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DOE/RL 88-31
Draft Revision 3

Draft Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1 Operable Unit, Hanford Site, Richland, Washington

United States
Department of Energy
Richland, Washington

Approved For
Public Release

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FEB 1990
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Date Published
February 1990

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PREFACE

This preface is provided for the 300-FF-1 Work Plan in order to better facilitate the regulatory review process. The 300-FF-1 Work Plan was originally drafted based on the concept of a combined groundwater and source operable unit. The first draft 300-FF-1 Work Plan was reviewed by Westinghouse Hanford Company (Westinghouse Hanford) and Pacific Northwest Laboratories (PNL), and the second draft by the U.S. Department of Energy-Richland Operations Office (DOE-RL) and its consultants under the assumption of the combined operable unit. However, during the U.S. Department of Energy (DOE) review cycle, it was formally determined that a 300 Area groundwater operable unit (300-FF-5) be established.

The Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) defines 300-FF-5 as a groundwater operable unit to be prepared as an addendum to 300-FF-1. The definition of the 300-FF-5 groundwater operable unit was not clearly defined until a meeting between Westinghouse Hanford, PNL, DOE-RL, and the U.S. Environmental Protection Agency (EPA) on March 17, 1989 and subsequent clarification. The results of this definition were that 300-FF-5 would include groundwater, surface water and sediments, and aquatic biota to become a 'wet' operable unit consistent with the approach taken for the 100 Area operable units. However, based on EPA's suggestion, the 300-FF-1 remedial investigation (RI) would initially include some groundwater, surface water, and sediment analyses. The extent of this work will be determined as the 300-FF-5 Work Plan is prepared and reviewed and results are obtained from the early 300-FF-1 RI.

Many of the DOE and subcontractor comments received regarding groundwater and surface water were not addressed in this version of the document, but deferred to the author of 300-FF-5. It is expected that regulatory personnel will review the 300-FF-1 Work Plan with the proper perspective of the 300-FF-1/300-FF-5 operable unit interface.

*Hanford Federal Facility Agreement and Consent Order, 1989, Washington Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

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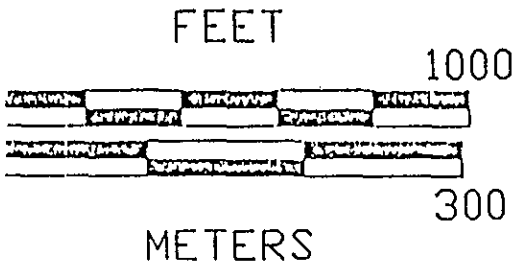

PLATE 2-1

300 AREA OPERABLE UNITS

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ACRONYMS AND ABBREVIATIONS

ac	acre
ACL	alternative concentration limit
amsl	above mean sea level
ANSI/ASME	American National Standards Institute/American Society of Mechanical Engineers
ARAR	legally applicable, or relevant and appropriate, environmental standards, requirements, criteria, and limitations
BOD	biochemical oxidation demand
BTDS	Basalt Waste Isolation Project Technical Data System
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
Ci	curie
CLP	contract laboratory program
cm	centimeter
CRP	community relations plan
d	day
DMP	data management plan
DMS	data management system
DNAPL	dense, nonaqueous phase liquid
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy-Richland, Washington
Ecology	Washington Department of Ecology
ECTS	Environmental Compliance Tracking System
EII	environmental investigations instructions
EIS	environmental impact statement
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
FR	Federal Register
FS	feasibility study
FSP	field sampling plan
ft	foot
g	gram
gal	gallon
h	hour
HECR	Hanford Environmental Compliance System
HEX	Flow Gemini--Environmental Information System
HGWDB	Hanford Groundwater Data Base
HISS	Hanford Inactive Site Survey
HMS	Hanford Meteorological Station
HP	Health Physics
HPT	Health Physics Technician
HSP	health and safety plan
in.	inch
IRA	interim remedial action
kg	kilogram
km	kilometer
L	liter

ACRONYMS AND ABBREVIATIONS (cont)

lb	pound
m	meter
mCi	millicurie
MCL	maximum contaminant level
MCLG	maximum contaminant level goals
μg	microgram
mho	micromho
mg	milligram
mi	miles
mL	milliliter
MSDS	material safety data sheet
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act of 1978
ng	nanogram
NPL	National Priorities List
NR	not reported
NTU	nephelometric turbidity unit
PCB	polychlorinated biphenyl
ORE	occupational radiation exposure
OVA	organic vapor analyzer
pCi	picocurie
PDMS	Program Data and Management System
PJSP	Prejob Safety Plan
PMP	project management plan
PNL	Pacific Northwest Laboratory
p/b	part per billion
p/m	part per million
PVC	polyvinylchloride
QA	quality assurance
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
QC	quality control
QCBSDB	Quality Control Blind Standards
RCRA	Resource Conservation and Recovery Act of 1976
RCW	Revised Code of Washington
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
ROD	record of decision
RQ	reportable quantity
RWP	radiation work permit
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act
SCBA	self-contained breathing apparatus
SPS	Sample Preparation System
SWP	protective coveralls
TLV	threshold limit value
TOC	total organic carbon
TOX	total organic halogen

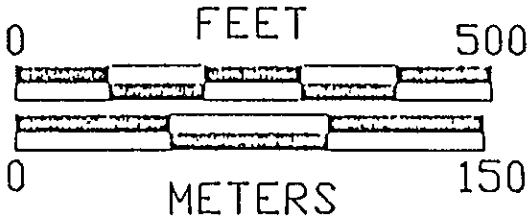

PLATE 2-2

300-FF-1 OPERABLE UNIT

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ACRONYMS AND ABBREVIATIONS (cont)

TRIS	Training Records Information System
TSD	treatment, storage, or disposal
UPR	unplanned release
WAC	Washington Administrative Code
Westinghouse Hanford	Westinghouse Hanford Company
WIDS	Waste Information Data System
WIMS	Waste Information Management System
wk	week
yr	year

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WORK PLAN

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1.0 INTRODUCTION

Over 1,400 waste facilities have been identified on the Hanford Site. These include active treatment, storage, and disposal (TSD) facilities, subject to permit application and/or closure under the Resource Conservation and Recovery Act of 1976 (RCRA) and the Hazardous Waste Disposal Act, Revised Code of Washington (RCW). Inactive waste facilities subject to corrective action under RCRA or remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) are also included in the total figure.

Most of the waste facilities are located within geographic areas on the Hanford Site that are referred to as the 100, 200, 300, 400, and 1100 areas. Figure 1 shows the location of these areas. The 600 Area includes the remainder of the Hanford Site that is outside the above designated areas. All waste facilities have been grouped into four aggregate areas (100, 200, 300, and 1100), each of which is on the National Priorities List (NPL) under CERCLA. The four aggregate areas are subdivided into 21 waste area groups on the basis of facility and type of operation. Each waste area group is further subdivided into operable units on the basis of waste disposal practices, geology, hydrogeology, and other pertinent site characteristics. A total of 78 source operable units has been identified to date. The identification process is continuing, and the total number of operable units and the individual facilities within each operable unit are subject to change.

