identification number.

Tracking Sample Collection

HEIS is capable of tracking samples from the time the sample label is produced until sample results are entered into the database. This allows for accountability of both sample collection and sample

analysis. When a sample label is generated, an accountability file for sample collection is automatically created for each analysis (i.e., radionuclide or groups of radionuclides as for a gamma scan). After the sample is collected, the collection date, as identified on the chain-of-custody form, is entered into the database, satisfying the sample collection portion of the accountability file.

The date that the sample is submitted to the laboratory is also entered into the database. This date activates the sample analysis tracking feature in the accountability file (see discussion below in Tracking Sample Analysis).

Reporting of Analytical Data

The analytical laboratory analyzes samples for the radionuclides identified on the sample label. The analytical laboratory reports results in addition to $\pm 2\text{-}\sigma$ counting uncertainty and the overall propagated uncertainty. Data are reported by diskette or hard copy and are entered into the database either electronically or manually.

The minimum required data that will be stored in the HEIS surface environmental surveillance database include the following:

- HEIS Sample Identification Number
- sample location
- sample collection date
- analysis
- result $\pm 2\text{-}\sigma$ total analytical uncertainty
- result unit
- sample volume
- comments as appropriate.

Data Validation

As new results are entered into the database, several mathematical tests are performed to determine whether the result is within the normal range of the established limits. The tests and supporting data include the following:

- Test 1: Was the minimum detectable concentration met?
- Test 2: Was the low limit exceeded?
- Test 3: Was the high limit exceeded?
- Statistics A: The maximum, minimum, and mean of last ten results at this sampling location are: . . .
- Statistics B: The maximum, minimum, and mean of results for this sample type at all locations for the previous 12 months are: . . .

As data are collected, the results are compared to previous results to help identify unusual measurements that require investigation or further statistical evaluation. If the result is unusual and fails any of the tests, it is considered an anomaly and the database automatically generates a one-page anomalous data report.

Outliers can represent a true extreme value or can indicate either errors in sample collection, preparation, measurement, or equipment malfunctions. On request, the analytical laboratory can perform a data recheck, recount, or reanalysis to assist in determining the value of the questionable result. Based on their investigation, the decision rests with the media task leader, with the approval of the Project Manager, to determine whether to include a result as valid or to reject it. These decisions are documented in the anomalous data report.

Tracking Sample Analysis

Sample analysis tracking is provided automatically by a subroutine that enters analytical results into the database. To aid in the accountability of the analytical results, a maximum turn-around time for reporting of results is established with the analytical laboratory. The subroutine uses the sample submission date and the laboratory turn-around time to calculate the date that the analytical result is due for each analysis. If no result has been reported by the specified turn-around time, the database generates a "late results" report. The late results report also indicates results that were reported late. An outstanding result will continue to appear on the late results report until the result is received and the accountability record has been completely satisfied.

Data Retrieval

One of the primary reasons for using a data management system is to store data and provide efficient and easy access to the thousands of analytical results recorded each year. A special data retrieval subroutine is used to provide working files of radionuclide-location combinations for specified periods covering sampling dates from 1971 to the present.

Once established, the results files can be used to create results reports or summary reports with simple statistical calculations (such as the mean, median, standard deviation, and standard error of the mean). The database will also create time-series plots with a laser printer.

Database Security

To prevent the loss of data because of fire, power failure, or other causes, HEIS undergoes a complete backup every week by the computer systems manager.

Quality Assurance

Records of data and other information developed during the operation of the HEIS are controlled and managed in compliance with the requirements in the project QA plan and the HEIS Software Control Procedures.

Data Analysis and Statistical Treatment

Data results will be reported and recorded with estimates of their uncertainty. Data sets will not be truncated and will include negative numbers. The database will contain results to the number of significant figures reported by the analytical facility, but summaries and reports will identify the appropriate number of significant figures. Results will be reported not as "less than detectable" but as less than the estimated quantitative detection limit.

Data contained in the database are varied in type, and any subset of data of a given type may or may not fit probability distributions typical of that type for a variety of potential reasons (sample size, mixed populations, etc.). Therefore, as a practical matter, routine statistical summaries produced by the database for review and reporting of data will normally be based on the arithmetic mean or median as measures of central tendency and on the range, standard deviation, and standard error of the mean as measures of dispersion.

Statistical tests to determine differences and effects will, however, be based on parametric or nonparametric tests appropriate to the sample sizes, distributions of the particular data sets being tested, and hypothesis being tested.

Tests for precision and accuracy are addressed in the Quality Assurance and Quality Control subsection.

Exceptions

No exceptions have been taken to *should** statements in DOE/EH-0173T.

Laboratory Procedures

All routine environmental surveillance samples are analyzed according to written analytical procedures. These procedures are described in general terms in this subsection and in detail in the International Technology Corporation (IT) Analytical Services Division's laboratory procedures manual and in the DataChem Laboratories, Inc., procedures manual. Contractual minimum detectable concentrations and contract-required detection limits for the various medium/analysis combinations and other analytical information are shown in Table III.A-14.1 for radiological analytes and in Table III.A-14.2 for chemical constituents. In practice, actual minimum detectable concentrations and method detection limits have historically been significantly lower for most analyses.

Table III.A-14.1. Radiological Monitoring Sampling Summary

Type of Analysis	Approximate Sample Size	Nominal Count Time	Minimum Detectable Concentration	Nominal Analysis Aliquot Size
Air				
Gross Alpha	800 m ³	50 min	0.001 pCi/m ³	800 m ³
Gross Beta	800 m ³	40 min	0.003 pCi/m ³	800 m ³
HTO ^(a)	10 m ³	150 min	0.3 pCi/m ³	5 m ³
¹⁴ C ^(b)	40 m ³	150 min	1.0 pCi/m ³	10 g of carbon
⁸⁵ Kr ^(b)	0.5 m ³	150 min	2.0 pCi/m ³	0.5 m ³
⁹⁰ Sr	1,500 m ³ per station	100 min	0.01 pCi/m ³	1,500 to 20,000 m ³
¹²⁹ I ^(c)	800 m ³ per station	NA ^(d)	0.00001 pCi/m ³	800 m ³
¹³¹ I	800 m ³	100 min	0.01 pCi/m ³	800 m ³
Gamma Scan (¹³⁷ Cs)	1,500 m ³ per station	100 min	0.01 pCi/m ³	1,500 to 7,700 m ³
²³⁸ Pu	1,500 m ³ per station	1,000 min	0.000005 pCi/m ³	1,500 to 20,000 m ³
^{239,240} Pu	1,500 m ³ per station	1,000 min	0.000005 pCi/m ³	1,500 to 20,000 m ³
²⁴¹ Am	1,500 m ³ per station	200 min	0.00005 pCi/m ³	1,500 to 20,000 m ³
U (Isotopic)	1,500 m ³ per station	1,000 min	0.00005 pCi/m ³	1,500 to 20,000 m ³
River and Surface Water				
Gross Alpha	1 L	50 min	4.0 pCi/L	200 ml
Gross Beta	4 L	20 min	4.0 pCi/L	200 ml
³ H (Lo)	1 L	600 min	10 pCi/L	150 mL
³ H	1 L	250 min	300 pCi/L	5 mL
⁸⁹ Sr ^(f)	10 L	100 min	0.6 pCi/L	10 L
⁹⁰ Sr	10 L	100 min	0.06 pCi/L	10 L

Table III.A-14.1. (cont'd)

Type of Analysis	Approximate Sample Size	Nominal Count Time	Minimum Detectable Concentration	Nominal Analysis Aliquot Size
^{99}Tc	4 L	150 min	1.0 pCi/L	4 L
^{129}I	6,000 L water	NA	0.000001 pCi/L	1,500 to 3,000
Gamma Scan (^{137}Cs)	750 L water	1,000 min	0.01 pCi/L	750 ml
Gamma Scan (^{137}Cs)	1 L	50 min	6 .0 pCi/L	4 to 10 L
$^{239,240}\text{Pu}$	750 L water	1000 min	0.0002 pCi/L	750 ml
U (Isotopic)	1 L	1,000 min	0.06 pCi/L	100 to 1,000 mL
Milk				
^3H	50 mL	250 min	300 pCi/L	5 mL
^{90}Sr	4 L	100 min	2.0 pCi/L	1 L
^{129}I	4 L	NA	0.00001 pCi/L	3 to 4 L
^{131}I (I)	4 L	100 min	0.5 pCi/L	4 L
Gamma Scan (^{137}Cs)	4 L	500 min	8 pCi/L	1 L
Fruit (Water)				
^3H	2 kg	250 min	300 pCi/L	10 mL (water)
^{90}Sr	500 g	200 min	0.005 pCi/g	100 g
^{129}I (LEPD)	500 g	200 min	1.0 pCi/g	50 g
Gamma Scan (^{137}Cs)	500 g	200 min	0.02 pCi/g	500 g
$^{239,240}\text{Pu}$	500 g	1,000 min	0.0004 pCi/g	100 g
Produce and Farm Products				
^{90}Sr	500 g	200 min	0.005 pCi/g	100 g
^{99}Tc	500 g	150 min	1.0 pCi/g	5 g
Gamma Scan (^{137}Cs)	500 g	200 min	0.02 pCi/g	500 g
$^{239,240}\text{Pu}$	500 g	1,000 min	0.0004 pCi/g	100 g
U (Isotopic)	500 g	1,000 min	0.02 pCi/g	10 g
Beef				
^{90}Sr	500 g	100 min	0.005 pCi/g	100 g
Gamma Scan (^{137}Cs)	500 g	200 min	0.02 pCi/g	500 g

Table III.A-14.1. (cont'd)

Type of Analysis	Approximate Sample Size	Nominal Count Time	Minimum Detectable Concentration	Nominal Analysis Aliquot Size
Poultry				
^{90}Sr	200 g (boneless muscle)	200 min	0.005 pCi/g	100 g
Gamma Scan (^{137}Cs)	500 g (boneless muscle)	200 min	0.02 pCi/g	500 g
Eggs				
^{90}Sr	500 g	100 min	0.005 pCi/g	100 g
Gamma Scan (^{137}Cs)	500 g	200 min	0.02 pCi/g	500 g
Wine				
^3H	1 L	150 min	300 pCi/L	5 mL
Gamma Scan (^{137}Cs)	1 L	500 min	6.0 pCi/L	1 L
Fish Fillet				
^{90}Sr	500 g	100 min	0.005 pCi/g	100 g
^{99}Tc	500 g	150 min	1.0 pCi/g	5 g
Gamma Scan (^{137}Cs)	500 g	200 min	0.02 pCi/g	500 g
U (Isotopic)	500 g	1,000 min	0.02 pCi/g	10 g
Fish Carcass				
^{90}Sr	500 g	100 min	0.005 pCi/g	100 g
Gamma Scan (^{137}Cs)	500 g	200 min	0.02 pCi/g	500 g
Geese and Game Birds				
^{90}Sr	500 g (bone)	100 min	0.005 pCi/g	100 g
^{99}Tc	500 g (muscle)	150 min	1.0 pCi/g	5 g
Gamma Scan (^{137}Cs)	500 g (muscle)	200 min	0.02 pCi/g	500 g
$^{239,240}\text{Pu}$	500 g (liver)	1000 min	0.0004 pCi/g	100 g
U (isotopic)	500 g (muscle)	1000 min	0.02 pCi/g	10 g
Deer				
Gamma Scan (^{137}Cs)	500 g (muscle)	200 min	0.02 pCi/g	500 g
^{90}Sr	500 g (bone)	100 min	0.005 pCi/g	100 g
$^{239,240}\text{Pu}$	500 g (liver)	1,000 min	0.0004 pCi/g	100 g
Rabbits				
^{90}Sr	500 g (bone)	100 min	0.005 pCi/g	100 g

Table III.A-14.1. (cont'd)

Type of Analysis	Approximate Sample Size	Nominal Count Time	Minimum Detectable Concentration	Nominal Analysis Aliquot Size
Gamma Scan (^{137}Cs)	500 g (muscle)	200 min	0.02 pCi/g	500 g
$^{239,240}\text{Pu}$	500 g (liver)	1000 min	0.0004 pCi/g	100 g
Soil and Sediment				
^{90}Sr	1 kg	100 min	0.005 pCi/g	100 g
Gamma Scan (^{137}Cs)	1 kg	200 min	0.02 pCi/g	500 g
Uranium (LEPD) ^(e)	1 kg	1,000 min	0.02 pCi/g	10 g
$^{239,240}\text{Pu}$	1 kg	1,000 min	0.0006 pCi/g	100 g
Native Vegetation				
Gamma Scan (^{137}Cs)	500 g	500 min	0.02 pCi/g	500 g
^{90}Sr	500 g	200 min	0.005 pCi/g	100 g
Total U	500 g	1000 min	0.02 pCi/g	10 g
$^{239,240}\text{Pu}$	500 g	1,000 min	0.0004 pCi/g	100 g
Direct Radiation Exposure				
Thermoluminescent Dosimeter (TLD)	5 TLDs per holder	NA	1.0 mR ^(f)	NA

(a) Tritiated water vapor.

(b) Not routinely analyzed for.

(c) Four locations.

(d) NA = not applicable.

(e) LEPD = low-energy photon detector.

(f) Absolute sensitivity in the manner it is used is well below 1 mrem.

Table III.A-14.2. Chemical Monitoring Sampling Summary

Constituent	Contract Required Detection Limit, $\mu\text{g/L}$
Aluminum	200
Antimony	200
Barium	20
Beryllium	3
Cadmium	10
Calcium	100
Chromium	20
Cobalt	20
Copper	20
Iron	20
Magnesium	100
Manganese	10
Nickel	30
Potassium	1000
Silver	20
Sodium	300
Tin	100
Vanadium	30
Zinc	10
Bromide	500
Chloride	200
Fluoride	100
Phosphate	500
Sulfate	500
Nitrite	200
Nitrate	200
Acetone	100
Benzene	5

Table III.A-14.2. (cont'd)

Constituent	Contract Required Detection Limit, $\mu\text{g/L}$
Carbon Tetrachloride	5
Chloroform	5
p-Dichlorobenzene	5
1,1-Dichloroethane	5
1,2-Dichloroethane	5
1,2-Dichloroethylene (cis & trans)	5
Methylene Chloride	5
Methyl Ethyl Ketone	100
4-Methyl-2-Pentanone	50
Tetrachloroethylene	5
Tetrahydrofuran	10
Toluene	5
1,1,1-Trichloroethane	5
1,1,2-Trichloroethane	5
Trichloroethylene	5
Vinyl Chloride	10
Total Xylene	5
1-Butanol	1000
Propionitrile	10
Carbon Disulfide	5

Air Samples

Alpha- and beta-emitting radionuclides are measured by a direct count from the glass fiber filter.^(a) Alpha radiation is counted on a low-background, gas-flow proportional counter, and beta radiation is counted on a gas-flow proportional counter.

Gamma-emitting radionuclides are counted directly from glass fiber filters using lithium-ion drifted germanium [Ge(Li)] or hyperpure germanium (HPGE) detectors with a multichannel, pulse-height analyzer. Listed below are the radionuclides that are reported for detectable concentrations:

⁷ Be ^(b)	⁵⁴ Mn ^(c)	⁶⁵ Zn ^(c)	¹⁰⁶ Ru ^(c)	¹³⁷ Cs ^(b)	¹⁵² Eu ^(c)
²² Na ^(c)	⁵⁹ Fe ^(c)	⁹⁵ ZrNb ^(c)	¹²⁵ Sb ^(c)	¹⁴⁰ BaLa ^{(c)1}	¹⁵⁴ Eu ^(b)
²⁴ Na ^(c)	⁵⁸ Co ^(c)	⁹⁹ Mo ^(c)	¹³¹ I ^(c)	⁴¹ Ce ^(c)	¹⁵⁵ Eu ^(b)
⁴⁰ K ^(b)	⁶⁰ Co ^(b)	¹⁰³ Ru ^(c)	¹³⁴ Cs ^(b)	¹⁴⁴ CePr ^(c)	

Strontium-90 is leached from glass fiber filters with fuming nitric acid, scavenged with barium chromate and ammonium hydroxide, precipitated as a carbonate, transferred to a stainless-steel planchet, and counted with a low-background, gas-flow proportional counter. After 15 days, the ⁹⁰Sr decay product is separated and counted with a proportional counter.

Uranium is leached from glass fiber filters with nitric acid, extracted into hexone as an ammonium salt, and then back-extracted into water. A portion of the water extract is purified, electrodeposited onto a stainless-steel planchet, and then counted with an alpha spectrometer to determine the uranium isotopic concentrations.

Plutonium is leached from glass fiber filters with nitric acid and passed through an anion-exchange resin. The plutonium on the resin column is eluted with hydrochloric acid containing ammonium iodide, electrodeposited on a stainless-steel disk, and then counted with an alpha spectrometer to determine the ²³⁸Pu and ^{239,240}Pu concentrations.

Americium-241 concentrations are determined by passing the eluate from the plutonium anion exchange resin column through a cation exchange resin column after concentration of eluate by oxalate precipitation. The americium is eluted from the resin with high concentration hydrochloric acid, electrodeposited on a stainless-steel disk, and then counted by alpha spectrometry.

Tritium is collected as tritiated water vapor using silica gel. The water vapor is removed from the gel by heat and vacuum action, and then collected in a freeze trap. The tritium content of the water vapor is determined with a liquid scintillation spectrometer.

Iodine-131 is collected on TEDA-treated activated charcoal (90% and 70% efficient for methyl iodine at 2.6 and 5.2 m³/h, respectively) and then counted on either a Ge(Li) or an HPGE detector with a multichannel, pulse-height analyzer.

(a) >99% efficient for 0.3-μm particles.

(b) Usually reported for all samples.

(c) Only reported if value exceeds 2-σ propagated error.

Iodine-129 is collected on a special petroleum-based charcoal. Iodine is removed from the charcoal, purified, and determined by mass spectrometry.

Carbon-14 is collected as CO₂ gas using soda lime. The CO₂ is released from the soda-lime sample with acid and injected into a benzene synthesizer instrument. The CO₂ is quantitatively converted to benzene through a series of catalytic reactions. The benzene product is mixed with scintillation solution and counted on a low-temperature, liquid scintillation counter.

Krypton-85 is collected using a gas cylinder. The air sample is purified using a specially constructed cryogenic chromatography instrument. The sample is passed through a series of cold traps to remove unwanted gases. The purified ⁸⁵Kr is then mixed with scintillation solution and counted on a low-temperature, liquid scintillation counter.

Water Samples

Alpha-emitting radionuclide (americium, neptunium, plutonium, and uranium) samples are treated with nitric acid and dried according to EPA SW-846. The residue is secured on a stainless-steel planchet using a collodion solution and counted with a low-background, gas-flow proportional counter.

Beta-emitting radionuclide samples are dried in the same way as the alpha-emitting radionuclides and are then counted directly using a gas-flow proportional counter.

Gamma-emitting radionuclides are counted directly from 500 mL of sample concentrate using either a Ge(Li) or an HPGE detector with a multichannel, pulse-height analyzer. See air samples discussion for a list of radionuclides included in gamma scan analysis.

Strontium-90 in large-volume water samples is measured in the same manner as in air samples, but the sample is acidified and boiled down, neutralized with ammonium hydroxide, and precipitated as the carbonate before exposure to fuming nitric acid.

Technetium-99 concentrations are determined using technetium separation by iron hydroxide precipitation followed by a carbonate precipitation. Further purification from interfering nuclides is performed by anion-exchange resin separation. The ⁹⁹Tc is counted by liquid scintillation spectrometry.

Tritium samples can be counted directly with a liquid scintillation spectrometer, or the sample can be enriched by alkaline electrolysis and then counted with a liquid scintillation spectrometer.

Uranium in the water sample is adsorbed onto anion resin following wet ashing, purified, electrodeposited onto a stainless-steel planchet, and then counted with an alpha spectrometer to determine uranium isotopic concentrations.

Filter-resin samples are analyzed for gamma-emitting radionuclides using either a Ge(Li) or an HPGE detector with a multichannel, gamma-ray spectrometer. Aliquots of the samples are analyzed by mass spectrometry for ¹²⁹I and by chemical separation and alpha spectrometry for plutonium.

Volatile Organic Compounds (VOCs) are determined by method 8240 found in EPA SW-846, Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods. Volatile compounds are introduced

in the gas chromatograph by the purge-and-trap method. The components are separated via the gas chromatograph and detected using a mass spectrometer.

Samples are acid digested before analysis by SW-846 method 6010, Inductively Coupled Plasma Atomic Emission Spectroscopy for metal constituents.

The anions, nitrate, nitrite, bromide, chloride, fluoride, phosphate, and sulfate are determined using methodology found in ASTM D4327-88, Annual Book of ASTM Standards, or EPA Method 300.0, EPA-600/4/84/017. The sample is introduced into an ion chromatograph and the anions of interest are separated and measured.

Milk

Gamma-emitting radionuclides in milk are counted directly using either a Ge(Li) or an HPGE detector with a multichannel, pulse-height analyzer.

Tritium in water distilled from milk is counted directly with a liquid scintillation spectrometer.

Iodine-129 is separated from milk with an anion-exchange resin, purified, and analyzed by mass spectrometry.

Iodine-131 is removed from milk with an anion-exchange resin. The iodine is eluted with sodium hypochlorite, purified, precipitated as palladium iodide, and beta counted with a low-background, gas-flow proportional counter.

Strontium-90 is measured in the same manner as in air samples, but samples are purified with a cation resin, eluted with sodium chloride, and precipitated as a carbonate before exposure to fuming nitric acid.

Foodstuffs

Gamma-emitting radionuclides in foodstuffs are counted directly on either a Ge(Li) or an HPGE detector with a multichannel, pulse-height analyzer.

Tritium in water distilled from farm produce is counted directly with a liquid scintillation spectrometer.

Iodine-129 in foodstuff samples (other than milk) is determined after the sample is dried and weighed. The dried sample is counted directly with a low-energy photon detector (LEPD) system.

Plutonium-²³⁸ and ^{239,240}Pu in foodstuffs is measured in the same manner as in air samples, after samples have been dried, ashed in a furnace, and treated with nitric acid.

Strontium-90 is measured in the same manner as in air samples, but samples are dried, ashed in a furnace, and treated with nitric acid before exposure to fuming nitric acid.

For technetium-99 determination, the matter is digested to inorganic salts with nitric acid and hydrogen peroxide and the digestate is processed in the same manner as for water samples.

Uranium isotopic concentrations in foodstuff media is dry and/or wet ashed to an inorganic salt. The salts are dissolved in nitric acid and extracted into hexone for purification. The sample is then electrodeposited onto a stainless-steel planchet, and then counted with an alpha spectrometer.

Vegetation and Wildlife

For technetium-99 determination, the matter is digested to inorganic salts with nitric acid and hydrogen peroxide and the digestate is processed in the same manner as for water samples.

Plutonium, strontium, uranium isotopic, and gamma-emitting radionuclides are measured using the procedures described for foodstuffs.

Soil and Sediment

All soil and sediment samples are pretreated by weighing, drying, and ball-milling to a constant particle size of 300 microns or less. Samples not requiring further pretreatment are counted directly to detect gamma- and low-energy photon-emitting radionuclides. For plutonium and strontium analyses requiring chemical separations, 1-g aliquots of samples are dissolved with concentrated acids by heating in pressurized containers in a microwave oven.

Gamma-emitting radionuclides are counted on either a Ge(Li) or an HPGE detector with a multichannel, pulse-height analyzer, after the sample is placed in a Marinelli beaker.

Plutonium and ^{90}Sr are measured after the sample is pretreated. Strontium is precipitated from the sample as strontium oxalate. The sample is then converted and precipitated as a carbonate, transferred to a planchet, and counted with a low-background, gas-flow proportional counter. After the strontium has been removed from the sample, the plutonium is co-precipitated with calcium oxalate, dissolved, and loaded onto an ion-exchange resin column. The plutonium is eluted from the resin column with nitric and hydrofluoric acids, deposited on a stainless-steel or platinum disk, and counted with an alpha spectrometer.

Uranium analysis is conducted after the sample is pretreated using an ion-exchange column. The sample is counted directly with an LEPD system.

Exceptions

No exceptions have been taken to *should** statements in DOE/EH-0173T.

Quality Assurance and Quality Control

In achieving the surveillance objectives identified in previous subsections, it is imperative that knowledge is maintained about the accuracy, precision, traceability, and limitations of data and information supporting project documentation. It is also imperative that an appropriate methodology to ensure control and legitimacy of project documentation is maintained. The quality of results is dependent on the control and verification of all components that provide input into the generation of reports and documentation. All components of work performed within the project are under an appropriate level of quality control (QC) and/or quality assurance (QA) scrutiny.

The goal of the QA/QC program is to ensure that accurate defensible data are produced. This subsection describes the elements of the program and how they are implemented. In obtaining the QA/QC goal, a management commitment to operating a surveillance project that accurately reflects Hanford Site environmental impacts and radiation doses to the environment and public is required. Management commitment to QA/QC is ensured through PNL-established management philosophies and is implemented through PNL-MA-70.

Requirements

The DOE QA requirements are contained in DOE Order 5700.6C, which requires QA plans and recommends the judicious and selective application of appropriate and recognized standards. The order identifies ASME NQA-1-1989 Edition as the preferred standard, though the standard does not address environmental surveillance specifically. These requirements are implemented through PNL-MA-70, which requires the development of an activity-specific QA plan.

Quality Assurance Plan

Surface environmental surveillance is conducted under a PNL-MA-70-directed project-specific QA plan. The QA plan addresses the 18 criteria of ASME NQA-1-1989 Edition as delineated in PNL-MA-70 and approved by the PNL QA Department.

Audits

Planned and scheduled audits of all components (sampling, analytical, record keeping, etc.) are performed periodically by the PNL Quality Verification Department. Audits are performed independently by personnel, using procedures and/or checklists, who are not directly responsible for the audited area. Audit results are documented and then reported and reviewed by responsible management and technical task leaders. Corrective actions are taken, documented, and verified by auditors.

Quality Control

Procedures

Quality control for quality-affecting activities is maintained through written procedures. Quality-affecting activities and required written procedures are identified in the project-specific QA plan.

In addition, QA/QC for service functions are defined in SOWs issued to the performing functional organization, whether internal to PNL or those of an external contractor. The PNL service functions are performed according to the QA plan and procedures established for that function, unless the SOW identifies special requirements.

Analytical Quality Control Program

Contracted analytical laboratories are required to maintain and participate in analytical QA programs to determine analytical precision and accuracy and to operate under written and approved procedures, as defined by a contract SOW. Quality control reports are generated periodically (typically quarterly) to summarize intralaboratory QC data and performance. Quality control reports, minimum detectable concentrations, and method detection limit determinations are reviewed by the QA/QC Task Leader with assistance from PNL's Analytical Support Services Program. Quality control deficiencies are identified and investigated. Corrective actions are documented, implemented, and verified. In addition to the laboratory's internal QC program, participation in national intercomparison studies is required.

Radiochemistry

The majority of the intralaboratory QC program consists of analyzing blanks, replicates, and National Institute of Standards and Technology (NIST) traceable spike samples (which must comprise no less than 15% of all ordered tests), and maintaining data that validate determinations of current minimum detectable concentrations. Requirements for accuracy and precision for internal analytical QA are shown below. Quarterly QC reports are generated to summarize intralaboratory QC data and performance. Determination and reporting of current minimum detectable concentrations are initiated by a request to the laboratory to report specific radionuclide-media minimum detectable concentrations for results reported within the previous month (no more than five per request) along with supporting data and calculations. Use of Equation 37 from Chapter 6 in EPA 520/1-80-012 is designated for the minimum detectable concentration, determinations.

The laboratory participates in two national intercomparison studies. The laboratories are required to analyze applicable radionuclide-media samples from the DOE Quality Assessment Program operated by the Environmental Measurements Laboratory (Sanderson 1985) and the EPA Environmental Radioactivity Laboratory Intercomparison Studies Program (EPA 600/4-78-032). Additional QC data are generated by sending split or collocated (blind) duplicate samples to the laboratory and independent organizations (i.e., state, FDA, EPA), and challenging the laboratory with characterized (blind) reference samples as described in the project analytical QC plan. The characterized (blind) reference samples are developed to challenge the capabilities of the laboratory in areas of significance (important pathway radionuclide-media or historically weak analytical areas). Reference sample material is

obtained from the NIST, DOE, EPA, International Atomic Energy Agency, or other sources with a significant level of reliability and accountability. Criteria used for judging the performance on QC samples are derived from appropriate references (EPA-600/4-81-004; Sanderson 1985).

Reports of contractor performance in the DOE and EPA programs are required. Performances on blind samples (split or characterized reference) are evaluated by QA/QC technical support personnel and reported to project management. These documents are reviewed and corrective actions (i.e., follow-up audits) taken if necessary.

The current radiochemistry analytical contract is with International Technology Corporation Analytical Services Division for all radiochemistry (except ^{129}I) analyses. PNL's Nuclear Chemistry Department performs ^{129}I analyses under a PNL SOW.

Chemical (Nonradiochemical) Analysis

The QC program for the chemical laboratory consists of analyzing blanks, replicates, matrix spikes, matrix spike duplicates, and laboratory control samples. The QC program should meet the QC criteria of EPA SW-846, Third Edition, and *Handbook for Analytical Quality Control in Water and Wastewater Laboratories*, EPA-600/4-79-091 (1979). Matrix spike recoveries are calculated by ASTM Method D-3856, Section 11.5.4, *Annual Book of ASTM Standards*, Volume 11.01 (1986). Quarterly QC reports are generated to summarize intralaboratory QC data and performance. Method detection limits (MDL) are determined biannually. The MDL will be provided following tests specified in 40 CFR, Chapter 1, Part 136, Appendix B, (7-1-91 Edition).

The laboratory participates in the EPA Water Pollution and Water Supply Performance Evaluation studies. Additional QC data are generated by sending split or collocated (blind) duplicate samples to the laboratory and independent organizations (i.e., DOH, EPA), and challenging the laboratory with characterized (blind) reference samples as described in the project analytical QC plan. Reference sample material is obtained from the NIST, DOE, EPA, International Atomic Energy Agency, or other sources with a significant level of reliability and accountability.

EPA Intercomparison programs reports of performance are required. Performances on blind samples (split or characterized reference) are evaluated by QA/QC technical support personnel and reported to project management. These documents are reviewed and corrective actions (i.e., follow-up audits) taken if necessary.

The current chemical analysis contract is with DataChem Laboratories, Inc., for all non-radiochemical analyses.

Analytical Accuracy and Precision Criteria

Radiochemical data accuracy and precision criteria call for analytical results of spiked samples to be within 20% to 30% of the known spike value. Accuracy and precision will be assessed using spiked samples and the criterion that 95% of the spiked sample results fall within the interval $\pm I \times R$, where R is the known spiked value, and I is given in Table III.A-15.1 for the various analysis types.

Table III.A-15.1. Accuracy Requirements

Type of Analysis	I
Gamma Spectrometry	0.20
Liquid Scintillation	0.20
Liquid Scintillation with Chemical Separation	0.30
Alpha Spectrometry	0.25
Beta Proportional	0.30
Alpha Proportional	0.30
Alpha-Gamma Coincidence	0.25
Beta-Gamma Coincidence	0.25
Uranium Fluorimetry (U-Natural)	0.30

Accuracy and precision of analytical results are assessed by analyzing spikes, blanks, and replicate samples. Such samples comprise no less than 15% of all ordered radiochemical tests. For non-radiochemical tests ordered, QC criteria are defined in the Chemical Analysis section above. Spikes and blanks are included in each batch of samples. Spikes have, insofar as possible, the matrix, volume, and other relevant characteristics of the actual samples being analyzed. Blanks are matrix or reagent blanks. Reagent and sample media blanks will be analyzed with each batch of samples.

Field Radiation Survey Instruments

Field survey instruments are calibrated with appropriate radiation sources and standards traceable to the NIST. Calibration methods and frequencies for field survey equipment are determined and controlled by the PNL Radiation Standards and Calibration Project, which provides radiation calibration service (including pick up and delivery) to the Hanford Site. Special studies are performed periodically by technical support personnel to characterize detection capabilities of more complex instruments, such as the road and rail monitors. Instruments are performance tested with appropriate check sources before and during (if required procedurally) surveys. Instruments determined not to be performing adequately are returned to the PNL Radiation Standards and Calibration Project for maintenance and calibration.

Exceptions

No exceptions have been taken to *should** statements in DOE/EH-0173T.

Records Management and Reporting

This subsection identifies and outlines surveillance project plans for record keeping and reporting to meet applicable requirements.

General record-keeping and reporting requirements are outlined in DOE Orders 5400.1 and 5400.5 and DOE/EH-0173T. These Orders specify the reporting responsibilities, timing, and distribution of routine reports and contain some details on the required content and format. Requirements for preparing and distributing accident reports are outlined in DOE Order 5484.1.

Record Keeping

DOE Order 5400.1 (pp. IV-3 and IV-10) and DOE Order 5400.5 (p. II-15) require maintenance and retention of auditable records relating to environmental surveillance, the fate of radioactive materials in the environment and their impact on radiation doses to the public, records of calculations, computer programs, raw data, procedures, etc. Records are to be protected against damage or loss; generally, this means separate storage of duplicates. DOE Order 1324.2A (Attachment V-1, pp. V-9 to V-10) establishes requirements for the retention and disposal of Environmental Contamination Measurement Records, which apply to surveillance records. (DOE-RL procedure RLIP 5400.1 implements this Order and assigns responsibilities for implementation). DOE Order 5700.6B establishes QA requirements.

These record-keeping requirements are implemented by the PNL Quality Assurance Plan, which conforms to the requirements of ASME NQA-1-1989 Edition as interpreted and implemented by PNL-MA-70.

It should be noted that the disposition schedule of DOE Order 1324.2A has been temporarily superseded by an RL Directive to contractors to discontinue destruction of retired record materials without the concurrence of PNL's and RL's legal offices.

Reporting

The reporting requirements applicable to environmental surveillance are contained in the following:

- DOE Order 5400.1
 - annual *Hanford Site Environmental Report* to be submitted by June 1 of the following year

Surveillance results are formally reported through the annual *Hanford Site Environmental Report*. The distribution of the report is reviewed each year to ensure that potentially affected local, state, and federal governments and agencies, Indian Nations, environmental interests, business interests, and owners of Hanford Reach islands are notified concerning the environmental status of the Site and surroundings.

-- *Preoperational Environmental Survey Report*

-- *Environmental Monitoring Plan* to be reviewed annually and updated at least every 3 years

This *Environmental Monitoring Plan* will be maintained per DOE Order 5400.1 and DOE/EH-0173T, and the *Preoperational Environmental Survey Report* will be prepared as directed by RL. Topical reports describing the fate of radioactive materials in the environment will be issued periodically, for information not reportable through the reports listed above, to meet site-specific and public assurance needs.

- DOE Orders 5000.3A and 5484.1

-- Occurrence Reporting: submit emergency, unusual occurrence, or off-normal occurrence reports (e.g., environmental releases of significant offsite consequences, threatening or degrading to the environment, exceedances of compliance or administrative limits, or degradation of compliance monitoring systems).

-- Notifications: submit notifications (e.g., damages, releases to the environment, occurrences resulting in press releases, or discovery of significant contamination).

Occurrences will be reported as required by the cited Orders.

- DOE Order 5400.5

-- Noncompliance: requires reporting when requirements of the Order may not be or may not have been met (p. I-4)

-- Potential Doses Exceeding Reporting Limits: requires reporting actual or potential exposures of the public that could result in either 1) a dose from DOE sources exceeding 10 mrem (EDE) in a year, or exceeding any limit or failing to meet any other requirement specified in the Order, or any other legal or applicable limits, or 2) a combined dose equal to or greater than 100 mrem (EDE) in a year from DOE and other anthropogenic sources.

Noncompliances with the Order will be reported as required.

Unusual results or trends in surveillance data that occur between issuances of the annual *Hanford Site Environmental Report* are reported when they occur, according to PNL-MA-580 procedures, to RL and the appropriate facility managers. Unusual report levels have been established, based on the environmental concentrations that would lead to an offsite public dose of either 1 or 10 mrem/yr, depending on the media, assuming that the condition persisted for an entire year. Unusual report levels to be utilized are shown in Table III.A-16.1.

Exceptions

No exceptions have been taken to *should** statements in DOE/EH-0173T.

