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Limited Field Investigation Report for the 100-DR-1 Operable Unit

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EXECUTIVE SUMMARY**BACKGROUND**

This limited field investigation (LFI) report summarizes the data collection and analysis activities conducted during the 100-DR-1 Source Operable Unit LFI and the associated qualitative risk assessment (QRA), and makes recommendations on the continued candidacy of high-priority sites for interim remedial measures (IRM). The results and recommendations presented in this report are generally independent of future land use scenarios. This report is unique in that it is based on Hanford-specific agreements discussed in the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990), the *Hanford Site Baseline Risk Assessment Methodology* (HSBRAM) (DOE-RL 1993b), the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-DR-1 Operable Unit* (DOE-RL 1992a), and the *Hanford Site Past Practice Strategy* (HSPPS) (DOE-RL 1991), described and justified in the *Hanford Federal Facility Agreement and Consent Order Change Package*, dated May 16, 1991 (Ecology et al. 1991), and emphasizes initiating and completing waste site cleanup through interim actions.

A LFI Report is required, in accordance with the HSPPS, when waste sites are to be considered for IRM. The purpose of the report is to identify those sites that are recommended to remain as candidates for IRM, provide a preliminary summary of site characterization studies, refine the conceptual model as needed, identify contaminant- and location-specific applicable or relevant and appropriate requirements (ARAR), and provide a qualitative assessment of the risks associated with the sites. This assessment includes consideration of whether contaminant concentrations pose an unacceptable risk that warrants action through IRM. An IRM is defined by the HSPPS in broad terms and is not restricted to limited- or near-term actions. Interim remedial measures are intended to achieve remedies that are likely to lead to a final Record of Decision (ROD). The final decision to conduct an IRM will rely on many factors including: risk, ARAR, future land use, point of compliance, time of compliance, a bias-for-action, and the threat to human health and the environment.

The unit managers assigned all known and suspected areas of contamination in the 100-DR-1 Operable Unit either a high- or low-priority, as listed in Table ES-1. The classification of sites was based on the collective knowledge of the three parties and information contained in existing work plans. The site classification decisions were made during joint meetings with the three parties and are documented by meeting minutes that are part of the administrative record. Sites classified as high-priority pose risk(s) through one or more pathways sufficient to recommend a streamlined action via an IRM. Low-priority sites do not pose risks sufficient to recommend streamlining.

The 100-DR-1 Operable Unit is one of four operable units associated with the 100 D/DR Area at the Hanford Site. The 100-DR-1, 100-DR-2, and 100-DR-3 Operable Units address contaminant sources while the 100-HR-3 Operable Unit addresses contamination present in the underlying groundwater. The 100-DR-1 Operable Unit

encompasses approximately 1.5 km² (0.59 mi²) and is located immediately adjacent to the Columbia River shoreline. In general, it contains waste facilities associated with the original plant facilities constructed to support D Reactor facilities, as well as cooling water retention basin systems for both D and DR Reactors.

The 100-DR-1 LFI began the investigative phase of the remedial investigation for a select number of high-priority sites. The LFI was performed to provide additional data needed to support selection, design and implementation of IRM, if needed. The LFI included data compilation, non-intrusive investigations, intrusive investigations, summarization of 100 Area aggregate studies, and data evaluation.

INVESTIGATION RESULTS

Two methods of intrusive investigation were used in the LFI: boreholes were drilled and test pits were excavated. Boreholes were surveyed for radiological contamination using downhole geophysical techniques to further delineate the locations and levels of contaminants. Materials removed from the boreholes and test pits were screened in the field for volatile organic compounds and radionuclides, to assist in selection of sample intervals. Samples were submitted for laboratory analysis. Analytical data were validated. All data associated with the LFI were evaluated.

A non-typical method of non-intrusive investigation was used in the LFI at one site (103-D): wipe samples were collected from the floor of the 103-D fuel element storage building. The samples were submitted for laboratory analysis, and the data validated.

Seventeen sites were intrusively investigated: 116-D-1A, 116-D-1B, 116-D-6, 116-D-7, 116-DR-9, 116-DR-1, 116-DR-2, 116-D-2A, 116-D-9, 132-D-3, 116-D-5, 116-DR-5, 116-D-3, 116-D-4, 130-D-1, 108-D, and the sodium dichromate tanks site. Site 120-D-1 was also intrusively investigated, however this site was transferred to the RCRA program and will not be discussed here. Test pits were excavated at 108-D and the sodium dichromate tanks site. Boreholes were drilled and sediments were sampled at the other fifteen intrusively investigated sites. The 116-DR-9 site had three boreholes drilled and sampled.

Radiological contamination is the primary concern as confirmed through this study. The principal radionuclides are: ⁶⁰Co, ⁹⁰Sr, ¹³⁷Cs, ¹⁵²Eu, ¹⁵⁴Eu, ^{239/240}Pu, and ²⁴¹Am. The highest concentrations of radionuclides were found in the 116-DR-9 retention basin. Metals contamination was found at 116-D-1A, 116-D-1B, 116-D-7, 116-DR-9, 116-DR-1, 116-DR-2, 116-D-3, 130-D-1 and the sodium dichromate tanks site. The highest concentrations were from the 116-D-1A site. The maximum concentrations were: cadmium - 1.0 mg/Kg; chromium - 108 mg/Kg; lead - 51.9 mg/Kg; and nickel - 42.0 mg/Kg. None of the metal concentrations detected at any of the sites exceeded a potential soil ARAR, Model Toxics Control Act (MTCA) Method B concentrations. Semi-volatile organic compounds were detected, however, in most cases below the contract required quantitation limits. Volatile organic compounds, while detected, were

generally low in concentration or are likely to be laboratory artifacts. Contamination concentrations and locations determined through the intrusive investigations generally confirm historical information (where available, i.e., not all of the sites were previously investigated) such as documented in Dorian and Richards (1978). If data was available from other analogous facilities, it was evaluated for the applicable sites in the 100-DR-1 Operable Unit. No 100-DR-1 sites showed contamination that would warrant an expedited response action (ERA).

QUALITATIVE RISK ASSESSMENT

A QRA was performed for the high-priority sites. Conservative assumptions, such as highest reported contaminant levels from either the LFI or historical data base were utilized. The QRA provides estimates of human health risks assuming either low-frequency or high-frequency use and includes considerations such as the attenuation of external dose provided by layers of clean gravel fill that overlie many sites. The QRA identifies the major human health risk to be external exposure from the radionuclides ^{60}Co , ^{137}Cs , ^{152}Eu , and ^{154}Eu . The QRA also provides environmental hazard quotient (EHQ) risk estimates for many of the 100-DR-1 high-priority sites.

IRM RECOMMENDATIONS

The 100-DR-1 high-priority sites were evaluated using the following criteria to identify sites recommended to continue as IRM candidates; a detailed discussion of the criteria is provided in Section 5.2 of this report:

- The QRA provides risk estimates for human health and the EHQ ratings. Sites with high or medium risks to human health for the low-frequency use scenario are recommended to continue as IRM candidates. High risk corresponds to an incremental cancer risk (ICR) greater than $1\text{E-}02$. Medium risk corresponds to an ICR between $1\text{E-}04$ and $1\text{E-}02$. Low risk corresponds to an ICR between $1\text{E-}06$ and $1\text{E-}04$. Very low risk corresponds to an ICR of less than $1\text{E-}06$. Sites with an EHQ rating greater than 1 are also recommended to continue as IRM candidates.
- If contaminants at a waste site exceed a chemical-specific ARAR, that site is recommended to continue as an IRM candidate. The Washington State MTCA Method B concentrations are potential ARARs for soil contamination, as discussed in Section 3-26 of this report and in the *100 Area Feasibility Study, Phases 1 and 2* (DOE-RL 1992b). Model Toxics Control Act Method B regulatory limits for soil contaminant concentrations are utilized because they are the standard method and are conservative.
- If LFI results indicate that a site is a current source of groundwater contamination then the site is recommended to continue as an IRM candidate.

- The conceptual model for the waste site includes sources of contamination, types of contaminants, affected media, known and potential routes of migration, known or potential human and environmental receptors, and the general understanding of the waste generation and disposal processes. If the conceptual model of the site is found to be incomplete, collection of data needed to complete the model through limited field sampling is recommended. Sites with incomplete conceptual models are recommended to continue as IRM candidates.
- The potential of the contaminants at a site to be reduced by natural attenuation, e.g., radioactive decay by the year 2018, may be a consideration for sites where the excess risk is caused by external exposure from radionuclides with half lives of less than 30 years. This is not a consideration for sites when multiple exposure pathways drive the risk.

Table ES-2 presents the evaluation of the high-priority waste sites using the above criteria, and the site-specific IRM candidate recommendations. The following sites are recommended to continue as IRM candidates:

- 116-D-1A, 116-D-1B, 116-D-7, 116-DR-9, 116-DR-1, 116-DR-2, 116-D-2A, 116-D-9, 132-D-3, 116-D-5, 116-DR-5, 130-D-1, 126-D-2, 103-D, 115-D, 117-D, Process Effluent Pipelines, and the 107-D/107-DR Sludge Disposal Trenches.

The 116-D-6, 116-D-3, 116-D-4, 108-D, and sodium dichromate tanks site, are recommended to be removed as IRM candidates because human health risks and ecological risks are low, soil contamination does not exceed ARARs, there is no impact to groundwater, and natural attenuation will further reduce site risks. Actions at these sites may be deferred until final remedy selection.

Burial grounds, i.e., sites 4A, 4B, and 18 are recommended as IRM candidates, as per the HSPPS and negotiations with the Tri-Parties.

Table ES-1 100-DR-1 Operable Unit High-Priority Sites and Low-Priority Sites

High-Priority Sites	Low-Priority Sites
116-D-1A Trench*	Waste Acid Reservoir
116-D-1B Trench*	Septic Tanks
116-D-6 French Drain	Septic Tank Tile Field
116-D-7 Retention Basin*	Fuel Oil Tank Pipeline
116-DR-9 Process Effluent Retention Basin	Fuel Oil Tank
116-DR-1 Trench*	Fuel Oil Tank
116-DR-2 Trench*	126-D-1 Ash Disposal Basin
116-D-2A Pluto Crib	Salt Dissolving Pit
116-D-9 Reactor Confinement Seal Pit Crib	Electrical Facilities
132-D-3 Effluent Pumping Station	1714-D Solvent Storage
116-D-5 Outfall Structure*	1715-D Oil and Paint Storage
116-DR-5 Outfall Structure*	1716-D Gas Station
116-D-3 Crib*	1722 Equipment Development
116-D-4 Crib*	1724-D2A Underwater Test Facility
130-D-1 Underground Storage Tank	183-D Filter Plant
108-D Demolished Office Building	185-D Thermal Hydraulics Lab
Sodium Dichromate Tanks	
103-D Fuel Element Storage Building	
126-D-2 Solid Waste Landfill	
4A, 4B, 18 Burial Grounds	
115-D Demolished Gas Recirculation Building	
117-D Demolished Exhaust Air Filter Building	
Process Effluent Pipelines	
107-D/107-DR Sludge Disposal Trenches (5)	

* = Additional data from analogous sites

Table ES-2 IRM Recommendations for 100-DR-1 High-Priority Sites

Waste Site	Qualitative Risk Assessment		Conceptual Model	Exceeds ARARs	Probable Current Impact on Groundwater	Potential for Natural Attenuation by 2018	IRM Candidate yes/no
	Low-frequency scenario	EHQ > 1					
116-D-1A	medium	no	adequate	no	yes	yes	yes
116-D-1B	medium	no	adequate	no	yes	yes	yes
116-D-6	low	no	adequate	no	no	yes	no
116-D-7	high	yes	adequate	no	yes	no	yes
116-DR-9	high	yes	adequate	no	yes	no	yes
116-DR-1	medium	no	adequate	no	yes	yes	yes
116-DR-2	medium	no	adequate	no	yes	yes	yes
116-D-2A	low	no	adequate	no	yes	yes	yes
116-D-9	medium	-	adequate	no	yes	yes	yes
132-D-3	low	-	adequate	no	no	yes	yes
116-D-5	medium	no	adequate	no	no	yes	yes
116-DR-5	medium	-	adequate	no	no	yes	yes
116-D-3	very low	no	adequate	no	no	yes	no
116-D-4	very low	no	adequate	no	no	yes	no
130-D-1	low	no	incomplete*	no	no	yes	yes
108-D	low	no	adequate	no	no	yes	no
Sodium Dichromate Tanks	low	no	adequate	no	no	yes	no
103-D	low	-	incomplete*	no	no	yes	yes
126-D-2	medium	-	incomplete*	unknown	no	yes	yes
115-D	low	-	adequate	unknown	no	unknown	yes
117-D	low	-	adequate	unknown	no	unknown	yes
Process Effluent Pipelines	medium	-	adequate	unknown	yes	unknown	yes
107-D	high	no	adequate	unknown	yes	no	yes
107-DR	high	yes	adequate	unknown	yes	no	yes
4A, 4B, and 18 Burial Grounds							yes
<p>EHQ = Environmental Hazard Quotient calculated by the qualitative ecological risk assessment - = Not rated by the qualitative ecological risk assessment * = Data needed concerning nature and vertical extent of contamination, site remains an IRM candidate until data are available. ARAR = Applicable or Relevant and Appropriate Regulation, specifically the Washington state Model Toxics Control Act Method B concentration values for soils</p>							

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ACRONYMS

ARAR	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CLP	Contract Laboratory Program
CRDL	contract required detection limit
CRQL	contract required quantitation limit
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EHQ	Environmental Hazard Quotient
EII	Environmental Investigation Instruction
EPA	U.S. Environmental Protection Agency
ERA	Expedited Response Action
GPR	ground penetrating radar
HCRL	Hanford Cultural Resources Laboratory
HEIS	Hanford Environmental Information System
HPGe	high purity germanium
HPT	Health Physics Technician
HSBRAM	Hanford Site Baseline Risk Assessment Methodology
HQ	Hazard Quotient
HSPPS	Hanford Site Past Practice Strategy
ICR	Incremental Cancer Risk
IRM	Interim Remedial Measure
LFI	Limited Field Investigation
LOEL	Lowest Observable Effect Level
MTCA	Model Toxics Control Act
NHPA	National Historic Preservation Act
NOEL	no observable effect level
OVM	organic vapor monitor
PCB	polychlorinated biphenyl
QC	Quality Control
QRA	Qualitative Risk Assessment
RCRA	Resource Conservation and Recovery Act
RFI/CMS	RCRA Facility Investigation/Corrective Measures Study
RI/FS	Remedial Investigation/Feasibility Study
RLS	Radiation Logging System
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
TAL	Target Analyte List
TCL	Target Compound List
UTL	Upper Threshold Limit
VOC	volatile organic compound
WAC	Washington Administrative Code
WHC	Westinghouse Hanford Company

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1.0 INTRODUCTION

This Limited Field Investigation (LFI) Report summarizes the data collection and analysis activities conducted during the 100-DR-1 Source Operable Unit LFI and the *Qualitative Risk Assessment of the 100-DR-1 Source Operable Unit*, (WHC 1993a). A LFI report is required, in terms of the *Hanford Site Past Practice Strategy* (HSPPS) (DOE-RL 1991), when waste sites are to be considered for interim action as interim remedial measures (IRM). The purpose of the report is to identify those sites that are recommended to remain as candidates for IRMs, provide a preliminary summary of site characterization studies, refine the conceptual model as needed, identify contaminant- and location-specific applicable or relevant and appropriate requirements (ARARs), and provide a qualitative assessment of the risks associated with the sites. This assessment includes a consideration of whether contaminant concentrations pose an unacceptable risk that warrants action through interim remedial measures. These objectives are described fully in the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-DR-1 Operable Unit* (DOE-RL 1992a).

The work plan (DOE-RL 1992a) divides the site characterization activities into 12 tasks. These are subjects of the LFI summary of characterization studies. Table 1-1 lists the 12 characterization tasks and how each is addressed in the LFI report.

In order to limit the size of the report and improve its readability, reliance is placed on the referral to other documents for specific details. This document is unique in that it is based on Hanford-specific agreements discussed in the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990), the HSPPS, the *Hanford Site Baseline Risk Assessment Methodology* (HSBRAM) (DOE-RL 1993b), and the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-DR-1 Operable Unit* (DOE-RL 1992a) and must be viewed in that context. An IRM, for example is defined in broad terms and is not restricted to limited or near term actions. It allows for interim action with the final goal of achieving final action levels. Indeed, an IRM may not be decided upon, if it is likely not to lead to a final Record of Decision (ROD). A qualitative risk assessment (QRA) is used only to assess risk for an IRM determination and is not intended to define current risk or baseline risk in a traditional sense. The final decision to conduct an IRM will rely on many factors including the QRA, ARAR, future land use, point of compliance, time of compliance, a bias-for-action, and the threat to human health and the environment including the threat to groundwater.

1.1 SITE BACKGROUND

The 100-DR-1 Operable Unit is one of four operable units associated with the 100 D/DR Area at the Hanford Site. The 100-DR-1, 100-DR-2 and 100-DR-3 Operable Units are source operable units. The fourth operable unit, 100-HR-3, is the groundwater operable unit.

The 100-DR-1 Operable Unit is located immediately adjacent to the Columbia River shoreline. In general, it contains waste units associated with the original plant facilities constructed to support D Reactor operation, as well as the cooling water retention basin systems for both D and DR Reactors. Figure 1-1 shows the approximate boundaries of the 100-DR-1 Operable Unit as defined by the waste units it includes, and its location with respect to the other operable units. The 100-DR-1 Operable Unit encompasses approximately 1.5 km² (0.59 mi²). It lies predominantly within the southeast quadrant of Section 15 and the southwest quadrant of Section 14 of T.14N, R.26E, and is located within latitude 46°41'30" and 46°42'30" and longitude 119°31'45" and 119°33'00". Figure 1-2 shows the layout of the 100-DR-1 Operable Unit.

The 100 D/DR Area contains two reactors: the D Reactor associated with the 100-DR-1 Source Operable Unit and the DR Reactor associated with the 100-DR-2 Source Operable unit. The D Reactor, operated from 1944 to 1967, when it was retired. Currently, sanitary and fire-protection water is provided to the 100 H and 100 F Areas from the 100 D Area. The water system is also a backup for systems from the 100-B Area that supply the 200 Areas.

The 100-HR-3 Groundwater Operable Unit is described in the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-HR-3 Operable Unit* (DOE/RL 1992). Groundwater in the 100 D/DR Area flows in a north/northwest direction toward the Columbia River. The depth to groundwater ranges from 74.4 feet south of the DR Reactor (Well 199-D2-5) to 55.8 feet near the river (Well 199-D8-53). The 100-HR-3 investigation identified Cr, ⁹⁰Sr, ³H, and nitrates as contaminants in the groundwater below the 100-DR-1 Operable Unit. Because groundwater contamination has the potential to migrate to the Columbia River, the potential impact to groundwater contamination by the source operable unit waste sites is an important consideration when recommending IRMs.

1.2 THE HANFORD SITE PAST-PRACTICE STRATEGY AND THE 100-DR-1 LFI

The signatories to the Tri-Party Agreement (Ecology et al. 1990), i.e., the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Washington Department of Ecology (Ecology), recognized the need for a new strategy of Resource Conservation Recovery Act/Comprehensive Environmental Response Compensation and Liability Act (RCRA/CERCLA) integration to provide greater uniformity in the applicability of requirements to the Hanford Site. Additionally, the signatories agreed that proceeding with the traditional CERCLA approach would likely require too much time and too large a portion of a limited budget before actual cleanup would occur. Another motivation for a new strategy was the need to coordinate past-practice investigations with RCRA closure activities since some operable units contain RCRA treatment, storage, and disposal facilities. This new strategy, the HSPPS, is described and justified in *The Hanford Federal Facility Agreement and Consent Order Change Package*, dated May 16, 1991 (Ecology et al. 1991).

In response to the above concerns, the three parties have decided to manage and implement all past-practice investigations under one characterization and remediation strategy, regardless of the regulatory agency lead (as defined in the Tri-Party Agreement). In order to enhance the efficiency of ongoing remedial investigation/feasibility study (RI/FS) and RCRA facility investigation/corrective measures study (RFI/CMS) activities at the 100 Area of the Hanford Site, and to expedite the ultimate goal of cleanup, more emphasis will be placed on initiating and completing waste site cleanup through interim actions.

This strategy streamlines the past-practice remedial action process and provides new concepts for:

- Accelerating decision-making by maximizing the use of existing data consistent with data quality objectives
- Undertaking expedited response actions (ERA) and/or IRMs, as appropriate, to either remove threats to human health and welfare and the environment, or to reduce risk by reducing toxicity, mobility, or volume of contaminants.

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

Figure 1-3 is a decision flow chart that shows the HSPPS process. The strategy includes three paths for interim decision-making and a final remedy-selection process for the operable unit that incorporates the three paths and integrates sites not addressed in those paths. An important element of this strategy is the application of the observational approach, in which characterization data are collected concurrently with cleanup.

As shown on Figure 1-3, the three paths for interim decision-making are:

- Expedited response action path, where an existing or near-term unacceptable health or environmental risk from a site is determined or suspected, and a rapid response is necessary to mitigate the problem.
- Interim remedial measure path, where existing data are sufficient to formulate a conceptual model and perform a QRA. If a decision is made to proceed with an IRM, the process will advance to select an IRM remedy, and may include a focused FS, if needed, to select a remedy.

- Limited field investigation path, where a LFI can provide sufficient data to formulate a conceptual model and perform a QRA. The data can be obtained in a less formal manner than that needed to support the operable unit ROD; however, regardless of the scope of the LFI, it is part of the RI process, and not a substitute for it.

The near-term past-practice strategy for the 100 Area provides for ERAs, IRMs, and LFIs for individual waste sites, grouped waste sites, and contaminated groundwater. The LFI is an integral part of the RI/FS process and functions as a focused RI for selection of IRMs. The information obtained from the LFIs and interim actions may be sufficient to perform the baseline risk assessment, and to select the remedy for the operable unit. If the data are not sufficient, additional investigations and studies will be performed to the extent necessary to support the operable unit remedy selection. These investigations would be performed within the framework and process defined for RI/FS programs.

Implementation of the HSPPS at the 100-DR-1 Operable Unit began with the development of Revision 0 of the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-DR-1 Operable Unit* (DOE-RL 1992a). As noted in Section 4.2.1 of the work plan the three parties assigned all known and suspected areas of contamination either a high- or low-priority, as listed in Table 1-2. The classification of sites was based on the collective knowledge of the three parties and information contained in existing work plans. The site classification decisions were made during joint meetings with the three parties and are documented by meeting minutes that are part of the administrative record. Sites classified as high-priority were thought to pose a risk(s) through one or more pathways sufficient to recommend streamlined action via an IRM. Low-priority sites were thought to not pose risks sufficient to recommend streamlining. The three parties agreed that:

- None of the high-priority sites pose risks that would require an ERA.
- Limited field sampling was sufficient for those high-priority sites where data are deemed insufficient to formulate the conceptual model and support the QRA.
- Investigative activities for the low-priority sites would be deferred to the final RI.
- Certain activities would be more efficient to implement at the 100 Area aggregate or Hanford Site scale instead of the operable unit scale.

The LFI and QRA are part of the 100-DR-1 RFI/CMS, as described by the work plan (DOE-RL 1992a). The work plan includes the following topics that are directly applicable to the 100-DR-1 LFI:

- operable unit site description (Section 2.1)
- physical setting (Section 2.2)

- operable unit conceptual model (Chapter 3.0)
- data quality objectives (Section 4.1.1)
- data needs (Section 4.1.2)
- 100-DR-1 Operable Unit sampling and analysis approach (Section 4.2.2)
- limited field investigations (Section 5.1.1)
- 100 Area aggregate studies and Hanford Site studies (Section 5.1.1).

The conceptual model for the 100-DR-1 Operable Unit was developed during the RFI scoping process. The conceptual model is presented in Chapter 3 of the work plan (Section 4.1.1) (DOE-RL 1992a). The conceptual model addresses the following:

- structure and process of the waste sites
- source of contaminants
- type of contaminants
- nature and potential routes of migration
- known and potential human and environmental receptors.

This conceptual model has been updated with data acquired through the LFI, and is presented in Chapter 5 of this report.

The 100-DR-1 LFI began the investigative phase of the RFI for a select number of high-priority sites. The LFI included data compilation, non-intrusive investigations, intrusive investigations, evaluations of information from 100 Area aggregate studies, and data evaluation.

1.3 HISTORICAL DATA

An integral part of the RFI/CMS process for the 100-DR-1 Operable Unit has been the acquisition, evaluation, and utilization of records pertaining to the construction, operation, and decontamination/decommissioning of the reactor and related 100 D/DR facilities. This information is categorized as "historical information," and includes operations records and reports, engineering drawings, photographs, interviews with former or retired operations personnel, and data from sampling and analysis of facilities and the local environment.

A primary reference for radiological characterization of the 100-DR-1 Operable Unit sources is a study of the 100 Area performed during 1975/1976 by Dorian and Richards (1978). In the 100-DR-1 Operable Unit area Dorian and Richards (1978) collected samples from the retention basins, liquid waste disposal trenches, outfall structures, and the miscellaneous trenches, cribs, and french drains located near the D Reactor. The samples were analyzed for radionuclides. Inventories of radionuclides for the facilities and sites were calculated. Results from Dorian and Richards (1978) were a major resource used in the development of the 100-DR-1 conceptual model and LFI data needs. It should be noted, however, that only concentrations and inventories of selected radionuclides were reported in the study.

1.4 100 AREA AGGREGATE STUDIES

The 100 Area aggregate studies and Hanford Site studies provide integrated analysis of selected issues on a larger scale than the operable unit, such as the Hanford Site background study. The 100-HR-3 work plan (DOE-RL 1992c) addresses activities common to the 100 Area such as a river impact study, a shoreline study, an ecological study, and a cultural resource study. These studies provide data to be used in the LFI and in the selection of final remedies. Results of the Hanford Site background study, the 100 Area ecological study, and the cultural resource study that are applicable to the 100-DR-1 LFI are summarized below.

1.4.1 Hanford Site Background

Results of the characterization of the natural chemical composition of Hanford Site soil samples is presented in *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analyses* (DOE-RL 1993a). This characterization is based on the chemical analysis of inorganic constituents from more than 200 samples. The characterization included analysis of physical properties and factors that might affect the natural soil chemical composition, as determined by regulatory protocols. Hanford Site soils have not been characterized sufficiently to establish the natural concentrations of the following types of constituents: volatile organic compounds (VOC), semi-volatile organic compounds (semi-vols), pesticides and polychlorinated biphenyls (PCB), and radionuclides.

Table 1-3 presents the 95th percentile of the data for a lognormal distribution, and the 95% confidence limit of the 95th percentile of the data distribution for inorganic analyses of Hanford Site soils (DOE-RL 1993a). The 95% confidence limit of the 95th percentile of the data distributions, abbreviated as the 95% upper threshold limit (95% UTL), is identified by the Washington Administrative Code (WAC), Model Toxics Control Act (MTCA) (WAC 173-340-706 [ld]) as one way to define threshold levels. The 95% UTL values for inorganic constituents have been utilized in the 100-DR-1 QRA (WHC 1993a) to establish site potential contaminants of concern. An inorganic constituent at a site is considered a contaminant if the reported concentration exceeds the 95% UTL values. Because site-wide background levels for organic and radionuclide constituents have not been established (DOE-RL 1993a) all detected concentrations of these constituents were considered in the QRA as potential contaminants of concern.

1.4.2 Ecological Analysis

The 100 Area operable units, which cover a total of 1,834 hectare (ha) (18.3 km²) are topographically and environmentally similar. Each is situated along the Columbia River bank, with the reactor located on a high gravel terrace left by the recession of glacial floodwaters at the end of the Pleistocene Epoch. Shoreline areas grade from steep banks with narrow cobble beaches to broad, stepped, well-defined terraces with gently sloping beaches. The floodplain terraces consist of sand deposited during the

Holocene Epoch and occur on at least two levels, one dating to the early or middle Holocene and another representing the later Holocene. Inland areas are broad flats broken only by stabilized dunes. The area from west of the 100 N Area to the western edge of the 100 D Area differs from this general pattern. In that vicinity are large, rounded gravel mounds, termed berg mounds, formed when ice blocks rafted downstream during catastrophic Pleistocene floods, deposited their sediment loads.

Vegetation on all sites is dominated by cheatgrass (*Bromus tectorum*), with scattered big sagebrush (*Artemisia tridentata*), tumble mustard (*Systembrium spp.*), thistle (*Salsola kali*), rabbit brush (*Chrysothamnus spp.*), and needle and thread grass (*stipa comata*). Small groves of deciduous trees and shrubs, usually black locust (*Robina pseudo-acacia*), willow (*Salix spp.*), and mulberry (*Morus spp.*) grow along the river bank at the site of early twentieth-century homesteads.

Ecological surveys and sampling have been conducted in the 100 Areas and in and around the Columbia River adjacent to the 100 Areas. Sampling included plants with either a past history of documented contaminant uptake or an important position in the food web, such as river algae, reed canary grass, tree leaves, and asparagus. In addition, samples were collected of caddisfly larvae (next step in the food chain from algae), and coyote scat, to determine possible contamination of the upper food chain. The results of these sample analyses are being compiled and will be printed as separate documents. Other sampling results by site-wide surveillance and facility monitoring programs will be used in the evaluation of ecological contamination. The analyses has found contamination only in two trees at the 100 K Area, with 35 and 6.5 pCi/g ⁹⁰Sr. While this level is not of great concern, additional samples have been taken at this site to further evaluate their significance.

In addition, bird, mammal, and plant surveys were conducted and reported in Sackschewsky and Landeen (1992). Current contamination data has been compiled from other sources, along with ecological pathways and lists of all wildlife and plants at the site, including threatened and endangered species. This information has been published in Weiss and Mitchell (1992).

1.4.3 Cultural Resources Review

In compliance with Section 106 of the National Historic Preservation Act (NHPA), and at the request of Westinghouse Hanford Company, the Hanford Cultural Resources Laboratory (HCRL) conducted an archaeological survey during Fiscal Year 1991 of the 100 Area reactor compounds on the U.S. Department of Energy's Hanford Site. This survey was conducted as part of a comprehensive cultural resources review of the 100 Area CERCLA operable units in support of CERCLA characterization activities. The work included a literature and records review and pedestrian survey of the project area following procedures set forth in the Hanford Cultural Resources Management Plan (PNL-1989).

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The 100 D Area consists of approximately 350 ha, nearly half (169 ha) of which was surveyed. This operable unit covers four terrace levels, two of Pleistocene age and two attributable to the Holocene. The uppermost surface is nearly level, with elevations ranging from 142 m to 144 m above sea level. In the northeast corner of the operable unit, this terrace slopes at a gradient of 30:1 to the second level, the elevation of which is from 137 m to 134 m. Berg mounds occur in the extreme western edge of the upper terrace. The lower Pleistocene terrace lacks such features. Both Pleistocene terraces consist of gravel overlain intermittently or occasionally by eolian sand. At the northeastern corner, along the northern edge of the second Pleistocene terrace, a slope with a gradient of 10:1, goes down to the older of two Holocene terraces, which has an upper elevation of 127.5 m. Along the center of the northwestern edge of the operable unit is a lower, therefore younger Holocene terrace. In this area the upper Pleistocene terrace ends at a 5:2 slope, below which the younger terrace occurs at an elevation of 120 m. This elliptical cobble and coarse sand surface is 500 m long by 75 m wide.

Six prehistoric archeological sites were located within the 100 D Area. Three sites (45BN442, 45BN443, and 45BN444) are cairns, sites 45BN439 and 45BN459 date from the Frenchman Springs Phase, and site 45BN416 is of indeterminate age at this time.

Three of the sites are located on the high terraces occupied by the reactor facilities. Native American sites 45BN442, 45BN443 and 45BN459 are at a higher risk of impact during CERCLA characterization studies. Also at high risk is site 45BN439 because it lies adjacent to or is intersected by radiation zones along the river floodplain.

Evaluation of the significance of all sites discovered in fiscal year 1991 is ongoing. The DOE is currently considering negotiating a programmatic agreement with the Washington State Historic Preservation Office, the Advisory Council for Historic Preservation, and affected native american tribes to aid in the mitigation of effects from CERCLA operable units. All excavation work and road building associated with CERCLA characterization of the 100 Areas will be reviewed by HRCL and DOE personnel and plans will be adjusted by Westinghouse Hanford Company (WHC) to avoid impacts to cultural resources whenever possible.

Figure 1-1. 100-DR-1 Operable Unit

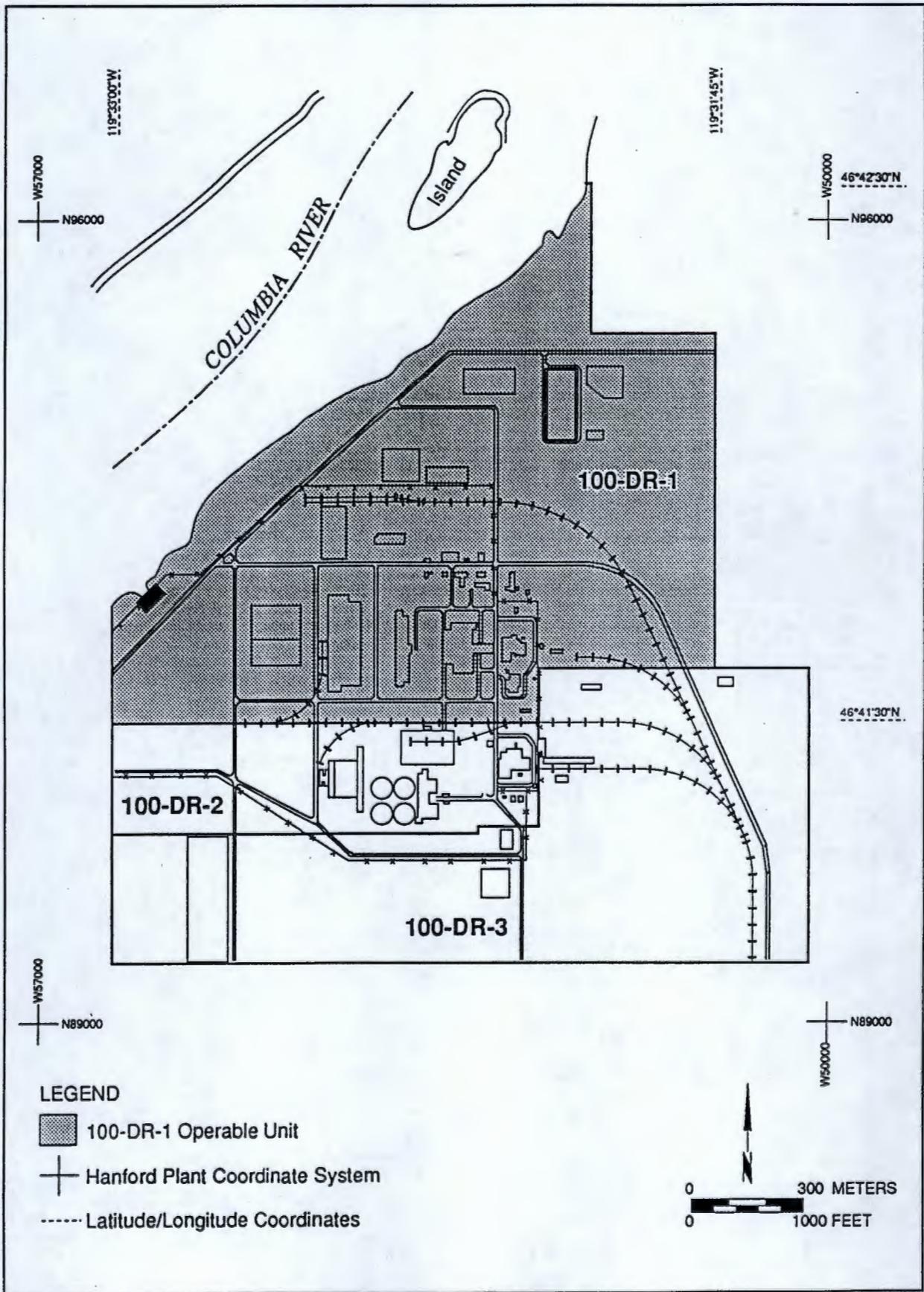
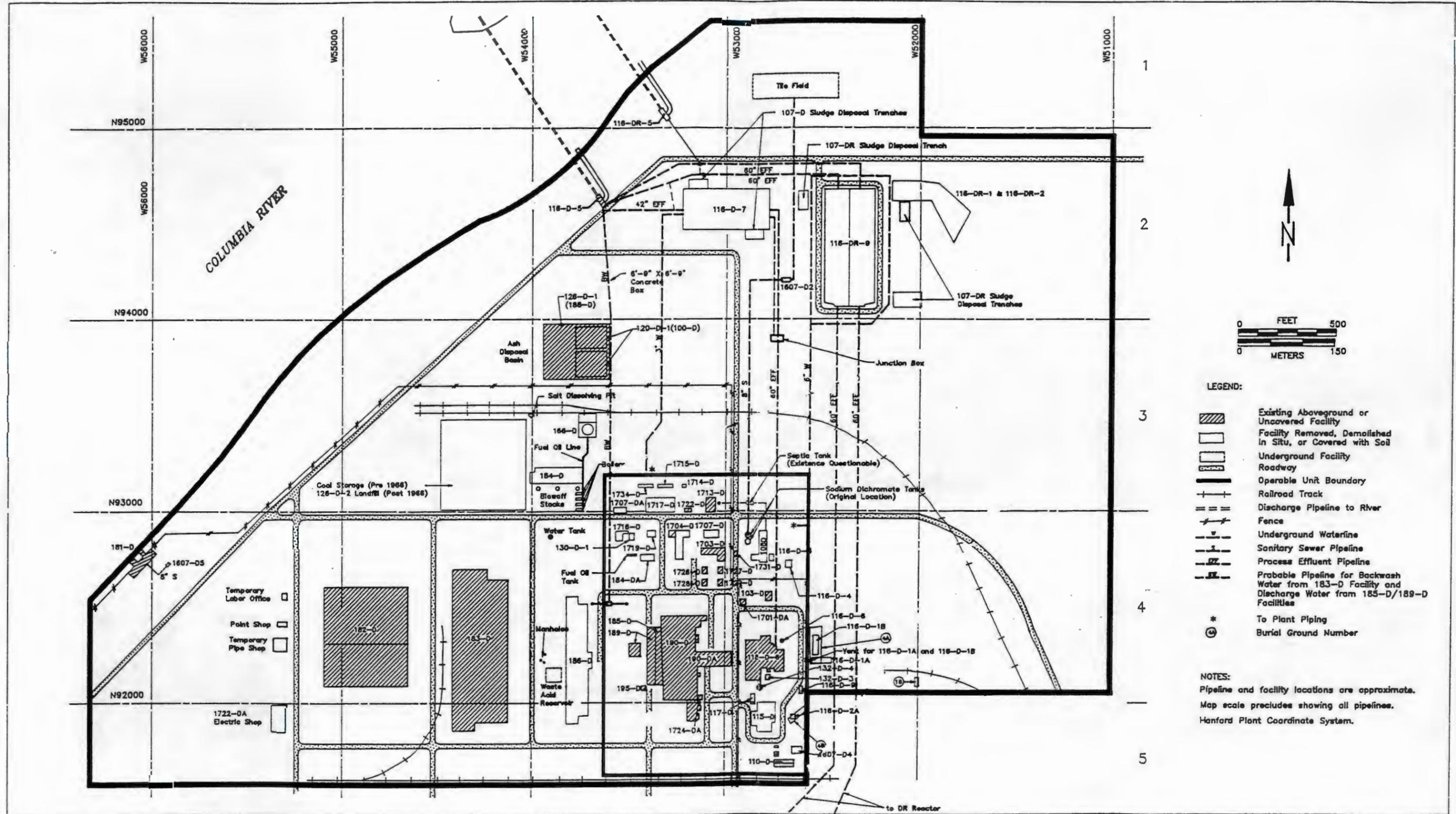


Figure 1-2 Layout of the 100-DR-1 Operable Unit



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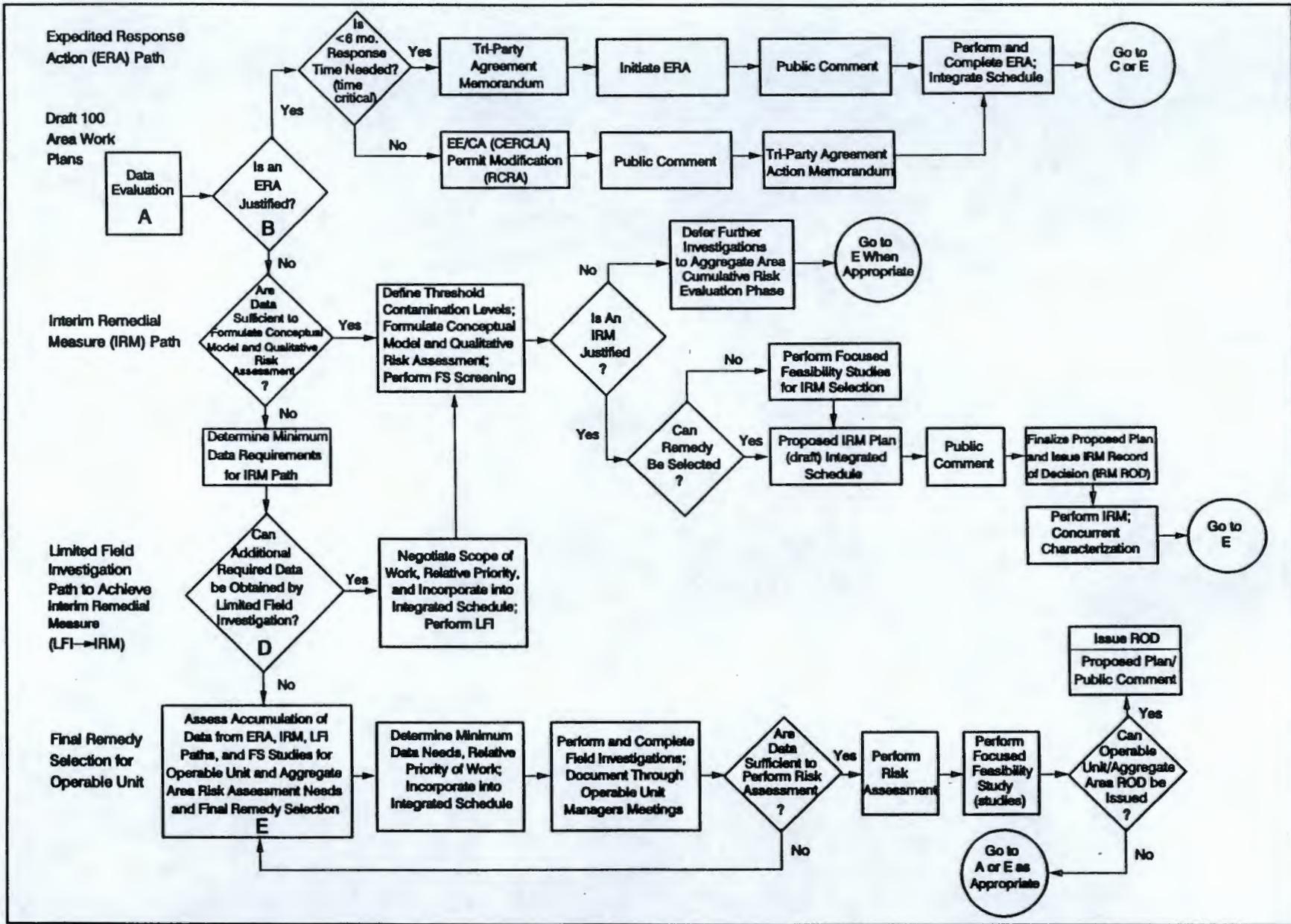
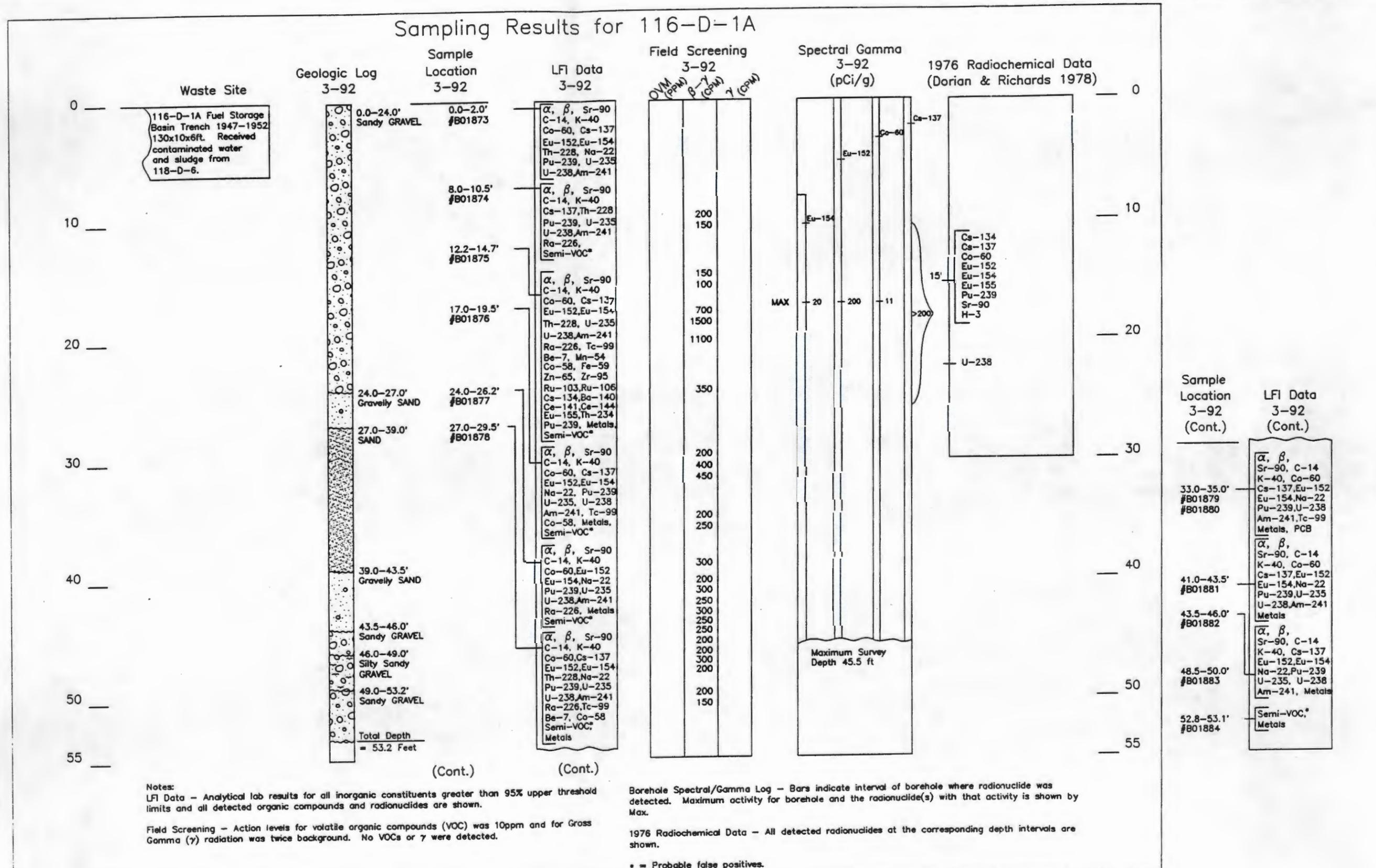
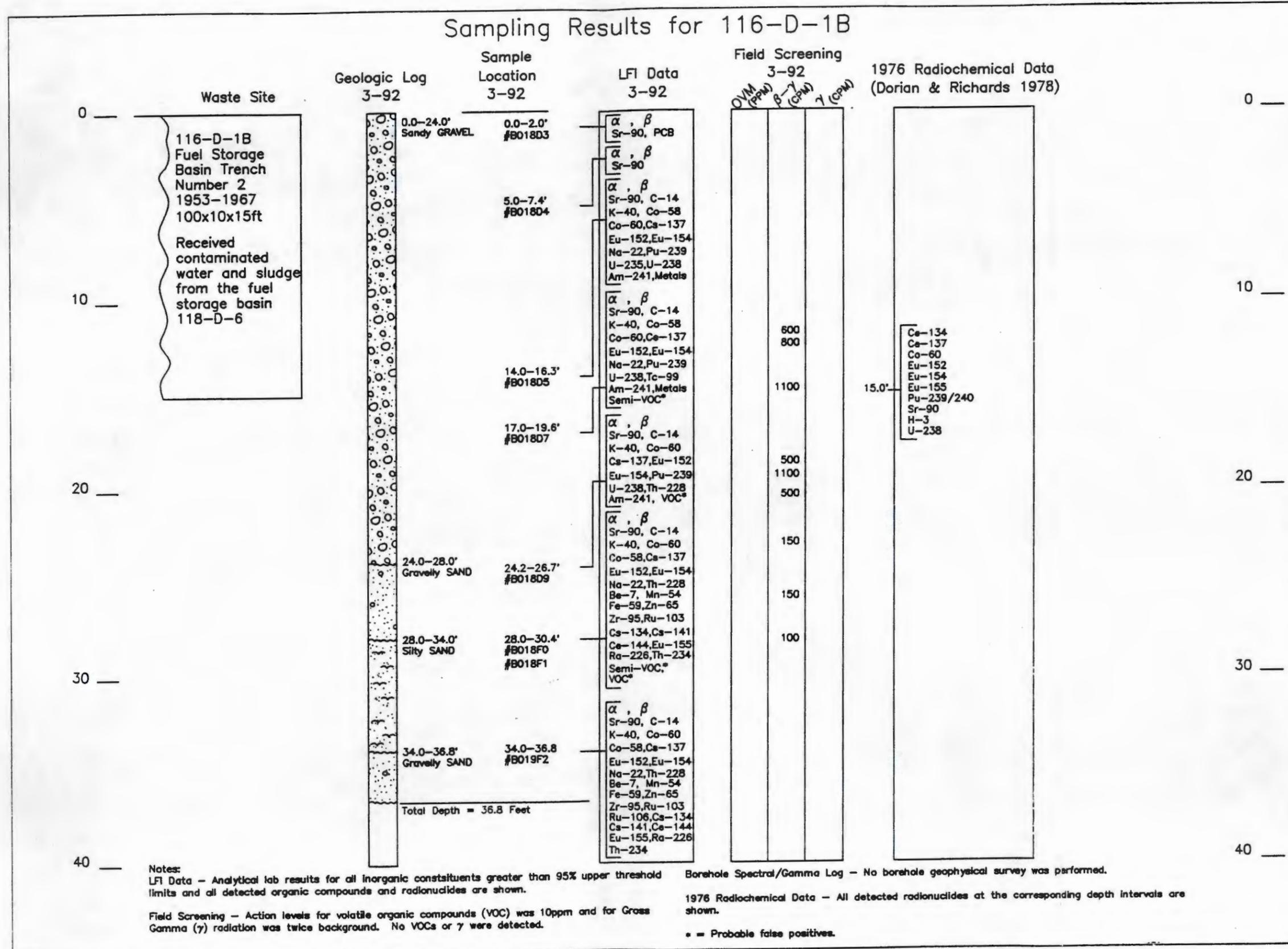