The purpose of this work plan is to document the project scoping process and to outline all remedial investigation/feasibility study (RI/FS) activities for operable unit 300-FF-1. The work plan was developed in accordance with: the statutory requirements of CERCLA, as amended; the regulatory requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); and relevant U.S. Environmental Protection Agency (EPA) guidance documents. Such relevant EPA guidance includes:

- Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA 1988c); and
- Data Quality Objectives for Remedial Response Activities (EPA 1987a).

This chapter sets forth the general purpose, scope, and goals of the project. The structure of the work plan, and functions of the various chapters and attachments, are also outlined.

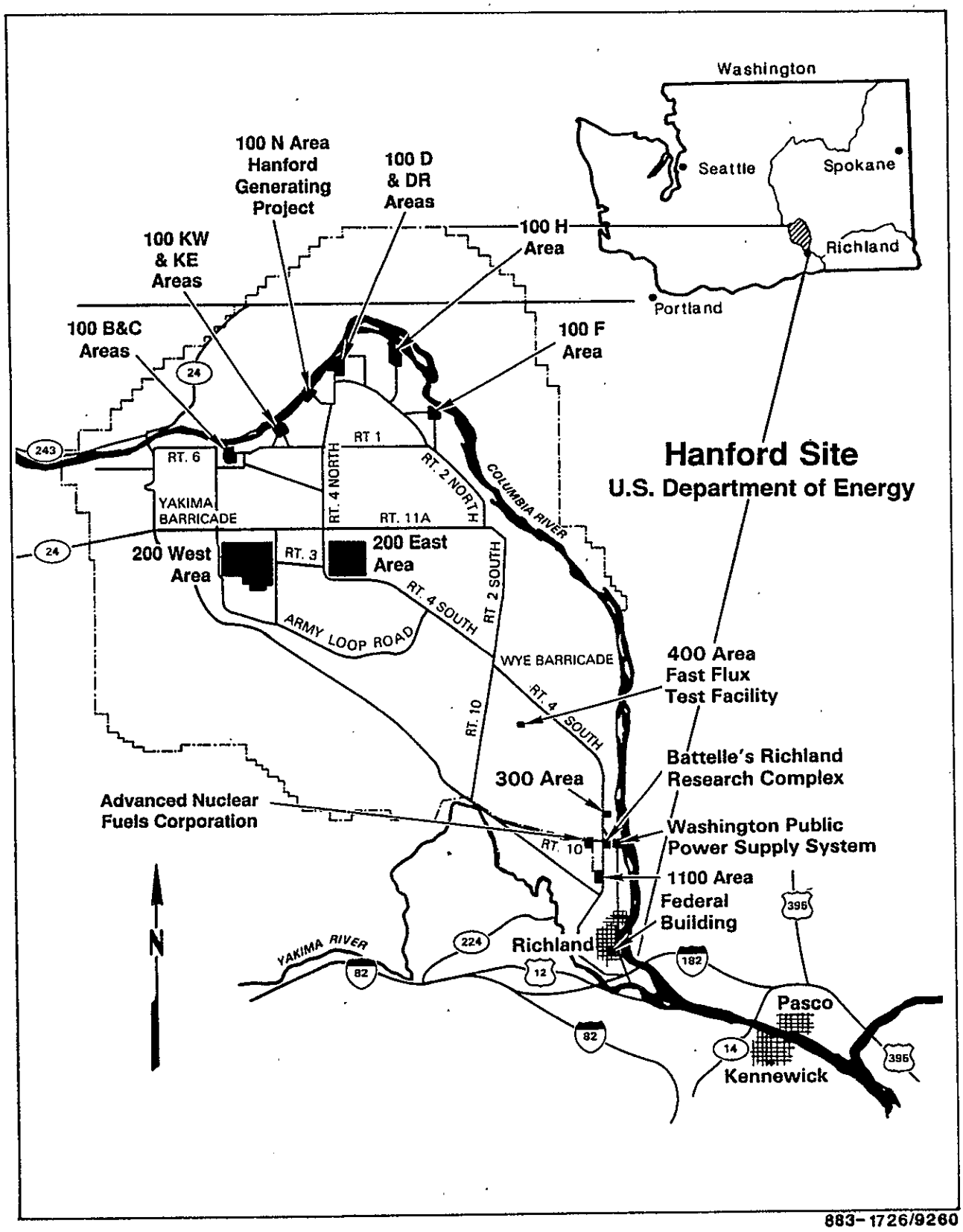

Figure 1. Hanford Site Map.

1.1 PURPOSE AND SCOPE OF THE RI/FS

Pursuant to CERCLA, the EPA proposed the 300 and 400 areas (the 300 Aggregate Area) at the U.S. Department of Energy (DOE) Hanford Site for inclusion on the NPL on June 24, 1988. In anticipation of this proposal being finalized, DOE has divided the 300 Aggregate Area into operable units for the purpose of increasing the manageability of the site characterization and remediation processes (Stenner et al. 1988).

A cluster of nominated waste facilities is located within the 300 Aggregate Area. The 300 Aggregate Area has been further subdivided into five operable units, including 300-FF-1. The 300-FF-1 is known as a process liquid operable unit because it contains all of the liquid waste disposal facilities within the 300 Area (WHC 1989). The DOE has assigned top priority to this process liquid operable unit due to documented groundwater contamination attributable to it.

The purpose of the RI/FS, in accordance with 40 CFR Part 300.68(d) (EPA 1988d), is to determine the nature and extent of the threat presented by releases of hazardous substances from the operable unit, and to evaluate proposed remedies for such releases.

1.2 PROJECT GOALS

The goal of the 300-FF-1 remedial investigation (RI) is to provide sufficient information needed to conduct the feasibility study (FS), by determining:

- The nature and extent of the threat, to public health and the environment, posed by releases of hazardous substances from 300-FF-1
- The performance of specific remedial technologies.

Such determinations will be carried out to the extent necessary and sufficient to allow for the evaluation of remedial alternatives during the FS.

The goal of the 300-FF-1 FS is to evaluate potential remedies that encompass a range of appropriate waste management options, by developing, screening, and analyzing remedial alternatives.

The ultimate goal of the RI/FS is to allow for the selection, for subsequent implementation, of a cost-effective remedial alternative that assures the protection of public health and the environment. After public review of the RI and FS reports, DOE, the EPA, and the Washington State Department of Ecology (Ecology), will select an appropriate remedy and document this choice in a record of decision (ROD). This ROD will be followed by design, implementation, and monitoring of the chosen remedial alternative.

The RI/FS is divided into five phases--two RI phases (operable unit characterization and treatability investigation) and three FS phases (remedial alternatives development, screening, and analysis). The RI and FS are conducted concurrently. The data collected in the RI provide the information needed to evaluate remedial alternatives in the FS; the FS, in turn, determines the data collection objectives for the RI.

Figure 2 shows how the RI/FS fits into the overall remedial action process. Each phase of the RI/FS, and its corresponding objective, is indicated.

1.3 ORGANIZATION OF WORK PLAN

The work plan for the 300-FF-1 operable unit conforms with current draft guidance for RI/FS activities under CERCLA and the NCP (EPA 1988c). It has been completed with current knowledge of conditions at the operable unit and may require modifications during the later phases of the project, once additional information becomes available and a better understanding of operable unit conditions is attained.

The work plan is intended to be a dynamic document which will be amended, as necessary, throughout the project. In this manner, the work plan will provide efficient and effective directions consistent with project goals. A dynamic work plan will also serve to help document the rationale for project decisions and conclusions, and thereby provide assistance in making subsequent remediation decisions.