Table III.A-16.1. Hanford Site Surface Environmental Surveillance Concentration Reporting Levels^(a)

	¹ H	⁶⁰ Co	⁸⁵ Kr	⁹⁰ Sr	⁹⁹ Tc	¹⁰⁶ Ru	¹²⁹ I	¹³¹ I	¹³⁷ Cs	¹⁵⁴ Eu	Natural U	^{234.5} U	^{239.04} Pu	²⁴¹ Am
Air (pCi/m ³)	1.2E+02	2.7E-01	3.0E+04	7.2E-02	—(b)	1.8E-01	2.8E-03	4.7E-02	1.1E-01	—	—	8.0E-04	3.9E-04	—
River Water (pCi/L)	1.0E+04	1.7E+00	—	3.0E-01	8.4E+00	1.5E+00	7.3E-01	2.7E-00	3.3E-02	—	3.3E+00	3.3+00	1.1E+00	—
Drinking Water (pCi/L)	2.0E+04	5.0E+01	—	1.0E+01	6.2E+02	(c)	5.0E+00	3.0E+01	3.0E+01	—	(c)	5.0E+00	(c)	—
Dairy Products (pCi/L)	5.4E+04	(c)	—	2.7E-01	—	(c)	1.3E+01	8.1E+01	8.1E+01	—	—	(c)	(c)	—
Meats, Poultry, Eggs (pCi/g wet weight)	1.8E+02	(c)	—	9.1E-02	—	(c)	(c)	(c)	2.7E-01	—	—	(c)	(c)	—
Cereals and Grains (pCi/g)	1.8E+02	(c)	—	9.1E-02	—	(c)	(c)	(c)	2.7E-01	—	—	(c)	2.5E-01	—
Leafy Vegetables (pCi/g)	5.0E+02	(c)	—	2.7E-01	1.5E+01	(c)	1.3E-01	(c)	6.0E-01	—	—	(c)	(c)	—
Fruit and Other Vegetables (pCi/g)	5.0E+01	(c)	—	2.5E-02	1.3E+00	(c)	1.2E-02	(c)	6.0E-02	—	—	1.1E-01	6.2E-02	—
Wine ^(d) (pCi/L)	2.0E+05	—	—	(c)	—	—	(c)	(c)	3.0E+02	—	—	(c)	(c)	—
Wildlife Meats ^(e) (pCi/g)	—	9.1E-01	—	1.8E-01	1.1E+01	—	—	—	5.4E-01	—	—	9.5E-01	5.0E-01	—
Soil ^(f) (pCi/g)	(c)	(c)	—	3.0E-01	—	(c)	(c)	(c)	5.8E+00	—	8.0E+00	3.1E+00	3.7E+00	5.5E-01
Vegetation and Alfalfa (pCi/g)	(c)	(c)	—	1.5E+00	1.0E+02	(c)	(c)	(c)	2.7E-01	—	1.3E-01	6.6E+00	4.2E+03	—
Sediment (pCi/g)	(c)	1.4E+00	—	3.0E+04	(c)	1.4E+011	(c)	(c)	6.0E+00	2.6E00	(c)	5.0E+01	8.1E+04	—

— = Not applicable.

(a) Concentrations are shown to two significant figures for consistency, but this does not imply the analytical precision, which varies with measurement type, or the precision of the dose model used.

(b) Not routinely analyzed and/or considered a significant dose contributor.

(c) Analysis is not typically reported, but determinations of other reportable levels included this media-milieuclide pathway dose contribution.

(d) Based on estimated maximally exposed individual (MEI) consumption rate of 70 L (approximately 100 bottles) of wine per year.

(e) Based on estimated MEI consumption rate of 40 kg of wildlife meat per year (from fish, deer, fowl, etc.); tritium concentrations are accounted for in fish only (not other wildlife types) from the river-water pathway calculation.

(f) Reporting levels for ⁹⁰Sr and ¹³⁷Cs in soil based on approximately 10 mrem EDE.

Sampling Plan Management

This subsection outlines how the surface environmental surveillance sampling plan will be managed and discusses the annual design review process. The surveillance plan will be developed, implemented, controlled, and modified by PNL.

Annual Review Process

Surveillance Design

The surveillance design is reviewed on an annual basis at a minimum. The process by which the design is evaluated is both continuous and cyclic. The need for changes in the surveillance design is evaluated continuously during the year in response to changing operations and/or environmental conditions. The design review cycle repeats itself each year using information generated during the previous year as the basis for the evaluation. Key steps in the process are discussed below.

Pathway Analysis. The process starts with the pathway analysis performed by PNL for the calendar year just ended (CY-1). This analysis is based on a review and report of facility emissions and effluents provided by WHC and PNL facility managers and the environmental surveillance results from the previous year. The pathway analysis serves as the basis for the annual *Hanford Site Environmental Report* (e.g. Dirkes et al. 1994) as well as the design review.

Hanford Site Environmental Report. The annual environmental report summarizes the findings of the surveillance activities conducted during the previous year. The evaluation of these results plays an integral part in the design evaluation, both in comparisons with the pathway analysis conclusions and in identifying changes in environmental conditions that may indicate a need for modifications to the sampling plan.

The distribution list for the annual *Hanford Site Environmental Report* is reviewed to ensure that potentially affected federal, state, and local governments and agencies; Indian Nations; environmental interests; business interests; and owners of Hanford Reach islands are notified concerning the environmental status of the Hanford Site and its surroundings. Feedback on the report contents and areas of concern relative to the project design are considered in the design review evaluation.

Site Activity Projection. Because the pathway analysis and the annual report are retrospective, a site activity projection from the Hanford Site contractors identifies future activities to be considered in terms of surveillance needs. This activity projection is requested by DOE-RL. Other resources useful in anticipating future environmental surveillance needs include the *Environmental Restoration and Waste Management Five-Year Plan* (DOE 1993a), the *United States Department of Energy Richland Operations Office Environmental Protection Implementation Plan* (DOE1993b), various contractor effluent and operational environmental monitoring plans and results from previous years' monitoring, and periodic environmental monitoring and characterization technical exchanges between environmental surveillance program personnel within each contractor.

Annual Surveillance Design Evaluation. The above information is considered in the annual surveillance design evaluation as the basis for planning the surveillance program for the following few FYs

and/or CYs. Results of field inspections of sampling and measurement locations conducted during the current year are reviewed to determine whether conditions at sample locations continue to meet siting and/or sampling design criteria. The design evaluation also includes a review for new surveillance compliance requirements (DOE Orders, directives, or other applicable state or federal requirements) and DOE/EH-0173T updates. Plans for the following years are discussed with appropriate Hanford contractors to ensure that any assumptions implicit in the surveillance project about the availability of related ambient monitoring data are valid and to determine whether recent ambient data indicate conditions or trends that must be considered in the design of the surveillance project. The results of the Annual Surveillance Design Evaluation and the action, if any, to be taken in response to changes are documented in SESP files.

Submit Scope and Budget for FY+1,+2,+3. Based on the results of the annual surveillance design evaluation, the scope and budget is prepared and submitted for the following few fiscal years (FY+1,+2,+3). Detail in the outyear scope and budget information is necessarily general in nature; however, it does provide targets on which to base future more detailed planning and specific scope and budget development.

Contractor Work Plan, FY+. Specific surveillance program objectives, work scope, and budget are provided in the project-specific Contractor Work Plans (CWP) written for the upcoming fiscal year (FY+). The CWP sets forth the plans and organization that will be used to conduct, control, and document the SESP. It represents an agreement between RL and PNL on the program objectives, scope, and work to be performed during the fiscal year.

Scope and Budget Approval. The scope and budget, as defined in the CWP, are reviewed and approved by RL, typically during the first half of the current FY. Approval of the scope and budget are documented through RL signature on the current FY CWP.

Surveillance Design Update. The Annual Surveillance Design Evaluation is documented through the CWP and in the development of the environmental surveillance master sampling schedule for the following CY sampling. Based on this evaluation, final plans for the following year are developed and discussed with other contractors to coordinate related activities. Final plans are also discussed with representatives from the WDOH to identify those samples to be included in the cooperative duplicate sampling program conducted by the two agencies.

Develop CY+ Master Surveillance Schedule. The final *Environmental Surveillance Master Sampling Schedule* for the next CY, based on the results of the annual design review process discussed in this subsection, is prepared and issued, documenting the environmental surveillance plan and schedule for the oncoming year.

Environmental Monitoring Plan Update, if required. The *Environmental Monitoring Plan* (EMP) is updated as necessary based on the results of the annual surveillance design evaluation. Minor adjustments in sampling schedule, locations, or methodology not considered to warrant revision of the EMP are documented in the CWP and master sampling schedule.

Dose Assessment

The need for updates to dose assessment codes or input data is controlled through procedures established by the Hanford Environmental Dose Overview Panel (HEDOP). The HEDOP establishes a

Site policy for reviewing and updating population and pathway data, a frequency for the review of input data, and guidelines for when new data must be incorporated into dose calculations.

Approvals, Changes, Deviations

This section (III.A) of this *Environmental Monitoring Plan* will be approved by the PNL Hanford Site SESP Manager, the cognizant line manager, Office of Hanford Environment (OHE), and RL when issued or reissued.

Modifications to the plan between reissues will be controlled under existing OHE project change control procedures. Between reissues of Section III.A, modifications will be recorded in the front of the plan on a record of changes form.

Substantive deviations from the plan are to be approved by OHE and RL and recorded on the record of changes form.

Document Control

Document control for this *Environmental Monitoring Plan* is maintained by OHE.

Operations/Conditions Change Notification

The potential exists for facility operations and/or environmental conditions to change during the course of the year. These changes may affect the needs for modifications or additions to the existing environmental surveillance program. To ensure that the need for changes in surveillance can be evaluated and acted on in a timely manner, the RL Site activity projection requests include guidance to contractors concerning the need to communicate such changes to RL and OHE. The SESP will evaluate these operation/condition changes and will document the decisions regarding the need for surveillance changes.

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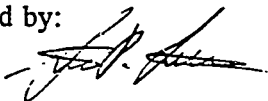
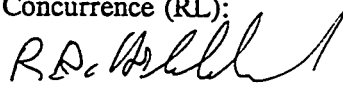
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Hanford Site Environmental Monitoring Plan **Section III.B. Ground-Water Surveillance**

Prepared by:  S. P. Luttrell	Date: 11/17/94	Concurrence (RL):  R. D. Hildebrand	Date: 11-17-94
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Introduction

Ground-Water surveillance is one aspect of the DOE requirements for environmental monitoring and is designed to meet the environmental surveillance and ground-water monitoring program objectives stated in DOE Order 5400.1 and described in DOE/EH-0173T. This section identifies the rationale and design criteria for monitoring radiological and chemical contaminants in ground water, for monitoring ground-water elevations, and for managing the data obtained to meet these objectives.

Ground-water surveillance monitoring provides an integrated assessment of ground-water quality on the Hanford Site. In addition to the monitoring activities performed specifically for environmental surveillance, other ground-water monitoring activities are being conducted at the Hanford Site to meet various requirements. Ground-water samples are collected to monitor the effects of operations in and around the 200 Areas for compliance with DOE (Johnson 1993) and for facility-specific monitoring for compliance with 40 CFR 265 and WAC 173-303 and -304 (Washington State Department of Ecology 1994). The facility-specific monitoring activities are discussed in Section II.B, Operational Environmental Monitoring. The operational and compliance monitoring results contribute information useful in determining the total impact of Hanford Site operations on ground water and, therefore, are used in meeting DOE's environmental surveillance responsibilities. Specific wells supplying water to the Fast Flux Test Facility (FFTF) water system, as well as back-up wells, are sampled by the Ground-Water Surveillance Project. Sampling and analysis for the programs referred to above is coordinated to eliminate redundancy.

Radiological and Chemical Monitoring

Radiological and chemical contaminants in ground water are monitored at the Hanford Site to meet the objectives stated in DOE Order 5400.1:

- verify compliance with applicable environmental laws and regulations
- verify compliance with environmental commitments made in environmental impact statements, environmental assessments, safety analysis reports, or other official DOE documents
- characterize and define trends in the physical, chemical, and biological condition of environmental media
- establish environmental quality baselines
- provide a continuing assessment of pollution abatement programs
- identify and quantify new or existing environmental quality problems.

The Ground-Water Surveillance Project is designed to monitor the effects of DOE activities at the Hanford Site on ground water, both onsite and offsite. Primary activities conducted by DOE and its predecessors include nuclear reactor fuel fabrication, irradiation of fuel, processing of fuel to extract plutonium, and plutonium purification. Table III.B-1 identifies contaminants observed in ground water

Table III.B-1. Major Chemical and Radiological Ground-Water Contaminants and Their Link to Site Operations

Facilities Type	Area	Constituents
Reactor Operations	100	^3H , ^{60}Co , ^{90}Sr , Cr^{6+} , SO_4^{2-}
Irradiated Fuel Processing	200	^3H , ^{90}Sr , ^{99}Tc , ^{129}I , ^{137}Cs , NO_3^- , Cr^{6+} , CN^- , F^- , U , Pu
Plutonium Purification	200	CCl_4 , CHCl_3
Fuel Fabrication	300	U , ^{99}Tc , Cr^{6+} , TCE

and their relationship to these processes. Ground-water samples are collected from wells completed in the unconfined and upper-confined aquifers. The unconfined aquifer is monitored extensively because it has been contaminated from Hanford operations (Dresel et al. 1993) and provides a pathway for contaminants to reach points of human exposure (e.g., water supply wells, Columbia River). The upper-confined aquifer is monitored because it may present a potential pathway for contaminants to migrate off the Hanford Site. The location of wells within the 600 Area of the Hanford Site used to collect ground-water samples from the unconfined aquifer are shown in Figure III.B-1. The locations of wells within the individual areas (e.g., 100-B) used to collect ground-water samples are provided in Figures III.B-2 through III.B-12. For completeness, the locations of wells supporting all programs are shown on these figures. Wells open to the upper-confined aquifer are shown in Figure III.B-13. These maps reflect the 1994 calendar year sampling schedule.

Monitoring wells to be sampled and their sampling frequency are identified each year in the *Environmental Surveillance Master Sampling Schedule* (e.g., Bisping 1994). Appendix A lists wells, analytical constituents, and sampling frequency, as well as monitoring by other projects. As noted before, sampling and analysis for all programs is coordinated to eliminate redundancy. Procedures used for sampling-related activities are contained in *Procedures for Ground-water Investigations* (PNL 1993).

Wells are selected to monitor ground water in six general categories:

- contaminant source areas
- known contaminant plumes
- near water supplies
- at the Hanford Site perimeter
- off the Hanford Site
- background or reference areas.

Figure III.B-14 illustrates the generalized locations of each of these categories and the locations of the unconfined aquifer wells located within the area of each category. Some wells lie outside any of these categories. Wells are also used for detecting the presence of potential contaminants at the request of the Washington State Department of Health (WDOH). The rationale for selecting wells and analyses to be performed is discussed in detail in the *Ground-Water Sample Collection and Analysis Plan for the Ground-Water Surveillance Project* (Bryce et al. 1991) and are summarized below.

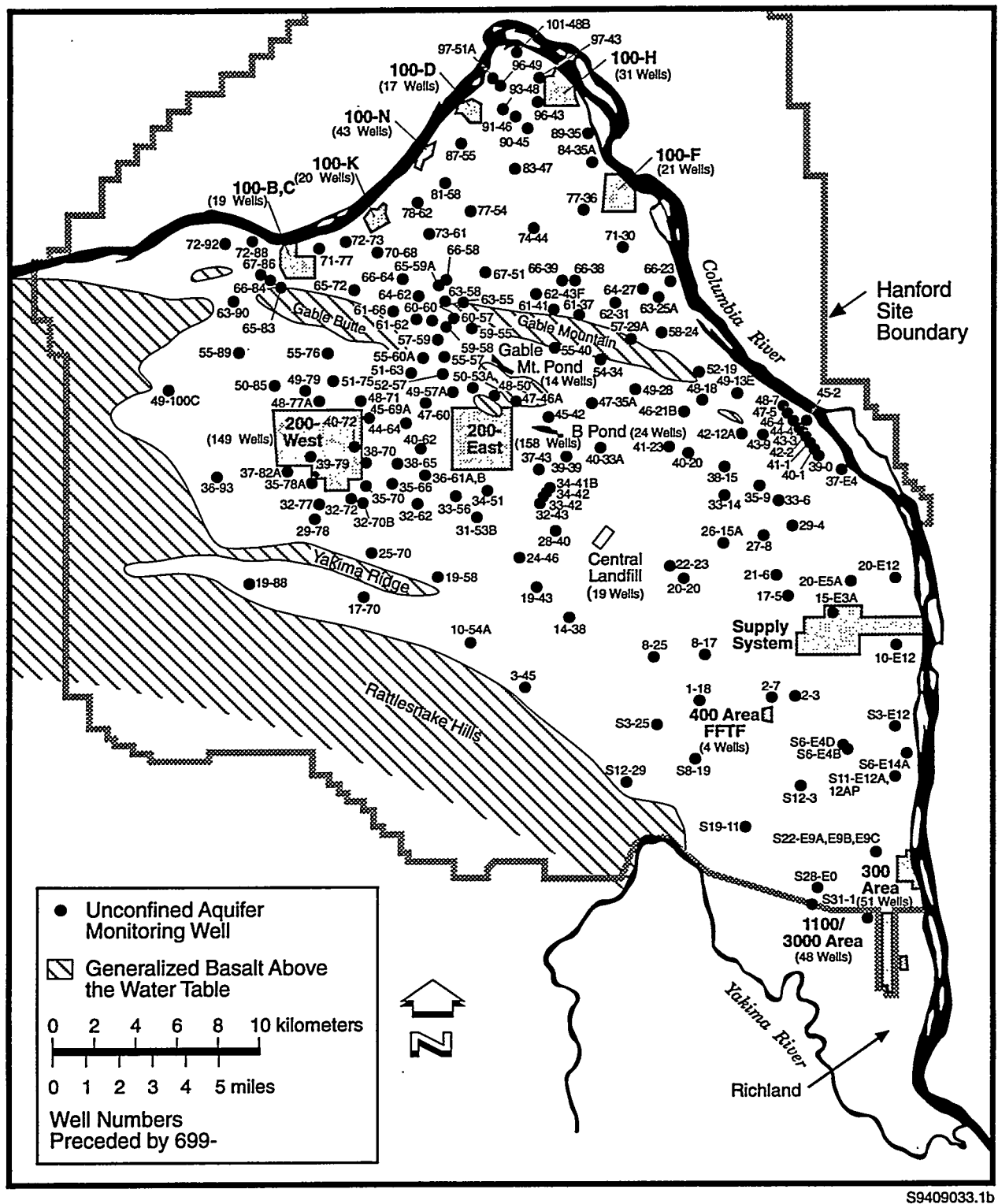
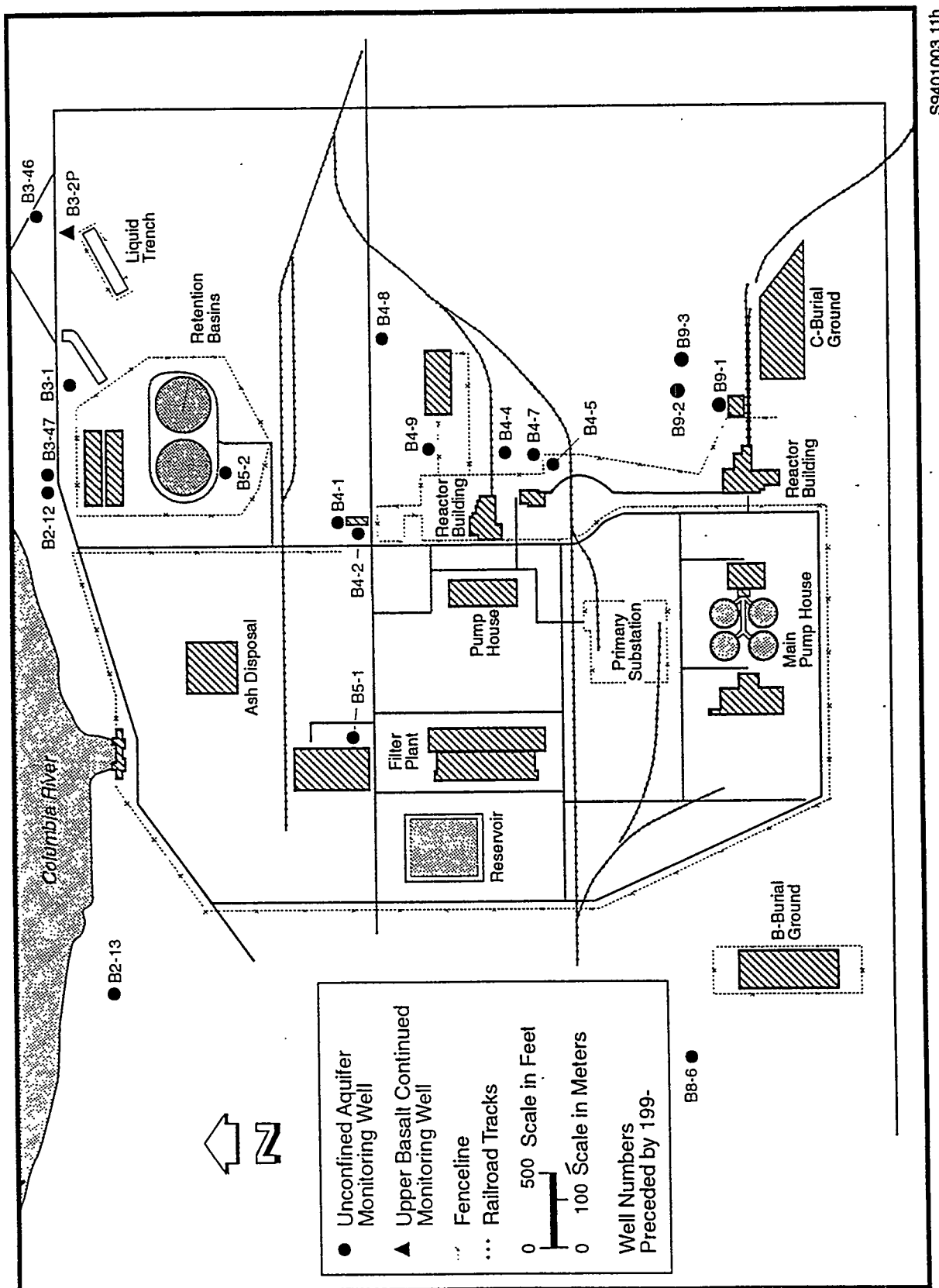
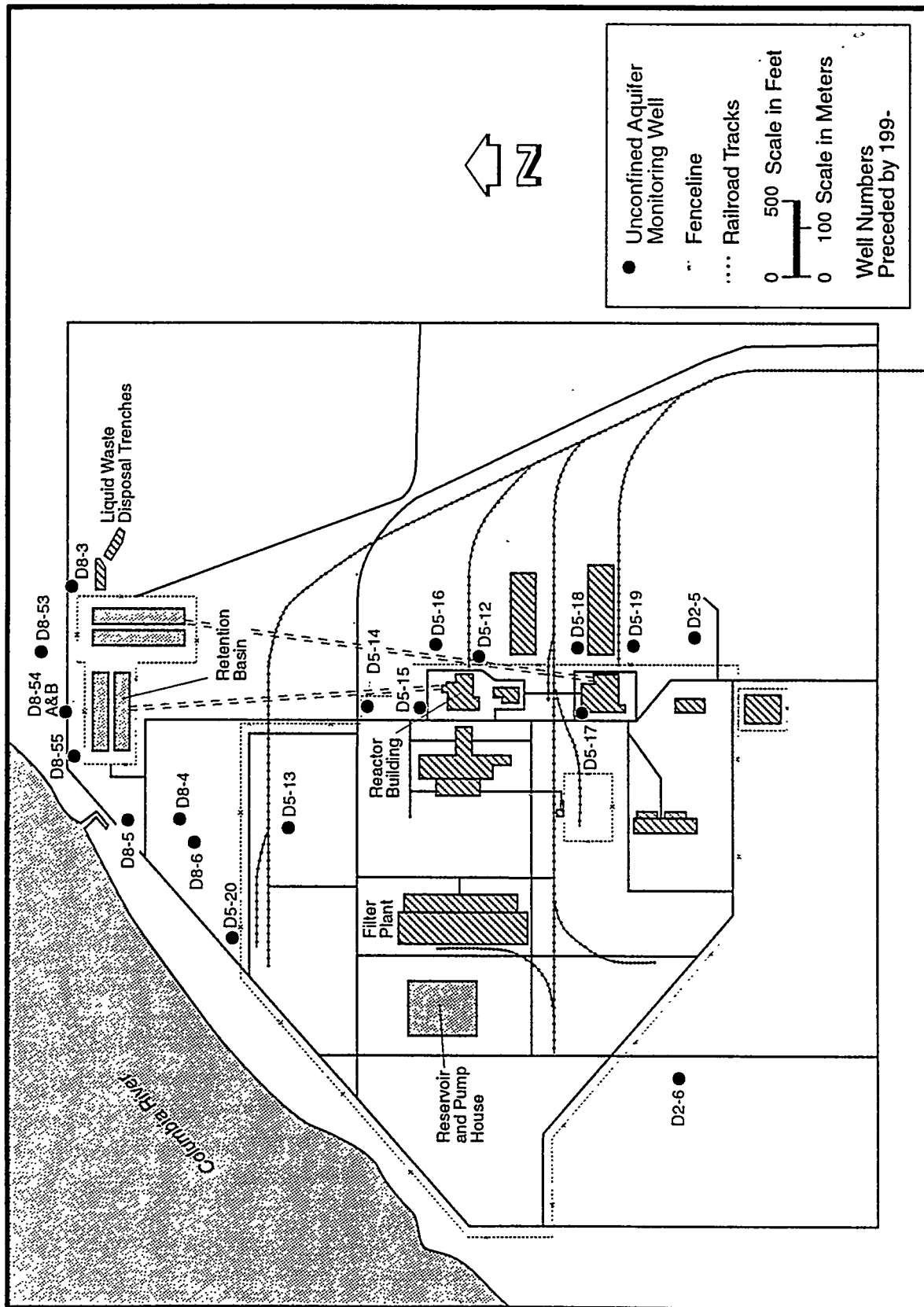


Figure III.B-1. Hanford Site 600 Area Unconfined Aquifer Monitoring Well Locations



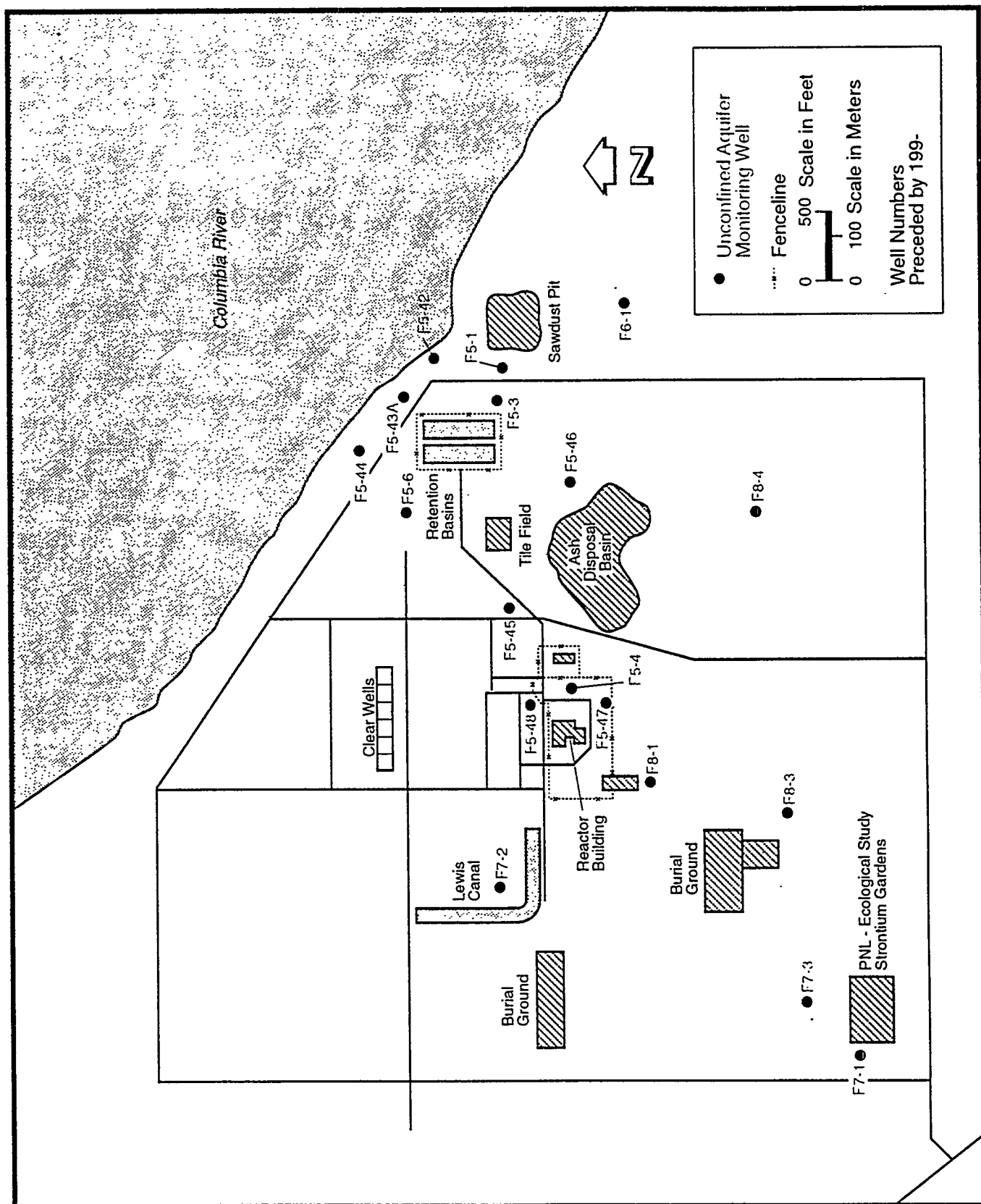
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Figure III.B-2. 100-B Area Monitoring Well Locations



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Figure III.B-3. 100-D Area Monitoring Well Locations



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Figure III.B-4. 100-F Area Monitoring Well Locations

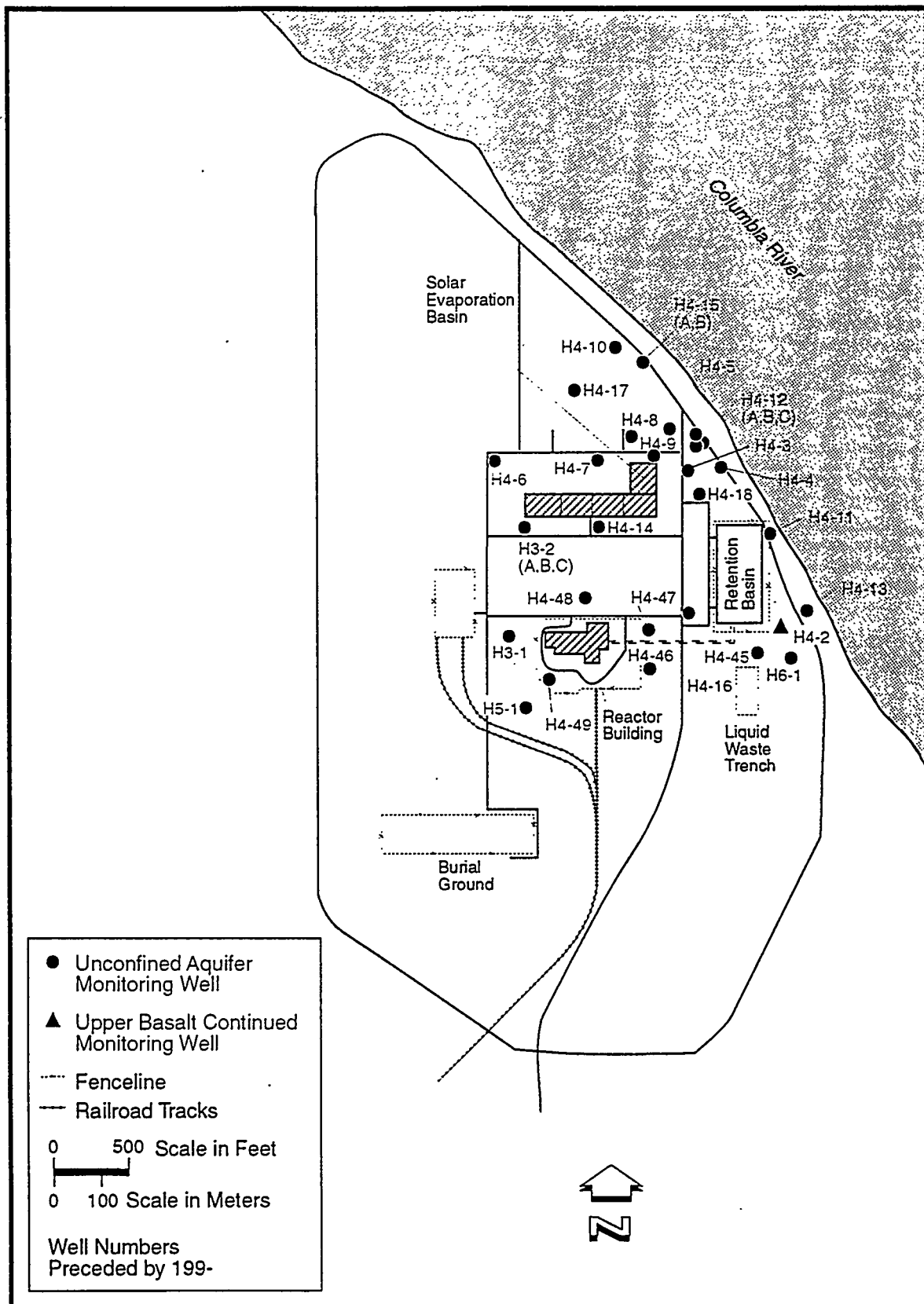
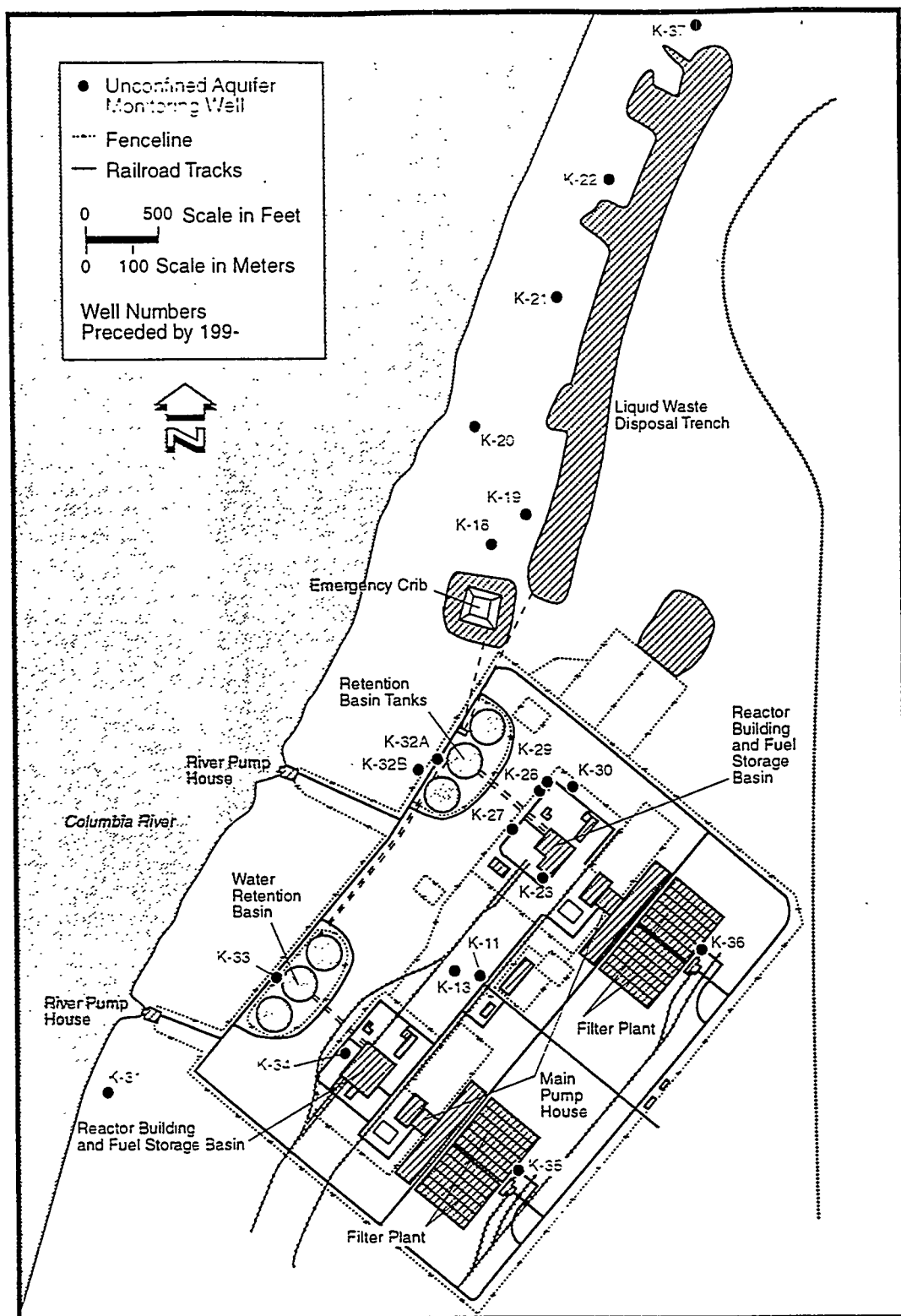


Figure III.B-5. 100-H Area Monitoring Well Locations

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Figure III.B-6. 100-K Area Monitoring Well Locations