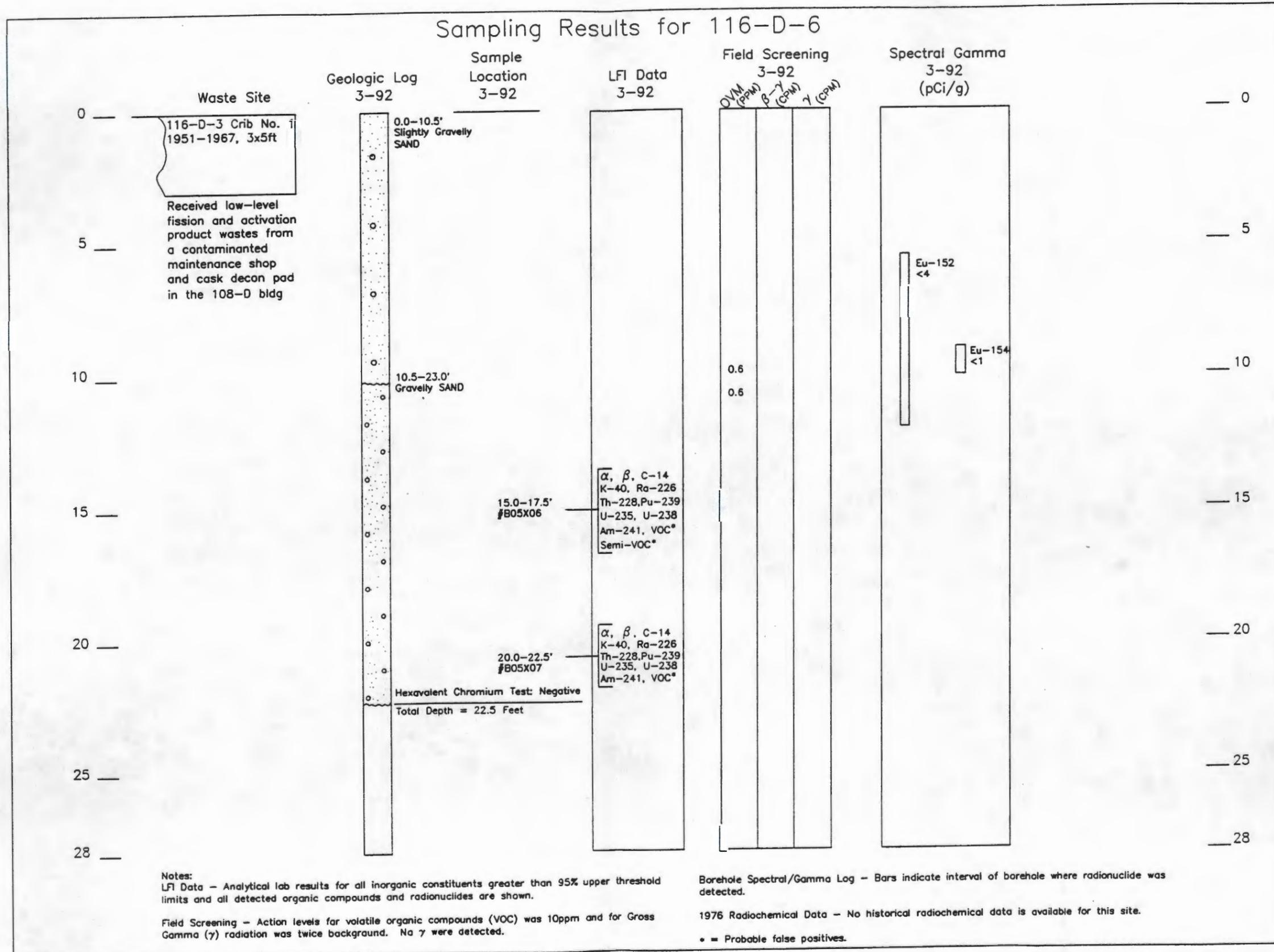
Figure 1-3. Hanford Site Past Practice Strategy Decision Flow Chart



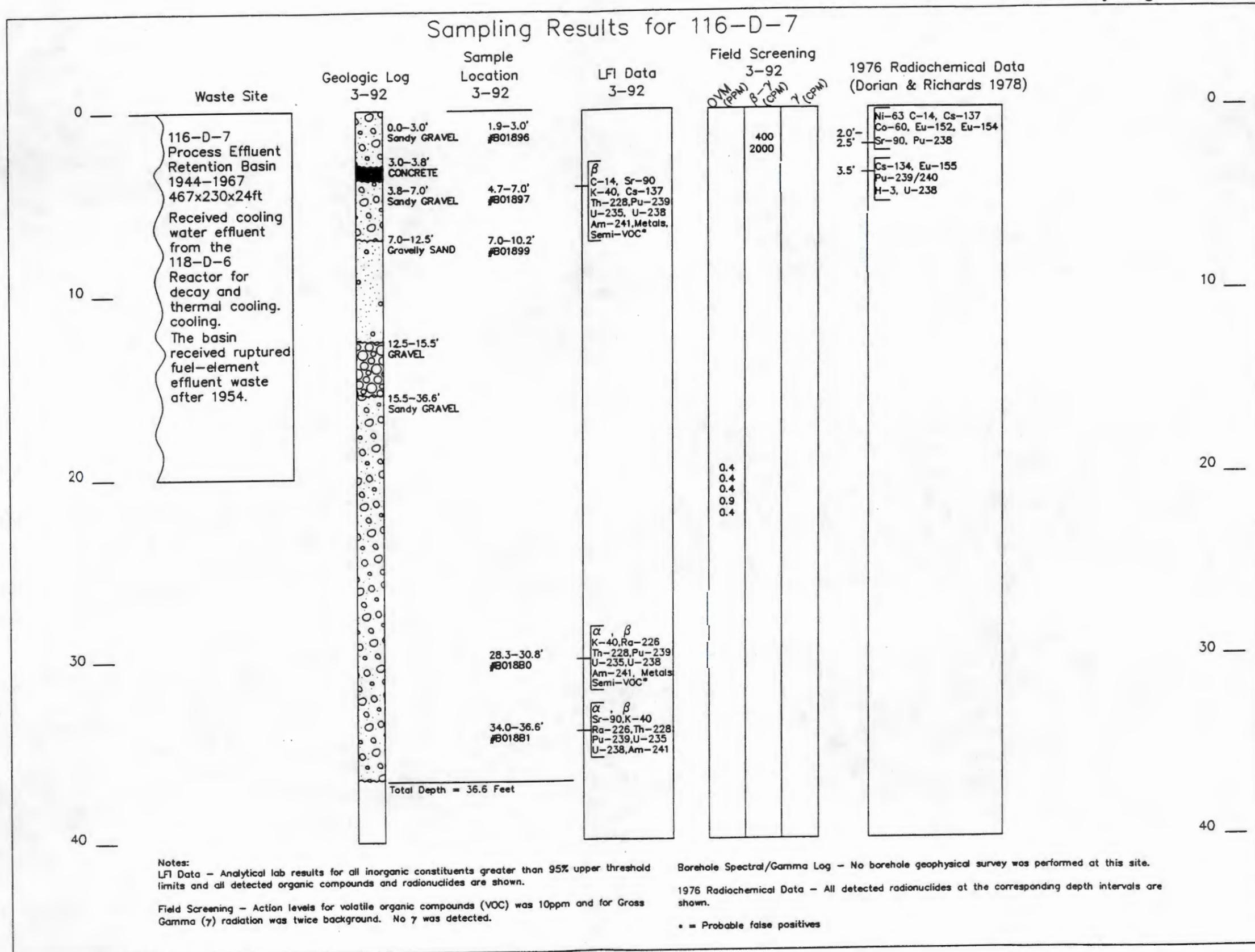
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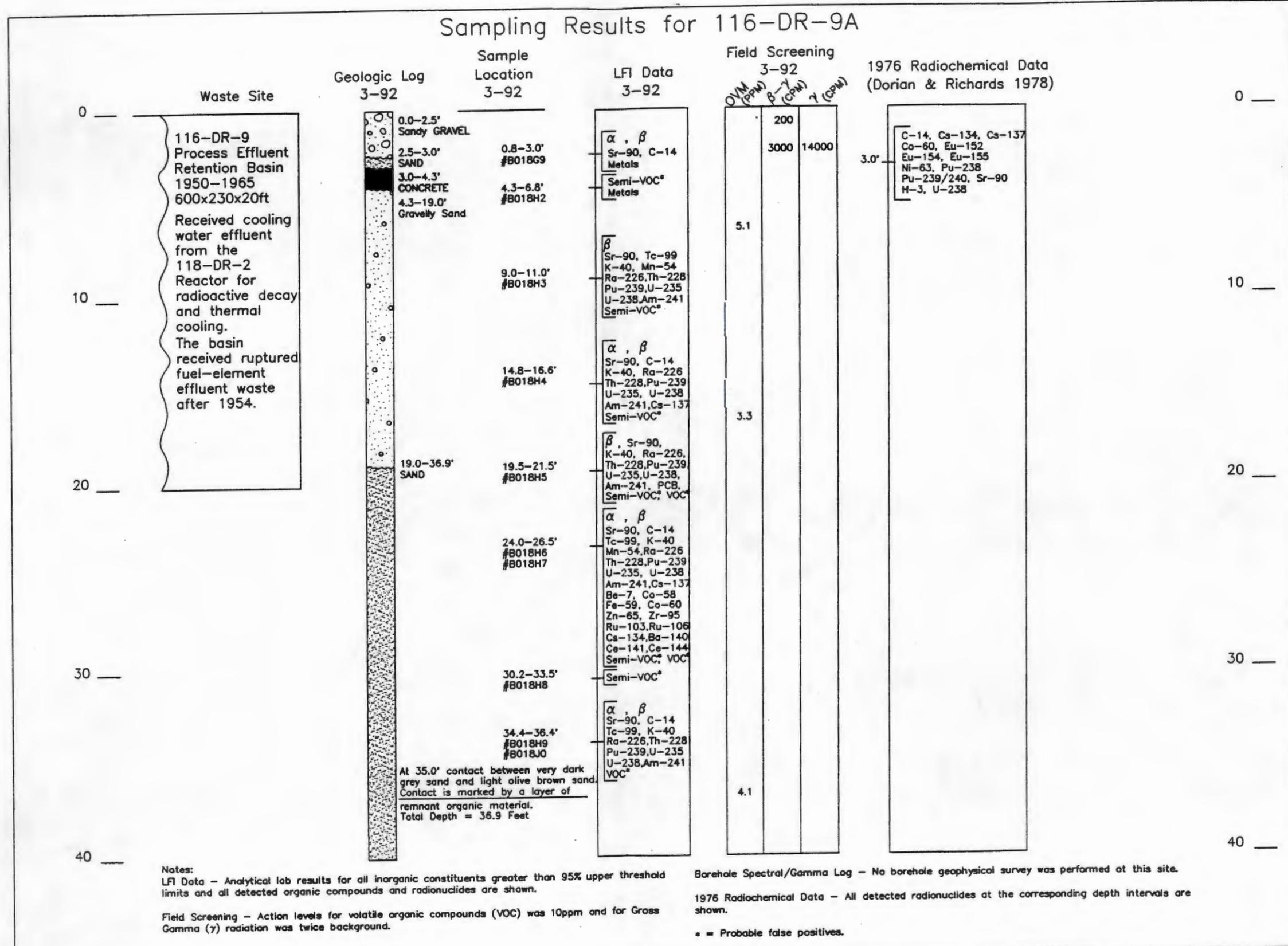
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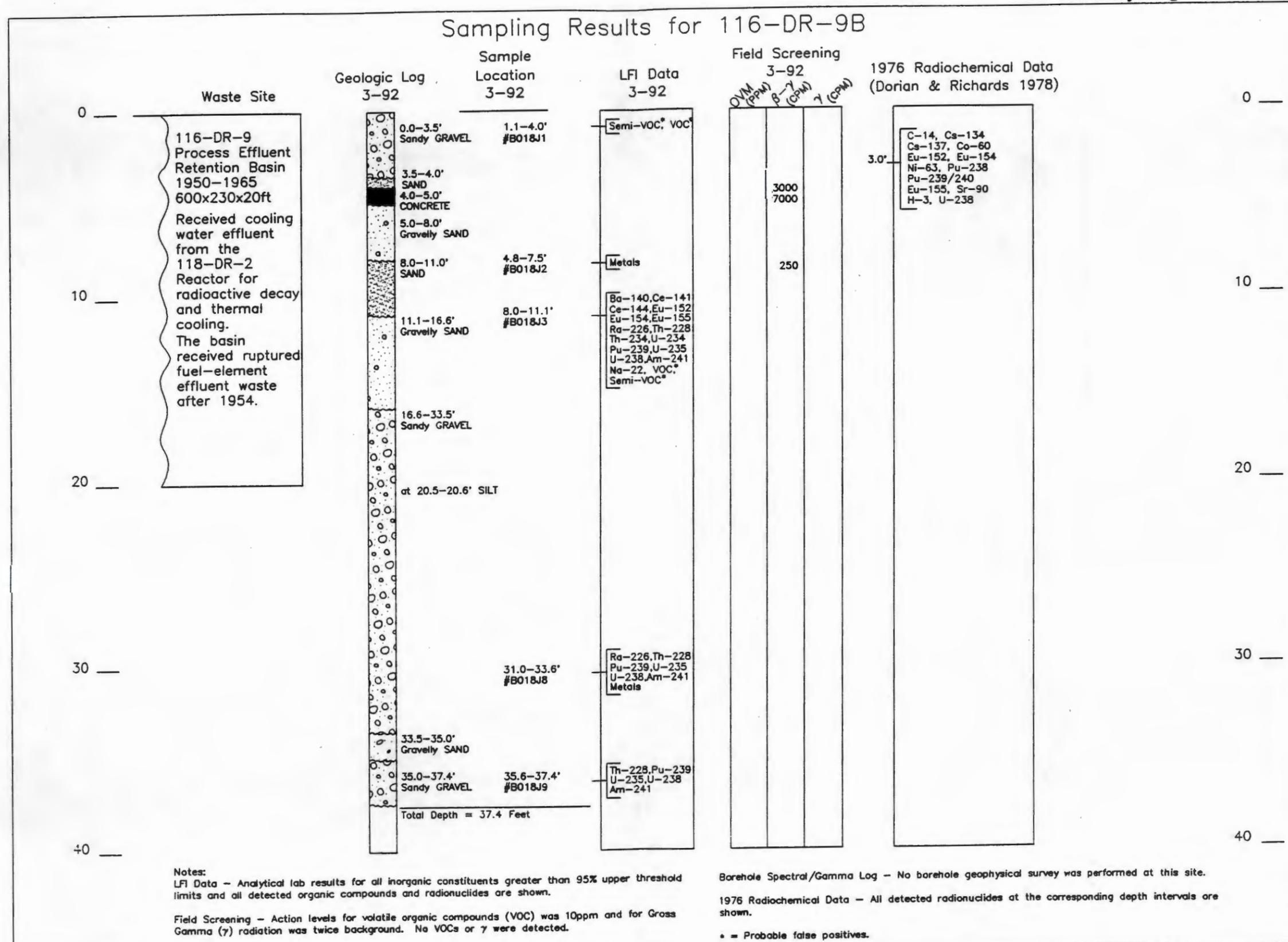
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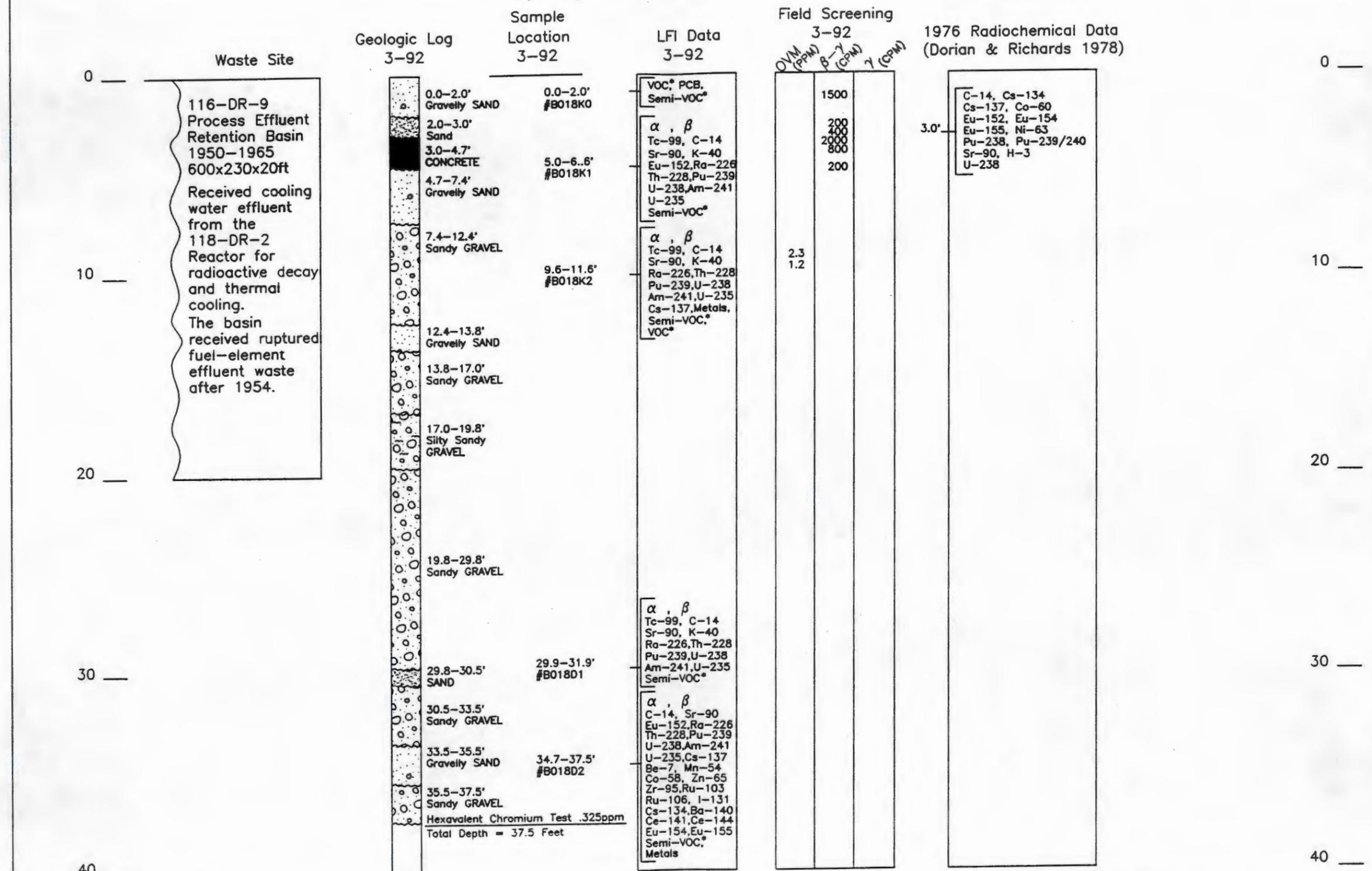


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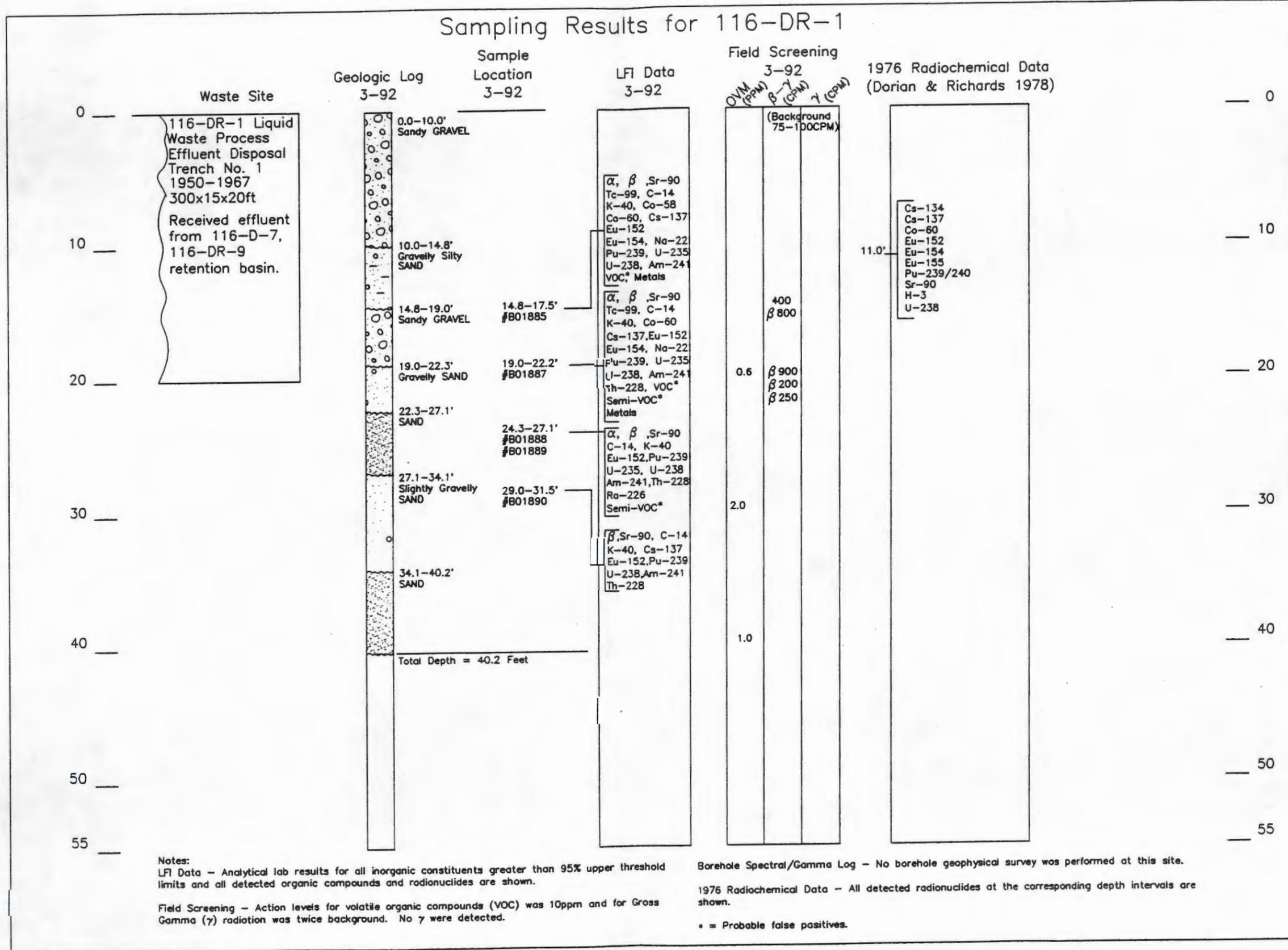
Sampling Results for 116-DR-9C



Notes:
LFI Data - Analytical lab results for all inorganic constituents greater than 95% upper threshold limits and all detected organic compounds and radionuclides are shown.
Field Screening - Action levels for volatile organic compounds (VOC) was 10ppm and for Gross Gamma (γ) radiation was twice background. No γ were detected.

Borehole Spectral/Gamma Log - No borehole geophysical survey was performed at this site.
1976 Radiochemical Data - All detected radionuclides at the corresponding depth intervals are shown.
* = Probable false positives.

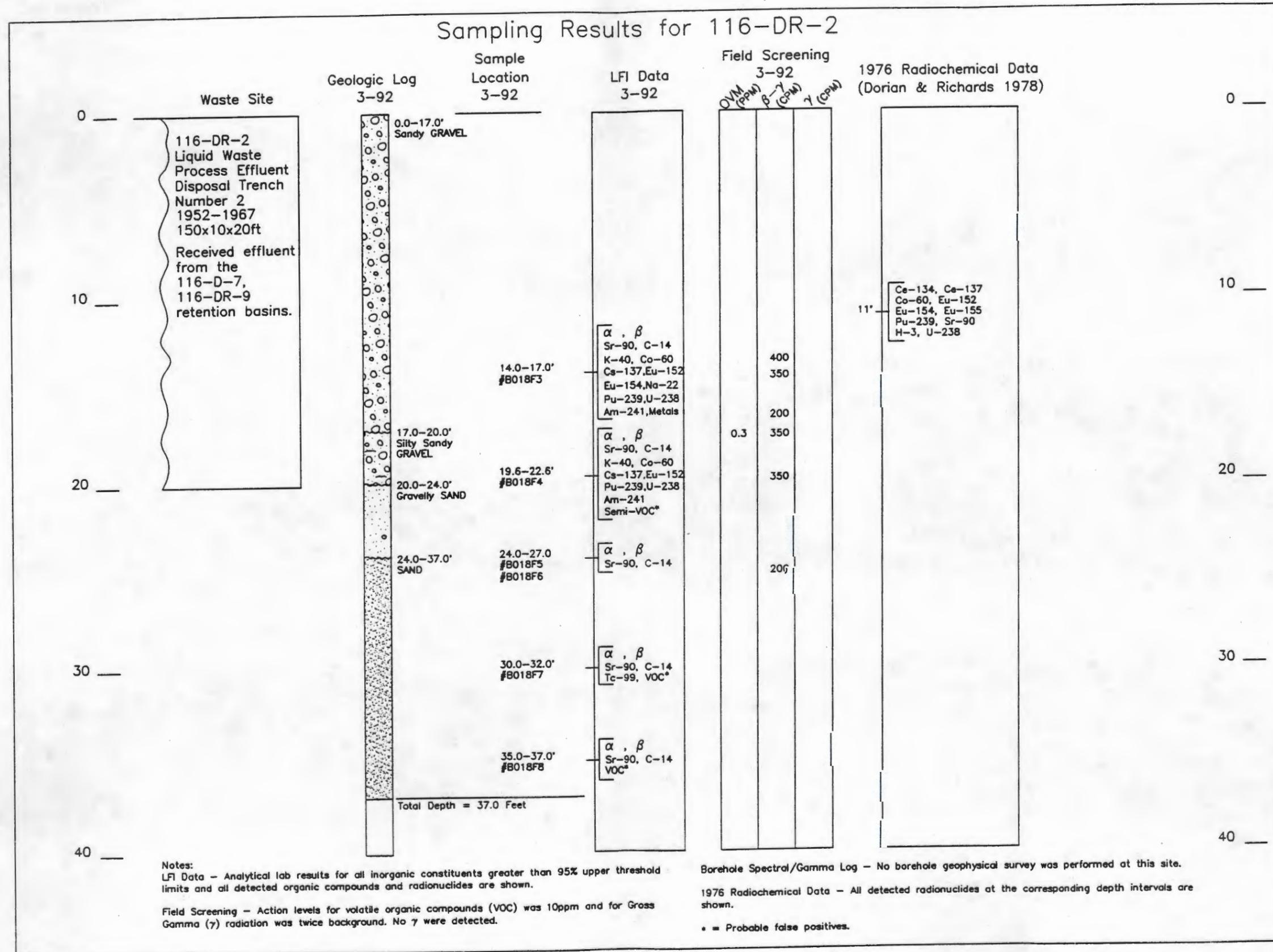
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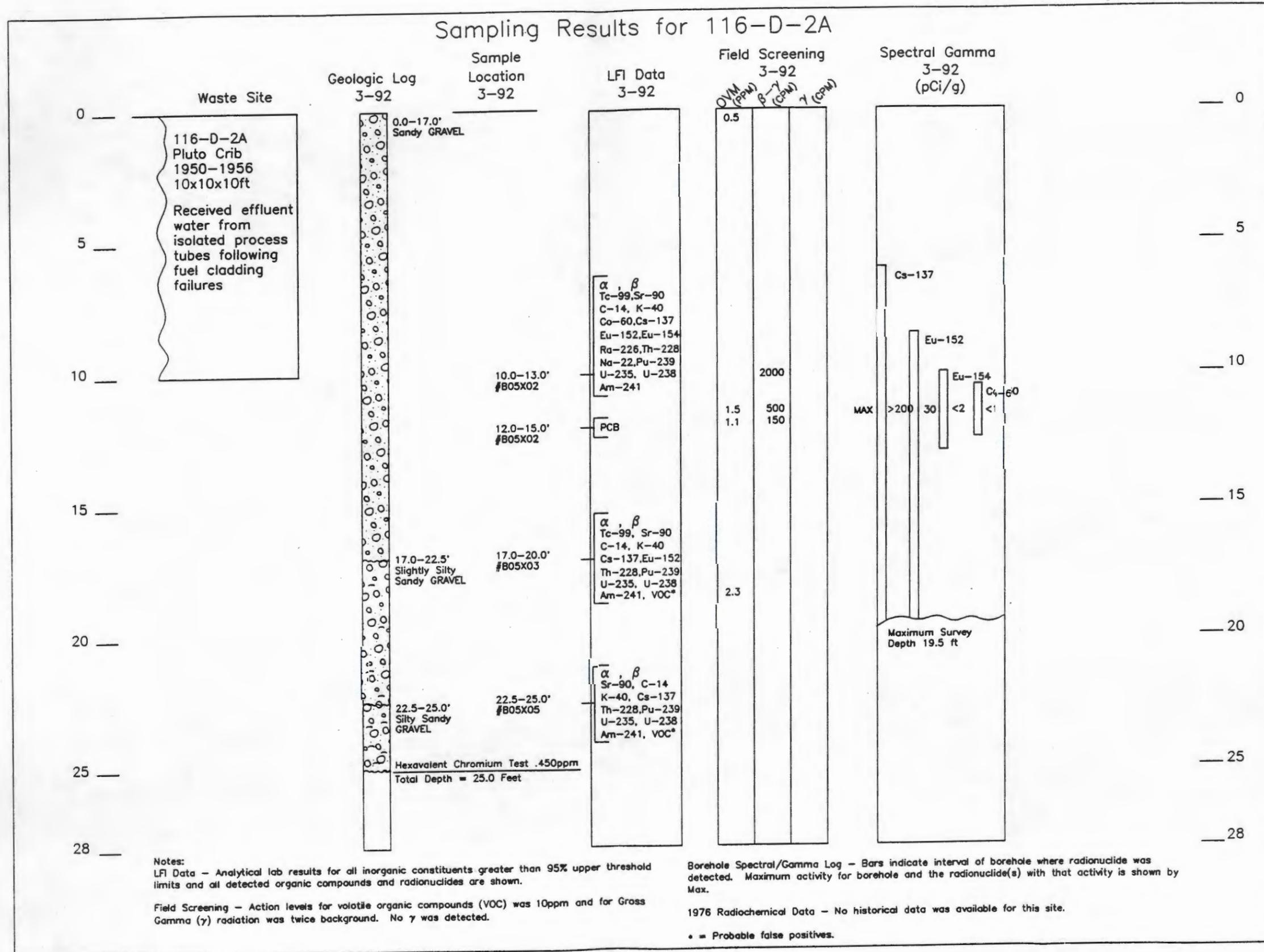
Notes:
 LFI Data - Analytical lab results for all inorganic constituents greater than 95% upper threshold limits and all detected organic compounds and radionuclides are shown.
 Field Screening - Action levels for volatile organic compounds (VOC) was 10ppm and for Gross Gamma (γ) radiation was twice background. No γ were detected.

Borehole Spectral/Gamma Log - No borehole geophysical survey was performed at this site.
 1976 Radiochemical Data - All detected radionuclides at the corresponding depth intervals are shown.
 * = Probable false positives.

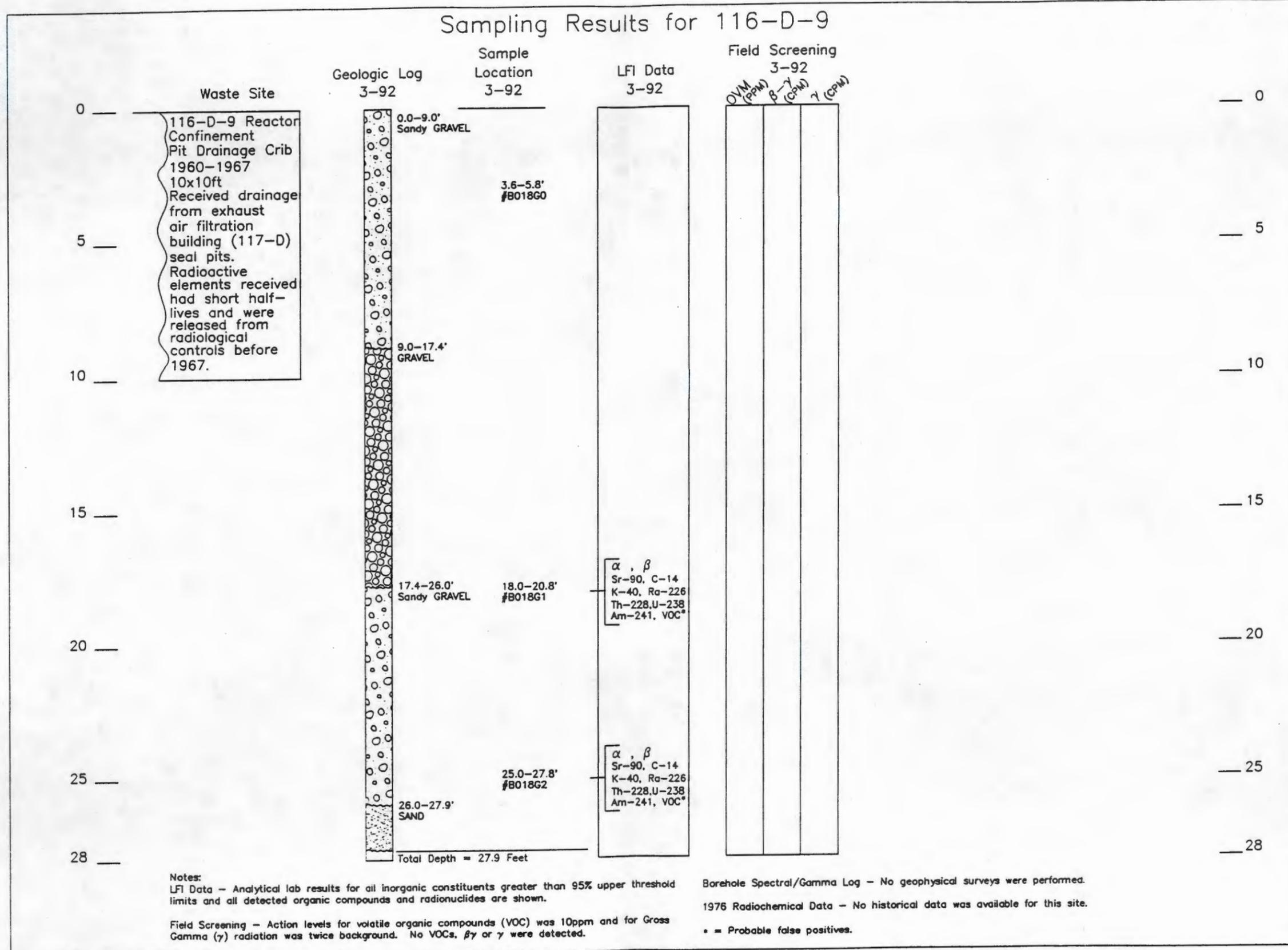
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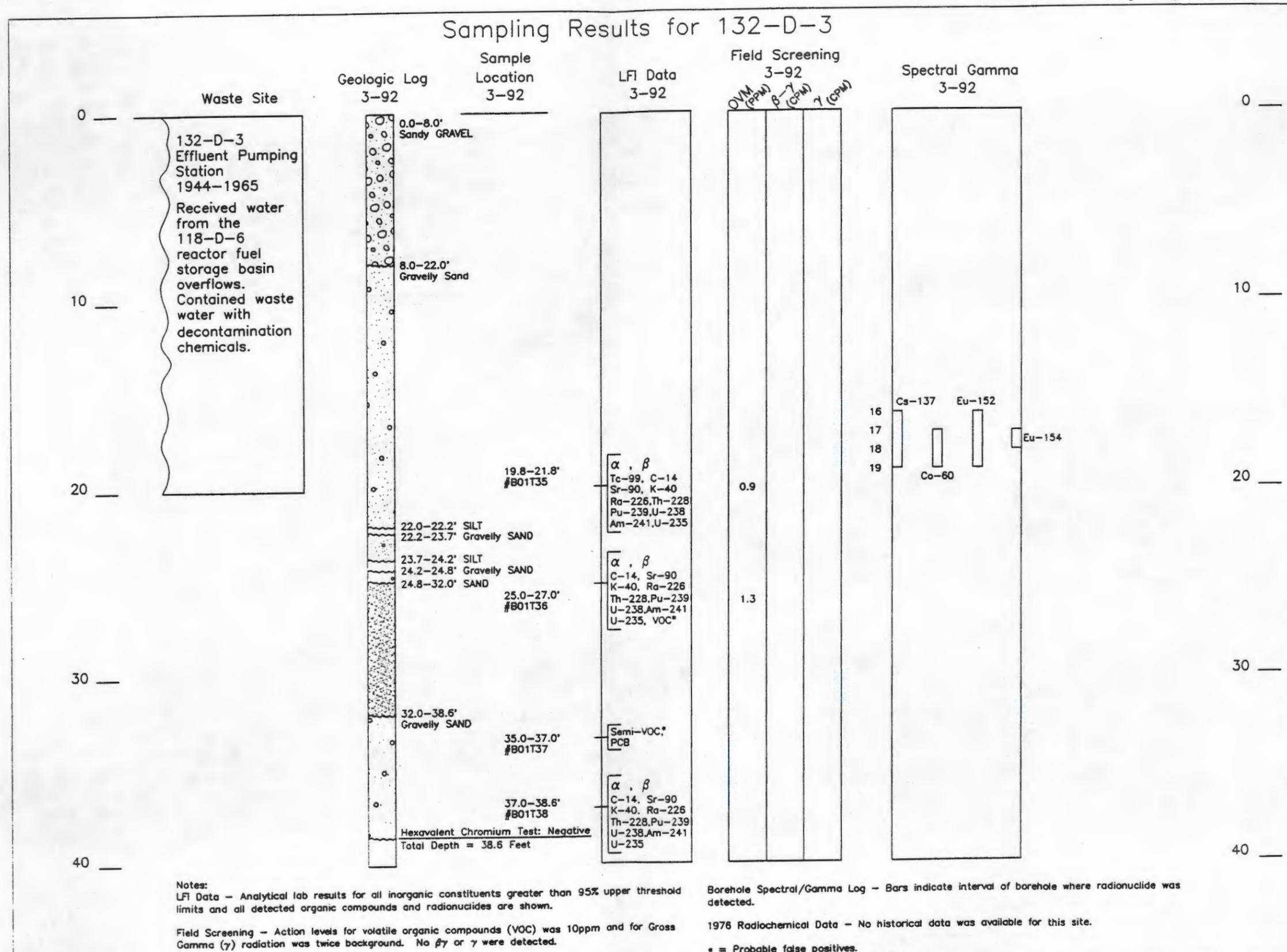
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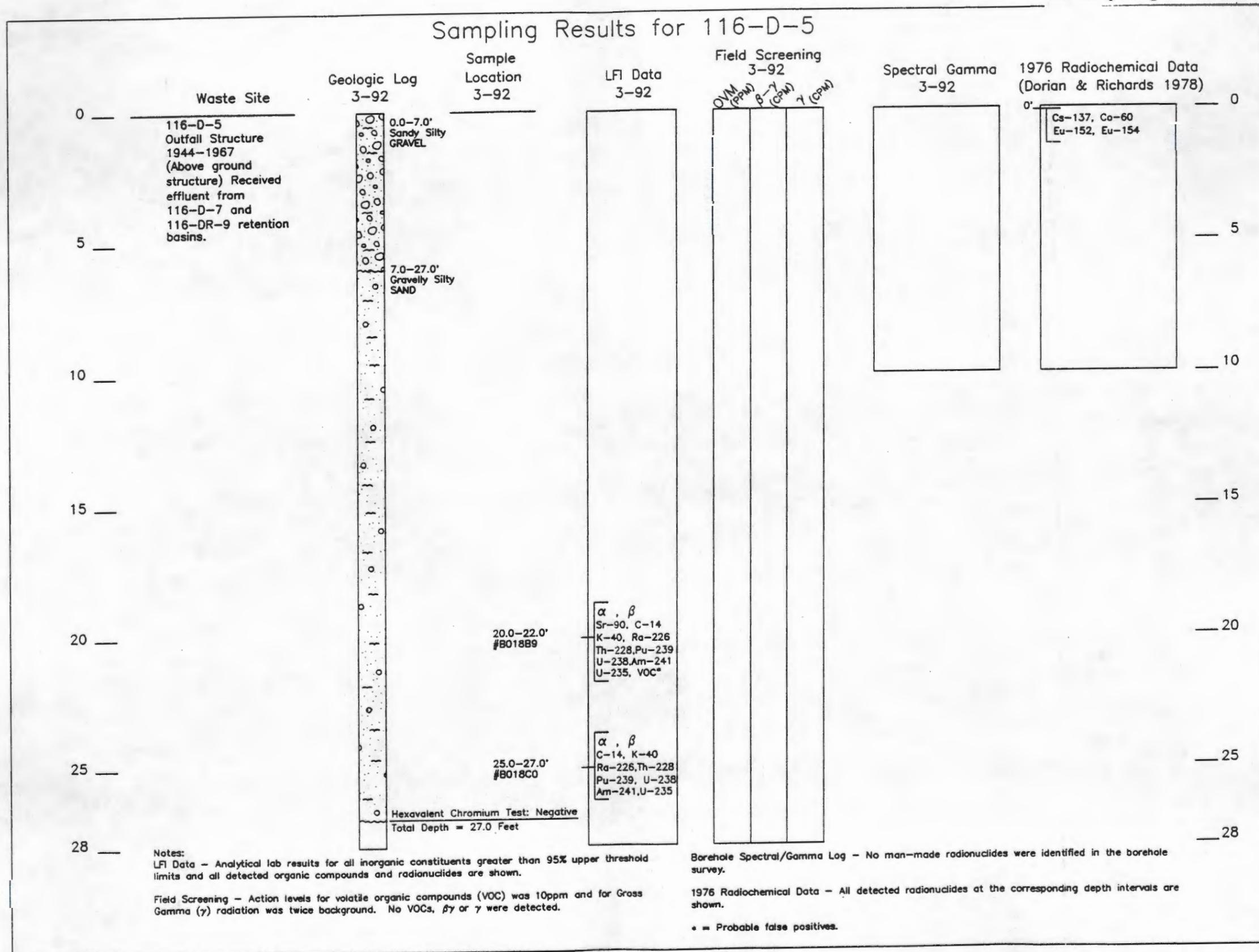
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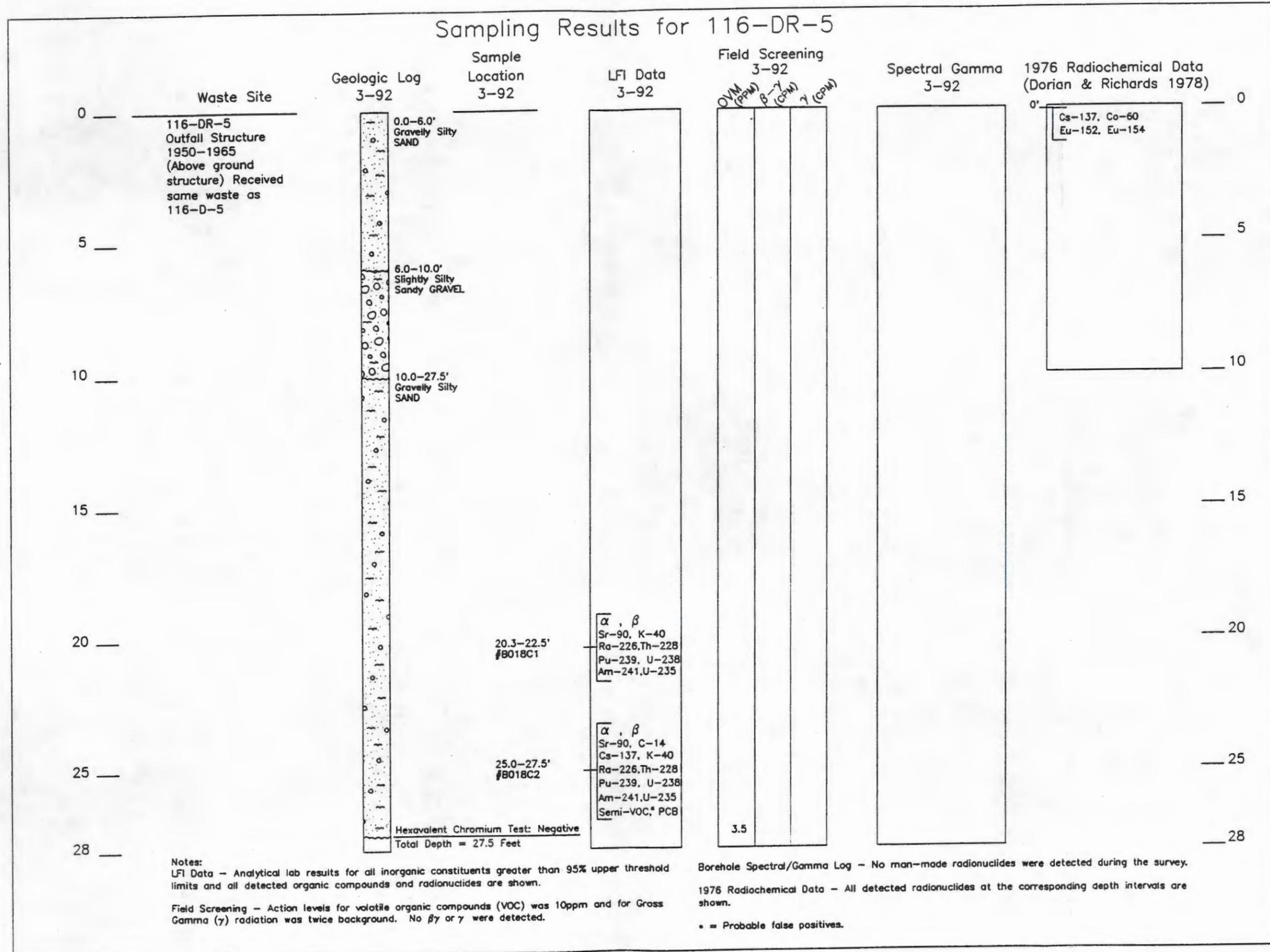
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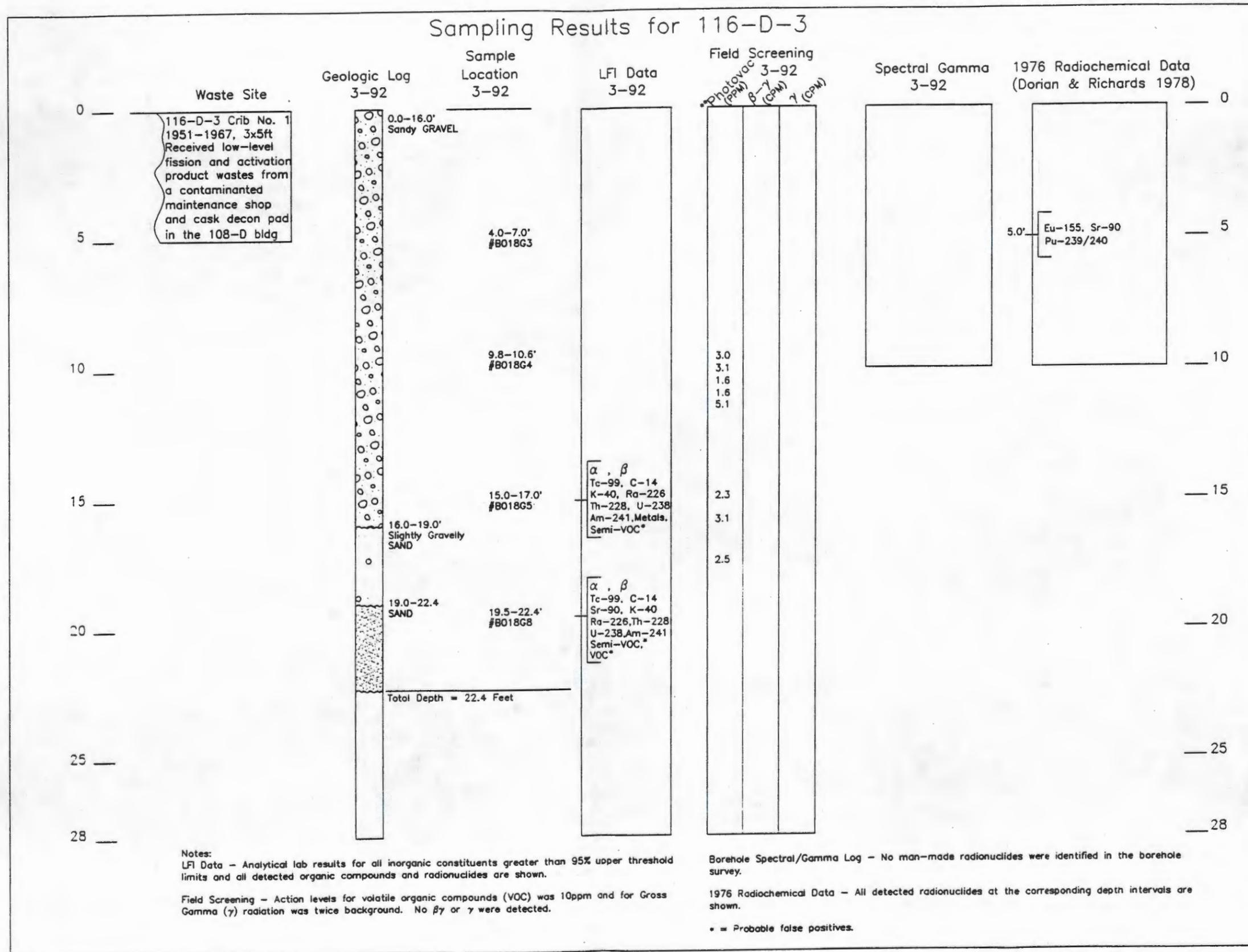
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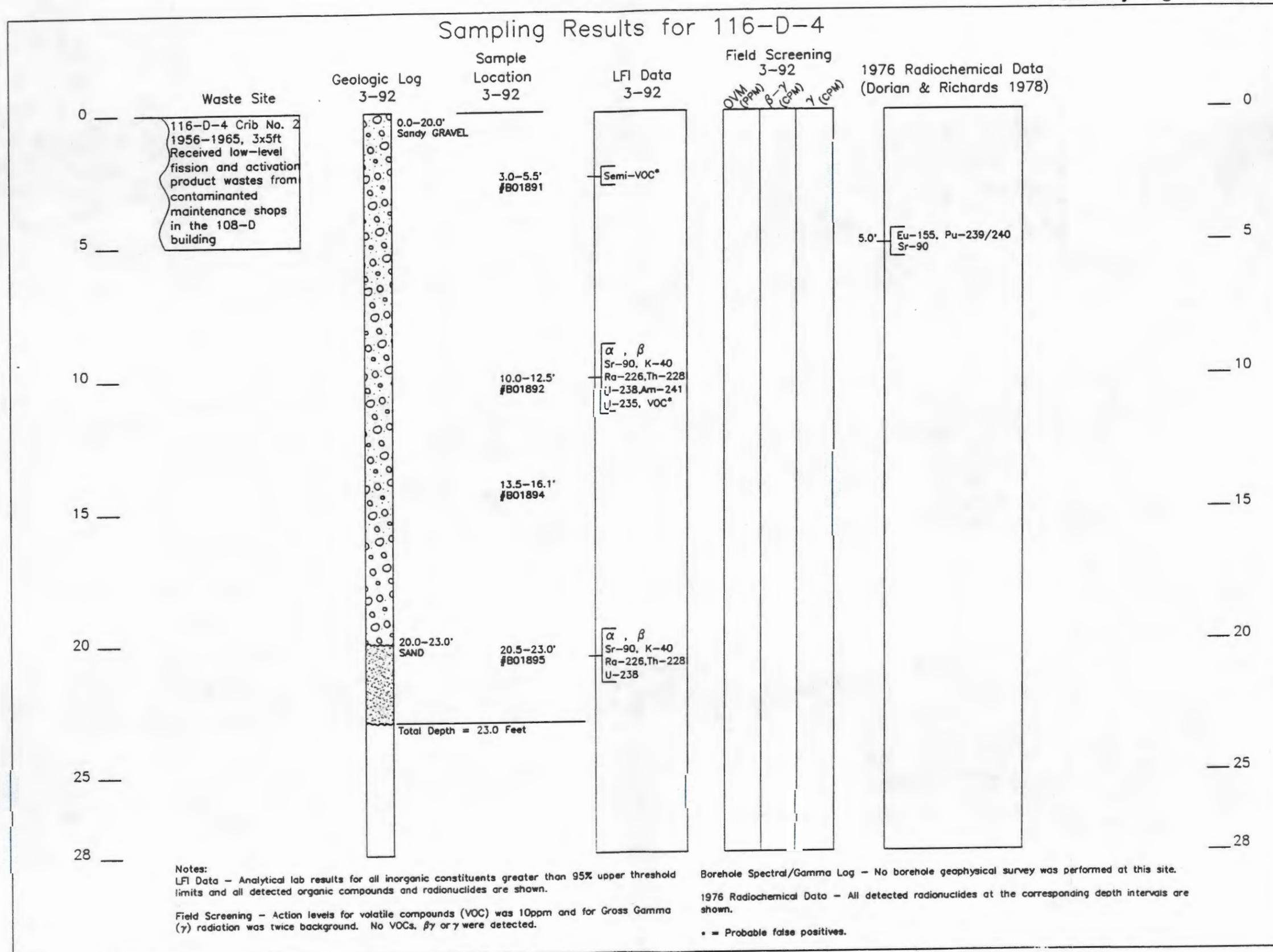
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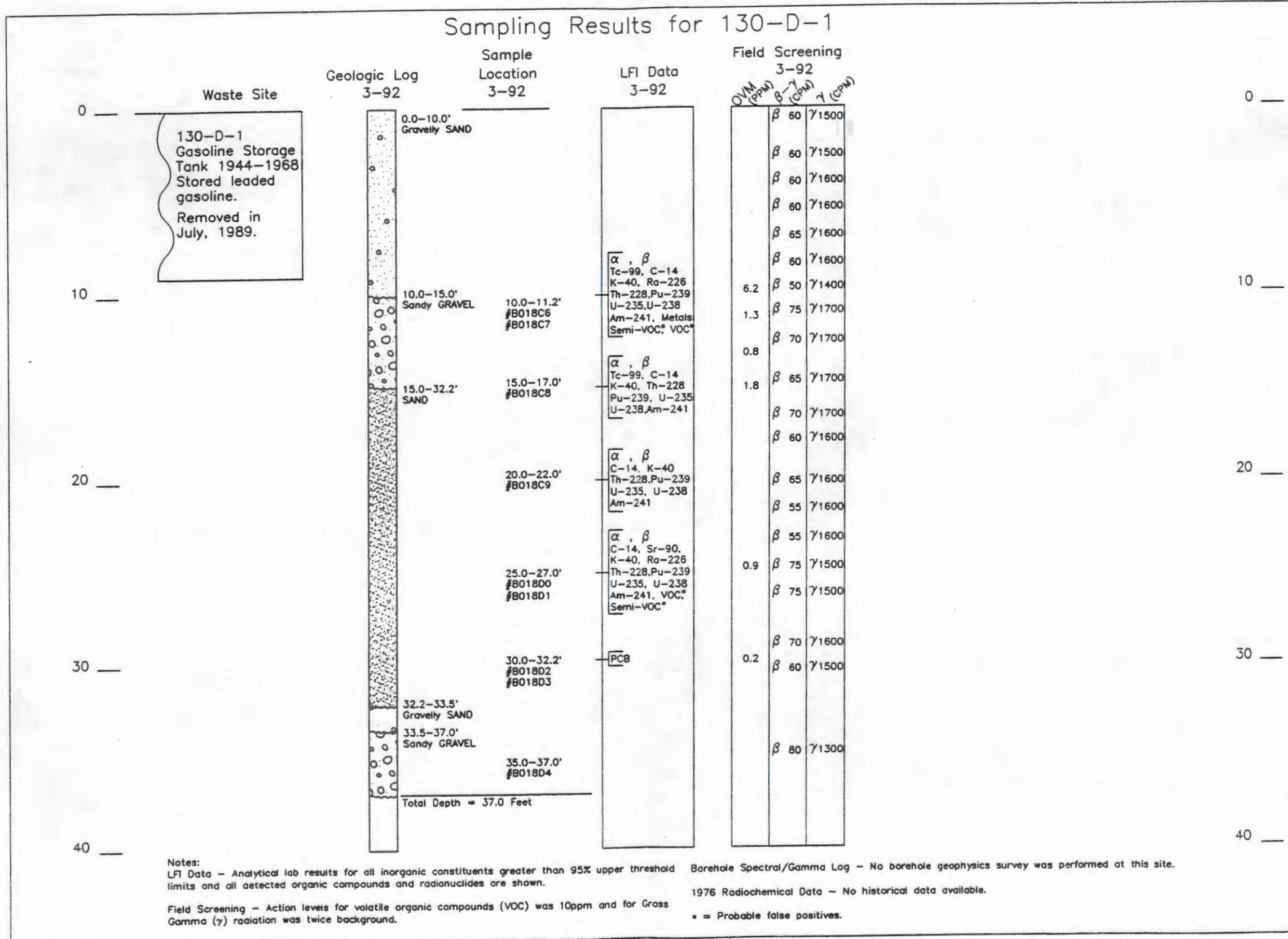