Seven chapters, in addition to this introduction, are included in the work plan. Chapter 2 presents the history and current understanding of the 300-FF-1 waste generation, transfer, storage, and disposal processes and facilities. The environmental setting for 300-FF-1 and its surroundings is also summarized.

Available data and potential contaminant exposure pathways are reviewed in Chapter 3 to develop a conceptual model for 300-FF-1. Waste sources, quantities, and characteristics are identified, along with the current understanding of the extent of contamination in the various environmental media. Legally applicable or relevant and appropriate environmental standards, requirements, criteria, and limitations (ARARs) for the various contaminants are identified, potential impacts to public health and the environment are assessed, and preliminary remedial action objectives are presented.

Chapter 4 provides the rationale and objectives for RI/FS activities. Data needs and the data quality required to attain these objectives are defined.

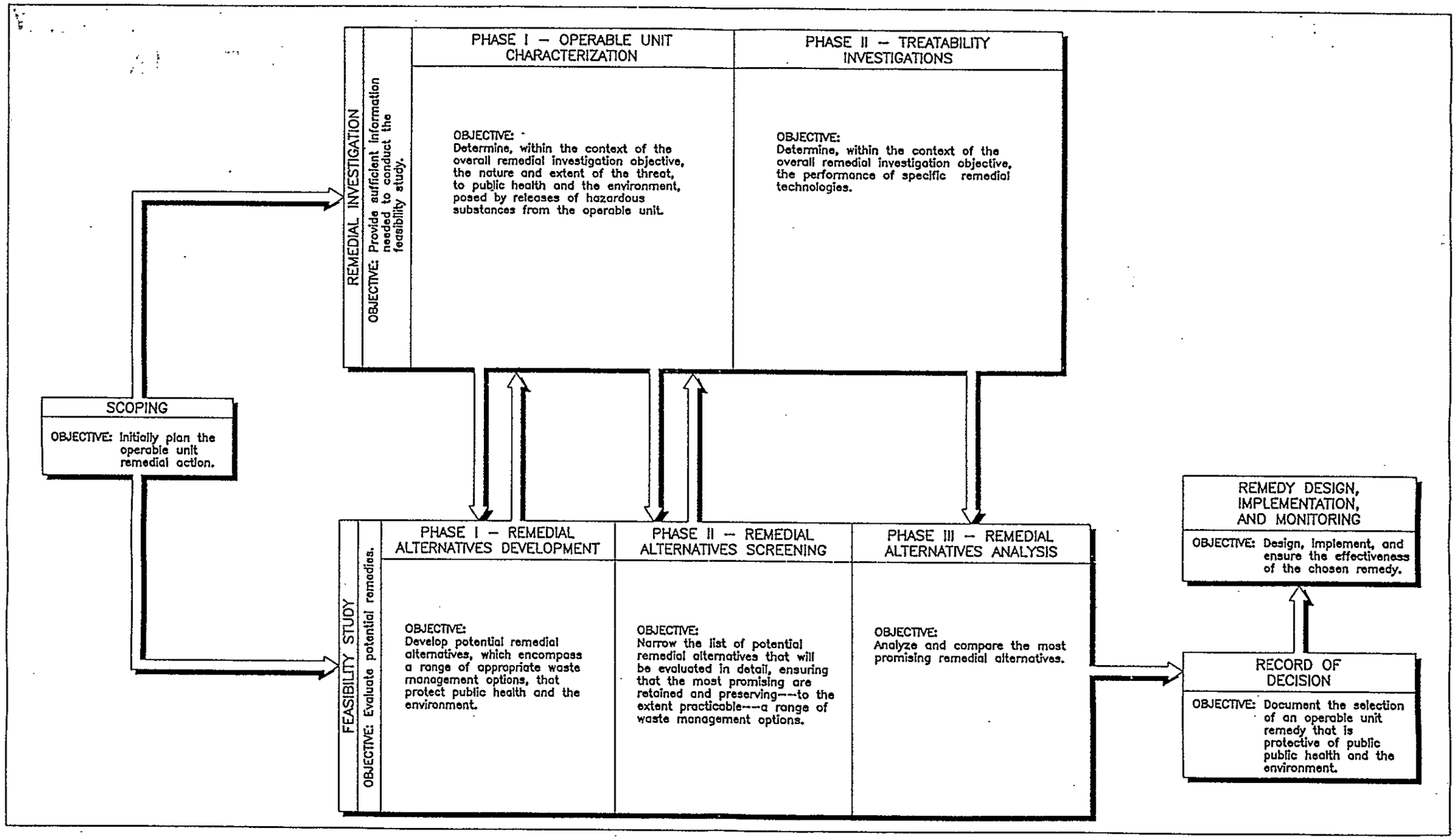

Figure 2. Remedial Action Process.

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Chapter 5 presents the tasks necessary to conduct the two phases of the RI and the three phases of the FS. Specific subtasks and activities for the treatability investigation are not set forth, because such activities will be dependent upon the information gathered during the operable unit characterization phase of the RI and the results of the initial phases of the FS.

A project schedule is presented in Chapter 6. Modifications to the schedule may need to be made as information is obtained during project implementation. Chapter 7 discusses project management responsibilities, and references for literature cited in the work plan are provided in Chapter 8.

There are five attachments to the work plan. These are:

- Attachment 1--Sampling and Analysis Plan
  - 1a--Field Sampling Plan
  - 1b--Quality Assurance Project Plan
- Attachment 2--Health and Safety Plan
- Attachment 3--Project Management Plan.
- Attachment 4--Data Management Plan
- Attachment 5--Community Relations Plan

Each plan was developed to be used in conjunction with the work plan and the other attachments, thus minimizing duplication of information.

1.4 QUALITY ASSURANCE

The basic objective of the work plan and its appended project plans is to ensure that the data and results or findings obtained are sufficiently accurate and reliable to support decisions associated with site evaluation, risk assessment, and evaluation and selection of remedial alternatives. In addition, all work on the Hanford Site is subject to the requirements of DOE-RL Order 5700.1A, Quality Assurance (DOE-RL 1983), which establishes broadly applicable quality assurance (QA) program requirements in compliance with American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) NQA-1 guidelines (ANSI/ASME 1986); the QA program requirements so defined apply to all types of project activities conducted on the Hanford Site.

To ensure that the objectives of the RI/FS are met in a manner consistent with DOE-RL Order 5700.1A (DOE-RL 1983), all work will be performed in compliance with Westinghouse Hanford Company's (Westinghouse Hanford) existing quality assurance manual and a QA program plan (QAPP) specific to CERCLA RI/FS activities. This QAPP describes the various plans, procedures, and instructions that will be used by Westinghouse Hanford to implement the

requirements of DOE-RL Order 5700.1A. The plan discusses areas such as the following:

- Management policies
- Organization charts and charters
- Management requirements and procedures
- Document clearance and information release
- Records management
- Quality audits and surveillances
- Operational health physics and radiological protection
- Emergency preparedness
- Standard engineering practices
- Radioactive and mixed solid waste packaging, storage, and disposal requirements
- Publication style
- Procurement.

Current EPA guidance for structure and content (EPA 1988c) will be followed in the preparation of the RI/FS work plan and the supporting project plans. These plans will be prepared within the overall DOE-mandated QA program structure and will be supported and implemented through the use of standard operating procedures drawn from the overall program.