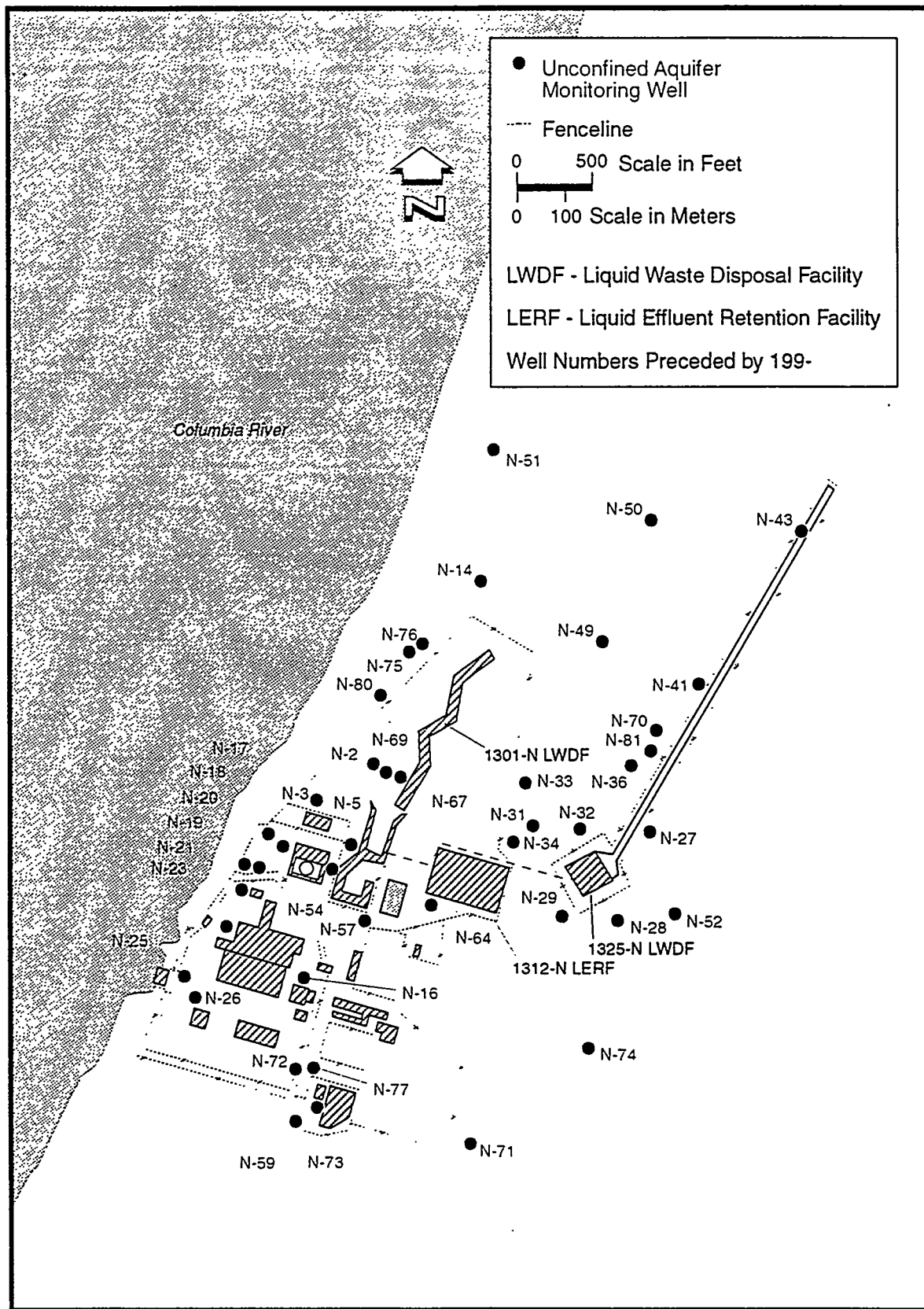
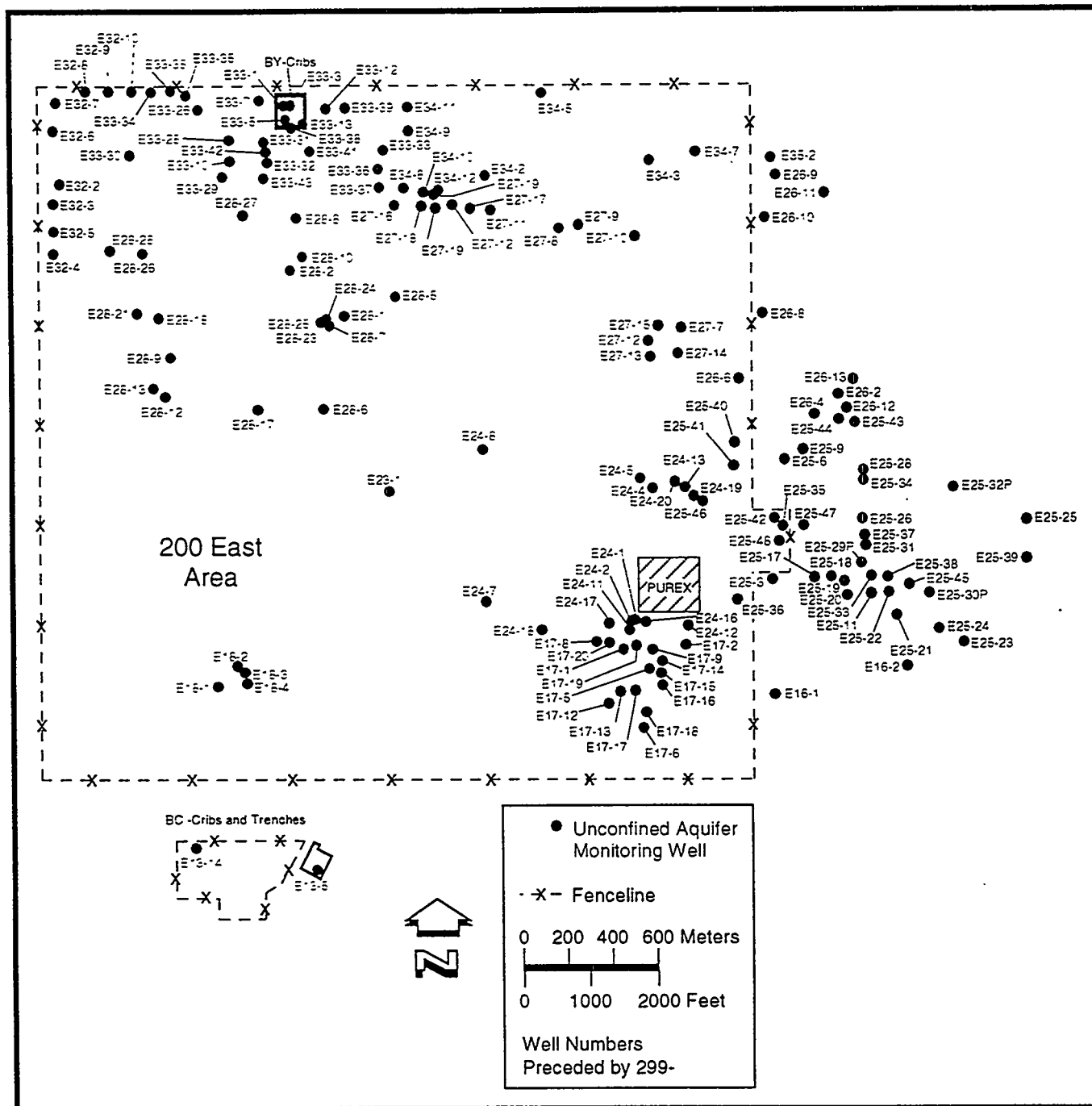


Figure III.B-7. 100-N Area Monitoring Well Locations

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Figure III.B-8. 200-East Area Monitoring Well Locations

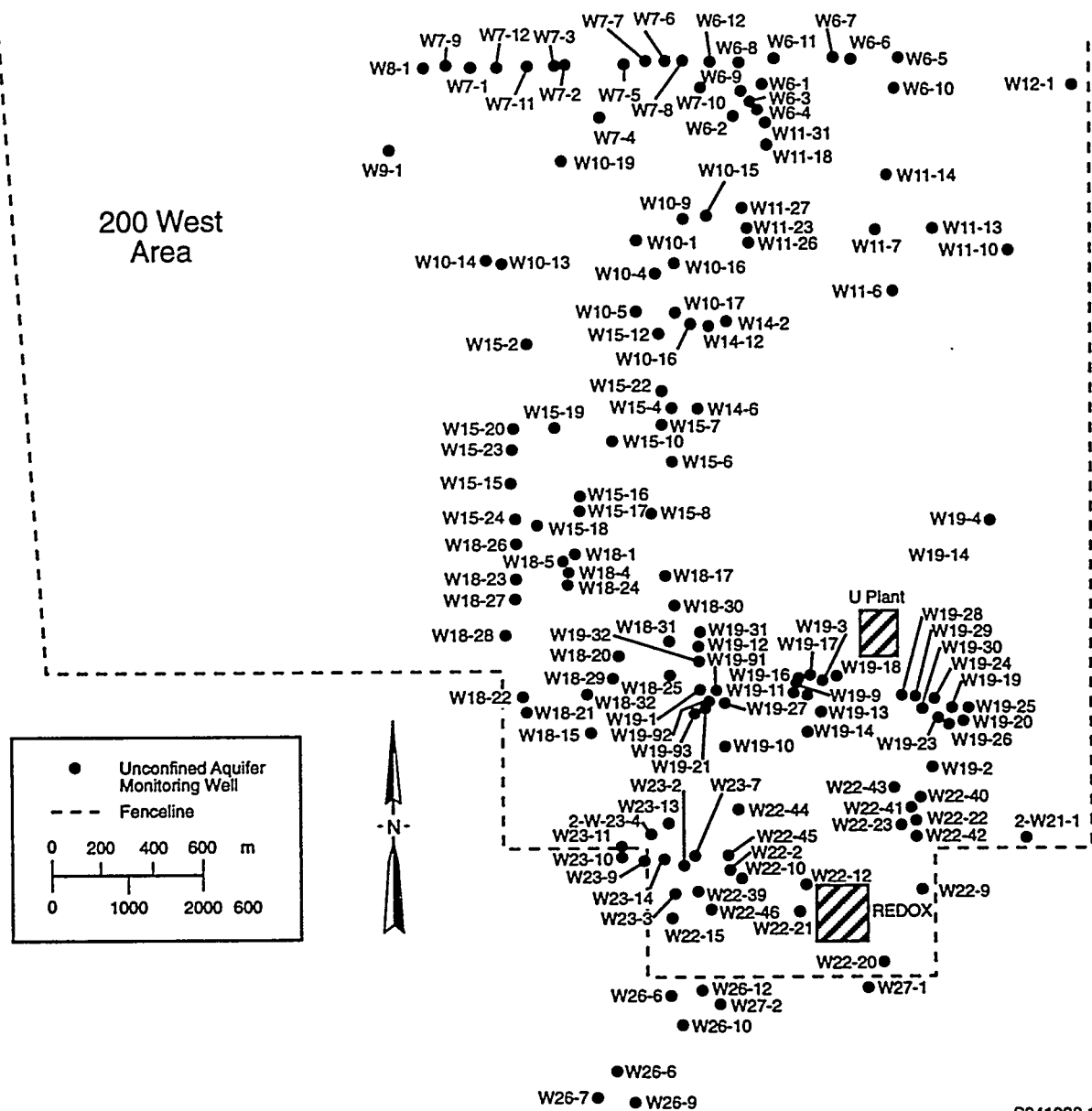


Figure III.B-9. 200-West Area Monitoring Well Locations

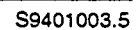
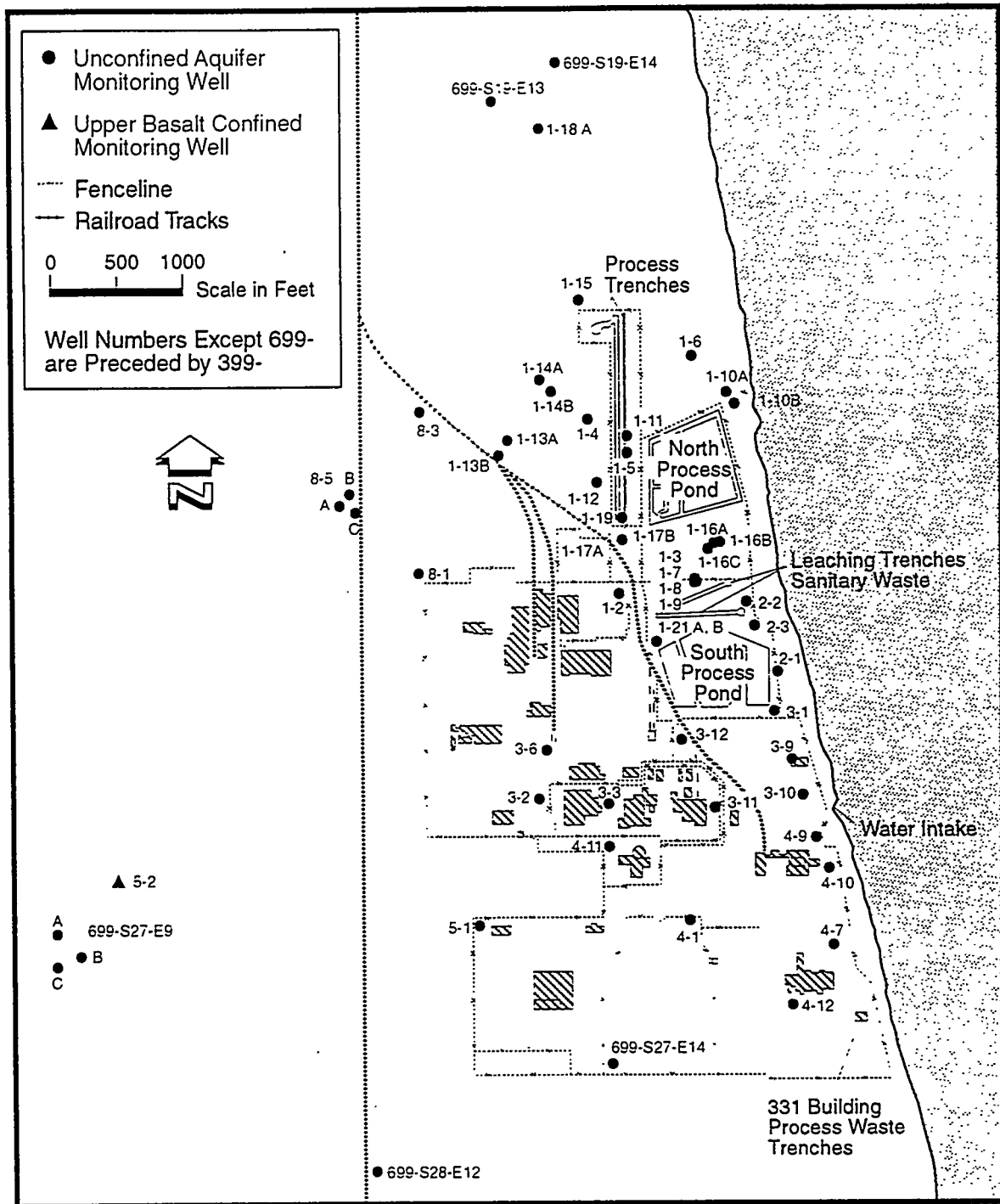
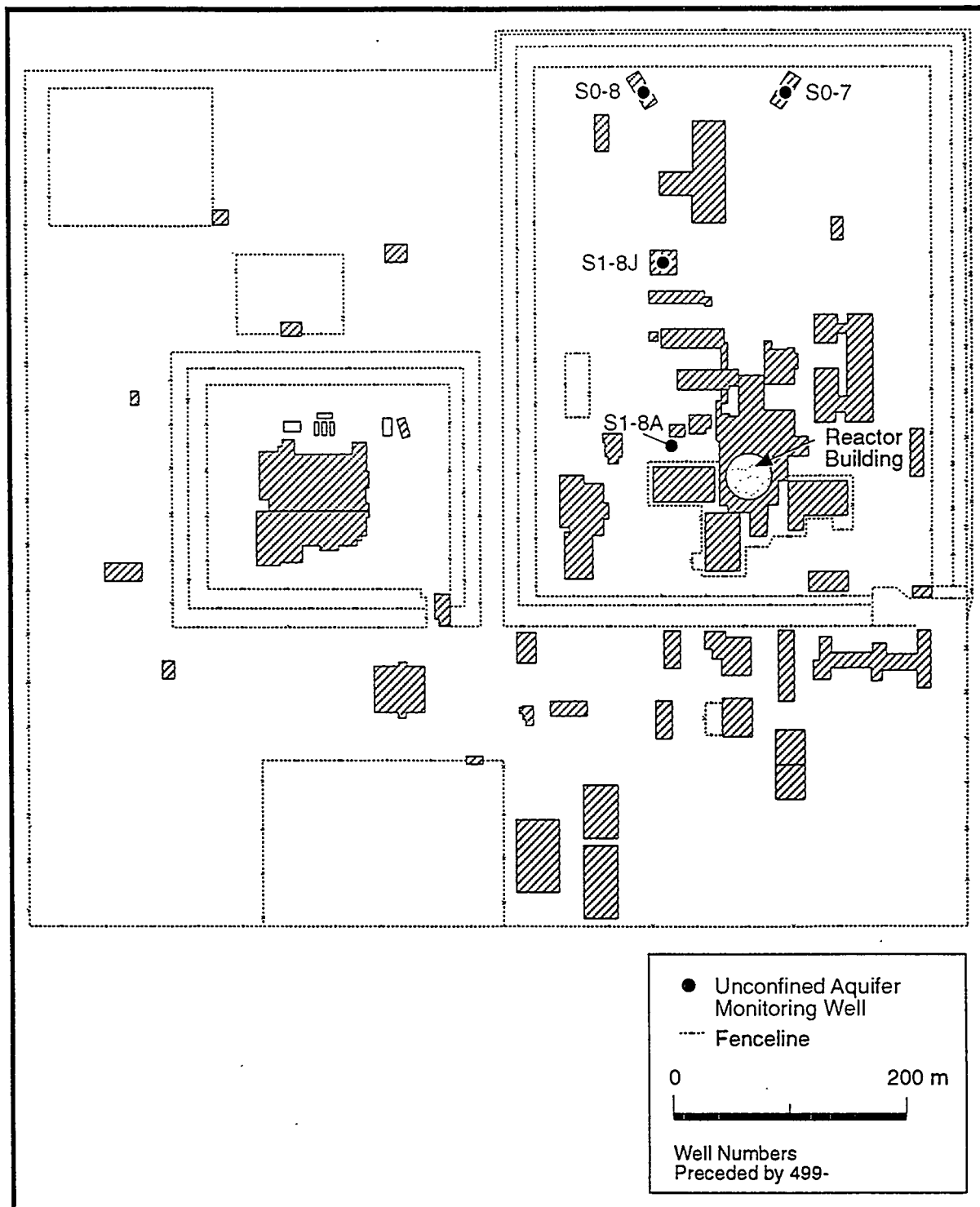


Figure III.B-10. 1100 and 3000 Area Monitoring Well Locations



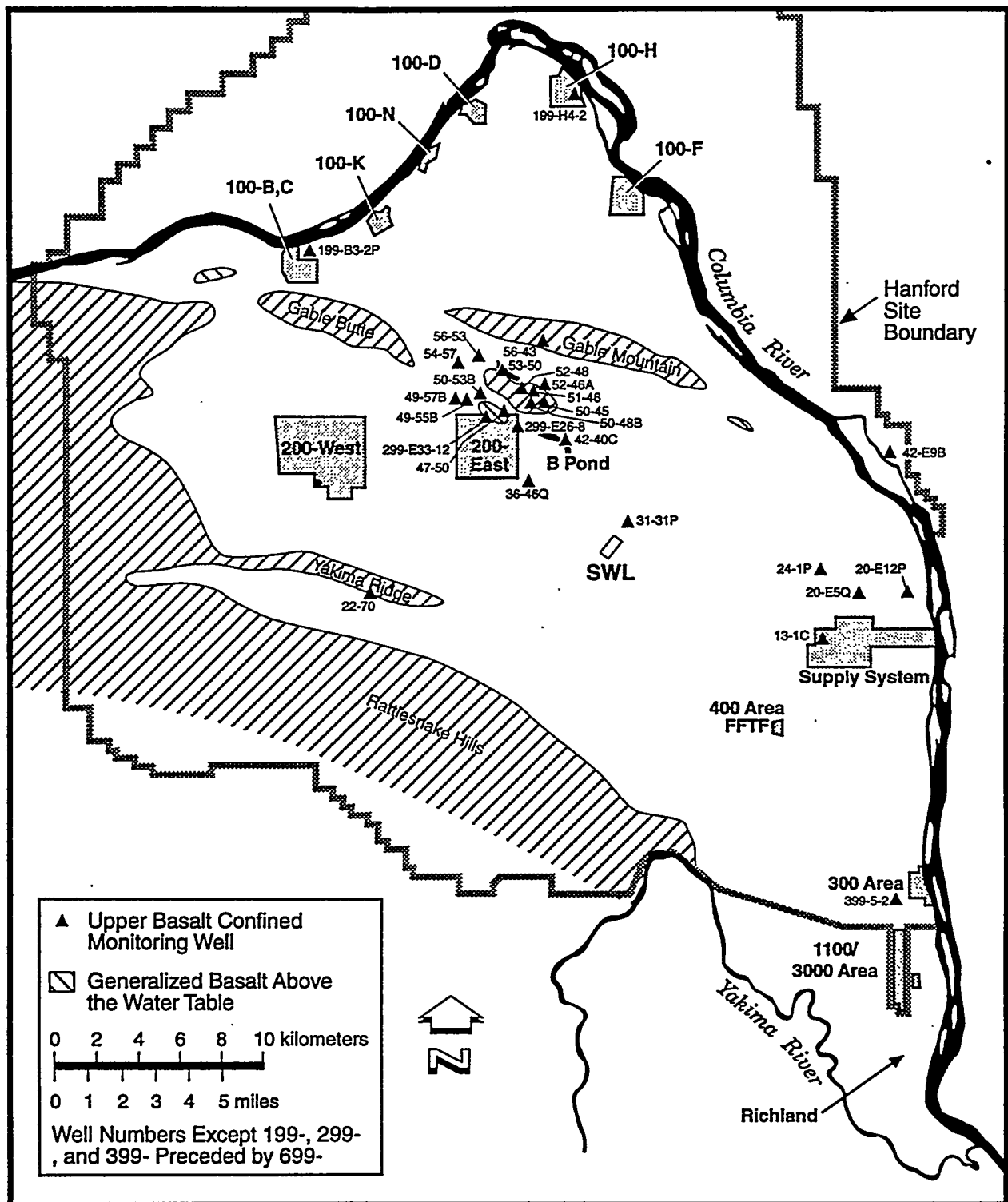
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Figure III.B-11. 300 Area Monitoring Well Locations



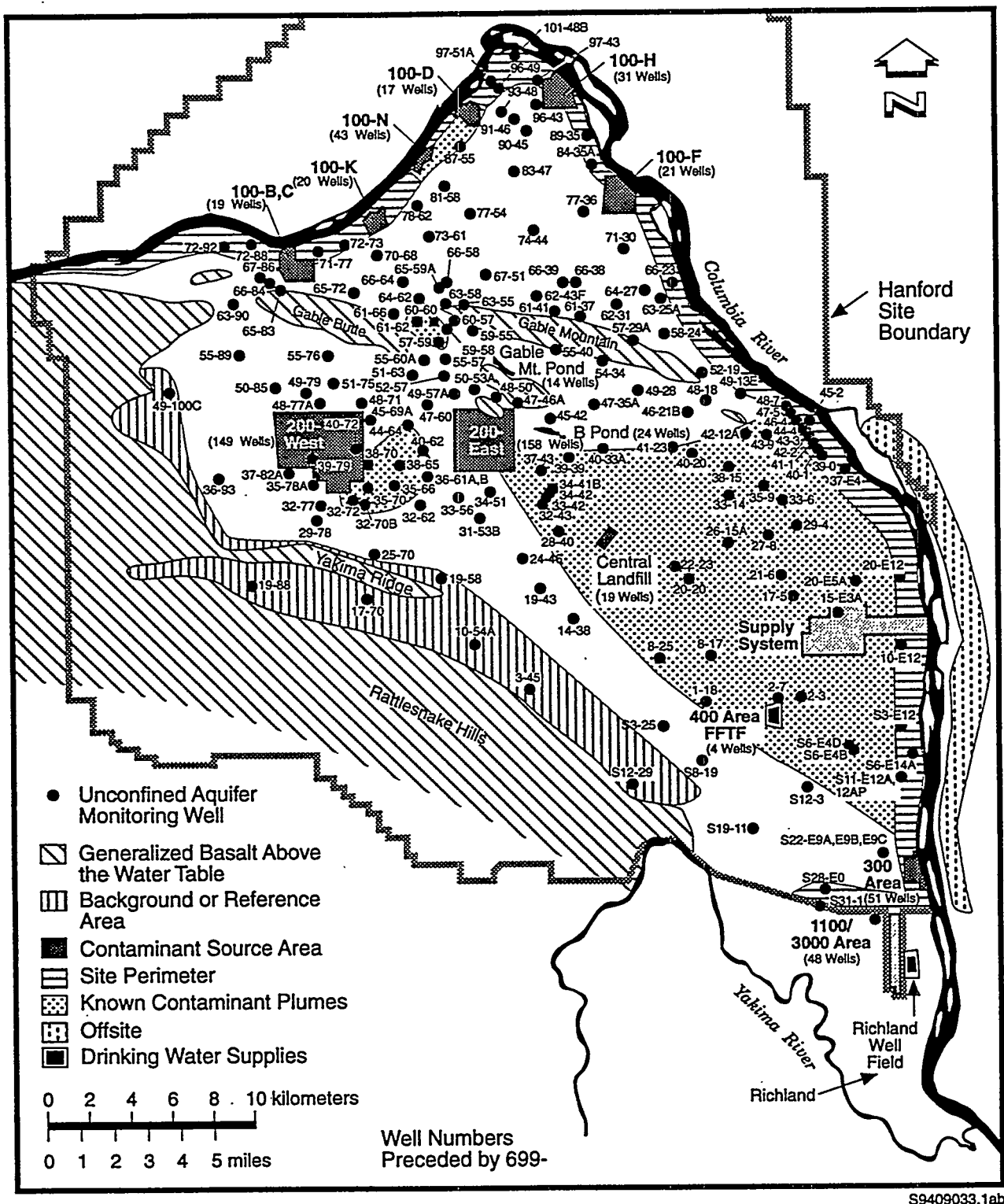
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Figure III.B-12. 400 Area Monitoring Well Locations



S9401003.6

Figure III.B-13. Hanford Site Upper-Confined Aquifer Monitoring Well Locations



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Figure III.B-14. Generalized Monitoring Categories and Well Locations

- **Contaminant Source Areas**--Contaminant source areas are monitored to characterize and define trends in the chemical condition of the ground water and to identify and quantify existing, emerging, or potential ground-water quality problems. Source areas include regions with active waste disposal facilities or with facilities that have generated or received waste in the past. These include the 100, 200 and 300 Areas on the Site as well as the central landfill. Ground-water monitoring in these areas is performed primarily by Resource Conservation and Recovery Act (RCRA) compliance or Operational Environmental Monitoring programs conducted by the operating contractor. Additional sampling has been initiated or is planned as part of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation/Feasibility Study (RI/FS) activities on the Hanford Site. The Ground-Water Surveillance Project will supplement these monitoring activities if it is required to meet the needs of the environmental surveillance program.
- **Known Contaminant Plumes**--Wells located within known contaminant plumes continue to be monitored to characterize and define trends in the concentrations of the associated radiological or chemical constituents. These wells are also monitored to meet the objective to quantify existing ground-water quality problems and to provide a baseline of environmental conditions against which future changes can be assessed. These wells will continue to be monitored as releases of waste to disposal facilities are halted and cleanup of the Site begins, to provide a continuing assessment of the effect of pollution abatement programs.
- **Near Water Supplies**--Water supplies on and near the Site potentially provide the most direct route for human exposure to contaminants in ground water. Three water supplies exist onsite. One of these is for the staff and visitors at the FFTF, one is at the Yakima Barricade guard house, and one is at the Hanford Patrol shooting range. Water supply wells for the City of Richland are adjacent to Hanford's southern boundary. Wells near these water systems and, in some cases, the water supply wells, are monitored to identify any potential water quality problems long before regulatory limits are reached.
- **Hanford Site Perimeter**--Wells along the Hanford Site perimeter are monitored to assess the quality of ground water when it leaves the region where access to the water can be restricted by the DOE. Wells in a region about 2 km wide along the boundary of the Site have been identified. Data gathered from wells in this region help address a number of the objectives of the program including the identification and quantification of existing, emerging, or potential ground-water quality problems, and the assessment of the potential for contaminants to migrate off the Hanford Site through the ground-water pathway.
- **Offsite**--Ground water is utilized as a source for domestic and agricultural water supply outside the Hanford Site. While it is unlikely that contaminants have migrated offsite through the ground-water pathway, these water sources are monitored to maintain a baseline of information on concentrations of contaminants that are potentially of Hanford origin.
- **Background or Reference Areas**--To determine the impact of Hanford operations on the environment, the quality of water on the Hanford Site unaffected by operations

must be known. Data on the concentration of contaminants of concern in ground water before Hanford operations are not available; therefore, concentrations of naturally occurring chemical and radiological constituents in ground water sampled from wells located in areas unaffected by Hanford operations provide the best estimate of pre-Hanford-operations ground-water quality. In addition, the concentration of contaminants contributed by offsite operations upgradient of Hanford must also be determined to allow the contribution from Hanford and non-Hanford sources to be distinguished.

Chemical constituents to be analyzed from samples collected at each well are listed in the *Environmental Surveillance Master Sampling Schedule* (e.g., Bisping 1994). Table III.B-2 lists constituents that are analyzed. Appendix III.B-A also lists constituents planned to be analyzed for specific wells. Constituents are chosen based on waste materials previously disposed of at Hanford (Stenner et al. 1988), ongoing waste disposal activities (e.g., Diediker and Rokkan 1993), and chemical contaminants observed in the past in neighboring wells (Dresel et al. 1993). Analytical methods and detection limits are listed by Bryce et al. (1991, Appendix B); however, the methods and detection limits may change as the analytical services contract Statement of Work (SOW) is revised.

Samples are collected at various frequencies depending on the historical trends of constituent data, regulatory or compliance requirements, and characterization requirements. Frequencies range from monthly to annually, with some constituents monitored even less frequently than annually in some wells.

Table III.B-2. Radionuclides and Chemicals Analyzed for in the Hanford Site Ground-Water Surveillance Program

Radiological Parameters	Chemical Parameters
^3H	pH (field and laboratory)
^{14}C	Conductance (field)
^{60}Co	Alkalinity
^{90}Sr	Total carbon
^{99}Tc	Total organic carbon
	Total organic halogens
^{106}Ru	Be, Na, Mg, Al, K
^{125}Sb	Ca, V, Cr, Mn, Fe, Ni
^{129}I	Cu, Zn, Sr, Ag, Cd, Sb, Ba
	F^- , Cl^- , NO_3^- , PO_4^{3-} , SO_4^{2-}
^{137}Cs	As, Se, Pb, Bi
^{241}Am	Hg
	CN^-
Uranium isotopes	NH_3
Uranium (total)	Volatile organic constituents
Plutonium isotopes	Semivolatile organic constituents
Gross alpha	
Gross beta	

Monitoring Well Design and Maintenance

Most monitoring wells on the Hanford Site are 10, 15, or 20 cm in diameter and are constructed of carbon-steel casing. A number of newer wells are constructed of stainless-steel casing. Most unconfined-aquifer wells are completed with well screens or perforations in the upper 3 to 6 m of the aquifer. Bryce et al. (1991) identify criteria for selection of acceptable well construction (e.g., carbon-steel or stainless-steel casing, perforated or screened) for monitoring particular chemical constituents.

Maintenance of wells and pumps is essential to the collection of acceptable ground-water samples. Maintenance is scheduled so the wells in the Ground-Water Surveillance Project network are cleaned and pumps replaced or cleaned at least once every 5 years.

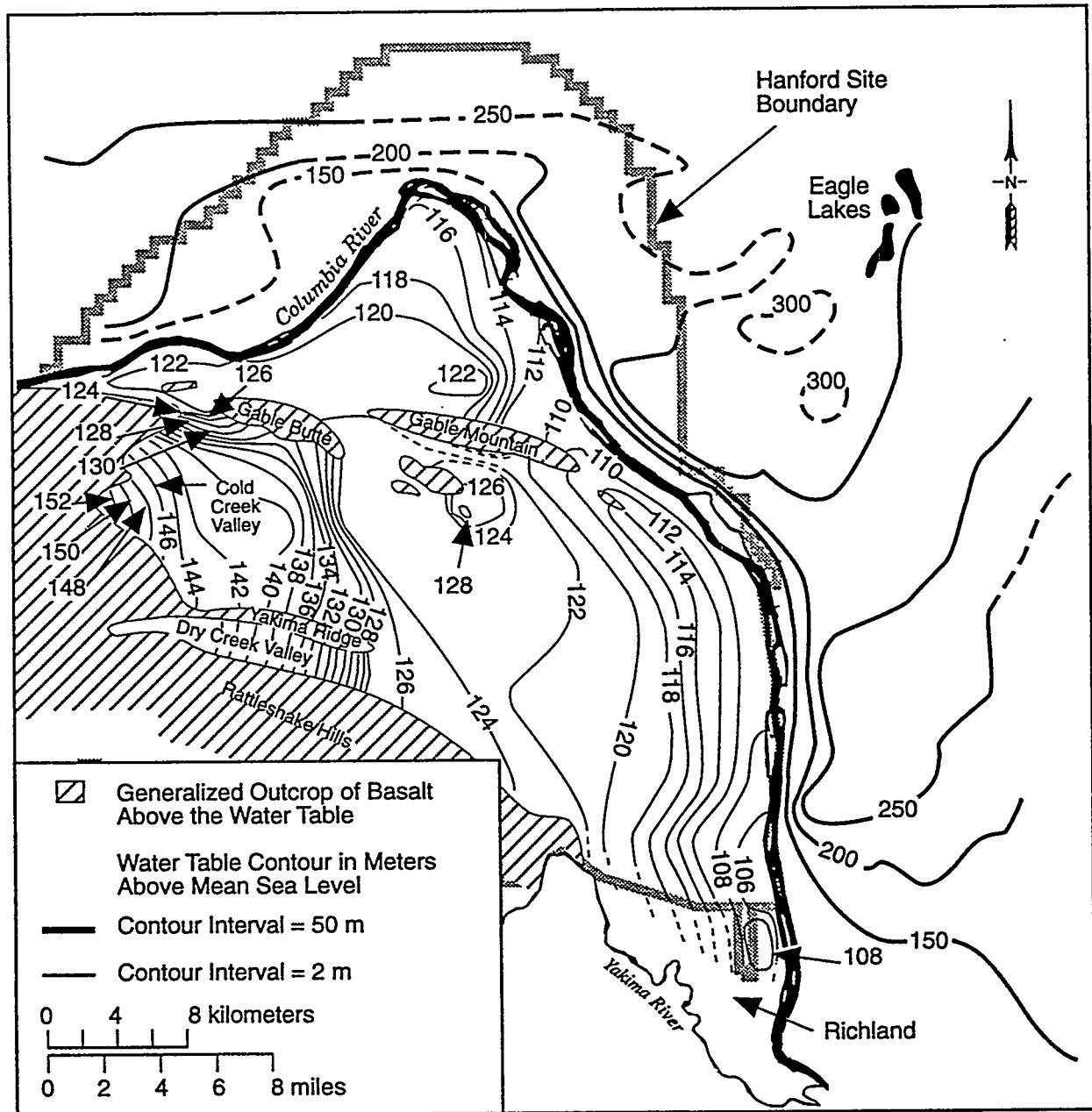
Water-Level Monitoring

Water-level monitoring is performed to help characterize the flow pattern in the unconfined aquifer and to determine the impact of Hanford Site operations on the ground-water flow system. Routine water-level measurements in the unconfined aquifer are made annually to construct a water-table map. Figure III.B-15 is the water-table map for the unconfined aquifer for the Hanford Site and vicinity. Water-level measurements for the map were made during 1993. This information may be used to:

- identify recharge and discharge areas
- evaluate the physical influence of wastewater discharges on ground-water flow directions
- determine potential for water movement between adjacent ground water and surface water bodies
- determine the horizontal hydraulic gradient and estimate the average linear velocity of ground-water flow
- improve the design of the water-level monitoring well network
- calibrate and verify numerical ground-water flow models.

The areal distribution of hydraulic head in the upper-confined aquifer is also monitored to assess the potential for contaminants to migrate off the Hanford Site through the upper-confined aquifer system and evaluate the hydraulic relationships between the unconfined and upper-confined aquifers.