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Sampling Results for 130-D-1



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Table 1-1 100-DR-1 Operable Unit Characterization Activities (page 1 of 2)

TASK	TITLE	WHERE ADDRESSED
1	Project Management	Accomplished throughout project
2	Source Investigation	See subtasks below
2a	Source Data Compilation and Review	Background information is incorporated into the work plan, QRA and LFI reports as appropriate.
2b	Surveying	Coordinates and locations of sampling sites are documented in the LFI report (Chapter 3).
2c	Field Activities	Source sampling results for the 116-C-5 retention basins are in the LFI report.
2d	Source Sample Laboratory Analysis and Data Validation	Analytical results and data validation are documented in data validation reports referenced in Chapter 2 of LFI report
2e	Source Data Evaluation	The data was evaluated for use in the QRA and also evaluated in the LFI report.
3	Geologic Investigation	Coordinated through the 100-BC-5 operable unit tasks.
4	Surface Water and Sediments Investigation	Not applicable to 100-BC-1
5	Vadose Zone Investigation	See subtasks below
5a	Data Compilation	See subtask 2a
5b	Borehole Soil Sampling and Logging	Results of the borehole investigations are presented in the LFI report (Chapter 3). Borehole logs are displayed in the figures in LFI report (Chapter 3).
5c	Soil Sample Analysis	The analysis and validation are documented in the data validation reports referenced in LFI report (Chapter 2).
5d	Geophysical Logging	The results of the geophysical logging are reported in the LFI report (Chapter 3, and Appendix B).
5e	Data Evaluation	The data was evaluated for use in the QRA and also evaluated in the LFI report.
6	Groundwater Investigation	Performed as part of the 100-BC-5 operable unit activities.

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Table 1-1 100-DR-1 Operable Unit Characterization Activities (page 2 of 2)

TASK	TITLE	WHERE ADDRESSED
7	Air Investigation	Routine health and safety monitoring was performed during the field activities.
8	Ecological Investigation	A discussion of the ecological investigation is included in the LFI report (Section 1.3.1).
9	Other Tasks	See subtask below
9a	Cultural Resource Investigation	A discussion of the cultural resource investigation is included in the LFI report (Section 1.3.2).
10	Data Evaluation	Evaluation and interpretation of the data is accomplished in the QRA and LFI reports. The evaluation of the data for other purposes such as Large Scale Remediation, FS activities and treatability testing is ongoing.
11	Risk Assessment	The data generated during the LFI was used in the QRA and will be used in the baseline risk assessment in the future.
11a	Human Health Evaluation	QRA and summarized in LFI report (Chapter 4)
11b	Ecological Evaluation	QRA and summarized in LFI report (Chapter 4)
12	Verification of Contaminant- and Location-Specific ARARs.	ARARs will be addressed in the FS report and FFS report. ARARs also discussed in LFI report (Chapter 3).
<p>ARAR - Applicable or Relevant and Appropriate Requirements FS - Feasibility Study FFS - Focused Feasibility Study LFI - Limited Field Investigation QRA - Qualitative Risk Assessment</p>		

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Table 1-2 100-DR-1 Operable Unit High-Priority Sites and Low-Priority Sites

High-Priority Sites	Low-Priority Sites
116-D-1A Trench*	Waste Acid Reservoir
116-D-1B Trench*	Septic Tanks
116-D-6 French Drain	Septic Tank Tile Field
116-D-7 Retention Basin*	Fuel Oil Tank Pipeline
116-DR-9 Process Effluent Retention Basin	Fuel Oil Tank
116-DR-1 Trench*	Fuel Oil Tank
116-DR-2 Trench*	126-D-1 Ash Disposal Basin
116-D-2A Pluto Crib	Salt Dissolving Pit
116-D-9 Reactor Confinement Seal Pit Crib	Electrical Facilities
132-D-3 Effluent Pumping Station	1714-D Solvent Storage
116-D-5 Outfall Structure*	1715-D Oil and Paint Storage
116-DR-5 Outfall Structure*	1716-D Gas Station
116-D-3 Crib*	1722 Equipment Development
116-D-4 Crib*	1724-D2A Underwater Test Facility
130-D-1 Underground Storage Tank	183-D Filter Plant
108-D Demolished Office Building	185-D Thermal Hydraulics Lab
Sodium Dichromate Tanks	
103-D Fuel Element Storage Building	
126-D-2 Solid Waste Landfill	
4A, 4B, 18 Burial Grounds	
115-D Demolished Gas Recirculation Building	
117-D Demolished Exhaust Air Filter Building	
Process Effluent Pipelines	
107-D/107-DR Sludge Disposal Trenches (5)	
* = Additional data from analogous sites	

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Table 1-3 Summary Statistics and Upper Threshold Limits (UTLs)
for Inorganic Analytes

Analyte	95% Distribution ^a (mg/kg)	95% UTL ^b (mg/kg)
Aluminum	13,800	15,600
Antimony	NR ^c	15.7 ^c
Arsenic	7.59	8.92
Barium	153	171
Beryllium	1.62	1.77
Cadmium	NR	0.66 ^c
Calcium	20,410	23,920
Chromium	23.4	27.9
Cobalt	17.9	19.6
Copper	25.3	28.2
Iron	36,000	39,160
Lead	12.46	14.75
Magnesium	7,970	8,760
Manganese	562	612
Mercury	0.614	1.25
Nickel	22.4	25.3
Potassium	2,660	3,120
Selenium	NR	5 ^c
Silver	1.4	2.7
Sodium	963	1,290
Thallium	NR	3.7 ^c
Vanadium	98.2	111
Zinc	73.3	79
Molybdenum	NR	1.4 ^c
Titanium	3,020	3,570
Zirconium	47.3	57.3
Lithium	35	37.1
Ammonia	15.3	28.2
Alkalinity	13,400	23,300
Silicon	108	192
Fluoride	6.4	12
Chloride	303	763
Nitrite	NR	21 ^c
Nitrate	96.4	199
Ortho-phosphate	3.7	16
Sulfate	580	1,320
Source: DOE-RL 1993b ^c NR = Not Reported ^a 95th percentile of the data for a lognormal distribution ^b 95% confidence limit of the 95th percentile of the data distribution ^c Limit of detection		

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2.0 INVESTIGATIVE APPROACH

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The 100-DR-1 LFI utilized intrusive and non-intrusive methods to investigate all the high-priority sites identified in the work plan (DOE-RL 1992a). Intrusive methods included sampling and subsequent analysis of soil and sediment, and borehole geophysical logging. Non-intrusive methods included ground penetrating radar (GPR) surveys, wipe sampling, evaluation of data collected from analogous sites by LFIs at other 100 Area operable units, evaluation of historical data, and a QRA. The GPR surveys were used solely to establish the location of boreholes. Intrusive sampling activities took place at sites 116-D-1A, 116-D-1B, 116-D-6, 116-D-7, 116-DR-9, 116-DR-1, 116-DR-2, 116-D-2A, 116-D-9, 132-D-3, 116-D-5, 116-DR-5, 116-D-4, 130-D-1, 108-D, and the sodium dichromate tanks. Analogous data from intrusive LFIs in the 100-BC-1 Operable Unit and 100-HR-1 Operable Unit were applied to the LFI evaluation of the 100-DR-1 sites such as the retention basins, 116-D-1A, 116-D-1B, 116-DR-1, and 116-DR-2. Non-intrusive investigations of the other 100-DR-1 high-priority sites relied on historical data from past sampling and analysis, such as Dorian and Richards (1978), and process knowledge. Table 2-1 lists the LFI investigative approaches applied to the high-priority sites.

Intrusive investigations of the 100-DR-1 Operable Unit high-priority sites were performed using two sampling methods. Boreholes were drilled and vadose zone samples collected at fifteen liquid waste disposal sites, i.e., cribs, trenches, and basins, to identify the nature and vertical extent of contamination. Test pits were excavated to sample potentially contaminated areas outside of the 108-D office building and the sodium dichromate tanks.

A non-intrusive investigation was performed at one high-priority site (103-D fuel element storage building). Wipe samples were collected from the inside floor of the building and submitted for analysis.

Intrusive investigations of the 100-DR-1 Operable Unit low-priority sites were performed by excavating a test pit and sampling the subsurface soils. The data are presented for information only because the low-priority sites are not under consideration as IRM candidates.

Investigative methods were used which allowed appropriate sample extraction. After the desired samples were taken, they were shipped off site for laboratory analysis. The analytical results were returned for validation and evaluation. The following sections describe the LFI activities in detail.

2.1 BOREHOLES

Seventeen vadose zone boreholes were drilled through high-priority liquid waste sites during the 100-DR-1 LFI. Boreholes were advanced using cable tool drilling methods and sampled with split-spoon samplers in accordance with the *Description of*

Work for the 100-DR-1 Operable Unit Vadose Investigation Activities (WHC 1991). Cable tool drilling was used for this task because of the gravels, cobbles and boulders common to the operable unit, and because the quantity of drilling residuals is minimal and can be easily controlled compared to other drilling methods. Detailed procedures for borehole drilling are described in the *Environmental Investigations and Site Characterization Manual*, Environmental Investigation Instruction (EII) 6.7, (WHC 1988).

Target depths for the boreholes were established based on process knowledge and historical records. These information sources provided the expected depth below grade of the specific liquid waste structure/facility. The boreholes were drilled through the bottom of the trench or crib structure into the underlying native sediment and advanced until field screening instruments indicated that contamination was less than the screening action levels in two consecutive samples removed from the borehole. Section 2.6 provides details of the field screening methods. The maximum allowed total depth of any vadose zone boreholes was restricted to no more than 1.5 m (5 ft) below the water table. After total depth of a borehole was reached a spectral gamma geophysical log was run, and the borehole was abandoned in accordance with EII 6.7 (WHC 1988).

2.2 TEST PITS

Test pits were dug at both the 108-D office building and one at the sodium dichromate tank site. The test pits were dug in accordance with the *Source Investigation Field Activities for the 100-DR-1 Operable Unit Description of Work* (WHC 1992f) and EII 5.2, Appendix I (WHC 1988) using a backhoe bucket to extract the soil material and to remove fill material that overlies the sites. Samples from the vadose zone test pits were taken from the bucket as described in Section 2.7.2.

2.3 WIPE SAMPLING

Wipe sampling of the concrete floor in the 103-D fuel element storage building was performed in accordance with the instructions given from qualified WHC laboratory personnel. This sampling was performed manually using gauze pads moistened with deionized water, hexone/acetone (50/50), and methylene chloride/acetone (50/50) over a measured area of 1m² (10.8 ft²).

2.4 PHYSICAL PROPERTIES SAMPLING

Physical properties samples were taken in support of "EPA Physical Sampling Criteria for the 100 Areas", Attachment 1 of the 100-DR-1 Operable Unit Work Plan (DOE-RL 1992a). The physical property samples were analyzed for the following parameters using American Society for Testing and Materials (ASTM) methods. Bulk density and K_{unsat} were calculated.

- bulk density
- particle size distribution (ASTM D422-63)
- moisture content (ASTM D2216)
- moisture retention (ASTM D2325-68, D3152-72)
- saturated hydraulic conductivity (K_{sat}) (ASTM D2434-68)
- unsaturated hydraulic conductivity (K_{unsat}) at 10% moisture content after full saturation.

2.5 GEOPHYSICAL BOREHOLE LOGGING

The WHC high resolution, passive spectral gamma-ray radiation logging system (RLS) was used to produce geophysical borehole logs during the 100-DR-1 LFI in accordance with EII 11.1 (WHC 1988). The RLS borehole surveys identify the presence of man-made gamma-ray emitting radionuclides, their concentration, and location in the borehole interval. The system provides graphs of radionuclide concentration in pCi/g versus depth for each man-made radionuclide identified in the vadose boreholes. The concentrations and locations of naturally occurring gamma-ray emitting isotopes of potassium, thorium and uranium are also recorded during the RLS surveys.

The RLS system includes a liquid nitrogen-cooled high purity germanium (HPGe) detector or sonde, a cable and draw works system which moves the sonde in the borehole and records the depth of the sonde, instrumentation and data recording systems, computers and associated software, calibration systems, and data manipulation software. The RLS system is truck-mounted. The HPGe sonde and the RLS were set up in a standard configuration, which is designed to detect low decay activities (low concentrations) of radionuclides. In this configuration the RLS has frequently shown a minimum activity detection capability of 0.3 pCi/g for radionuclides that emit gamma-rays with energies above 500 keV and number of gammas per decay above 50 percent. The maximum activity that the RLS has detected in the standard configuration is about 10,000 pCi/g. The maximum decay activity detected by the RLS during the 100-DR-1 LFI was greater-than 200 pCi/g of ^{137}Cs in borehole 116-D-1A. Copies of borehole spectral gamma-ray geophysical logs which were obtained during limited field investigations in the 100-DR-1 Operable Unit are in Appendix A. The complete results of borehole spectral-gamma geophysical are presented in Spectral Gamma-Ray Log Report for the 100 Area Borehole Surveys.

2.6 FIELD SCREENING

During drilling, sediments were screened using portable on-site instruments for radionuclides and VOCs (DOE-RL 1992a). The screening was used to assist in the

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selection of sample intervals and borehole total depths. The field geologist screened for VOCs using an organic vapor monitor (OVM) which was used, maintained, and calibrated consistent with EII 3.2 (WHC 1988) and EII 3.3 (WHC 1988). The action level for volatile organic screening was 10 ppm above background.

Radionuclides were also screened per EII 3.3 (WHC 1988). Radionuclide screening was performed by the field geologist or field team leader using a Ludlum model 14-C scintillation counter to measure levels of beta-gamma activity. The field geologist recorded screening results in the borehole log per EII 9.1 (WHC 1988). The action level for radionuclide screening was twice background. Background was established as 50 to 100 cpm. Health physicist technicians (HPT) also performed field screening for gamma radiation using a Geiger-Mueller detector with a P-11 probe.

Chromium screening was performed on sediment collected at borehole total depth using a portable hexavalent Cr test kit per EII 3.4 (WHC 1988). The Cr screening was done for informational purposes only and was not used to make decisions in the field. The Cr screening was not performed at each waste site.

2.7 SOIL SAMPLING

Soil sampling intervals in boreholes and test pits were selected on the basis of field screening results and the predicted waste site target depths. Soil removed from the borehole or test pit was screened for VOCs and radioactivity. The borehole or test pit was deepened until either sediment was encountered that exceeded the field screening action level, or the maximum expected waste site target depth was reached. Once action levels were exceeded, sampling then continued at 1.5 m (5 ft) intervals until either two consecutive sample intervals did not exceed the action level, or the borehole had reached a depth 1.5 m (5 ft) below the water table. If the sediment did not exceed the action levels and the maximum expected waste site target depth had been reached, sampling then continued at 1.5 m (5 ft) intervals until two consecutive samples did not exceed the action levels.

2.7.1 Vadose Boreholes

Samples were collected using a split-spoon sampler per the 100-DR-1 Operable Unit Work Plan (DOE-RL 1992a) and EII 5.2, Appendix B (WHC 1988). All soil cuttings were screened per the criteria stated in Section 2.6 from the surface to the final depth.

2.7.2 Test Pits

Samples from the vadose zone test pit were collected directly from the backhoe bucket using hand tools and standard soil sampling techniques per EII 5.2, Appendix I (WHC 1988). A bucket of soil was removed from the desired sampling interval and

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brought to the side of the test pit for sampling. Samples were collected from soil in the middle of the bucket, away from the bucket sides. Excavated soil was screened per the criteria stated in Section 2.6, from the surface to the final depth. Sample depths were estimated using measured dimensions of the backhoe bucket and arm.

2.8 SAMPLE ANALYSIS

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Samples collected from the boreholes, test pits and wipe samples for chemical analysis were analyzed for the full suite of CERCLA Contract Laboratory Program (CLP) Target Compound List (TCL) and Target Analyte List (TAL) constituents, specific anions that may be present, and radionuclides. The CLP TCL constituents are VOCs, semi-volatile organic compounds, pesticides, and PCBs. The CLP TAL constituents include metals and cyanide. Chemical analysis was conducted using CLP methods.

Analytical methods, routine analytical detection and quantitation limits, and precision and accuracy specified for the methods are listed in Table QAPjP-1 of the Quality Assurance Project Plan in the 100-DR-1 Operable Unit Work Plan (DOE-RL 1992a).

2.9 DATA VALIDATION

Data validation was performed by a qualified independent participant contractor. The validation responsibilities are defined in associated statements of work. All validation was performed in compliance with WHC *Sample Management Administration Manual*, (WHC 1990) Section 2.2 for organic analyses, Section 2.1 for inorganic analyses, and Section 2.3 and 2.4 for radionuclide analyses. All data packages were assessed. The chemical and radionuclide data were validated. The physical properties data were not validated. The following reports present the data validation packages:

- *Data Validation for the 100-DR-1 Operable Unit Vadose Sampling* (WHC 1992a).
- *Data Validation Report for the 100-DR-1 Operable Unit, Sodium Dichromate Tanks*, (WHC 1992b).
- *Data Validation Report for the 100-DR-1 Operable Unit, 108-D Office Building*, (WHC 1992c).

In addition to the data validation identified above, the LFI data were evaluated for use in the LFI and QRA. The data validation process is discussed below.

The first step in the data evaluation process was to develop a detailed inventory of all samples collected for the LFI. This information was gathered from the project

sample list, borehole logs, sample tracking sheets, and sample location maps. Multiple information sources were reviewed, as no one source contained all required information.

The second step was to compile and review the analytical data. This was done to verify that validation results were incorporated into the analytical database and that the data qualifiers were listed. Rejected data were assigned the qualifier "R". Data rejected for major quality deficiencies (e.g., technical concerns) were not used, however data rejected for administrative reasons, (e.g., calibration data delivered late) were used after the calibration data became available and the sample and corresponding calibration data were reviewed. Sources of data for the evaluation were Hanford Environmental Information System (HEIS), CLP analysis data disks, validated analytical reports, i.e., "form 1" sheets, and CLP data packages.

The third step was to review trip, equipment, and field blank data to determine if sample data detections were due to sources other than media contamination. This review was conducted using the EPA's "five or ten times rule". The ten times rule applies to common laboratory contaminants, e.g., acetone, 2-butanone, methylene chloride, toluene, and common phthalate esters. Detected concentrations of common lab contaminants had to be greater than 10 times their corresponding blank value to be considered valid. Detected concentrations of other contaminants had to be greater than five times their corresponding blank value to be considered valid.

One result of the data evaluation and validation process is the assignment of data qualifier letter codes to individual analytical results. The following qualifier letter codes were applied to data from the LFI investigation:

- "U" indicates that the analyte was analyzed for and not detected. The numerical value reported is the contract required detection limit (CRDL) or the contract required quantitation limit (CRQL). Contract required detection limits apply to EPA CLP protocol analyses of inorganic constituents and to detection limits established by WHC for radionuclide analyses. Contract required quantitation limits apply to EPA CLP protocol analyses of organic constituents. Sample quantitation limits and sample detection limits may be lower or higher than CRQLs or CRDLs, depending on instrumentation, matrix, and concentration factors.
- "J" indicates that the analyte was analyzed for and detected. The concentration reported is an estimate due to identified quality control (QC) deficiencies. For example, if the amount present is less than the CRDL or CRQL, the concentration reported is considered an estimated value.
- "UJ" indicates the analyte was analyzed for and not detected. The detection or quantitation limit for the sample can be only be estimated due to identified QC deficiencies.

- "JN" indicates the analyte was analyzed for and that there is presumptive evidence for the presence of the analyte. The concentration reported is considered an estimate usable only for information purposes.
- "E" indicates the analyte was analyzed for and detected at a concentration outside the calibration range of the instrument. The reported concentration is an estimate possibly containing significant error.
- "R" indicates that the data were rejected during validation by the independent contractor because of quality assurance problems or for administrative reasons. Many sets of data from radionuclide analyses were marked "R" during the validation process because the instrument calibration data arrived late from the analytical laboratory. Evaluation of the radionuclide analytical results and the calibration data during the qualitative risk assessment indicated the analytical data were usable, although the "R" qualifier code was retained.
- "B" indicates that the analyte was detected in the sample and in the blank associated with the sample.

Data marked with "J" or "R" qualifiers were used for the LFI and QRA as were data that had no qualifiers attached. Data that were marked with "U" or "UJ" qualifiers were not used. Data that were marked with "B" qualifiers were evaluated using the EPA five and ten times rule to assess if they were usable.

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Table 2-1 LFI Investigation Activities for 100-DR-1
Operable Unit High-Priority Sites (page 1 of 2)

Site	Name - Size	Comments	LFI Investigative Approach
116-D-1A	105-D Fuel Storage Basin Trench No. 1 40m x 3m x 1.8m deep	Received contaminated water and sludge from 118-D-6 storage basin	B, C, G, F, R, H
116-D-1B	105-D Fuel Storage Basin Trench No. 2 30m x 3m x 5m deep	Received contaminated water and sludge from 118-D-6 storage basin	B, C, F, R, H
116-D-6	Cushion Corridor Decontamination French Drain 1m x 1m diameter	Received domestic water from changing room and water from the mask decontamination station	B, C, G, F, R
116-D-7	107-D Retention basin 142m x 70m x 6m deep	Received cooling water waste, decontamination waste, ruptured fuel element waste	B, C, F, R, H
116-DR-9	107-DR Retention Basin 183m x 70m x 6m deep	Received cooling water waste from 118-DR-2 reactor, received ruptured fuel element waste	B, C, F, R, H
116-DR-1	107-DR Liquid Waste Disposal Trench No. 1 91m x 5m x 6m deep	Received effluent overflow from 116-D-7 and 116-DR-9 retention basins	B, C, P, F, R, H
116-DR-2	107-DR Liquid Waste Disposal Trench No. 2 46m x 3m x 6m deep	Received effluent overflow wastes from 107-D and 107-DR retention basins	B, C, F, R, H
116-D-2A	Pluto Crib 3m x 3m x 3m deep	Received effluent water from tubes following fuel cladding failures	B, C, G, F, R
116-D-9	117-D Reactor Confinement Seal Pit Drainage Crib 3m x 3m x 3m deep	Received 420,000l of waste	B, C, F, R
132-D-3	Effluent Pumping Station	Received water from 118-D-6 reactor fuel storage basin overflows	B, C, G, F, R
116-D-5	Outfall Structure	Received effluent from 116-D-7 and 116-DR-9 retention basins	B, C, G, F, R, H
116-DR-5	Outfall Structure	Received effluent from 116-D-7 and 116-DR-9 retention basins	B, C, G, F, R, H
116-D-3	Crib No. 1 (French Drain) 1m x 1.5m diameter	Received low-level fission product effluent from contaminated maintenance shop and cask decontamination pad in 108 building	B, C, G, F, R, H

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**Table 2-1 LFI Investigation Activities for 100-DR-1
Operable Unit High-Priority Sites (page 2 of 2)**

Site	Name - Size	Comments	LFI Investigative Approach
116-D-4	Crib No. 2 (French Drain) 1m x 1.5m diameter	Received low-level fission product wastes from contaminated maintenance shop and cask decontamination pad	B, C, F, R, H
130-D-1	Underground Storage Tank 46 in diameter x 12 ft	Gasoline storage tank	B, C, F, R
108-D	Demolished Office Building	Received wastes associated with decontamination and repair of contaminated reactor process tube equipment	T, C, F
	Sodium Dichromate Tanks	Two tanks that stored sodium dichromate	T, C, F
103-D	Fuel Element Storage Building	Stored unirradiated fuel elements; later used to store packaged radioactive sample	W, C, F
126-D-2	Solid Waste Landfill	Received decommissioning/demolition waste	N
4A, 4B, 18	Burial Grounds	Received radioactive and non-radioactive waste	N
115-D	Demolished Gas Recirculation Building	Recirculated cover gases around reactor core	N, H
117-D	Demolished Exhaust Air Filter Building	Received reactor building exhaust gas	N, H
	Process Effluent Pipelines	Received cooling water, decontamination wastes, contaminated reactor cooling water	N
107-D/ 107-DR	Sludge Disposal Trenches	Received sludge from retention basins	N
<p>B = Vadose zone borehole - drilling, geologic logging, and sampling C = Chemical and radionuclide analysis of samples P = Physical properties analysis of samples G = Borehole spectral gamma-ray geophysical log F = Field screening for radioactivity, volatile organic compounds, and hexavalent chromium R = Ground penetrating radar to position boreholes T = Test pits W = Wipe samples N = No intrusive investigation H = Historical data reviewed</p>			

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3.0 INVESTIGATION RESULTS AND CONCLUSIONS

This chapter presents results and conclusions from the investigations of the high-priority sites (Figures 3-1 through 3-3) in the 100-DR-1 Operable Unit. Sections 3.1 through 3.17 address the high-priority sites where intrusive investigations occurred. Sections 3.18 through 3.24 address the non-intrusive investigations that occurred at the remaining high-priority sites. Section 3.25 addresses the intrusive investigation performed at a low-priority site. Section 3.26 presents a summary of potential ARARs for the 100-DR-1 Operable Unit.

The following types of data are presented in discussions of the high-priority sites:

- Site location, size, characteristics, history, and expected contaminants.
- Geologic data obtained during the investigation.
- Analysis of results from off-site laboratory analyses of sediment samples for volatile organic compounds, semi-volatile organic compounds, metals, pesticides, PCBs, radionuclides, specific anions, and on-site laboratory analyses of physical properties. Data validation qualifier codes associated with specific analyses are included in tables at the end of Section 3 and in the analytical data appendices.
- Field screening data collected using hand-held instruments during sampling. Field screening was intended to assist in selection of sample intervals and to determine the depth at which drilling and sampling was stopped. Field screening data are qualitative; the identification of specific constituents and their concentrations are provided by analytical results from the off-site labs.
- Borehole spectral gamma geophysical logging results.
- Results of the comparison of data collected during the 1992 LFI and data from previous "historical" investigations at the site.
- Data applicable to the 100-DR-1 LFI that were obtained from the vadose zone during the limited field investigation of the 100-HR-3 Groundwater Operable Unit.
- Concentrations of ^3H and ^{90}Sr in groundwater from monitoring wells downgradient and upgradient of the high-priority sites are reviewed to assess the potential impact on groundwater in the uppermost unconfined aquifer. These data were obtained during the 100-HR-3 LFI. Values used for the groundwater assessment were the maximum concentrations detected from the 1993 sampling rounds.

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3.1 116-D-1A FUEL STORAGE BASIN TRENCH NO. 1

This trench was 40 m (130 ft) x 3 m (10 ft) x 1.8 (6 ft) deep. It was in use from 1947 to 1952 and received contaminated water and the sludge from the fuel storage basin 118-D-6.

In addition to radionuclide contamination, approximately 1,000 kg (2,200 lb) of sodium dichromate were reportedly disposed of in this trench.

Figure 3-1 shows the 116-D-1A trench and the approximate location of the vadose zone soil boring. One borehole was placed near the influent end of the trench. Figure 3-4 shows a summary of LFI borehole data and historical data.

3.1.1 Geology

The 116-D-1A site is covered by sandy gravel fill to a depth of 6 feet below land surface (bls). Sandy gravel is also present from 6 to 24 feet bls. The lithology changes to gravelly sand at 24 to 27 feet bls. From 27 to 39 feet bls the lithology is sand. At 39 feet bls gravelly sand is present to a depth of 44 feet bls. The lithology from 44 to 46 feet bls is silty sandy gravel. Sandy gravel is again present from 49 to 53.2 feet bls, the total depth of the borehole.

3.1.2 Soil Samples

Twelve soil samples were collected and submitted for chemical and radionuclide analyses from the 116-D-1A vadose zone borehole.

3.1.2.1 Chemical Analysis. No volatile organic compounds were found.

The semi-volatile organic compounds bis(2-ethylhexyl) phthalate, di-n-butyl phthalate, 1,3-dichloro-benzene, and carbazole were detected in six samples in concentrations less than the CRQL. Bis(2-ethylhexyl)phthalate was detected in samples BO1874 (8.0 - 10.5 ft bls), BO1876 (17.0 - 19.5 ft bls), BO1877 (24.0 - 26.3 ft bls), and BO1878 (27.0 - 29.5 ft bls) having the following concentrations: 48, 37, 350 and 350 $\mu\text{g}/\text{Kg}$, respectively. Di-n-butyl phthalate was detected in samples BO1876 (17.0 - 19.5 ft bls) and BO1877 (24.0 - 26.3 ft bls) having concentrations of 77 and 51 $\mu\text{g}/\text{Kg}$, respectively. 1,3-Dichlorobenzene was detected in sample BO1877 having a concentration of 38 $\mu\text{g}/\text{Kg}$. Carbazole was detected in sample BO1884 (52.8 - 53.1 ft bls) having a concentration of 52 $\mu\text{g}/\text{Kg}$. Table 3-1 presents a summary of the analytical results.

No PCB compounds were detected. Beta benzene hexachloride (BHC) was detected in one sample BO1880 (33.0 - 35.0 ft bls) having a concentration less than the CRQL, i.e., at a concentration of 7.8 $\mu\text{g}/\text{Kg}$. The results of the analysis are presented in Table 3-2.

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Chromium, Cd, Pb, and Ni were detected in concentrations above the Hanford Site background 95% UTL (Table 3-3). The elevated levels of Cr occurred in BO1875 (12.2 - 14.7 ft bls), BO1876 (17.0 - 19.5 ft bls), BO1879 (33.0 - 35.0 ft bls), BO1880 (33.0 - 35.0 ft bls), and BO1881 (41.0 - 43.5 ft bls) having the following concentrations: 41.6, 87.1, 108, 82.3, and 42.1 mg/Kg. The elevated levels of cadmium occurred in BO1876 (17.0 - 19.5 ft bls), BO1879 (33.0 - 35.0 ft bls), BO1881 (41.0 - 43.5 ft bls), and BO1884 (52.8 - 53.1 ft bls) having the following concentrations: 1.0, 0.95, 1.0, and 0.67 mg/Kg. The elevated levels of lead occurred in BO1876 (17.0 - 19.5 ft bls), BO1877 (24.0 - 26.2 ft bls), BO1878 (27.0 - 29.5 ft bls), BO1879 (33.0 - 35.0 ft bls), BO1880 (33.0 - 35.0 ft bls), BO1881 (41.0 - 43.5 ft bls) and BO1882 (43.0 - 46.0 ft bls) having the following concentrations: 38.6, 19.4, 27.6, 36.0, 51.9, 32.0 and 36.0 mg/Kg. The elevated levels of nickel occurred in BO1879 (33.0 - 35.0 ft bls) and BO1880 (33.0 - 35.0 ft bls) having the following concentrations: 42.5 and 35.4 mg/Kg.

3.1.2.2 Radionuclide Analysis. Radioactive isotopes of Be, Na, K, Fe, Co, Sr, Tc, Zr, Ru, Cs, Ce, Ba, Eu, Ra, Th, U, Pu, and Am were detected in activities above the CRDL. Radionuclide contamination is present from the surface to the bottom of the borehole (see Figure 3-4), with the maximum concentrations present between the 17.0 and 30.0 ft interval.

3.1.2.3 Field Screening. The well site geologist performed field screening for VOCs. No VOCs were detected. The HPT performed field screening of beta-gamma activity using a Geiger-Mueller detector with a P-11 probe. Detections were recorded in the interval of 8.0 feet bls to 49.0 feet bls. The highest values, 1500 and 1100 counts per minute (cpm) occurred in the 17.0 to 19.5 feet bls interval.

3.1.2.4 Geophysical Logging. Man-made radionuclides identified during the RLS Spectral Gamma-Ray survey of borehole 116-D-1A are ^{137}Cs , ^{60}Co , ^{152}Eu , and ^{154}Eu . Cesium-137 was detected in the borehole survey from the surface to the maximum survey depth of 45.5 feet. The maximum activity (exceeded 200 pCi/g) occurred in the interval from 14 to 28 feet. Cobalt-60 was detected in the borehole from the surface to the maximum survey depth of 45.5 feet. Europium-152 was detected in the borehole survey from the surface to the maximum survey depth of 45.5 feet. The maximum activity (200 pCi/g) occurred at 17.0 feet. Europium-154 was detected in the borehole survey from 8 feet to the maximum survey depth of 45.5 feet. The maximum activity (20 pCi/g) occurred at 17 feet. Europium-154 was detected when the activity of ^{152}Eu reached 10 pCi/g.

3.1.3 Conclusions

No volatile organic compounds were detected in the soil samples collected from the 116-D-1A. Six of the nine samples analyzed from borehole 116-D-1A detected concentrations of semi-volatile compounds. The source of these compounds are not known. The pesticide beta-BHC was detected in one sample (33.0 - 35.0 ft bls) having a concentration less than the CRQL. Chromium, Cd, Pb and Ni were detected in concentrations above the Hanford Site background 95% UTL. The maximum

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concentration of Cr detected was from the 33.0 ft sample. The maximum concentration of Cd detected came from the surface and 41.0 ft samples. The maximum concentration of lead detected came from the 33.0 ft sample and the maximum concentration of nickel detected also came from the 33.0 ft sample. These metals are considered potential contaminants of concern. Historical data for inorganic and organic, nonradionuclide constituents are not available for comparison.

Radionuclide contamination at the 116-D-1A site was expected at the 15.0 ft depth (Dorian and Richards 1978), as shown by Figure 3-4. Field screening data collected during the LFI revealed levels of radioactivity in the 10.0 ft to 53.2 ft interval. Limited field investigation geophysical borehole logs detected the presence of radionuclides from the surface to the maximum survey depth (45.5 ft). The maximum activity (Cs-137, >200 pCi/g) occurred in the interval of 14.0 ft to 28.0 ft. Limited field investigation soil sample data indicates that the maximum radionuclide contamination is present between 17.0 ft and 30.0 ft.

One site considered to be analogous to 116-D-1A located in the 100-BC-1 Operable Unit has been examined thus far by LFIs. This site is 116-B-2. To assess the concept that these sites are analogous, a comparison of the radionuclide and chemical analytical results from the 100-BC-1 LFI samples and data from 116-D-1A follows.

Radionuclides found in both sites included ^{60}Co , ^{90}Sr , ^{137}Cs , ^{152}Eu , ^{235}U , ^{238}U , $^{239/240}\text{Pu}$. Many radionuclide contaminants are present in samples from 116-D-1A which were not found in 116-B-2 samples. These include ^7Be , ^{14}C , ^{22}Na , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{65}Zn , ^{99}Zr , ^{99}Tc , ^{103}Ru , ^{106}Ru , ^{134}Cs , ^{140}Ba , ^{141}Ce , ^{144}Ce , and ^{154}Eu . At site 116-B-2 there are no inorganic or metal contaminants. At site 116-D-1A, Cd, Cr, Ni, and Pb are contaminants. Semi-volatile compounds were detected at 116-D-1A. The pesticide beta-BHC (beta isomer of benzene hexachloride) was found at site 116-D-1A. The disparities in the contaminants found in samples from 116-B-2 and 116-D-1A indicate that the sites are not analogous. The most obvious reasons are the operating histories; 116-B-2 was used once in 1946; 116-D-1A was used from 1947 to 1952.

3.1.4 Groundwater Assessment

Monitoring well 199-D5-12 is upgradient of site 116-D-1A. Monitoring well 199-D5-16 is downgradient of site 116-D-1A. The Cr concentrations from monitoring well 199-D5-16 groundwater samples is higher than the concentrations found in groundwater samples from monitoring well 199-D5-12. The ^3H concentrations are lower in the downgradient well than those detected in the upgradient well. Strontium-90 was detected in samples from the upgradient well but was not detected in samples from the downgradient well.

3.2 116-D-1B FUEL STORAGE BASIN TRENCH NO. 2

This trench was 30 m (100 ft) x 3 m (10 ft) x 5 m (15 ft) deep. It was in use from 1953 to 1967 and received contaminated water and sludge from the fuel storage basin 118-D-6.

In addition to radionuclide contamination, approximately 700 kg (1,540 lb) of sodium dichromate and 2,000 kg (4,400 lb) each of sodium formate and sodium sulfamate were reportedly disposed of in this trench. The DOE/RL (1992d) reports that 2,000 kg (4,400 lb) of sodium oxylate, rather than sodium formate, were disposed into this trench.

Figure 3-1 shows the 116-D-1B trench and the approximate location of the vadose zone soil borehole. One borehole was placed near the influent end of the trench. Figure 3-5 summarizes the LFI data and historical data.

3.2.1 Geology

This site is characterized by sandy gravel fill to a depth of 20 feet bls. Sandy gravel is also present from 20 to 24 feet bls. From 24 to 28 feet bls the lithology changes to gravelly sand. Silty sand is present from 28 to 34 feet bls. The interval from 34 to 36.8 feet bls, the total depth of the borehole is composed of gravelly sand.

3.2.2 Soil Samples

Eight soil samples were collected and submitted for chemical and radionuclide analysis.

3.2.2.1 Chemical Analysis. The VOCs methylene chloride, acetone, and toluene were detected in concentrations less than the CRQLs. Methylene chloride was detected in BO18D9 (24.2 - 26.7 ft bls) and BO18F0 (28.0 - 30.4 ft bls) having the following concentrations: 7 and 11 $\mu\text{g}/\text{Kg}$. Acetone was also detected in BO18D9 and BO18F0 having the following concentrations: 26 and 41 $\mu\text{g}/\text{Kg}$. Toluene was detected in BO18F0 having a concentration of 1.0 $\mu\text{g}/\text{Kg}$. The analytical results are summarized in Table 3-5.

The semi-volatile organic compounds di-n-butyl phthalate, carbazole, and chrysene were detected in two samples having concentrations less than the CRQL. Di-n-butyl phthalate was detected in BO18D7 (17.0 - 19.6 ft bls) having a concentration of 35.0 $\mu\text{g}/\text{Kg}$. Carbazole and chrysene were detected in BO18F0 (28.0 - 30.4 ft bls) having concentrations of 54 and 58 $\mu\text{g}/\text{Kg}$, respectively. The analytical results are summarized in Table 3-6.

The pesticide aldrin was detected in sample BO18D3 (0.0 - 2.0 ft bls) having a concentration less than the CRQL, i.e., the concentration being 7.5 $\mu\text{g}/\text{Kg}$. The analytical results are summarized in Table 3-7.

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Chromium and Zn were detected in the sample BO18D5 (14.0 - 16.3 ft bls) having concentrations of 30.4 and 106 mg/Kg, respectively, which exceed the Hanford Site background 95% UTL. Lead was detected in samples BO18D5 and BO18D7 (17.0 - 19.6 ft bls) having concentrations of 22.0 and 16.3 mg/Kg respectively, which exceed the Hanford Site background 95% UTL. The analytical results are presented in Table 3-8.

3.2.2.2 Radionuclide Analysis. Radioactive isotopes of Be, C, Na, K, Cr, Co, Fe, Zn, Sr, Tc, Zr, Ru, Cs, Ce, Eu, Ra, Th, U, Pu, and Am were detected having activities above the CRDL, and are shown in Table 3-9. All eight samples analyzed show radionuclide contamination, with the maximum activities detected in the 14.0 - 20.0 ft interval.

3.2.2.3 Field Screening. Field screening for VOCs was performed by the field geologist. No VOCs were detected. The HPT performed field screening of beta-gamma activity using a Geiger-Mueller detector with a P-11 probe. Observed beta-gamma levels were recorded between 10 and 28 feet, with the maximum value (1100 cpm) occurring at the 14.0 and 24.2 feet bls intervals.

3.2.3 Conclusions

Volatile organic compounds acetone, methylene chloride, and toluene were detected in concentrations less than the CRQL. Although acetone, methylene chloride, and toluene are most likely attributable to sampling media or lab contamination the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. Historical records do not indicate that acetone, methylene chloride and toluene were disposed of in the 100-DR-1 Operable Unit.

Sources of the semi-volatile compounds carbazole, chrysene, and di-n-butyl phthalate, are unknown. The pesticide aldrin was detected at the surface, having a concentration below the CRQL. It was not detected in any of the remaining samples. Chromium and Zn were detected in concentrations exceeding the Hanford Site background 95% UTL at the 14.0 ft interval. Lead was also detected in concentrations exceeding the Hanford Site background 95% UTL at the 14.0 ft interval and 17.0 ft interval. These metals are considered potential contaminants of concern. Historical data for organic and inorganic, non-radionuclide constituents are not available for a comparison to the 116-D-1B site.

Radionuclide contamination at the 116-D-1B site was expected at the 15.0 ft interval (Dorian and Richards 1978), as shown by Figure 3-5. Field screening data collected during the LFI revealed radioactivity in the 10.0 to 20.0 ft interval. LFI soil sample analytical data reveals radionuclide contamination in all of the samples collected, with the maximum activities occurring in the 14.0 - 20.0 ft interval. This corresponds with the field screening data and the historical data.

One site considered to be analogous to the 116-D-1A site located in the 100-BC-1 Operable Unit has been examined thus far by the LFIs. This site is 116-B-2. To assess the concept that these sites are analogous, a comparison of the radionuclide and

chemical analytical results from the 100-BC-1 LFI samples and data from 116-D-1B follows.

Radionuclides found in both sites included ^{60}Co , ^{90}Sr , ^{137}Cs , ^{152}Eu , ^{235}U , ^{238}U , $^{239/240}\text{Pu}$. Many radionuclides contaminants are present in samples from 116-D-1B which were not found in 116-B-2 samples. These include ^7Be , ^{14}C , ^{22}Na , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{65}Zn , ^{99}Zr , ^{99}Tc , ^{103}Ru , ^{106}Ru , ^{134}Cs , ^{140}Ba , ^{141}Ce , ^{144}Ce , and ^{154}Eu .

At site 116-D-1B, Cr, Pb and Zn are contaminants. Acetone, methylene chloride and toluene were detected at 116-D-1B. Semi-volatile compounds were detected at 116-D-1B. The pesticide aldrin was found at 116-D-1B. The disparities in the contaminants found in samples from 116-B-2 and 116-D-1B indicate that the sites are not analogous. The most obvious reason are the operating histories; 116-B-2 was used once in 1946; 116-D-1B was used from 1953 to 1967.