2.0 OPERABLE UNIT BACKGROUND AND SETTING

2.1 OPERABLE UNIT DESCRIPTION

2.1.1 Location

Operable unit 300-FF-1 is situated within the 300 Area of the Hanford Site in the south-central portion of the State of Washington. The 300 Area is located along the Columbia River at the southeast corner of the site, approximately 1 mi north of the City of Richland in Benton County (Figure 3).

The 300-FF-1 operable unit is located immediately adjacent to the Columbia River in the northeast corner of the 300 Area (Plate 2-1), and covers an area of approximately 140 acres.

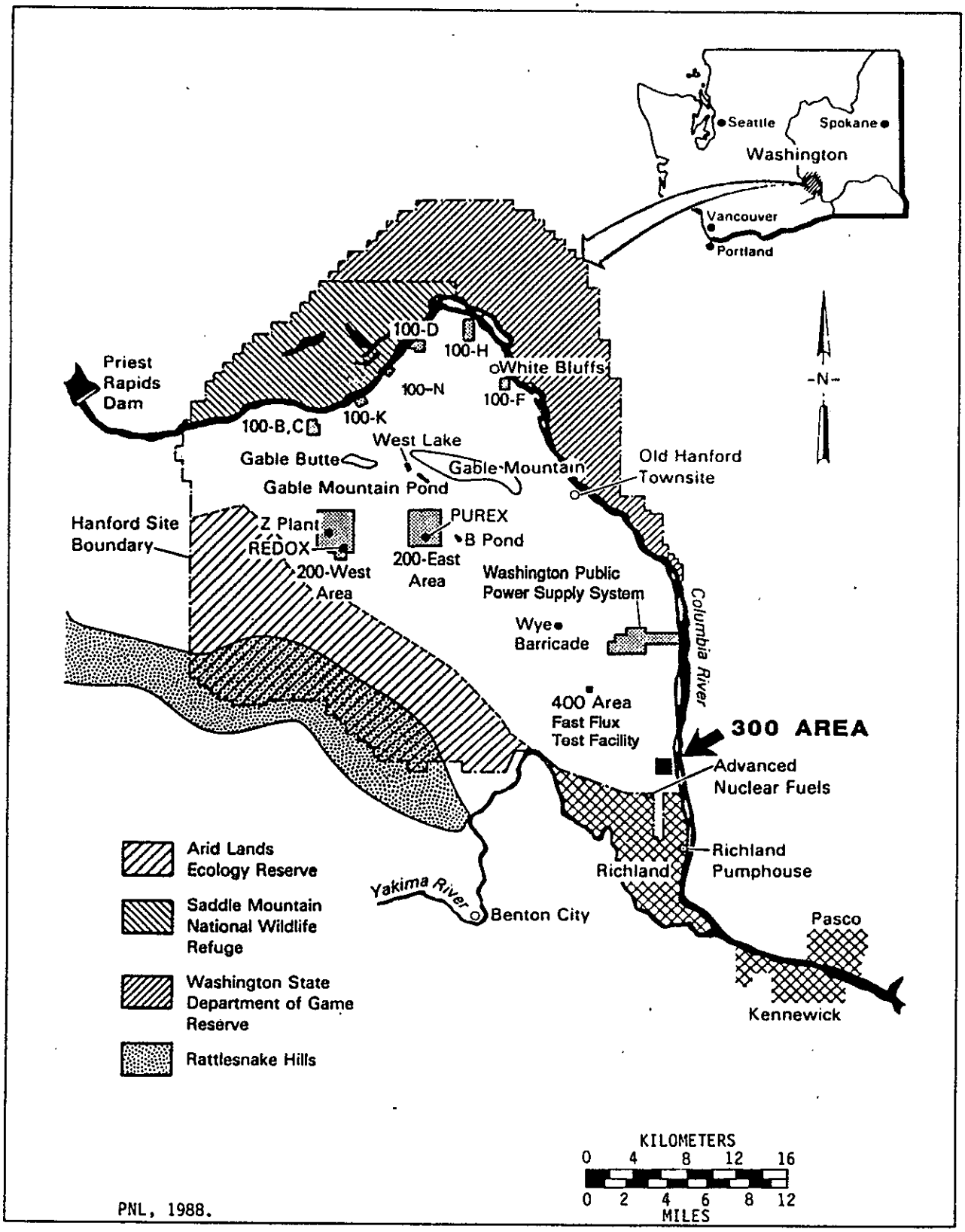

Figure 3. Location of the 300 Area Within the Hanford Site.

2.1.2 History of Operations

In 1943, after the Fermi experiment showed that nuclear fission could be controlled in a small reactor, the U.S. Army Corps of Engineers selected Hanford as the location to build larger versions of the Fermi reactor to produce plutonium for possible use in military weapons. Construction started in March 1943 on three reactor facilities, three chemical processing facilities, and the 300 Area--a fuel fabrication complex. The first of the reactors went into operation about 18 mo after the start of construction, and the first plutonium was available some 4 mo later.

After World War II, five reactors similar to those built during the war were constructed. A total of eight graphite-moderated reactors used the Columbia River for once-through cooling (i.e., water circulated through the reactors only once before being released back to the river).

Early in the 1950's, construction began on the research and development facilities, known as the Hanford Laboratories, in the 300 Area. This marked the first diversification of the Hanford Site from a purely defense-materials production facility to one heavily involved in peacetime uses of the atom.

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

A presidential decision was made in early 1964 to begin shutting down the older Hanford Site reactors. This decision resulted in the closing down of all eight of the older reactors by the end of 1971, leaving the N Reactor as the only operational production reactor until it was recently placed on a cold standby status after operating through 1986.

Initial construction at the 300 Area was completed in 1943. Most of the facilities in the area were involved in the fabrication of nuclear reactor fuel elements. In addition to the fuel manufacturing processes, many technical support, service support, and research and development activities related to fuel fabrication were and are carried out within the 300 Area.

As the Hanford Site production reactors have been shut down, fuel fabrication activities in the 300 Area have decreased. At the same time, research and development activities have increased, especially over the past two decades. The newer buildings in the area house primarily laboratory and large test facilities. Current research and development activities focus on peaceful uses of plutonium, reactor fuels development, liquid metal technology, fast-flux test facility support, gas-cooled reactor development, and life science research.

The 300 Area contains a number of support facilities, including a convertible oil/coal powerhouse for process steam production; a raw water intake, treatment, and storage facility; and other facilities necessary to support fuels production, research, and development.

Operable unit 300-FF-1 is known as a process liquid operable unit because it contains all the major past and present liquid waste disposal facilities for the 300 Area (Stenner et al. 1988). These disposal facilities are located within 300 to 1,600 ft of the Columbia River.

2.1.3 Waste Generating Processes

2.1.3.1 Process Wastes. Fuel elements are fabricated in the 300 Area by a coextrusion process. This process forms the zirconium cladding and the uranium/silicon fuel core from primary material components and bonds the two together in one operation. The fuel elements are protected with a copper jacket for the extrusion process. The jacket also prevents atmospheric contamination of the reactive fuel element, and the copper is easily lubricated for extrusion. Lubricants are removed using organic solvents such as trichloroethylene. After extrusion into billets, the copper is removed by dissolution into nitric acid (Stenner et al. 1988).