The frequency of water-level measurements is determined by a variety of factors. Annual or semi-annual monitoring is conducted for most onsite and offsite wells. Near-continuous water-level monitoring is maintained in areas likely to experience rapid or significant changes in the water table. These areas are generally located in known recharge or discharge areas (e.g., waste disposal facilities, public water supply wells, and wells near the Columbia River). Water levels are measured routinely in wells before any ground-water sampling is performed. Water levels in a well network established to monitor the unconfined aquifer are measured annually in June (see Dresel et al. [1993] for well locations). A smaller well network has been established for monitoring water levels every December. These wells



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Figure III.B-15. Water-Table Map for the Unconfined Aquifer, 1993

provide information for areas expected to be affected by steep hydraulic gradients and by wastewater discharge mounds and also where widespread areal changes have been previously observed or expected.

Ground-water level measurement schedules are coordinated with WHC to reduce duplication; however, overlap of approximately 20% of the measurements allows for a check. PNL also measures water levels in a number of wells offsite and in other specific areas of interest. Procedures used for obtaining water levels are documented in *Procedures for Ground-Water Investigations* (PNL 1993).

Hydrologic Characterization and Modeling

Hydrologic characterization activities are conducted to gain understanding of hydrogeologic controls on ground water and contaminant movement. These activities are directed toward developing a three-dimensional hydrogeologic model of the Hanford Site. A three-dimensional, multi-layer numerical ground-water model of the unconfined aquifer system is being constructed in conjunction with characterization. The model is used to predict the movement of ground water and contaminants under present and future Site conditions. The model will help determine the best location for monitoring wells (vertically as well as areally) as Hanford Site activities change and contaminant sources and plumes are cleaned up.

Quality Assurance/Quality Control

Quality assurance (QA) and quality control (QC) practices encompass all aspects of the Hanford Site ground-water monitoring program. Samples are collected according to controlled procedures and are analyzed according to documented standard analytical procedures. Analytical data quality is verified by a continuing program of internal laboratory QC, participation in interlaboratory cross-checks, replicate sampling and analysis, submittal of blind standard samples and blanks, and splitting samples with other laboratories.

Comprehensive QA programs, including various QC practices, are maintained to ensure the quality of data collected through the Ground-Water Surveillance Project. QA plans are maintained for all surveillance activities, defining the appropriate controls and documentation. The program implements the requirements of RL Order RL5700.6C, "Quality Assurance," and is based on ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities* (ASME 1989). The program is defined in PNL's *Quality Assurance Manual* (PNL 1992).

The Ground-Water Surveillance Project has a current QA plan (EES059, Rev. 2) written to QAMS-005 (EPA 1983) format, that describes the specific QA elements and how they apply to the project. These plans are approved by a QA organization that conducts assessments to verify compliance with the plans. Work performed through contracts, such as sample analysis, must meet the same QA requirements.

The Ground-Water Surveillance Project has considered the needs of other federal government agencies, state government agencies, local agencies, and others in establishing Data Quality Objectives (DQOs) to be applied to data collection and analysis. The intent of DQOs established for chemical constituents, in particular, is to quantify these constituents below concentrations that are of concern to

public health and safety (e.g., the United States EPA Drinking Water Standards). Contractually required minimum detection levels are provided under the section on Laboratory Procedures.

Sample Collection Quality Assurance/Quality Control

Samples for ground-water monitoring are collected by trained staff according to approved and documented procedures in *Procedures for Ground-Water Investigations* (PNL 1993). Chain-of-Custody procedures (EPA 1986; EPA SW-846 guidance) are followed that provide for the use of evidence tape in sealing sample bottles to maintain the integrity of the samples during shipping. A field QC program consists of full trip blanks and field duplicates obtained during field operations.

Analytical Results Quality Assurance/Quality Control

Routine hazardous and nonhazardous chemical analyses for ground-water surveillance samples are performed by DataChem Laboratories, Inc., Salt Lake City, Utah. The laboratory participates in the EPA Water Pollution and Water Supply Performance Evaluation Studies. DataChem Laboratories maintain an internal QC program that meets the requirements of EPA SW-846 (EPA 1986), which PNL audits and reviews. PNL submits additional QC blind spiked samples for analysis. An internal PNL laboratory is also used for analysis of some constituents.

Routine radiochemical analyses for ground-water surveillance samples are performed by International Technology Corporation's (IT) Richland Laboratory. IT's Richland Laboratory participates in the DOE's Quality Assessment Program and the EPA's Laboratory Intercomparison Studies. An additional QC blind spiked sample program is also conducted. IT's Richland Laboratory also maintains an internal QC program, which is audited and reviewed internally and by PNL. Additional information on these QC efforts is provided in the following subsections.

U.S. Department of Energy and U.S. Environmental Protection Agency Comparison Studies

DataChem Laboratories participated in the EPA Water Pollution and Water Supply Performance Evaluation Studies. Standard water samples are distributed blind to participating laboratories. These samples contain specific organic and inorganic analytes with concentrations unknown to the analyzing laboratories. After analysis, the results are submitted to EPA for comparison to known values and other participating laboratory concentrations.

IT's Richland Laboratory participates in the DOE's Quality Assessment Program and EPA's Laboratory Intercomparison Studies Program. These programs provide standard samples containing specific amounts of one or more radionuclides that are unknown by the participating laboratory. After sample analysis, the results are forwarded to DOE or EPA for comparison with known values and results from other laboratories. Both EPA and DOE have established criteria for evaluating the accuracy of results (Jarvis and Siu 1981; Sanderson 1985).

Pacific Northwest Laboratory Evaluation

In addition to DOE and EPA interlaboratory QC programs, PNL maintains a QC program to evaluate analytical contractor precision and accuracy and to conduct special intercomparisons. This program includes the use of blind spiked samples and replicate samples. Blind spiked QC samples and blanks are prepared and submitted to the laboratories to check the accuracy and precision of analyses at DataChem Laboratories and IT's Richland Laboratory. Specific analytes are chosen for spiking based on evidence of contamination on the site. These analytes are chromium, nitrate, fluoride, cyanide,

carbon tetrachloride, chloroform, trichloroethylene, ^3H , ^{60}Co , ^{90}Sr , ^{99}Tc , ^{129}I , ^{137}Cs , ^{239}Pu , and uranium.

PNL also participates in a Quality Assurance Task Force, a program conducted by the WDOH. Organizations, both public and private, from Idaho, Oregon, and Washington participate in analyzing the intercomparison samples.

Laboratory Internal Quality Assurance Programs

The DataChem Laboratories and IT's Richland Laboratory are required to maintain an internal QC program. These programs are reviewed and audited periodically for compliance. At the DataChem Laboratories, the QC program meets the QC criteria of EPA SW-846 (EPA 1986). This program also requires the laboratory to maintain a system for reviewing and analyzing the results of the QC samples to detect problems arising from contamination, inadequate calibrations, calculations, or procedure performance. Method Detection Level determinations are performed biannually.

IT's Richland Laboratory internal QC program involves routine calibrations of counting instruments, yield determinations of radiochemical procedures, frequent radiation check sources and background counts, replicate and spiked sample analyses, matrix and reagent blanks, and maintenance of control charts to indicate analytical deficiencies. Available calibration standards traceable to the National Institute of Standards and Technology (NIST) are used for radiochemical calibrations.

Laboratory Comparisons

Additional comparisons are conducted on samples. The WDOH obtains cosamples from approximately 80 ground-water wells with the Ground-Water Surveillance Project on a quarterly schedule. The WDOH reports results in their annual report.

Laboratory Procedures

Routine ground-water surveillance samples are analyzed according to written analytical procedures. Chemical constituent analysis methodology conforms to EPA SW-846 (EPA 1982; EPA 1986) or other EPA methods, and ASTM Standards (ASTM 1986). Radiochemical constituent analysis methodologies are developed by the analyzing laboratory and are recognized as acceptable procedures within the technical radiochemical industry. They may or may not conform to published EPA methods. These procedures are described in general terms in this subsection and in detail in the IT Corporation Analytical Services Divisions's laboratory procedures manual (International Technology 1991).

Contractually required minimum detectable levels for radiological and chemical samples are shown in Tables III.B-3 and III.B-4, respectively.

Brief descriptions of the methodology used to obtain routine data results for the project samples are given below.

Table III.B-3. Radiological Analysis Detection Levels

Type of Analysis	Contract Detection Level
Gross beta (excluding ^3H)	8 pCi/L
Gross alpha	4 pCi/L
Gamma scan (^{137}Cs)	20 pCi/L
^3H	500 pCi/L
^3H low level	10 pCi/L
^{14}C	20 pCi/L
$^{89,90}\text{Sr}$	5 pCi/L
^{99}Tc	15 pCi/L
^{99}Tc -low level	1 pCi/L
^{129}I	15 pCi/L
^{129}I low level	1 pCi/L
^{238}Pu ; $^{239,240}\text{Pu}$	0.10 pCi/L
U-Natural	0.5 $\mu\text{g/L}$
U-Isotopic	0.1 pCi/L
^{241}Am	0.1 pCi/L
Radium (α)	1 pCi/L

Chemical Constituent Methods

Volatile Organic Compound Analysis. Volatile organic compounds (VOC) are analyzed by SW-846 Method 8010/8020 or EPA Method 502.2. VOCs are extracted through a purge-and-trap system (SW-836 method 5030). Volatile compounds are introduced in the gas chromatograph by the purge-and-trap method. The components are separated via the gas chromatograph and detected using a combination of chemical detectors.

Semi-Volatile Organic Compound Analysis. Semi-volatile organic compounds, analyzed by SW-846 Method 8270, are determined by extraction into methylene chloride, elution from a gas chromatographic fused-silica capillary column, and analyzed via gas chromatography/mass spectrometry (GC/MS).

Cyanide. Cyanide is analyzed by SW-846 method 9010 or 9012. After preparation, the cyanide concentration is determined by either colorimetry or automated ultraviolet (UV) colorimetry.

ICP Metals Analysis. Samples are acid digested before analysis, which is by SW-846 method 6010.

Alkalinity. Alkalinity of a sample is determined using methodology found in ASTM D1067A, or EPA method 310.2. These methods are colorimetric methods using methyl orange indicator.

Anions. The anions nitrate, nitrite, bromide, chloride, fluoride, phosphate, and sulfate are determined using methodologies found in ASTM D4327-88, or EPA Method 300.0. The sample is introduced into an ion chromatograph and the anions of interest are separated and measured.

Table III.B-4. Chemical Analysis Detection Levels

Constituent	Contract Detection Level
Aluminum	200 µg/L
Antimony	200 µg/L
Barium	20 µg/L
Beryllium	3 µg/L
Cadmium	10 µg/L
Calcium	100 µg/L
Chromium	20 µg/L
Cobalt	20 µg/L
Copper	20 µg/L
Iron	20 µg/L
Magnesium	100 µg/L
Manganese	10 µg/L
Nickel	30 µg/L
Potassium	1000 µg/L
Silver	20 µg/L
Sodium	300 µg/L
Tin	100 µg/L
Vanadium	30 µg/L
Zinc	10 µg/L
Bromide	500 µg/L
Chloride	200 µg/L
Fluoride	100 µg/L
Phosphate	500 µg/L
Sulfate	500 µg/L
Nitrite	200 µg/L
Nitrate	200 µg/L
Cyanide	20 µg/L
Alkalinity	50 mg/L
Selected Volatile Organic Constituents	
Carbon Tetrachloride	2 µg/L
Chloroform	0.5 µg/L
Tetrachloroethylene	0.5 µg/L
Toluene	2 µg/L
Trichloroethylene	1 µg/L
Selected Semivolatile Organic Constituents	
o-Cresol	10 µg/L
Decane	10 µg/L
Naphthalene	10 µg/L
Pentachlorophenol	50 µg/L
Phenol	10 µg/L
2-Nitrophenol	10 µg/L
Kerosene	10000 µg/L

Radiological Constituent Methods

Gross Alpha and Gross Beta. Gross alpha and gross beta are determined by SW-846 method 9310. An aliquot of water is evaporated onto a stainless-steel counting planchet. The residue is dried to constant weight and counted for alpha and beta radioactivity. Activity is determined using a counting efficiency vs. sample solids standardized curve for the detector system.

Gamma Spectrometry. Gamma scans provide a quantitative assay for a large number of isotopes including ^{60}Co , ^{106}Ru , ^{125}Sb and ^{137}Cs . Samples are counted directly using an Intrinsic (hyperpure) germanium or lithium drifted germanium detector. Isotopes with gamma-ray energies from 60 to 2000 KeV are detected. Activity concentrations are determined using a Nuclear Data computer system supplied with a library of isotopes.

Total Uranium. The sample is evaporated and fused with sodium and lithium fluoride flux. The yellow-green uranium fluorescence is then measured using a fluorophotometer. A U-232 tracer is used to determine recovery from the purification process, and a natural uranium standard addition is used to adjust for interferences and quantification of sample reading.

Tritium. Sodium hydroxide is added to the sample. The alkaline sample is then distilled and a fraction (about 5 ml) is mixed with scintillation cocktail, allowed to sit for decay of chemiluminescence and then counted by liquid-scintillation instrumentation.

Low-Level Tritium. The sample is distilled in the presence of potassium permanganate to eliminate solids and organic material that may cause quenching. The sample is then enriched in a basic medium by electrolysis to a small volume. The reduced, enriched volume is transferred to a liquid scintillation vial with scintillation cocktail. It is then counted by liquid scintillation instrumentation.

Technetium-99. The samples are wet-washed with nitric acid and hydrogen peroxide to destroy organic material in the sample. Actinides, lanthanides, alkaline earths, transition metals, and lead are removed through precipitation as hydroxides and carbonates. Technetium as the pertechnetate ion is adsorbed from a weak nitric acid solution on a strongly basic anion-exchange resin column. The technetium is then eluted with a stronger nitric acid solution and counted by liquid scintillation beta counting.

Strontium-90. Samples are precipitated first as a nitrate and then as a carbonate. Calcium, barium, radium and lead are removed by co-precipitation on barium chromate. Iron and other fission products are removed through a hydroxide scavenge. Gravimetric yield of carrier (or ^{89}Sr tracer yield), is determined along with the ^{89}Sr and ^{90}Sr activity by beta counting following final carbonate precipitation. ^{90}Y is then separated from the strontium by hydroxide and oxalate precipitations. The yttrium oxalate is converted to yttrium oxide, weighed for chemical recovery, and counted by beta proportional counting for activity.

Americium-241. Americium and curium are concentrated in the sample through coprecipitation on ferric hydroxide. Plutonium and thorium are separated from the americium and curium by passing the sample through an anion exchange column conditioned with dilute nitric acid. The iron is then separated from the americium and curium by coprecipitation on calcium oxalate. The americium and curium are then extracted into a bidentate organophosphorus solvent (DDCP) from a nitric acid solution and then back-extracted with weak nitric acid. Traces of iron, thorium, and any organic

residue are removed by passing the solution through a cation exchange column. The americium and curium are eluted from the cation exchange column with dilute hydrochloric acid, electrodeposited or precipitated on a counting disk, and counted by alpha spectrometry.

Plutonium Isotopic. The sample is acidified with nitric acid, the plutonium oxidation state is adjusted to +4 with sodium nitrite and the solution is loaded onto an anion exchange column. The plutonium is eluted with hydrochloric acid and ammonium iodide. The sample is electrodeposited or coprecipitated on a counting disc and the activity counted by alpha spectrometry.

Uranium Isotopic. The uranium is separated from thorium, radium, and lead by an 8M hydrochloric acid anion-exchange column and iron is removed by passing the sample through an 8M nitric acid anion-exchange resin column. The uranium fraction is eluted and electrodeposited on a disc for alpha spectrometry counting.

Iodine-129. Iodine isotopes are separated from interfering radioactive isotopes by oxidation to iodine (I_2) with sodium nitrite and extracted into carbon tetrachloride from dilute acid media. The iodine is then reduced to iodide with sodium bisulfite. It is then back-extracted into water, precipitated as silver iodide, and counted on a low-energy photon detector. Chemical yield is determined gravimetrically.

Holding Times

Chemical constituent concentrations in ground-water samples are required to be determined within a specified time frame, or "hold time." Samples must be analyzed within this time frame, as the concentration of the constituents of concern may be compromised because of decomposition or chemical change. Samples are also refrigerated to slow down the chemical changes within the sample matrix. Hold times are from time of collection to analysis or preparation time. For EPA SW-846 methods, the hold time for volatile organic analysis is 14 days, semivolatile analysis is 7 days before extraction and 40 days after extraction, cyanide analysis is 14 days, and ICP metals analysis is 6 months. As required by ASTM and EPA methodology, hold time is 48 hours for the determination of the anions nitrate, nitrite, and phosphate, and 28 days for chloride, bromide, fluoride, sulfate, and ammonium. Radiochemical constituents are not required to be analyzed within a designated hold time as they do not chemically change or decompose under ambient temperatures.

Data Management

Data received from the analytical laboratory are stored on the computerized Hanford Environmental Information System (HEIS) database. Data from analytical laboratories are sent to the appropriate HEIS data manager in electronic format. The electronic media can be loaded into HEIS using software written and maintained by HEIS personnel. Samples submitted to the laboratory are tracked to ensure that all analyses requested are received.

Water-level data, analytical results from internal laboratories, and field measurements (pH and specific conductance) are manually entered and stored on the HEIS database. Checking for data entry accuracy is done shortly after entry, and a trend check is performed periodically to detect possible errors.

If a data problem is noted, a Request for Data Review is initiated. Changes to data, if necessary, are recorded in the HEIS database by storing the replaced value. The reason for replacing an erroneous value is recorded in a comment field within the database.

Management of the records stored in HEIS are pursuant to Document Control and Records Management (WHC 1988). The HEIS programmers and HEIS data owners ensure database integrity and data consistency through membership in the HEIS Configuration Control Board. The HEIS personnel are responsible for maintaining certain data tables central to the operation of HEIS.

Implementation

Programmatic implementation of the Ground-Water Surveillance Project is accomplished through the Pacific Northwest Laboratory Office of Hanford Environment, Environmental Management Directorate. The majority of the technical support is provided through the Earth and Environmental Sciences Center. Documents that describe the implementation of the Ground-Water Surveillance Project are the annual Contractor Work Plan and the *Quality Assurance Project Plan* (EES 059, Rev. 2).

Data Evaluation and Reporting

Each analysis of a ground-water sample provides information on the chemical composition of ground water at one time at one location in the aquifer. Uncertainty in analyses results from a number of sources, including aquifer chemistry fluctuations, sampling techniques, well construction, and laboratory analysis, which includes random and systematic errors. Overall sample uncertainty may be factored into data evaluation by considering the concentration trend in a well over time.

Sampling and analysis results from all programs are evaluated on an ongoing basis. The evaluations identify trends in constituent concentrations and correlate these trends to disposal practices and site hydrogeology. WHC and DOE are contacted if any results show unexpected increases in contaminant concentration. Operators of other monitoring programs (e.g., surface water) are also contacted if unexpected results are observed in areas relevant to their programs.

Results and conclusions from the data evaluation are reported and summarized in *The Hanford Site Environmental Report* (e.g., Dirkes et al. 1994). Results and interpretation of ground-water analyses are also reported in detail in annual ground-water monitoring reports (e.g., Dresel et al. 1993). The reports include contaminant plume maps of several constituents, contaminant trend plots, and discussion of these results.

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40 CFR 265, Code of Federal Regulations, Title 40, Part 265, *Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*.²²

Hanford Site Environmental Monitoring Plan

Section III.B - Appendix A Wells in the 100, 200, 300, 400, 600, 1100, and 3000 Areas of the Hanford Site

The ground-water sampling schedule identifies ground-water sampling events used by PNL for environmental surveillance of the Hanford Site. Some of these samples are collected and analyzed by other ground-water monitoring programs at Hanford (e.g., Resource Conservation and Recovery Act [RCRA], Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA], or Operational Environmental Monitoring). They are indicated by a number in the analysis column of the ground-water tables and a project designation in the CERCLA or RCRA/OPER column.

Abbreviations

Frequency Symbols Used

A	annually
M	monthly
Q	quarterly
SA	semiannually

Numbers: The numbers in the tables indicate the estimated number of samples to be collected each year by other projects.

Analysis Symbols Used

Generally, standard elements, chemical, and isotope designations are used to indicate the analyses performed. Other analysis designations used are:

Alk	alkalinity
Alpha	total alpha activity
Anion	major anions - generally Cl, F, NO ₃ , SO ₄
Beta	total beta activity
CN ⁻	cyanide
ICP-f	major metals by inductively coupled plasma spectrometry - samples filtered in the field
ICP-u	major metals by inductively coupled plasma spectrometry - samples unfiltered
Lo ³ H	low-level tritium
U-iso	isotopic uranium
VOA	volatile organic analytes

Notes Abbreviations Used

The abbreviations in the table are as designated:

CAS	well sampled as part of a confined aquifer study
DOH	well co-sampled with the Washington State Department of Health
DWS	water supply wells and wells near water supplies
LERF	liquid effluent retention facility
LLBG	low-level burial ground
LLWMA	low-level waste management area
NRDWL	nonradioactive dangerous waste landfill
SWL	solid waste landfill
SST	single-shell tanks

A.1.0 100 Area Wells

A.1.1 100-B Area Wells^(a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
199-B2-12	2			2			2				2	2	2	2				100-BC-5		
199-B2-13	2			2			2				2	2	2	2				100-BC-5		
199-B3-1	2			2			2				2	2	2	2				100-BC-5		
199-B3-2P	A		A				A		A		A	A	A	A	A			100-BC-5		CAS
199-B3-46	2			2			2				2	2	2	2				100-BC-5		
199-B3-47	2			2			2				2	2	2	2				100-BC-5		
199-B4-1	2			2			2				2	2	2	2				100-BC-5		
199-B4-2			A			A	A	A	A		A	A	A	A	A			100-BC-5		
199-B4-4	2			2			2				2	2	2	2				100-BC-5		
199-B4-5	2			2			2				2	2	2	2				100-BC-5		
199-B4-7	2			2			2				2	2	2	2				100-BC-5		
199-B4-8	2			2			2				2	2	2	2				100-BC-5		
199-B4-9	2			2			2				2	2	2	2				100-BC-5		
199-B5-1	2			2			2				2	2	2	2				100-BC-5		
199-B5-2	2			2			2				2	2	2	2				100-BC-5		
199-B8-6	2			2			2				2	2	2	2				100-BC-5		
199-B9-1	2			2			2				2	2	2	2				100-BC-5		
199-B9-2	2		A	2		A	2	2	A		A	2	A	2	A	2		100-BC-5		
199-B9-3	2			2			2				2	2	2	2				100-BC-5		

A.1.2 100-D Area Wells^(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
199-D2-5	2						2							2				100-HR-3		
199-D2-6	2						2							2				100-HR-3		
199-D5-12	2		A				A	2			A	2	A	2	A			100-HR-3		
199-D5-13			2	2	2		2	2						2				100D		
199-D5-14	2						2				2			2				100-HR-3		
199-D5-15	2						2				2			2				100-HR-3		
199-D5-16	2						2				2			2				100-HR-3		

A.1.2 100-D Area Wells(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes
199-D5-17	2	A					A	2			A		A	2	A		A		100-HR-3	
199-D5-18	2						2		A				A	2					100-HR-3	
199-D5-19	2						2						2						100-HR-3	
199-D5-20	2						2						2						100-HR-3	
199-D8-3	2	A					A	2			A	2	A	2	A		A		100-HR-3	100D
199-D8-4		2	2	2			2		2				2							100D
199-D8-5		2	2	2			2		2				2							100D
199-D8-53	2						2				2		2						100-HR-3	
199-D8-54A	2	A					A	2			A	2	A	2	A		A		100-HR-3	
199-D8-54B	2						2						2						100-HR-3	

A.1.3 100-F Area Wells(c)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes
199-D8-55	2						2				2		2						100-HR-3	
199-D8-6		2	2	2			2		2				2							100D
199-F1-2		2	2	2			2		2		2	A	2	2	A		2		2 100-FR-3	
199-F5-1		2	A	2	2		2		2		2	A	2	2	A		2		2 100-FR-3	
199-F5-3		2	A	2	2		2		2	A	2	A	2	2	A		2	A	2 100-FR-3	
199-F5-4		2	2	2	2		2		2		2	2	2	2			2		2 100-FR-3	
199-F5-42		2	2	2	2		2		2		2	2	2	2			2		2 100-FR-3	
199-F5-43A		2	2	2	2		2		2		2	2	2	2			2		2 100-FR-3	
199-F5-44		2	2	2	2		2		2		2	2	2	2			2		2 100-FR-3	
199-F5-45		2	A	2	2		2		2	A	2	A	2	2	A		2	A	2 100-FR-3	
199-F5-46		2	2	2	2		2		2		2	2	2	2			2		2 100-FR-3	
199-F5-47		2	2	2	2		2		2		2	2	2	2			2		2 100-FR-3	
199-F5-48		2	2	2	2		2		2		2	2	2	2			2		2 100-FR-3	
199-F5-6		2	2	2	2		2		2		2	2	2	2			2		2 100-FR-3	
199-F6-1		2	2	2	2		2		2		2	2	2	2			2		2 100-FR-3	
199-F7-1		2	A	2	2		2		2		2	A	2	2	A		2	A	2 100-FR-3	
199-F7-2		2	2	2	2		2		2		2	2	2	2			2		2 100-FR-3	
199-F7-3		2	A	2	2		2		2	A	2	A	2	2	A		2	A	2 100-FR-3	

A.1.3 100-F Area Wells(c)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U 3H	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
199-F8-1	A										A		A		A					
199-F8-3		2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	100-FR-3	
199-F8-4		2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	100-FR-3	

A.1.4 100-H Area Wells(d)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U 3H	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
199-H3-1	2						2						A						100-HR-3	
199-H3-2A		4	4	4				4	A				4	A	4				183H	
199-H3-2B						A			A				A							
199-H3-2C		4	4	4				4	A				4	A	4				183H	
199-H4-10	2						2											100-HR-3		
199-H4-11		4	4	4				4					4		4				183H	
199-H4-12A		4	4	4				4	A				4	A	4				183H	
199-H4-12B		A					A		A				A							
199-H4-12C		4	4	4				4	A				4	A	4				183H	
199-H4-13	2						2					2		2				100-HR-3		
199-H4-14		4	4	4				4					4		4			100-HR-3	183H	
199-H4-15A	2	4	4	4			2	4				2	4	2	4			100-HR-3	183H	
199-H4-15B																				
199-H4-16	2						2					2		A				100-HR-3		
199-H4-17	2	4	4	4			2	4					4	A	4			100-HR-3	183H	
199-H4-18		4	4	4				4					4	A	4			183H		
199-H4-2	A						A													CAS
199-H4-3		12	12	12			8	12					4		4			100-HR-3	183H	
199-H4-4	A	Q	12	Q	12	Q	SA	8	12	A			Q	4	Q	4	A		183H	DOH
199-H4-45	2						2					2		2				100-HR-3		
199-H4-46	2						2					2		2				100-HR-3		
199-H4-47	2						2					2		2				100-HR-3		
199-H4-48	2						2					2		2				100-HR-3		

A.1.4 100-H Area Wells(d)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
199-H4-49	2						2					2		2					100-HR-3	
199-H4-5		4	4	4				4				4			4				100-HR-3	183H
199-H4-6		4	4	4				4				4			4				100-HR-3	183H
199-H4-7		4	4	4				4				4	A		4				183H	
199-H4-8		4	4	4				4				4	A		4				183H	
199-H4-9		12	12	12			8	12				4	A		4				183H	
199-H5-1A	2						2		A		2		A	2	A				100-HR-3	
199-H6-1	2	A					2		A		2	A	A	2	A				100-HR-3	

A.1.5 100-K Area Wells(e)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
199-K-11	2	4	4	4			4	4	2		2	2	2	14				2	100-KR-4	OPER
199-K-13	2	2	2	2			2	2	A		2	A	2	14				2	100-KR-4	OPER
199-K-18	2	2	A	2			2	2	2	A	2	A	2	A	2			2	100-KR-4	
199-K-19	2	4	4	4			2	4	4	2	2	A	2	14				2	100-KR-4	OPER
199-K-20	2	4	4	4			2	4	4	2	2	A	2	4				2	100-KR-4	OPER
199-K-21	2	2	A	2			2	2	2	2	2	A	2	2				2	100-KR-4	
199-K-22	2	4	4	4			2	4	4	2	2	2	2	4				2	100-KR-4	OPER
199-K-23	2	2	A	2			2	2	2	A	2	A	2	A	14			2	100-KR-4	
199-K-27	A	2	q	6	q	6	2	q	6	2	A	2	q	2	q	14		2	100-KR-4	OPER
199-K-28		4	4	4			4	4		A		A		12					OPER	
199-K-29		4	4	4			4	4		A		A		12				A	OPER	
199-K-30	2	6	6	6			2	6	2	A	2	A	2	14				2	100-KR-4	OPER
199-K-31	2	2	2	2			2	2	2	2	2	2	2	2				2	100-KR-4	
199-K-32A	2	2	A	2			2	2	2	2	2	A	2	A	2			2	100-KR-4	
199-K-32B	2	2	2	2			2	2	2	2	2	A	2	2				2	A	2 100-KR-4
199-K-33	2	2	2	2			2	2	2	2	2	A	2	2				2	A	2 100-KR-4
199-K-34	2	2	A	2			2	2	2	A	2	A	2	A	2			2	A	2 100-KR-4

DOH

A.1.5 100-K Area Wells(e)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	¹²⁹ I	Pu	⁹⁰ Sr	⁹⁹ Tc	³ H	Lo ³ H U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
199-K-35	2	2	A	2	2	2	A	2	2	2	A	2	A	2	A	2	2	100-KR-4	
199-K-36	2	2	A	2	2	2	A	2	2	2	A	2	A	2	A	2	A	100-KR-4	
199-K-37	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	100-KR-4	

A.1.6 100-N Area Wells(f)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	¹²⁹ I	Pu	⁹⁰ Sr	⁹⁹ Tc	³ H	Lo ³ H U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
199-N-14	A	Q	4	Q	4	Q	4	A	4	A	Q	4	A	Q	4	Q		1301	DOH
199-N-16		2	A	2	2	2	2	2	2		2	A	2	A	2	A	100-NR-2		
199-N-17		2		2	2	A	2				A	2		2			100-NR-2		
199-N-18																	100-NR-2		
199-N-19		A									A		A				100-NR-2		
199-N-2		4	4	4	4	4	4	4	4		4		4				1301		
199-N-20																	100-NR-2		
199-N-21		2	A	2	2	2	2	2	2		A	2	A	2			100-NR-2		
199-N-23		2	2	2	2	2	2	2	2		2	2	2	2			100-NR-2		
199-N-25		2	2	2	2	2	2	2	2		2	2	2	2			100-NR-2		
199-N-26		2	2	2	2	2	2	2	2		2	2	2	2			100-NR-2		
199-N-27		2	2	2	2	2	2	2	2		2	2	2	2			1325		
199-N-28		A				A			A		A	A	A						
199-N-29		2	2	2	2	2	2	2	2		2		2	2			1325		
199-N-3		SA	4	A	4	SA	4	4	A	A	SA	4	A	SA	4		100-NR-2	1301	DOH
199-N-31		A				A					A		A						
199-N-32		3	3	3	3	3	3	3	3		3		3	3			100-NR-2	1325	
199-N-33						A					A								
199-N-34		4	4	4	4	4	4	4	4		4		4	4			1301		
199-N-36		A				A	A	A	A		A		A						
199-N-41		2	2	2	2	2	2	2	2		2		2	2			1325		

A.1.6 100-N Area Wells(f)

Well	Alk	Alpha	Antion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129 I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-150	VOA	CERCLA	RCRA/OPER	Notes
199-N-43		2	2	2	2	2	2	2	2		2	2	2	2					1325	
199-N-49		2	A	2	2	2	2	2	2		A	2	A	2					100-NR-2	
199-N-5		A									A		A							
199-N-50		2	A	2	2	2	2	2	2		A	2	A	2					100-NR-2	
199-N-51		2	A	2	2	2	2	2	2		A	2	A	2					100-NR-2	
199-N-52		A									A		A							
199-N-54		2	A	2	2	A	2				A	2	A	2					100-NR-2	
199-N-57		4	4	4	4	4	4	4	4		4	4	4	4					1301	
199-N-59	4		4				4	4	4									4	1324	
199-N-64		2	A	2	2	2	A	2	A	2	A	2	A	2					100-NR-2	
199-N-67		4	4	4	4	4	4	4	4		4	4	4	4					1301	
199-N-69		4	4	4	4	4	4	4	4		4	4	4	4					1301	
199-N-70		2	2	2	2	2	2	2	2		2	2	2	2					1325	
199-N-71	4		A	4			4	4	4				A					4	1324	
199-N-72	4		4				4	4	4									4	1324	
199-N-73	4		4				4	4	4				A					4	1324	
199-N-74		2	2	2	2	2	2	2	2		2	2	2	2					1325	
199-N-75		4	4	4	4	4	4	4	4			4	4	4					1301	
199-N-76	A	SA	4	SA	4	SA	4	4	4	A	SA	4	A	SA	4		A		1301	DOH
199-N-77	4		4				4	4	4									4	1324	
199-N-80		2	A	2	2	A	2	A	2		A	2	2	A	2		A		100-NR-2	
199-N-81		3	3	3	3	3	3	3	3		3	3	3	3					1325	

- (a) Refer to Figure 1.1, 100-B Area Well Locations.
 (b) Refer to Figure 1.2, 100-D Area Well Locations.
 (c) Refer to Figure 1.3, 100-F Area Well Locations.
 (d) Refer to Figure 1.4, 100-H Area Well Locations.
 (e) Refer to Figure 1.5, 100-K Area Well Locations.
 (f) Refer to Figure 1.6, 100-N Area Well Locations.