3.2.4 Groundwater Assessment

Monitoring well 199-D5-12 is upgradient of site 116-D-1B. Monitoring well 199-D5-16 is downgradient of 116-D-1B. The Cr concentration from monitoring well 199-D5-16 groundwater samples is higher than the concentrations found in groundwater samples from monitoring well 199-D5-12. The ^3H concentration is lower in samples from the downgradient well than those detected in samples from the upgradient well. Strontium-90 was detected in samples from the upgradient well but was not detected in samples from the downgradient well.

3.3 116-D-6 CUSHION CORRIDOR DECONTAMINATION FRENCH DRAIN

This french drain was 1 m (3 ft) by 1 m (3 ft) in diameter. It was in use from 1961 to 1967 and received domestic water from the changing room and water from the mask decontamination station.

Figure 3-1 shows the location of the 116-D-6 french drain and the approximate location of the vadose zone soil borehole. One borehole was placed near the center of the french drain. Figure 3-6 is a summary diagram of the LFI borehole data.

3.3.1 Geology

The 116-D-6 site is covered by a minimum of 3 feet of slightly gravelly sand. Slightly gravelly sand is also present from 3 to 10 feet bls. At 10 feet bls, the lithology is gravelly sand, and is present to 23 feet bls, the total depth of the borehole.

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3.3.2 Soil Samples

Two soil samples were collected and submitted for chemical and radionuclide analysis.

3.3.2.1 Chemical Samples. Volatile organic compounds acetone and toluene were detected having concentrations less than the CRQL. Acetone was detected in sample BO5X06 (15.0-17.5 ft bls) having a concentration of 27 $\mu\text{g}/\text{Kg}$. Toluene was detected in samples BO5X06 and BO5X07 (20.0 - 22.5 ft bls) having concentrations of 2 and 2 mg/Kg, respectively. Table 3-10 presents a summary of the analytical data.

Semi-volatile organic compounds benzo(b)fluoranthene, chrysene, di-n-octyl phthalate and were detected in sample BO5X06 (15.0 - 17.5 ft bls) having concentrations of 59, 62, and 38 $\mu\text{g}/\text{Kg}$, respectively, which are less than the CRQL. Table 3-11 presents a summary of the analytical data.

No pesticides or PCB compounds were detected.

No metals or inorganic compounds were detected in concentrations exceeding the Hanford Site background 95% UTL.

3.3.2.2 Radionuclide Analysis. Table 3-12 presents a summary of the detected radionuclides. All analysis listed are less than the CRDL. Both samples analyzed identified the same types of radionuclide contamination present, and similar activity levels.

3.3.2.3 Field Screening. The field geologist performed field screening for VOCs. Two readings of 0.6 and 0.6 ppm were detected at the 10.0 and 11.0 feet bls intervals, respectively. The HPT performed field screening of beta-gamma activity using a Geiger-Mueller detector with a P-11 probe. There were no observed beta-gamma levels above the background detected during the field screening efforts.

The well site geologist performed an analysis on soil from 20.0 - 22.5 feet bls for hexavalent chromium. The results were negative.

3.3.2.4 Geophysical Logging. Man-made radionuclides identified during the RLS Spectral Gamma-Ray borehole are ^{152}Eu and ^{154}Eu . Europium-152 was detected in the borehole from 6 to 12 feet, having an activity of less the 4 pCi/g. Europium-154 was detected in the borehole from 9 to 10 feet having an activity of less the 1 pCi/g.

3.3.3 Conclusions

Acetone was detected in one sample and toluene was detected in two samples. Historical records do not indicate that either toluene or acetone were disposed of in the 100-DR-1 Operable Unit. Although both acetone and toluene are most likely attributed to sampling media or lab contamination the analyses were not flagged with the "B"

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qualifier to indicate laboratory blank contamination. Benzo(b)fluoranthene, chrysene, and di-n-butyl phthalate were detected in one sample, however the source of these contaminants is unknown. Phthalates are typical laboratory contaminants, yet there were no data flagged with the "B" qualifier to indicate laboratory blank contamination. No other organic compounds were detected. No metals or inorganic compounds were detected in concentrations exceeding the Hanford Site background 95% UTL.

Radionuclide contamination at the 116-D-6 site is shown on Figure 3-6. Field screening data collected during the LFI did not indicate radionuclide contamination was present. Geophysical logs collected during the LFI revealed radionuclides present between 6.0 and 12.0 ft. No samples were collected and analyzed from this interval. The soil sample analytical results indicate that the presence of radionuclide contamination is between 15.0 and 22.5 ft. The radionuclides detected had similar activities from each sample.

There are no sites considered to be analogous to 116-D-6 located in other 100 Area source operable units that have been examined thus far by LFIs.

3.3.4 Groundwater Assessment

There is an upgradient monitoring well in the vicinity of 116-D-6, (199-D5-16), however there is no downgradient well from which to gather data and draw any conclusions.

3.4 116-D-7 PROCESS EFFLUENT RETENTION BASIN

This retention basin was 142 m (467 ft) x 70 m (230 ft) x 6 m (20 ft) deep. It was in use from 1944 to 1967 and received cooling water effluent from the 118-D-6 (105-D) reactor for radioactive decay and thermal cooling before effluent was released to the Columbia River. The basin received ruptured fuel-element effluent waste after 1954.

Figure 3-2 shows the location of site 116-D-7 and the approximate location of the vadose zone borehole. One borehole was placed near the influent end of the trench. Figure 3-7 is a summary diagram of the LFI borehole data and historical data.

3.4.1 Geology

This 116-D-7 retention basin site was characterized by about 20 feet of fill material above native sediments. The interval from the surface to 3.0 ft bls is sandy gravel. From 3.0 - 3.8 ft bls is concrete. Beneath the concrete, from 3.8 - 7.0 ft bls is sandy gravel. Gravelly sand exists from 7.0 - 12.5 ft bls. From 12.5 - 15.5 ft bls the lithology changes to gravel. From 15.5 - 20.0 ft bls the lithology changes back to sandy gravel. The interval from 20.0 - 36.6 ft bls, the total depth, is sandy gravel.

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3.4.2 Soil Samples

Three samples were collected and submitted for chemical and radionuclide analysis from the 116-D-7 vadose zone borehole.

3.4.2.1 Chemical Samples. No volatile organic compounds were detected.

Semi-volatile organic compound phenol was detected in sample BO1897 (4.2 - 7.3 ft bls) and di-n-butyl phthalate was detected in sample BO18B0 (28.3 - 30.8 ft bls). The di-n-butyl phthalate and phenol concentrations were less than the CRQL. Table 3-13 presents a summary of the analytical results.

No pesticides or PCB compounds were detected.

Chromium was detected in concentrations above the Hanford Site background 95% UTL in two samples: BO1897 (4.0 - 7.0 ft bls) and BO18B0 (28.3 - 30.8 ft bls). The concentrations were 51.60 and 34.90 mg/Kg, respectively. Table 3-14 presents a summary of the analytical results.

3.4.2.2 Radionuclide Analysis. Table 3-15 presents a summary of the detected radionuclides. The detected activities of ^{235}U , ^{238}U , ^{239}Pu , and ^{241}Am were above the CRDL. The sample depth intervals at which these radionuclides were detected are as follows: 4.7 - 7.0 ft bls; 28.3 - 30.8 ft bls; and 34.0 - 36.6 ft bls. The maximum activities detected occur in the 4.7 - 7.0 ft interval.

3.4.2.3 Field Screening. The well site geologist performed field screening for VOCs. Volatile organic compounds were detected and recorded during the drilling/sampling operations at the depth interval of 19.3 - 21.8 feet. The values recorded are: 0.4 ppm, 0.4 ppm, 0.4 ppm, 0.9 ppm, and 0.4 ppm. The HPT performed field screening for beta-gamma activity. Two recorded readings occurred at the 1.9 to 3.0 ft interval, having values of 400 and 2000 cpm. The results are shown in Figure 3-7.

3.4.3 Conclusions

No VOCs were detected. Semi-volatile compounds di-n-butyl phthalate and phenol were detected at this site. The source of these compounds is unknown. Phthalates are typical laboratory contaminants, however the analytical data were not flagged with the "B" qualifier to indicate laboratory blank contamination. Historical records do not indicate that either of the semi-volatile compounds detected were disposed in the 100-DR-1 Operable Unit. No pesticides or PCBs were detected.

Chromium was detected in concentrations above the Hanford Site background 95% UTL (4.0 and 28.3 ft bls) and is considered a potential contaminant of concern.

Radionuclide contamination at the 116-D-7 site was expected in the 2.0 ft to 3.5 ft interval (Dorian and Richards 1978), as shown by Figure 3-7. Field screening data

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collected during the LFI indicated the presence of radioactivity at the 2.0 ft to 2.5 ft interval. The LFI soil sample analytical data did confirm the presence of radionuclide contamination as determined by the historical data. The maximum activities detected at site 116-D-7 were found in the 4.7 ft to 7.0 ft interval.

The 116-C-5, 116-B-11, 116-DR-9 and 116-H-7 sites are considered analogous sites to 116-D-7. The 116-B-11, 116-C-5 and 116-H-7 sites were sampled during the 100-BC-1 and 100-HR-1 LFIs. The 116-DR-9 site was sampled during the 100-DR-1 LFI. To assess the concept that this site is analogous, a comparison of the radionuclide and chemical analytical results from the 100-BC-1 and 100-HR-1 samples and the 100-DR-1 data, follows. The analysis of 116-C-5 sludge identified ^{60}Co , ^{90}Sr , ^{137}Cs , ^{152}Eu , ^{154}Eu , ^{155}Eu , ^{226}Ra , $^{233/234}\text{U}$, ^{238}U , ^{239}Pu , $^{239/240}\text{Pu}$, and ^{241}Am in material sampled above the concrete floor, however only ^{14}C and ^{90}Sr were detected in material above the concrete in the other basins. The ^{14}C and ^{90}Sr were found in one of five samples in the 116-D-7 site, but not in samples from the 116-H-7 site. Review of the data indicates that samples of sludge were probably not obtained at the 116-D-7, 116-DR-9 and 116-H-7 sites. For this reason it is not appropriate to assume that sludge present at the 116-C-5 site is analogous to materials in 116-D-7 or 116-DR-9.

The radionuclide contaminants found beneath the 116-D-7 and 116-H-7 sites are similar; both sites contain ^{60}Co , ^{90}Sr , ^{137}Cs , ^{152}Eu , ^{154}Eu , ^{226}Ra , ^{228}Th , $^{239/240}\text{Pu}$, ^{241}Am , ^{235}U and ^{238}U . There are many radionuclide contaminants found in the 116-DR-9 site that are absent at 116-D-7 and 116-H-7. There are ^7Be , ^{22}Na , ^{54}Mn , ^{58}Co , ^{59}Fe , ^{65}Zn , ^{95}Zr , ^{99}Tc , ^{103}Ru , ^{106}Ru , ^{134}Cs , ^{140}Ba , ^{141}Ce , and ^{144}Ce . Comparisons of metallic contaminants in samples from the three sites revealed no patterns; Ag, Cd, Cr, and Pb are the contaminants. The 116-D-7 and 116-H-7 sites have similar assemblages of organic compounds. The 116-DR-9 site contained VOCs, semi-volatile compounds, pesticides and PCBs that were not found in 116-D-7 and 116-H-7 samples. Because the additional radionuclides at site 116-DR-9 have not been detected in 100-BC-1 LFI samples, the 116-C-5, 116-B-11, and 116-H-7 sites are better analogous sites for the 116-D-7 site vadose zone radionuclide contamination. This is also the case for pesticides and PCBs.

3.4.4 Groundwater Assessment

There are no downgradient wells in the vicinity of 116-D-7 from which groundwater data can be compared to the upgradient monitoring well groundwater data.

3.5 116-DR-9 PROCESS EFFLUENT RETENTION BASIN

This retention basin was 183 m (600 ft) x 70 m (230 ft) x 6 m (20 ft) deep. It was in use from 1950 to 1965 and received cooling water effluent from the 118-DR-2 (105-DR) reactor for radioactive decay and thermal cooling before effluent was released to the Columbia River. The basin received ruptured fuel-element effluent waste after 1954.

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Figure 3-2 shows the location of the 116-DR-9 site and the approximate locations of the vadose zone boreholes. Figures 3-8 through 3-10 are summary diagrams of the LFI borehole data and historical data.

3.5.1 Geology

The 116-DR-9 retention basin was characterized by three vadose zone boreholes (116-DR-9A, 116-DR-9B and 116-DR-9C). The interval from 0 to 20 feet bls is probable fill material. The lithology from 0-3.0 ft bls is sandy gravel. Concrete exists from 3.0 - 4.3 ft bls. Underneath the concrete, from 4.3 - 20 ft bls is a mixture of gravelly sand, sand, and sandy gravel. In borehole 116-DR-9A, the lithology from 20.0 - 36.9 ft bls (total depth) is sand. At 35.0 ft bls, a contact between very dark grey sand and light to olive brown sand is marked by a layer of remnant organic material. In borehole 116-DR-9B, the interval from 20.0 - 37.4 ft bls (total depth), included sandy gravel, silt (20.5 ft bls), gravelly sand and sandy gravel. In borehole 116-DR-9C, the interval from 20.0 - 37.5 ft bls (total depth) included intervals of sandy gravel, sand, sandy gravel, gravelly sand and sandy gravel.

3.5.2 Soil Samples

A total of fourteen soil samples were collected and submitted for chemical and radionuclide analysis from the three boreholes drilled in the 116-DR-9 site (seven samples from 116-DR-9A, three samples from 116-DR-9B, and four samples from 116-DR-9C).

3.5.2.1 Chemical Analysis. Toluene was detected in six samples, BO18H5 (19.5 - 21.5 ft bls), BO18H6 (24.0 - 26.5 ft bls), BO18H7 (duplicate of BO18H6), BO18H9 (34.4 - 36.9 ft bls), BO18J1 (1.1 - 4.0 ft bls), and BO18K2 (9.6 - 12.2 ft bls). The toluene concentrations detected were all less than the CRQL, except for sample BO18H5, where the concentration detected is 11.0 $\mu\text{g}/\text{Kg}$. Methylene chloride was detected in samples BO18J0 (34.0 - 36.9 ft bls), and BO18J3 (8.0 - 11.1 ft bls) in concentrations below the CRQL. Acetone was detected in samples BO18J0 and BO18K2 (9.6 - 12.2 ft bls) in concentrations below the CRQL. Trichloroethene was detected in sample BO18K0 (0.0 - 2.0 ft bls) having a concentration less than the CRQL. Tables 3-16, 3-21 and 3-25 present a summary of the analytical results by borehole.

The following semi-volatile organic compounds were detected in sample BO18J1 (1.1 - 4.0 ft bls): anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k) fluoranthene, benzo(a)pyrene, indeno(1,2,3,cd)pyrene, benzo(g,h,i)perylene and pyrene. The concentrations detected were all below the CRQL. Pentachlorophenol and 2-nitrophenyl were detected in sample BO18K0 (0.0 - 2.0 ft bls) having concentrations below the CRQL. Butylbenzyl phthalate, bis(2-ethylhexyl) phthalate, and di-n-butyl phthalate were detected in sample BO18K1 (5.0-7.4 ft bls) having concentrations less than the CRQL. Bis(2-ethylhexyl) phthalate was also detected in sample BO18K2 (9.6-12.2 ft bls) having a concentration less than the CRQL.

Butylbenzyl phthalate, bis(2-ethylhexyl) phthalate, benzoic acid, diethyl phthalate, and di-n-butyl phthalate were detected in sample BO18D1 (29.9-32.7 ft bls). Butylbenzyl phthalate and bis(2-ethylhexyl) phthalate were detected in concentrations above the CRQL, i.e., 1900 and 4800 $\mu\text{g}/\text{Kg}$, respectively. Butylbenzyl phthalate and bis(2-ethylhexyl) phthalate were detected in sample BO18D2 (34.7-37.5 ft bls), having concentrations above the CRQL, i.e., 2200 and 5200 $\mu\text{g}/\text{Kg}$, respectively. Tables 3-17, 3-22 and 3-26 present the analytical results by borehole.

The PCB, Arochlor 1260, was detected in samples BO18H5 (19.5 - 22.1 ft bls) and BO18K0 (0.0 - 2.0 ft bls). The concentration (130 mg/Kg) detected in sample BO18K0 is below the CRQL. Tables 3-18 and 3-27 present the analytical results by borehole.

Cadmium was detected in samples BO18G9 (0.8 - 0.3 ft bls), BO18D2 (34.7 - 36.7 ft bls) and BO18J8 (31.0 - 33.6 ft bls) in concentrations that exceed the Hanford Site background 95% UTL, i.e., 0.68, 1.2 and 1.10 mg/Kg, respectively.

Arsenic was detected in sample BO18H2 (4.3 - 6.3 ft bls) having a concentration above the Hanford Site background 95% UTL, i.e., 12.4 mg/Kg. Chromium was detected in samples BO18K2 (9.6 - 11.6 ft bls) and BO18J2 (5.5 - 7.5 ft bls) having concentrations above the Hanford Site background 95% UTL, i.e., 73, 40 and 30 mg/Kg, respectively. Nickel was detected in sample BO18K2 (9.6 - 11.6 ft bls) having a concentration above the Hanford Site background 95% UTL, i.e., 37 mg/Kg. Tables 3-19, 3-23 and 3-28 present a summary of the analytical data by borehole.

3.5.2.2 Radionuclide Analysis. Tables 3-20, 3-24 and 3-29 present summaries of radionuclides detected per borehole. All radionuclides detected were above the CRDL. Summary figures 3-8, 3-9 and 3-10 show extensive radionuclide contamination ranging from the surface to the bottom of the borehole. The maximum activities detected occur in the 20.0 ft to 32.0 ft interval.

3.5.2.3 Field Screening. The well site geologist performed field screening for VOCs. Volatile organic compounds were detected at 4.3 - 6.8 and 16.0 ft intervals in borehole 116-DR-9A having values of 5.1 ppm and 3.3 ppm, respectively. Volatile organic compounds were also detected in borehole 116-DR-9C at the 9.6 - 10.4 ft interval, having values of 2.3 ppm and 1.3 ppm, respectively.

An HPT also performed field screening for radionuclide activity using a Geiger-Mueller detector with a P-11 probe. The results show detections in the 0 - 5.0 ft interval, ranging from 200 to 14,000 cpm.

3.5.3 Conclusions

Volatile organic compounds acetone, methylene chloride, toluene, and trichloroethene were detected in samples from the 116-DR-9 site. Historical records do not indicate that toluene, methylene chloride or acetone was disposed in the 100-DR-1 Operable Unit. Although acetone, methylene chloride, and toluene are most likely

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attributable to sampling media or lab contamination, the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. The source of the semi-volatile compounds detected are not known. The PCB Arochlor 1260 was also detected at the 116-DR-9 site. Arsenic, Cd, Cr and Ni were all detected in concentrations exceeding the Hanford Site background 95% UTL and are considered potential contaminants of concern. Cadmium was the only metal detected deeper than 12.0 ft bls. The other three metals were all detected in samples collected from intervals 12.0 ft or less bls. Historical data for organic and inorganic, non-radionuclide constituents are not available for comparison.

Radionuclide contamination at the 116-DR-9 site was expected at the 3.0 ft interval (Dorian and Richards 1978) as shown by Figures 3-8 through 3-10. Field screening data collected during the LFI revealed the presence of radionuclides in the 0 to 6.0 ft interval, with the highest readings occurring in the 3.0 to 4.0 ft interval. This confirms the historical data. The analytical data presented in the summary figures (3-8 through 3-10) show radionuclide contamination ranging from the surface to the total depth of the boreholes. The maximum activities detected occur in the 20.0 ft to 32.0 ft interval. There is a slight decrease in radionuclide activities with depth.

This site should be considered analogous to 116-C-5, 116-B-11, 116-D-7 and 116-H-7. However, the review of the data (presented in Section 3.4.3) indicates that site 116-DR-9 is not analogous to sites 116-C-5, 116-B-11, 116-D-7 and 116-H-7.

3.5.4 Groundwater Assessment

There are no upgradient wells in the vicinity of 116-DR-9 from which groundwater data can be compared to downgradient monitoring well groundwater data.

3.6 116-DR-1 LIQUID WASTE DISPOSAL TRENCH NO. 1

This trench was 91 m (300 ft) x 5 m (15 ft) x 6 m (20 ft) deep. It was in use from 1950 to 1967 and received effluent from 116-D-7 (107-D) and 116-DR-9 (107-DR) retention basins after 118-D-6 (105-D) and 118-DR-2 (105-DR) had outages caused by ruptured fuel elements.

In addition to radionuclide contamination, approximately 40 kg (88 lb) of sodium dichromate was disposed into this trench.

Figure 3-2 shows the location of the 116-DR-1 site and the approximate location of the vadose zone borehole. One borehole was placed near the influent end of the trench. Figure 3-11 is the summary diagram of the LFI borehole data and historical data.

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3.6.1 Geology

The 116-DR-1 liquid waste disposal trench was characterized by about 20 feet of fill material above native sediments that included the following: sandy gravel from 0.0 - 10.0 ft bls, gravelly silty sand from 10.0 - 14.8 ft bls, sandy gravel from 14.8 - 19.0 ft bls and gravelly sand from 19.0 - 20.0 ft bls. The interval from 20.0 - 40.2 ft, the total depth, included slightly gravelly sand from 20.0 - 23.0 ft bls, sand from 24.3 - 27.1 ft bls, slightly gravelly sand from 27.1 - 34.1 ft bls and sand from 34.1 - 40.2 ft bls.

3.6.2 Soil Samples

Five soil samples were submitted for chemical and radionuclide analysis. Three soil samples were collected for physical properties analysis.

3.6.2.1 Chemical Analysis. The volatile organic compounds toluene was detected in sample BO1885 (14.8 - 17.5 ft bls) having a concentration less than the CRQL, i.e., 3.0 $\mu\text{g}/\text{Kg}$, and methylene chloride was detected in sample BO1887 (19.0 - 22.3 ft bls), having a concentration less than the CRQL, i.e., 1.0 $\mu\text{g}/\text{Kg}$. Table 3-30 presents a summary of the analytical results.

Semi-volatile organic compounds 4-chloro-3 methylphenol, 2-chlorophenol, 1,3-dichlorobenzene, and 1,4-dichlorobenzene were detected in sample BO1887 (19.0 - 22.3 ft bls), having concentrations less than the CRQL, i.e., 38, 47, 48 and 37 $\mu\text{g}/\text{Kg}$. Benzoic acid was detected in sample BO1889 (24.2 - 27.1 ft bls), also having a concentration less than the CRQL, i.e., 250 $\mu\text{g}/\text{Kg}$. Table 3-31 presents a summary of the analytical results.

No pesticides or PCB compounds were detected.

Chromium, Ag, and Zn were detected in concentrations above the Hanford Site background 95% UTL (Table 3-32). Chromium was detected in sample BO1885 (14.8 - 17.5 ft bls) having a concentration of 186 mg/Kg. Silver was detected in samples BO1885 and BO1887 (19.0 - 22.2 ft bls) having concentrations of 3.5 and 3.3 mg/Kg, respectively. Zinc was detected in sample BO1885 having a concentration of 109 mg/Kg. These metals are considered potential contaminants of concern.

3.6.2.2 Radionuclide Analysis. Table 3-33 presents a summary of the detected radionuclides. All five soil sample analytical results showed radionuclide contamination. The interval from which the samples were collected from was 14.8 ft to 31.5 ft. The following radionuclides detected were above the CRDL: ^{14}C , and ^{90}Sr .

3.6.2.3 Field Screening. The well-site geologist performed field screening for VOCs. Volatile organic compounds were detected at 20.0 ft, 32.5 - 34.1 ft, and 39.1 - 39.7 ft; values detected were 0.6 ppm, 2.0 ppm, and 1.0 ppm, respectively.

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An HPT performed field screening for radioactivity using a Ludlum 14C portable scintillation detector with a gross gamma probe, and a Geiger-Mueller detector for beta-gamma. At 14.0 - 17.0 ft, detections were recorded as follows: 400 cpm β , and 800 cpm β , and at 19.0 - 22.2 ft, the recorded detections were 900 cpm β , 200 cpm β , and 250 cpm β .

3.6.3 Physical Properties Samples

Three samples were taken in conjunction with the 116-DR-1 LFI for physical properties analysis. The samples were analyzed as described in Section 2.4. The results will be used to support the 100 Area wide physical properties report to be issued at a later date.

3.6.3.1 Sampling Data. Split tube samples were collected from vadose borehole 116-DR-1 at 31.0 - 32.0 ft, 34.6 - 35.6 ft, and 38.1 - 39.1 ft bls. These sediments were dry, slightly gravelly sand composed of about 5-10% pebbles and 90-95% sand. All three samples were collected in the vadose zone.

3.6.3.2 Discussion of Physical Properties. The specific gravity (sG) was determined for both the coarse and fine fraction of the samples. The average sG for the three sample intervals was 2.78. Specific gravity was determined without vibration, and therefore, the sG values correspond to soil in the "loose" state rather than the "dense" state.

The moisture content of the 31.0 ft, 34.0 ft, and 38.1 ft samples was 4.05%, 3.15%, and 4.01%, respectively.

The hydraulic conductivity varied from 1.4E-03 to 4.9E-03 cm/s.

The porosity of the 31.0 ft sample was 35.21%, the porosity for the 34.6 ft sample was 35.62%, and the porosity of the 38.1 ft sample was 43.18%.

3.6.4 Conclusions

Volatile organic compounds methylene chloride and toluene were detected in samples collected and analyzed from the 116-DR-1 site. Historical records do not indicate that toluene or methylene chloride were disposed of in the 100-DR-1 Operable Unit. Although toluene and methylene chloride are most likely attributable to sampling media or lab contamination the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. The source of the semi-volatile compounds detected are unknown. Chromium, Ag, and Zn were detected in concentrations above the Hanford Site background 95% UTL and are considered potential contaminants of concern. Chromium, Ag, and Zn were detected in the 14.8 ft to 17.5 ft interval and silver was again detected in the 19.0 ft to 22.2 ft interval. Historical data for organic and inorganic, nonradionuclide constituents are not available for comparison.

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Radionuclide contamination at the 116-DR-1 site was expected at the 11.0 ft interval (Dorian and Richards 1978), as shown by Figure 3-11. Field screening data collected during the LFI revealed the presence of radionuclide contamination at the 14.8 ft to 22.8 ft interval. The maximum activities detected occur in the 14.8 ft to 17.5 ft interval. The activity values decrease with increasing depth.

Two sites which are located in the other 100 Area source operable units and were considered to be analogous to the 116-DR-1 site have been examined thus far by the LFIs. These sites are 116-H-1 and 116-B-1. 116-DR-2 is also considered to be analogous to 116-DR-1. To assess the concept that these sites are analogous, a comparison of radionuclide and chemical analytical results from the LFI samples from the four sites follows. The radionuclides contaminants present in samples from the three sites are similar. Chromium is a potential contaminant of concern in three of the four sites. Chromium is not a potential contaminant of concern at site 116-DR-2; cadmium and silver are. At site 116-H-1, As, Cr, and Pb are considered potential contaminants of concern. Volatile organic compounds were found at all four sites. The compounds detected are acetone, methylene chloride and toluene. Semi-volatile compounds were detected in three of the four sites, but there was little consistency of compounds between the sites. No PCBs or pesticides were found at the four sites. Based upon review of the data these sites are considered analogous.

3.6.5 Groundwater Assessment

There are no monitoring wells in the vicinity of 116-DR-1 from which groundwater data can be compared and assessed.

3.7 116-DR-2 LIQUID WASTE DISPOSAL TRENCH NO. 2

This trench was 46 m (150 ft) x 3 m (10 ft) x 6 m (20 ft) deep. It was in use from 1952 to 1967 and received effluent from the 116-D-7 (107-D) and 116-DR-9 (107-DR) retention basins after 118-D-6 (105-D) and 118-DR-2 (105-DR) had outages caused by ruptured fuel elements.

In addition to radionuclide contamination, an estimated 40 kg (88 lb) of sodium dichromate was disposed into this trench.

Figure 3-2 shows the location of the 116-DR-2 site and the approximate location of the vadose zone borehole. One borehole was placed near the influent end of the trench. Figure 3-12 is a summary diagram of the LFI borehole data and historical data.

3.7.1 Geology

The 116-DR-2 liquid waste disposal trench was characterized as having about 20 feet of fill material overlying the native sediments. This interval included sandy gravel from 0.0 - 17.0 ft bls and silty sandy gravel from 17.0 - 20.0 ft bls. The interval from 20.0 - 37.0 ft bls, the total depth, included gravelly sand from 20.0 - 24.0 ft bls, and sand from 24.0 - 37.0 ft bls.

3.7.2 Soil Samples

Six soil samples were collected during the LFI and submitted for chemical and radionuclide analysis.

3.7.2.1 Chemical Analysis. The volatile organic compound methylene chloride was detected in samples BO18F7 (30.0 - 32.0 ft bls) and BO18F8 (35.0 - 37.0 ft bls) having concentrations below the CRQL, i.e., 9.0 and 8.0 $\mu\text{g}/\text{Kg}$, respectively. Acetone was also detected in samples BO18F7 and BO18F8. The concentrations detected in both samples were above the CRQL. Table 3-34 presents a summary of the analytical results.

The semi-volatile organic compound di-n-butyl phthalate was detected in sample BO18F4 (19.6 - 22.6 ft bls) having a concentration below the CRQL, i.e., 35 $\mu\text{g}/\text{Kg}$. Table 3-35 presents a summary of the analytical results.

No pesticides or PCB compounds were detected.

Cadmium and Ag were detected in one sample, BO18F3 (14.0 - 17.0 ft bls) having concentrations above the Hanford Site background 95% UTL (Table 3-36). The concentration of cadmium detected was 1.10 mg/Kg and the concentration of silver detected was 3.70 mg/Kg . These two metals are considered potential contaminants of concern.

3.7.2.2 Radionuclide Analysis. Table 3-37 presents a summary of detected radionuclides from the LFI activities at this site. The following radionuclides detected had activities above the CRDL: ^{14}C , ^{40}K , ^{51}Cr , ^{60}Co , ^{90}Sr , ^{99}Tc , and ^{137}Cs . All six samples analyzed revealed radionuclide contamination, however the greatest concentration of radionuclides detected occurred in the 14.0 ft to 17.0 ft and 19.6 ft to 22.6 ft samples.

3.7.2.3 Field Screening. The well-site geologist performed field screening for VOCs. Volatile organic compounds were detected at the 18.0 ft interval having a value of 0.3 ppm.

An HPT performed field screening for beta-gamma using a Geiger-Mueller detector. A range of detects were observed and recorded in the interval from 14.0 ft to 27.0 ft. The values detected ranged from 200 to 400 cpm. The 400 cpm occurred at the 14.0 ft to 17.0 ft interval.

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3.7.3 Conclusions

Volatile organic compounds acetone and methylene chloride were detected in samples collected and analyzed during the LFI activities at the 116-DR-2 site. Historical records do not indicate that acetone or methylene chloride were disposed of in the 100-DR-1 Operable Unit. Although the acetone and methylene chloride are most likely attributable to sampling media or lab contamination the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. The source of the semi-volatile compound di-n-butyl phthalate is unknown. It may also be a lab or sampling media contaminant, however the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. Cadmium and Ag were detected in concentrations above the Hanford Site background 95% UTL and are considered potential contaminants of concern. Both metals were detected in the sample collected from the 14.0 ft to 17.0 ft interval. Historical data for organic and inorganic, nonradionuclide constituents are not available for comparison.

Radionuclide contamination at the 116-DR-2 site was expected at the 11.0 ft interval (Dorian and Richards 1978), as shown by Figure 3-12. Field screening data collected during the LFI revealed radionuclide contamination in the 14.0 ft to 27.0 ft interval. Maximum activities of the radionuclides detected in the soil samples analyzed from the LFI occurs in the 14.0 ft to 17.0 ft interval. Radionuclide activities decreased as depth increased.

Analogous site information for site 116-DR-2 is presented in Section 3.6.4.

3.7.4 Groundwater Assessment

There are no monitoring wells in the vicinity of 116-DR-2 from which groundwater data can be compared and assessed.

3.8 116-D-2A PLUTO CRIB

This crib was 3 m (10 ft) x 3 m (10 ft) x 3 m (10 ft) deep. It was in use from 1950 to 1956 and received effluent water from isolated process tubes following fuel cladding failures.

Figure 3-1 shows the location of the 116-D-2A site and the approximate location of the vadose zone borehole. One borehole was placed near the center of the crib. Figure 3-13 is a summary diagram of the LFI borehole data.

3.8.1 Geology

The 116-D-2A pluto crib was covered by approximately 10 feet of sandy gravel fill. The interval from 10 ft to 21 ft is also sandy gravel. Silty sandy gravel is present from

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21 ft to 24 ft. From 24 ft to 25 ft, the total depth of the borehole, the lithology is silty sand.

3.8.2 Soil Samples

Three soil samples were collected and submitted for chemical and radionuclide analysis during the LFI activities at the 116-D-2A site.

3.8.2.1 Chemical Analysis. Methylene chloride was detected in the sample BO5X03 (17.0 - 20.0 ft bls) having a concentration less than the CRQL, i.e., 3.0 $\mu\text{g}/\text{Kg}$ and toluene was detected in the sample BO5X05 (22.5 - 25.0 ft bls) having a concentration less than the CRQL, i.e., 2.0 $\mu\text{g}/\text{Kg}$. Table 3-38 presents a summary of the analytical results.

No semi-volatile organic compounds were detected.

The pesticide endrin was detected in the sample BO5X02 (12.0 - 15.0 ft bls) having a concentration less than the CRQL, i.e., 16.0 $\mu\text{g}/\text{Kg}$. Table 3-39 summarizes the results.

No metals or inorganic compounds were detected in concentrations above the Hanford Site background 95% UTL.

3.8.2.2 Radionuclide Analysis. Table 3-40 presents a summary of radionuclides detected in the borehole samples. The following radionuclides had detected activities above the CRDL: ^{14}C , ^{90}Sr , ^{99}Tc , ^{235}U , ^{238}U , ^{239}Pu and ^{241}Am . The analytical results from the 10.0 - 13.0 ft interval sample had the greatest number of radionuclides and the highest activities.

3.8.2.3 Field Screening. The well-site geologist performed field screening for VOCs. Volatile organic compounds were detected at 1.0 ft, 14.0 ft, 16.0 ft and 17.6 ft bls. The values recorded were 0.5, 1.5, 1.1 and 2.3 ppm, respectively.

An HPT performed field screening for beta-gamma activity using a Geiger-Mueller detector. Radionuclides were detected at the 10.0 ft, 14.0 ft and 16.0 ft intervals. The values were 2,000, 500 and 150 cpm, respectively.

The well-site geologist also performed an analysis for hexavalent chromium on soil collected from the 21.0 to 25.0 ft interval. A value of 0.0450 ppm hexavalent chromium was detected.

3.8.2.4 Geophysical Logging. Man-made radionuclides identified during the RLS Spectral Gamma-Ray borehole survey are ^{137}Cs , ^{60}Co , ^{152}Eu and ^{154}Eu . It should be noted that the ^{137}Cs and ^{154}Eu activities were detected to the bottom of the survey depth (19.5 ft), which was not the total depth of the borehole. Cesium-137 was detected in the interval from 5 ft to 19.5 ft. The activity detected exceeded 200 pCi/g in the 9.0 to

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14.0 ft interval. Cobalt-60 was detected in the interval from 10.0 ft to 13.5 ft. The activity detected was less than 1 pCi/g. Europium-152 was detected in the interval from 8.0 ft to 19.5 ft. The maximum activity detected was 30 pCi/g at 12.0 ft. Europium-154 was detected in the 10.0 ft to 14.0 ft interval. The activity detected was less than 2 pCi/g.

3.8.3 Conclusions

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Volatile organic compounds methylene chloride and toluene were detected in samples collected and analyzed from the 116-D-2A site during the LFI. Historical records do not indicate that methylene chloride or toluene were disposed of in the 100-DR-1 Operable Unit. Although toluene and methylene chloride are most likely attributable to sampling media or lab contamination the analyses were not flagged with the "B" qualifier to indicate laboratory contamination. The pesticide endrin was detected in the sample collected and analyzed from the 12.0 ft to 15.0 ft interval. No other organic compounds were detected. No metals or inorganic compounds were detected in concentrations above the Hanford Site background 95% UTL. Historical data for organic and inorganic, nonradionuclide constituents are not available for comparison.

The 116-D-2A site was not sampled previously, therefore there is no historical data to review for comparative purposes or expected presence of radionuclide contamination. Field screening data and geophysical logs collected during the LFI indicate the presence of radionuclide contamination. Field screening results revealed the presence of radionuclides in the 10.0 ft to 13.0 ft interval. Data from the geophysical logs revealed the presence of radionuclides in the 5.0 ft to 19.5 ft interval. The maximum activity detected (^{137}Cs) exceeded 200 pCi/g in the 9.0 ft to 14.0 ft interval. Analytical results from the three soil samples collected and analyzed show that the maximum activities detected were from the 10.0 ft to 13.0 ft interval, and that in general, the activities of the radionuclides detected decrease as depth increases.

There are no analogous sites from other source operable units that have been examined by LFIs as yet.

3.8.4 Groundwater Assessment

Monitoring well 199-D5-17 is the upgradient well to site 116-D-2A. Monitoring well 199-D5-12 is the downgradient well to site 116-D-2A. The concentration of Cr is greater in samples collected from the downgradient well samples than those detected in the upgradient well samples. The ^3H concentration is lower in samples from the downgradient well than those detected in samples from the upgradient well.

3.9 116-D-9 REACTOR CONFINEMENT SEAL PIT DRAINAGE CRIB

This crib was 3 m (10 ft) deep x 3 m (10 ft) in diameter. It was in use from 1960 to 1967 and received drainage from the exhaust air infiltration building (117-D) seal pits.

The radioactive elements received had short half-lives, and thus, this site was released from radiological controls before 1967.

Figure 3-1 shows the location of the 116-D-9 site and the approximate location of the vadose zone borehole. One borehole was placed in this crib. Figure 3-14 is the summary diagram of the LFI borehole data.

3.9.1 Geology

The 116-D-9 reactor confinement seal pit was covered by approximately 9 feet of sandy gravel fill. The interval from 9 feet to 17.4 feet bls consists of gravel. From 17.4 feet to 26 feet bls, the lithology changes to sandy gravel. The interval from 26 feet to the total depth of 27.9 feet is sand.

3.9.2 Soil Samples

Two soil samples were collected and submitted for chemical and radionuclide analysis.

3.9.2.1 Chemical Analysis. Acetone was detected in samples BO18G1 (17.3 - 20.9 ft bls) and BO18G2 (24.6 - 27.8 ft bls) having concentrations that exceed the CRQL, i.e., 60 and 39 $\mu\text{g}/\text{Kg}$, respectively. Table 3-41 presents a summary of the analytical results.

No semi-volatile organic compounds were detected.

No pesticides or PCB compounds were detected.

No metals or inorganics were detected in concentrations above the Hanford Site background 95% UTL.

3.9.2.2 Radionuclide Analysis. Table 3-42 presents a summary of radionuclides detected in soil samples collected and analyzed during the LFI. The following radionuclides were above the CRDL: ^{14}C and ^{238}U . The radionuclides were detected in both samples collected, from the depths of 18.0 - 20.2 ft and 24.6 - 27.8 ft bls.

3.9.2.3 Field Screening. The well-site geologist performed field screening for VOCs. No VOCs were detected throughout the drilling efforts.

An HPT performed field screening for radioactivity throughout the drilling and sample collection efforts, no levels above background were detected.

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3.9.3 Conclusions

The two samples analyzed from borehole 116-D-9 contained concentrations of acetone. Historical records do not indicate that acetone was disposed of in the 100-DR-1 Operable Unit. Although acetone is most likely attributable to sampling media or lab contamination the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. No other organic compounds were detected. No metals or inorganics were detected in concentrations above the Hanford Site background 95% UTL.

Radionuclides ^{14}C , ^{40}K , ^{90}Sr and ^{226}Ra were detected in both samples analyzed having activities above the CRDL. The activity detected for ^{90}Sr is higher in the 18.0 ft to 20.8 ft sample, however the activities for the other three radionuclides are very similar from both samples. Field screening data collected during the LFI did not reveal any radionuclides in the borehole.

There are no sites considered to be analogous to the 116-D-9 site located in other 100 Area source operable units that have been examined this far by LFIs.

3.9.4 Groundwater Assessment

Monitoring well 119-D5-17 is the upgradient well to site 116-D-9. Monitoring well 199-D5-16 is the downgradient well to site 116-D-9. The concentration of Cr detected in samples from 199-D5-16 are an order of magnitude greater than those detected in samples from 199-D5-17. Strontium-90 was not detected in samples from either well and ^3H concentrations are an order of magnitude lower in 199-D5-16 than that detected in 199-D5-17.

3.10 132-D-3 EFFLUENT PUMPING STATION

This pumping station functioned as a collection sump for potentially radioactive or contaminated liquids from the 118-D-6 (105-D) reactor building.

In addition to radioactive contamination, chemical contamination may be present because chromic acid, nitric acid and sulfuric acid may have been used as decontamination chemicals and may be present in the wastewater.

Figure 3-1 shows the 132-D-3 site and the approximate location of the vadose zone borehole. One borehole was placed in this site. Figure 3-15 is the summary diagram of the LFI borehole data.

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3.10.1 Geology

The 132-D-3 effluent pumping station site geology is characterized by sandy gravel from 0.0 - 8.0 ft bls, gravelly sand from 8.0 - 22.0 bls, silt from 22.0 - 22.2 ft bls, gravelly sand from 22.2 - 23.7 ft bls, silt from 23.7 - 24.2 ft bls, gravelly sand from 24.2 - 24.8 ft bls, sand from 24.8 - 32.0 ft bls, and gravelly sand from 32.0 - 38.6 ft bls.

3.10.2 Soil Samples

Three soil sample were collected and submitted for chemical and radionuclide analysis.

3.10.2.1 Chemical Analysis. Toluene was detected in sample BO1T36 (25.0 - 27.0 ft bls) (Table 3-43) having a concentration above the CRQL, i.e., 8 $\mu\text{g}/\text{Kg}$.

Semi-volatile organic compounds butylbenzyl phthalate, diethyl phthalate, and di-n-butyl phthalate were detected in sample BO1T37 (35.0 - 36.8 ft bls) (Table 3-44). Both butylbenzyl phthalate and di-n-butyl phthalate concentrations were below the CRQL, having concentrations of 590 and 4300 $\mu\text{g}/\text{Kg}$, respectively.

The pesticide heptachlor was detected in sample BO1T37 having a concentration of 8.4 $\mu\text{g}/\text{Kg}$, which is above the CRQL. Table 3-45 presents the analytical results.

No metals or inorganics were detected in concentrations above the Hanford Site background 95% UTL.

3.10.2.2 Radionuclide Analysis. Table 3-46 presents a summary of radionuclides detected in samples from borehole 132-D-3. The following radionuclides had activities above the CRDL: ^{14}C , ^{90}Sr , ^{99}Tc , ^{235}U , ^{238}U , ^{239}Pu and ^{241}Am . Each sample collected and analyzed had more or less the same radionuclides detected and similar activities.

3.10.2.3 Field Screening. The well site geologist performed field screening for VOCs. Volatile organic compounds were detected at depths of 19.8 - 21.8 ft and 24.8 - 27.0 ft having values of 0.9 ppm and 1.3 ppm respectively.

An HPT performed field screening for radioactivity throughout the drilling and sampling efforts, however no levels above background were detected.

3.10.2.4 Geophysical Logging. Man-made radionuclides identified during the RSL Spectral Gamma-Ray Survey are ^{60}Co , ^{137}Cs , ^{152}Eu and ^{154}Eu . Cesium-137 was detected in the interval of 16 to 19 ft, having an activity of less than 2 pCi/g. Cobalt-60 was detected in the interval of 17 to 19 ft, having an activity of less than 1 pCi/g. Europium-152 was detected in the interval of 16 to 19 ft, having an activity of less than 2 pCi/g. Europium-154 was detected in the interval of 17 to 18 ft, having an activity of less than 1 pCi/g.

3.10.3 Conclusions

Toluene was detected in one of the three samples collected and analyzed from the 132-D-3 site. Historical records do not indicate that toluene was disposed of in the 100-DR-1 Operable Unit. Although toluene is most likely attributable to sampling media or lab contamination the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. The source of the semi-volatile compounds detected are unknown. Phthalate esters are typical laboratory contaminants, however the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. The pesticide heptachlor was detected in one sample collected from the 35.0 ft to 36.8 ft depth interval. No metals or inorganics were detected in concentrations above the Hanford Site background 95% UTL.

Carbon-14, ^{40}K , ^{90}Sr , ^{99}Tc and ^{226}Ra were detected in soil samples collected and analyzed during the LFI having activities above the CRDL. Field screening data collected during the LFI did not reveal any radionuclides. Geophysical logs collected during the LFI revealed the presence of radionuclides (^{60}Co , ^{137}Cs , ^{152}Eu and ^{154}Eu) in the 16.0 ft to 19.0 ft depth interval. The maximum activity recorded was less than 2 pCi/g.

There are no sites considered to be analogous to the 132-D-3 site located in other 100 Area source operable units that have been examined thus far by LFIs.

3.10.4 Groundwater Assessment

There are no downgradient monitoring wells for site 132-D-3, thus an assessment of potential impact to groundwater emanating from site 132-D-3 cannot be made.

3.11 116-D-5 OUTFALL STRUCTURE

The 116-D-5 outfall structure received effluent from 116-D-7 (107-D) and 116-DR-9 (107-DR) retention basins. It was in use from 1944 to 1967.

Figure 3-2 shows the location of the 116-D-5 site and approximate location of the vadose zone borehole. One borehole was placed at this site. Figure 3-16 is a summary diagram of the LFI data and historical data for site 116-D-5.

3.11.1 Geology

The 116-D-5 site geology is characterized by silty sandy gravel from 0.0 to 7 ft bls, followed by slightly silty sand to the total depth of 27.0 ft.

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3.11.2 Soil Samples

Two soil samples were collected and submitted for chemical and radionuclide analysis.

3.11.2.1 Chemical Analysis. Trichloroethene was detected in sample BO18B9 (20.0 - 21.5 ft bls) (Table 3-47).

No semi-volatile organic compounds, pesticides, or PCB compounds were detected.

No metals or inorganics were detected in concentrations above the Hanford Site background 95% UTL.

3.11.2.2 Radionuclide Analysis. Table 3-48 presents a summary of radionuclides detected in samples collected from borehole 116-D-5. The following radionuclides had activities above the CRDL: ^{14}C , ^{235}U , ^{238}U , ^{239}Pu and ^{241}Am . Both of the samples analyzed show the same radionuclides detected and similar activities.

3.11.2.3 Field Screening. The well site geologist performed field screening for VOCs. Field screening results did not reveal any VOCs. However, the soil sample collected and analyzed from the 20.0 to 21.5 ft interval disclosed the presence of trichloroethene.

An HPT performed field screening for radioactivity. No activities above background were detected.

The well site geologist also performed an analysis for hexavalent chromium on soil from 25.0 - 27.5 ft. The result was negative.

3.11.2.4 Geophysical Logging. No man-made radionuclides were detected during the RLS Spectral Gamma-Ray survey.

3.11.3 Conclusions

The volatile organic compound trichloroethene was detected in the 20.0 ft to 21.5 ft depth sample, having a concentration less than the CRQL. Field screening data collected during the LFI did not reveal the presence of VOCs in the borehole. No other organic compounds were detected. No metals or inorganics were detected in concentrations exceeding the Hanford Site background 95% UTL. Historical data for organic and inorganic, nonradionuclide constituents are not available for comparison.

The 116-D-5 site was sampled for radionuclides in 1976 (Dorian and Richards 1978). Surface samples were collected and analyzed. The results are shown on Figure 3-16. LFI data indicates that ^{14}C , ^{40}K , ^{226}Ra and ^{228}Th were detected in activities above CRDL. Geophysical logs collected during the LFI did not identify any man-made radionuclides in the 116-D-5 borehole.

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There are no analogous sites to the 116-D-5 site located in other 100 Area source operable units that have been examined thus far by LFIs. Site 116-DR-5 was sampled during the 100-DR-1 LFI. The radionuclides detected at 116-DR-5 are the same as those detected at 116-D-5. Semi-volatile organic compounds were detected at 116-DR-5, but not at 116-D-5. Trichloroethene was detected at 116-D-5, but not at 116-DR-5. Samples analyzed from both sites did not have any metals or inorganic compounds having concentrations above the Hanford Site background 95% UTL. The pesticide dieldrin was detected at 115-DR-5, but no PCBs were detected at either site.

3.11.4 Groundwater Assessment

There is no well downgradient of site 116-D-5 with which to compare groundwater analyses results to. Monitoring well 199-D8-5 is the upgradient well for site 116-D-5. Chromium has been detected in the groundwater samples.

3.12 116-DR-5 OUTFALL STRUCTURE

This outfall structure was used to dispose of process effluent from the 116-D-7 and 116-DR-9 retention basins to the Columbia River. It was in use from 1950 - 1965.

Figure 3-2 shows the location of the 116-DR-5 site and the approximate location of the vadose zone borehole. One borehole was placed at this site. Figure 3-17 is a summary diagram of the LFI borehole data and historical data.

3.12.1 Geology

The 116-DR-5 site geology is characterized by gravelly silty sand from 0.0 to 6 ft bls, silty sandy gravel from 6.0 to 10 feet bls, and gravelly silty sand from 10.0 to the total depth of 27.5 feet bls.

3.12.2 Soil Samples

Two soil samples were collected and submitted for chemical and radionuclide analysis.

3.12.2.1 Chemical Analysis. No volatile organic compounds were detected.

Semi-volatile organic compounds bis (2-ethylhexyl) phthalate and butylbenzyl phthalate were detected in sample BO18C2 (25.0 - 27.0 ft bls). The concentrations detected, 5500 and 2100 $\mu\text{g}/\text{Kg}$ respectively, were above the CRQL. Table 3-49 presents a summary of the analytical results.

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The pesticide dieldrin was also detected in sample BO18C2, although the concentration (2.1 mg/Kg) was below the CRQL. No PCB compounds were detected. Table 3-50 presents the analytical results.

No metals or inorganics were detected in concentrations above the Hanford Site background 95% UTL.