The uranium core is recessed by chemical milling so that the billets can receive an end cap. The chemical milling is performed using copper sulfate, nitric acid, and sulfuric acid. A zirconium end cap is then brazed on with beryllium. The fuel elements are tested for cap attachment, cap to core bonding, cladding to core bonding, and cladding to cap bonding before fuel-element supports and locking clips are attached. Next, the tubes are autoclaved in steam to detect any perforations in the cladding or end caps. Finally, the elements are packed for storage and shipment (Stenner et al. 1988).

Prior to the late 1960's, aluminum-clad fuel was manufactured in the 300 Area as well, and thorium fuel fabrication was initiated in 1969 (Stenner et al. 1988).

Other chemicals routinely used in the fuel fabrication processes include (Douglas United Nuclear 1967; Stenner et al. 1988):

- Chromic acid
- Chromium trioxide
- Hydrofluoric acid
- Oxalic acid
- Phosphoric acid
- Potassium nitrite
- Sodium aluminate
- Sodium bisulfate
- Sodium carbonate
- Sodium dichromate
- Sodium fluorosilicate
- Sodium gluconate
- Sodium hydroxide
- Sodium nitrate
- Sodium nitrite
- Sodium pyrophosphate
- Sodium silicate.

The fuel fabrication processes also generated waste radioactive fission products, most of which were discharged to the radioactive liquid waste sewer system. Some of these substances, however, occasionally entered the process sewer. Radioactive isotopes known to be generated in the 300 Area include (Douglas United Nuclear 1967):

- Scandium-46
- Chromium-51
- Cobalt-58
- Iron-59
- Cobalt-60
- Zinc-65
- Zirconium/niobium isotopes
- Cesium-137
- Promethium-147
- Thorium-234
- Uranium isotopes
- Plutonium isotopes.

2.1.3.2 Laboratory Wastes. Because many of the laboratory buildings in the 300 Area provided support for fuel fabrication process development, the wastes generated by these facilities are probably of a nature similar to that of the process wastes. However, with the wide variety of research and development activities pursued over the years, almost any chemical may have been discharged from these buildings in laboratory quantities (DOE 1985). The fact that the 307 retention basins were constructed to hold laboratory wastes for predisposal radiological screening implies that the potential for radiological contamination of the laboratory waste stream was substantially greater than that for the process waste stream.

2.1.3.3 Miscellaneous Wastes. In addition to sanitary wastes from the 300 Area, the sanitary sewer system received an estimated 1 gal/wk of miscellaneous photochemicals from sign shop operations until 1985. Current sign and paint shop contributions consist of trace, nonhazardous concentrations of carry-over fixers, developers, inks, thinners, solvents, and rinsewaters from the spray booth fume scrubbing system (DOE 1989a).

Filter backwash from the 300 Area water treatment plant can be expected to have elevated levels of hydrated aluminum sulfate (alum) (DOE 1989a). Alum is used as a coagulant/flocculent to remove suspended particles during the water treatment process.

Operation of the 300 Area convertible oil/coal powerhouse generates the flyash which is slurried to the 300-FF-1 ash pits.

Operational activities in the 300 Area generated solid wastes. Some of these solid wastes became contaminated with uranium and ended up being buried at burial ground No. 4 or burned, then buried, at burial ground No. 5. Operations of the liquid waste disposal ponds and trenches also resulted in the generation of contaminated solid wastes in the form of pond and trench sediments.

2.1.4 Waste Transfer, Storage, and Disposal Facility Characteristics

All of the 300-FF-1 waste transfer, storage, and disposal facilities can be allocated among the following categories:

- Process liquid waste transfer and disposal facilities
- Other liquid waste transfer and disposal facilities
- Burial grounds
- Radioactive liquid waste transfer and storage facilities
- Hazardous waste storage facilities.

Table 1 lists each of the 300-FF-1 facilities, its period of use, and sources of wastes. Plate 2-2 shows the location of each facility within the operable unit. Any environmental sampling activities associated with each of the facilities are noted in the following discussions. Details on the results of such sampling activities are provided in Section 3.1.

2.1.4.1 Process Liquid Waste Transfer and Disposal Facilities.

2.1.4.1.1 Process Sewer System. The process sewer system was originally constructed in 1943 to transfer process liquid wastes (i.e., process sewage) from the various buildings in the 300 Area to the south process pond (316-1). The system was extended to serve the new north process pond (316-2) in 1948, modified in 1953 to allow for either simultaneous or alternating use of the south and north ponds, and extended once again in 1975 to transfer wastes to the currently active process trenches (316-5) (DOE 1985). The portion of the process sewer system that served the north and south process ponds was retired in 1975.

The process sewer system is now connected to 43 buildings in the 300 Area (Table 2). The system is constructed of vitreous clay bell and spigot sewer pipes, 24 in. in diameter along the main line, and it is possible that leakage may be occurring at many of the joints.

In addition to process water from fuel fabrication operations, the process sewer system receives, or has received, cooling water, steam condensate, water treatment salts, and a wide variety of waste liquids from laboratory drains throughout the 300 Area. Due to the number of laboratories in the area, and the diverse nature of the research and development activities over the years, practically any chemical may have been discharged to the system--and subsequently to either the south process pond, the north process pond, or the process trenches--in laboratory quantities. Numerous chemical spills are known to have entered the process sewer system through the many floor drains in 300 Area buildings (DOE 1985).

Table 1. Waste Disposal, Transfer, and Storage Facilities Included in Operable Unit 300-FF-1. (Sheet 1 of 2)

Process Liquid Waste Disposal Transfer Facilities	Periods of Use	Waste Types
Process sewer system	1943-present	Process sewage, i.e., cooling water, low-level radioactive wastes from fuel fabrication processes, laboratory and test-facility wastes, and process chemical spills.
South process pond (316-1)	1943-1975	Process sewage, water treatment plant filter backwash.
North process pond (316-2)	1948-1974	Process sewage, coal flyash.
307 retention basins	1953-present	Laboratory sewage, i.e., cooling water, seal water, laboratory, and test-facility wastes.
307 trenches (316-3)	1953-1963	Laboratory sewage, sediments from 316-1, coal flyash.
Process trenches (316-5)	1975-present	Process sewage.
Other Liquid Waste Disposal and Transfer Facilities	**Periods of Use**	**Waste Types**
Sanitary sewer system	1943-present	Sanitary sewage, cooling water, minute quantities of photochemical process wastes.
Ash pits	1943(?)-present	Slurried coal flyash.
Retired filter backwash pond (east basin of south process pond)	1975-1987	Water treatment plant filter backwash.
Filter backwash pond	1987-present	Water treatment plant filter backwash.

Table 1. Waste Disposal, Transfers and Storage Facilities Included in Operable Unit 300-FF-1. (Sheet 2 of 2)

Burial Grounds	Periods of Use	Waste Types
Burial ground No. 4 (618-4)	1955-1961	Uranium-contaminated miscellaneous materials.
Burial ground No. 5 (618-5)	1945-1962	Burning pit for trash, including uranium-contaminated trash.
North process pond scraping disposal area (618-12)	1949-1964	Sediments from 316-2, coal flyash.
Radioactive Liquid Waste Transferred Storage Facilities	**Periods of Use**	**Waste Types**
Retired radioactive sewer system	1954-1975	Radioactive sewage, i.e., radioactive wastes from fuel fabrication, laboratory, and test-facility operations.
Radioactive sewer system	1975-present	Radioactive sewage.
340 Complex	1954-present	Radioactive sewage.
Hazardous Waste Storage Facilities	**Periods of Use**	**Waste Types**
340 Complex Hazardous Waste Staging Area	1954-present	Drummed waste oil storage, empty hazardous waste drum storage.
332 Hazardous Waste Staging Area	1983-present	Small-container hazardous waste storage.