A.2.0 200 Area Wells

A.2.1 200-East Area Wells(a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	¹²⁹ I	Pu	⁹⁰ Sr	⁹⁹ Tc	³ H	Lo ³ H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
299-E13-14	A																			
299-E13-5	A					A						A	A		A					
299-E16-1	1	1	1	1					A			A	1							OPER
299-E16-2	1	1	1	1		1	1				1	A	1							OPER
299-E17-1	1					2		1	A		A	A	2			2	2			A-10
299-E17-12	2	2	2	2			2		1		A	A	2							OPER
299-E17-13	2	2	2	2			2		A			A	2							OPER
299-E17-14	1					2			A			A	2							A-36B
299-E17-15	4	5	4			2	4	6	A			A	6							A-29/A-36B
299-E17-16	1					2		2	A			A	2							A-36B
299-E17-17	1					2		2	A			A	2							A-36B
299-E17-18	1					2		2	A			A	2							A-36B
299-E17-19	1					2		1	A			A	2			2	2			A10
299-E17-2	A								A		A	A	A							
299-E17-20	4	5	4			2	4	5	A		A	A	6			2	2			A-29
299-E17-5	1					2		2	A		A	A	2							A-36B
299-E17-6	A					A									A					
299-E17-8	A								A		A	A	A							
299-E17-9	1					2		2	A			A	2							A36-B
299-E18-1	6	2	6	1		1	2	6					4							B-POND/2101-M
299-E18-2	2	2	2	2			2	2								1				2101-M POND
299-E18-3	2	2	2	2			2	2								1				2101-M POND
299-E18-4	2	2	2	2			2	2								1				2101-M POND
299-E23-1	1	1	1						A		A	A	1							OPER
299-E24-1	A								A		A		A							
299-E24-11	A								A				A							

A.2.1 200-East Area Wells(a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo	3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes
299-E24-12	A								A												
299-E24-13	4	4	4	4		1	4		A		1		4			1				OPER	
299-E24-16	1					2		1	A		A		2				2	2		A-10	
299-E24-17	1					2		1	A		A		2				2	2		A-10	
299-E24-18	1					2		1	A		A		2				2	2		A-10	
299-E24-19	3	2	3			2	1	1	2	2	2	2	3			2				SST-A-AX/OPER	
299-E24-2	1					2		1					2				2	2		A-10	
299-E24-20	2	1	2			2	1	1	2	2	2	2	2			2				SST-A-AX	
299-E24-4	1	1	1						A				1							OPER	
299-E24-5	1	1	1						A				1							OPER	
299-E24-7	1	1	1						A		A		1							OPER	
299-E24-8	A								A				A								
299-E25-1000	4	4	4	4			4	4					4					1		GROUT	
299-E25-11	9	9	9			1	9	8	A		1		9			1				A29/OPER	
299-E25-17	1	1	1						A				1							OPER	
299-E25-18	8	8	8				8	8					8							A29/OPER	
299-E25-19	4	4	4				4	4					4							A29	
299-E25-20	8	9	8			2	8	9	A			A	10				2	2		A29/OPER	
299-E25-21	4	4	4				4	4	A				4							A29	
299-E25-22	2	2	2			2	2				2		2			2				OPER	
299-E25-23	A												A								
299-E25-24	2	2	2			2	2		A		2		2			2				OPER	
299-E25-25	2	1	2				2	2					2							GROUT	
299-E25-26	4	4	4				4	4	A				4							A-29	
299-E25-28	4	4	4				4	4	A				4							A-29	
299-E25-29P	2	1	2				2	2					2							GROUT	
299-E25-3	A								A				A								
299-E25-30P	2	1	2				2	2					2							GROUT	
299-E25-31	6	5	6				6	6	A				2			6				GROUT/A-29	

A.2.1 200-East Area Wells(a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo	3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes
299-E25-32P		6	5	6			6	6					2	6							GROUT/A-29
299-E25-33		3	2	3			2	2					2	3							GROUT/OPER
299-E25-34		4	4	4			4	4	A			A		4							A-29
299-E25-35		4	4	4			4	4						4							A-29
299-E25-36		4	5	4			2	4	5	A		A		6			2	2			A-29
299-E25-37		3	2	3			2	2	2	A			2	3							GROUT/OPER
299-E25-38		2	1	2			2	2					2	2							GROUT
299-E25-39		3	2	3			2	2	2	A		A	2	3							GROUT/OPER
299-E25-40		2	1	2			2	1	1	2		2	2	2			2				SST-A-AX
299-E25-41		3	2	3			2	1	1	2		2	2	3			2				SST-A-AX
299-E25-42		4	4	4			4	4	4	A				4							A-29
299-E25-43		4	4	4			4	4	4	A				4							A-29
299-E25-44		2	1	2			2	2					2	2							GROUT
299-E25-45		2	1	2			2	2					2	2							GROUT
299-E25-46		2	1	2			2	1	1	2		2	2	2			2				SST-A-AX
299-E25-47		4	4	4			4	4	4	A		A		4							A-29
299-E25-48		4	4	4			4	4	4	A				4							A-29
299-E25-49		4	4	4			4	4	4				4	4				1			GROUT
299-E25-50		4	4	4			4	4	4				4	4				1			GROUT
299-E25-6		2	2	2			2	2	2			2		2			2				OPER
299-E25-9		1	1	1			1	1	1	A		1	A	1			1				LERF
299-E26-10	2		2				2	2	2	A				3				3			LERF
299-E26-11	2	1	3	1			2	2	2					4				3			LERF
299-E26-12		4	4	4			4	4	4	A				4							A-29
299-E26-13		4	4	4			4	4	4	A				4							A-29
299-E26-2		1	1	1										1							OPER
299-E26-4		A							A				A								
299-E26-6		2	2	2			2		A			A		2							OPER
299-E26-8		1	1	1					A				A	1							OPER
																					CAS

A.2.1 200-East Area Wells (a)

Well	Alk	Alpha	Antion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129 I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-iso	VDA	CERCLA	RCRA/OPER	Notes
299-E26-9	1	1	2	1	1	1	1	1	1				3				2		LERF	
299-E27-10		2	2	2	2	2	2	2	A			A	2			2		LLWMA2		
299-E27-11		2	3	2	2	2	2	4	2				4			2	2	B-63/LLWMA2		
299-E27-12		2	1	2	2	2	1	1	2			2	2			2		SST-C		
299-E27-13		2	1	2	2	2	1	1	2			2	2			2		SST-C		
299-E27-14		3	2	3	2	2	1	1	2			2	2			2		SST-C/OPER		
299-E27-15		3	2	3	2	2	1	1	2			2	2			2		SST-C/OPER		
299-E27-16			1					2	2				2			2	2	B-63		
299-E27-17		2	3	2	2	2	2	4	2				4			2	4	B-63/LLWMA2		
299-E27-18			1					2	2			A	2			2	2	B-63		
299-E27-19			1					2	2				2			2	2	B-63		
299-E27-7		2	1	2	2	2	1	1	2			2	2			2		SST-C		
299-E27-8		2	3	2	2	2	2	4	2				4			2	4	B-63/LLWMA2		
299-E27-9		2	3	2	2	2	2	4	2				4			2	4	B-63/LLWMA2		
299-E28-1		1	A	1	1	A	A	A	A			A	A	1	A	A		OPER		
299-E28-10		A				A	A	A	A				A		A					
299-E28-12		1	1	1	1								1		A					
299-E28-13			A					A	A			A								
299-E28-17			A			A	A	A	A			A	A		A					
299-E28-18		2	2	2	2	1	2					1	2		1			OPER		
299-E28-2		1	A	1	1	A			A			A	A	1	A			OPER		
299-E28-21		2	2	2	2	1	2		A			1	2		1			OPER		
299-E28-23		1	A	1	1	A	1		A			A	A	1	A					
299-E28-24		1	A	1	1	A	1		A			A	A	1	A					
299-E28-25		1	A	1	1	A	1		A			A	A	1	A					
299-E28-26		4	4	4	4		4	4	A			A	4		4			LLWMA-1		
299-E28-27		4	4	4	4	A	4	4	A			A	4		4			LLWMA-1		
299-E28-28		4	4	4	4		4	4				A	4		4			LLWMA-1		
299-E28-5		1	A	1	1	A			A			A	A	1	A		A		OPER	

A.2.1 200-East Area Wells (a)

Well	Alk	Alpha	Anlon	Beta	CN	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo	3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes
299-E28-6		1	1	1	1	A			A	A	A	A	1			A					OPER
299-E28-7		A				A			A	A	A	A	A			A					
299-E28-8						A			A	A	A	A	A			A					
299-E28-9		1	1	1	1								1								OPER
299-E32-10		4	4	4	4		4	4	A				4								LLWMA-1
299-E32-2		6	6	6	2	2	6	6	A	2	2	A	2	6					200-BP-5		LLWMA-1
299-E32-3		4	4	4	4		4	4					4								LLWMA-1
299-E32-4		8	4	8	1	1	4	8	A		A	A	8								B-POND/LLWMA1
299-E32-5		5	5	5			4	4	A				5								LLWMA-1
299-E32-6		4	4	4	4		4	4					4								LLWMA-1
299-E32-7		4	4	4	4		4	4					4								LLWMA-1
299-E32-8		4	4	4	4		4	4	A				4								LLWMA-1
299-E32-9		4	4	4	4		4	4					4								LLWMA-1
299-E33-1		2	A	2	2	2	2	2	A	2	2	2	A	2					200-BP-5		
299-E33-10		A							A			A	A								CAS
299-E33-12		2	A	2	A	2	2	2		2	2	A	2	A	2				200-BP-5		
299-E33-13		2	2	2	2	2	2	2		2	2	2	2	2					200-BP-5		
299-E33-26		2	2	2	2	2	2	2		2	2	2	2	2					200-BP-5		
299-E33-28		6	6	6	2	2	6	6		2	2	2	6						200-BP-5		LLWMA-1
299-E33-29		6	6	6	2	2	6	6		2	2	2	6						200-BP-5		LLWMA-1
299-E33-3		2	A	2	2	2	2	2		2	2	A	2	A	2				200-BP-5		
299-E33-30		6	6	6	2	2	6	6	A		2	2	6						200-BP-5		LLWMA-1
299-E33-31		4	3	4	2	4	3	3		2	4	4	4						200-BP-5		SST-B-BY-BX
299-E33-32		4	3	4	2	4	3	3		2	4	4	4						200-BP-5		SST-B-BY-BX
299-E33-33		2	2	2	2	2	1	3		4	2	2	2	4				2	2		B-63/SST-B-BY-BX
299-E33-34		4	4	4	4		4	4	A				4								LLWMA-1
299-E33-35		4	4	4	4		4	4	A				4								LLWMA-1
299-E33-36		2	2	2	2	2	1	3		4	2	2	4					2	2		B-63/SST-B-BY-BX
299-E33-37		1	2	1			2	2		2			3					2	2		B-63

A.2.1 200-East Area Wells (a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	¹²⁹ I	Pu	⁹⁰ Sr	⁹⁹ Tc	³ H	Lo ³ H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
299-E33-39	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	200-BP-5		
299-E33-41	2	1	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2		SST-B-BY-BX	
299-E33-42	2	1	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2		SST-B-BY-BX	
299-E33-43	2	1	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2		SST-B-BY-BX	
299-E33-5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	200-BP-5		
299-E33-7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	200-BP-5		
299-E34-10	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	B-63/LLWMA2	
299-E34-11	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	LLWMA2	
299-E34-12	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	LLWMA2	
299-E34-2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	LLWMA2	
299-E34-3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	LLWMA2	
299-E34-5	4	4	4	4	4	2	4	4	4	2	2	2	2	4	4	4	4	2	200-BP-5	
99-E34-7	3	3	3	3	2	2	2	2	2	2	2	2	2	3	3	2	2	2	LLWMA2	
299-E34-8	1	2	1	2	1	2	2	2	2	2	2	2	2	3	3	2	2	2	B-63	
299-E34-9	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	LLWMA2	
299-E35-2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	3	3	LERF	

A.2.2 200-West Area Wells (b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	¹²⁹ I	Pu	⁹⁰ Sr	⁹⁹ Tc	³ H	Lo ³ H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
299-W10-1	1	1	1	1	1							A	1	1	1		1	1	OPER	
299-W10-13	4	4	4	4	4	4	4	4	A			A	4	4	4		4	4	LLWMA3	
299-W10-14	4	4	4	4	4	4	4	4	4				4	4	4		4	4	LLWMA3	
299-W10-15	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	SST-T	
299-W10-16	5	5	5	5	5	4	4	4	4	4	4	4	4	5	4	4	1	1	SST-T	
299-W10-17	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	SST-TX-TY	
299-W10-18	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	SST-TX-TY	
299-W10-19	4	4	4	4	4	4	4	4	A			A	4	4	4		4	4	LLWMA3	
299-W10-20	4	4	4	4	1	4	4	4	4	4			4	4	1		4	4	LLBG	

A.2.1 200-East Area Wells(a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes
299-W10-21		4	4	4	4	1	4	4	4				4	4	1		4		LLBG	
299-W10-4		1	1	1	1								1	1			1		OPER	
299-W10-5		1	1	1	1							A	1	1			1		OPER	
299-W10-9		A					A					A	A				A			
299-W11-10		1	1	1	1		A		A			A	1	1	A		1		OPER	
299-W11-14		1	1	1	1		A		A			A	1	1	A		1		OPER	
299-W11-18		1	1	1	1		A		A				1	1			1		OPER	
299-W11-23		1	1	1	1								1	1			1		OPER	
299-W11-27	2	4	4	4	4		4	4	4	4	4	4	4	4	4		2		SST-T	
299-W11-28		4	4	4	4		4	4	4	4	4	4	4	4	4		A		SST-T	
299-W11-3		1	1	1	1		A					A	1	1	A		1		OPER	
299-W11-31		2	2	2	2		2	2	A			A	2	2	2		2		LLWMA5	
299-W11-6		1	1	1	1		A					A	1	1			1		OPER	
299-W11-7		1	1	1	1		A					A	1	1	A		1		OPER	
299-W12-1		1	1	1	1				A			A	1	1	A		1		OPER	
299-W14-12	2	4	4	4	4		4	4	4	4	4	4	4	4	4		2		SST-TX-TY	
299-W14-2		1	1	1	1							A	1	1	A		1		OPER	
299-W14-6		1	1	1	1								1	1			1		OPER	
299-W15-10		A					A		A	A			A		A		A			
299-W15-12		1	1	1	1				A			A	1	1			1		OPER	
299-W15-15		1	1	1	1		1	1				A	1	1	1		A		LLWMA4	
299-W15-16		1	1	1	1		1	1				A	1	1	1		3		LLWMA4	
299-W15-17		1	1	1	1		1	1					1	1	1		1		LLWMA4	
299-W15-18		1	1	1	1		1	1	A			A	1	1	1		1		LLWMA4	
299-W15-19		2	2	2	2		1	1	A			A	2	2	1		2		LLWMA4	
299-W15-2		1	1	1	1								1	1			1		OPER	
299-W15-20		1	1	1	1		1	1					1	1	1		1		LLWMA4	
299-W15-22	2	5	5	5	5		4	4	4	4	4	4	4	5	4		3		SST-TX-TY	
299-W15-23		1	1	1	1		1	1					1	1	1		1		LLWMA4	

A.2.1 200-East Area Wells (a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes
299-W15-24		2	2	2	1	1	1	1	1					2	1			2	LLWMA4	
299-W15-4		1	1	1						A		A		1	A			1	OPER	
299-W15-6		A		A	A				A	A		A		A	A			A	OPER	
299-W15-7		1	A	1	1	SA			A	SA		A		A	A			A	OPER	
299-W18-17		4	4	4	4	2	4				2			4	2			4	OPER	
299-W18-20		5	5	5		3	5				3			5	3			5	OPER	
299-W18-21		1	1	1	1	1	1	1	1					1	1			1	LLWMA4	
299-W18-22		2	2	2	1	1	1	1	1					2	1			2	LLWMA4/OPER	
299-W18-23		1	1	1	1	1	1	1	1					1	1			1	LLWMA4	
299-W18-24		1	1	1	1	1	1	1	1					1	1			1	LLWMA4	
299-W18-25		3	5	3		2	1	1	2	2	2	2	2	3	2			3	SST-U/OPER	
299-W18-26		1	1	1	1	1	1	1	1					1	1			1	LLWMA4	
299-W18-27		1	1	1	1	1	1	1	1					1	1			1	LLWMA4	
299-W18-28		1	1	1	1	1	1	1	1					1	1			1	LLWMA4	
299-W18-29		5	5	5	1	2	5	1			2			5	3			5	LLWMA4/OPER	
299-W18-30		2	4	2		2	1	1	2	2	2	2	2	2	2			2	SST-U	
299-W18-31		2	4	2		2	1	1	2	2	2	2	2	2	2				SST-U	
299-W18-32		1	1	1	1	1	1	1	1					1	1			1	LLWMA4	
299-W18-4		A		A	A				A				A					A		
299-W18-5		A		A								A	A					A		
299-W19-1		4	4	4		1	4	1			1	A		4	4			4	OPER	
299-W19-10		1	1	1			1					A		1	1			1	OPER	
299-W19-11		1	1	1		A	1		A			A		1	1			1	OPER	
299-W19-12		1	1	1					A			A		1	A			1	SST-U	
299-W19-13		A							A			A		A	A			A		
299-W19-14		A							A			A		A	A			A		
299-W19-15		1	1	1			1		A			A		1	1			1	OPER	
299-W19-16		1	1	1			1		A			A		1	1			1	OPER	
299-W19-17		1	1	1			1		A			A		1	1			1	OPER	

A.2.1 200-East Area Wells(a)

Well	Alk	Alpha	Antion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U 3H	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
299-W19-18		2	2	2	2		1	1	A			A	2	2	1		2		OPER	
299-W19-19		4	4	4	4		4	2	A			A	4	4	4		4		OPER	
299-W19-2		2	2	2	2		1	1	A			A	2	2	A 1		2		OPER	
299-W19-20		4	4	4	4		4	2	A			A	4	4	4		4		OPER	
299-W19-21		4	4	4	4	1	4	1			1		4	4	4		4		OPER	
299-W19-23		4	4	4	4		4	2	A			A	4	4	4		4		OPER	
299-W19-24		4	4	4	4		4	2	A			A	4	4	4		4		OPER	
299-W19-25		4	4	4	4		4	2	A			A	4	4	4		4		OPER	
299-W19-26		4	4	4	4		4	2					4	4	4		4		OPER	
299-W19-27		4	4	4	4	1	4	1	A		1	A	4	4	4		4		OPER	
299-W19-28		2	2	2	2	A	2		A		A	2	2	2	2		2		OPER	
299-W19-29		3	3	3	3	A	2		A		A	2	3	3	2		3		OPER	
299-W19-3		2	2	2	2	A	1		A		A	A	2	2	1		2		OPER	
299-W19-30	A								A			A	A	A	A		A		SST-U/OPER	
299-W19-31		3	5	3	3		2	1	1	2	2	2	3	3	2		1		SST-U	
299-W19-32		2	4	2	2		2	1	1	2	2	2	2	2	2		2		SST-U	
299-W19-4		1	1	1	1		A		A			A	1	1	A		1		OPER	
299-W19-9		1	1	1	1			1					1	1	1		1		OPER	
299-W19-91		5	5	5	5		2	5	2		2		5	5	5		5		OPER	
299-W19-92		5	5	5	5		2	5	2	A	2	A	5	5	5		5		OPER	
299-W19-93		5	5	5	5		2	5	2		2		5	5	5		5		OPER	
299-W21-1	A				A				A			A	A	A	A		A			
299-W22-10	A					A	A		A		A	A	A	A			A			
299-W22-12		1	1	1	1		A		A		A	A	1	1			1		OPER	
299-W22-2	A						A		A	A	A		A	A			A			
299-W22-20	A	Q	1	Q	1	Q	A		A			A	Q	1	Q		A	1	OPER	DOH
299-W22-21		1	A	1	1		A		A			A	A	1	A		A	1	OPER	
299-W22-22		4	4	4	4		4	4	4	4	4	4	4	4	A		4	4	U-12	
299-W22-23		4	4	4	4		4	4	4	4	4	4	4	4	4		4	4	U-12	

A.2.1 200-East Area Wells (a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo	3H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
299-W22-39	3	2	3	2	3	2	1	1	2	2	2	2	2	3	2	2	2	1	1	SST-S-SX/OPER	
299-W22-40	5	5	5	4	5	A	4	4	4	4	4	4	4	5	A	4	4	5	5	U-12/OPER	
299-W22-41	4	4	4	4	4	A	4	4	4	4	4	4	4	4	4	4	4	4	4	U-12	
299-W22-42	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4	4	4	4	U-12	
299-W22-43	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4	4	4	4	U-12	
299-W22-44	2	1	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2	A	A	SST-S-SX	
299-W22-45	2	1	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2	A	A	SST	
299-W22-46	2	1	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2	A	A	SST	
299-W22-9	1	1	1	1	1	A	A	A	A	A	A	A	A	1	A	A	1	1	1	OPER	
299-W23-10	A													A	A	A	A	A	A	OPER	
299-W23-11	1	1	1	1	1									1						OPER	
299-W23-13	2	1	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2	A	A	SST-S-SX	
299-W23-14	3	2	3	2	3	2	1	1	2	2	2	2	2	3	2	2	2	1	1	SST-S-SX	
299-W23-15	2	1	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2	A	A	SST-S-SX	
299-W23-2	A					A			A	A	A	A	A	A	A	A	A	A	A		
299-W23-3	A					A			A	A	A	A	A	A	A	A	A	A	A		
299-W23-4	A													A	A	A	A	A	A		
299-W23-7	A					A			A	A				A	A	A	A	A	A		
299-W23-9	1	1	1	1	1				A					1	A	A	1	1	1	OPER	
299-W26-10	2	1	2	2	2		1	1	A		A	1	1	1	1	2	2	1	1	S-10	
299-W26-12	2	1	2	2	2		1	1	A		A	1	1	1	1	2	2	1	1	S-10	
299-W26-6	1	1	1	1	1									1	1			1	1	OPER	
299-W26-7	2	1	2	2	2		1	1	A		A	1	1	1	1	2	2	1	1	S-10	
299-W26-8	2	1	2	2	2	A	1	1			A	1	1	1	1	2	2	1	1	S-10	
299-W26-9	2	1	2	2	2		1	1	A		A	1	1	1	1	2	2	1	1	S-10	
299-W27-1	4	4	4	4	4	4	4	4			4			4	4	4	4	4	4	OPER	
299-W27-2	2	1	2	2	2		1	1				1	1	1	1	2	2	1	1	S-10	
299-W6-1	1	1	1	1	1				A			A	A	1	1	2	2	1	1	OPER	
299-W6-10	2	2	2	2	2	2	2	2	A			A	A	2	2	2	2	2	2	LLWMA5	

A.2.1 200-East Area Wells (a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129_I	Pu	90_Sr	99_Tc	3_H	Lo	3_H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
299-W6-11		2	2	2	2	2	2	2	2					2		2		2		LLWMA5	
299-W6-12		2	2	2	2	2	2	2	2					2		2		2		LLWMA5	
299-W6-2		7	7	7	2	6	6	6	6					7		2		7		LLWMA3/5	
299-W6-3		2	2	2	2	2	2	2	2					2		2		2		LLWMA5	
299-W6-4		2	2	2	2	2	2	2	2					2		2		2		LLWMA5	
299-W6-5		2	2	2	2	2	2	2	2	A		A		2		2		2		LLWMA5	
299-W6-6		2	2	2	2	2	2	2	2					2		2		2		LLWMA5	
299-W6-7		2	2	2	2	2	2	2	2					2		2		2		LLWMA5	
299-W6-8		2	2	2	2	2	2	2	2					2		2		2		LLWMA5	
299-W6-9		2	2	2	2	2	2	2	2	A		A		2		2		2		LLWMA5	
299-W7-1		4	4	4	4	4	4	4	4					4		2		4		LLWMA3	
299-W7-10		6	6	6	6	2	6	6	6					6		2		6		LLWMA3/5	
299-W7-11		4	4	4	4	4	4	4	4					4		4		4		LLWMA3	
299-W7-12		4	4	4	4	4	4	4	4					4		4		4		LLWMA3	
299-W7-2		4	4	4	4	4	4	4	4					4		4		4		LLWMA3	
299-W7-3		4	4	4	4	4	4	4	4					4		4		4		LLWMA3	
299-W7-4		4	4	4	4	4	4	4	4	A		A		4		4		4		LLWMA3	
299-W7-5		4	4	4	4	4	4	4	4					4		4		4		LLWMA3	
299-W7-6		5	5	5	5	A	4	4	4	A		A		5		4		5		LLWMA3	
299-W7-7		4	4	4	4	4	4	4	4					4		4		4		LLWMA3	
299-W7-8		4	4	4	4	4	4	4	4	A		A		4		4		4		LLWMA3	
299-W7-9		4	4	4	4	4	4	4	4					4		4		4		LLWMA3	
299-W8-1		4	4	4	4	4	4	4	4					4		4		4		LLWMA3	
299-W9-1		4	4	4	4	4	4	4	4					4		4		4		LLWMA3	

(a) Refer to Figure 2.1, 200-East Area Well Locations.

(b) Refer to Figure 2.2, 200-West Area Well Locations.

A.3.0 1100, 3000, and 300 Area Wells

A.3.1 1100 and 3000 Area Wells^(a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
1199-34-15A				A	A							A		A			A			DWS
1199-39-15				A	A		A							A			A			DWS
1199-39-16C				A	A		A							A			A			DWS
1199-39-16E				A	A		A							A			A			DWS
1199-40-15				A	A		A							A			A			DWS
1199-40-16B				A	A		A					A		A			A			DWS
3099-42-16				A	A		A							A			A			DWS

A.3.2 300 Area Wells^(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
399-1-10A	1	1	A	1	1		1	1	1				1	1		1		1	300-TRENCH	
399-1-10B			A				A						A			A				
399-1-11	1	1	A	1	1		1	1	1				1	1		1		1	300-TRENCH	
399-1-12	1	1	A	1	1		1	1	1				1	1		1		1	300-TRENCH	
399-1-13A			A										A							
399-1-13B			A				A	A					A			A				
399-1-14A	1	1	A	1	1		1	1	1				1	1		1		1	300-TRENCH	
399-1-14B			A				A						A			A				
399-1-15			A										A			A				
399-1-16A	1	1	A	1	1		1	1	1				1	1		1		1	300-TRENCH	
399-1-16B	1	1	1	1	1		1	1	1				1	1		1		1	300-TRENCH	
399-1-16C																2	2	2	300-TRENCH	
399-1-17A	A	1	Q	1	Q	2	1	1	1	A		2	A	Q	1	Q	3	2	3	DOH
399-1-17B	1	1	1	1	1		1	1	1				1	1		1		1	300-TRENCH	

A.3.1 1100 and 3000 Area Wells (a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
399-1-18A	1	1	A	1	1	1	1	1	1				1	1						300-TRENCH
399-1-19			A										A		A					
399-1-2			A										A		A					
399-1-21A			A				A	A				A	A	2	2	A	2	300-FF-5		
399-1-21B			A				A	A					A		A					
399-1-3			A										A		A					
399-1-4			A										A		A					
399-1-5													2	2	2	2	300-FF-5			
399-1-6			A									A	A		A					
399-1-7			A										2	2	2	2	300-FF-5			
399-1-8			A										A		A					
399-1-9			A										A		A					
399-2-1	1	1	A	1	1	1	1	1	1				1	1						300-TRENCH
399-2-2			A			A							A	2	2	A	2	300-FF-5		
399-2-3			A			A							A		A					
399-3-1			A										A		A					
399-3-10	1	1	A	1	1	1	1	1	1				1	1						300-TRENCH
399-3-11			A			A					A		A	2	2	A	2	300-FF-5		
399-3-12			A										A	2	2	A	2	300-FF-5		
399-3-2			A										A	2	2	A	2	300-FF-5		
399-3-3			A										A		A					
399-3-6			SA									SA	SA		SA					
399-3-7			A										A		A					
399-3-9			A										A		A					
399-4-1			A										SA		A					
399-4-10			A										A	2	2	A	2	300-FF-5		
399-4-11			A										A		A					
399-4-12			A										A	2	2	A	2	300-FF-5		
399-4-7			A										A	2	2	2	2	300-FF-5		

A.3.1 1100 and 3000 Area Wells (a)																			
Well	Alk	Alpha	Anton	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo ³ H U	U-1so	VOA	CERCLA	RCRA/OPER	Notes
399-4-9					A								A			A			
399-5-1					A							A	A			A			
399-5-2					A							A	A						CAS
399-8-1					A											A			
399-8-3					A								A						
399-8-5A					A											A			
399-8-5B					A								A			A			
399-8-5C					A								A			A			

(a) Refer to Figure 3.1, 1100 and 3000 Area Well Locations.

(b) Refer to Figure 3.2, 300 Area Well Locations.

A.4.0 400 Area Wells

A.4.1 400 Area Wells (a)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo	3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes
499-S0-7			A						A			A	M					A			DWS
499-S0-8			A										M					A			DWS
499-S1-8A			A						A			A	A								
499-S1-8J	A	A	A	A			A		A		A	A	M			A	A	A			
DWS/DOH																					

(a) Refer to Figure 4.1, 400 Area Well Locations.

A.5.0 600 Area Wells(a)(b)

A.5.1 600 Area Wells(a)(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes
699-1-18		4	4	4			4		A			A		4					OPER	
699-10-54A				A									A							
699-10-E12				A								A		A			A			
699-101-48B			SA				SA	SA			A	A	SA		A					CAS
699-13-1C			A										A							
699-14-38			A				A						A							
699-15-E3A			A										A							
699-17-5		A	SA	SA			A	A	A			A	SA							DOH
699-17-70			A						A			A		A						
699-19-43			A										A							
699-19-58			A										A							
699-19-88			A										A							
699-2-3		4	4	4			4							4					OPER	
699-2-7		4	4	4			4							4					OPER	
699-20-20	Q	Q	Q	Q			Q	A	A			A	Q							DOH
699-20-E12		A										A	A							
699-20-E12P		A										A	A							CAS
699-20-E5A		A										A	A							
699-20-E5Q		A										A	A							CAS
699-21-6		A							A			A	A							
699-22-23		A							A			A	A							
699-22-35	4	4	4	4			4							4					SWL	
699-22-70		A										A	A							CAS
699-23-34A	2	2	2	2			2		A			A		2					SWL	
699-23-34B	4	4	4	4			4		A			A		4					SWL	
699-24-1P		A											A							CAS

A.5.1 600 Area Wells (a)(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes
699-24-33	4	4	4	4	4		4						4	4				4	SWL	
699-24-34A	4	4	4	4	4		4						4	4				4	SWL	
699-24-34B	4	4	4	4	4		4						4	4				4	SWL	
699-24-34C	4	4	4	4	4		4						4	4				4	SWL	
699-24-35	4	4	4	4	4		4						4	4				4	SWL	
699-24-46		A											A							
699-25-33A	2	2	2	2	2		2	2					2	2				2	NRDL	
699-25-34A	2	2	2	2	2		2	2					2	2				2	NRDL	
699-25-34B	2	2	2	2	2		2	2	A			A	2	2				2	NRDL	
699-25-34C	4	4	4	4	4		4						4	4				4	SWL	
699-25-34D	2	2	2	2	2		2	2	A			A	2	2				2	NRDL	
699-25-70		A							A			A	A							
699-26-15A		A							A			A	SA							
699-26-33	2	2	2	2	2		2	2					2	2				2	NRDL	
699-26-34A	2	2	2	2	2		2	2					2	2				2	NRDL	
699-26-34B	2	2	2	2	2		2	2					2	2				2	NRDL	
699-26-35A	6	6	6	6	6		6	2					6	6				6	NRDL	
699-26-35C	2	2	2	2	2		2	2					2	2				2	NRDL	
699-27-8		A							A			A	SA							
699-28-40		A							A			A	A							
699-29-4		A											A							
699-29-78		A							A			A	A							
699-3-45		A											A							
699-31-31	A	A	A	A			A		A			A	A				A			DOH
699-31-31P	A		A				A		A			A	A				A			CAS
699-31-53B		A					A		A				A		A					
699-32-43	A	SA	SA	SA	SA		A	A	A		A	A	SA				A			DOH
699-32-62		1	1	1	1									1					OPER	
699-32-70B		A					A		A			A	SA							

A.5.1 600 Area Wells(a)(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo	3H	U	U-150	VOA	CERCLA	RCRA/OPER	Notes
699-32-72A		A							A			A	A		A						DOH
699-32-77	A	A		A					A			A	A								
699-33-14		A											A								
699-33-42		A							A				SA								
699-33-56		A				A			A		A		A								
699-33-6		A							A			A	A								
699-34-41B													A								
699-34-42		1	A	1	1				A			A	A	1						OPER	
699-34-51		A				A			A		A		A								
699-35-68A		A							A			A	SA								
699-35-70	A	SA	1	SA	1	SA	A	A	A		A	A	SA	1		SA				OPER	DOH
699-35-78A		A							A			A	SA			A					
699-35-9		A							A			A	SA								
699-36-46Q		A							A		A		A								CAS
699-36-61A		1	A	1	1				A			A	SA	1						OPER	
699-36-61B		A							A			A	A								
699-36-93		A											A								
699-37-43		1	A	1	1				A			A	A	1						OPER	
699-37-82A		1	A	1	1								SA	1						OPER	
699-37-E4		A										A	A								
699-38-15		A							A			A	SA								
699-38-65	A	SA	SA	SA		SA	A	A	A			A	SA			SA					DOH
699-38-70		1	A	1	1	A	A	A	A			A	SA	1		SA		SA		OPER	
699-39-0		A										A	SA								
699-39-39		A											SA								
699-39-79		1	A	1	1				A			A	A	1				A		OPER	
699-40-1		A											A								
699-40-20		A											A								
699-40-33A	A	A		A		A	A	A	A			A	A								DOH

A.5.1 600 Area Wells(a)(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo	H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
699-40-36	4	4	4	4	4	1	1	4					4							B-POND	
699-40-39	4	4	4	4	4	1	1	4					4							B-POND	
699-40-40B	4	4	4	4	4	1	1	4					4							B-POND	
699-40-62	1	1	1	1	1			A				A	SA	1						OPER	
699-40-72	1	1	1	1	1								1							OPER	
699-40-40A	4	4	4	4	4	1	1	4					4							B-POND	
699-41-1	A	Q	Q	Q	Q	Q	A	A	A		Q	Q	Q								DOH
699-41-23		A						A	A			A	SA								
699-41-35	4	4	4	4	4	1	1	4					4							B-POND	
699-41-40	4	A	4	4	4	1	A	4	A			A	4					A		B-POND	
699-41-42	4	4	4	4	4	1	1	4					4							B-POND	
699-42-12A	SA							A	A		A	A	SA								
699-42-2	A												A								
699-42-37	4	4	4	4	4	1	1	4					4							B-POND	
699-42-39A	4	A	4	4	4	1	1	4	A			A	4							B-POND	
699-42-39B	4	A	4	4	4	1	A	4	A			A	4							B-POND	
699-42-40A	4	4	4	4	4	1	1	4					4							B-POND	
699-42-40C	4	A	4	4	4	1	1	4	A			A	A	4						B-POND	CAS
699-42-41	4	4	4	4	4	1	1	4					4							B-POND	
699-42-42A	1	1	1	1	1								1							OPER	
699-42-42B	4	A	4	4	4	1	1	4	A			A	4							B-POND	
699-42-E9B	A	SA	SA	SA	SA	SA	A	A	A		SA	SA	SA		SA		A				
DOH/CAS																					
699-43-3	A							A				A	A								
699-43-40	4	4	4	4	4	1	1	4					4							B-POND	
699-43-41E	4	A	4	4	4	1	A	4	A			A	4							B-POND/A-29	
699-43-41F	4		4	4	4	1	1	4					4							B-POND	
699-43-41G	4	4	4	4	4	1	1	4					4							B-POND	
699-43-42J	4	4	4	4	4	1	1	4					4							B-POND	

A.5.1 600 Area Wells (a)(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo	3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes	
699-43-43		8	A	4	8		1	4	8	A		A		8							B-POND	
699-43-45		8		4	8		1	4	8					8							B-POND/A-29	
699-43-9			A									A		A							B-POND	
699-44-39B		4			4		1		4					4								
699-44-4														A								
699-44-42		4			4		1		4					4							B-POND	
699-44-43B		4			4		1		4					4							B-POND	
699-44-64		1	A	1	1	SA						A	SA	1		A					OPER	
699-45-2			A									A		A								
699-45-42		1		1	1							A		1							OPER	
699-45-69A		1		1	1	A						A		1		A					OPER	
699-46-21B			A											A								
699-46-4			A									A		A								
699-47-35A			A								A			A								
699-47-46A			A											A								
699-47-5														A								
699-47-50	A		A					A				A		A					200-BP-5			CAS
699-47-60			A		A									A					200-BP-5			
699-48-18			A									A		A								
699-48-7A														A								
699-48-71		1	A	1	1							A	SA	1		A					OPER	
699-48-77A		4			4		1		4					4							B-POND	
699-48-50																			200-BP-5			
699-49-100C	A	SA	A	SA	SA	SA	A	A	A				SA	SA		SA						DOH
699-49-13E														A								
699-49-28			A											A								
699-49-55A			A		SA	SA			A				SA	SA					200-BP-5			CAS
699-49-55B			A		A	A							A	A					200-BP-5			
699-49-57A			A		SA	SA			A			A	SA	SA					200-BP-5			

A.5.1 600 Area Wells (a)(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	¹²⁹ I	Pu	⁹⁰ Sr	⁹⁹ Tc	³ H	Lo	³ H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes	
699-49-57B																				200-BP-5	CAS	
699-49-79		1	A	1	1								A	1						OPER		CAS
699-50-45	A						A															CAS
699-50-48B	A						A															CAS
699-50-53A	A	SA	SA	SA	SA	SA	A	A	SA	SA		SA	SA	SA		SA			200-BP-5		DOH	
699-50-53B							A						A						200-BP-5		CAS	
699-50-85													A									CAS
699-51-46	A						A															
699-51-63							A		A			A	A									
699-51-75							A		A				A						A			
699-52-19													A									
699-52-46A	A	1	A	1	1			A				A		1						OPER		CAS
699-52-48	A							A				A										CAS
699-52-54																				200-BP-5		
699-52-57																				200-BP-5		
699-53-47A													A									
699-53-47B		1	1	1	1			1						1							OPER	
699-53-48A		1	A	1	1	A						A		A	1						OPER	
699-53-48B		1	1	1	1			1						1							OPER	
699-53-50	A	1	A	1	1			A						1							OPER	CAS
699-53-55A																				200-BP-5		
699-53-55B																				200-BP-5		
699-53-55C																				200-BP-5		
699-54-34																						
699-54-45B		1	1	1	1										1						OPER	
699-54-48		1	A	1	1							A		A	1						OPER	
699-54-49		2	2	2	2	A		1				A	1	2							OPER	
699-54-57																				200-BP-5		CAS
699-55-40																						

A.5.1 600 Area Wells (a)(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-iso	VOA	CERCLA	RCRA/OPER	Notes
699-55-50C		2	2	2	A	A	1				1	A	2						OPER	
699-55-55																		200-BP-5		
699-55-57		A		A	A	A	A	A	A			A	A				A	200-BP-5		
699-55-60A		1	1	1	A	A		A					1						OPER	
699-55-76			A			A							A							
699-55-89			A										A							
699-56-53	A	1	A	1	1		A						1						OPER	CAS
699-57-29A			A										A				A			
699-57-59																		200-BP-5		
699-56-43	A	1	A	1	1		A					A	1						OPER	CAS
699-58-24			A										A							
699-58-48		1	1	1	1		1				1		1						OPER	
699-59-55		1	1	1	1								1						OPER	
699-59-58		1	A	1	1	A	A		A		A	A	1					200-BP-5	OPER	
699-60-57			A										SA					200-BP-5		
699-60-60																		200-BP-5		
699-61-37													A							
699-61-41													A							
699-61-62		SA		SA	SA				A		SA	SA	SA							
699-61-66			A		A				A		A	A	A							
699-62-31			A										A							
699-62-43F		SA					A						SA				A			
699-63-25A			A										A							
699-63-55			A						A		A	A	A							
699-63-58		SA		A	A				A		A	A	SA							
699-63-90		2	A	2			2	2			2	2	A	2				100-BC-5		
699-64-27			A										A				A			
699-64-62		SA							A		A	A	SA							
699-65-59A			A						A		A	A	A							