3.12.2.2 Radionuclide Analysis. Table 3-51 presents a summary of the radionuclides detected in samples from borehole 116-DR-5. The following radionuclides had detected activities above the CRDL: ^{14}C , ^{235}U , ^{238}U , ^{239}Pu and ^{241}Am .

3.12.2.3 Field Screening. The well site geologist performed field screening for VOCs. One value was detected (3.5 ppm) at 27.0 ft.

An HPT performed field screening for radioactivity. No activities above background were detected.

3.12.2.4 Geophysical Logging. No man-made radionuclides were detected during the RLS Spectral Gamma-Ray survey.

3.12.3 Conclusions

No VOCs were detected at site 116-DR-5. Semi-volatile organic compounds were detected at site 116-DR-5. The source of these compounds are unknown. Although phthalate esters are most likely attributable to sampling media or lab contamination the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. The pesticide dieldrin was detected in one sample collected from the 21.0 ft to 27.0 ft depth interval. The concentration was above the CRQL. No metals or inorganic compounds were detected in concentrations above the Hanford Site background 95% UTL. Historical data for organic and inorganic, nonradionuclide constituents are not available for comparison.

Site 116-DR-5 was sampled for radionuclides in 1976 (Dorian and Richards 1978). Surface samples were collected, analyzed and identified radionuclide contamination. No subsurface samples were collected. Field screening data and geophysical logs collected during the LFI did not reveal the presence of radionuclides in the 116-DR-5 borehole. Two borehole soil samples collected and analyzed during the LFI revealed radionuclide contamination at the 20.0 and 25.0 ft bls intervals. The radionuclides detected (^{14}C , ^{40}K , ^{226}Ra and ^{228}Th) had similar activities detected in both samples.

Site 116-D-5 is the only analogous site having undergone LFI activities thus far. The discussion of this site is in Section 3.11.3.

3.12.4 Groundwater Assessment

There is only an upgradient well for site 116-DR-5 from which groundwater data has been collected. Contaminants of concern detected in the groundwater samples are Cr and ³H.

3.13 116-D-3 CRIB NO. 1 (FRENCH DRAIN)

This crib was 1.5 m (5 ft) deep and 1 m (3 ft) in diameter. It was in use from 1951 to 1967 and received low-level fission and activation product waste from a contaminated maintenance shop and cask decontamination pad in the 108-D building.

Figure 3-1 shows the location of the 116-D-3 site and the approximate location of the vadose zone borehole. One borehole was placed near the center of the crib. Figure 3-18 is a summary diagram of the 116-D-3 borehole data and historical data.

3.13.1 Geology

The 116-D-3 crib site geology is characterized by a sandy gravel interval from 0.0 to 15 feet bls, followed by a zone of slightly gravelly sand at 16.0 - 19.0 ft bls overlying a sand zone at 19.0 to 24.0 feet, the total depth of the borehole.

3.13.2 Soil Samples

Two soil samples were collected and submitted for chemical and radionuclide analysis.

3.13.2.1 Chemical Analysis. 2-Butanone was detected in sample BO18G8 (19.4 - 22.4 ft bls) having a concentration less than the CRQL, i.e., 10 µg/Kg (Table 3-52).

Semi-volatile organic compounds di-n-butyl phthalate and bis(2-ethylhexyl) phthalate were each detected in samples BO18G5 (14.0 - 17.0 ft bls) and BO18G8 (19.4 - 22.4 ft bls). The di-n-butyl phthalate concentrations (140 and 37 µg/Kg) and bis(2-ethylhexyl) phthalate concentrations (100 and 45 µg/Kg) are below the CRQL. Table 3-53 presents the analytical results.

No pesticides or PCB compounds were detected.

Silver was detected in sample BO18G5 having a concentration (3.40 mg/Kg) above the Hanford Site background 95% UTL (Table 3-54).

3.13.2.2 Radionuclide Analysis. Table 3-55 presents a summary of radionuclides detected in the two samples submitted for analysis. The following radionuclides were detected having activities above the CRDL: ¹⁴C, ⁹⁰Sr, ⁹⁹Tc, and ²⁴¹Am.

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3.13.2.3 Field Screening. The well site geologist performed field screening for VOCs. Volatile organic compounds were detected at 9.8 - 12.5 ft (3.0, 3.1, 1.6, 1.6 and 5.1 ppm), 15.0 - 17.0 ft (2.3 and 3.1 ppm) and 18.0 ft (2.5 ppm). The archive samples for these intervals were re-screened and the results indicate a value of 0.4 ppm as the highest level measured.

An HPT performed field screening for radioactivity and no levels above background were detected.

3.13.2.4 Geophysical Logging. No man-made radionuclides were detected during the RLS Spectral Gamma-Ray survey.

3.13.3 Conclusions

The volatile organic compound 2-butanone was detected in one sample from the 116-D-3 site. Historical records do not indicate that 2-butanone was disposed of in the 100-DR-1 Operable Unit. Although 2-butanone is most likely attributable to sampling media or lab contamination the analysis was not flagged with the "B" qualifier to indicate laboratory blank contamination. Sources of the two semi-volatile compounds is also unknown. Phthalate esters are most likely attributable to sampling media or lab contamination though the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. No other organic compounds were detected. Silver was detected in a concentration above the Hanford Site background 95% UTL in one sample (15.0 ft to 17.0 ft bls) and is considered a potential contaminant of concern. Historical data for organic and inorganic, nonradionuclide constituents are not available for comparison.

Radionuclide contamination at the 116-D-3 site was expected at the 5.0 ft interval (Dorian and Richards 1978) as shown by Figure 3-18. Field screening data and geophysical logs collected during the LFI did not reveal any radionuclides in the borehole. Analytical data from the LFI borehole soil samples indicate the presence of ^{14}C , ^{40}K , ^{90}Sr , ^{99}Tc and ^{226}Ra in the borehole at the 15.0 ft and 19.5 ft intervals. Both of the samples had similar activities of the radionuclides detected.

Analytical data from the LFI sampling of the 116-D-4 crib are considered analogous. Volatile organic compound 4-methyl-2 pentanone was detected in 116-D-4. Semi-volatile compounds were detected in both sites, however the compounds were dissimilar. No pesticides or PCBs were detected in either site. No metals or inorganics were detected in concentrations above the Hanford Site background 95% UTL at the 116-D-4 site. Both ^{226}Ra and ^{228}Th were detected at both sites.

3.13.4 Groundwater Assessment

Monitoring well 199-D5-15 is the upgradient well to site 116-D-3. Monitoring well 199-D5-14 is the downgradient well to site 116-D-3. The concentration of Cr

detected in samples from the downgradient well are approximately an order of magnitude less than that detected in samples from the upgradient well, and the concentration of ^3H in the downgradient well are approximately half the concentration detected in samples from the upgradient well. Strontium-90 was not detected in samples from either well.

3.14 116-D-4 CRIB NO. 2 (FRENCH DRAIN)

This crib is 1.5 m (5 ft) deep and 1 m (3 ft) in diameter. It was in use from 1956 to 1965 and received low-level fission and activation product wastes from contaminated maintenance shops in the 108-D building and the cask decontamination pad.

Figure 3-1 shows the location of the 116-D-4 site and the approximate location of the vadose zone borehole. One borehole was placed near the center of the site. Figure 3-19 is a summary diagram of the 116-D-4 LFI borehole data and historical data.

3.14.1 Geology

The 116-D-4 site geology is characterized as having a sandy gravel zone from 0.0 to 20 feet bls, overlying a sand zone interval from 20.0 to 23.0 feet bls, the total depth of the borehole.

3.14.2 Soil Samples

Two soil samples were collected and submitted for chemical and radionuclide analysis.

3.14.2.1 Chemical Analysis. The volatile organic compound 4-methyl-2-pentanone was detected in sample BO1892 (10.0 - 12.5 ft bls) (Table 3-56) having a concentration ($4.0 \mu\text{g}/\text{Kg}$) less than the CRQL.

Semi-volatile organic compounds pyrene and fluoranthene were detected in sample BO1891 (3.0 - 5.5 ft bls) (Table 3-57) in concentrations (37 and $37 \mu\text{g}/\text{Kg}$, respectively) less than the CRQL.

No pesticides or PCB compounds were detected.

No metals or inorganics were detected in concentrations above the Hanford Site background 95% UTL.

3.14.2.2 Radionuclide Analysis. Table 3-58 presents a summary of radionuclides detected in the two samples collected and analyzed.

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3.14.2.3 Field Screening. The well site geologist performed field screening for VOCs and did not detect any levels above background.

An HPT performed field screening for radioactivity. No activities above background were detected.

3.14.3 Conclusions

The volatile organic compound 4-methyl-2 pentanone was detected in one sample from the 116-D-4 site. Historical records do not indicate that 4-methyl-2 pentanone was disposed of in the 100-DR-1 Operable Unit. Although 4-methyl-2 pentanone is most likely attributable to sampling media or lab contamination the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. Two semi-volatile compounds were detected in one sample from 116-D-4. The sources of these compounds are unknown. No other pesticides or PCB compounds were detected. No metals or inorganics were detected in concentrations above the Hanford Site background 95% UTL. Historical data for organic and inorganic, nonradionuclide constituents are not available for comparison.

Radionuclide contamination at the 116-D-4 site was expected at the 5.0 ft interval (Dorian and Richards 1978) as shown by Figure 3-19. Field screening data collected during the LFI did not reveal any radionuclides in the borehole. Soil samples collected and analyzed during the LFI revealed the presence of radionuclide contamination in borehole 116-D-4. In both samples ^{40}K and ^{226}Ra were detected having activities above the CRDL. The activities detected are very similar in both samples.

Site 116-D-3 is the only analogous site located in the 100 Area Source operable units that has been examined thus far by the LFIs. The discussion of 116-D-3 and 116-D-4 is found in Section 3.13.3.

3.14.4 Groundwater Assessment

Monitoring well 199-D5-15 is the upgradient well for site 116-D-4. Monitoring well 199-D5-14 is the downgradient well for site 116-D-4. The concentration of Cr detected in samples from the downgradient well are approximately an order of magnitude less than that detected in samples from the upgradient well, and the concentration of ^3H detected in samples from the upgradient well are almost double those detected in the downgradient well samples. Strontium-90 was not detected in samples from either well.

3.15 130-D-1 UNDERGROUND STORAGE TANK

This tank stored leaded gasoline. It was in use from 1944 to 1968. It was removed in 1989 as part of the ongoing Hanford Site underground storage tank removal

program. The tank was 1.25 m (4 ft) in diameter by 3.5 m (12 ft) long. The capacity was approximately 3800 ℓ (1000 gal). During the removal process the site was surveyed for beta, gamma and alpha activities. The results of the survey were less than background activity. During the removal activities of the tank, the top of the tank was estimated to be 1.25 m (4 ft) to 1.5 m (5 ft) below existing grade.

Figure 3-3 shows the location of the 130-D-1 site and the approximate location of the vadose zone borehole. One borehole was placed in the waste site. Figure 3-20 is a summary diagram of the LFI borehole data.

3.15.1 Geology

The 130-D-1 site is characterized as having a gravelly sand interval from 0.0 ft to 10.0 ft, sandy gravel from 10.0 - 15.0 ft, sand from 15.0 - 32.2 ft, gravelly sand again from 32.2 to 33.5 ft, and sandy gravel from 33.5 ft to 37.0 ft, the total depth of the borehole.

3.15.2 Soil Samples

Four soil samples were collected and submitted for chemical and radionuclide analysis during this LFI.

3.15.2.1 Chemical Analysis. Toluene was detected in two samples, BO18C7 (10.0 - 11.4 ft) and BO18D0 (25.0 - 27.0 ft) having concentrations (6 and 2 $\mu\text{g}/\text{Kg}$, respectively). Methylene chloride and acetone were detected in the sample BO18D0 having concentrations of 6 and 77 $\mu\text{g}/\text{Kg}$, respectively and their concentrations are above the CRQL. Table 3-59 presents the analytical results.

The semi-volatile organic compounds butylbenzyl phthalate and bis(2-ethylhexyl) phthalate were detected having concentrations (2600 and 5500 $\mu\text{g}/\text{Kg}$, respectively) above the CRQL, in the sample BO18C6 (10.0-11.4 ft bls). Di-n-butyl phthalate and diethyl phthalate were detected having concentrations (130 and 130 $\mu\text{g}/\text{Kg}$, respectively) less than the CRQL in sample BO18D0 (25.0 - 27.0 ft bls). Di-n-butyl phthalate was below the CRQL in BO18C6 also. Table 3-60 presents the summary of the analytical results.

The pesticide aldrin was detected in the sample BO18D3 (30.2 - 32.2 ft) having a concentration (7.5 $\mu\text{g}/\text{Kg}$) below the CRQL. Table 3-61 presents the analytical results. No PCB compounds were detected.

Lead was detected in the samples BO18C6 (10.0 - 11.2 ft) and BO18C7 (duplicate of BO18C6) having concentrations (18.8 and 19.2 mg/Kg, respectively) above the Hanford Site background 95% UTL (Table 3-62).

3.15.2.2 Radionuclide Analysis. Table 3-63 presents the summary of radionuclides detected in the four samples collected and analyzed from this site during the LFI. The

following radionuclides were detected having activities above the CRDL: ^{14}C , ^{90}Sr , ^{99}Tc , ^{235}U , ^{238}U , ^{239}Pu and ^{241}Am . The radionuclide activities detected are similar in all four samples.

3.15.3 Field Screening

The well-site geologist performed field screening for VOCs. Volatile organic compounds were detected at the following intervals, 10.0 ft, 11.2 ft, 13.0 ft, 15.0 ft, 25.0 ft and 30.0 ft, having the following values, 6.2 ppm, 1.3 ppm, 0.8 ppm, 1.8 ppm, 0.9 ppm and 0.2 ppm, respectively.

An HPT performed field screening for radioactivity and continuously detected radionuclides from the surface to the bottom of the borehole. Beta-gamma values ranged from 50 to 80 cpm, with the 80 cpm occurring at the 35.0 ft interval. Gamma values ranged from 1300 to 1700 cpm with the 1700 cpm occurring at the 10.0 ft, 15.0 ft and 17.0 ft intervals.

3.15.4 Conclusions

Acetone, methylene chloride and toluene were detected in samples analyzed from LFI borehole 130-D-1. The VOC data are most likely attributable to sampling media or lab contamination. Acetone, methylene chloride and toluene are typical laboratory contaminants. Historical records do not indicate that these compounds were disposed in the 100-DR-1 Operable Unit. No other volatile organic compounds were detected.

Sources of the semi-volatile compounds are unknown. The pesticide aldrin was detected in a sample collected from 30.2 ft bls. Lead was detected having a concentration above the Hanford Site 95% UTL and is considered a potential contaminant of concern. Historical data for organic and inorganic, nonradionuclide constituents are not available for comparison.

Radionuclide contamination was not expected at the 130-D-1 site. Samples analyzed from LFI borehole 130-D-1 contained contamination by radionuclides. Radionuclide contamination was detected from 10.0 ft to 27.0 ft bls. The radionuclides and their associated activities detected were very similar in all the samples analyzed. Field screening data collected during the LFI identified the presence of radionuclides from the surface to the bottom of the borehole.

There are no sites considered to be analogous to the 130-D-1 site located in the 100 Area source operable units that have been examined thus far by the LFIs.

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3.15.5 Groundwater Assessment

There are no upgradient or downgradient monitoring wells located near the 130-D-1 site. Thus an assessment of the potential impact to groundwater cannot be made.

3.16 108-D DEMOLISHED OFFICE BUILDING

This building was located just north of the 103-D fuel-element storage building and has been demolished. The building was a large structure with three floors and a basement, approximately 40 m (132 ft) long, 10 m (32 ft) wide, and 12.5 m (41 ft) high. The building was used as an office complex and decontamination and repair shop for contaminated reactor process tube replacement equipment.

3.16.1 Geology

The 100-DR-1 LFI did include a test pit excavation and sample collection activity from underneath a sewer line located at the site. Samples were collected from approximately 5 ft below grade. There is no geological description from this LFI activity but it is assumed that the site is underlain by sands and gravels similar to that encountered at other waste sites.

3.16.2 LFI Data

Because the nature of the 100-DR-1 LFI performed at this site, data are not available for the following:

- physical properties of the soils
- field screening for VOCs
- geophysical borehole logs.

3.16.3 Soil Samples

Three soil samples were collected for chemical and radiological analysis from this site. The samples were collected from approximately 5 ft below grade, underneath a sewer line.

3.16.3.1 Chemical Analysis. No VOCs, semi-volatile compounds, PCB compounds or pesticides were detected. No metals were detected in concentrations above the Hanford Site background 95% UTL.

3.16.3.2 Radiological Analysis. Table 3-64 presents a summary of the radionuclides detected in samples collected from the 108-D site. The following radionuclides were

detected having activities above the CRDL: ^{14}C , ^{40}K , ^{226}Ra , ^{228}Th , and ^{232}Th . The samples were collected from the 5.0 ft bls interval.

3.16.3.3 Field Screening. Background readings were established for the site prior to initiating sampling activities. The value established was 0-50 cpm. An HPT surveyed the soil and pipe for radionuclides and detected nothing above background.

3.16.4 Conclusions

Radionuclide contamination was determined to be present at the site. No organic compounds or metals were determined to be a concern at the site. No analogous sites from other 100 Area source operable units have had LFIs thus far.

3.16.5 Groundwater Assessment

Monitoring well 199-D5-15 is the upgradient well for site 108-D. Monitoring well 199-D5-14 is the downgradient well for site 108-D. The concentrations of ^3H and Cr detected in samples from the downgradient well are much lower in values than those detected in samples collected from the upgradient well.

3.17 SODIUM DICHROMATE TANKS

Two large tanks of undetermined size were originally installed above ground, west of the 108-D office and equipment decontamination building. The tanks were intended for sodium dichromate storage in accordance with the buildings original intended purpose of chemical feeding for water treatment. The tanks are no longer present. No historical information is available regarding possible contaminants that may remain at this site.

3.17.1 LFI Data

Three soil samples (including one duplicate sample) were collected and submitted for chemical and radionuclide analysis from shallow test pits located around the periphery of the two tank foundations. Four locations per tank foundation were chosen as potential sample collection sites. Each site was then screened for hexavalent chromium using Hach® kits. One sample site per tank foundation periphery was then chosen, sampled, and the samples submitted to the laboratory for analysis. Two samples collected (BO18T3 and BO18T6) came from locations N-3 (4.0 ft bls) and S-1 (3.0 ft bls), respectively. BO18T4 is a duplicate of BO18T3. Figure 3-21 shows the site layout and sample locations.

Because the 100-DR-1 LFI performed a limited sampling effort of the sodium dichromate tanks site, data are not available for the following:

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- physical properties of soils
- field screening for VOCs and radiological contamination
- geophysical borehole logs.

3.17.2 Soil Samples

Three soil samples were collected and submitted for chemical and radionuclide analysis from this site.

3.17.2.1 Chemical Analysis. The volatile organic compound toluene was detected in sample BO18T3 (4.0 ft bls) and in BO18T4 (duplicate of BO18T3) having concentrations less than the CRQL, i.e., 1 and 1 $\mu\text{g}/\text{Kg}$, respectively. Table 3-65 presents a summary of the analytical results.

Semi-volatile organic compound di-n-butyl phthalate was detected in samples BO18T3, BO18T4 and BO18T6 (3.0 ft bls) having concentrations below the CRQL, i.e., 170, 93, and 120 $\mu\text{g}/\text{Kg}$, respectively. Table 3-66 presents a summary of the analytical results.

No PCB compounds or pesticides were detected.

Barium was detected in concentrations above the Hanford Site background 95% UTL in both samples and the duplicate. The concentrations were 659, 556, and 666 mg/Kg , respectively.

3.17.2.2 Radionuclide Analysis. Table 3-67 presents a summary of the radionuclides that were detected from the sodium dichromate tanks site. Potassium-40 were detected in all three samples, and ^{228}Th and ^{226}Ra were detected in BO18T4 and BO18T6.

3.17.3 Conclusions

Toluene was detected in two samples collected and analyzed from the LFI activities at the sodium dichromate tanks site. Historical records do not indicate that toluene was disposed of at the 100-DR-1 Operable Unit. Although toluene is most likely attributable to sampling media or lab contamination the analyses were not flagged with the "B" qualifier to indicate laboratory blank contamination. The source of the semi-volatile compounds detected is unknown. Phthalate esters are typical laboratory contaminants. Barium was detected in concentrations above the Hanford Site background 95% UTL and is considered a potential contaminant of concern. Historical data for organic and inorganic, nonradionuclide constituents are not available for comparison.

Radionuclide contamination is present at the sodium dichromate tanks site. Potassium-40, ^{226}Ra and ^{228}Th were detected in samples collected from the site during

LFI activities. Because the samples were collected from only two sites and from such shallow depths, an assessment as to the extent of the contamination cannot be made.

There are no analogous sites present in the 100 Area source operable units that have had LFIs performed thus far.

3.17.4 Groundwater Assessment

Monitoring well 199-D5-15 is the upgradient well to the sodium dichromate tanks site. Monitoring well 199-D5-14 is the downgradient well to the sodium dichromate tanks site. The concentration of Cr detected in samples from the downgradient well are approximately an order of magnitude less than that detected in samples from the upgradient well, and the concentration of ^3H detected in samples from the upgradient well are almost double those detected in the downgradient well samples. Strontium-90 was not detected in samples from either well.

3.18 103-D FUEL ELEMENT STORAGE BUILDING

The 103-D fuel element storage building is located north of the D Reactor building within the confines of the security fence surrounding the reactor building. The building was originally used to store unirradiated fuel elements. This building was later used to store packaged radioactive samples collected during the Dorian and Richards 1976 study. Verbal reports indicate that the building was not contaminated during its role as a fuel storage building. However, contamination of the building possibly resulted from use of the facility to package and store radioactive waste. Field visits revealed herbicide and solvent warning signs posted outside the building. The building is 8 m (25 ft) wide x 16 m (50 ft) long, cinder block construction with a noncoated concrete floor.

3.18.1 Geology

The 100-DR-1 LFI did not include an intrusive field investigation of the 103-D site. It is assumed that the site is underlain by sands and gravels similar to that encountered at other waste sites.

3.18.2 LFI Data

Because the 100-DR-1 LFI did not include an intrusive field investigation of the 103-D site, data are not available for the following:

- soil concentrations of organic, inorganic and metallic constituents
- physical properties of soils

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- field screening for VOCs
- geophysical borehole logs.

Five wipe samples were collected and submitted for chemical and radionuclide analysis. Wipe sampling of the interior concrete floor was conducted using gauze pads moistened with deionized water, hexone/acetone (50/50) and methylene chloride/acetone (50/50) over a measured area of 1m² (10.8 ft²). Prior to sampling, an HPT surveyed the building using a Geiger-Mueller detector. Two contaminated locations were identified by the survey. One location registered 1000 cpm (near the southeast door entrance) and the second location registered 3000 cpm (northeast corner of the building, caged area). As a result of the survey, these two locations were chosen for sample collection. A third site was chosen, located near the southwest door entrance. A duplicate sample was collected from the site near the southeast door. Figure 3-22 shows the sample locations. Figure 3-23 shows how the sample locations were sampled for the specified analyses.

3.18.2.1 Chemical Analysis. The herbicide 2,4-D was detected in two of the samples collected and analyzed during the LFI. Table 3-68 presents the analytical results. The concentrations detected were both below the CRQL. The following metals were detected in four samples: Al, Ba, Ca, Cd, Cr, Cu, Fe, Hg, K, Mg, Mn, and Zn. Lead and Vn were each detected in three samples, As and Na were reported in two samples, and Co and Ni were reported from one sample. Table 3-69 presents a summary of the analytical results.

3.18.2.2 Radionuclide Analysis. Gross alpha and gross beta were detected in all the samples. Activities for gross alpha ranged from 1.04 to 358 pCi/sample. Activities for gross beta ranged from 5.56 to 2670 pCi/sample. Cobalt-60, ¹³⁷Cs, ¹⁵²Eu, ¹⁵⁴Eu and ²⁴¹Am were detected in one sample having the following activities: 4.83, 2770, 30.9, 2770 and 32.2 pCi/sample, respectively. Americium-241 was detected in one sample having an activity of 32.2 pCi/sample. Table 3-70 presents a summary of the analytical results.

3.18.2.3 Field Screening. An HPT surveyed the building using a Geiger-Mueller detector with a P-11 probe. Two locations were identified as contaminated, registering 1000 and 3000 cpm, respectively.

3.18.3 Conclusions

The analytical data from the LFI show that there is radionuclide contamination, herbicide contamination and metals contamination present inside the 103-D building.

3.18.4 Groundwater Assessment

There are no groundwater monitoring wells in the vicinity of this site. Thus, an assessment as to whether or not this site is potentially impacting the groundwater cannot be made.

3.19 126-D-2 SOLID WASTE LANDFILL

This solid waste landfill contains waste materials from decommissioning and demolition activities, concrete, steel and other building materials. It was used as an open landfill for approximately 20 years. It was covered in 1986.

3.19.1 Geology

The 100-DR-1 LFI did not include an intrusive field investigation of the 126-D-2 site. It is assumed that the landfill is underlain by sands and gravels similar to that encountered at the other waste sites investigated.

3.19.2 LFI Data

Because the 100-DR-1 LFI did not include an intrusive field investigation of the 126-D-2 site, data are not available for the following:

- soil concentrations of organic, inorganic and metallic constituents
- physical properties of the soils
- field screening for VOC and radiological contamination
- geophysical borehole logs.

3.19.3 Conclusion

No historical sampling data for the 126-D-2 site are available. It was not sampled during the radiological investigation (Dorian and Richards 1978).

3.19.4 Groundwater Assessment

There are no downgradient wells in the vicinity of this site. Therefore an assessment as to whether or not this site is impacting the groundwater cannot be made.

3.20 4A, 4B, 18 BURIAL GROUNDS

These burial grounds are located in the southeast portion of the 100-DR-1 Operable Unit and were among several small construction burial grounds that are now collectively known as the 118-D-4 construction burial ground. The burial grounds received both radioactive and non-radioactive wastes. No prior or recent sampling has been performed at this site.

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3.20.1 Geology

The 100-DR-1 LFI did not include a field investigation of the 4A, 4B and 18 burial grounds. It is assumed that the burial grounds are underlain by sands and gravels similar to that encountered at other waste sites.

3.20.2 LFI Data

Because the 100-DR-1 LFI did not include a field investigation of the 4A, 4B, and 18 burial grounds, data are not available for the following:

- soil concentrations of organic, inorganic and metallic constituents
- physical properties of the soils
- field screening for VOC and radiological contamination
- geophysical borehole logs.

3.20.3 Conclusions

No historical sampling data for the 4A, 4B, and 18 burial grounds are available. It was not sampled during the 1976 radiological investigation (Dorian and Richards 1978).

3.20.4 Groundwater Assessment

Monitoring well 199-D5-12 is the upgradient well for site 4A. Monitoring well 199-D5-16 is the downgradient well for site 4A. The concentration of Cr detected in the downgradient well is slightly higher than that detected in samples from the upgradient well (811 $\mu\text{g}/\ell$, 564 $\mu\text{g}/\ell$, respectively). Strontium-90 was not detected in samples from the downgradient well and the ^3H concentration is an order of magnitude less in samples from the downgradient well than that detected in samples from the upgradient well.

Monitoring well 199-D5-17 is the upgradient well for site 4B. Monitoring well 199-D5-12 is the downgradient well for site 4B. The Cr concentration detected in the downgradient well samples is approximately an order of magnitude greater than that detected in samples from the upgradient well. Strontium-90 was detected in samples from the downgradient well but was not detected in samples from the upgradient well. The ^3H concentration detected in samples from the downgradient well are approximately one-third that of the detected concentrations from the upgradient well samples.

There are no upgradient wells in the vicinity of site 18 from which a comparison of groundwater data can be made.

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3.21 115-D DEMOLISHED GAS RECIRCULATION BUILDING

The reactor core was surrounded by a helium and carbon dioxide cover gas. The cover gas in the reactor was used to remove moisture and foreign gases, to aid in heat transfer between different parts of the reactor, and to detect water leaks. The 115-D building housed the driers and injection and circulation equipment that was used to recirculate the helium and carbon dioxide cover gases in the 118-D-6 and 118-DR-2 reactors. This building was demolished in 1986.

The 115-D building was sampled for radioactive contamination during September of 1976. Direct scan and standard smear samples were taken off the floors, walls and fixtures (pipes, drains, filter boxes, etc.) of the rooms in the building. The survey results reported in Dorian and Richards (1978) show a total of 46 direct scan samples, 57 standard smear samples, and 10 general background readings were taken inside 115-D. The standard smears were analyzed for total activity (cpm), total beta (d/m), total alpha (d/m) and ^3H , ^{14}C , ^{60}Co , ^{90}Sr , ^{134}Cs , ^{137}Cs , ^{152}Eu , ^{154}Eu , ^{155}Eu , ^{238}Pu , and $^{239/240}\text{Pu}$ (pCi/sample).

Direct scan readings ranged from <200 to 8,000 cpm. Standard smear results ranged from <100 to 2,500 cpm, from background to 31,000 d/m beta, from 0 to 4 d/m alpha, from 4,300 to 13,000 pCi/sample ^3H , from 97,000 to 140,000 pCi/sample ^{14}C , from 840 to 1,700 pCi/sample ^{60}Co , from 6.7 to 8 pCi/sample ^{90}Sr , from nondetected to 1.6 pCi/sample ^{134}Cs , from 1,100 to 4,800 pCi/sample ^{137}Cs , from 4.5 to 26 pCi/sample ^{152}Eu , from 77 to 510 pCi/sample ^{154}Eu , from 31 to 40 pCi/sample ^{155}Eu , from 0.35 to 1.3 pCi/sample ^{238}Pu , and from 1.6 to 3.5 pCi/sample $^{239/240}\text{Pu}$. General background ranged from 75 to 300 cpm.

3.21.1 Geology

The 100-DR-1 LFI did not include a field investigation of the 115-D building site. It is assumed that the building is underlain by sands and gravels similar to that encountered in other waste sites.

3.21.2 LFI Data

Because the 100-DR-1 LFI did not include a field investigation of the 115-D building, data are not available for the following:

- soil concentrations of organic, inorganic and metallic constituents
- physical properties of the soils
- field screening for VOC and radiological contamination
- geophysical borehole logs.

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3.21.3 Conclusions

Historical data are available for the 115-D building. However, the sampling occurred prior to the demolition of the building in-situ.

3.21.4 Groundwater Assessment

Monitoring well 199-D5-17 is the upgradient well to site 115-D. Monitoring well 199-D5-12 is the downgradient well for site 115-D. The concentration of Cr detected in samples from 199-D5-12 is approximately an order of magnitude greater than that detected in samples from 199-D5-17. Strontium-90 was detected in samples from 199-D5-12, but not in samples from 199-D5-17. The ^3H concentration is approximately three times as great in samples from 199-D5-17, than that detected in samples from 199-D5-12.

3.22 117-D DEMOLISHED EXHAUST AIR FILTER BUILDING

The 118-D-6 reactor building exhaust air filters and air flow control systems were housed in the 117-D building. Reactor exhaust gases, containing particulates and halogens, passed through both particulate and activated charcoal filters in a two-filter cell underground facility that was 18 m (59 ft) long, 12 m (39 ft) wide, and 11 m (35 ft) high. Contaminated concrete ventilation and gas piping tunnels connected this facility to the reactor exhaust stack. The 117-D filter building was built in 1961 and demolished in 1986.

The 117-D building was sampled for radioactive contamination during September of 1976. Direct scan and standard smear samples were taken off the floors, walls, and fixtures (cells, vanes, filter frames, etc.) of the tunnels and cells in the building. The survey results reported in Dorian and Richards (1978) show a total of six direct scans samples, eighteen standard smear samples, and four general background readings were taken inside 117-D. The standard smears were analyzed for total activity (cpm), total beta (d/m), total alpha (d/m), and ^3H , ^{14}C , ^{60}Co , ^{90}Sr , ^{134}Cs , ^{137}Cs , ^{154}Eu , ^{155}Eu , ^{238}Pu , and $^{239/240}\text{Pu}$ (pCi/sample).

Direct scan readings ranged from 200 to 25,000 cpm. Standard smear results ranged from < 100 to 3,500 cpm, from 120 to 60,000 d/m beta, from 0 to 100 d/m alpha, from 2,500 to 5,900 pCi/sample ^3H , from 54,000 to 2,100,000 pCi/sample ^{14}C , 240 to 5,800 pCi/sample ^{60}Co , 230 to 740 pCi/sample ^{90}Sr , from undetected to 17 pCi/sample ^{134}Cs , from 930 to 4,800 pCi/sample ^{137}Cs , from 0.42 to 1.3 pCi/sample ^{238}Pu and from 0.49 to 3.8 pCi/sample $^{239/240}\text{Pu}$. Europium-152, ^{154}Eu and ^{155}Eu were not detected in any of the samples analyzed. General background ranged from 200 to 1,000 cpm.

3.22.1 Geology

The 100-DR-1 LFI did not include a field investigation of the 117-D filter building. It is assumed that the 117-D site is underlain by sands and gravels similar to that encountered in other waste sites.

3.22.2 LFI Data

Because the 100-DR-1 LFI did not include a field investigation of the 117-D filter building, data are not available for the following:

- soil concentrations of organic, inorganic and metallic constituents
- physical properties of the soils
- field screening for VOC and radiological contamination
- geophysical borehole logs.

3.22.3 Conclusions

The historical data (Dorian and Richards 1978) are available for evaluation. However, the sampling activity took place prior to the demolition of the facility in-situ.

3.22.4 Groundwater Assessment

Monitoring well 199-D5-17 is the upgradient well to site 117-D. Monitoring well 199-D5-12 is the downgradient well to site 117-D. The concentration of Cr detected in samples from 199-D5-12 is approximately an order of magnitude greater than that detected in samples from 199-D5-17. Strontium-90 was detected in samples from 199-D5-12, but not in samples from 199-D5-17. The ³H concentration detected in samples from 199-D5-17 are approximately three times as great as that detected in samples from 199-D5-12.

3.23 PROCESS EFFLUENT PIPELINES

Process effluent pipelines emanate from the 118-D-6 and 118-DR-2 buildings to the various process effluent disposal and treatment facilities. These lines continue out from the 116-D-7 (107-D) and 116-DR-9 (107-DR) retention basins to both the river and disposal trenches.

These pipelines transferred reactor coolant and some decontamination wastes for the 100 D/DR Area. Some of these pipelines are known to have developed leaks at various times during their periods of operation (Dorian and Richards 1978).

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3.23.1 Geology

The 100-DR-1 LFI did not include a field investigation of the process effluent pipelines. It is assumed that the process effluent pipelines are underlain by sands and gravels similar to that encountered at other waste sites.

3.23.2 LFI Data

Because the 100-DR-1 LFI did not include a field investigation of the process effluent pipelines data are not available for the following:

- soil concentrations of organic, inorganic and metallic constituents
- physical properties of the soils
- field screening for VOC and radiological contamination
- geophysical borehole logs.

3.23.3 Conclusions

No historical sampling data for the process effluent pipelines are available. It was not sampled during the 1976 radiological investigation (Dorian and Richards 1978).

3.23.4 Groundwater Assessment

Because of the extensive nature of the process effluent pipelines system across the site, and the proximity to the other waste sites in question, an assessment as to whether or not the pipelines are contributing to groundwater contamination cannot be made. It can be assumed that due to the leaks/unplanned releases that have occurred in the past, that the potential exists that the pipelines may have been a contributor to the current impact on groundwater.

3.24 107-D AND 107-DR SLUDGE DISPOSAL TRENCHES (5)

Five sludge trenches were excavated around the 116-D-7 (107-D) and 116-DR-9 (107-DR) retention basins to dispose of accumulated sludges from the basin bottoms while the basins were being repaired in 1953. The trenches were covered with clean soil when work was completed. Material from the area of the trenches was used as fill in the 116-D-7 and 116-DR-9 retention basins when they were undergoing deactivation (Dorian and Richards 1978).

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3.24.1 Geology

The 100-DR-1 LFI did not include a field investigation of the 107-D and 107-DR sludge disposal trenches. It is assumed that the 107-D and 107-DR sites are underlain by sands and gravels similar to that encountered in other waste sites.

3.24.2 LFI Data

Because the 100-DR-1 LFI did not include a field investigation of the 107-D and 107-DR sludge disposal trenches, data are not available for the following:

- soil concentrations of organic, inorganic and metallic constituents
- physical properties of the soils
- field screening for VOC and radiological contamination
- geophysical borehole logs.

3.24.3 Conclusions

No historical sampling data for the 107-D and 107-DR sludge trenches are available. They were not sampled during the 1976 radiological investigation (Dorian and Richards 1978).

3.24.4 Groundwater Assessment

There are no monitoring wells in the vicinity of sites 107-D/DR from which a comparison of groundwater data can be made.

3.25 1607 D-4 SANITARY SEPTIC SYSTEM (LOW-PRIORITY SITE)

This septic tank received sanitary sewage from the 115-D recirculation building. The tank was a five person capacity tank with the following dimensions: 1 m (3.5 ft) x 1.6 m (5 ft). The tank has been backfilled with a soil/rock mixture.

3.25.1 Geology

The 100-DR-1 LFI included a limited intrusive field investigation of the 1607 D-4 site. It is assumed that the 1607 D-4 site is underlain by sands and gravels similar to that encountered in other waste sites.

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3.25.2 LFI Data

The 100-DR-1 LFI performed a very limited investigation of the 1607 D-4 site, data are not available for the following:

- physical properties of soils
- geophysical borehole logs.

3.25.3 Soil Samples

Three soil samples were submitted for chemical and radionuclide analysis. However, the data submitted for analysis was never validated. Thus, there are no chemical or radiological data to evaluate for this low-priority site.

3.25.3.1 Field Screening. Field screening was performed for both VOCs and beta-gamma radiation. There were no detections of VOCs or beta-gamma radiation above background.

3.25.4 Conclusions

Three soil samples were collected and submitted for analysis during the LFI for site 1607-D-4. The data were never validated, thus an evaluation cannot be made regarding the potential contamination at this site. Site 1607-H-4 was sampled during the 100-HR-1 LFI. This site is considered analogous to site 1607-D-4, so the data from 1607-H-4 are evaluated and used to support the conclusions for site 1607-D-4.

The chemical analysis of the soil samples taken from the test pit at the 1607-H-4 septic tank indicates no contamination of the soil in the leach field. However, a sample taken from inside the septic tank discharge pipe did indicate contamination. This contamination consisted of several heavy metals (Ba, Cu, Pb, and Zn) at levels above the 95% UTL, and semi-volatile PNA compounds. The PNAs were detected in concentrations of less than 3 ppm. The pesticides 4,4-DDD, 4,4-DDE, and gamma-chlordane were detected at levels of less than 1 mg/Kg in the sample taken from the discharge pipe.

The soil samples taken directly from the test pit, the 1607-H-4 septic tank and leach field contained no radionuclide contamination above typical background levels. The sample taken from the septic tank discharge pipe did contain small amounts of ¹³⁷Cs and ¹⁵²Eu (0.67 pCi/g and 1.2 pCi/g, respectively).

Heavy metals, small amounts of PNAs, and radionuclide contamination were found in a sample taken from the discharge pipe of the 1607-H-4 septic tank. No contaminants were detected in the soil samples taken from the test pit in the septic tank leach field. This suggests that there may be isolated areas of concentrated contaminants

within the septic tank itself and in and immediately around the discharge piping, but there is no contamination above detectable limits within the leach field itself.

3.25.5 Groundwater Assessment

Monitoring well 199-D5-17 is the upgradient well to site 1607-D-4. Monitoring well 199-D5-12 is the downgradient well to site 1607-D-4. The Cr concentration detected in samples from 199-D5-12 are approximately an order of magnitude greater than that detected in samples from 199-D5-17. Strontium-90 was detected in samples from 199-D5-12, but not in samples from 199-D5-17. The ³H concentration detected in the upgradient well is almost three times as great as that detected in samples from the downgradient well.

3.26 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires that fund-financed, enforcement, and federal facility remedial actions comply with ARARs of federal environmental laws and more stringent, promulgated state environmental or facility siting laws.

Comprehensive Environmental Response Compensation and Liability Act defines applicable requirements as those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to that particular site.

In addition to ARARs, CERCLA also provides for the consideration of to-be-considered (TBC) guidance, non-promulgated advisories or guidance documents issued by federal or state governments that do not have the status of potential ARARs but which may be considered in determining necessary levels of protection of health or the environment.

Applicable or relevant and appropriate requirements may be further subdivided into the following categories:

- *Chemical-specific requirements* - health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, results in the establishment or numerical values. If a chemical has more than one such requirement that is an ARAR, compliance should generally be with the most stringent requirement.

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- *Location-specific requirements* - restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations, such as wetlands or historic places.
- *Action-specific requirements* - technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy.

Potential chemical- and location-specific ARARs are defined during the field investigation portion of the CERCLA process and refined in the feasibility study and proposed plan. Action-specific ARARs are generally defined during the phase I and II feasibility study and refined in detailed analysis and the proposed plan. Potential ARARs and TBCs in all categories are defined in the *100 Area Feasibility Study Phases 1 and 2* (DOE-RL 1992b). For purposes of this LFI, only the chemical- and location-specific ARARs are discussed. The ARARs are presented in Tables 3-71 through 3-75.

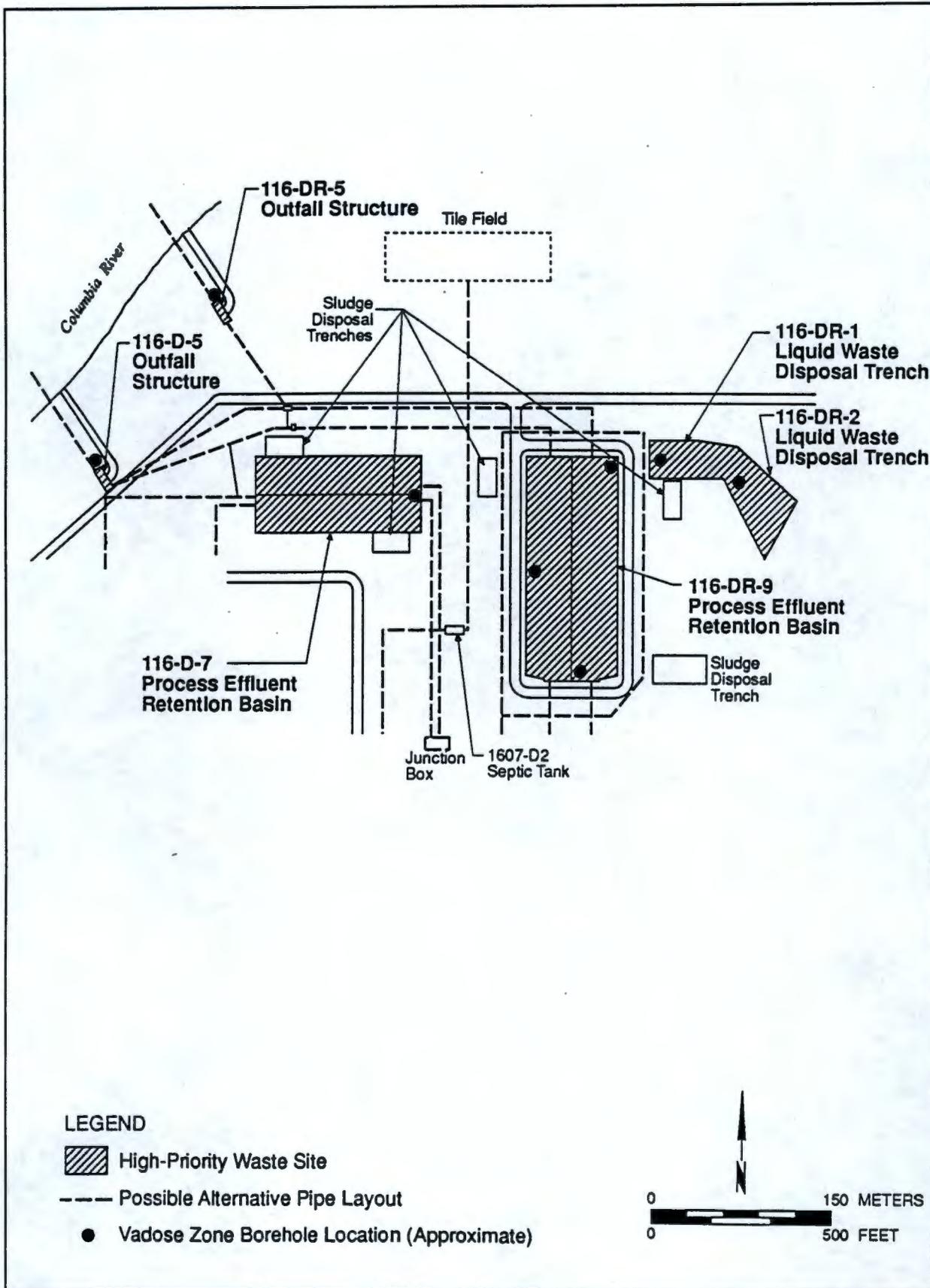
Chemical-specific ARARs for soils are limited to those levels for hazardous constituents prescribed in the state's MTCA. Currently, MTCA has not defined levels for radionuclides. Additional soil limits are presented in Subpart S of RCRA for hazardous constituents and in DOE Order 5400.5 for radionuclides. These are considered TBCs for the 100 Area operable units. Potential chemical-specific ARARs for air emissions are also identified for the 100 Area; however, these tend to also be based on specific actions which have a tendency to increase releases to the air. Therefore, these are more appropriately addressed in the focused feasibility study. Potential chemical-specific ARARs are listed in Tables 3-71 and 3-72; TBCs are included in Table 3-73.

Potential location-specific ARARs are identified for the 100 Area because of the presence of threatened or endangered species and archaeological resources. In addition, potential location-specific ARARs based on possible impacts to wetlands and floodplains are included. These are included in Tables 3-74 and 3-75; TBCs are in Table 3-76.

The discussion of potential ARARs is intended to be a refinement of ARARs presented in the work plan. Additional evaluation of potential ARARs will be done in the FS phase. Final ARARs will be determined in the ROD.