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Table 2. List of 300 Area Buildings Connected to the Process Sewer System.

303F	Chemical Pump House
303J	Storage
303K	Storage
304	Construction Facility
305	Hot Cell Verification Facility
305A	Construction Office
306E	Fabrication and Testing Laboratory
306W	Metal Fabrication Development Building
308	Fuels Development Laboratory
309	SP-100 Ground Engineering System Facility
311	Steel House
313	Fuel Manufacturing Facility
314	Engineering Department
315	Filter Water Plant
318	HTLT Reactor and Monitoring Service
320	Low-Level Radiochemistry Building
321	Hydromechanical Laboratory
324	Chemical Engineering Laboratory
325	Radiochemistry Laboratory
326	Materials Technology Laboratory
327	Post-irradiation Testing Laboratory
329	Biophysics Laboratory
331	Life Science Laboratory
333	N Fuels Manufacturing
335	Sodium Test Facility
336	High Bay Test Facility
337	High Temperature Sodium Facility and Offices
338	300 Area Maintenance Facility
382	Pump House
384	Powerhouse
3701D	Patrol Headquarters
3705	Pacific Northwest Laboratory Photography
3706	Information Services
3707C	Automated Technology
3708	Radiation Measurements
3717B	Standards Laboratory
3718F	Sodium Storage
3720	Central Service and Laboratory
3722	Construction Shop
3730	Gamma Neutron Irradiation Facility
3732	Storage
3745	Radiological Calibrations and Standards
3746A	Radiological Physics Laboratory

Source: DOE (1989a).

Some of the substances discharged to the process sewer were of a radioactive nature. Much of this burden to the system was removed in 1953 when a separate laboratory waste transfer and disposal system (the 307 system) was installed. The laboratory system was operated independently of the process sewer system until 1963. In 1963, the systems were reintegrated, but retention basins allow for screening of wastes too high in radioactivity for final disposal in the 300 Area (Douglas United Nuclear 1967).

Many unplanned releases are known to have entered the process sewer over the years. Most of these spills consisted of process wastes or chemicals and were ultimately routed to the disposal pond or trench in use at the time. Of the 37 documented unplanned releases assigned to 300-FF-1, 32 were discharges to the process sewer system: UPR-300-37, -36, -35, -34, -33, -32, -31, -30, -29, -28, -27, -26, -25, -24, -23, -22, -21, -20, -19, -15, -9, -8, ten additional releases which occurred after 1980 (Stenner et al. 1988; DOE 1989a). These releases occurred in the period from 1972 through 1988. Releases of an unspecified amount of plutonium to the system in 1950, and 750 mCi of promethium-147 in 1967, are also known to have occurred.

Administrative controls were implemented in 1985 to eliminate all discharges of hazardous wastes to the process sewer system. Process sewage is analyzed monthly for operational purposes (DOE 1985).

2.1.4.1.2 South Process Pond (316-1). An inactive, 8 acre, unlined surface impoundment, the south process pond, located within the 300 Area perimeter fence in the southern section of the operable unit, was the first process liquid waste disposal facility for the 300 Area. It was constructed in 1943 and was operated until 1975. In addition to receiving wastes from the process sewer, the south pond received very small quantities of organic solutions through a stainless steel pipe running along the north dike. Prior to 1957, liquid wastes were also trucked to the pond for disposal (Dennison et al. 1989).

The pond structure varied over the years, but the final configuration consisted of a series of three small settling basins and two infiltration basins (Figure 4), each separated by dikes approximately 15 ft high. The original inlet was located in the southwest corner of the pond; but in 1953 the process sewer modification, which allowed for either simultaneous or alternating use of the south and north process ponds, was installed with the inlet at the northwest corner of the pond (Dennison et al. 1989).

Process sewage entered the first of the settling basins and overflowed to the remaining basins through flumes in the tops of the dikes. This overflow allowed suspended solids to settle. The pond had no outlet structure; final disposal in the infiltration basins occurred through infiltration and evaporation. The pond was periodically dredged to improve infiltration after a dike failure in 1948 resulted in an unplanned release to the Columbia River. Periodic dredging continued through 1969, when the production of aluminum-clad fuel ceased, ending the disposal of sodium aluminate, which apparently precipitated in large enough quantities to restrict infiltration (Dennison et al. 1989). Dredged soils were disposed by spreading on impoundment dikes.