A.5.1 600 Area Wells (a)(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129_I	Pu	90_Sr	99_Tc	3_H	Lo	3_H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
699-65-72	2	A	2	A	2	A	2	2	A		2	A	2	A	2				100-BC-5		
699-65-83	2		2		2		2	2			2	2	2	2	2				100-BC-5		
699-66-23	A						A	A						A				A			
699-66-38	A													A							
699-66-39	A													A							
699-66-58	SA								A			A	SA								
699-66-64	2	A	2		2		2	2			2	A	2	A	2				100-BC-5		
699-66-84	2		2		2		2	2			2	2	2	2	2				100-BC-5		
699-67-51	A											A	A								
699-67-86	2		2		2		2	2			2	2	2	2	2			A	100-BC-5		
699-70-68	2	A	2	2	2	2	2	2		2	2	A	2	A	2		2	2	100-KR-4		
699-71-30	A						A	A					A					A			
699-71-77	2		2		2		2	2			2	2	2	2	2			A	100-BC-5		
699-72-73	2		2		2		2	2			2	2	2	2	2			A	100-BC-5		
699-72-88	A						A	A				SA						A			
699-72-92	2		2		2		2	2			2	2	2	2	2			100-BC-5			
699-73-61	2	A	2	2	2	2	2	2		2	2	A	2	A	2		2	2	100-KR-4		
699-74-44	A												A					A			
699-77-36	A												A					A			
699-77-54	A											A	A								
699-78-62	2	2	2	2	2	2	2	2		2	2	2	2	2	2		2	2	100-KR-4		
699-8-17	A								A			A	A					A			
699-81-58	A												A								
699-83-47	A						A	A					A					A			
699-84-35A	A						A	A				A	A					A			
699-8-25	A								A			A	A								
699-87-55	A						A	A				A	SA					A			
699-89-35	A						A	A				A	A					A			
699-90-45	A						SA	SA				A	SA								

A.5.1 600 Area Wells (a)(b)

Well	Alk	Alkha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U 3H	U-iso	VOA	CERCLA	RCRA/OPER	Notes
699-91-46	2						2							2				100-HR-3		
699-93-48A	2						2							2				100-HR-3		
699-96-43	2		A				A 2	A			A	A	A 2	A 2	A			100-HR-3		
699-96-49	2						2						2	2				100-HR-3		
699-97-43	2		A				A 2	A			A	A	A 2	A 2	A			100-HR-3		
699-97-51A	2						2						2	2				100-HR-3		
699-ATH						A						A	A	A	A					
699-S11-E12A			SA									SA								
699-S11-E12AP	A						A				A									
699-S12-29													A	A						
699-S12-3													A	A						
699-S19-11	SA	SA	SA	SA	SA	SA							SA	SA						DOH
699-S19-E13	Q	Q	Q	Q	Q	Q			A			A	Q	Q	Q					DOH
699-S19-E14			A										A	A						
699-S22-E9A			A										A	A						
699-S22-E9B			A										A	A						
699-S22-E9C			A										A	A						
699-S27-E14	SA						A				A	A	SA	SA			A	300-FIRE		
699-S27-E9A			A								A	A	A	A						
699-S27-E9B			A										A	A						
699-S27-E9C			A										A	A						
699-S28-E0			A										A	A						DWS
699-S28-E12			A										A	A			A			
699-S29-E11	4		4					4				A	A	A	A		A	4 11-EH-1		
699-S29-E12			A									A	A	A	A		A			
699-S29-E16A			SA				A				A	A		Q	A		A			
699-S29-E16B			SA				A				A			SA	A		A			
699-S29-E16C			SA				A							SA	A		A			
699-S3-25			A										A							

A.5.1 600 Area Wells (a)(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U	U-Iso	VOA	CERCLA	RCRA/OPER	Notes
699-S3-E12			A						A			A	SA							
699-S30-E10A	4	A	A	4			A	4				A			A		A	4 11-EM-1		
699-S30-E10B	4	A	A	4			A	4				A			A		A	4 11-EM-1		
699-S30-E15A	A	SA	SA	SA		SA						A		SA	SA					DOH
699-S31-1			A									A			A		A			
699-S31-E10A	4	A	A	4		A	A	4				A			A		A	4 11-EM-1		
699-S31-E10B		SA	SA			A					SA	SA		SA	SA		SA			
699-S31-E10C	4	A		4		A	A	4				A			A		A	4 11-EM-1		
699-S31-E10D	4	A		4		A	A	4				A			A		A	4 11-EM-1		
699-S31-E11	4			4				4										4 11-EM-1		
699-S31-E8A	4	A	A	4		A	A	4				A			A		A	4 11-EM-1		
699-S32-E11	4			4				4										4 11-EM-1		
699-S31-E10E		SA	SA				SA					A			A	SA	SA			
699-S32-E13A														SA	SA		SA			
699-S32-E13B												A		SA	SA		SA			
699-S32-E8							A					A	SA		SA		A			
699-S34-E10		A					A						A		A		A			
699-S36-E12B													A				A			
699-S36-E13A													A				A			
699-S36-E13B													A				A			
699-S37-E11A	1	A	1					1					A				A	1 11-EM-1		
699-S37-E14		Q	Q	Q		Q	A	A			Q	Q	Q				A			DOH
699-S38-E11	1	A	1					1					A				A	1 11-EM-1		
699-S38-E12A	1	A	1					1					A				A	1 11-EM-1		
699-S38-E12B													A				A			
699-S40-E14							SA						SA				SA			
699-S41-E11A	1	A	1					1					A				A	1 11-EM-1		
699-S41-E12	1			1				1					A				A	1 11-EM-1		
699-S41-E13A							A					A	A		A		A			

A.5.1 600 Area Wells (a)(b)

Well	Alk	Alpha	Anion	Beta	CN ⁻	Gamma	ICP-f	ICP-u	129I	Pu	90Sr	99Tc	3H	Lo 3H	U 3H	U-iso	VOA	CERCLA	RCRA/OPER	Notes
699-S41-E13B				A			A						A		A					
699-S41-E13C				A			A						A		A					
699-S43-E12				A									A		A					
699-S6-E14A				A									SA							
699-S6-E4B				A									SA							
699-S6-E4D		SA	SA	SA	SA	SA	A	A	A			A	SA		SA					DOH
699-S8-19				A									A							

(a) Refer to Figure 5.1, 600 Area Unconfined Aquifer Well Locations.

(b) Refer to Figure 5.2, 600 Area Confined Aquifer Well Locations.

Hanford Site Environmental Monitoring Plan

Section III.C. Meteorological Monitoring

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Introduction

Meteorological monitoring is another aspect of the U.S. Department of Energy's (DOE's) requirements for environmental monitoring and is designed to meet the environmental surveillance and meteorological monitoring program objectives stated in DOE 5400.1 and described in DOE/EH-0173T. This section identifies the data required to support environmental monitoring activities and to represent other meteorological conditions important to environmental surveillance activities. Also, as a specific element of all environmental monitoring plans, a meteorological information/monitoring program has been developed.

DOE/EH-0173T details the specific requirements of a meteorological monitoring program and addresses the following considerations:

- meteorological program basis
- calculations for dose assessment
- meteorological measurements
- inspection, maintenance, and calibration
- data summarization and archiving
- quality assurance.

The balance of this section will discuss the composition of the Hanford Site meteorological monitoring program as it relates to DOE 5400.1 and DOE/EH-0173T.

Meteorological and Climatological Services Project

The Pacific Northwest Laboratory (PNL) Meteorological and Climatological Services Project provides the DOE Richland Operations Office (RL), and Hanford Site contractors with meteorological and climatological support for emergency response, weather forecasting, climatological data, and related special requests through the daily, 24-h operation of the Hanford Meteorology Station (HMS). The project responds to Hanford Site needs through a program that includes 1) extensive data acquisition through a sitewide meteorological monitoring network; 2) 24-h/d forecasting capability, using weather satellite imagery and National Weather Service products (through the Automation of Field Operations and Services system); 3) 24-h/d surface observation program, 6-h synoptic observations, and twice daily pilot balloon releases; and 4) climatological data support through monthly and annual summaries, as well as meteorological input to annual environmental reports.

Meteorological Monitoring Network

The Hanford Site covers a large area with significant variations in topography and with elevations ranging from approximately 100 to nearly 1,100 m above sea level (Figure III.C-1). To characterize the meteorological conditions on and around the Hanford Site, 28 monitoring stations have been located onsite and nearby offsite (Table III.C-1 and Figure III.C-2). Station locations were selected to reflect the influence of the varied topography, especially on wind speed and direction, and to optimize the data obtained for atmospheric transport and diffusion modeling and for site characterization. The station-selection process was based on an understanding of the effects of synoptic- and subsynoptic-scale meteorological events on wind flow over the Hanford Site and also from studying results of

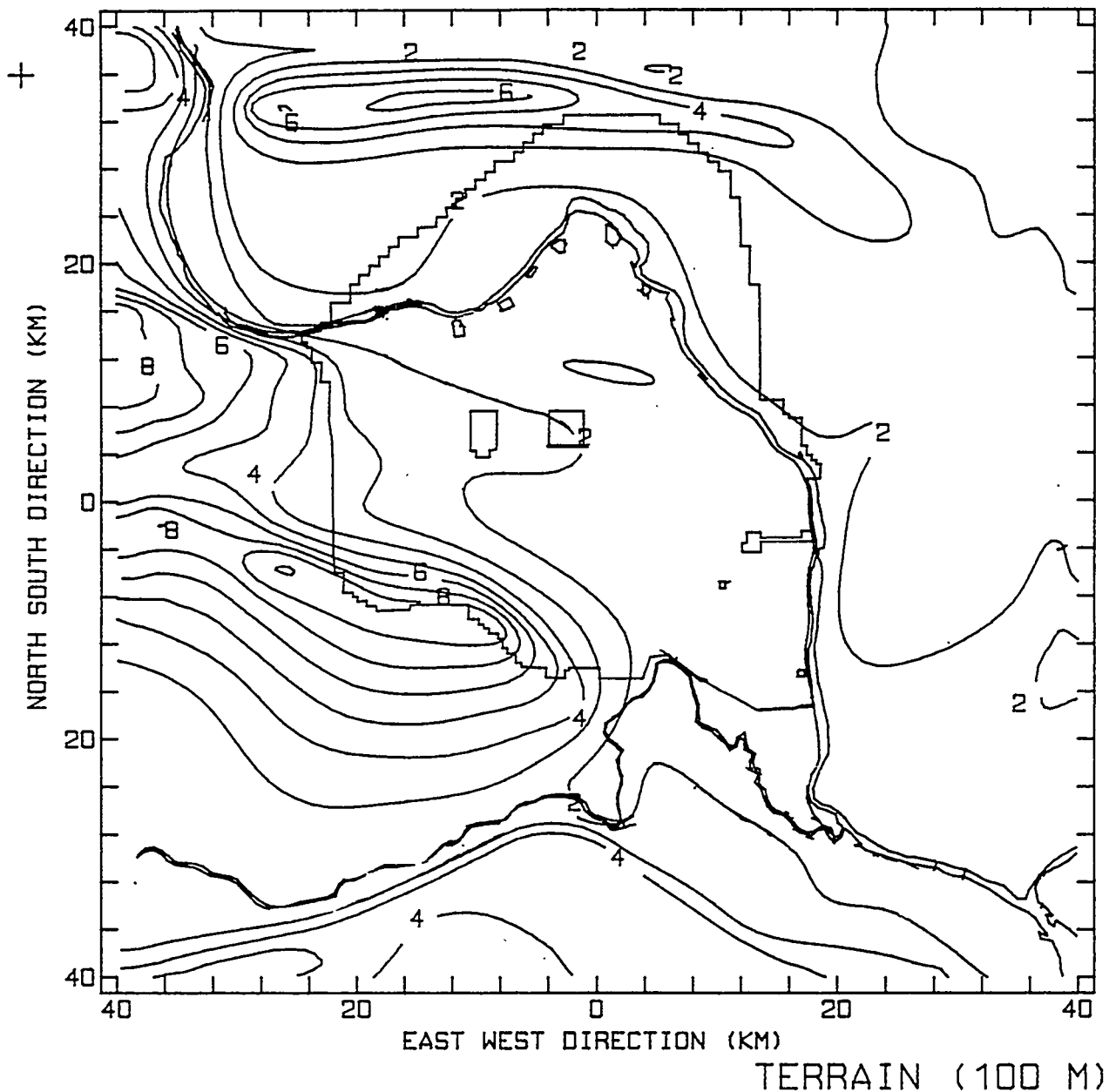


Figure III.C-1. Terrain Map of the Hanford Site and Surrounding Areas

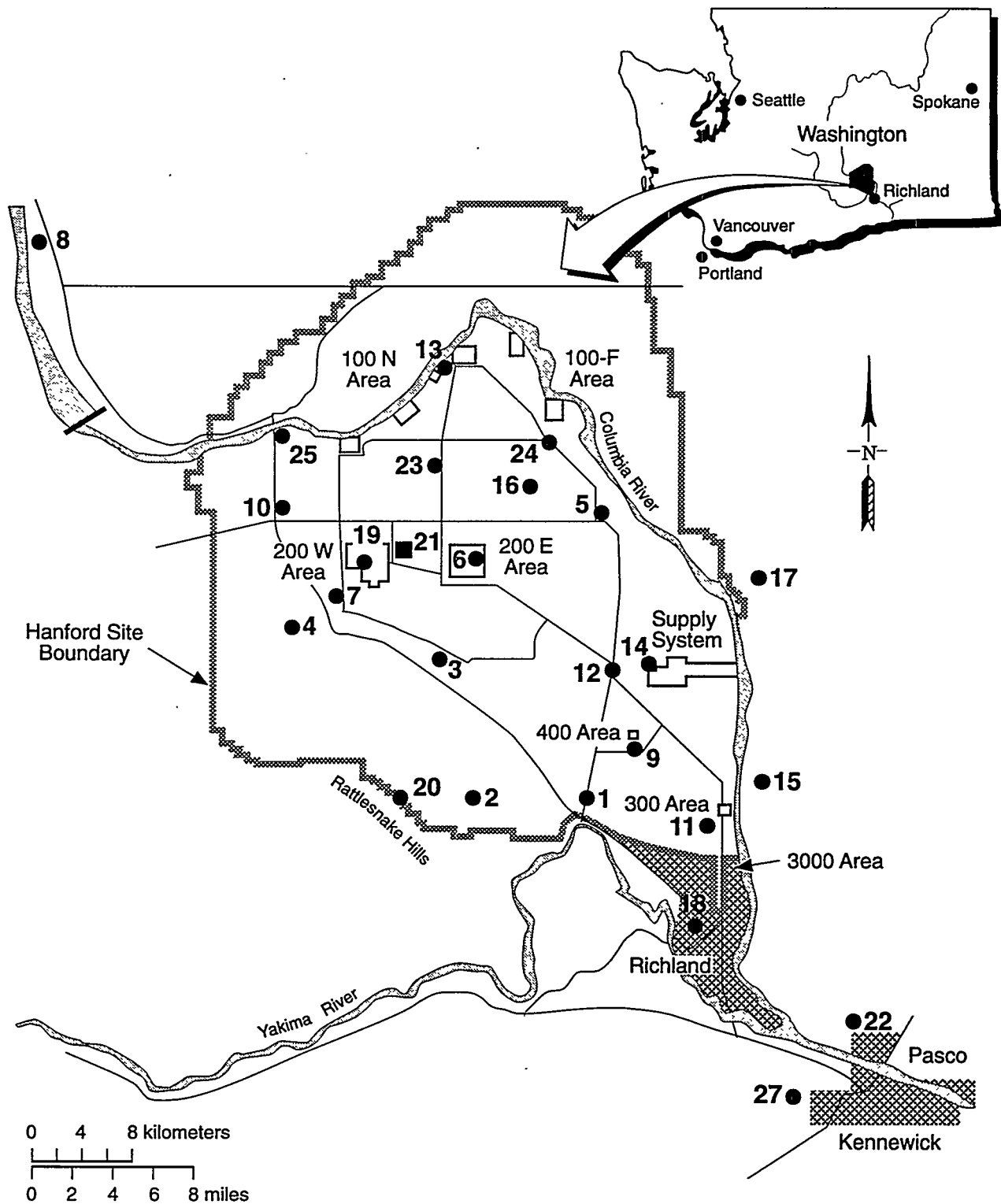
atmospheric transport model simulations that were run specifically to indicate areas where additional wind data were required. The meteorological monitoring network was designed 1) to implicitly represent the effect of the varying topography of the Hanford Site on meteorological measurements by strategic siting of the individual stations; 2) to monitor and collect real-time meteorological data at locations where operations are conducted that could have a possible negative impact in the event of an emergency; 3) to provide meteorological data for day-to-day operational forecasting for Hanford Site activities; 4) to provide real-time meteorological data for atmospheric transport and diffusion modeling; and 5) to provide climatological data for environmental assessments, environmental impact statements, facilities planning, etc.

Table III.C-1. Station Numbers, Names, and Instrumentation for Each Hanford Meteorological Monitoring Site

Site Number	Site Name	Instrumentation ^(a)
1	Prosser Barricade	WS, WD, T, P
2	Emergency Operations Center	WS, WD, T, P
3	Army Loop Road	WD, T, P
4	Rattlesnake Springs	WS, WD, T, P
5	Edna	WS, WD, T
6	200 East Area	WS, WD, T, P, AP
7	200 West Area	WS, WD, T, P
8	Beverly	WS, WD, T, P
9*	Fast Flux Test Facility	WS, WD, T, TD, DP, P, AP
10	Yakima Barricade	WS, WD, T, P, AP
11*	300 Area	WS, WD, T, TD, DP, P, AP
12	Wye Barricade	WS, WD, T, P
13*	100-N Area	WS, WD, T, TD, DP, AP
14	WNP-2	WS, WD, T, P
15	Franklin County	WS, WD, T
16	Gable Mountain	WS, WD, T
17	Ringold	WS, WD, T
18	Richland Airport	WS, WD, T, AP
19	200 West (PFP)	WS, WD, T, AP
20	Rattlesnake Mountain	WS, WD, T, P
21	Hanford Meteorology Station	WS, WD, T, P, AP
22	Pasco	WS, WD, T, P
23	Gable West	WS, WD, T
24	100-F	WS, WD, T
25	Vernita Bridge	WS, WD, T
26	Test Station - 622R	WS, WD, T
27	Vista	WS, WD, T, P
28	Roosevelt	WS, WD, T

NOTE: All towers are 10 m tall, except for those asterisked, which are 60 m tall.

- (a) DP = dew-point temperature; P = precipitation; T = temperature; TD = temperature difference; WD = wind direction; WS = wind speed; AP = atmospheric pressure.



S9406053.1

Figure III.C-2. Map of the Hanford Site and Surrounding Areas

A 125-m tower, located at the HMS, is instrumented at multiple levels for wind speed and direction and temperature. This tower has been used for collecting data since the mid-1940s. Three 60-m monitoring stations, instrumented at multiple levels, are located in onsite areas where significant operations are conducted. These stations provide additional necessary information as input to atmospheric transport and diffusion models. Detailed descriptions of each meteorological monitoring site, including narrative and photographic depictions of the topography proximate to each, can be found in Glantz and Islam (1988).

Meteorological Instrumentation

The meteorological instrumentation monitors and collects data on wind speed and direction, temperature, temperature difference, dew-point temperature, and precipitation. Other data are collected via the surface observation program, including sky condition, cloud type and amount, ceiling height, mixing depth, atmospheric pressure, weather and obstructions to visibility, relative humidity, and solar radiation (Andrews 1988).

Wind

Wind speed and direction are measured at the 10-m level at all of the remote meteorological monitoring stations, at the 25- and 60-m levels on the three 60-m towers onsite (see Table III.C-1), and at the 2.1-, 15.2-, 30.5-, 61.0-, 91.4-, and 121.9-m levels on the 125-m tower at the HMS.

Wind speed at most monitoring stations (except Stations 20 and 25) is measured using sensors (3-cup heavy-duty aluminum anemometer) with a low starting threshold and wide dynamic response over a wide range of wind speeds. At Station 20, where light winds are unusual and sustained wind speeds in excess of 45 m/s are not uncommon, a sturdier wind monitor (with a propeller, rather than cup anemometer, and with a higher starting threshold but a greater range) is used. At Station 25, which is solar powered and therefore can't be heated, a monitor less susceptible to freezing (due to moisture and fog near the river) is used.

Wind Speed Sensor Specifications

Stations 1 to 19, 21 to 24, and 26 to 28

Threshold	0.22 m/s
Operating range	0 to 56 m/s
Accuracy	± 0.07 m/s or $\pm 1.0\%$, whichever is greater.

Station 20

Threshold	0.7 m/s
Operating range	0 to 60 m/s (gust survivability to 100 m/s).

Station 25

Threshold	0.4 m/s
Operating range	0 to 38 m/s (gust survivability to 38 m/s).

Wind direction sensors at most of the monitoring stations (except Stations 20 and 25, where wind monitors are used) are counterbalanced, lightweight vanes attached to a shaft coupled to a precision low-torque potentiometer. These sensors have low starting thresholds and fast dynamic response.

Wind Direction Sensors

Stations 1 to 19, 21 to 24, and 26 to 28

Threshold	0.22 m/s
Operating range	0° to 360°
Accuracy	$\pm 2^\circ$
Damping ratio	0.4 at 10° initial angle of attack
Distance constant	1.1 m.

Station 20

Threshold	1.0 m/s
Operating range	0° to 360°
Accuracy	$\pm 5^\circ$.

Station 25

Threshold	0.7 m/s
Operating range	0° to 360°
Accuracy	$\pm 5^\circ$.

The wind speed and wind direction sensors at all monitoring locations (except Stations 20 and 25) are heated to minimize the accumulation of rime and/or freezing precipitation during the winter.

Temperature

Air temperature is measured at 1.7 m at all of the monitoring stations, with additional measurements at the 10- and 60-m levels (for measurement of ΔT for atmospheric stability designation) at the three 60-m monitoring stations (see Table III.C-1). Temperature is measured at the 0.9-, 9.1-, 15.2-, 30.5-, 61.0-, 76.2-, 91.4- and 121.9-m levels of the 125-m tower.

The temperature sensor (on all but the 125-m tower) is an epoxy-coated thermistor composite that exhibits relatively large resistance changes in response to small temperature changes. Fast-response sensors (with a time constant of 0.6 s) are used. All of the 10-m monitoring stations have naturally aspirated radiation shields, and the three 60-m stations have mechanically aspirated shields.

Thermistor Temperature Sensor Specifications

Probe accuracy	$\pm 0.15^\circ\text{C}$
Range	-30.0 to 50.0°C
Time constant	0.6 s.

On the 125-m tower, temperatures are measured using a platinum resistance temperature device contained in a 15-cm-long stainless steel housing mounted in a mechanically aspirated radiation shield.

Platinum Resistance Temperature Sensor Specifications

Probe accuracy	$\pm 0.1^{\circ}\text{C}$
Range	-50.0 to 100.0°C
Time constant	15 s.

Temperature Differencing

Temperature differencing is one of several methods used to determine atmospheric stability, which is one of the parameters used in transport and diffusion calculations. Atmospheric stability is a measurement of the buoyancy of a parcel of air. The buoyancy of a parcel of air depends on its density relative to the density of the environment at the same level. If a parcel is heavier than its environment, it will tend to sink (stable); if a parcel is lighter than its environment, it will tend to rise (unstable); and if the weight is the same, it will remain at the same level as its environment (neutral). Stability classes can be determined by measuring the difference between air temperatures at two levels.

The ΔT calculation at the 125-m tower is made using the difference between actual temperatures measured at the 61.0- and 9.1-m levels of the tower. The three 60-m monitoring stations, which measure resistance rather than actual temperature, have temperature differencing systems to measure ΔT between the 10- and 60-m levels on these towers. A ΔT translator at each of the three 60-m monitoring stations contains the electronics for converting the variable resistance from the temperature thermistor elements to low-impedance signals, then takes the difference between the two signals and converts this difference into a ΔT . The temperature sensors used are discussed above.

Dew-Point Temperature

Dew-point temperatures are measured at the 1.7-m level at the three 60-m towers. The dew-point sensor is housed in a mechanically aspirated temperature/dew-point shield, and consists of bifilar gold electrodes wound on a lithium chloride-impregnated glass fiber wick that encloses a thermistor temperature sensor.

Dew-Point Sensor Specifications

Operating range	-40 to $+50^{\circ}\text{C}$
Relative humidity	From 100% to the relative humidity at which the operating limits lithium chloride salt temperature is 2°C above the ambient temperature (11% to 18%).

At the HMS, a hygrothermometer system is used to measure the dew-point temperature. The monitor is located 1.5 m above the ground and uses a chilled-mirror system to monitor the dew point.

Hygrothermometer Specifications

Operating temperature	-50 to 70°C
Relative humidity	5% to 100%
Ambient temperature	$\pm 0.6^{\circ}\text{C}$ from -50 to 50°C accuracy
Dew-point accuracy	$\pm 0.6^{\circ}\text{C}$ when $> 0^{\circ}\text{C}$.

Precipitation

Precipitation measurements, using remote recording rain gages, are made at 19 of the 28 monitoring stations. Each rain gage has a 20-cm-diameter opening to collect precipitation. Two compartments alternately fill with precipitation and tip, causing momentary closure of a mercury switch. The funnels are electrically heated for measuring the water equivalent of frozen precipitation. The heater is thermostatically controlled to be activated when the ambient temperature drops to 4°C. These gages are sensitive to 0.25 mm and are accurate to 0.5% for a rainfall rate of 12.70 mm/h. The normal precipitation event at the HMS is only 2.34 mm.

Atmospheric Pressure

Atmospheric pressure is measured at the 2-m level at the 8 sites indicated in Table III.C-1. The sensors are located within the Signal Interface Unit (SIU) enclosures.

Pressure Sensor Specifications

Scaling Range	800 to 1100 mbar
Nonlinearity	+/- 0.05% of full scale
Full Scale Accuracy	+/- 0.1% of full scale or +/- 0.3 mbar

Instrument Calibration and Maintenance

All measurement and test equipment (M&TE) is calibrated on an annual basis, and the calibrations are spread throughout the year. The Craft Services calibration recall system is used to notify the project manager when instrument calibration is due. However, because data are reviewed hourly by the forecaster on duty, any apparent problems with data from a particular station are immediately noted and the instrument specialists are advised. Instruments are recalibrated after any repair before being returned to use. Because of the large number of monitoring locations and the distances involved, it is not practical to perform total system calibration on a more frequent basis. Again, because of the large number of monitoring locations that contribute data to the meteorological monitoring system, the temporary loss of data from one or two locations is not critical to the operation of the system as a whole. Even so, every attempt is made to keep the amount of down time to a minimum.

The PNL Craft Services Department maintains, in accordance with PNL-MA-70, the procedures for calibration of all M&TE used by the Meteorological and Climatological Services Project. Primary, secondary, and tertiary calibration standards are traceable through the Westinghouse Hanford Company (WHC) Electrical and Physical Standards Laboratory to the National Institute of Standards and Technology (NIST). The procedures state that 2 months before the expiration of calibration on any piece of equipment or instrument, a Notice of Instrument Calibrations is generated by the PNL Craft Services Department that specifies the instrumentation scheduled for calibration. The notice is reviewed and signed by the instrument custodian (in this case the Manager, Meteorological and Climatological Services Project), authorizing the calibration of the equipment specified. On completion of calibration, a PNL Craft Services Record of Calibration (Figure III.C-3) is generated, and copies of the record are provided to the applicable instrument laboratory, the instrument custodian, and the Craft Services Department.

PNL Craft Services Record of Calibration

[illegible]

Figure III.C-3. Record of Calibration Form

Data Acquisition

Data are acquired and processed at each monitoring station using a signal interface unit (SIU) and a telemetry unit. Most of the SIUs and telemetry units are powered commercially; however, units at three sites (7, 8, and 25) are powered by batteries charged by solar panels. The SIU acquires and processes the signals from the individual instruments, and the telemetry unit transmits the processed data to the HMS (via a radio repeater on Rattlesnake Mountain). Inputs to the SIU may be analog, counter, or digital. The SIU scans its channels for information every 5 s (or every second for the tipping bucket rain gage), stores the information for 15 min, and sends the 15-min-averaged values (made up of 180 samples) to the HMS. Values are transmitted on the hour and at 15-min intervals. The output is a digital sequence of numbers, transmitted at 416.5 Mhz with 4 W of power.

The data transmitted from the remote monitoring stations are received at a base station located at the HMS and data are sent to a IBM RISC System/6000 computer via an RS-232 serial data link.

Atmospheric Transport and Diffusion

Because the Hanford Site covers a large area with varying topographic characteristics, a meteorological monitoring system with a network of remote stations is used in an attempt to accurately represent the meteorological conditions across the complex terrain of the Site.

Because of the varying terrain on the Hanford Site, use of a straight-line Gaussian model is not appropriate; instead, a trajectory model that treats atmospheric transport and diffusion as separate processes is used. An interactive Lagrangian puff dispersion model, MESOI Version 2.0 (Ramsdell et al. 1983), was selected for use at Hanford for estimating the transport and diffusion of effluents released to the atmosphere, and the Mesorad Dose Assessment Model (Scherpelz et al. 1986) was selected for emergency response applications.

Quality Assurance

Quality assurance (QA) for the Meteorological and Climatological Services Project is established and implemented by PNL's formal QA Program, as contained in PNL-MA-70. The QA Program conforms to the requirements of ASME NQA-1-1989 Edition and QAMS-005/80.

Independent surveillances and audits of the Meteorological and Climatological Service Project activities and procedures to ensure compliance with PNL-MA-70 and the project QA plan are conducted by the PNL Process Quality Department. These surveillances and audits can be initiated by the DOE-RL Program Manager, the PS&RPP Program Manager, the project manager or the project quality engineer on either a routine and/or a random basis.

Data Management

Meteorological data from the remote monitoring network (10- and 60-m towers) and from the 125-m tower are collected, processed, and archived on an IBM RISC System/6000 computer system at the HMS. This system is a "nearly fault-tolerant" system, with dual central processing units (CPUs)

and redundant mirrored disks. Incoming data is written to several independent hard disks on separate disk servers simultaneously, so that data is available even in the event of the failure of a disk or disk server. Each CPU also has a separate uninterruptible power supply in the event of a power outage. The operating system runs High Availability Clustered Multi-Processing (HACMP) software to help assure that no single component or software failure will disable the system.

The Scientific Application, Visualization, and Initialization in Three Dimensions (savi3D) environmental workbench software is used for data management and display. This software is used for both data management and real-time QA on incoming data.

Fifteen-minute-averaged data from the remote monitoring network are used as input to atmospheric transport and diffusion models for emergency response, and are maintained for 10 days on the main-frame computer. At the beginning of the eleventh day, the first day of the 15-min data is purged, and 15-min data from the newly designated tenth day are stored.

For permanent storage, the 15-min data are converted into hourly data. These data are processed daily using the ARCHIVE computer code (Andrews and Burk 1989). This computer program converts hourly binary meteorological data from the 10-, 60-, and 125-m towers into formatted data and organizes the converted data into appropriate monthly files.

At the beginning of every month, the monthly data on the IBM RISC System/6000 are processed prior to permanent storage. All data are reviewed using quality assurance computer programs (Burk and Andrews 1989). These programs check all data for the following types of potential errors: parameters out of range (e.g., January temperature $> 16.7^{\circ}\text{C}$), unreasonable changes in parameter magnitude from one hour to the next (e.g., temperature change $> 5.6^{\circ}\text{C}$), parameter conflict (e.g., wind direction = 0, with a non-zero wind speed). These programs generate error listings that allow for the resolution of possible data irregularities. These computer-generated error listings are maintained on file; however, errors that can be readily resolved are corrected and archived. If they cannot be corrected, the data are indicated as "missing."

On completion of these monthly QA checks, the final data are archived on multiple hard disks, and are available for additional processing (e.g., joint frequency distributions, wind roses, data summaries), as necessary.

Exceptions

No exceptions have been taken to *should** statements in DOE/EH-0173T.

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Hanford Site Environmental Monitoring Plan

Section IV.A. Environmental Restoration Ground-Water Monitoring

Prepared by:	Date:	Concurrence (RL):	Date:
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Environmental monitoring performed by the Hanford Site Environmental Restoration Contract team (ERC team) for DOE is designed to support activities defined in the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1992), more commonly called the Tri-Party Agreement. The ERC team for the Hanford Site is Bechtel Hanford, Incorporated (BHI), CH2MHill Hanford, Incorporated (CHI), IT Corporation (IT), and ThermoAnalytical, Incorporated (TMA). The Tri-Party Agreement coordinates three important regulatory programs, RCRA, CERCLA, and the State of Washington Hazardous Waste Management Act (HWMA). The Tri-Party Agreement provides the legal and procedural basis for cleanup and regulatory compliance at the Hanford Site's numerous hazardous waste sites.

The magnitude of the environmental restoration challenge is revealed by the number of hazardous waste sites. The Hanford Site has been subdivided into four subareas that are included on the National Priorities List of hazardous waste sites. These subareas contain over 1,500 past-practice sites as defined by either CERCLA or RCRA. These sites have been grouped into 74 "operable units". Sixty-three operable units are "source" units which address waste disposal sites above the groundwater. Ten groundwater operable units are identified which address contamination from multiple source units. One combined source/groundwater operable unit completes the grouping. In addition to past-practice units, there are sixteen RCRA Treatment, Storage, and Disposal Units (TSD units) that have been transferred to the ERC team.

This section of the EMP focuses primarily on ground-water monitoring activities conducted by the ERC team. Other monitoring activities will be incorporated into future revisions to the document.

Ground-water monitoring objectives stated in DOE Order 5400.1 that are applicable to the environmental restoration program are:

- to verify compliance with applicable environmental laws and regulations
- to verify compliance with environmental commitments made in environmental impact statements, environmental assessments, safety analysis reports, or other official DOE documents
- to characterize and define trends in the physical and chemical condition of environmental media.

Distinctions in the applicability of the objectives to past-practice units and RCRA TSD units are discussed in this section.

Regulatory Program Processes

Waste sites that are the responsibility of the ERC team fall into two general categories: RCRA TSD units designated for closure and past-practice units (which can be either RCRA or CERCLA). Ground-water monitoring for these units can likewise be categorized into two types, characterization and surveillance. Characterization monitoring is performed to support decisions leading up to a Record of Decision (ROD) at past-practice units and to support optimization and modifications to treatment systems. Surveillance ground-water monitoring involves activities that meet the objectives of DOE Order 5400.1 as stated above and in general is performed as a regulatory requirement at a waste site as specified in a ROD or in a specific RCRA TSD regulation. The applicability of ground-water monitoring for the two general categories of waste sites is discussed below.

RCRA Treatment, Storage, and Disposal Units

RCRA TSD units that have been identified for closure are to be transferred to the ERC team. The ERC team will accept the units for management and closure pending inspection to verify that all operation of the unit has ceased. At present, the ERC team has accepted 16 units for management. A summary of these units and the ground-water monitoring status of each is presented in Table IV.A-1.

All ground-water monitoring of RCRA TSD units is designated as surveillance monitoring. Monitoring activities will continue to be conducted by WHC until the units go into actual closure, at which time the ERC team will take over closure and post-closure (as necessary) monitoring activities. Sampling schedules, constituent lists, and well location maps are presented in Appendix A.