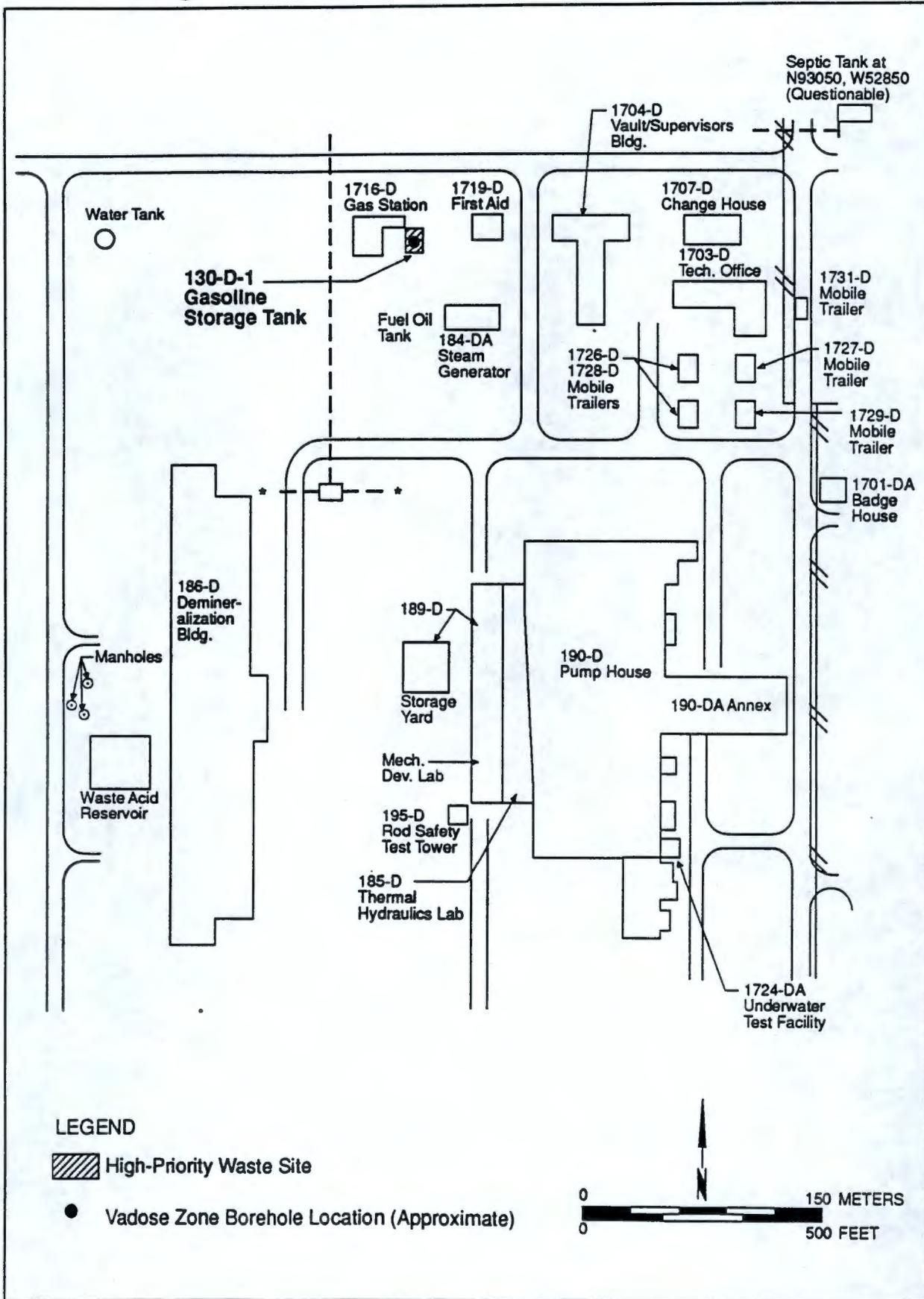
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Figure 3-2. High-Priority Waste Facilities in the Vicinity
of Retention Basins



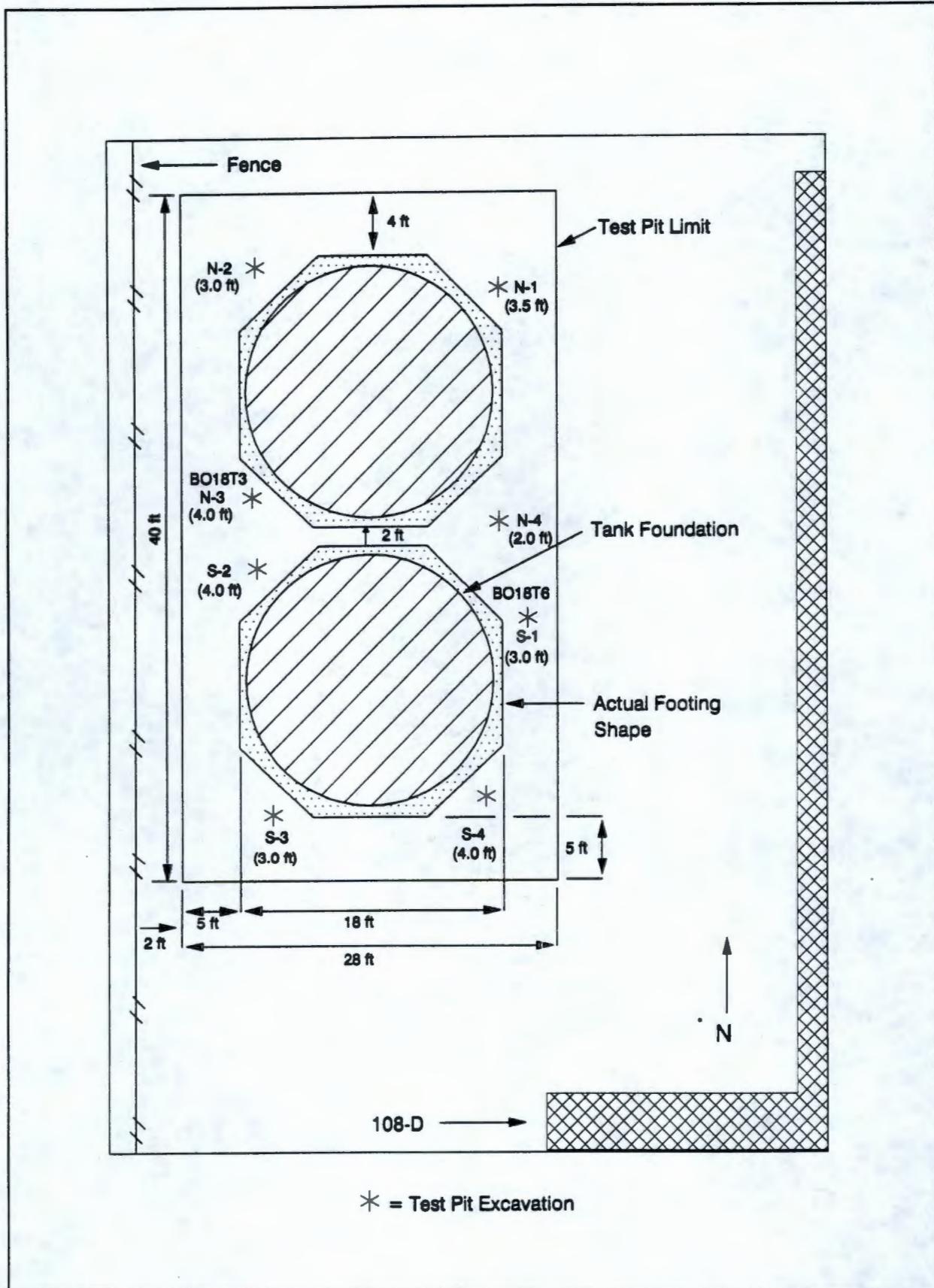
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Figure 3-3. Location of the 130-D-1 Gasoline Storage Tank



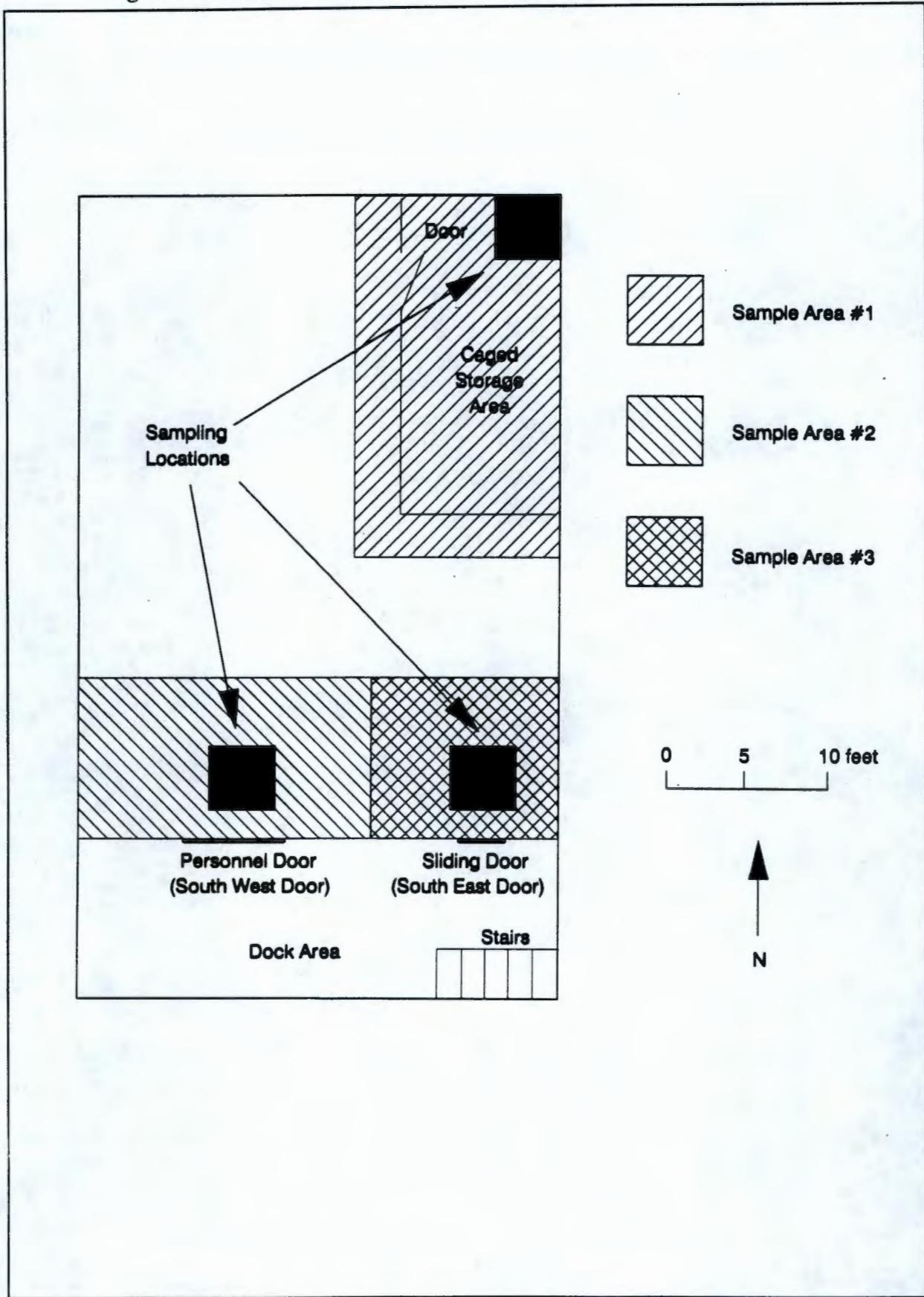
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Figure 3-21. Sodium Dichromate Tanks Site Layout and Sample Locations



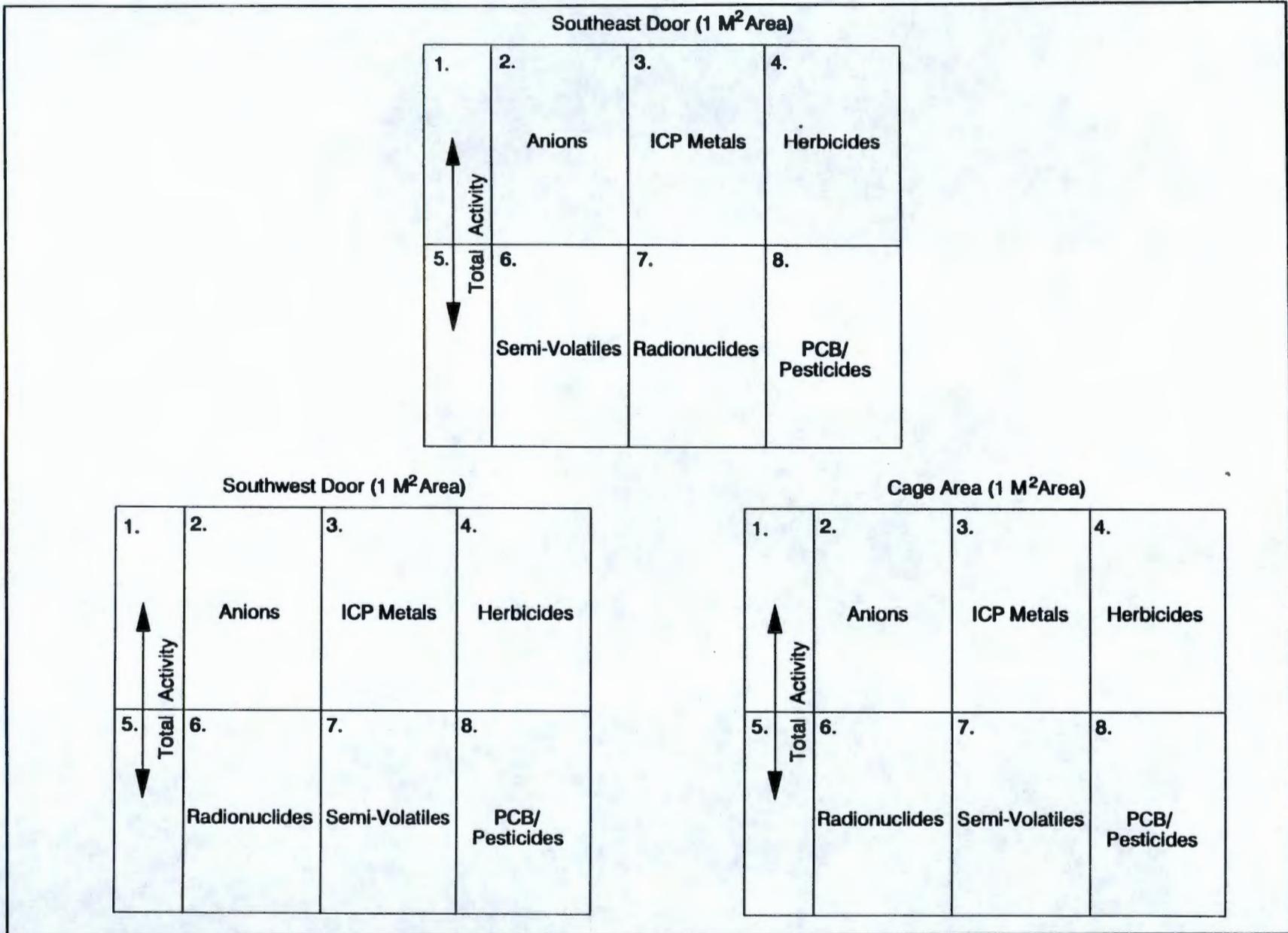
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Figure 3-22. 103-D Fuel Element Storage Building Sample Locations



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Figure 3-23. The Three Sampling Site Were Selected and Marked as Shown. Samples Were Collected from Areas as Indicated.



**Table 3-1. Semi-Volatile Organic Compounds Detected in 116-D-1A
Vadose Soil Boring Soil Samples
(concentrations in µg/Kg) (depths in feet)**

Sample Number	BO1874	BO1875	BO1876	BO1877	BO1878	BO1884
Sample Depth	8.0-10.5	12.2-14.8	17.0-19.5	24.0-26.3	27.0-29.5	52.8-53.1
bis(2-ethylhexyl) phthalate	48 ^j	ND	37 ^j	350 ^j	350 ^j	ND
Carbazole	NR	NR	NR	NR	NR	52 ^j
1,3 Dichlorobenzene	ND	ND	ND	38 ^j	ND	ND
Di-n-butyl phthalate	ND	77 ^j	51 ^j	ND	ND	ND
^j = Value estimated, concentration less than contract required detection limit. ND = Not detected NR = Not reported						

**Table 3-2. Pesticides/PCBs Detected in 116-D-1A
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO1880
Sample Depth	33.0-35.0
Beta-BHC	7.8 ^J
^J = Value estimated, concentration less than contract required detection limit.	

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Table 3-3. Metals and Inorganics in 116-D-1A Vadose Borehole Soil Samples Above the Hanford Site Background 95% Upper Threshold Limit (concentrations in mg/Kg) (depths in feet)

Sample Number	BO1875	BO1876	BO1877	BO1878	BO1879	Duplicate BO1880	BO1881	BO1882	BO1884	Hanford UTL 95% of 95th*
Sample Depth	12.2-14.7	17.0-19.5	24.0-26.2	27.0-29.5	33.0-35.0	33.0-35.0	41.0-43.5	43.0-46.0	52.8-53.1	
Cadmium	ND	1.0	BB	BB	.95	ND	1.0	ND	.67	0.66
Chromium	41.6	87.1 ¹	BB	BB	108	82.3	42.1	BB	BB	27.9
Lead	BB	38.6	19.4	27.6	36.0	51.9	32.0	36.0	BB	14.7
Nickel	BB	BB	ND	ND	42.5	35.4	BB	BB	BB	25.3

¹ = Value estimated, concentration less than contract required detection limit.
 ND = Not detected
 BB = Below Hanford Upper Threshold Limit
 * = Hanford Site Background: Part 1 Background for Nonradioactive Analytes, DOE-RL 1993a

Table 3-4. Radionuclides Detected in 116-D-1A Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet) (page 1 of 2)

Sample Number	BO1873	BO1874	BO1875	BO1876	BO1877	BO1878	BO1879	BO1880	BO1881	BO1882
Sample Depth	0.0-2.0	8.0-10.5	12.2-14.7	17.0-19.5	24.0-26.2	27.0-29.5	33.0-35.0	33.0-35.0	41.0-43.5	43.0-46.0
Gross Alpha	6.3 ^R	5.7 ^R	2.6 ^R	23 ^R	11 ^R	11 ^R	8.1 ^R	15 ^R	14 ^R	11 ^R
Gross Beta	81 ^R	82 ^R	63 ^R	510 ^R	390 ^R	370 ^R	35 ^R	280 ^R	170 ^R	210 ^R
Beryllium 7	ND	ND	7 ^R	ND	ND	90 ^J	ND	ND	ND	ND
Carbon 14	.4 ^R	.4 ^R	-.096 ^R	.45 ^R	.48 ^R	.4 ^R	.15 ^R	.14 ^R	.36 ^R	.029 ^R
Sodium 22	.338 ^J	NR	NR	4.72 ^J	2.39 ^J	2.21 ^J	1.84 ^J	1.81 ^J	1.71 ^J	2.6 ^J
Potassium 40	10.4 ^J	11.1 ^J	13.4 ^R	6.4 ^J	7.73 ^J	8.79 ^J	7.85 ^J	8.27 ^J	10.5 ^J	12 ^J
Manganese 54	ND	ND	.07 ^R	ND						
Cobalt 58	ND	ND	.2 ^R	4.44 ^J	ND	2.34 ^J	ND	ND	ND	ND
Iron 59	ND	ND	1 ^R	ND						
Cobalt 60	1.02 ^J	ND	.06 ^R	10.9 ^J	1.41 ^J	1.59 ^J	1.54 ^J	1.33 ^J	2.08 ^J	5.57 ^J
Zinc 65	ND	ND	.2 ^R	ND						
Strontium 90	5.0 ^J	4.2 ^J	3.6 ^R	.11	.18	.45	.12	1.2	2.2	1.8
Zirconium 95	ND	ND	.3 ^R	ND						
Technetium 99	ND	ND	.08 ^R	.099 ^R	ND	.27 ^R	.51	ND	ND	ND
Ruthenium 103	ND	ND	1 ^R	ND						
Ruthenium 106	ND	ND	.8 ^R	ND						
Cesium 134	ND	ND	.07 ^R	ND						
Cesium 137	25.7 ^J	.0788 ^J	19.9 ^R	148 ^J	ND	305 ^J	189 ^J	190 ^J	68.1 ^J	94.6 ^J
Barium 140	NR	NR	400 ^R	NR	NR	NR	ND	ND	ND	ND
Cerium 141	ND	ND	3 ^R	ND						
Cerium 144	ND	ND	.5 ^R	ND						
Europium 152	9.17 ^J	ND	1.26 ^R	112 ^J	48.6 ^J	45.8 ^J	37.2 ^J	38.1 ^J	34.8 ^J	59 ^J

Sample Number	BO1873	BO1874	BO1875	BO1876	BO1877	BO1878	BO1879	BO1880	BO1881	BO1882
Sample Depth	0.0-2.0	8.0-10.5	12.2-14.7	17.0-19.5	24.0-26.2	27.0-29.5	33.0-35.0	33.0-35.0	41.0-43.5	43.0-46.0
Europium 154	.869 ^J	ND	.2 ^R	10 ^J	5.97 ^J	62.5 ^J	4.83 ^J	6.17 ^J	4.77 ^J	7.25 ^J
Europium 155	ND	ND	.2 ^R	NR	NR	NR	NR	NR	NR	NR
Radium 226	ND	.803 ^J	1 ^R	ND	42.8 ^J	37.4 ^J	ND	ND	ND	ND
Thorium 228	.562 ^J	.636 ^J	.63 ^R	ND	ND	.5 ^J	ND	ND	ND	ND
Thorium 234	ND	ND	1 ^R	ND	ND	ND	NR	NR	NR	NR
Uranium 235	.0071 ^R	.0044 ^R	.0054 ^R	.0067 ^R	.012 ^R	.0083 ^R	ND	.0073 ^J	.0091 ^J	.0086 ^J
Uranium 238	.11 ^R	.13 ^R	.18 ^R	.28 ^R	.04 ^R	.0083 ^R	.11 ^J	.083 ^J	.1 ^J	.12 ^J
Plutonium 239	.46 ^R	.47 ^R	ND	6.8 ^R	7.1 ^J	.008 ^R	7.5 ^J	8.3 ^J	3.9 ^J	5.7 ^J
Americium 241	.17 ^R	.12 ^R	.015 ^R	1.0 ^R	1.1 ^R	.97 ^R	1.4 ^R	1.3 ^R	.77 ^R	1.3 ^R
^R = Value marked as rejected in validation because of missing calibration data. ^J = Value estimated, concentration less than contract required detection limit. ND = Not detected NR = Not reported										

Table 3-4. Radionuclides Detected in 116-D-1A Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet) (page 2 of 2)

**Table 3-5. Volatile Organic Compounds Detected in 116-D-1B
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18D9	BO18F0
Sample Depth	24.2-26.7	28.0-30.4
Acetone	26 ^J	41 ^J
Methylene Chloride	7 ^J	11 ^J
Toluene	ND	1 ^J
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

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**Table 3-6. Semi-Volatile Organic Compounds Detected in 116-D-1B
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18D7	BO18F0
Sample Depth	17.0-19.6	28.0-30.4
Carbazole	ND	54 ^J
Chrysene	ND	58 ^J
Di-n-butyl phthalate	35 ^J	ND
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

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**Table 3-7. Pesticides/PCBs Detected in 116-D-1B
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18D3
Sample Depth	0.0-2.0
Aldrin	7.5 ^J
^J = Value estimated, concentration less than contract required detection limit.	

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**Table 3-8. Metals and Inorganics in 116-D-1B Vadose Borehole Soil Samples
Above the Hanford Site Background 95% Upper Threshold Limit
(concentrations in mg/Kg) (depths in feet)**

Sample Number	BO18D5	BO18D7	Hanford UTL 95% of 95th ^a
Sample Depth	14.0-16.3	17.0-19.6	
Chromium	30.4	BB	27.9
Lead	22.0	16.3	14.7
Zinc	106	BB	79

BB = Below Hanford Upper Threshold Limit
^a = Hanford Site Background: Part 1 Soil Background for
Nonradioactive Analyses, DOE-RL 1993a

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Table 3-9. Radionuclides Detected in 116-D-1B Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet) (page 1 of 2)

Sample Number Sample Depth	BO18D3 0.0-2.0	BO18D4 5.0-7.4	BO18D5 14.0-16.3	BO18D7 17.0-19.6	BO18D9 24.2-26.7	BO18F0 28.0-30.4	BO18F1 28.0-30.4	BO18F2 34.0-36.8
Gross Alpha	3.0 ^R	6.3 ^R	11 ^R	11 ^R	4.2 ^R	<2	.07	5.9
Gross Beta	30 ^R	40 ^R	760 ^R	490 ^R	63 ^R	39	23.1	50
Beryllium 7	NR	NR	ND	ND	ND	<9.0	NR	<8.0
Carbon 14	ND	ND	.023 ^R	.44 ^R	.35 ^R	<.5	-5.18	<.6
Sodium 22	NR	NR	5.7 ^J	3.43 ^J	NR	.125	NR	.112
Potassium 40	NR	NR	8.99 ^J	14.1 ^J	8.86 ^J	8.84	8.364	8.33
Chromium 51	NR	NR	NR	NR	NR	NR	112.7	NR
Manganese 54	NR	NR	ND	ND	ND	<.05	NR	<.05
Cobalt 57	NR	NR	NR	NR	NR	NR	1.583	NR
Cobalt 58	NR	NR	1.7 ^J	1.11 ^J	ND	<.4	ND	<.4
Iron 59	NR	NR	ND	ND	ND	<4.0	NR	<.4
Cobalt 60	NR	NR	16.3 ^J	10.5 ^J	.17 ^J	.0963	.15111	<.03
Zinc 65	NR	NR	ND	ND	ND	<.3	.7850	<.2
Strontium 90	1.6 ^J	1.3	32	25	8.4	8.4	6.13	7.4
Zirconium 95	NR	NR	ND	ND	ND	2.99	NR	<.6
Technetium 99	ND	ND	ND	.49 ^R	ND	ND	.12	ND
Ruthenium 103	NR	NR	ND	ND	ND	<4.0	NR	<4.0
Ruthenium 106	NR	NR	ND	ND	ND	<.4	NR	<.4
Cesium 134	NR	NR	ND	ND	ND	<.04	.1952	<.04
Cesium 137	NR	NR	322 ^J	198 ^J	1.51 ^J	.621	.4194	.0535
Cerium 141	NR	NR	ND	ND	ND	<10	NR	<20
Cerium 144	NR	NR	ND	ND	ND	<.3	NR	<.3

Table 3-9. Radionuclides Detected in 116-D-1B Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet) (page 2 of 2)

Sample Number	BO18D3	BO18D4	BO18D5	BO18D7	BO18D9	BO18F0	BO18F1	BO18F2
Sample Depth	0.0-2.0	5.0-7.4	14.0-16.3	17.0-19.6	24.2-26.7	28.0-30.4	28.0-30.4	34.0-36.8
Europium 152	NR	NR	147 ^J	9.6 ^J	.396 ^J	3.24	2.869	1.42
Europium 154	NR	NR	15.9 ^J	98.2 ^J	.423 ^J	.323	NR	<.1
Europium 155	NR	NR	NR	NR	NR	<.1	NR	<.1
Radium 226	NR	NR	ND	ND	ND	<.5	<.3069	<.6
Thorium 228	NR	NR	ND	ND	.825 ^J	.472	.5354	.510
Thorium 232	NR	NR	NR	NR	NR	NR	.6082	NR
Thorium 234	NR	NR	NR	NR	NR	<.6	NR	<.6
Uranium 235	NR	NR	.0067 ^J	ND	ND	NR	NR	NR
Uranium 238	NR	NR	.25 ^J	.22 ^J	.12 ^J	NR	NR	NR
Plutonium 239	NR	NR	5.3 ^J	4.1 ^J	0.4 ^J	NR	NR	NR
Americium 241	NR	NR	1.3 ^R	.89 ^R	.071 ^R	NR	NR	NR

^R = Value marked as rejected in validation because of missing calibration data.
^J = Value estimated, concentration less than contract required detection limit.
ND = Not detected
NR = Not reported
< = less than contract detection limits

**Table 3-10. Volatile Organic Compounds Detected in 116-D-6
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO5X06	BO5X07
Sample Depth	15.0-17.5	20.0-22.5
Acetone	27 ^J	ND
Toluene	2 ^J	2 ^J
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

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**Table 3-11. Semi-Volatile Organic Compounds Detected in 116-D-6
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO5X06
Sample Depth	15.0-17.5
Chrysene	62 ^J
Benzo(b)fluoranthene	59 ^J
Di-n-octyl phthalate	38 ^J
^J = Value estimated, concentration less than contract required detection limit.	

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**Table 3-12. Radionuclides Detected in 116-D-6 Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO5X06	BO5X07
Sample Depth	15.0-17.5	20.0-22.5
Gross Alpha	8.4 ^R	7.8 ^R
Gross Beta	29 ^R	23 ^R
Carbon 14	.0036 ^R	.23 ^R
Potassium 40	11 ^J	11.1 ^J
Radium 226	.897 ^J	.98 ^J
Thorium 228	.69 ^J	.755 ^J
Uranium 235	.0066 ^R	.0032 ^R
Uranium 238	.13 ^R	.091 ^R
Plutonium 239	.0005 ^R	.00072 ^R
Americium 241	.0053 ^R	.0048 ^R
^R = Value marked as rejected in validation because of missing calibration data. ^J = Value estimated, concentration less than contract required detection limit.		

**Table 3-13. Semi-Volatile Organic Compounds Detected in 116-D-7
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO1897	BO18B0
Sample Depth	4.2-7.3	28.3-30.8
Di-n-butyl phthalate	ND	89 ^J
Phenol	350 ^J	ND
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

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Table 3-14. Metals and Inorganics in 116-D-7 Vadose Borehole Soil Samples Above the Hanford Site Background 95% Upper Threshold Limit (concentrations in mg/Kg) (depths in feet)

Sample Number	BO1897	BO18B0	Hanford UTL
Sample Depth	4.7-7.0	28.3-30.8	95% of 95th ^a
Chromium	51.60	34.90 ^j	27.9
^j = Value estimated, concentration less than contract required detection limit. ^a = Hanford Site Background: Part 1 Soil Background for Nonradioactive Analytes, DOE-RL 1993a			

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**Table 3-15. Radionuclides Detected in 116-D-7 Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO1897	BO18B0	BO18B1
Sample Depth	4.7-7.0	28.3-30.8	34.0-36.6
Gross Alpha	ND	5.3 ^J	6.4 ^J
Gross Beta	37 ^J	2.9 ^J	38 ^J
Carbon 14	.43 ^J	ND	ND
Potassium 40	8.71 ^J	12.5 ^J	15.8 ^J
Strontium 90	1.9 ^J	ND	0.57
Cesium 137	9.55 ^J	ND	ND
Radium 226	ND	.585 ^J	.749 ^J
Thorium 228	.538 ^J	.449 ^J	.56 ^J
Uranium 235	.0042 ^R	.0046 ^R	.015 ^R
Uranium 238	.18 ^R	.13 ^R	.18 ^R
Plutonium 239	.016 ^R	.0043 ^R	.0056 ^R
Americium 241	.0028 ^R	.012 ^R	.0032 ^R

^R = Value marked as rejected in validation because of missing calibration data.
^J = Value estimated, concentration less than contract required detection limit.
 ND = Not detected

**Table 3-16. Volatile Organic Compounds Detected in the 116-DR-9A
Vadose Soil Borehole Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18H5	BO18H6	BO18H7	BO18H9	BO18J0
Sample Depth	19.5-21.5	24.0-26.5	24.0-26.5	34.4-36.9	34.4-36.9
Acetone	ND	ND	ND	ND	27 ^J
Methylene Chloride	ND	ND	ND	ND	16 ^J
Toluene	11	1 ^J	1 ^J	4 ^J	ND
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected					

**Table 3-17. Semi-Volatile Organic Compounds Detected in the 116-DR-9A
Vadose Soil Borehole Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18H2	BO18H3	BO18H4	BO18H5	BO18H6	BO18H7	BO18H8
Sample Depth	4.3-6.8	9.0-11.8	14.8-17.2	19.5-22.1	24.0-26.5	24.0-26.5	30.1-32.6
bis(2-ethylhexyl) phthalate	90 ^J	220 ^J	ND	ND	ND	ND	ND
Butylbenzyl phthalate	ND	ND	1200	430	320 ^J	130 ^J	82 ^J
Di-n-butyl phthalate	ND	36 ^J	2200	2200	ND	2400	2400
pentachloro phenol	ND	ND	ND	ND	56 ^J	ND	ND
pyrene	ND	ND	ND	ND	350	ND	ND

^J = Value estimated, concentration less than contract required detection limit.
ND = Not detected

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**Table 3-18. Pesticides/PCB Detected in the 116-DR-9A
Vadose Soil Borehole Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18H5
Sample Depth	19.5-22.1
Arochlor 1260	21 ^J
^J = Value estimated, concentration is less than detection limit.	

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Table 3-19. Metals and Inorganics in 116-DR-9A Vadose Soil Borehole Soil Samples Above the Hanford Site Background 95% Upper Threshold Limit (concentrations in mg/Kg) (depths in feet)

Sample Number	BO18G9	BO18H2	Hanford UTL 95% of 95th ^a
Sample Depth	0.8-3.0	4.3-6.3	
Arsenic	BB	12.4 ^R	8.92
Cadmium	.68 ^J	ND	.66
^R = Value marked as rejected in validation because of missing calibration data. ^J = Value estimated, concentration less than contract required detection limit. BB = Below Hanford Upper Threshold Limit ND = Not detected ^a = Hanford Site Background: Part 1 Soil Background for Nonradioactive Analytes, DOE-RL 1993a			

Table 3-20. Radionuclides Detected in 116-DR-9A Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)

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Sample Number	BO18G9	BO18H3	BO18H4	BO18H5	BO18H6	BO18H7	BO18H8	BO18H9	BO18J0
Sample Depth	0.8-3.0	9.0-11.0	14.8-16.6	19.5-21.5	24.0-26.5	24.0-26.5	30.2-33.5	34.4-36.4	34.4-36.9
Gross Alpha	7.0 ^R	ND	6.4 ^J	ND	1.0	4.0	<3.0	9.4 ^R	4.95 ^R
Gross Beta	18 ^R	31 ^J	30 ^J	33 ^J	30	37	24.0	38 ^R	13.3 ^R
Beryllium 7	NR	ND	ND	ND	<.4	<.4	<.4	ND	NR
Carbon 14	.41 ^R	ND	.22 ^R	ND	<.5	<.6	<.5	.17 ^R	25.06
Potassium 40	NR	8.71 ^J	11.3 ^J	13.4 ^J	14.7	14	10.2	13.1 ^J	10.59
Manganese 54	NR	.02 ^J	ND	ND	<.03	<.03	<.03	ND	NR
Cobalt 58	NR	ND	ND	ND	<.04	<.05	<.03	ND	NR
Iron 59	NR	ND	ND	ND	<.1	<.1	<.1	ND	NR
Cobalt 60	NR	ND	ND	ND	<.02	<.03	<.02	ND	ND
Zinc 65	NR	ND	ND	ND	<.07	<.06	<.06	ND	ND
Strontium 90	.1	2.1 ^J	1.1	.66	.42	.44	.28	.19	ND
Zirconium 95	NR	ND	ND	ND	<.05	<.05	<.04	ND	NR
Technetium 99	ND	.081	ND	ND	<.8	<1.0	<.9	.08 ^R	.56
Ruthenium 103	NR	ND	ND	ND	<.01	<.06	<.05	ND	NR
Ruthenium 106	NR	ND	ND	ND	<.2	<.3	<.2	ND	NR
Iodine 131	NR	ND	ND	ND	ND	<3.0	<2.0	ND	NR
Cesium 134	NR	ND	ND	ND	<.03	<.03	<.03	ND	ND
Cesium 137	NR	ND	.0487 ^J	ND	<.03	<.03	<.02	ND	ND
Barium 140	NR	ND	ND	ND	<.6	<.5	<.4	ND	NR
Cerium 141	NR	ND	ND	ND	<.1	<.1	<.09	ND	NR
Cerium 144	NR	ND	ND	ND	<.2	<.2	<.1	ND	NR
Radium 226	NR	.7 ^J	.765 ^J	.812 ^J	.813	.706	.814	1.25 ^J	.4901
Thorium 228	NR	.419 ^J	.583 ^J	.562 ^J	.575	.512	.507	.584 ^J	1.02
Thorium 232	NR	NR	NR	NR	NR	NR	NR	NR	.7117
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	.51 ^J
Uranium 235	NR	.0019 ^R	.0022 ^R	.0067 ^R	<.01	<.008	<.007	.0073 ^R	ND
Uranium 238	NR	.14 ^R	.12 ^R	.13 ^R	.2	.085	.14	.11 ^R	.46 ^J
Plutonium 239	NR	.0024 ^R	.00013 ^R	.0013 ^R	<.5	<.004	<.009	.0038 ^R	ND
Americium 241	NR	.015 ^R	.0086 ^R	.013 ^R	<.5	<.005	<.01	.0092 ^R	ND

^R = Value marked as rejected in validation because of missing calibration data.
^J = Value estimated, concentration less than contract required detection limit.
 ND = Not detected
 NR = Not reported
 < = less than contract required detection limits

**Table 3-21. Volatile Organic Compounds Detected in the 116-DR-9B
Vadose Soil Borehole Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18J1	BO18J3
Sample Depth	1.1-4.0	8.0-11.1
Methylene Chloride	ND	4 ^J
Toluene	3 ^J	ND
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

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**Table 3-22. Semi-Volatile Organic Compounds Detected in the 116-DR-9B
Vadose Soil Borehole Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18J1	BO18J3
Sample Depth	1.1-4.0	8.0-11.1
Anthracene	150 ^J	ND
Benzo(a)anthracene	130 ^J	ND
Benzo(b)fluroanthene	120 ^J	ND
Benzo(k)fluroanthene	95 ^J	ND
Benzo(g,h,i)perylene	85 ^J	ND
Benzo(a)pyrene	110 ^J	ND
Chrysene	140 ^J	ND
Fluoranthene	240 ^J	ND
Indeno(1,2,3,cd)pyrene	76 ^J	ND
Pyrene	240 ^J	38 ^J
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

**Table 3-23. Metals and Inorganics in 116-DR-9B Vadose Borehole Soil Samples
Above the Hanford Site Background 95% Upper Threshold Limit
(concentrations in mg/Kg) (depths in feet)**

Sample Number	BO18J2	BO18J8	Hanford UTL 95% of 95th ^a
Sample Depth	5.5-7.5	31.0-33.6	
Cadmium	ND	1.10	.66
Chromium	30	BB	27.9

ND = Not detected
BB = Below Hanford Upper Threshold Limit
^a = Hanford Site Background: Part 1 Soil Background for
Nonradioactive Analytes, DOE-RL 1993a

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**Table 3-24. Radionuclides Detected in 116-DR-9B Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO18J2	BO18J3	BO18J8	BO18J9
Sample Depth	4.8-7.5	8.0-11.1	31.0-33.6	35.6-37.4
Gross Alpha	<3.0	2.4	8.4 ^R	6.3 ^R
Gross Beta	28	<2	29 ^R	33 ^R
Beryllium 7	<4	<5	ND	ND
Carbon 14	<.5	.3	.34 ^R	.46 ^R
Sodium 22	NR	.103	NR	NR
Potassium 40	8.22	7.66	11.6 ^J	11 ^J
Manganese 54	<.05	<.05	ND	ND
Cobalt 58	<.2	<.2	ND	ND
Iron 59	<1.0	<2.0	ND	ND
Cobalt 60	.255	.275	ND	ND
Zinc 65	<.1	<.1	ND	ND
Strontium 90	2.4	<.05	.77	.84
Zirconium 95	<.3	<.3	ND	ND
Ruthenium 103	<1.0	<1.0	ND	ND
Ruthenium 106	<.4	<.5	ND	ND
Cesium 134	<.04	<.04	ND	ND
Cesium 137	1.05	1.98	.236 ^J	ND
Barium 140	<2000	<2000	ND	ND
Cerium 141	<3.0	<5.0	ND	ND
Cerium 144	<.3	<.5	ND	ND
Europium 152	.488	.817	NR	NR
Europium 154	<.1	<.1	NR	NR
Europium 155	<.1	<.2	NR	NR
Radium 226	.819	<.8	1.07 ^J	.801 ^J
Thorium 228	.476	.436	.538 ^J	.53 ^J
Thorium 234	<.6	<1.0	NR	NR
Uranium 234	.16	.18	NR	NR
Uranium 235	<.008	.011	.0046 ^R	.0095 ^R
Uranium 238	.39	.34	.12 ^R	.11 ^R
Plutonium 239	.0065	<.007	.0019 ^R	.024 ^R
Americium 241	<.02	<.02	.0013 ^R	.0026 ^R

^R = Value marked as rejected in validation because of missing calibration data.
^J = Value estimated, concentration less than contract required detection limit.
 ND = Not detected
 NR = Not reported
 < = less than contract required detection limits

**Table 3-25. Volatile Organic Compounds Detected in 116-DR-9C
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18K0	BO18K2
Sample Depth	0.0-2.0	9.6-12.2
Acetone	ND	55 ^J
Toluene	ND	1 ^J
Trichloroetnene	6	ND

^J = Value estimated, concentration less than contract required detection limit.
ND = Not detected

**Table 3-26. Semi-Volatile Organic Compounds Detected in 116-DR-9C
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18K0	BO18K1	BO18K2	BO18D1	BO18D2
Sample Depth	0.0-2.0	5.0-7.4	9.6-12.2	29.9-32.7	34.7-37.5
Benzoic acid	ND	ND	ND	74 ^J	ND
bis(2-ethylhexyl) phthalate	ND	61 ^J	77 ^J	4800	5200
Butylbenzyl phthalate	ND	36 ^J	ND	1900	2200
Diethyl phthalate	ND	ND	ND	34 ^J	ND
Di-n-butyl phthalate	ND	2900	ND	1000 ^J	2200 ^J
2-Nitrophenol	350 ^J	ND	ND	ND	ND
Pentachlorophenol	53 ^J	ND	ND	ND	ND

^J = Value estimated, concentration less than contract required detection limit.
ND = Not detected

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**Table 3-27. Pesticides/PCB Detected in 116-DR-9C
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18K0
Sample Depth	0.0-2.0
Arochlor 1260	130 ^J
^J = Value estimated, concentration less than contract required detection limit.	

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Table 3-28. Metals and Inorganics in 116-DR-9C Vadose Borehole Soil Samples Above the Hanford Site Background 95% Upper Threshold Limit (concentrations in mg/Kg) (depths in feet)

Sample Number	BO18K2	BO18D2	Hanford UTL
Sample Depth	9.6-11.6	34.7-36.7	95% of 95th ^a
Cadmium	ND	1.2	.66
Chromium	73.40 ^j	BB	27.9
Nickel	37 ^j	BB	25.3
ND = Not detected ^j = Value estimated, concentrations is less than the detection limit. BB = Below Hanford Upper Threshold Limit ^a = Hanford Site Background: Part 1 Soil Background for Nonradioactive Analytes, DOE-RL 1993a			

**Table 3-29. Radionuclides Detected in 116-DR-9C Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO18K1	BO18K2	BO18D1	BO18D2
Sample Depth	5.0-6.6	9.6-11.6	29.9-31.9	34.7-36.7
Gross Alpha	1.6 ^R	3.4 ^R	11 ^R	5.2 ^R
Gross Beta	27 ^R	28 ^R	35 ^R	32 ^R
Beryllium 7	ND	ND	ND	1.0 ^J
Carbon 14	.3 ^R	.021 ^R	.021 ^R	.33 ^R
Potassium 40	8.1 ^J	8.46 ^J	12.8 ^J	ND
Manganese 54	ND	ND	ND	.03 ^J
Cobalt 58	ND	ND	ND	.08 ^J
Iron 59	ND	ND	ND	.04 ^J
Cobalt 60	ND	ND	ND	.03 ^J
Zinc 65	ND	ND	ND	.09 ^J
Strontium 90	3.8	2.5	.075	.32
Zirconium 95	ND	ND	ND	0.1 ^J
Technetium 99	1.5 ^R	.66 ^R	.24 ^R	ND
Ruthenium 103	ND	ND	ND	.2 ^J
Ruthenium 106	ND	ND	ND	.3 ^J
Iodine 131	ND	NR	ND	200 ^J
Cesium 134	ND	ND	ND	.03 ^J
Cesium 137	ND	.0533 ^J	ND	.03 ^J
Barium 140	ND	ND	ND	20 ^J
Cerium 141	ND	ND	ND	.6 ^J
Cerium 144	ND	ND	ND	.2 ^J
Europium 152	.6 ^J	ND	NR	.07 ^J
Europium 154	ND	ND	ND	.09 ^J
Europium 155	ND	ND	ND	.09 ^J
Radium 226	1.1 ^J	.802 ^J	1.23 ^J	.607 ^J
Thorium 228	.38 ^J	.475 ^J	.69 ^J	.533 ^J
Uranium 235	.0044 ^R	.0019 ^R	.0056 ^R	.0087 ^R
Uranium 238	.15 ^R	.13 ^R	.17 ^R	.096 ^R
Plutonium 239	.0007 ^R	.01	.00057 ^R	.00055 ^R
Americium 241	.01 ^R	.011 ^R	.0006 ^R	.00066 ^R
^R = Value marked as rejected in validation because of missing calibration data. ^J = Value estimated, concentration less than contract required detection limit. ND = Not detected NR = Not reported				

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**Table 3-30. Volatile Organic Compounds Detected in 116-DR-1
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO1885	BO1887
Sample Depth	14.8-17.5	19.0-22.3
Methylene Chloride	ND	1 ^J
Toluene	3 ^J	ND
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

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**Table 3-31. Semi-Volatile Organic Compounds Detected in 116-DR-1
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO1887	BO1889
Sample Depth	19.0-22.3	24.3-27.1
Benzoic Acid	ND	250 ^J
4-chloro-3 methylphenol	38 ^J	ND
2 Chlorophenol	47 ^J	ND
1,3 Dichlorobenzene	48 ^J	ND
1,4 Dichlorobenzene	37 ^J	ND
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

Table 3-32. Metals and Inorganics in 116-DR-1 Vadose Borehole Soil Samples Above the Hanford Site Background 95% Upper Threshold Limit (concentrations in mg/Kg) (depths in feet)

Sample Number	BO1885	BO1887	Hanford UTL 95% of 95th ^a
Sample Depth	14.8-17.5	19.0-22.2	
Chromium	186 ^J	BB	27.9
Silver	3.50 ^R	3.3 ^R	2.7
Zinc	109 ^J	BB	79

^R = Value marked as rejected in validation because of missing calibration data.
^J = Value estimated, concentration less than contract required detection limit.
BB = Below Hanford Upper Threshold Limit
^a = Hanford Site Background: Part 1 Background for Nonradioactive Analytes, DOE-RL 1993a

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Table 3-33. Radionuclides Detected in 116-DR-1 Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)

Sample Number	BO1885	BO1887	BO1888	BO1890	BO1889
Sample Depth	14.8-17.5	19.0-22.2	24.3-27.1	29.0-31.5	24.3-27.1
Gross Alpha	5.6 ^R	2.6 ^R	5.2 ^R	0 ^R	5.7 ^R
Gross Beta	160 ^R	49 ^R	26 ^R	34 ^R	25 ^R
Carbon 14	.084 ^R	.17 ^R	.082 ^R	.01 ^R	.53 ^R
Sodium 22	9.91 ^J	.61 ^J	NR	NR	NR
Potassium 40	20 ^J	8.42 ^J	9.84 ^J	10.2 ^J	10.3 ^J
Cobalt 58	14.1 ^J	ND	ND	ND	ND
Cobalt 60	23.1 ^J	1.59 ^J	ND	ND	ND
Strontium 90	10 ^J	2.2	1.7 ^J	.16 ^J	1.7 ^J
Technetium 99	.91 ^R	.53 ^R	ND	ND	0 ^R
Cesium 137	147 ^J	28.8 ^J	ND	.198 ^J	ND
Europium 152	258 ^J	13.3 ^J	.323 ^J	.339 ^J	.336 ^J
Europium 154	25.7	1.59 ^J	NR	NR	NR
Radium 226	ND	ND	.66 ^J	ND	.924 ^J
Thorium 228	ND	.508 ^J	.428 ^J	.433 ^J	.464 ^J
Uranium 235	.013 ^J	.013 ^J	.0051 ^J	ND	ND
Uranium 238	.2 ^J	.19 ^J	.11 ^J	0.12 ^J	.13 ^J
Plutonium 239	.82 ^J	.11 ^J	.019 ^J	.011 ^J	.012 ^J
Americium 241	.15 ^J	.034 ^J	.0024 ^R	.013 ^R	.0094 ^R

^R = Value marked as rejected in validation because of missing calibration data.

^J = Value estimated, concentration less than contract required detection limit.

ND = Not detected

NR = Not reported

**Table 3-34. Volatile Organic Compounds Detected in 116-DR-2
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18F7	BO18F7
Sample Depth	30.0-32.0	35.0-37.0
Acetone	10	22
Methylene Chloride	9	8

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**Table 3-35. Semi-Volatile Organic Volatiles Detected in 116-DR-2
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18F4
Sample Depth	19.6-22.6
Di-n-butyl phthalate	35 ^J
^J = Value estimated, concentration less than contract required detection limit.	

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**Table 3-36. Metals and Inorganics in 116-DR-2 Vadose Borehole Soil Samples
Above the Hanford Site Background 95% Upper Threshold Limit
(concentrations in mg/Kg) (depths in feet)**

Sample Number	BO18F3	Hanford UTL
Sample Depth	14.0-17.0	95% of 95th ^a
Cadmium	1.10 ^J	.66
Silver	3.70 ^R	2.7
^R = Value marked as rejected in validation because of missing calibration data. ^J = Value estimated, concentration less than contract required detection limit. ^a = Hanford Site Background: Part 1 Soil Background for Nonradioactive Analytes, DOE-RL 1993a		

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**Table 3-37. Radionuclides Detected in 116-DR-2 Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO18F3	BO18F4	BO18F5	BO18F6	BO18F7	BO18F8
Sample Depth	14.0-17.0	19.6-22.6	24.0-27.0	24.0-27.0	30.0-32.0	35.0-37.0
Gross Alpha	8.2 ^R	3.2 ^R	2.1 ^R	4.77	5.7 ^R	3.1 ^R
Gross Beta	370 ^R	200 ^R	39 ^R	24.3	32 ^R	32 ^R
Carbon 14	.83 ^R	.68 ^R	.12 ^R	-6.14	.19 ^R	.0066 ^R
Sodium 22	.979 ^J	ND	NR	NR	NR	NR
Potassium 40	10 ^J	9.09 ^J	NR	8.733	NR	NR
Chromium 51	NR	NR	NR	< 63.68	NR	NR
Cobalt 60	3.75 ^J	.567 ^J	NR	.1106	NR	NR
Zinc 65	ND	ND	NR	< .2892	NR	NR
Strontium 90	.78 ^J	1.1 ^J	.92	.4	.99	1.7
Technetium 99	ND	ND	ND	.34	1.1 ^R	ND
Cesium 134	ND	ND	NR	< .07204	NR	NR
Cesium 137	233 ^J	177 ^J	NR	15.4	NR	NR
Europium 152	24 ^J	6.39 ^J	NR	NR	NR	NR
Europium 154	2.53 ^J	ND	NR	NR	NR	NR
Radium 226	ND	ND	NR	.4069	NR	NR
Thorium 228	ND	ND	NR	.3665	NR	NR
Thorium 232	NR	NR	NR	.4833	NR	NR
Uranium 238	.17 ^J	.14 ^J	NR	NR	NR	NR
Plutonium 239	14 ^J	.034 ^J	NR	NR	NR	NR
Americium 241	.026 ^J	.0055 ^J	NR	NR	NR	NR

^R = Value marked as rejected in validation because of missing calibration data.

^J = Value estimated, concentration less than contract required detection limit.

ND = Not detected

NR = Not reported

< = less than contract required detection limits

**Table 3-38. Volatile Organic Compounds Detected in 116-D-2A
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO5X03	BO5X05
Sample Depth	17.0-20.0	22.5-25.0
Methylene Chloride	3 ^J	ND
Toluene	ND	2 ^J
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

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**Table 3-39. Pesticides/PCB Detected in 116-D-2A
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO5X02
Sample Depth	12.0-15.0
Endrin	16 ^J
^J = Value estimated, concentration less than contract required detection limit.	

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**Table 3-40. Radionuclides Detected in 116-D-2A Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO5X02	BO5X03	BO5X05
Sample Depth	10.0-13.0	17.0-20.0	22.5-25.0
Gross Alpha	4.4 ^R	2.6 ^R	6.8 ^R
Gross Beta	290 ^R	63 ^R	.22 ^R
Carbon 14	.044 ^R	-.096 ^R	-.22 ^R
Sodium 22	.214 ^J	NR	NR
Potassium 40	10.7 ^J	13.4 ^J	8.54 ^J
Cobalt 60	.162 ^J	ND	ND
Strontium 90	26	3.6	.33
Technetium 99	.058 ^R	.08	ND
Cesium 137	105 ^J	19.9 ^J	1.07 ^J
Europium 152	6.87 ^J	1.26 ^J	ND
Europium 154	5.01 ^J	ND	ND
Radium 226	13 ^J	ND	ND
Thorium 228	.377 ^J	.63 ^J	.423 ^J
Uranium 235	.0084 ^R	.0054 ^R	.017 ^R
Uranium 238	.13 ^R	.18 ^R	.092 ^R
Plutonium 239	1.0 ^R	.14 ^R	.014 ^R
Americium 241	.1 ^R	.015 ^R	.0006 ^R

^R = Value marked as rejected in validation because of missing calibration data.
^J = Value estimated, concentration less than contract required detection limit.
 ND = Not detected
 NR = Not reported

**Table 3-41. Volatile Organic Compounds Detected in 116-D-9
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18G1	BO18G2
Sample Depth	17.3-20.9	24.6-27.8
Acetone	60	39

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**Table 3-42. Radionuclides Detected in 116-D-9 Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO18G1	BO18G2
Sample Depth	18.0-20.8	25.0-27.8
Gross Alpha	2.3 ^R	2.9 ^R
Gross Beta	20 ^R	25 ^R
Carbon 14	.26 ^J	.15 ^R
Potassium 40	7.39 ^J	9.35 ^J
Strontium 90	2.9 ^J	.088 ^J
Radium 226	.355 ^J	.726 ^J
Thorium 228	.352 ^J	.479 ^J
Uranium 238	.18 ^J	.32 ^R
Americium 241	.0061 ^J	ND
^R = Value marked as rejected in validation because of missing calibration data. ^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

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**Table 3-43. Volatile Organic Compounds Detected in 132-D-3
Vadose Soil Borehole Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO1T36
Sample Depth	25.0-27.0
Toluene	8

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**Table 3-44. Semi-Volatile Organic Compounds Detected in 132-D-3
Vadose Soil Borehole Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO1T37
Sample Depth	35.0-36.8
butylbenzyl phthalate	590 ^J
diethyl phthalate	100 ^J
di-n-butyl phthalate	4300 ^J
^J = Value estimated, concentration less than contract required detection limit.	