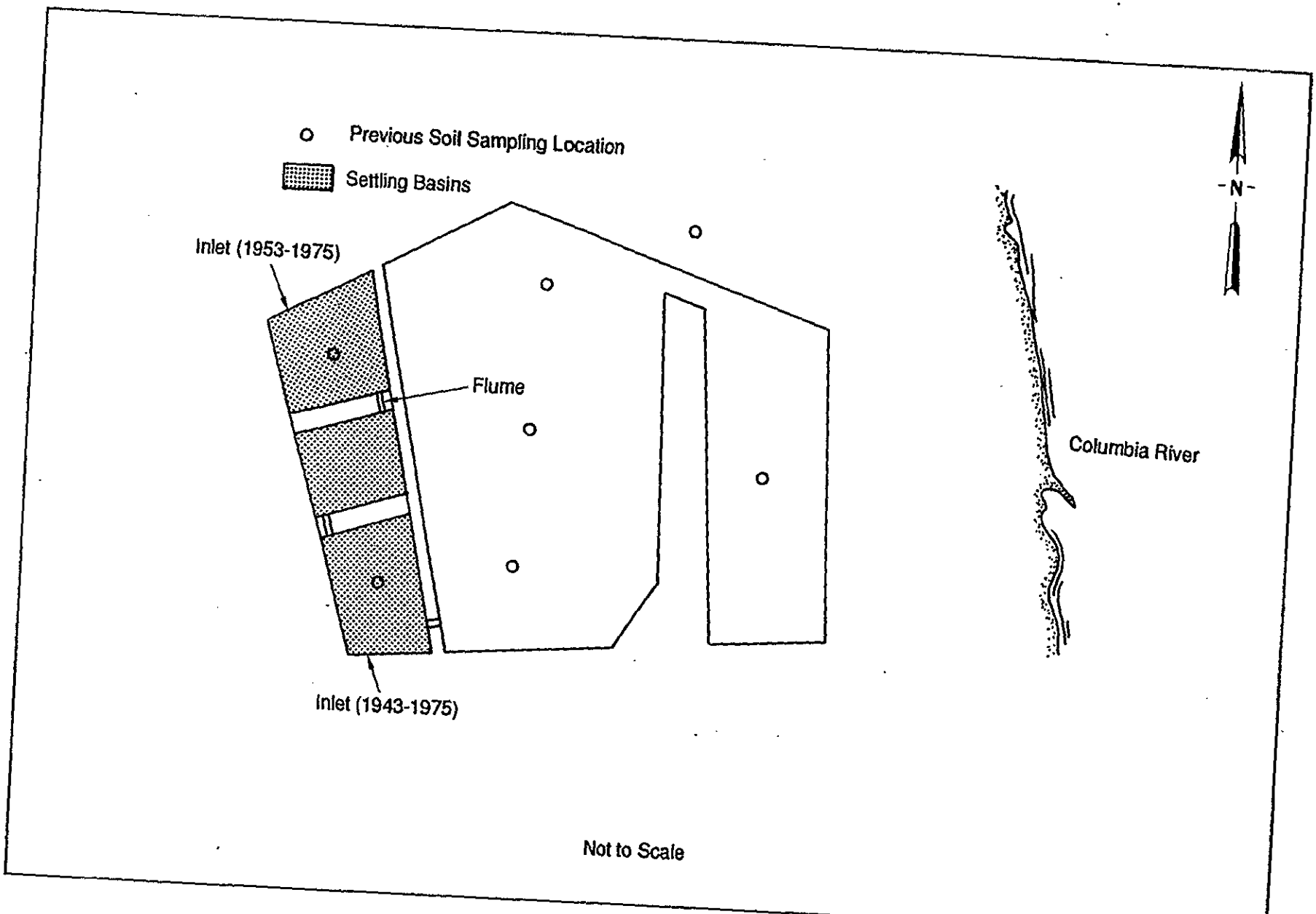


Figure 4. Final Operational Configuration of the South Process Pond.

Upon deactivation in 1975, the east infiltration basin was put into service as a filter backwash pond (Dennison et al. 1989; DOE 1989a). The dikes separating the settling basins and the west infiltration basin were partially removed at this time to provide cover for the pond sediments (Stenner et al. 1988).

South pond soils have been analyzed in 1974, 1975, and 1988 (Dennison et al. 1989). The 1988 samples were obtained from trenches that are still in existance. The sample locations are shown in Figure 4. The groundwater monitoring network for the 300 Area also includes several wells in the vicinity of this pond (Schalla et al. 1988).

2.1.4.1.3 North Process Pond (316-2). The north process pond was constructed in 1948 after the dike in the south process pond failed. The pond is situated in the center of the operable unit outside of the 300 Area perimeter fence. In addition to receiving water from the process sewer, liquid wastes from fuel fabrication operations were trucked to the north pond through 1956. The north and south ponds were operated simultaneously or alternately until both were retired in 1975 (Dennison et al. 1989).

The north process pond originally consisted of a single large infiltration basin. This basin was later subdivided into three small settling basins and one large infiltration basin (Figure 5). Flumes on top of 15 ft high partitioning dikes interconnected the basins. The entire system covered approximately 10 acres. The original three settling basins were replaced by three new basins in 1961/1962, and the original basins on the west side of the facility were retained for sediment disposal. The inlet for the pond was at the southwest corner (Dennison et al. 1989).

No outlet structure existed at the pond; the water would infiltrate or evaporate from the infiltration basin. Combined flows to the north and south process ponds ranged from 400,000 to 3,000,000 gal/d. The pond was periodically dredged to improve infiltration from 1948 through 1969. Dredged soils were spread on the dikes and buried in the adjacent north process pond scraping disposal area (Dennison et al. 1989; Stenner et al. 1988).

After deactivation in 1975, some of the dikes were removed to provide cover for the basin soils, minimizing the potential for contaminant migration via fugitive dust. Parts of the north pond were used to dispose of flyash from the 300 Area ash pits (Dennison et al. 1989). The exact period of flyash disposal within this facility is unknown; however, it is presumed to have occurred following deactivation in 1975.

Soils from the north pond were sampled and analyzed in 1970 and 1988, and several groundwater monitoring wells are located nearby (Dennison et al. 1989; Schalla et al. 1988). The 1988 samples were obtained from trenches that are still in existance. The sample locations are shown in Figure 5.

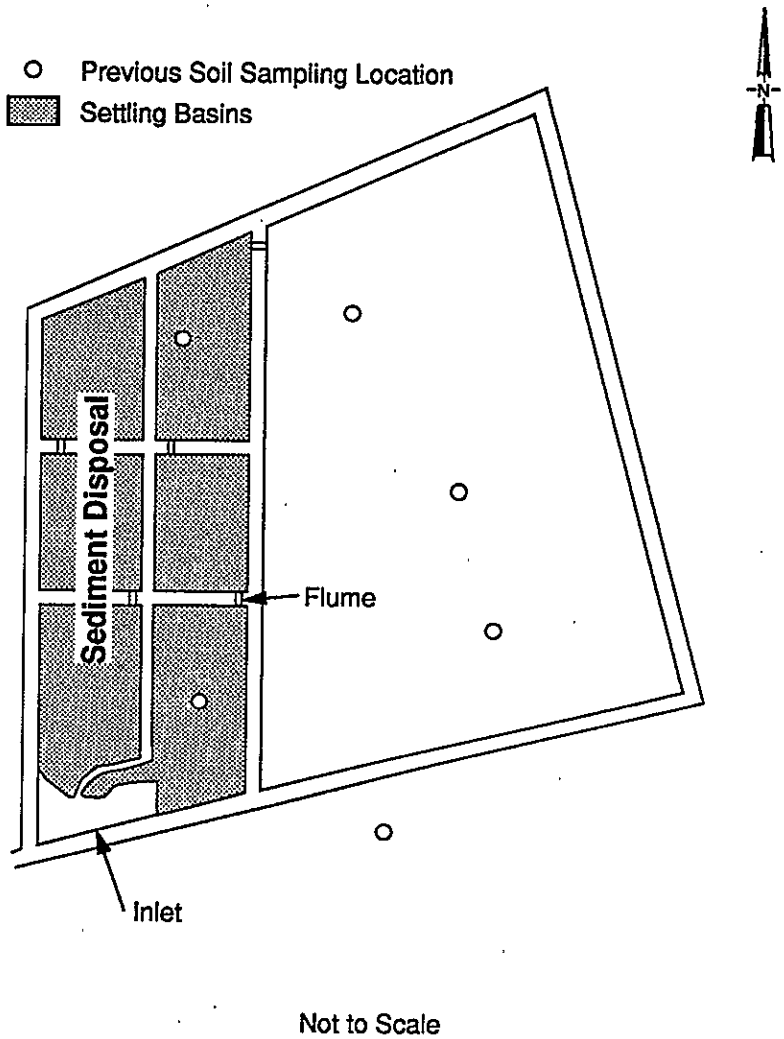


Figure 5. Final Operational Configuration of the North Process Pond.

2.1.4.1.4 307 Retention Basins. The 307 retention basins were constructed in 1953, along with the 307 trenches, to accommodate the expansion of laboratory facilities in the 300 Area. They are located in the southwest corner of the operable unit, just south of the 340 complex. Buildings in the 300 Area which have connections to the 307 basins are listed in Table 3.

Table 3. List of 300 Area Buildings Connected to the 307 Retention Basins.

308	Fuels Development Laboratory
325	Radiochemistry Laboratory
326	Materials Technology Laboratory
327	Post-Irradiation Testing Laboratory
328	Mechanical Development Building
329	Biophysics Laboratory

Source: DOE (1989a).