Table IV.A-1. Current Ground-Water Monitoring Status of ERC Team-Managed RCRA TSD Units

RCRA TSD Unit	Ground-Water Monitoring Status			Final Status
	Interim Status			
	Background Monitoring	Indicator Parameter Evaluation	Ground-Water Quality Assessment	
100-D Ponds		X		
1324-N Surface Impoundment			X	
1324-NA Percolation Pond			X	
183-H Solar Evaporation Basins				X
1301-N Liquid Waste Disposal Facility		X		
Hexone Storage and Treatment Facility		None required		
241-CX Tank System		None required		
216-S-10 Pond and Ditch		X		
216-A-29 Ditch			X	
216-B-3 Main Pond			X	
216-A-10 Crib		X		
216-U-12 Crib			X	
216-A-36B Crib		X		
216-A-37-1 Crib		None required		
Nonradioactive Dangerous Waste Landfill		X		

Past-Practice Unit Monitoring

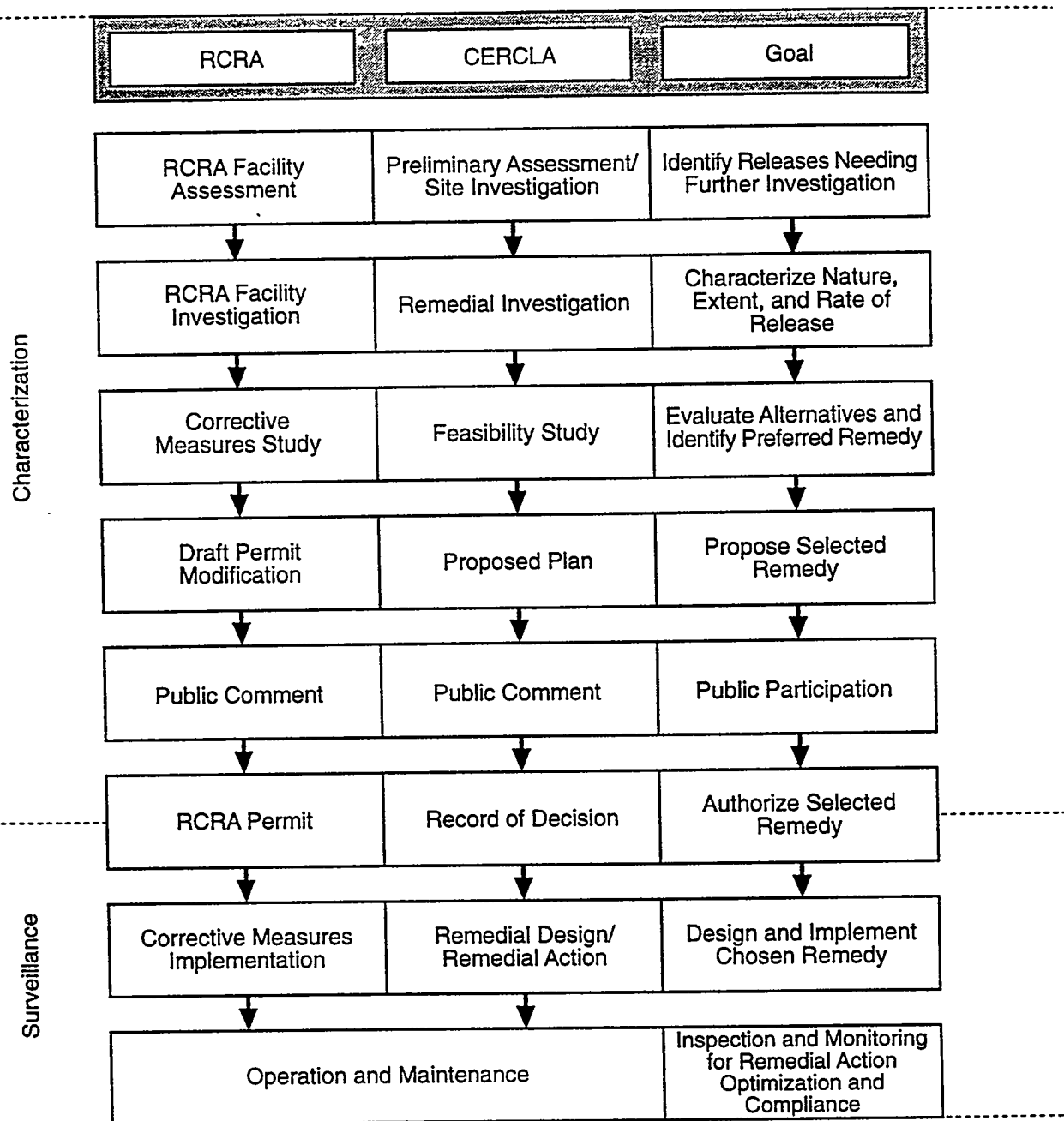
A past-practice unit is a waste management site where wastes or substances have been disposed of and that is not subject to regulation as a RCRA TSD unit. There are both RCRA and CERCLA past-practice units. Because of the large number of past-practice units at the Hanford Site, a process has been established for organizing these units into groups called operable units. The concept of operable units is to group the numerous units (primarily by geographic area) into manageable components for investigation and remedial action. There are 63 source, 10 ground-water, and 1 combined source/ground-water operable units. Ground-water operable units are linked to numerous source operable units, which may have contributed to regional plumes of contamination, but are treated separately from the source units for remediation.

Past-practice units within an operable unit are designated as either RCRA past-practice (RPP) units or CERCLA past-practice (CPP) units. This designation ensures that only one past-practice program will be applied at each operable unit. A comparison of the two past-practice program remedial processes is presented in Figure IV.A-1 with the type of monitoring required (characterization or surveillance). Note that regardless of the applicable regulatory past-practice program, the break between characterization and surveillance monitoring is at the same place in the process, when the Record of Decision or RCRA Permit (as applicable) is issued. Only one operable unit, 1100-EM-1, has received a Record of Decision and is, therefore, in the ERC team surveillance-level monitoring. Sampling schedules and constituent lists are contained in an appendix to this section. A table listing the ground-water operable units, the status of each relative to Record of Decision/RCRA Permit issuance, and the general category of monitoring is contained in Table IV.A-2.

Treatability testing for groundwater remediation is currently being conducted at five locations within four operable units. These activities are part of the CERCLA remedial investigation phase of the process and are classified as characterization monitoring and not included in this plan.

DOE Order 5820.2A Assessment

ERC team-managed facilities and activities are currently being evaluated for applicability of the DOE Order. The final evaluation will be completed on December 30, 1994. The results of this evaluation will be incorporated into the next revision of this EMP.



R9411091.1

Figure IV.A-1. Comparison of RCRA and CERCLA Remedial Processes with Ground-Water Monitoring Level

Table IV.A-2. Ground-Water Operable Unit Summary

Operable Unit Designation	Regulatory Program Classification	Status Relative to ROD/RCRA Permit ^(a)	Monitoring Category
1100-EM-1 (Ground-Water and Source Operable Unit)	CPP	Post-ROD	Surveillance
300-FF-5	CPP	Pre-ROD (ROD expected 9/95)	Characterization
100-HR-3	RPP	Pre-Permit	Characterization
100-BC-5	CPP	Pre-Rod	Characterization
100-KR-4	CPP	Pre-ROD	Characterization
100-NR-2	RPP	Pre-Permit	Characterization
100-FR-3	CPP	Pre-ROD	Characterization
200-BP-5	CPP	Pre-ROD	Characterization
200-UP-1	CPP	Pre-ROD	Characterization
200-ZP-1	CPP	Pre-ROD	Characterization
200-PO-1	CPP	Pre-ROD	Characterization

(a) ROD = Record of Decision.

Hanford Site Environmental Monitoring Plan

Section IV.A - Appendix A RCRA TSD Unit Ground-Water Monitoring Schedules and Maps

The FY94 detailed sampling schedules and well location maps for the environmental restoration RCRA sites are provided in this appendix. Schedules are subject to change during the year as environmental conditions and/or budget constraints dictate.

RCRA Site Format. Discussions for each of the individual RCRA sites begin with a well location map followed by a sampling schedule and an analyte or constituent list. The constituent lists are letter coded to each schedule. Column header abbreviations used in the sampling schedules are as follows:

- Well:** well identification number used for Hanford wells; the first digit indicates the area; i.e., 1 for 100 Area, 2 for 200 Area, 3 for 300 Area, 4 for 400 Area, and 6 for 600 Area. Well numbers on the location maps do not include the area designator.
- UP:** a "U" entry in this column indicates the well is an upgradient well.
- WMA:** refers to a specific waste management area; a number 1 through 5 appears in this column only for the low-level burial ground sites.
- Reps:** a "Y" or "N" is used to designate whether replicate samples are taken at a sampling event
- List:** a letter code in this column refers to the analyte list used for that well and or sampling event. The analyte list and corresponding letter code are different for each site.
- COSAMP:** entries in this column indicate cases where there is shared sampling with another project (i.e., where two or more projects may use the same well and results to avoid duplication.) Letter codes in this column refer to the specific project by name (e.g., 216-A-36B Crib would be entered as A-36B, etc.).

Constituent list column heading explanations are as follows:

- List:** the letter code in this column corresponds to the letter code entered in the "List" column of the sampling schedule.
- Group:** the analytical constituent group or individual constituent analyzed. Specific codes and breakdown of analyte groups are included in the annual statement of work.
- Filtered:** indicates the constituent or analyte group sample is filtered (F) or unfiltered (U); a blank entry in this column is understood to be unfiltered.

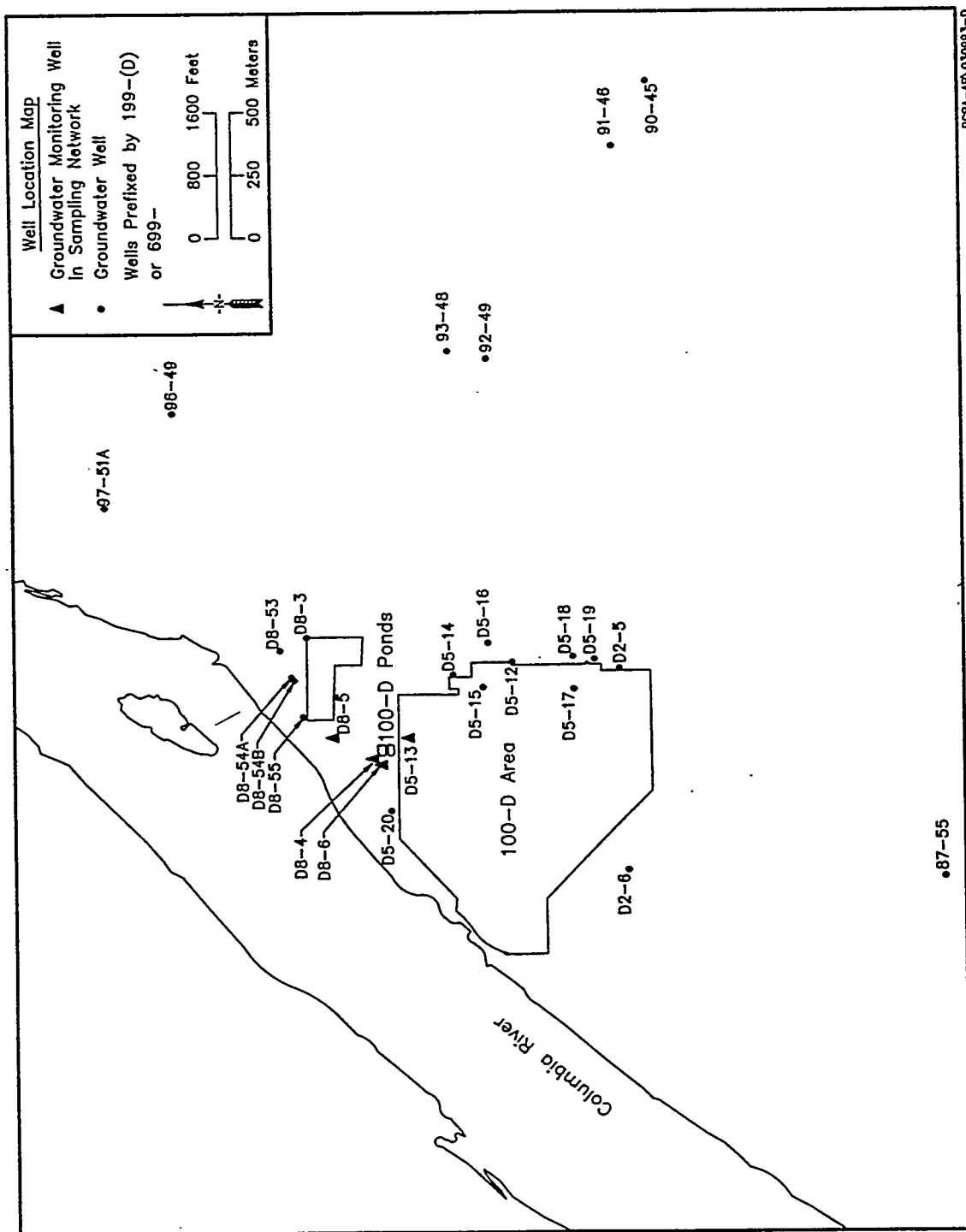


Figure IV.A-A.1. RCRA Monitoring Well Locations at the 100-D Area.

100-D Area 1994 Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
1-D5-13	U		Y	A	February		
1-D5-13	U		Y	Q	May		
1-D5-13	U		Y	Q	November		
1-D5-13	U		Y	SA	August		
1-D8-4			Y	A	February		
1-D8-4			Y	SA	August		
1-D8-5			Y	A	February		
1-D8-5			Y	SA	August		
1-D8-6			Y	A	February		
1-D8-6			Y	SA	August		

100-D Area Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Anions			
A	Conductivity-Lab			
A	ICP Metals	F		
A	ICP Metals	U		
A	Mercury	F		
A	Mercury	U		
A	Ph-Lab			
A	Phenols			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
Q	TOX (Weston)			
SA	Alpha, Beta			
SA	Anions			
SA	Conductivity-Lab			
SA	ICP Metals	F		
SA	ICP Metals	U		
SA	Mercury	F		
SA	Mercury	U		
SA	Ph-Lab			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			
SA	Turbidity			

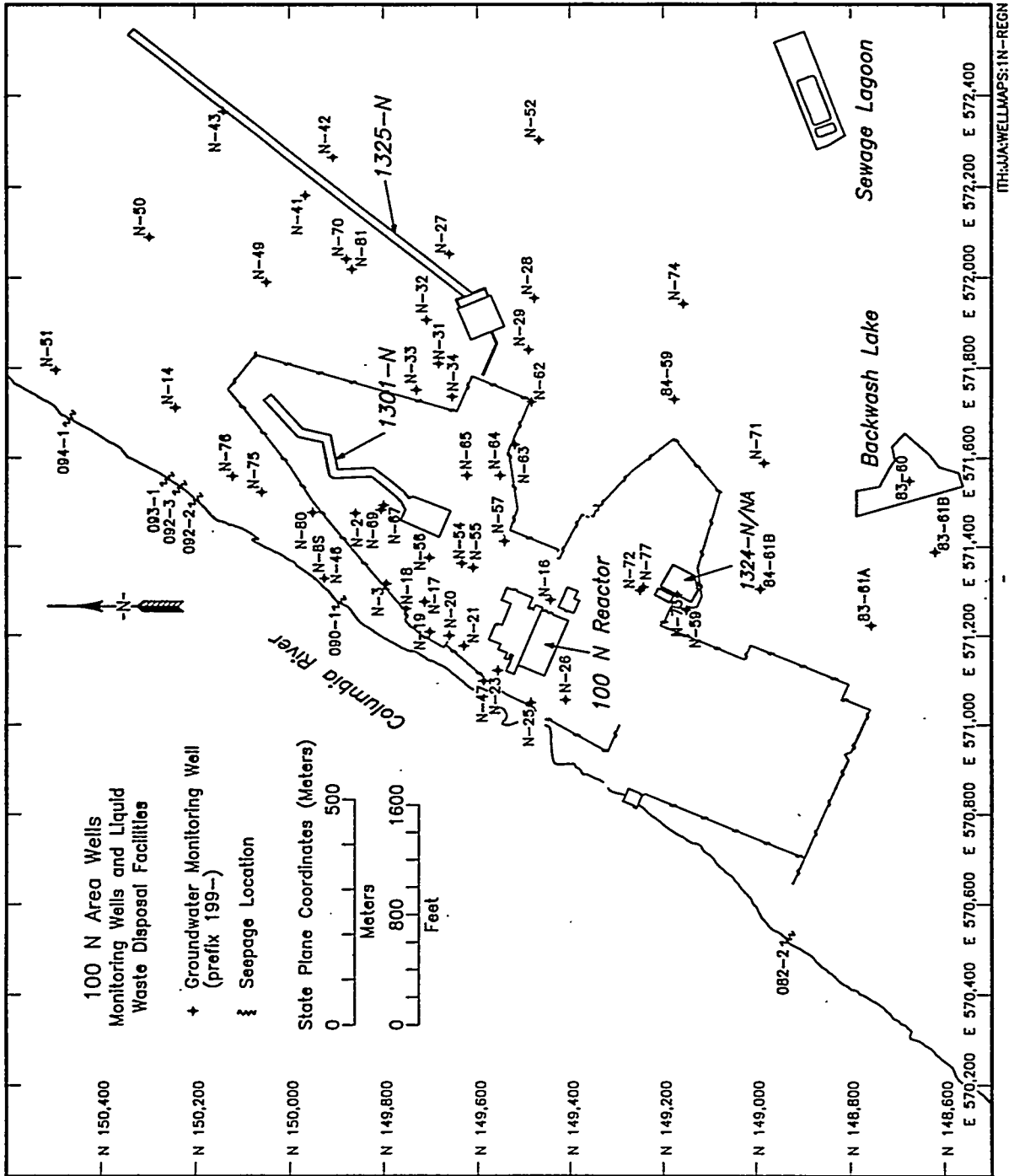


Figure IV.A-A.2. RCRA Monitoring Well Locations for the 1301-N, 1325-N, and 1324-N/NA Facilities.

1301-N Facility 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
1-N-14			Y	Q	August		
1-N-14			Y	Q	February		
1-N-14			Y	Q	May		
1-N-14			Y	Q	November		
1-N-2			Y	Q	August		
1-N-2			Y	Q	February		
1-N-2			Y	Q	May		
1-N-2			Y	Q	November		
1-N-3			Y	Q	August		NR-2
1-N-3			Y	Q	February		NR-2
1-N-3			Y	Q	May		
1-N-3			Y	Q	November		
1-N-34	U		Y	Q	August		
1-N-34	U		Y	Q	February		
1-N-34	U		Y	Q	May		
1-N-34	U		Y	Q	November		
1-N-57	U		Y	Q	August		
1-N-57	U		Y	Q	February		
1-N-57	U		Y	Q	May		
1-N-57	U		Y	Q	November		
1-N-67			Y	Q	August		
1-N-67			Y	Q	February		
1-N-67			Y	Q	May		
1-N-67			Y	Q	November		
1-N-69			Y	Q	August		
1-N-69			Y	Q	February		
1-N-69			Y	Q	May		
1-N-69			Y	Q	November		
1-N-75			Y	Q	August		
1-N-75			Y	Q	February		
1-N-75			Y	Q	May		
1-N-75			Y	Q	November		
1-N-76			Y	Q	August		
1-N-76			Y	Q	February		
1-N-76			Y	Q	May		
1-N-76			Y	Q	November		

1301-N Facility Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta			
A	Anions			
A	Conductivity-Lab			
A	Gamma Scan			
A	Hydrazine			
A	ICP, Arsenic, Lead	F		
A	ICP, Arsenic, Lead	U		
A	pH-Lab			
A	Phenols			
A	Strontium-90			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
Q	Alpha, Beta			
Q	Anions			
Q	Coliform			
Q	Conductivity-Lab			
Q	Gamma Scan			
Q	Hydrazine			
Q	ICP, Arsenic, Selenium, Lead	F		
Q	ICP, Arsenic, Selenium, Lead	U		
Q	Mercury	F		
Q	Mercury	U		
Q	pH-Lab			
Q	Phenols			
Q	Radium			
Q	Strontium-90			
Q	TOC			
Q	TOX (Weston)			
Q	Tritium			
Q	Turbidity			
Q1	Alkalinity			
Q1	Anions			
Q1	Conductivity-Lab			
Q1	ICP, Arsenic, Lead	F		
Q1	ICP, Arsenic, Lead	U		

1301-N Facility Well Constituent List (cont'd)

List	Group	Filtered	Other W. O.	Change Date
Q1	pH-Lab			
Q1	TC			
Q1	TDS			
Q1	TOC			
Q1	TOX (Weston)			
Q1	Turbidity			
Q1	VOA (GC)			
Q2	TOX (Weston)			
SA	Alpha, Beta			
SA	Anions			
SA	Conductivity-Lab			
SA	Gamma Scan			
SA	Hydrazine			
SA	ICP, Arsenic, Lead	F		
SA	ICP, Arsenic, Lead	U		
SA	pH-Lab			
SA	Strontium-90			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			

1324-N Facility 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
1-N-59				Q	August		
1-N-59				Q	February		
1-N-59				Q1	May		
1-N-59				Q1	November		
1-N-71	U		Y	Q1	August		
1-N-71	U		Y	Q1	February		
1-N-71	U		Y	Q1	May		
1-N-71	U		Y	Q1	November		
1-N-72				Q1	August		
1-N-72				Q1	February		
1-N-72				Q1	May		
1-N-72				Q1	November		
1-N-73				Q1	August		
1-N-73				Q1	February		
1-N-73				Q1	May		
1-N-73				Q1	November		
1-N-77				Q1	August		
1-N-77				Q1	February		
1-N-77				Q1	May		
1-N-77				Q1	November		

1324-N Facility Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta			
A	Anions			
A	Conductivity-Lab			
A	Gamma Scan			
A	Hydrazine			
A	ICP, Arsenic, Lead	F		
A	ICP, Arsenic, Lead	U		
A	pH-Lab			
A	Phenols			
A	Strontium-90			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
Q	Alpha, Beta			
Q	Anions			
Q	Coliform			
Q	Conductivity-Lab			
Q	Gamma Scan			
Q	Hydrazine			
Q	ICP, Arsenic, Selenium, Lead	F		
Q	ICP, Arsenic, Selenium, Lead	U		
Q	Mercury	F		
Q	Mercury	U		
Q	pH-Lab			
Q	Phenols			
Q	Radium			
Q	Strontium-90			
Q	TOC			
Q	TOX (Weston)			
Q	Tritium			
Q	Turbidity			
Q1	Alkalinity			
Q1	Anions			
Q1	Conductivity-Lab			
Q1	ICP, Arsenic, Lead	F		
Q1	ICP, Arsenic, Lead	U		

1324-N Facility Well Constituent List (cont'd)

List	Group	Filtered	Other W. O.	Change Date
Q1	pH-Lab			
Q1	TC			
Q1	TDS			
Q1	TOC			
Q1	TOX (Weston)			
Q1	Turbidity			
Q1	VOA (GC)			
Q2	TOX (Weston)			
SA	Alpha, Beta			
SA	Anions			
SA	Conductivity-Lab			
SA	Gamma Scan			

1325-N Facility 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
1-N-27			Y	A	February		
1-N-27			Y	SA	August		
1-N-29			Y	A	February		
1-N-29			Y	SA	August		
1-N-32			Y	A	February		NR-2
1-N-32			Y	SA	August		NR-2
1-N-41			Y	A	February		
1-N-41			Y	SA	August		
1-N-43			Y	A	February		
1-N-43			Y	SA	August		
1-N-70			Y	A	February		
1-N-70			Y	SA	August		
1-N-74	U		Y	A	February		
1-N-74	U		Y	Q2	May		
1-N-74	U		Y	Q2	November		
1-N-74	U		Y	SA	August		
1-N-81			Y	A	February		
1-N-81			Y	SA	August		

1325-N Facility Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta			
A	Anions			
A	Conductivity-Lab			
A	Gamma Scan			
A	Hydrazine			
A	ICP, Arsenic, Lead	F		
A	ICP, Arsenic, Lead	U		
A	pH-Lab			
A	Phenols			
A	Strontium-90			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
Q	Alpha, Beta			
Q	Anions			
Q	Coliform			
Q	Conductivity-Lab			
Q	Gamma Scan			
Q	Hydrazine			
Q	ICP, Arsenic, Selenium, Lead	F		
Q	ICP, Arsenic, Selenium, Lead	U		
Q	Mercury	F		
Q	Mercury	U		
Q	pH-Lab			
Q	Phenols			
Q	Radium			
Q	Strontium-90			
Q	OC			
Q	TOX (Weston)			
Q	Tritium			
Q	Turbidity			
Q1	Alkalinity			
Q1	Anions			
Q1	Conductivity-Lab			

1325-N Facility Well Constituent List (cont'd)

List	Group	Filtered	Other W. O.	Change Date
Q1	ICP, Arsenic, Lead	F		
Q1	ICP, Arsenic, Lead			
Q1	pH-Lab			
Q1	TC			
Q1	TDS			
Q1	TOC			
Q1	TOX (Weston)			
Q1	Turbidity			
Q1	VOA (GC)			
Q2	TOX (Weston)			
SA	Alpha, Beta			
SA	Anions			
SA	Conductivity-Lab			
SA	Gamma Scan			
SA	Hydrazine			
SA	ICP, Arsenic, Lead	F		
SA	ICP, Arsenic, Lead	U		
SA	pH-Lab			
SA	Strontium-90			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			

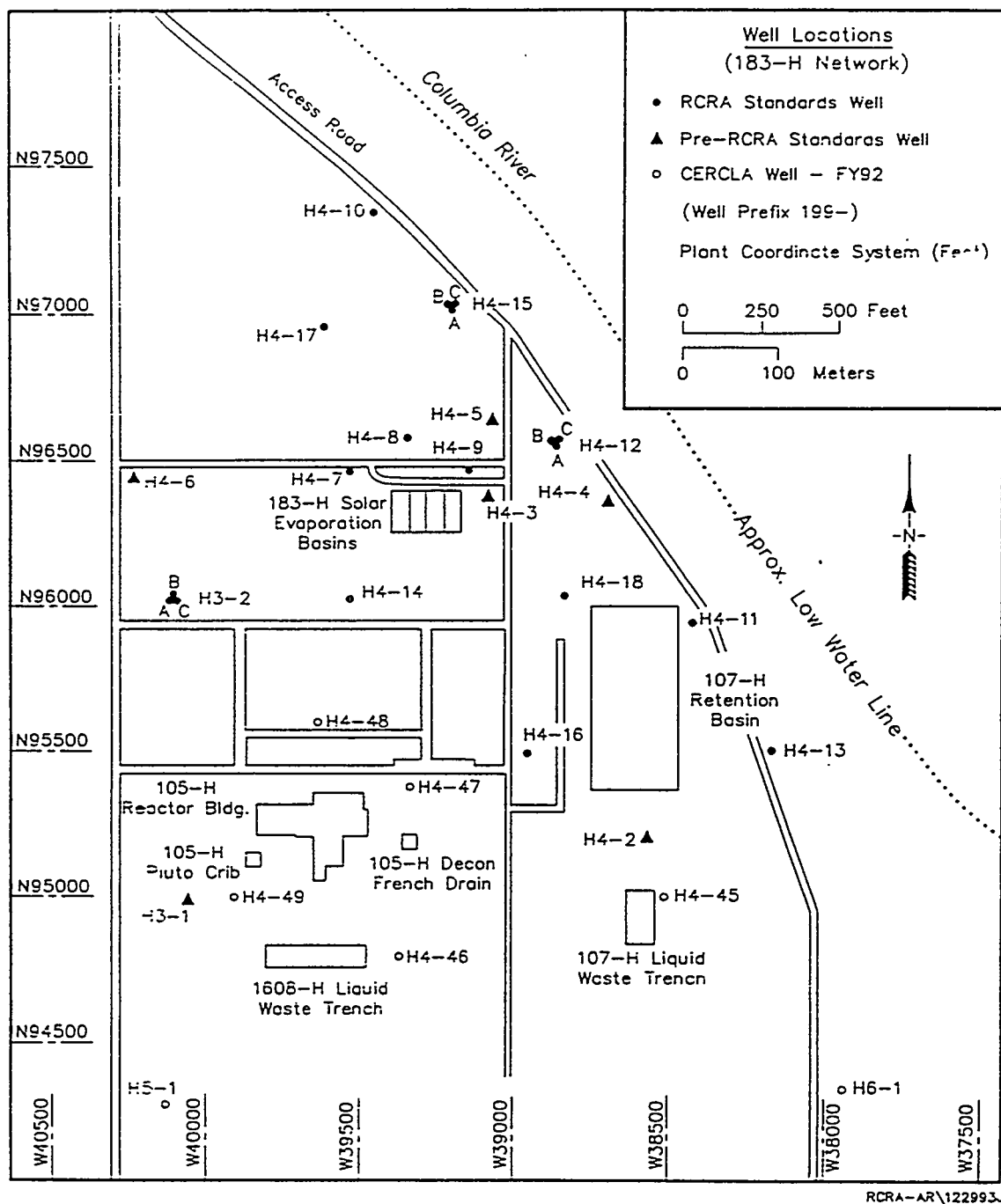


Figure IV.A-A.3. RCRA Monitoring Well Locations at 183-H

183-H 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
1-H3-2A	U			Q	December		
1-H3-2A	U			Q	June		
1-H3-2A	U			Q	March		
1-H3-2A	U			Q	September		
1-H3-2C	U			Q	December		
1-H3-2C	U			Q	June		
1-H3-2C	U			Q	March		
1-H3-2C	U			Q	September		
1-H4-11				Q	December		
1-H4-11				Q	June		
1-H4-11				Q	March		
1-H4-11				Q	September		
1-H4-12A				Q	December		
1-H4-12A				Q	June		
1-H4-12A				Q	March		
1-H4-12A				Q	September		
1-H4-12C				Q	December		
1-H4-12C				Q	June		
1-H4-12C				Q	March		
1-H4-12C				Q	September		
1-H4-14	U			Q	December		
1-H4-14	U			Q	June		
1-H4-14	U			Q	March		
1-H4-14	U			Q	September		
1-H4-18				Q	December		
1-H4-18				Q	June		
1-H4-18				Q	March		
1-H4-18				Q	September		
1-H4-3				M	April		
1-H4-3				M	August		
1-H4-3				M	February		
1-H4-3				M	January		
1-H4-3				M	July		
1-H4-3				M	May		
1-H4-3				M	November		
1-H4-3				M	October		

183-H 1994 Well Sampling Schedule (cont'd)

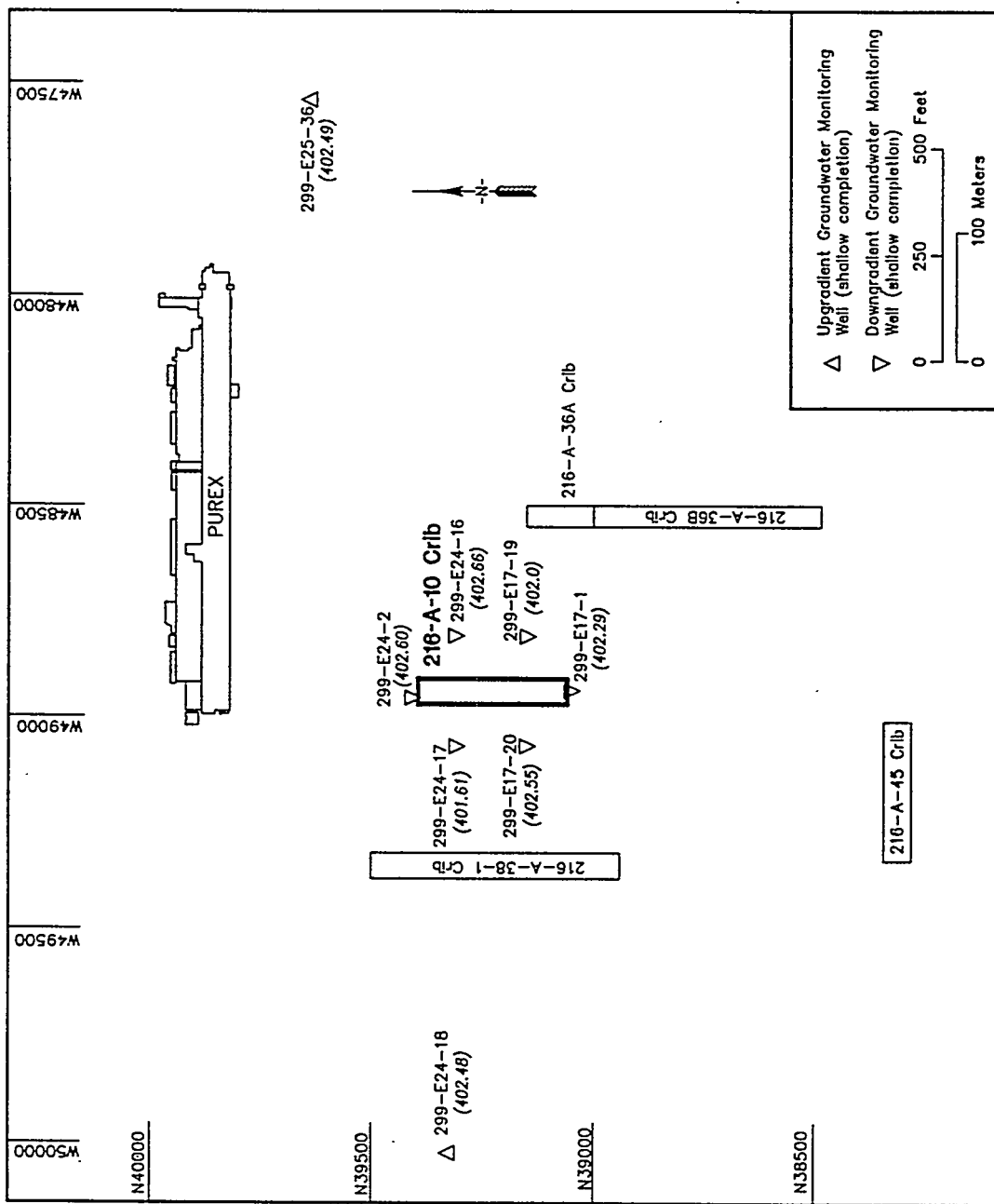
<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
1-H4-3				Q	December		
1-H4-3				Q	June		
1-H4-3				Q	March		
1-H4-3				Q	September		
1-H4-4				M	April		
1-H4-4				M	August		
1-H4-4				M	February		
1-H4-4				M	January		
1-H4-4				M	July		
1-H4-4				M	May		
1-H4-4				M	November		
1-H4-4				M	October		
1-H4-4				Q	December		
1-H4-4				Q	June		
1-H4-4				Q	March		
1-H4-4				Q	September		
1-H4-5				Q	December		
1-H4-5				Q	June		
1-H4-5				Q	March		
1-H4-5				Q	September		
1-H4-6	U			Q	December		
1-H4-6	U			Q	June		
1-H4-6	U			Q	March		
1-H4-6	U			Q	September		
1-H4-7	U			Q	December		
1-H4-7	U			Q	June		
1-H4-7	U			Q	March		
1-H4-7	U			Q	September		
1-H4-8	U			Q	December		
1-H4-8	U			Q	June		
1-H4-8	U			Q	March		
1-H4-8	U			Q	September		
1-H4-9				M	April		
1-H4-9				M	August		
1-H4-9				M	February		
1-H4-9				M	January		
1-H4-9				M	July		

183-H 1994 Well Sampling Schedule (cont'd)

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
1-H4-9				M	May		
1-H4-9				M	November		
1-H4-9				M	October		
1-H4-9				Q	December		
1-H4-9				Q	June		
1-H4-9				Q	March		
1-H4-9				Q	September		

183-H Well Constituent List

<u>List</u>	<u>Group</u>	<u>Filtered</u>	<u>Other W.O.</u>	<u>Change Date</u>
M	Alpha, Beta			
M	Anions			
M	ICP Metals	F		
M	ICP Metals	U		
M	Turbidity			
Q	Alpha, Beta, Uranium			
Q	Anions			
Q	Conductivity-Lab			
Q	ICP Metals	F		
Q	ICP Metals	U		
Q	Technetium-99			
Q	TOC			
Q	TOX (Weston)			
Q	Turbidity			



RCRA-AR\011593-A

Figure IV.A-A.4. RCRA Monitoring Well Locations for the 216-A-10 Crib

216-A-10 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
2-E17-1			Y	A	October		
2-E17-1			Y	SA	April		
2-E17-19			Y	A	October		
2-E17-19			Y	SA	April		
2-E17-20			Y	A	October		A-29
2-E17-20			Y	SA	April		A-29
2-E24-16			Y	A	October		
2-E24-16			Y	SA	April		
2-E24-17			Y	A	October		
2-E24-17			Y	SA	April		
2-E24-18	U		Y	A	October		A-36B
2-E24-18	U		Y	SA	April		A-36B
2-E24-2			Y	A	October		
2-E24-2			Y	SA	April		
2-E25-36	U		Y	A	October		A-29
2-E25-36	U		Y	A	October		A-36B
2-E25-36	U		Y	SA	April		A-29
2-E25-36	U		Y	SA	April		A-36B

216-A-10 Well Constituent List

<u>List</u>	<u>Group</u>	<u>Filtered</u>	<u>Other W. O.</u>	<u>Change Date</u>
A	Alpha, Beta			
A	Anions			
A	Conductivity-Lab			
A	Gamma Scan			
A	ICP Metals	U		
A	Iodine-129			
A	pH-Lab			
A	Phenols			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
SA	Alpha, Beta			
SA	Anions			
SA	Conductivity-Lab			
SA	Gamma Scan			
SA	Iodine-129			
SA	pH-Lab			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			
SA	Turbidity			

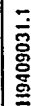


Figure IV.A-A.5. RCRA Monitoring Well Locations for the 216-A-29 Crib

216-A-29 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMO
2-E17-15				Q	December		A-36B
2-E17-15				Q	June		A-36B
2-E17-20				Q	April		A-10
2-E17-20				Q	January		
2-E17-20				Q	July		
2-E17-20				Q	October		A-10
2-E25-11				Q	April		
2-E25-11				Q	January		
2-E25-11				Q	July		
2-E25-11				Q	October		
2-E25-18				Q	April		
2-E25-18				Q	January		
2-E25-18				Q	July		
2-E25-18				Q	October		
2-E25-19				Q	April		
2-E25-19				Q	January		
2-E25-19				Q	July		
2-E25-19				Q	October		
2-E25-20				Q	April		
2-E25-20				Q	January		
2-E25-20				Q	July		
2-E25-20				Q	October		
2-E25-21				Q	April		
2-E25-21				Q	January		
2-E25-21				Q	July		
2-E25-21				Q	October		
2-E25-26		Y		Q1	April		
2-E25-26		Y		Q1	January		
2-E25-26		Y		Q1	July		
2-E25-26		Y		Q1	October		
2-E25-28		Y		Q1	April		
2-E25-28		Y		Q1	January		
2-E25-28		Y		Q1	July		
2-E25-28		Y		Q1	October		
2-E25-31				Q	April		
2-E25-31				Q	January		