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**Table 3-45. Pesticides Detected in 132-D-3
Vadose Soil Borehole Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO1T37
Sample Depth	35.0-36.8
Heptachlor	8.4 ^R
^R = Value marked as rejected in validation because of missing calibration data.	

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**Table 3-46. Radionuclides Detected in 132-D-3 Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO1T35	BO1T36	BO1T38
Sample Depth	19.8-21.8	25.0-27.0	37.0-38.6
Gross Alpha	3.1 ^R	3.7 ^R	3.9 ^R
Gross Beta	23 ^R	21 ^R	21 ^R
Carbon 14	-.12 ^R	.076 ^R	.033 ^R
Potassium 40	10.5 ^J	9.22 ^J	10.7 ^J
Strontium 90	.15	2.7	.018
Technetium 99	-.13 ^R	ND	ND
Radium 226	.927 ^J	.699 ^J	ND
Thorium 228	.49 ^J	.472 ^J	.448 ^J
Uranium 235	.0058 ^R	.0042 ^R	.007 ^R
Uranium 238	.13 ^R	.1 ^R	.17 ^R
Plutonium 239	.007 ^J	.0005 ^R	.00028 ^R
Americium 241	.01 ^R	.0014 ^R	.0031 ^R

^R = Value marked as rejected in validation because of missing calibration data.
^J = Value estimated, concentration less than contract required detection limit.
 ND = Not detected

9313027-0166

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**Table 3-47. Volatile Organic Compounds Detected in 116-D-5
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18B9
Sample Depth	20.0-21.5
Trichloroethene	5

9313027.0166

**Table 3-48. Radionuclides Detected in 116-D-5 Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO18B9	BO18C0
Sample Depth	20.0-22.0	25.0-27.0
Gross Alpha	8.9 ^R	5.7 ^R
Gross Beta	3.3 ^R	28 ^R
Carbon 14	.4 ^R	.27 ^R
Potassium 40	12 ^J	12 ^J
Strontium 90	.047	ND
Radium 226	.891 ^J	.75 ^J
Thorium 228	.592 ^J	.49 ^J
Uranium 235	.0013 ^R	.0055 ^R
Uranium 238	.12 ^R	.17 ^R
Plutonium 239	0 ^R	.0067 ^R
Americium 241	.0013 ^R	-.008 ^R

^R = Value marked as rejected in validation because of missing calibration data.
^J = Value estimated, concentration less than contract required detection limit.
 ND = Not detected

93072062

**Table 3-49. Semi-Volatile Organic Compounds Detected in 116-DR-5
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18C2
Sample Depth	25.0-27.0
bis(2-ethylhexyl) phthalate	5500
Butylbenzyl phthalate	2100
Di-n-butyl phthalate	1900 ^J
^J = Value estimated, concentration less than contract required detection limit.	

931027.0169

**Table 3-50. Pesticides/PCB Detected in 116-DR-5
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18C2
Sample Depth	25.0-27.0
Dieldrin	2.1 ^J
^J = Value estimated, concentration less than contract required detection limit.	

931302.0169

**Table 3-51. Radionuclides Detected in 116-DR-5 Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO18C1	BO18C2
Sample Depth	20.3-22.5	25.0-27.5
Gross Alpha	4.7 ^R	8.9 ^R
Gross Beta	30 ^R	36 ^R
Carbon 14	NR	.084 ^R
Potassium 40	13 ^J	13.5 ^J
Strontium 90	.24	.21
Cesium 137	ND	.03 ^J
Radium 226	.752 ^J	.807 ^J
Thorium 228	.559 ^J	.657 ^J
Uranium 235	.002 ^R	.0041 ^R
Uranium 238	.12 ^R	.14 ^R
Plutonium 239	.002 ^R	.0019 ^R
Americium 241	.0048 ^R	.0026 ^R
^R = Value marked as rejected in validation because of missing calibration data. ^J = Value estimated, concentration less than contract required detection limit. ND = Not detected NR = Not reported		

**Table 3-52. Volatile Organic Compounds Detected in 116-D-3
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18G8
Sample Depth	19.4-22.4
2-Butanone	10 ^J
^J = Value estimated, concentration less than contract required detection limit.	

9313027.07

**Table 3-53. Semi-Volatile Organic Compounds Detected in 116-D-3
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18G5	BO18G8
Sample Depth	14.0-17.0	19.4-22.4
bis(2-ethylhexyl) phthalate	100 ^J	45 ^J
Di-n-butyl phthalate	140 ^J	37 ^J
^J = Value estimated, concentration less than contract required detection limit.		

9313027.0172

**Table 3-54. Metals and Inorganics in 116-D-3 Vadose Borehole Soil Samples
Above the Hanford Site Background 95% Upper Threshold Limit
(concentrations in mg/Kg) (depths in feet)**

Sample Number	BO18G5	Hanford UTL
Sample Depth	15.0-17.0	95% of 95th ^a
Silver	3.40	2.7
^a = Hanford Site Background: Part 1 Soil Background for Nonradioactive Analytes, DOE-RL 1993a		

9313027.073

**Table 3-55. Radionuclides Detected in 116-D-3 Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO18G5	BO18G8
Sample Depth	15.0-17.0	19.5-22.4
Gross Alpha	2.1 ^R	2.1 ^R
Gross Beta	21 ^R	19 ^R
Carbon 14	.15 ^R	.18 ^R
Potassium 40	8.92 ^J	8.99 ^J
Strontium 90	ND	.085
Technetium 99	.34 ^R	.43 ^R
Radium 226	.512 ^J	.685 ^J
Thorium 228	.17 ^J	.49 ^J
Uranium 238	.17 ^J	.16 ^J
Americium 241	.0043 ^R	.013 ^R
^R = Value marked as rejected in validation because of missing calibration data. ^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

930207

**Table 3-56. Volatile Organic Compounds Detected in 116-D-4
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO1892
Sample Depth	10.0-12.5
4-methyl-2-pentanone	4 ^J
^J = Value estimated, concentration less than contract required detection limit.	

9313027.0175

**Table 3-57. Semi-Volatile Organic Compounds Detected in 116-D-4
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO1891
Sample Depth	3.0-5.5
Fluoranthene	37 ^j
Pyrene	37 ^j
^j = Value estimated, concentration less than contract required detection limit.	

9302.076

**Table 3-58. Radionuclides Detected in 116-D-4 Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO1892	BO1895
Sample Depth	10.0-12.5	20.5-23.0
Gross Alpha	1.6 ^R	4.7 ^R
Gross Beta	25 ^R	23 ^R
Potassium 40	9.69 ^J	9.09 ^J
Strontium 90	.46 ^J	.13 ^J
Radium 226	.54 ^J	.731 ^J
Thorium 228	.425 ^J	.39 ^J
Uranium 235	.0044 ^J	ND
Uranium 238	.15 ^J	.084 ^J
Americium 241	.0031 ^J	ND

^R = Value marked as rejected in validation because of missing calibration data.
^J = Value estimated, concentration less than contract required detection limit.
 ND = Not detected

**Table 3-59. Volatile Organic Compounds Detected in 130-D-1
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18C7	BO18D0
Sample Depth	10.0-11.4	25.0-27.0
Acetone	ND	77
Methylene Chloride	ND	6
Toluene	6	2 ^J
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

931302.079

**Table 3-60. Semi-Volatile Organic Compounds Detected in 130-D-1
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18C6	BO18D0
Sample Depth	10.0-11.4	25.0-27.0
bis(2-ethylhexyl) phthalate	5500	ND
butylbenzyl phthalate	2600	ND
Diethyl phthalate	ND	130 ^J
Di-n-butyl phthalate	2100 ^J	130 ^J
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected		

9313027.073

**Table 3-61. Pesticides/PCB Detected in 130-D-1
Vadose Soil Boring Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18D3
Sample Depth	30.2-32.2
Aldrin	7.5 ^J
^J = Value estimated, concentration less than contract required detection limit.	

991302.000

**Table 3-62. Metals and Inorganics in 130-D-1 Vadose Borehole Soil Samples
Above the Hanford Site Background 95% Upper Threshold Limit
(concentrations in mg/Kg) (depths in feet)**

Sample Number	BO18C6	BO18C7	Hanford UTL 95% of 95th ^a
Sample Depth	10.0-11.2	10.0-11.2	
Lead	18.8	19.2	14.7
^a = Hanford Site Background: Part 1 Soil Background for Nonradioactive Analytes, DOE-RL 1993a			

931302.00

Table 3-63. Radionuclides Detected in 130-D-1 Vadose Soil Borehole Soil Samples
(concentrations in pCi/g) (depths in feet)

Sample Number	BO18C7	BO18C8	BO18C9	BO18D0
Sample Depth	10.0-11.2	15.0-17.0	20.0-22.0	25.0-27.0
Gross Alpha	1.0	1.6	.52 ^R	1.0 ^R
Gross Beta	25	22	15 ^R	21 ^R
Carbon 14	.0036 ^R	.0036 ^R	.013 ^R	.067 ^R
Potassium 40	9.23 ^J	9.54 ^J	8.75 ^J	9.07 ^J
Strontium 90	ND	ND	ND	.083
Technetium 99	1.1	1.0	ND	ND
Radium 226	.83 ^J	ND	ND	.583 ^J
Thorium 228	.572 ^J	.57 ^J	.398 ^J	.401 ^J
Uranium 235	.0046 ^R	.011 ^R	.0056 ^R	.0079 ^R
Uranium 238	.13 ^R	.15 ^R	.12 ^R	.12 ^R
Plutonium 239	.00062 ^R	.004 ^R	.00088 ^R	.00092 ^R
Americium 241	.00067 ^R	.00055 ^R	.00087 ^R	.0054 ^R

^R = Value marked as rejected in validation because of missing calibration data.
^J = Value estimated, concentration less than contract required detection limit.
 ND = Not detected

9313027-0002

**Table 3-64. Radionuclides Detected in 108-D Test Pit Soil Sample
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO18W0	BO18W1	BO18W2
Sample Depth	5.0	5.0	5.0
Carbon 14	-7.5 ^J	-11 ^J	39 ^R
Potassium 40	13 ^R	12 ^R	12.1 ^J
Radium 226	.57 ^R	.59 ^R	.877 ^J
Thorium 228	.82 ^R	.75 ^R	.681 ^J
Thorium 232	.21 ^R	.74 ^R	NR
^R = Marked as rejected in validation because of missing calibration data. ^J = Value estimated, concentration less than contract required detection limit. NR = Not reported			

931302-000

**Table 3-65. Volatile Organic Compounds Detected in Sodium Dichromate
Tanks Site Test Pit Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18T3	BO18T4
Sample Depth	4.0	4.0
Toluene	1 ^J	1 ^J
^J = Value estimated, concentration less than contract required detection limit.		

9313027.0004

**Table 3-66. Semi-Volatile Organic Compounds Detected in Sodium Dichromate
Tanks Site Test Pit Soil Samples
(concentrations in $\mu\text{g}/\text{Kg}$) (depths in feet)**

Sample Number	BO18T3	BO18T4	BO18T6
Sample Depth	4.0	4.0	3.0
Di-n-butyl phthalate	170 ^j	93 ^j	120 ^j
^j = Value estimated, concentration less than contract required detection limit.			

9313027.085

**Table 3-67. Radionuclides Detected in Sodium Dichromate
Tanks Site Test Pit Soil Samples
(concentrations in pCi/g) (depths in feet)**

Sample Number	BO18T3	BO18T4	BO18T6
Sample Depth	4.0	4.0	3.0
Potassium 40	10.2 ^J	10.5 ^J	12.8 ^J
Radium 226	ND	0.61 ^J	0.773 ^J
Thorium 228	0.495 ^J	0.576 ^J	0.586 ^J
^J = Value estimated, concentration less than contract required detection limit. ND = Not detected			

9313027.0006

**Table 3-68. Pesticides Detected in Wipe Samples Collected from
103-D Fuel Element Storage Building
(concentrations in $\mu\text{g}/\text{Kg}$)**

Sample Number	BO7264	BO7267
2,4-D	0.75 ^J	0.58 ^J
^J = Value estimated, concentration less than contract required detection limit.		

9313027.007

**Table 3-69. Metals Detected in Wipe Samples Collected from
103-D Fuel Element Storage Building
(concentrations in $\mu\text{g}/\text{Kg}$)**

Sample Number	BO7264	BO7265	BO7266	BO7267
Aluminum	3450	3660	3780	7430
Arsenic	2.0	2.0 ^u	2.0 ^u	3.2
Barium	158	217	206	331
Cadmium	11.1	12.9	10.9	6.8
Calcium	16400	14600	12100	25500
Chromium	24.7	15.5	14.6	48.4
Cobalt	10.0 ^u	10.0 ^u	10.0 ^u	11.1
Copper	32.3	20.7	19.5	41.7
Iron	49.3	3150	4120	9440
Lead	316 ^u	122	68.0	274
Magnesium	3240	1900	2060	3990
Manganese	198	158	153	363
Mercury	0.10	0.07	0.12	0.18
Nickel	8.0 ^u	8.0 ^u	8.0 ^u	15.1
Potassium	4630	1460	1300	2950
Sodium	1380	1000 ^u	1000 ^u	1350
Vanadium	10.0 ^u	11.5	11.7	21.4
Zinc	1110	243	191	461

^u = Analyte was analyzed for and not detected. The numerical value is the contract required detection limit (CRDL).

**Table 3-70. Radionuclides Detected in Wipe Samples Collected from
103-D Fuel Element Storage Building
(concentrations in pCi/g)**

Sample Number	BO7264	BO7265	BO7266	BO7267
Gross Alpha	358	196	228	1.04
Gross Beta	2670	5.56	6.79	6.80
Cobalt 60	4.83	ND	ND	ND
Cesium 137	2770	ND	ND	ND
Europium 152	30.9	ND	ND	ND
Europium 154	2770	ND	ND	ND
Americium 241	33.2	NR	NR	NR

ND = Not detected
NR = Not reported

9313027.0089

Table 3-71 Potential Federal Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-DR-1 Operable Unit (sheet 1 of 3)

DOE/RL-93-29
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Description	Citation	A/ R&A*	Requirements	Remarks
Atomic Energy Act of 1954, as amended	42 U.S.C. 2011 et seq.		Authorizes DOE to set standards and restrictions governing facilities used for research, development, and utilization of atomic energy.	
Radiation Protection Standards	40 CFR Part 191		Establishes standards for management and disposal of high-level and transuranic waste and spent nuclear fuel.	
Standards for Management and Storage	40 CFR §191.03	A	Requires that management and storage of spent nuclear fuel or high-level or transuranic radioactive wastes at all facilities for the disposal of such fuel or waste that are operated by the DOE and that are not regulated by the Commission or Agreement States shall be conducted in such a manner as to provide reasonable assurance that the combined annual dose equivalent to any member of the public in the general environment resulting from discharges of radioactive material and direct radiation from such management and storage shall not exceed 25 millirems to the whole body and 75 millirems to any critical organ.	Applicable to wastes disposed of after November 18, 1985.
Nuclear Regulatory Commission Standards for Protection Against Radiation	10 CFR Part 20			
Radiation Dose Standards	10 CFR §§20.101-20.105	R&A	Sets specific radiation doses, levels, and concentrations for restricted and unrestricted areas.	May be relevant and appropriate, as radioactive materials in the 100 Area can contribute radiation doses, levels, and concentrations which could exceed the limits; however, Hanford is not an NRC-licensed facility.

Table 3-71 Potential Federal Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-DR-1 Operable Unit (sheet 2 of 3)

DOE/RL-93-29
Draft A

Description	Citation	A/ R&A*	Requirements	Remarks
<p>Safe Drinking Water Act</p> <p>National Primary Drinking Water Regulations</p> <p>National Secondary Drinking Water Regulations</p>	<p>42 U.S.C. 300f et seq.</p> <p>40 CFR Part 141</p> <p>40 CFR Part 143</p>	<p>R&A</p> <p>R&A</p>	<p>Creates a comprehensive national framework to ensure the quality and safety of drinking water.</p> <p>Establishes maximum contaminant levels (MCL) and maximum contaminant level goals (MCLG) for organic, inorganic, and radioactive constituents. The MCL for combined radium-226 and radium-228 is 5 pCi/L. The MCL for gross alpha particle activity (including radium-226 but excluding radon and uranium) is 15 pCi/L. The average annual concentration of beta particle and photon radioactivity from manmade radionuclides in drinking water shall not produce an annual dose equivalent to total body or any internal organ in excess of 4 millirem/year.</p> <p>Controls contaminants in drinking water that primarily affect the aesthetic qualities relating to the public acceptance of drinking water.</p>	<p>Applicable to public water systems. Potential chemicals and radionuclides of concern may migrate to the drinking water supply as a result of remedial activities. Although federal MCLGs are not enforceable standards, they are potential ARARs under the Washington State Model Toxics Control Act when more stringent than other standards. See state ARARs.</p> <p>Although federal secondary drinking water standards are not enforceable, they are potential ARARs under the Washington State Model Toxics Control Act when more stringent than other standards. See state ARARs.</p>
<p>Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA)</p> <p>Groundwater Protection Standards</p>	<p>42 U.S.C. 6901 et seq.</p> <p>40 CFR §264.92 [WAC 173-303-645]¹</p>	A	<p>Establishes the basic framework for federal regulation of solid and hazardous waste.</p> <p>A facility shall not contaminate the uppermost aquifer underlying the waste management area beyond the point of compliance, which is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated area. The concentration of certain chemicals shall not exceed background levels, certain specified maximum concentrations, or alternate concentration limits, whichever is higher.</p>	<p>Groundwater concentration limits in this section do not exceed 40 CFR 141, except for chromium which has a limit of 50 µg/L.</p>

^aThese are State of Washington regulatory citations which are equivalent to Title 40 Code of Federal Regulations, Parts 264 and 268 as stated in Washington Administrative Code 173-303.

Table 3-71 Potential Federal Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-DR-1 Operable Unit (sheet 3 of 3)

Description	Citation	A/ R&A*	Requirements	Remarks
<p>Uranium Mill Tailings Radiation Control Act of 1978</p> <p>Standards for Uranium and Thorium Mill Tailings</p> <p>Land Cleanup Standards</p> <p>Implementation</p>	<p>Public Law 95-604, as amended</p> <p>40 CFR 192</p> <p>40 CFR §§192.10 - 192.12</p> <p>40 CFR §§192.20 - 192.23</p>	<p></p> <p>R&A</p> <p>R&A</p>	<p>Establishes standards for control, cleanup, and management of radioactive materials from inactive uranium processing sites.</p> <p>Requires remedial actions to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site, the concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than 5 pCi/g, averaged over the first 15 cm of soil below the surface, and 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface. In any habitable building, a reasonable effort shall be made during remediation to achieve an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 Working Level (WL). In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL and the level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.</p> <p>Requires that when radionuclides other than radium-226 and its decay products are present in sufficient quantity and concentration to constitute a significant radiation hazard from residual radioactive materials, remedial action shall reduce other residual radioactivity to levels as low as reasonably achievable (ALARA).</p>	<p>May be relevant and appropriate, as any radium-226 encountered during remediation did not result from uranium processing.</p> <p>May be relevant and appropriate, as any radium-226 encountered during remediation did not result from uranium processing.</p>

*NOTE: A = Applicable, R&A = Relevant and Appropriate

Table 3-72 Potential State Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-DR-1 Operable Unit (sheet 1 of 3)

DOE/RL-93-29
Draft A

Description	Citation	A/ R&A*	Requirements	Remarks
Model Toxics Control Act (MTCA)	70.105D RCW		Requires remedial actions to attain a degree of cleanup protective of human health and the environment.	
Cleanup Regulations	WAC 173-340		Establishes cleanup levels and prescribes methods to calculate cleanup levels for soils, groundwater, surface water, and air.	
Groundwater Cleanup Standards	WAC 173-340-720	A	<p>Requires that where the groundwater is a potential source of drinking water, cleanup levels under Method B must be at least as stringent as concentrations established under applicable state and federal laws, including the following:</p> <p>(A) Maximum contaminant levels established under the Safe Drinking Water Act and published in 40 CFR 141, as amended;</p> <p>(B) Maximum contaminant level goals for noncarcinogens established under the Safe Drinking Water Act and published in 40 CFR 141, as amended;</p> <p>(C) Secondary maximum contaminant levels established under the Safe Drinking Water Act and published in 40 CFR 143, as amended; and</p> <p>(D) Maximum contaminant levels established by the state board of health and published in Chapter 248-54 WAC, as amended.</p>	Federal maximum contaminant level goals for drinking water (40 CFR Part 141) and federal secondary drinking water regulation standards (40 CFR Part 143) are potential ARARs under MTCA when they are more stringent than other standards. Method B cleanup levels are levels applicable to remediation at Hanford unless a demonstration can be made that method C (alternate cleanup levels) is valid.

Table 3-72 Potential State Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-DR-1 Operable Unit (sheet 2 of 3)

Description	Citation	N/ R&A*	Requirements	Remarks																																																												
Soil Cleanup Standards	WAC 173-340-740	A	<p>MTCA Method B concentration limits in milligrams per kilogram for potential contaminants in soils, sediments, and sludges are:</p> <table data-bbox="851 349 1276 1161"> <tbody> <tr><td>Barium</td><td>5,600</td></tr> <tr><td>Cadmium</td><td>40</td></tr> <tr><td>Chromium (III)</td><td>80,000</td></tr> <tr><td>Chromium (VI)</td><td>400</td></tr> <tr><td>Copper</td><td>2,960</td></tr> <tr><td>Manganese</td><td>8,000</td></tr> <tr><td>Mercury</td><td>24</td></tr> <tr><td>Silver</td><td>240</td></tr> <tr><td>Zinc</td><td>16,000</td></tr> <tr><td>Acetone</td><td>8,000</td></tr> <tr><td>Benzene</td><td>34.5</td></tr> <tr><td>Carbon disulfide</td><td>8,000</td></tr> <tr><td>Methyl ethyl ketone</td><td>4,000</td></tr> <tr><td>Methyl Isobutyl Ketone</td><td>4,000</td></tr> <tr><td>Methylene chloride</td><td>133</td></tr> <tr><td>Toluene</td><td>16,000</td></tr> <tr><td>Anthracene</td><td>24,000</td></tr> <tr><td>Benzo(a)anthracene</td><td>0.172</td></tr> <tr><td>Benzo(b)fluoranthene</td><td>0.172</td></tr> <tr><td>Benzo(k)fluoranthene</td><td>0.172</td></tr> <tr><td>Benzoic acid</td><td>320,000</td></tr> <tr><td>Benzyl alcohol</td><td>24,000</td></tr> <tr><td>Bis(2-ethylhexyl)phthalate</td><td>71.4</td></tr> <tr><td>Chrysene</td><td>0.172</td></tr> <tr><td>Di-n-butylphthalate</td><td>8,000</td></tr> <tr><td>Diethyl phthalate</td><td>64,000</td></tr> <tr><td>Fluoranthene</td><td>3,200</td></tr> <tr><td>N-nitrosodiphenylamine</td><td>204</td></tr> <tr><td>Pyrene</td><td>2040</td></tr> <tr><td>Pentachlorophenol</td><td>8.33</td></tr> </tbody> </table>	Barium	5,600	Cadmium	40	Chromium (III)	80,000	Chromium (VI)	400	Copper	2,960	Manganese	8,000	Mercury	24	Silver	240	Zinc	16,000	Acetone	8,000	Benzene	34.5	Carbon disulfide	8,000	Methyl ethyl ketone	4,000	Methyl Isobutyl Ketone	4,000	Methylene chloride	133	Toluene	16,000	Anthracene	24,000	Benzo(a)anthracene	0.172	Benzo(b)fluoranthene	0.172	Benzo(k)fluoranthene	0.172	Benzoic acid	320,000	Benzyl alcohol	24,000	Bis(2-ethylhexyl)phthalate	71.4	Chrysene	0.172	Di-n-butylphthalate	8,000	Diethyl phthalate	64,000	Fluoranthene	3,200	N-nitrosodiphenylamine	204	Pyrene	2040	Pentachlorophenol	8.33	
Barium	5,600																																																															
Cadmium	40																																																															
Chromium (III)	80,000																																																															
Chromium (VI)	400																																																															
Copper	2,960																																																															
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Mercury	24																																																															
Silver	240																																																															
Zinc	16,000																																																															
Acetone	8,000																																																															
Benzene	34.5																																																															
Carbon disulfide	8,000																																																															
Methyl ethyl ketone	4,000																																																															
Methyl Isobutyl Ketone	4,000																																																															
Methylene chloride	133																																																															
Toluene	16,000																																																															
Anthracene	24,000																																																															
Benzo(a)anthracene	0.172																																																															
Benzo(b)fluoranthene	0.172																																																															
Benzo(k)fluoranthene	0.172																																																															
Benzoic acid	320,000																																																															
Benzyl alcohol	24,000																																																															
Bis(2-ethylhexyl)phthalate	71.4																																																															
Chrysene	0.172																																																															
Di-n-butylphthalate	8,000																																																															
Diethyl phthalate	64,000																																																															
Fluoranthene	3,200																																																															
N-nitrosodiphenylamine	204																																																															
Pyrene	2040																																																															
Pentachlorophenol	8.33																																																															

Description	Citation	A/ R&A*	Requirements	Remarks
Washington State Department of Health	RCW 43.70			
Radiation Protection -- Air Emissions	WAC 246-247		Establishes procedures for monitoring, control, and reporting of airborne radionuclide emissions.	
New and Modified Sources	WAC 246-247-070	A	Requires the use of best available radionuclide control technology (BARCT).	
Radiation Protection Standards	WAC 246-221		Establishes standards for protection against radiation hazards.	
Radiation dose to individuals in restricted areas	WAC 246-221-010	A	Specifies dose limits to individuals in restricted areas for hands and wrists, ankles and feet of 18.75 rem/quarter and for skin of 7.5 rem/quarter.	

*NOTE: A = Applicable, R&A = Relevant and Appropriate

Table 3-72 Potential State Chemical-Specific Applicable or Relevant and Appropriate Requirements for the 100-DR-1 Operable Unit (sheet 3 of 3)

Description	Citation	Requirements	Remarks
Model Toxics Control Act Cleanup Regulations	70.105D RCW WAC 173-340	The State Department of Ecology is currently adapting the calculations in MTCA to be applicable to radioactive contaminants. These cleanup standards may become available prior to or during remediation.	
Solid Waste Disposal Act, as amended by RCRA Criteria for Classification of Solid Waste Disposal Facilities and Practices Corrective Action for Solid Waste Management Units	42 U.S.C. 6901 et seq. 40 CFR §257.3-4 40 CFR 264 Subpart S, proposed	A facility or practice shall not contaminate an underground drinking water source beyond the solid waste boundary. Establishes requirements for investigation and corrective action for releases of hazardous waste from solid waste management units.	The courts or the state may establish alternate boundaries.
U.S. Department of Energy Orders Radiation Protection of the Public and the Environment Radiation Dose Limit (All Pathways) Radiation Dose Limit (Drinking Water Pathway)	DOE 5400.5 DOE 5400.5, Chapter II, Section 1a DOE 5400.5, Chapter II, Section 1d	Establishes radiation protection standards for the public and environment. The exposure of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem from all exposure pathways, except under specified circumstances. Provides a level of protection for persons consuming water from a public drinking water supply operated by DOE so that persons consuming water from the supply shall not receive an effective dose equivalent greater than 4 mrem per year. Combined radium-226 and radium-228 shall not exceed $5 \times 10^{-9} \mu\text{Ci/mL}$ and gross alpha activity (including radium-226 but excluding radon and uranium) shall not exceed $1.5 \times 10^{-4} \mu\text{Ci/mL}$.	Pertinent if remedial activities are "routine DOE activities." Pertinent if radionuclides may be released during remediation.

Table 3-73 Potential Chemical-Specific To-Be-Considered Guidance for the 100-DR-1 Operable Unit (sheet 1 of 2)

Description	Citation	Requirements	Remarks
Residual Radionuclides in Soil	DOE 5400.5 Chapter IV, Section 4a	<p>Generic guidelines for radium-226 and radium-228 are:</p> <ul style="list-style-type: none"> • 5 pCi/g averaged over the first 15 cm of soil below the surface; and • 15 pCi/g averaged over 15-cm-thick layers of soil more than 15 cm below the surface. <p>Guidelines for residual concentrations of other radionuclides must be derived from the basic dose limits by means of an environmental pathway analysis using specific property data where available. Procedures for these deviations are given in "A Manual for Implementing Residual Radioactive Material Guidelines" (DOE/CH-8901). Procedures for determination of "hot spots," "hot-spot cleanup limits," and residual concentration guidelines for mixtures are in DOE/CH-8901. Residual radioactive materials above the guidelines must be controlled to the required levels in 5400.5, Chapter II and Chapter IV.</p>	Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m ² .

Table 3-73 Potential Chemical-Specific To-Be-Considered Guidance for the 100-DR-1 Operable Unit (sheet 2 of 2)

Table 3-74 Potential Federal Location-Specific Applicable or Relevant and Appropriate Requirements for the 100-DR-1 Operable Unit

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Description	Citation	A/ R&A*	Requirements	Remarks
Archaeological and Historical Preservation Act of 1974	16 U.S.C. 469	A	Requires action to recover and preserve artifacts in areas where activity may cause irreparable harm, loss, or destruction of significant artifacts.	Applicable when remedial action threatens significant scientific, prehistorical, historical, or archaeological data.
Endangered Species Act of 1973	16 U.S.C. 1531 et seq.		Prohibits federal agencies from jeopardizing threatened or endangered species or adversely modifying habitats essential to their survival.	
Fish and Wildlife Services List of Endangered and Threatened Wildlife and Plants	50 CFR Parts 17, 222, 225, 226, 227, 402, 424	A	Requires identification of activities that may affect listed species. Actions must not threaten the continued existence of a listed species or destroy critical habitat.	Requires consultation with the Fish and Wildlife Service to determine if threatened or endangered species could be impacted by activity.
Historic Sites, Buildings, and Antiquities Act	16 U.S.C. 461	A	Establishes requirements for preservation of historic sites, buildings, or objects of national significance. Undesirable impacts to such resources must be mitigated.	
National Historic Preservation Act of 1966, as amended.	16 U.S.C. 470 et seq.	A	Prohibits impacts on cultural resources. Where impacts are unavoidable, requires impact mitigation through design and data recovery.	Applicable to properties listed in the National Register of Historic Places, or eligible for such listing. B reactor is listed on the Register.
Wild and Scenic Rivers Act	16 U.S.C 1271	A	Prohibits federal agencies from recommending authorization of any water resource project that would have a direct and adverse effect on the values for which a river was designated as a wild and scenic river or included as a study area.	The Hanford Reach of the Columbia River is under study for inclusion as a wild and scenic river.

*NOTE: A = Applicable, R&A = Relevant and Appropriate

Table 3-75 Potential State Location-Specific Applicable or Relevant and Appropriate Requirements for the 100-DR-1 Operable Unit

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Description	Citation	A/ R&A*	Requirements	Remarks
Habitat Buffer Zone for Bald Eagle Rules	RCW 77.12.655			
Bald Eagle Protection Rules	WAC 232-12-292	A	Prescribes action to protect bald eagle habitat, such as nesting or roost sites, through the development of a site management plan.	Applicable if the areas of remedial activities includes bald eagle habitat.
Regulating the Taking or Possessing of Game	RCW 77.12.040			
Endangered, Threatened, or Sensitive Wildlife Species Classification	WAC 232-12-297	A	Prescribes action to protect wildlife classified as endangered, threatened, or sensitive, through development of a site management plan.	Applicable if wildlife classified as endangered, threatened, or sensitive are present in areas impacted by remedial activities.

*NOTE: A = Applicable, R&A = Relevant and Appropriate

Description	Citation	Requirements	Remarks
Floodplains/Wetlands Environmental Review	10 CFR Part 1022	Requires federal agencies to avoid, to the extent possible, adverse effects associated with the development of a floodplain or the destruction or loss of wetlands.	Pertinent if remedial activities take place in a floodplain or wetlands.
Protection and Enhancement of the Cultural Environment	Executive Order 11593	Provides direction to federal agencies to preserve, restore, and maintain cultural resources.	Pertains to sites, structures, and objects of historical, archeological, or architectural significance.
Hanford Reach Study Act	PL 100-605	Provides for a comprehensive river conservation study. Prohibits the construction of any dam, channel, or navigation project by a federal agency for 8 years after enactment. New federal and non-federal projects and activities are required, to the extent practicable, to minimize direct and adverse effects on the values for which the river is under study and to utilize existing structures.	This law was enacted November 4, 1988.

Table 3-76 Potential Location-Specific To-Be-Considered Guidance for the 100-DR-1 Operable Unit

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4.0 SUMMARY AND CONCLUSIONS OF THE QUALITATIVE RISK ASSESSMENT

This chapter provides a summary of the methods and results of the QRA that was performed for the high-priority waste sites in the 100-DR-1 Operable Unit (WHC 1993a).

4.1 QUALITATIVE RISK ASSESSMENT PROCESS

The QRA is an evaluation of risk for a predefined set of human and ecological exposure scenarios. The QRA is not intended to replace or be a substitute for a baseline risk assessment. Consequently, the QRA is streamlined to consider only two human health scenarios (frequent and occasional use) with four exposure pathways (soil ingestion, fugitive dust inhalation, inhalation of volatile organics, and external radiation exposure) and a limited ecological evaluation. The use of these scenarios and pathways was agreed to by the 100 Area Tri-Party Unit Managers (December 21, 1992, and February 8, 1993). Future waste site risk estimates considering the decay of radionuclides to the year 2018 and the effect on external radiation exposure by shielding provided by current soil and gravel covers is also presented.

4.1.1 Approach

The QRA is conducted using the HSB RAM (DOE-RL 1993b) as guidance and consists of:

- an evaluation of the data sources and/or process information
- identification of maximum constituent concentrations, where data is available
- a human health risk evaluation
- an ecological risk evaluation
- an analysis of potential impacts to groundwater.

Key factors that contribute to uncertainty throughout the risk assessment process are also identified.

4.1.2 Guidelines Used in the Qualitative Risk Assessment

The following guidelines were agreed to by the Tri-Party Unit Managers prior to performing the QRA:

- Site-wide soil background concentration data are used to screen inorganic constituents.
- Historical radionuclide concentrations are decayed to 1992.
- The maximum contaminant concentration within the upper 4.6 m (15 ft) of soil, either from historical or LFI data, are used to estimate risk in the QRA.
- Two scenarios, frequent use and occasional use, are evaluated in the human health section of the QRA.
- For the human health exposure assessment, the pathways evaluated in the QRA are: soil ingestion, fugitive dust inhalation, inhalation of volatile organics, and external radiation exposure.
- Ecological scenarios are evaluated using the Great Basin pocket mouse because it is a key component of the Hanford area food chain and a biological endpoint with a range similar in size to the dimensions of most individual waste sites.

Several other guidelines are used in the QRA. The data collection during the LFI for the operable unit followed a known process and therefore the data are considered to be of high quality. Historical data (e.g., Dorian and Richards 1978) are considered to be of medium quality because the data were not validated and documentation was less rigorous. Where historical data do not specify U isotopes, ^{238}U is evaluated because it represents >99% of natural U. Chromium is assumed to be present as Cr (VI) because it provides the most conservative evaluation and Cr was not speciated during analysis. Nickel in the soil environment is not considered carcinogenic because the pyrolytic activity which generates the carcinogenic form of Ni was not present in the operable unit. If toxicity factors are not available for a constituent, surrogate factors are generally not used, unless specifically noted.

The qualitative risk estimations are grouped into high (ICR > 1E-02), medium (ICR > 1E-04 to 1E-02), low (ICR 1E-06 to 1E-04), and very low (ICR < 1E-06) risk categories. A frequent-use scenario is evaluated in 2018 to ascertain potential future risks associated with each waste site after additional radionuclide decay. For the current occasional-use scenario, the effect of radiation shielding by the upper 2 m (6 ft) of soil on the external exposure risk at each waste site is evaluated.

For the ecological risk assessment, metals are assumed to be bioavailable for uptake by vegetation. The identified concentrations are assumed to be uniformly distributed over the site, biologically active, and available for transport. Hazard quotients for ecological exposure to radionuclides are based on an exposure limit of 1 rad/day (DOE Order 5400.5) and the no observable effect level (NOEL) dose.

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4.2 HUMAN HEALTH QUALITATIVE RISK ASSESSMENT

The QRA provides estimates of risk that might occur under frequent-use or occasional-use scenarios based on the best available knowledge of current contaminant conditions, but does not represent actual risks since neither frequent-use nor occasional-use of high priority sites currently occurs.

4.2.1 Overview of the Human Health Risk Evaluation Process

The frequent-use and occasional-use scenarios are evaluated using residential and recreational exposure parameters from HSB RAM (DOE-RL 1993b), respectively. Frequent-use is addressed for current (1992) and future (2018) contaminant concentrations. Air inhalation of volatile organics is eliminated from this analysis because concentrations of volatile organics in the soil did not exceed risk-based screening values. Therefore, inhalation of volatile organics is not a likely exposure pathway for this operable unit. For the soil ingestion and external exposure pathways, maximum sample concentrations from the upper 4.6 m (15 ft) of soil are used. For the fugitive dust inhalation pathway, maximum contaminant concentrations in the upper 4.6 m (15 ft) of soil are used in conjunction with a particulate emission factor. This factor relates contaminant concentrations in the soil to concentrations of respirable particles in the air due to fugitive dust emissions. Quantification of exposures is conducted using Section 2.2 of HSB RAM (DOE-RL 1993b).

The external exposure pathway is also evaluated for the current occasional-use scenario while considering the effect of shielding by existing soil cover. In this evaluation, only radionuclides detected in the upper 2 m (6 ft) of soil are considered as contributors to external radiation exposure. These external exposure risks are considered to be more representative of current site conditions where activities in a contaminated zone are controlled.

Section 2.3 of HSB RAM (DOE-RL 1993b) contains the general procedures followed in the QRA for toxicity assessment. The toxicity assessment in the QRA involves the selection of slope factors and reference doses for contaminants of potential concern and includes sufficient toxicity information on contaminants of potential concern to assist project managers in reaching decisions on IRMs.

Risk characterization for the individual waste sites differs depending on the type and amount of data available for the specific waste site. Risk characterization is conducted in accordance with Section 2.4 of HSB RAM (DOE-RL 1993b). The risk characterization for each site is performed by calculating contaminant-specific ICRs and HQs and then summing contaminant-specific risks to obtain a risk estimate for the waste site.

For sites where sampling data are not available to calculate ICRs and HQs, the risk characterization consists of a qualitative discussion of the site, the potential threat posed by the site, and the confidence in the information available to assess the threat.

Risk estimates from analogous sites are used, where appropriate, to qualitatively determine possible contaminants and potential risk levels. The basic intake equations presented in Appendix C are modified to identify soil contaminant concentrations associated with an ICR of 1E-06 or an HQ of 1, using HSB RAM (DOE-RL 1993b) exposure parameters.

4.2.2 Results of the Human Health QRA

An overview of the human health QRA, and associated uncertainties, for the 100-DR-1 QRA are summarized in the following sections.

Information summarized in Tables 4-1, 4-2 and 4-3 for the human health QRA includes:

- data availability and confidence in data
- the qualitative risk estimation
- the risk driving contaminants for the frequent-use and occasional-use scenarios
- the risk driving pathways for the frequent-use and occasional-use scenarios.

The risk-driving contaminants for both the frequent-use and occasional-use scenarios are generally radionuclides and the primary risk-driving pathway is usually the external exposure pathway.

The high-priority waste sites listed in Table 4-2 of the 100-DR-1 Work Plan (DOE-RL 1992a) are evaluated in the QRA. Where LFI data were not collected, historical data were used in the risk assessment. Where sampling data were not available, risk estimates from analogous waste sites (if any) were considered in evaluating the potential risk from the waste site.

Based on the QRA, the high-priority waste sites within the 100-DR-1 Operable Unit are grouped into high, medium, low, and very low risk categories as shown in Table 4-3. The results of the frequent-use scenario are summarized as follows:

- The waste sites considered high risk for the frequent-use scenario are the 116-D-1A trench (1992, 2018), 116-D-1B trench (1992, 2018), 116-D-5 outfall structure (1992, 2018), 116-D-7 basin/107-D sludge trenches (1992, 2018), 116-DR-1 trench (1992, 2018), 116-DR-2 trench (1992, 2018), and 116-DR-9 basin/107-DR sludge trenches (1992, 2018).

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- The waste sites considered medium risk for the frequent-use scenario are the 108-D office building (1992), 116-D-2A crib (1992, 2018), 116-D-6 french drain (1992), 130-D-1 storage tank (1992), and sodium dichromate tanks (1992).
- The waste sites considered low risk for the frequent-use scenario are the 108-D office building (2018), 116-D-3 french drain (1992, 2018), 116-D-4 french drain (1992, 2018), 116-D-6 french drain (2018), 130-D-1 storage tank (2018), and sodium dichromate tanks (2018).

The results of the occasional-use scenario are summarized as follows:

- The waste sites considered high risk for the occasional-use scenario are the 116-D-7 basin/107-D sludge trenches, and 116-DR-9 basin/107-DR sludge trenches.
- The waste sites considered medium risk for the occasional-use scenario are the 116-D-1A trench, 116-D-1B trench, 116-D-5 outfall structure, 116-DR-1 trench, and 116-DR-2 trench.
- The waste sites considered low risk for the occasional-use scenario are the 108-D office building, 116-D-2A crib, 116-D-6 french drain, 130-D-1 storage tank, and sodium dichromate tanks
- The waste sites considered very low risk for the occasional-use scenario are the 116-D-3 crib (french drain), and 116-D-4 crib (french drain).

Other results of the QRA as presented in Tables 4-2 and 4-3 are:

- Radionuclides are identified as the primary contributors to the overall risks via the external exposure pathway. The specific radionuclides identified as key contributors are ^{60}Co , ^{137}Cs , ^{152}Eu , and ^{154}Eu .
- There are several sites where potential contaminants are identified only on the basis of historical information, process knowledge, or LFI soil sampling results from below the zone of likely exposure [6 m (15 ft)]. These sites include the 103-D building, 116-D-9 crib, 116-DR-5 outfall structure, 126-D-2 landfill, 115-D building, 117-D building, and 132-D-3 pump station. Contaminant concentrations at which an ICR of 1E-06 or HQ of 1 would exist are calculated for the potential contaminants. Estimated risks are considered qualitative estimates and are based on suspected risk-driving contaminants, disposal information, decommissioning activities, and the size of the waste site.
- For two sites (process effluent pipelines and burial grounds 4A, 4B, and 18) no data were collected during the LFI. For the process effluent pipeline, a qualitative risk estimate was based on the QRA conducted at an

analogous facility in the 100-BC-1 Operable Unit. There is little information available for the burial grounds on which to base a qualitative risk estimate.

The risks, both carcinogenic and non-carcinogenic, presented in this QRA are deterministic estimates given multiple assumptions about exposure, toxicity, and variables. Consequently, uncertainty exists for the evaluation of the contaminants, the exposures, the toxicities, and the risk characterization for the QRA. This uncertainty is discussed more extensively in the following sections.

4.2.3 Summary of Key Uncertainties in the Human Health Risk Assessment

In general, the QRA is based on a limited data set. Uncertainties are associated with both the contaminants identified for each waste site and the concentrations of the contaminants. Collected samples may not be representative of conditions throughout the waste site and historical data may not accurately represent current conditions. Because the samples may not be completely representative of the site, risks may be underestimated or overestimated.

Uncertainty exists with respect to the identification of specific contaminants. Where the isotope of U is not specified U is evaluated as ^{238}U . The slope factors for the various U isotopes differ slightly from one another, resulting in slightly different risks if each is evaluated separately. However, the use of slope factors for ^{238}U provides the most conservative estimate of risk. The valence state of Cr identified in the QRA samples was not known. For the risk estimate, the most toxic form was assumed (Cr VI). However, risks are overestimated if Cr exists as the less toxic form (Cr III).

External exposure slope factors are appropriate for a uniform contaminant distribution, infinite in depth and areal extent (i.e., an infinite slab source), with no clean soil cover. For high-energy gamma emitters (e.g., ^{60}Co and ^{137}Cs), the assumption of an infinite slab source can only be satisfied if these radionuclides extend to nearly 2 m (6 ft) below ground surface, and over a distance of a few hundred meters or more. If the site being evaluated is smaller than this, or if the site has a clean soil cover, then use of external exposure slope factors is likely to provide risk estimates that are unrealistic. The fact that the external exposure pathway is the risk-driver at many waste sites is not surprising and in some cases may be indicative of the conservatism built into the evaluation of this pathway rather than the actual associated risk. The shielding effects of 2 m (6 ft) of clean fill or external exposures to radionuclides contaminants is provided in Appendix F of WHC (1993a).

There is uncertainty associated with the toxicity information available to assess potential adverse effects. The interpretation of the toxicity data and the actual toxicity values used for the QRA are both sources of uncertainty. These uncertainties contribute to the uncertainty in the risk assessment.

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When there is a high degree of uncertainty associated with the information used to determine toxicity, there is less confidence in the assessment of the risk associated with exposure. The primary sources of these uncertainties include the following:

- Use of information on dose-response effects from high-dose exposure scenarios to predict effect at low-dose exposure scenarios.
- Use of animal dose-response data to predict effects in humans.
- Use of short-term exposure data to extrapolate to long-term exposure, or vice versa.
- Use of dose-response information from a homogeneous animal or healthy human population to predict the effects that may occur in the general population where there are varying sensitivities to different contaminants.

Uncertainty in the risk characterization also results from summing ICRs and HQs across contaminants and pathways, a process which gives equal weight to toxicity information derived from different sources or species. Exposures to multiple contaminants may result in additive effects or effects that are greater or less than additive.

Historical information and risk estimates from analogous sites may be used to evaluate some of the high-priority waste sites. The selection of analogous sites for the QRA is based on available information at the time the QRA is prepared. As additional information is identified and incorporated into the LFI report for an operable unit, the QRA should be updated to utilize additional pertinent information.

4.3 ECOLOGICAL QUALITATIVE RISK ASSESSMENT

The 100-DR-1 Operable Unit is a terrestrial waste unit. The approach consistent with the objective of the QRA is to assess the dose to the Great Basin pocket mouse. The mouse is used as the indicator receptor because its home range is comparable to the size of most waste sites and will receive most of its dose from a waste site. This allows a risk comparison between waste sites.

Ecological Effects. Contaminants found in the soil at waste sites within the 100-DR-1 Operable Unit include radioactive and non-radioactive elements. For non-radioactive elements, ecological effects were evaluated from uptake from the soil by plants, and by accumulation of these elements through the foodweb. Radioactive elements have ecological effects resulting from their presence in the abiotic environment (external dose), and from ingestion (consumption dose), resulting in a total body burden. Total daily doses to an organism is the sum of doses (weighted by energy of radiation) received from all radioactive elements ingested, residing in the body, and available in the organism's environment. Radiological dose calculation methodology as reviewed by

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Baker and Soldat (1992), were applied in this QRA. The radiological dose an organism receives is usually expressed as rad/day.

Endpoint Selection. The assessment and measurement endpoint is the health and mortality of the Great Basin pocket mouse, respectively. The dose to the pocket mouse was used to screen the level of risk of an individual waste site.

Risk is evaluated for the Great Basin pocket mouse based on a two-step accumulation model. The method of integration is based on averaging waste site constituent concentrations over the operable unit as a fraction of the total operable unit area.

Exposure Analysis. The exposure analysis integrates the spatial and temporal distributions of the ecological components and stressors.

All non-radioactive and radioactive constituents identified as of potential concern in the human health risk assessment (before the risk-based screening) were considered to be of concern in the ecological risk assessment. Because of the lack of site-specific ecological data, it was assumed the receptor spends some fraction of its life in the site, obtains all its food from the site when present, and all consumed food is contaminated. However, because there is no source of water within the site, drinking water was not considered a route of exposure.

The major route of all contaminants to plants is assumed to be direct uptake from soil. Ingestion of vegetation is assumed to be a major route of exposure to the mouse. For radionuclides, the exposure pathway considered uptake from contaminated food resulting in internal exposure. For all contaminants, the dose is based on receptor whole-body concentrations. Metals stressors are assumed to be bioavailable for uptake by vegetation.

4.3.1 Results of the Ecological Evaluation

A qualitative ecological risk assessment was completed for the 100-DR-1 Operable Unit. Site 116-DR-9 retention basin/107-DR sludge disposal trenches exceeded the 1 rad/day with an EHQ > 1 (Table 4-4). For nonradiological constituents, site 116-D-7/107-D sludge disposal trenches exceeded the NOEL for Cr (Table 4-5).

For sites that exceeded the radionuclide 1 rad/d benchmark, all of the dose is from ⁹⁰Sr.

The estimated dose from ⁹⁰Sr to the Great Basin pocket mouse exceeded 1 rad/day from all waste sites that had measurable ⁹⁰Sr at the 100-DR-1 Operable Unit (Table 4-4 of the QRA). This extremely high calculated dose is believed to be an artifact of the modeling parameters (e.g., source term) and does not reflect actual conditions. The significance of dose estimates, either radiological or hazardous chemicals, as the risk driver is governed by the accuracy of the source terms. If the

source of ^{90}Sr is 6 to 15 feet below the surface, the dose may not represent real ecological risk since the exposure scenario is unrealistic. The approach in the QRA is to use the maximum level of contamination irrespective of depth (anywhere from 0 to 15 ft depth) that drives the QRA far into the conservative side and makes the results useful only for comparison between waste sites.

4.3.2 Summary of Key Uncertainties in the Ecological Evaluation

The uncertainty in contaminant concentrations for the ecological evaluation is related to the accuracy of the data. For the QRA, uncertainty exists in both contaminants identified and exposure concentrations. As for the human health assessment, the maximum contaminant concentration was used.

The QRA models the potential exposure of wildlife thought present in or near the waste site. The issues of concern with regard to ecological risk assessment (particularly qualitative) are the uncertainties in using an assortment of environmental variables in risk modeling. This begins with the source term. If this number is not realistic, no amount of modeling will overcome this deficiency. For example, in the case of the QRA, the maximum reported waste concentration was used as the source term no matter how deep this concentration.

Generally, site-specific organisms (e.g., pocket mouse), are identified as being associated with a site, but little if any data may exist concerning transfer of contaminants to site-specific organisms. Often, it is necessary to use biological trophic transfer information for related species.

A significant source of uncertainty in the exposure scenario is that the waste site is uniformly contaminated and in the case of the mouse, all foodstuff is assumed to be contaminated. No provision is made for dilution of contaminated foodstuff by noncontaminated foodstuff. It was also assumed contaminants were not passed through the gut but completely retained (100% absorption efficiency).

To complete the QRA for the 100-DR-1 Operable Unit it was necessary to use data from surrogate organisms in place of the pocket mouse since no site data is available for this organism. This contributes to overall QRA uncertainty. In addition, transfer coefficients used to model uptake of contaminants from soil to plants were not Hanford specific, the approach did not consider whether roots of a plant actually grow deep enough to contact a contaminant, and the model did not account for reduced concentrations from plant to seed (it was assumed the seed concentration was the same as the plant). The pocket mouse food consumption rate was generalized and seasonal behavior (hibernation) that would reduce exposure and body burden was not considered.

Uncertainty associated with wildlife toxicity values is significant, particularly for nonradiological contaminants. The approach used in the QRA tends to build conservatism into the toxicity value.

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4.4 QUALITATIVE OVERVIEW OF POTENTIAL GROUNDWATER IMPACTS

4.4.1 Evaluation of Potential Groundwater Impacts

The constituents present in sediments or soils associated with high-priority waste sites in the 100-DR-1 Operable Unit have the potential to migrate through the vadose zone and into groundwater. The only constituents detected at significant levels in groundwater beneath the 100-HR-1 Operable Unit are gross beta, ^3H , ^{90}Sr , Cr, and nitrate.

The reactor cooling water effluent is the likely source of the radionuclides and Cr and is associated primarily with the 116-D-7 retention basins and 116-D-1A and 116-D-1B trench. Other radionuclides associated with the reactor cooling water have generally flushed to the river, decayed, or are sorbed to soils in the vadose zone.

Because of the high degree of uncertainty related to groundwater impacts, numerical risk estimates are not calculated. Instead, the potential for groundwater impacts is qualified as either high, medium, or low, as shown in Tables 4-2 and 4-3. "High" indicates that there is a significant possibility that groundwater is being impacted from the waste site. "Medium" indicates that it is possible, but not highly likely, that groundwater is being impacted from the waste site. "Low" indicates that there is a very small chance that groundwater is being impacted from the waste site. An "unknown" rating indicates that there is insufficient information available to assess the possibility of groundwater being impacted from the waste site.

4.4.2 Uncertainties Associated with Evaluating Potential Groundwater Impacts

Uncertainty exists in the evaluation of potential impact to groundwater for the following reasons:

- Little contaminant data is available from vadose zone soils near the water table.
- Little information exists regarding constituent solubilities, soil/water partitioning, and infiltration rates.
- Actual sources responsible for observed groundwater In general, the QRA is based on a limited data set. contamination are difficult to identify.

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**Table 4-1. Summary of Data Availability and Data Confidence
(for sites where data are available).**

Waste Site	Summary of Data Availability and Data Confidence				
	Historical Data ^a	LFI Data ^a	Data from the same Medium ^b	Confidence in Contaminant Identification	Confidence in Contaminant Concentrations
108-D building	-	R,I,O		high	high
116-D-1A trenches	R	R,I,O	Yes	high	high
116-D-1B trenches	R	R,I,O	Yes	high	high
116-D-2A crib	-	R,I,O		high	high
116-D-3 french drains	R	R,I,O	Yes	high	high
116-D-4 french drains	R	R,I,O	Yes	high	high
116-D-5 outfall structure	R	R,I,O		high	low
116-D-6 french drain	-	R,I,O		high	high
116-D-7 basin/107-D sludge trenches	R	R,I,O		high	medium
116-DR-1 trenches	R	R,I,O	Yes	high	high
116-DR-2 trenches	R	R,I,O	Yes	high	high
116-DR-9 basin/107-DR sludge trenches	R	R,I,O		high	high
130-D-1 storage tank	O	R,I,O	Yes	high	medium
sodium dichromate tanks	-	R,I,O		high	high
<p>- = Not applicable ^a R = radionuclide, I = inorganic, O = organic contaminant ^b LFI and Historical Data are from the same medium (e.g., both from soil) or from different media (e.g., soil and sludge)</p>					

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Site	Disposal Information	Suspected Risk-Driving Contaminants	Description and Notes	Qualitative Risk Rating*	Rationale for Rating	Potential Groundwater Impact
103-D building	Used for storage of unirradiated fuel elements and as facility to package and store radioactive waste, solvents, and herbicides	Aldrin, DDT, arsenic	Metal storage building	low	Building will be decontaminated and demolished	low
116-D-9 crib	Received drainage from drainage from 117-D seal pits	Cs-137, Eu-152, Ra-226, Th-228	Crib is 3 m in diameter and 3 m deep	medium	Received radioactive waste but now covered with clean soil.	low
116-DR-5	Used to dispose of reactor effluent from basins to river	Cs-137, Ra-226, Th-228	Open concrete structure with concrete spillway	medium	Based on analogous site-116-D-5	low
126-D-2 demolition and inert landfill	Unknown volume of demolition and inert waste from demolished facilities, e.g., 184-D, 108-D, 115-D/DR, 186-D, etc.	C-14, Cs-137, Eu-152, Eu-154, H-3, Sr-90, TCE	Excavated pit originally used to store coal for the powerhouse. Covered with approximately 1 ft of soil.	medium	potential for radioactive contaminants in building rubble	low
115-D building	Housed equipment used to recirculate cover gases for D and DR reactors	C-14, Cs-137, Eu-152, Eu-154, H-3, Sr-90	Concrete building, 168 x 98 x 20 ft, demolished and buried in-situ in 1986. Some rubble was buried in the 126-D-2 landfill. Backfilled to grade with clean fill.	low	building decommissioned using ARCL methodology; building rubble buried under fill	low
117-D building	Filtered reactor exhaust air prior to emission using HEPA and halogen filters.	C-14, Co-60, Cs-137, Eu-152, Eu-154, H-3, Sr-90	59 x 39 x 35 ft. concrete building, 90% below ground. Demolished and buried in-situ in 1983 and covered with 3 ft of soil.	low	building rubble buried under 3 ft. of fill; filters removed	low
132-D-3 pump station	Received water from reactor building drains containing trace quantities of radionuclides and decontamination solutions	Ra-226, Th-228	Concrete structure that extended 32 ft below grade	low	site was decommissioned and covered with 1 m of soil	low

Table 4-2. Human Health Data and Risk Assessment Summary
(for sites where only process knowledge is available). (page 1 of 2)

Site	Disposal Information	Suspected Risk-Driving Contaminants	Description and Notes	Qualitative Risk Rating*	Rationale for Rating	Potential Groundwater Impact
Process effluent pipelines	Carried effluent from D and DR reactors to trenches, basins.	Co-60, Cs-137, Eu-152, Eu-154, Pu-238, Pu-239/240, U	Approximately 2,100 m long and 6 m below grade.	medium	Based on analogous site QRA: 100-BC-1.	high
Burial grounds 4A, 4B, 18	Received unknown volumes of radioactive and nonradioactive solid waste, including vertical safety rod thimbles	Al, B; no other waste inventory	Solid waste burial grounds received miscellaneous wastes from D and D reactors	high	unknown quantity of radioactive material possibly disposed at site	low

* Rating is qualitative based on process information, analogous site information, and site-specific information such as size, potential contaminants, and location of contamination as indicated under rationale column. Additional discussion on the rating is provided for each site in the 100-DR-1 QRA (WHC-SD-EN-RA-005, Rev. 0 1993a)

Table 4-2. Human Health Data and Risk Assessment Summary
(for sites where only process knowledge is available). (page 2 of 2)

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**Table 4-3. Human Health Risk Assessment Summary
(for sites where data are available).**

Waste Site	Human Health Risk Assessment Summary					Potential Groundwater Impact
	Frequent-Use Scenario		Occasional-Use Scenario			
	Qualitative Risk Estimation		Risk Driving Contaminant ^a (and pathway ^c)	Qualitative Risk Estimation (1992)	Risk Driving Contaminant ^a (and pathway ^c)	
1992	2018					
108-D building	medium	low	R(E,I) ^{def} O(I)	low	R(E) ^d	low
116-D-1A trench	high	high	R(E,I,O) ^d I(I)	medium	R(E) ^d	high
116-D-1B trench	high	high	R(E,I,O) ^d I(I)	medium	R(E) ^d	high
116-D-2A crib	medium	medium	R(E,I,O) ^d	low	R(E) ^d	high
116-D-3 crib no. 1 (french drain)	low	low	R(E) ^{de}	very low	-	low
116-D-4 crib no. 2 (french drain)	low	low	R(E) ^{de}	very low	-	low
116-D-5 outfall structure	high	high	R(E,O) ^{de}	medium	R(E) ^d	low
116-D-6 french drain	medium	low	R(E) ^{de}	low	R(E) ^d	low
116-D-7 basin/ 107-D sludge trenches	high	high	R(E,I,O) ^d I(I)	high	R(E,I,O) ^d	high
116-DR-1 trench	high	high	R(E,I,O) ^d I(I)	medium	R(E) ^d	high
116-DR-2 trench	high	high	R(E,I,O) ^d I(I)	medium	R(E) ^d	high
116-DR-9 basin/ 107-DR sludge trenches	high	high	R(E,I,O) ^d I(I,O) O(O)	high	R(E,O) ^d	high
130-D-1 storage tank	medium	low	R(E) ^{de}	low	R(E) ^d	low
sodium dichromate tanks	medium	low	R(E,I) ^{de}	low	R(E) ^{de}	low

- = Not applicable

^a R = radionuclide, I = inorganic, O = organic contaminant

^b LFI and Historical Data are from the same medium (e.g., both from soil) or from different media (e.g., soil and sludge)

^c O = oral, I = inhalation, E = external exposure pathways

^d Radionuclides contributing > 1E-06 to the risk have half-lives of 30 years or less

^e Only the external exposure pathway has the risk driving contaminants for 2018.

^f Radionuclide concentrations analyzed and detected in upper 2 m (6 ft) did not exceed ICR of 1E-06 (see Appendix F in the 100-DR-1 QRA).

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Table 4-4. Environmental Hazard Quotients Summary for Radionuclides by Waste Site.

Waste Site	Dose Rate Exceeds EHQ of 1
108-D Office Building and Decon. Station	no
116-D-1A and 116-D-1B Fuel Storage Basin Trench	no
116-D-2A Pluto Crib	no
116-D-3 and 116-D-4 Cribs	no
116-D-5 Outfall Structure	no
116-D-6 French Drain	no
116-D-7 Retention Basin and 107-D Sludge Disposal Trenches	no
116-DR-1 and 116-DR-2 Liquid Waste Disposal Trenches	no
130-D Gasoline Storage Tank	no
Sodium Dichromate Tanks	no
116-DR-9 Retention Basin and 107-DR Sludge Disposal Trenches	yes

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Table 4-5. Environmental Hazard Quotient Summary for Non-radiological Contaminants by Waste Site.

Contaminant	Dose Rate Exceeds EHQ of 1
116-D-7 Retention Basin	
Chromium	yes

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5.0 RECOMMENDATIONS

The primary purpose of the LFI report is to recommend those high-priority sites that should remain candidates for the IRM path and those high-priority sites which should not remain candidates for the IRM path. Sites that are not recommended as candidates for an IRM will be addressed in the final remedy selection process. These recommendations are generally independent of future land-use scenarios.

5.1 GENERAL CONSIDERATIONS

Analyses of LFI samples from high-priority sites detected pesticides, PCBs, semi-volatile organic compounds and VOCs. Although the VOCs are most likely the result of contamination present in the analytical laboratories, the VOC concentration data were evaluated in the QRA and are predicted to pose no human health risk. The detected semi-volatile compounds include typical constituents in creosote and other wood preservatives. Metals contamination was found at 116-D-1A, 116-D-1B, 116-D-7, 116-DR-9, 116-DR-1, 116-DR-2, 116-D-3, 130-D-1 and the sodium dichromate tanks site. The highest concentrations were found in soil samples collected and analyzed from the 116-D-1A site. Radionuclide contamination was the greatest in 116-DR-9, and present in all other sampled high-priority waste sites. The radionuclides ^{60}Co , ^{137}Cs , ^{152}Eu , and ^{154}Eu are the main contributors to overall risk via external exposure. Metals also contribute to elevated risks at 116-D-1A and 116-D-1B.

None of the sites pose an imminent threat to human health or the environment, or pose risks sufficient to warrant an ERA. The evaluation of sites is presented in the following sections.

5.2 HIGH-PRIORITY SITE IRM CANDIDATE EVALUATION CRITERIA

The 100-DR-1 high-priority sites were evaluated using the following criteria to identify those sites where continued IRM candidacy is recommended:

- the 100-DR-1 QRA (WHC 1993a)
- the assessment of the waste site conceptual model
- identification of any ARARs exceedance for vadose zone contaminants
- an evaluation of site-specific contaminant impact on groundwater
- identification of sites where natural attenuation by the year 2018 may reduce risks and mitigate contamination.

5.2.1 Qualitative Risk Assessment

The QRA provides risk estimates for human health and for adverse ecological effects. Human health risks, specifically ICR, for high-priority sites were developed in the QRA using two scenarios: high-frequency use and low-frequency use. The low-frequency use risk values are used to evaluate the continued candidacy of high-priority sites for IRMs. The qualitative risk estimations presented in Table 5-3 are grouped into high (ICR > 1E-02), medium (ICR > 1E-04 to 1E-02), low (ICR 1E-06 to 1E-04), and very low (ICR < 1E-06) risk categories based on results presented in Chapter 3 of the 100-DR-1 QRA (WHC 1993a). Sites that pose medium or high risks to human health under the low-frequency use scenario are recommended to continue as IRM candidates.

Environmental hazard quotient (EHQ) ratings are from the qualitative ecological risk assessment that was performed in the QRA. Sites that have an EHQ rating greater than 1 for radionuclides or non-radiological constituents present potentially adverse ecological impact and are recommended to continue as IRM candidates.

5.2.2 Conceptual Model

The conceptual model for the waste site includes sources of contamination, types of contaminants, nature and extent of contamination in each affected media, known and potential routes of migration, known or potential human and environmental receptors, and the general understanding of the site structure/process. This information is included in Chapter 3 of the 100-DR-1 work plan (DOE-RL 1992a) and has been revised using data obtained during the LFI. Table 5-1 presents sources of contamination, types of contaminants, nature and extent of contamination in each affected media, and the general understanding of the structure/process (waste generation and handling) for each high-priority waste site. Figure 5-1 presents the known and potential routes of migration, known or potential human and environmental receptors for the operable unit. If the conceptual model of a site is incomplete, the site is recommended to remain as an IRM candidate while the data needed to complete the model are collected. After the data are available the site will be reevaluated for continued candidacy for an IRM. The additional data may be obtained through limited field sampling.

5.2.3 Applicable or Relevant and Appropriate Requirements

The Washington State MTCA Method B concentrations are potential ARARs for soil contamination, as discussed in Section 3.26 of this report and in the *100 Area Feasibility Study, Phases 1 and 2* (DOE-RL 1992b). Model Toxics Control Act Method B regulatory limits for soil contaminant concentrations are utilized since they are the standard approach and are conservative. Table 5-2 lists the Hanford Site background 95% UTL values for metallic constituents in soils and MTCA Method B guidelines for soil. Sites that have concentrations of contaminants which exceed this potential chemical-specific ARAR are recommended to continue as IRM candidates.

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5.2.4 Current Impact on Groundwater

The probability of current impact on groundwater is evaluated for each site by comparing groundwater contaminant concentrations from monitoring wells located upgradient and downgradient of each specific site, where wells are available. Concentrations of ^3H and ^{90}Sr in upgradient and downgradient wells are compared. Groundwater contaminant concentrations in a downgradient well that are higher than in an upgradient well indicate current impact to groundwater. Sites that are impacting groundwater are recommended to continue as IRM candidates.

5.2.5 Potential for Natural Attenuation

The potential for the contaminants at a site to be reduced by natural attenuation, i.e., radioactive decay by the year 2018, may be a consideration at sites where radionuclides with half lives less than 30 years are the primary contaminant and external exposure is the only pathway. Sites with excess risk, i.e., greater than $1\text{E-}06$, attributed to radionuclides with half lives less than 30 years, i.e., ^{60}Co , ^{137}Cs , ^{152}Eu , and ^{154}Eu , have potential for natural reduction of risk through radioactive decay. Natural attenuation is not a consideration for sites contaminated by metals, by radionuclides with half lives greater than 30 years, or when there are multiple radionuclide exposure pathways.

5.3 HIGH-PRIORITY SITE IRM CANDIDATE RECOMMENDATIONS

The final selection of IRM sites, priority of action, and order performance are decisions left to the Tri-Party Agreement signatories. Factors that the Tri-Party Agreement signatories may consider in the selection and prioritization of IRM sites include:

- impact of IRM actions in relation to the 100 Area Environmental Impact Statement, e.g., disposition of the reactors
- access control
- relation to the IRM Program Plan recommendations
- land use
- point of compliance
- time of compliance
- feasibility
- bias-for-action

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- threat to human health and the environment.

The high-priority sites recommended to continue as IRM candidates are identified in the "IRM Candidate" column of the Table 5-3. Burial grounds, i.e., 4A, 4B, and 18, are recommended as IRM candidates, as per the HSPPS (DOE 1991) and negotiations with the Tri-Parties. The recommendations for the remaining sites are discussed below.

5.3.1 116-D-1A Fuel Storage Basin Trench No. 1

The 116-D-1A fuel storage basin trench is recommended to continue as a candidate for an IRM because groundwater monitoring data indicate the site may be impacting groundwater, and the human health risks are medium. The Cr concentration from monitoring well 199-D5-16 (downgradient) samples are higher than the concentration detected in groundwater samples from monitoring well 199-D5-12 (upgradient). The EHQ rating is less than 1. Concentrations of non-radioactive contaminants in the soil do not exceed MTCA Method B guidelines. Natural attenuation by the year 2018, e.g., radioactive decay, will reduce the risk posed by the principal contaminants and associated exposure pathway.

5.3.2 116-D-1B Fuel Storage Basin Trench No. 2

The 116-D-1B fuel storage basin trench is recommended to continue as a candidate for an IRM because groundwater monitoring data indicate the site may be impacting groundwater, and the human health risks are medium. The Cr concentration from monitoring well 199-D5-16 (downgradient) samples are higher than the concentration detected in groundwater samples from monitoring well 199-D5-12 (upgradient). The EHQ rating is less than 1. Concentrations of non-radioactive contaminants in the soil do not exceed MTCA Method B guidelines. Natural attenuation by the year 2018, e.g., radioactive decay, will reduce the risk posed by the principal contaminants and associated exposure pathway.

5.3.3 116-D-6 Cushion Corridor Decontamination French Drain

The 116-D-6 french drain is recommended to be removed as a candidate for an IRM because the human health risks are low, the EHQ rating is less than 1, and soil contamination does not exceed MTCA Method B guidelines. There is no downgradient well so a comparison of groundwater monitoring data cannot be made to assess potential impact to groundwater. Natural attenuation by year 2018, e.g., radioactive decay, will further reduce the risk posed by the principal contaminants.

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5.3.4 116-D-7 Process Effluent Retention Basin

The 116-D-7 process effluent retention basin is recommended to continue as a candidate for an IRM because the human health risk is high. Concentrations of non-radioactive contaminants in the soil do not exceed MTCA Method B guidelines. Natural attenuation by year 2018, e.g., radioactive decay, will not mitigate the risk posed by the principal contaminants and associated exposure pathway. The EHQ is greater than 1. There are no groundwater monitoring wells in the vicinity from which groundwater data can be compared and assessed. However, due to the extensive contamination in the soil column, this site is a potential candidate to impact groundwater.

5.3.5 116-DR-9 Process Effluent Retention Basin

The 116-DR-9 retention basin is recommended to continue as a candidate for an IRM because the human health risks are high, and the EHQ rating is greater than 1. Concentrations of metals present do not exceed MTCA Method B guidelines. Natural attenuation by year 2018, e.g., radioactive decay, will not mitigate the risk posed by the principal contaminants and associated exposure pathway.

5.3.6 116-DR-1 Liquid Waste Disposal Trench No. 1

The 116-DR-1 liquid waste trench is recommended to continue as a candidate for an IRM because the human health risks are medium. The EHQ rating is less than 1. Concentrations of non-radioactive contaminants in the soil do not exceed MTCA Method B guidelines. Natural attenuation by the year 2018, e.g., radioactive decay, will reduce the risk posed by the principal contaminants and associated exposure pathway. Because there are no upgradient groundwater monitoring wells in the vicinity of this site an assessment as to whether or not the site is currently impacting groundwater cannot be made. However, the site is a potential candidate to impact groundwater because of the nature and depth of soil contamination that were detected during the LFI.

5.3.7 116-DR-2 Liquid Waste Disposal Trench No. 2

The 116-DR-2 liquid waste disposal trench is recommended to continue as a candidate for an IRM because the human health risk is medium. The EHQ rating is less than 1. Concentrations of non-radioactive contaminants in the soil do not exceed MTCA Method B guidelines. Natural attenuation by the year 2018, i.e., radioactive decay, will reduce the risk posed by the principal contaminants and associated exposure pathway. Because there are no upgradient wells in the vicinity of this site, a comparison of data cannot be made and thus an assessment as to whether the site is currently impacting groundwater cannot be made. However, the site is a potential candidate to impact groundwater because of the nature and depth of soil contamination that was detected during the LFI.

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5.3.8 116-D-2A Pluto Crib

The 116-D-2A pluto crib is recommended to continue as a candidate for an IRM because groundwater monitoring data indicate the site may be impacting groundwater. The human health risks are low and the EHQ rating is less than 1. Concentrations of non-radioactive contaminants in the soil do not exceed MTCA Method B guidelines. Natural attenuation by year 2018, i.e., radioactive decay, will reduce the risk posed by the principal contaminants and associated exposure pathway.

5.3.9 116-D-9 Reactor Confinement Seal Pit Drainage Crib

The 116-D-9 crib is recommended to continue as a candidate for an IRM because groundwater monitoring data indicate the site may be impacting groundwater and the human health risks are medium. The ^3H concentration in downgradient well 199-D5-17 is 74,000 pCi/ ℓ and the ^3H concentration in upgradient well 199-D5-12 is 20,000 pCi/ ℓ . Because high-priority sites 116-D-2A, 115-D, 117-D and 4B are also upgradient of well 199-D5-17 they may also be contributing to the contamination found in monitoring well 199-D5-17. Concentrations of non-radioactive contaminants in the soil do not exceed MTCA Method B guidelines. The QRA rates this site as having a low potential for impacting groundwater, however, there remains a remote chance that this site is contributing to current groundwater contamination.

5.3.10 132-D-3 Effluent Pumping Station

The 132-D-3 effluent pumping station is recommended to be dropped as a candidate for an IRM because the site is an equivalent to a burial ground. The health risks are low, the potential for groundwater impact from the site is low, soil contamination does not exceed MTCA Method B guidelines, and natural attenuation by the year 2018 will reduce the principal risk.

5.3.11 116-D-5 Outfall Structure

The 116-D-5 outfall structure is recommended to continue as a candidate for an IRM because the human health risk is medium. It is not clear if this site is impacting groundwater because there is no upgradient well from which groundwater data can be compared to groundwater data from the downgradient well. The QRA rated this site as low with regard to potential for impact to groundwater. The EHQ rating is less than 1. Natural attenuation by year 2018, i.e., radioactive decay, will reduce the risk posed by the principal contaminants and associated exposure pathway. No contaminants were found that exceed MTCA Method B guidelines. The site is not considered as a potential candidate to impact groundwater because of the limited nature and extent of contamination detected during the LFI.

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5.3.12 116-DR-5 Outfall Structure

The 116-DR-5 outfall structure is recommended to continue as a candidate for an IRM because the human health risks are medium. It is not clear if this site is currently impacting groundwater because there is no upgradient well from which groundwater data can be compared to groundwater data from the downgradient well. Natural attenuation by year 2018, i.e., radioactive decay, may reduce the risk posed by the principal contaminants and associated exposure pathway. No contaminants were found that exceed MTCA Method B guidelines. The site is not considered as a potential candidate to impact groundwater because of the limited nature and extent of contamination detected during the LFI.

5.3.13 116-D-3 Crib No. 1 (French Drain)

The 116-D-3 crib is recommended to be dropped as a candidate for an IRM because the human health risks are very low, the EHQ rating is less than 1, and there are no concentrations of non-radioactive contaminants in the soil that exceed MTCA Method B guidelines. The concentration of Cr detected in samples from the upgradient well (199-D5-15) is an order of magnitude greater than that detected in samples from the downgradient well (199-D5-14) and the concentration of ^3H detected in samples from well 199-D5-15 are almost double that detected in samples from well 199-D5-14. Natural attenuation by year 2018, e.g., radioactive decay, will further reduce the risk posed by the principal contaminants and associated exposure pathway.

5.3.14 116-D-4 Crib No. 2 (French Drain)

The 116-D-4 crib is recommended to be dropped as a candidate for an IRM because the human health risks are very low, the EHQ rating is less than 1, and there are no concentrations of non-radioactive contaminants in the soil that exceed MTCA Method B guidelines. The concentration of Cr detected in samples from the upgradient well (199-D5-15) is an order of magnitude greater than that detected in samples from the downgradient well (199-D5-14) and the concentration of ^3H detected in samples from well 199-D5-15 are almost double that detected in samples from well 199-D5-14. Natural attenuation by year 2018, e.g., radioactive decay, will further reduce the risk posed by the principal contaminants and associated exposure pathway.

5.3.15 130-D-1 Underground Storage Tank

The 130-D-1 underground storage tank is recommended to continue as an IRM candidate because of the uncertainty regarding the source of the radionuclides detected during the LFI, thus the conceptual model is incomplete. Limited additional field sampling is recommended to resolve the uncertainties. Once the data are available this site should be evaluated for continued consideration as an IRM candidate. The human health risks are low, and the EHQ rating is less than 1. Assessment of potential impact

to groundwater by this site cannot be made because there is no downgradient well from which data can be collected and compared to the upgradient well data. Soil contaminant concentrations do not exceed the MTCA Method B guidelines. Natural attenuation by year 2018, i.e., radioactive decay, will reduce the risk posed by the principal contaminants and associated exposure pathway.

5.3.16 108-D Demolished Office Building

The 108-D office building is recommended to be dropped as an IRM candidate because the human health risks are low and the EHQ rating is less than 1. Concentrations of non-radioactive contaminants in the soil do not exceed MTCA Method B guidelines. Natural attenuation by year 2018, e.g., radioactive decay, will reduce the risk posed by the principal contaminants along the associated exposure pathway.

5.3.17 Sodium Dichromate Tanks

The sodium dichromate tanks site is recommended to be dropped as a candidate for an IRM because the human health risks are low, the EHQ rating is less than 1, and soil contamination does not exceed MTCA Method B guidelines. The QRA rates the potential of this site to impact groundwater as low. Natural attenuation by year 2018, e.g., radioactive decay, will reduce the risk posed by the principal radioactive contaminants along the associated exposure pathway.

5.3.18 103-D Fuel Element Storage Building

The 103-D fuel element storage building is recommended to remain as a candidate for an IRM because the soils underlying the building have not been investigated and a determination cannot be made now as to whether or not historical activities involving the building have impacted the soils. A limited sampling effort is recommended to resolve the uncertainties. The human health risks are low, the EHQ rating is less than 1, and the QRA rates the potential for impact to groundwater from this site to be low.

5.3.19 126-D-2 Solid Waste Landfill

The 126-D-2 solid waste landfill is recommended to remain as a candidate for an IRM because the human health risks are medium. There is no downgradient well from which groundwater data can be compared to groundwater data from the upgradient well. The QRA rates the potential for impact to groundwater from this site as low. Limited field sampling is recommended to resolve the uncertainties. Once the data are available this site should be evaluated for continued consideration as an IRM candidate.

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5.3.20 115-D Demolished Gas Recirculation Building and 117-D Demolished Air Filter Building

Both of these sites are recommended to continue as IRM candidates because they are the equivalent of burial grounds. Both sites were demolished in-situ. The human health risks for both sites are low.

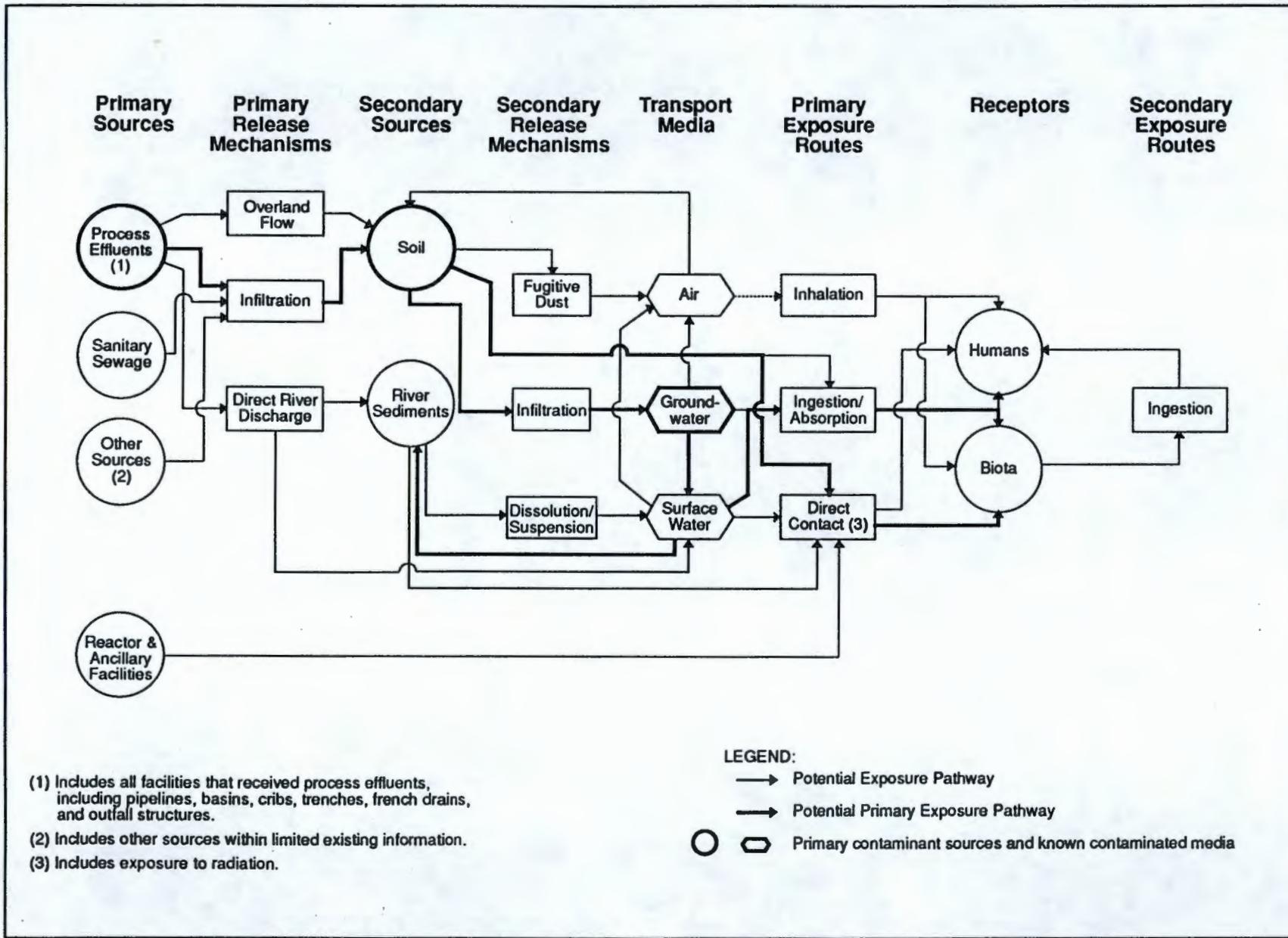
5.3.21 Process Effluent Pipelines

The process effluent pipelines are recommended to continue as an IRM candidate because the human health risks are medium. The rationale was based on the analogous site QRA for the 100-BC-1 Operable Unit. A groundwater assessment cannot be addressed because there are no wells from which to gather data for comparison. Because of known leaks in the effluent piping systems, the process effluent pipelines have a high potential for groundwater impact.

5.3.22 107-D and 107-DR Sludge Disposal Trenches

The 107-D and 107-DR sludge disposal trenches are recommended to continue as candidates for an IRM because human health risks are high and the EHQ rating for 107-DR is greater than 1. Natural attenuation by year 2018, e.g., radioactive decay, will not mitigate the risk posed by the principal contaminants and associated pathway.

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SF-1

Figure 5-1. Conceptual Model Contaminant Exposure Pathway for the 100-DR-1 Operable Unit

Table S-1 Conceptual Model of 100-DR-1 High-Priority Sites: Structure/Process, Source and Type of Contaminants, and Nature and Extent of Contamination
 (Page 1 of 4)

Site	Structure/Process	Contaminant Source	Contaminants	NATURE AND EXTENT OF CONTAMINATION'
116-D-1A	105-D Fuel Storage Basin Trench #1 130 ft X 10 ft X 6 ft deep	Received 200,000 liters of contaminated water and sludge from 105-D storage basin. This site may be contributing to high Cr in D5-12 well.	Alpha, Beta, Be-7, C-14, Na-22, K-40, Mn-54, Co-58, Fe-59, Co-60, Zn-65, Sr-90, Zr-95, Tc-99, Ru-103, Ru-106, Cs-134, Cs-137, Ba-140, Ce-141, Ce-144, Eu-152, Eu-154, Eu-155, Ra-226, Th-228, Th-234, U-235, U-238, Pu-239, Am-241, Bis(2-ethylhexyl)phthalate, Carbazole, 1,3 Dichloro-benzene, Di-n-butyl phthalate, Beta-BHC, Cd, Cr, Pb, Ni	Soil contamination from surface to 53.1 ft below grade, maximum concentration between 17.0 and 30.0 ft, source of groundwater contamination.
116-D-1B	105-D Fuel Storage Basin Trench #2 100 ft X 10 ft X 15 ft deep	Received contaminated water and sludge from 105-D Fuel Storage Basin, total volume approx. 8M liters. This site may be contributing to high Cr in D5-12 well.	Alpha, Beta, Be-7, C-14, Na-22, K-40, Mn-54, Fe-59, Co-58, Co-60, Zn-65, Sr-90, Zr-95, Tc-99, Ru-103, Ru-106, Cs-134, Cs-137, Cs-141, Ce-144, Eu-152, Eu-154, Eu-155, Ra-226, Th-228, Th-234, U-235, U-238, Pu-239, Am-241, Acetone, Methylene Chloride, Toluene, Carbazole, Chrysene, Di-n-butyl phthalate, Aldrin, Cr, Pb, Zn	Soil contamination from surface to 36.8 ft below grade, maximum concentration between 14.0 and 20.0 ft, source of groundwater contamination.
116-D-6	Cushion Corridor Decontamination French Drain 3 ft X 3 ft deep	Received domestic water from changing room and water from the mask decontamination station. This site may be contributing to high Cr in D5-12 well.	Alpha, Beta, C-14, K-40, Ra-226, Th-228, U-235, U-238, Pu-239, Am-241, Acetone, Toluene, Chrysene, Benzo(b)fluoranthene, Di-n-octyl phthalate	Soil contamination between 15.0 and 22.5 ft.
116-D-7	107-D Retention Basin 467 ft X 230 ft X 20 ft deep	Received cooling H ₂ O waste, decontamination waste, discharged mostly to Columbia River, sludge removed to adjacent 107-D trench, probably received ruptured fuel element waste; much leakage from basin to soil.	Alpha, Beta, C-14, K-40, Sr-90, Cs-137, Ra-226, Th-228, Pu-239, U-235, U-238, Am-241, Di-n-butyl phthalate, Phenol, Cr	Soil contamination from 4.7 to 7.0 ft, and 28.3 to 36.6 ft., maximum concentration between 4.7 and 7.0 ft.

Table 5-1 Conceptual Model of 100-DR-1 High-Priority Sites: Structure/Process, Source and Type of Contaminants, and Nature and Extent of Contamination
 (Page 2 of 4)

Site	Structure/Process	Contaminant Source	Contaminants	NATURE AND EXTENT OF CONTAMINATION*
116-DR-9	107-DR Retention Basin 600 ft X 230 ft X 20 ft deep	Received cooling H ₂ O waste from 105-DR reactor, probably received ruptured fuel element waste, may have been much leakage to soils from basins.	Alpha, Beta, Be-7, C-14, Na-22, K-40, Mn-54, Co-58, Fe-59, Co-60, Zn-65, Sr-90, Zr-95, Tc-99, Ru-103, Ru-106, I-131, Cs-134, Cs-137, Ba-140, Ce-141, Ce-144, Eu-152, Eu-154, Eu-155, Ra-226, Th-228, Th-234, U-234, U-235, U-238, Pu-239, Am-241, Acetone, Methylene, Methylene Chloride, Toluene, Trichloroethene, Anthracene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Benzo(g,h,i)pyrene, Benzoic acid, Bis(2-ethylhexyl)phthalate, Butylbenzyl phthalate, Chrysene, Diethyl phthalate, Di-n-butyl phthalate, Fluoranthene, Indeno(1,2,3,cd)pyrene, 2-Nitrophenol, Pentachlorophenol, Pyrene, Arochlor 1260, As, Cd, Cr, Ni,	Soil contamination from surface to 37.5 ft, maximum concentrations from 20.0 to 32.0 ft.
116-DR-1	107-DR Liquid Waste Disposal Trench #1 300 ft X 15 ft X 20 ft deep	Received 40M liters effluent overflow from the 107-D and 107-DR retention basins at times of high activity due to fuel element failure.	Alpha, Beta, C-14, Na-22, K-40, Co-58, Co-60, Sr-90, Tc-99, Cs-137, Eu-152, Eu-154, Ra-226, Th-228, U-235, U-238, Pu-239, Am-241, Methylene chloride, Toluene, Benzoic Acid, 2 Chlorophenol, 4-chloro-3methylphenol, 1,3 Dichlorobenzene, 1,4 Dichlorobenzene, Ag, Cr, Zn	Soil contamination from 14.8 to 31.5 ft, maximum concentrations between 14.8 and 17.5 ft.
116-DR-2	107-DR Liquid Waste Disposal Trench #2 150 ft X 10 ft X 20 ft deep	Received 40M liters effluent overflow wastes from 107-D and 107-DR retention basins at times of high activity due to fuel element failure.	Alpha, Beta, C-14, Na-22, K-40, Co-60, Sr-90, Tc-99, Cs-137, Eu-152, Eu-154, U-238, Pu-239, Am-241, Acetone, Methylene Chloride, Di-n-butyl phthalate, Ag, Cd,	Soil contamination from 14.0 to 37.0 ft, maximum concentrations from 14.0 to 17.0 ft and 19.0 - 22.0 ft.
116-D-2A	Pluto Crib 10 ft X 10 ft X 10 ft deep	Received 4,000 liters effluent water from tubes following fuel cladding failures. In 1956 site was covered to grade with clean soil, sampling did not determine contamination, however, may not have found correct location of crib.	Alpha, Beta, C-14, Na-22, K-40, Co-60, Sr-90, Tc-99, Cs-137, Eu-152, Eu-154, Ra-226, Th-228, U-235, U-238, Pu-239, Am-241, Methylene Chloride, Toluene, Endrin	Soil contamination from 10.0 to 25.0 ft, maximum concentrations from 10.0 to 13.0 ft., source of groundwater contamination.

Table 5-1 Conceptual Model of 100-DR-1 High-Priority Sites: Structure/Process, Source and Type of Contaminants, and Nature and Extent of Contamination
(Page 3 of 4)

Site	Structure/Process	Contaminant Source	Contaminants	NATURE AND EXTENT OF CONTAMINATION*
116-D-9	117-D Reactor Confinement Seal Pit Drainage Crib 10 ft X 10 ft X 10 ft deep	Received 420,000 liters of waste.	Alpha, Beta, C-14, K-40, Sr-90, Ra-226, Th-228, U-238, Am-241, Acetone	Soil contamination from 18.0 to 27.8 ft.
132-D-3	Effluent Pumping Station	Received water from 118-D-6 reactor fuel storage basin overflows, also contained decontamination chemicals.	Alpha, Beta, C-14, K-40, Sr-90, Tc-99, Ra-226, Th-228, U-235 U-238, Pu-239, Am-241, Toluene, Butylbenzyl phthalate, Diethyl phthalate, Di-n-butyl phthalate, Heptachlor	Soil contamination from 19.8 to 38.6 ft.
107-D and 107-DR	Sludge Disposal Trenches (5)	Received sludge from retention basins when they were dredged for repairs.	Assumed to be same found in 116-D-7 and 116-DR-9 retention basins.	Unknown
Process Effluent Pipelines from Reactor Building to Retention Basins	Pipelines (3) 60 in. diameter	Received reactor cooling water, decontamination wastes, contaminated reactor cooling water, and/or reactor confinement seal pit drainage.	Assumed to be Co-60, Cs-137, EU-152, Eu-154, Pu-238, Pu-239/240, Acetone, Methylene chloride, Toluene	Unknown
116-D-5	Process Effluent Outfall Structure & Pipelines to River	Received effluent from 116-D-7 and 116-DR-9 retention basins.	Alpha, Beta, C-14, K-40, Sr-90, Ra-226, Th-228, U-235, U-238, Pu-239, Am-241, Trichloroethene	Soil contamination from 20.0 to 27.0 ft.
116-DR-5	Process Effluent Outfall Structure & Pipelines to River	Received effluent from 116-D-7 and 116-DR-9 retention basins.	Alpha, Beta, C-14, K-40, Sr-90, Cs-137, Ra-226, Th-228, U-235, U-238, Pu-239, Am-241, Bis(2-ethylhexyl) phthalate, Butylbenzyl phthalate, Di-n-butyl phthalate, Dieldrin	Soil contamination from 20.3 to 27.5 ft.
116-D-3	Crib #1 French Drain 3 ft X 5 ft deep	Received 30,000 liters low-level fission product effluent from the contaminated maintenance shop and cask decontamination pad in the 108 building.	Alpha, Beta, C-14, K-40, Sr-90, Tc-99, Ra-226, Th-228, U-238, Am-241, 2-Butanone, Bis(2-ethylhexyl) phthalate, Di-n-butyl phthalate, Ag	Soil contamination from 15.0 to 22.4 ft.
116-D-4	Crib #2 French Drain 3 ft X 5 ft deep	Received 30,000 liters low-level fission product wastes from the contaminated maintenance shop and cask decontamination pad in the 108 building.	Alpha, Beta, K-40, Sr-90, Ra-226, Th-228, U-235, U-238, Am-241, 4-methyl-2-pentanone, Fluroanthene, Pyrene	Soil contamination from 10.0 to 23.0 ft.

Table S-1 Conceptual Model of 100-DR-1 High-Priority Sites: Structure/Process, Source and Type of Contaminants, and Nature and Extent of Contamination
 (Page 4 of 4)

Site	Structure/Process	Contaminant Source	Contaminants	NATURE AND EXTENT OF CONTAMINATION*
130-D-1	Gasoline Storage Tank 46 in. X 12 ft	Release has been demonstrated, tank removed.	Alpha, Beta, C-14, K-40, Sr-90, Tc-99, Ra-226, Th-228, U-235, U-238, Pu-239, Am-241, Acetone, Methylene Chloride, Toluene, Bis(2-ethylhexyl) phthalate, Butylbenzyl phthalate, Diethyl phthalate, Di-n-butyl phthalate, Aldrin, Pb	Soil contamination from 10.0 to 32.2 ft.
103-D	Fuel Element Storage Building 27 ft X 53 ft	Originally stored unirradiated fuel elements; later used to store packaged radioactive samples; herbicide and solvent storage.	Alpha, Beta, Co-60, Cs-137, EU-152, Eu-154, Am-241, Cd, Cr, Cu, Fe, Hg, K, Mn, 2n, 2,4-D	Contamination found on floor of building.
	Sodium Dichromate Tanks		K-40, Ru-226, Th-228, Ba, Toluene, Di-n-butyl phthalate	Soil contamination at 3.0 to 4.0 ft.
126-D-2	Solid Waste Landfill	Received decommissioning/demolition waste.	Assumed to be non-radioactive material	
4A, 4B, 18	Burial Grounds	Received radioactive and nonradioactive solid waste; 4A is under 116-D-1A and 116-D-1B trenches.	Assumed to be Alpha, Beta	Unknown
108-D	Demolished Office Building and Equipment Decontamination Building 132 ft X 37 ft X 41 ft	Received wastes associated with decontamination and repair of contaminated reactor process tube equipment.	C-14, K-14, Ra-226, Th-228, Th-232	Soil contamination at 5.0 ft.
115-D	Demolished Gas Recirculation Building	Recirculated cover gases around reactor core.	Assumed to be Alpha, Beta, C-14, Co-60, Sr-90, Cs-134, Cs-137, Eu-152, Eu-154, Pu-238, Pu-239/240	Unknown
117-D	Demolished Exhaust Air Filter Building	Received reactor building exhaust gas.	Assumed to be Alpha, Beta, H-3, C-14, Co-60, Sr-90, Cs-134, Cs-137, Eu-154, Eu-155, Pu-238, Pu-239/240	Unknown
* = Lateral extent of contamination is assumed to be equal to the facility dimensions, unless otherwise noted. The limited field investigation was not designed to establish the lateral (areal) extent of contamination.				

Table 5-2 Hanford Site Background 95% Upper Threshold Limits (UTLs) and Model Toxics Control Act (MTCA) Method B Guidelines for Inorganic Analytes.

Analyte ^a	95% UTL ^b (mg/kg)	MTCA Method B ^c (mg/kg)
Alkalinity	23,300	N/L
Ammonia	28.2	N/L
Antimony	15.7 ^d	32
Arsenic	8.92	60 (1.4) ^e
Barium	171	5,600
Beryllium	1.77	400 (0.23) ^e
Cadmium	0.66 ^d	40
Chloride	763	N/L
Chromium	27.9	400 ^f
Cobalt	19.6	N/L
Copper	28.2	2,960
Fluoride	12	4,800
Lead	14.75	U
Lithium	37.1	N/L
Manganese	612	8,000
Mercury	1.25	24
Molybdenum	1.4 ^d	320
Nickel	25.3	U
Nitrate	199	N/L
Nitrite	21 ^d	8,000
Ortho-phosphate	16	N/L
Selenium	5 ^d	N/L
Silicon	192	N/L
Silver	2.7	240
Sulfate	1,320	N/L
Thallium	3.7 ^d	5.6 - 7.2 ^g
Titanium	3,570	N/L
Vanadium	111	560
Zinc	79	16,000
Zirconium	57.3	N/L

Source: DOE-RL 1993a

NL = Not listed in MTCA Human Health Risk Based Method B Formula Values table for soil

U = Unavailable

^a Analytes essentially non-toxic in soil are not listed (DOE-RL 1993b). These include aluminum, calcium, iron, magnesium, potassium, sodium.

^b 95% confidence limit of the 95th percentile of the data distribution

^c Non-carcinogen risk-based concentration, no carcinogen risk except as shown in parenthesis

^d Limit of detection

^e Carcinogen risk-based concentration in parenthesis

^f Hexavalent chromium

^g Range of risk-based concentrations for thallium compounds

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Table 5-3 IRM Recommendations for 100-DR-1 High-Priority Sites

Waste Site	Qualitative Risk Assessment		Conceptual Model	Exceeds ARARs	Probable Current Impact on Groundwater	Potential for Natural Attenuation by 2018	IRM Candidate yes/no
	Low-frequency scenario	EHQ > 1					
116-D-1A	medium	no	adequate	no	yes	yes	yes
116-D-1B	medium	no	adequate	no	yes	yes	yes
116-D-6	low	no	adequate	no	no	yes	no
116-D-7	high	yes	adequate	no	yes	no	yes
116-DR-9	high	yes	adequate	no	yes	no	yes
116-DR-1	medium	no	adequate	no	yes	yes	yes
116-DR-2	medium	no	adequate	no	yes	yes	yes
116-D-2A	low	no	adequate	no	yes	yes	yes
116-D-9	medium	-	adequate	no	yes	yes	yes
132-D-3	low	-	adequate	no	no	yes	yes
116-D-5	medium	no	adequate	no	no	yes	yes
116-DR-5	medium	-	adequate	no	no	yes	yes
116-D-3	very low	no	adequate	no	no	yes	no
116-D-4	very low	no	adequate	no	no	yes	no
130-D-1	low	no	incomplete*	no	no	yes	yes
108-D	low	no	adequate	no	no	yes	no
Sodium Dichromate Tanks	low	no	adequate	no	no	yes	no
103-D	low	-	incomplete*	no	no	yes	yes
126-D-2	medium	-	incomplete*	unknown	no	yes	yes
115-D	low	-	adequate	unknown	no	unknown	yes
117-D	low	-	adequate	unknown	no	unknown	yes
Process Effluent Pipelines	medium	-	adequate	unknown	yes	unknown	yes
107-D	high	no	adequate	unknown	yes	no	yes
107-DR	high	yes	adequate	unknown	yes	no	yes
4A, 4B, and 18 Burial Grounds							yes

EHQ = Environmental Hazard Quotient calculated by the qualitative ecological risk assessment
 - = Not rated by the qualitative ecological risk assessment
 * = Data needed concerning nature and vertical extent of contamination, site remains an IRM candidate until data are available.
 ARAR = Applicable or Relevant and Appropriate Regulation, specifically the Washington state Model Toxics Control Act Method B concentration values for soils

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