216-A-29 1994 Well Sampling Schedule (cont'd)

Well	UP	WMA	Reps	List	Month	Change	COSAMO
2-E25-31				Q	July		
2-E25-31				Q	October		
2-E25-32P	U	Y		Q1	April		
2-E25-32P	U	Y		Q1	January		
2-E25-32P	U	Y		Q1	July		
2-E25-32P	U	Y		Q1	October		
2-E25-34		Y		Q1	April		
2-E25-34		Y		Q1	January		
2-E25-34		Y		Q1	July		
2-E25-34		Y		Q1	October		
2-E25-35		Y		Q1	April		
2-E25-35		Y		Q1	January		
2-E25-35		Y		Q1	July		
2-E25-35		Y		Q1	October		
2-E25-36		Y		Q1	April		A-10
2-E25-36		Y		Q1	April		A-36B
2-E25-36		Y		Q1	January		
2-E25-36		Y		Q1	July		
2-E25-36		Y		Q1	October		A-10
2-E25-36		Y		Q1	October		A-36B
2-E25-42		Y		Q1	April		
2-E25-42		Y		Q1	January		
2-E25-42		Y		Q1	July		
2-E25-42		Y		Q1	October		
2-E25-43		Y		Q1	April		
2-E25-43		Y		Q1	January		
2-E25-43		Y		Q1	July		
2-E25-43		Y		Q1	October		
2-E25-47		Y		Q1	April		
2-E25-47		Y		Q1	January		
2-E25-47		Y		Q1	July		
2-E25-47		Y		Q1	October		
2-E25-48		Y		Q1	April		
2-E25-48		Y		Q1	January		
2-E25-48		Y		Q1	July		
2-E25-48		Y		Q1	October		
2-E26-12		Y		Q1	April		

216-A-29 1994 Well Sampling Schedule (cont'd)

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMO</u>
2-E26-12		Y		Q1	January		
2-E26-12		Y		Q1	July		
2-E26-12		Y		Q1	October		
2-E26-13		Y		Q1	April		
2-E26-13		Y		Q1	January		
2-E26-13		Y		Q1	July		
2-E26-13		Y		Q1	October		
6-43-43	U	Y		Q1	April		B Pond
6-43-43	U	Y		Q1	January		B Pond
6-43-43	U	Y		Q1	July		B Pond
6-43-43	U	Y		Q1	October		B Pond
6-43-45	U	Y		Q1	April		B Pond
6-43-45	U	Y		Q1	January		B Pond
6-43-45	U	Y		Q1	July		B Pond
6-43-45	U	Y		Q1	October		B Pond

216-A-29 Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
Q	Alpha, Beta			
Q	Ammonium			
Q	Anions			
Q	Coliform			
Q	Herbicides, Pesticides, Phenols			
Q	Hydrazine			
Q	ICP, Arsenic, Selenium, Lead	F		
Q	ICP, Arsenic, Selenium, Lead	U		
Q	Mercury	F		
Q	Mercury	U		
Q	Radium			
Q	TOC			
Q	TOX (Weston)			
Q	Tritium			
Q	Turbidity			
Q1	Alpha, Beta			
Q1	Ammonium			
Q1	Anions			
Q1	Coliform			
Q1	Conductivity-Lab			
Q1	Herbicides, Pesticides, Phenols			
Q1	Hydrazine			
Q1	ICP, Arsenic, Selenium, Lead	F		
Q1	ICP, Arsenic, Selenium, Lead	U		
Q1	Mercury	F		
Q1	Mercury	U		
Q1	Radium			
Q1	TOC			
Q1	TOX (Weston)			
Q1	Tritium			
Q1	Turbidity			

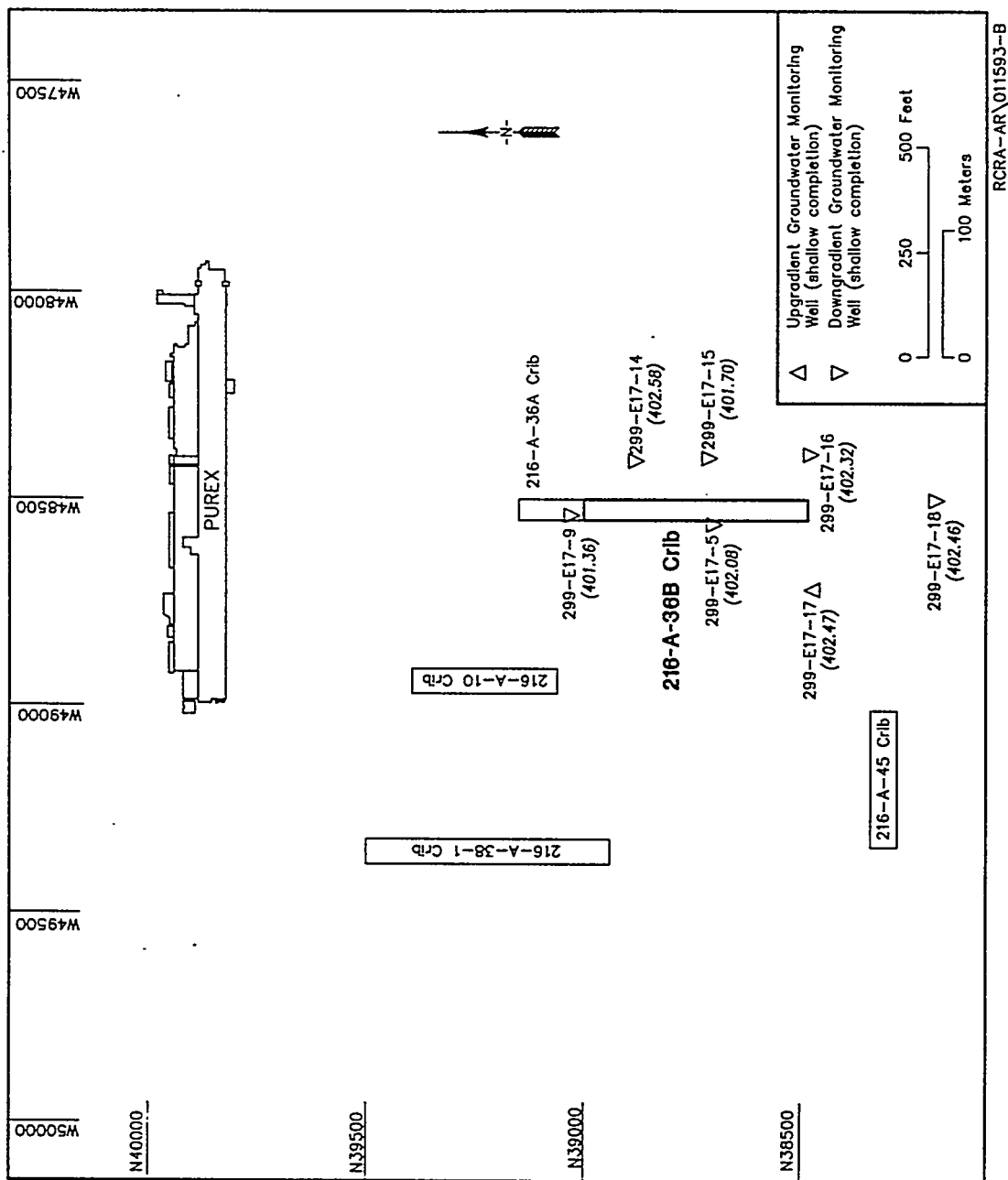


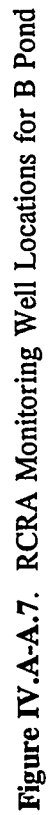
Figure IV.A-A.6. RCRA Monitoring Well Locations for the 216-A-36B Crib

216-A-36B Well 1994 Sampling Schedule

Well		Reps	List	Month	Change	COSAMP
2-E17-14		Y	A	December		
2-E17-14		Y	SA	June		
2-E17-15		Y	A	December		A-29
2-E17-15		Y	SA	June		A-29
2-E17-16		Y	A	December		
2-E17-16		Y	SA	June		
2-E17-17	U	Y	A	December		
2-E17-17	U	Y	SA	June		
2-E17-18		Y	A	December		
2-E17-18		Y	SA	June		
2-E17-5		Y	A	December		
2-E17-5		Y	SA	June		
2-E17-9		Y	A	December		
2-E17-9		Y	SA	June		
2-E24-18	U	Y	A	October		A-10
2-E24-18	U	Y	SA	April		A-10
2-E25-36	U	Y	A	October		A-10
2-E25-36	U	Y	A	October		A-29
2-E25-36	U	Y	SA	April		A-10
2-E25-36	U	Y	SA	April		A-29

216-A-36B Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alpha, Beta			
A	Ammonium			
A	Anions			
A	Conductivity-Lab			
A	Gamma Scan			
A	ICP Metals	U		
A	Iodine-129			
A	pH-Lab			
A	Phenols			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
SA	Alpha, Beta			
SA	Anions			
SA	Conductivity-Lab			
SA	Gamma Scan			
SA	Iodine-129			
SA	pH-Lab			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			
SA	Turbidity			



B Pond 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
2-E18-1	U		Y	Q	December		2101
2-E18-1	U		Y	Q	June		2101
2-E18-1	U		Y	Q1	March		
2-E18-1	U		Y	Q1	September		
2-E32-4	U		Y	Q	April		
2-E32-4	U		Y	Q	October		
2-E32-4	U		Y	Q1	January		
2-E32-4	U		Y	Q1	July		
6-40-39			Y	Q	April		
6-40-39			Y	Q	October		
6-40-39			Y	Q1	January		
6-40-39			Y	Q1	July		
6-40-40A			Y	Q	April		
6-40-40A			Y	Q	October		
6-40-40A			Y	Q1	January		
6-40-40A			Y	Q1	July		
6-40-40B			Y	Q	April		
6-40-40B			Y	Q	October		
6-40-40B			Y	Q1	January		
6-40-40B			Y	Q1	July		
6-41-40			Y	Q	April		
6-41-40			Y	Q	October		
6-41-40			Y	Q1	January		
6-41-40			Y	Q1	July		
6-41-42			Y	Q	April		
6-41-42			Y	Q	October		
6-41-42			Y	Q1	January		
6-41-42			Y	Q1	July		
6-42-39A			Y	Q	April		
6-42-39A			Y	Q	October		
6-42-39A			Y	Q1	January		
6-42-39A			Y	Q1	July		
6-42-39B			Y	Q	April		
6-42-39B			Y	Q	October		
6-42-39B			Y	Q1	January		
6-42-39B			Y	Q1	July		

B Pond 1994 Well Sampling Schedule (cont'd)

Well	UP	WMA	Reps	List	Month	Change	COSAMP
6-42-40A			Y	Q	April		
6-42-40A			Y	Q	October		
6-42-40A			Y	Q1	January		
6-42-40A			Y	Q1	July		
6-42-40C			Y	Q	April		
6-42-40C			Y	Q	October		
6-42-40C			Y	Q1	January		
6-42-40C			Y	Q1	July		
6-42-41			Y	Q	April		
6-42-41			Y	Q	October		
6-42-41			Y	Q1	January		
6-42-41			Y	Q1	July		
6-42-42B			Y	Q	April		
6-42-42B			Y	Q	October		
6-42-42B			Y	Q1	January		
6-42-42B			Y	Q1	July		
6-43-40			Y	Q	April		
6-43-40			Y	Q	October		
6-43-40			Y	Q1	January		
6-43-40			Y	Q1	July		
6-43-41E			Y	Q	April		
6-43-41E			Y	Q	October		
6-43-41E			Y	Q1	January		
6-43-41E			Y	Q1	July		
6-43-41F			Y	Q	April		
6-43-41F			Y	Q	October		
6-43-41F			Y	Q1	January		
6-43-41F			Y	Q1	July		
6-43-41G			Y	Q	April		
6-43-41G			Y	Q	October		
6-43-41G			Y	Q1	January		
6-43-41G			Y	Q1	July		
6-43-42J			Y	Q	April		
6-43-42J			Y	Q	October		
6-43-42J			Y	Q1	January		
6-43-42J			Y	Q1	July		
6-43-43			Y	Q	April		

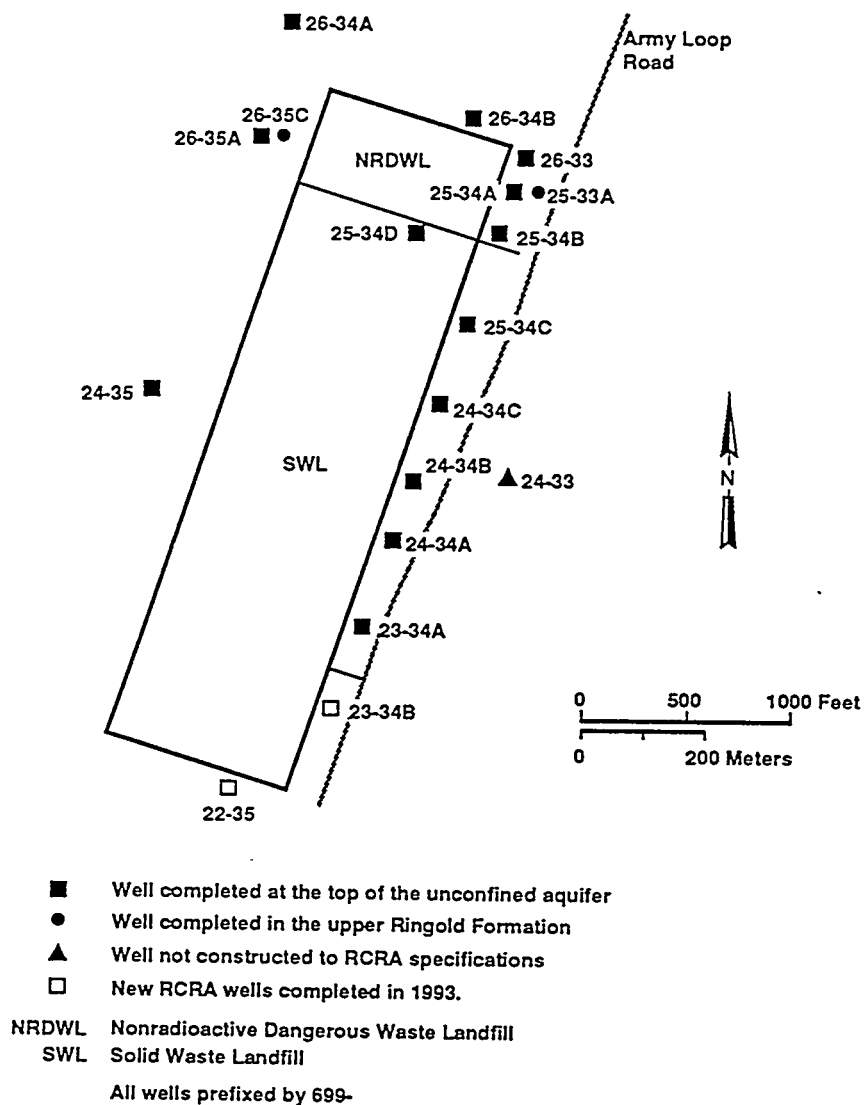
A-29

B Pond 1994 Well Sampling Schedule (cont'd)

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
6-43-43			Y	Q	October		A-29
6-43-43			Y	Q1	January		A-29
6-43-43			Y	Q1	July		A-29
6-43-45			Y	Q	April		A-29
6-43-45			Y	Q	October		A-29
6-43-45			Y	Q1	January		A-29
6-43-45			Y	Q1	July		A-29
6-44-39B			Y	Q	April		
6-44-39B			Y	Q	October		
6-44-39B			Y	Q1	January		
6-44-39B			Y	Q1	July		
6-44-42			Y	Q	April		
6-44-42			Y	Q	October		
6-44-42			Y	Q1	January		
6-44-42			Y	Q1	July		
6-44-43B			Y	Q	April		
6-44-43B			Y	Q	October		
6-44-43B			Y	Q1	January		
6-44-43B			Y	Q1	July		
6-48-77A			Y	Q	April		
6-48-77A			Y	Q	October		
6-48-77A			Y	Q1	January		
6-48-77A			Y	Q1	July		

B Pond Well Constituent List

<u>List</u>	<u>Group</u>	<u>Filtered</u>	<u>Other W. O.</u>	<u>Change Date</u>
Q	Coliform			
Q	pH-Lab			
Q	Semi-VOA			
Q	TOC			
Q	TOX (Weston)			
Q	Tritium			
Q	Turbidity			
Q1	Coliform			
Q1	ICP Metals	F		
Q1	ICP Metals	U		
Q1	pH-Lab			
Q1	Semi-VOA			
Q1	TOC			
Q1	TOX (Weston)			
Q1	Tritium			
Q1	Turbidity			



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Figure IV.A-A.8. RCRA Monitoring Well Locations for the NRDWL

NRDWL 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
6-25-33A			Y	A	February		
6-25-33A			Y	SA	August		
6-25-34A			Y	A	February		
6-25-34A			Y	SA	August		
6-25-34B			Y	A	February		
6-25-34B			Y	SA	August		
6-25-34D			Y	A	February		
6-25-34D			Y	SA	August		
6-26-33			Y	A	February		
6-26-33			Y	SA	August		
6-26-34A	U		Y	A	February		
6-26-34A	U		Y	SA	August		
6-26-34B			Y	A	February		
6-26-34B			Y	SA	August		
6-26-35A	U		Y	A	February		SWL
6-26-35A	U		Y	SA	August		SWL
6-26-35C	U		Y	A	February		
6-26-35C	U		Y	SA	August		

NRDWL Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
A	Alkalinity			
A	Alpha, Beta			
A	Anions			
A	Coliform			
A	Conductivity-Lab			
A	ICP Metals	F		
A	ICP Metals	U		
A	pH-Lab			
A	Phenols			
A	TC			
A	TDS			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	Turbidity			
A	VOA (GC)			
SA	Alkalinity			
SA	Alpha, Beta			
SA	Anions			
SA	Coliform			
SA	Conductivity-Lab			
SA	ICP Metals	F		
SA	pH-Lab			
SA	TC			
SA	TDS			
SA	TOC			
SA	TOX (Weston)			
SA	Tritium			
SA	Turbidity			
SA	VOA (GC)			

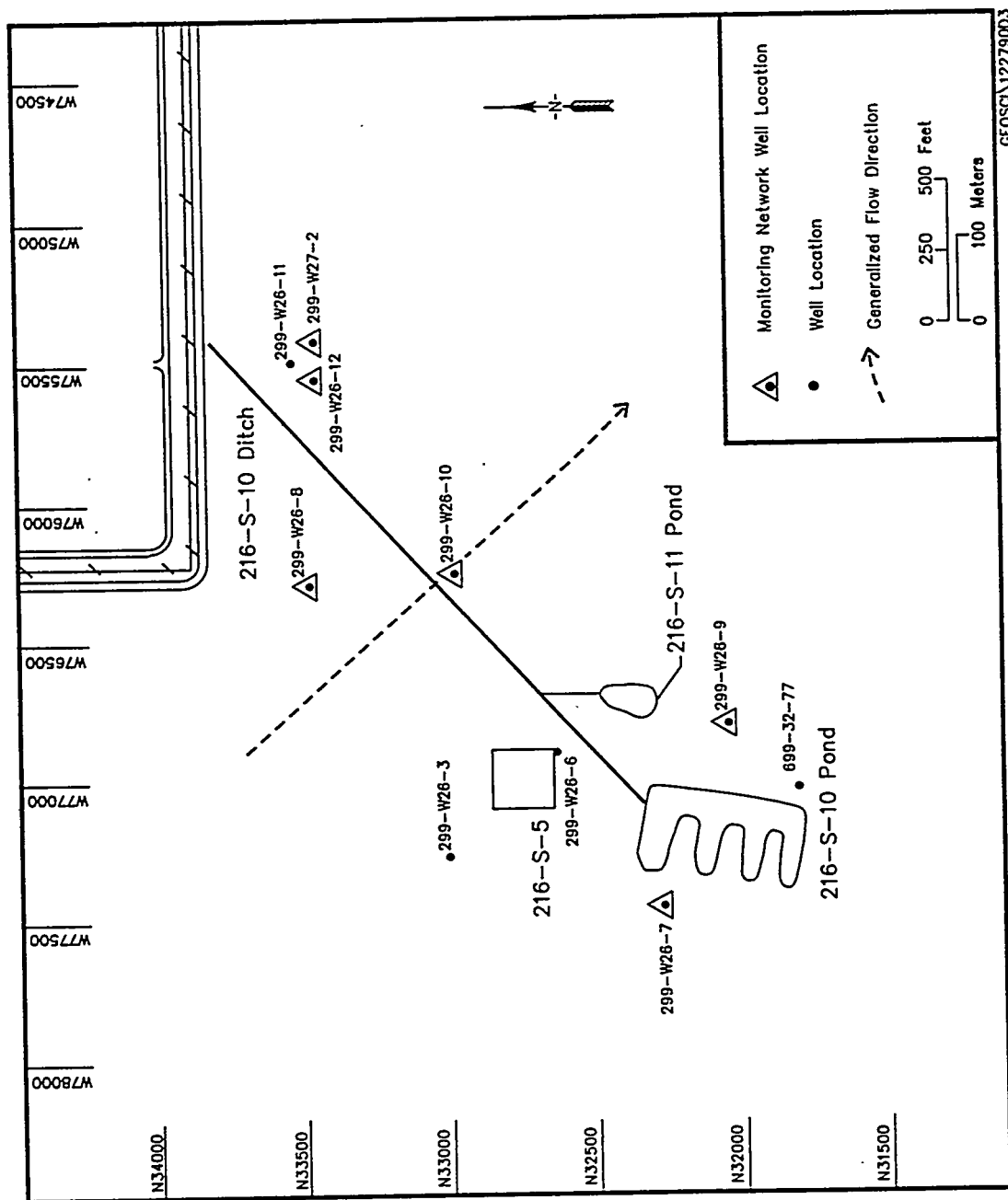


Figure IV.A-A.9. RCRA Monitoring Well Locations for the 216-S-10 Ditch

216-S-10 Ditch 1994 Well Sampling Schedule

<u>Well</u>	<u>UP</u>	<u>WMA</u>	<u>Reps</u>	<u>List</u>	<u>Month</u>	<u>Change</u>	<u>COSAMP</u>
2-W26-10			Y	A	December		
2-W26-10			Y	SA	June		
2-W26-12			Y	A	December		
2-W26-12			Y	SA	June		
2-W26-7	U		Y	A	December		
2-W26-7	U		Y	SA	June		
2-W26-8	U		Y	A	December		
2-W26-8	U		Y	SA	June		
2-W26-9			Y	A	December		
2-W26-9			Y	SA	June		
2-W27-2			Y	A	December		
2-W27-2			Y	SA	June		

216-S-10 Ditch Well Constituent List

<u>List</u>	<u>Group</u>	<u>Filtered</u>	<u>Other W. O.</u>	<u>Change Date</u>
A	Alpha, Beta, Uranium			
A	Anions			
A	Conductivity-Lab			
A	ICP Metals	F		
A	ICP Metals	U		
A	pH-Lab			
A	Phenols			
A	Technetium-99			
A	TOC			
A	TOX (Weston)			
A	Tritium			
A	VOA (GC)			
SA	Alpha, Beta, Uranium			
SA	Conductivity-Lab			
SA	pH-Lab			
SA	TOC			
SA	TOX (Weston)			

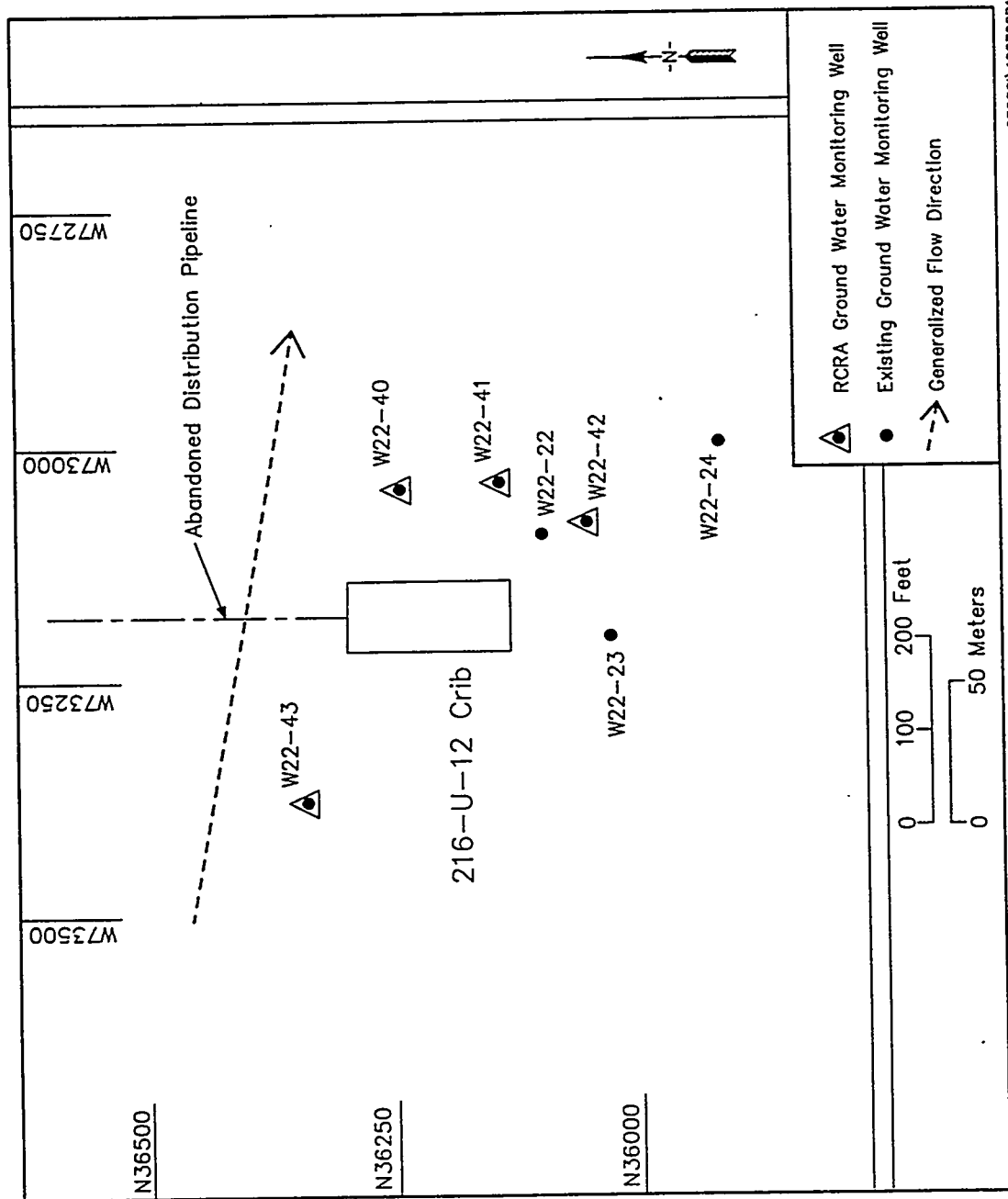


Figure IV.A-A.10. RCRA Monitoring Well Locations for the 216-U-12 Crib

216-U-12 Crib 1994 Well Sampling Schedule

Well	UP	WMA	Reps	List	Month	Change	COSAMP
2-W22-22				Q	December		
2-W22-22				Q	June		
2-W22-22				Q	March		
2-W22-22				Q	September		
2-W22-22			Y	F	April		
2-W22-22			Y	F	August		
2-W22-22			Y	F	February		
2-W22-22			Y	F	January		
2-W22-22			Y	F	July		
2-W22-22			Y	F	May		
2-W22-22			Y	F	November		
2-W22-22			Y	F	October		
2-W22-23	U			Q	December		
2-W22-23	U			Q	June		
2-W22-23	U			Q	March		
2-W22-23	U			Q	September		
2-W22-23	U		Y	F	April		
2-W22-23	U		Y	F	August		
2-W22-23	U		Y	F	February		
2-W22-23	U		Y	F	January		
2-W22-23	U		Y	F	July		
2-W22-23	U		Y	F	May		
2-W22-23	U		Y	F	November		
2-W22-23	U		Y	F	October		
2-W22-40				Q	December		WEST
2-W22-40				Q	June		
2-W22-40				Q	March		
2-W22-40				Q	September		
2-W22-41				Q	December		
2-W22-41				Q	June		
2-W22-41				Q	March		
2-W22-41				Q	September		
2-W22-41			Y	F	April		
2-W22-41			Y	F	August		
2-W22-41			Y	F	February		
2-W22-41			Y	F	January		
2-W22-41			Y	F	July		
2-W22-41			Y	F	May		
2-W22-41			Y	F	November		
2-W22-41			Y	F	October		

216-U-12 Crib 1994 Well Sampling Schedule (cont'd)

Well	UP	WMA	Reps	List	Month	Change	COSAMP
2-W22-42				Q	December		ERDF
2-W22-42				Q	June		ERDF
2-W22-42				Q	March		ERDF
2-W22-42				Q	September		ERDF
2-W22-42			Y	F	April		
2-W22-42			Y	F	August		
2-W22-42			Y	F	February		
2-W22-42			Y	F	January		
2-W22-42			Y	F	July		
2-W22-42			Y	F	May		
2-W22-42			Y	F	November		
2-W22-42			Y	F	October		
2-W22-43	U		Y	F	April		
2-W22-43	U		Y	F	August		
2-W22-43	U		Y	F	February		
2-W22-43	U		Y	F	January		
2-W22-43	U		Y	F	July		
2-W22-43	U		Y	F	May		
2-W22-43	U		Y	F	November		
2-W22-43	U		Y	F	October		
2-W22-43	U		Y	Q	December		
2-W22-43	U		Y	Q	June		
2-W22-43	U		Y	Q	March		
2-W22-43	U		Y	Q	September		
6-36-70A			Y	L	June		ERDF
6-36-70A			Y	Q1	March		ERDF
6-36-70A			Y	Q1	September		ERDF
6-36-70A			Y	Q1	December		ERDF

216-U-12 Crib Well Constituent List

List	Group	Filtered	Other W. O.	Change Date
F	Conductivity-Field			
F	pH-Field			
L	Alpha, Beta			
L	Anions			
L	Coliform			
L	Conductivity-Lab			
L	D&D			
L	Herbicides, Pesticides, Phenols			
L	ICP, Arsenic, Selenium, Thallium	F		
L	ICP, Arsenic, Selenium, Thallium	U		
L	Iodine-129			
L	Mercury	F		
L	Mercury	U		
L	Pesticides, Organic			
L	Radium			
L	Semi-VOA APPX IX			
L	Strontium-90			
L	Sulfide			
L	Technetium-99			
L	TOC			
L	TOX (Weston)			
L	Tritium			
L	Turbidity			
L	U-ISO			
L	VOA (GC/MS) APPX IX			
Q	Alpha, Beta			
Q	Anions			
Q	Conductivity-Lab			
Q	ICP Metals	F		
Q	ICP Metals	U		
Q	Iodine-129			
Q	Strontium-90			
Q	Technetium-99			
Q	TOC			
Q	TOX (Weston)			
Q	Tritium			
Q	Turbidity			
Q	U-ISO			
Q1	Alpha, Beta			

216-U-12 Crib Well Constituent List (cont'd)

List	Group	Filtered	Other W. O.	Change Date
Q1	Anions			
Q1	Coliform			
Q1	Conductivity-Lab			
Q1	Herbicides, Pesticides, Phenols			
Q1	ICP, Arsenic, Selenium, Lead	F		
Q1	ICP, Arsenic, Selenium, Lead	U		
Q1	Iodine-129			
Q1	Mercury	F		
Q1	Mercury	U		
Q1	Radium			
Q1	Strontium-90			
Q1	Technetium-99			
Q1	TOC			
Q1	TOX (Weston)			
Q1	Tritium			
Q1	Turbidity			
Q1	U-ISO			

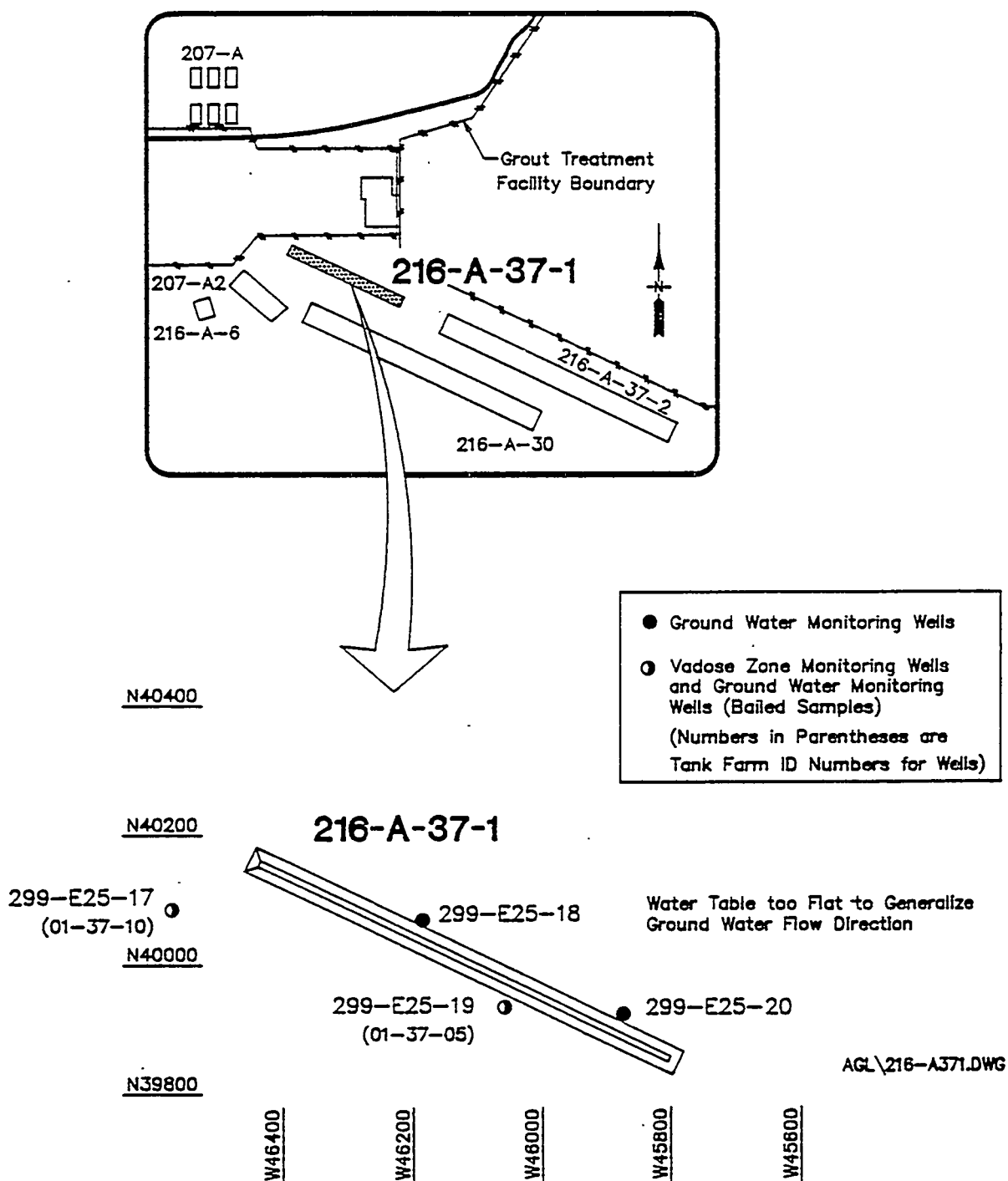


Figure IV.A-A.11. RCRA Monitoring Well Locations for the 216-A-37-1 Crib

Hanford Site Environmental Monitoring Plan

Section IV.A - Appendix B

1100-EM-1 Environmental Restoration Program

Sampling and Analysis Schedule for FY95

Appendix B

1100-EM-1 Environmental Restoration Program
Sampling and Analysis Schedule for FY95

Well	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
699-S31-E8		X			X			Y			X	
699-S30-E10A		X			X			Y			X	
699-S30-E10B		X			X			Y			X	
699-S31-E10A		X			X			Y			X	
699-S31-E10C		X			X			Y			X	
699-S31-E10D		X			X			Y			X	
699-S32-E11		X			X			Y			X	
699-S29-E11		X			X			Y			X	
699-S31-E12		X			X			Y			X	
699-S41-E12		X			X			Y			X	
699-S38-E12A								Y				
699-S37-E11								Y				

"X" list:

Trichloroethylene

1,1,1-trichloroethane

Anions (nitrate, nitrite, phosphate, chloride, fluoride, sulfate)

Ammonia

Metals (barium, calcium, iron, magnesium, manganese, potassium, sodium)

"Y" list:

"X" list analytes

Pesticides/PCBs

Metals (arsenic, antimony, beryllium, cadmium, chromium, copper, lead, mercury, nickel, silver, thallium)

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