The 307 basins consist of four 25,000-gal concrete retention basins where laboratory wastewaters can be held for analysis. If analysis showed the wastes to be below acceptable radiological discharge limits for ground disposal in the 300 Area before 1963, the wastes were transferred by pipe to the 307 trenches. After the 307 trenches were retired in 1963, these wastes were routed to the process sewer system. If the wastes were determined to be above the radiological discharge limits, they were transferred to the 340 complex for tank storage. The acceptable discharge limit was 5,000 pCi/L and 1,000 pCi/L of total alpha and beta activity, respectively. The 307 retention basins are still in use; however, the pipe used to transfer waste between the 307 basin and 307 trenches was retired in 1963. No information on the integrity of this facility is available.

Because of difficulties with sampling, about 40% of the wastes received by the retention basins between 1953 and 1963 were released to the trenches without sampling. Because of this practice, it is possible that wastes exceeding discharge limits were unknowingly released to the trenches. Data for the period from 1953 through 1960, however, indicate that the discharge limits were never exceeded. Only radiological monitoring was performed; the chemical nature of the wastes was never determined.

2.1.4.1.5 307 Trenches (316-3). The 307 trenches, or laboratory waste disposal trenches, are two parallel, inactive leaching trenches located at the southern boundary of 300-FF-1 within the 300 Area perimeter fence. The western portion of this former facility is also located within a fenced, high security area. These trenches were constructed in 1953 to dispose of laboratory and test-facility wastewaters from the 307 retention basins. Each trench was 500 ft long by 20 ft wide by 20 ft deep. Flows to the trenches ranged from 30,000 to 100,000 gal/d.

These trenches were retired in 1963. Upon retirement, the trenches were excavated and the bulk of the contaminated soils were disposed in the 300 north burial ground, which is located outside of the operable unit boundaries. In 1965, the trenches were used for the disposal of contaminated soils from the south process pond. These soils were then covered with flyash from the 300 Area ash pits. This facility is now backfilled and has a gravel surface, except for two storage buildings that occupy areas above the old trenches.

In 1987, a portion of the 307 trenches area was used for testing a liquid waste solidification process. A trench, 50 ft by 20 ft by 9 ft deep was excavated. Discolored soils were encountered in the lower 2 to 3 ft of the excavation. The excavation was lined with a synthetic membrane liner and filled with a grout mixture of simulated liquid waste. The solidified grout was removed, along with samples of the liner, and the lined excavation was left open. Limited sampling of the exposed trench sediments was undertaken at this time, and the nearest groundwater monitoring well is located 150 ft away.

2.1.4.1.6 Process Trenches (316-5). The process trenches constitute the active liquid process waste disposal facility for the 300 Area. Located along the west boundary of the operable unit, outside the 300 Area perimeter fence, each of the two parallel leaching trenches is 1,500 ft long by 10-ft wide (at the trench bottoms) by 15 ft deep, and was constructed in 1975. Slope failure has resulted in the formation of an approximately 150-ft by 10 ft extension lobe off the north end of the western trench. The two trenches are operated alternately, with the switching frequency ranging from two to six times per year. An inlet for each trench is located on the south end, and the discharge to the facility ranges up to 3,000,000 gal/d (DOE 1985).

The wastes collected by the process sewer system discharge to the trenches via the inlet structure at the south end of the facility. The inlet structure is concrete and is approximately 70 ft long by 10 ft wide by 9 ft high. Water from the process sewer flows toward both ends of the structure. At each end of the structure is an oil baffle and a sluice gate. The sluice gates control diversion of water to the trenches. The water flows through the sluice gate and down a concrete apron into the trench. There is no outlet for the trenches; all water either infiltrates or evaporates (DOE 1985).

Current plans call for retiring this facility in the 1990's and replacing it with a process water treatment plant. Soil sampling in both trenches and in the soils of the partitioning berm occurred in 1987 (Zimmerman and Kossick 1987), and a groundwater monitoring network has been established around the facility (Schalla et al. 1988).

2.1.4.2 Other Liquid Waste Transfer and Disposal Facilities.

2.1.4.2.1 Sanitary Sewer System. Sewage from the 300 Area is routed through vitreous tile pipes to septic tanks. Overflow from the septic tanks, in a volume of about 500,000 gal/d, drains into one of two subparallel

leaching trenches. The septic tanks and the 500 ft long by 12 ft wide trenches are located between the south and north process ponds within the perimeter fence for the 300 Area (DOE 1989a).

The date of construction for the sanitary trenches is unknown. The 300 Area plans, dated 1960, show the existing trenches; but plans from 1954 do not show the trenches, and they indicate that the septic tanks discharged to a now abandoned tile drain field situated beneath and to the north of the present location of the northern trench.

When the septic tanks are periodically cleaned, the solids are deposited in an adjacent sludge pit (Douglas United Nuclear 1967). Several groundwater monitoring wells are located in the vicinity of the sanitary trenches (Schalla et al. 1988).

2.1.4.2.2 Ash Pits. Coal flyash from the convertible oil/coal power plant for the 300 Area is suspended in a water slurry and transported to the two ash pits within 300-FF-1. These pits are 15 to 20 ft deep and are located in the south-central portion of the operable unit, between the south process pond and the 307 trenches. About 15,000,000 gal/yr of flyash slurry are deposited in the pits (DOE 1989a). These pits are currently in use, but their date of construction is uncertain. A single ash trench in the same location shows up in site plans from 1954.

Once the flyash dries, it is currently hauled for disposal to a pit west of the 300 Area (DOE 1989a). In the past, these ashes have been deposited in areas of the north process pond and were used, in part, to backfill the 307 trenches (Dennison et al. 1989; Schalla et al. 1988). The dates of these latter disposal events are unknown; however, they presumably occurred after the respective retirement dates for the north process pond and the 307 trenches.

Analyses of the flyash show it to be extraction procedure nontoxic (DOE 1989a). Flyash quality data are also available from the 1988 sediment studies of the north pond because samples were obtained from areas of ash deposition (Dennison et al. 1989). There are several monitoring wells in the area, the closest being within 150 ft (Schalla et al. 1988).

2.1.4.2.3 Filter Backwash Pond. This facility, located directly east of the ash pits within the 300 Area perimeter fence, was placed in operation in 1987. The pond receives about 50,000 gal/d of sediments from filter backwashing operations at the water treatment plant for the 300 Area. Sampling of the backwash indicates it is nonhazardous (DOE 1989a). Two of the 300 Area groundwater monitoring wells are located nearby (Schalla et al. 1988).

2.1.4.2.4 Retired Backwash Pond. This facility is the old east infiltration basin of the south process pond (see Figure 4). When the south pond was retired in 1975, the east basin was used for disposal of 30,000 to 50,000 gal/d of water treatment plant filter backwash. This basin operated in this capacity until 1987 at which time it was retired. The backwash

water has been shown to be nonhazardous (DOE 1989a), and two groundwater monitoring wells are located close to the facility (Schalla et al. 1988).

2.1.4.3 Burial Grounds.

2.1.4.3.1 Burial Ground No. 4 (618-4). Little information is available on this and the other two burial grounds within 300-FF-1. Burial ground No. 4 is located in the northwest corner of the operable unit, outside of the 300 Area perimeter fence and covers an area of approximately 110,000 ft^2. It was used from 1955 through 1961, and is only known to contain miscellaneous materials, which are contaminated with uranium (Stenner et al. 1988). It is not known whether or not liquid wastes were disposed here.

In 1979, 20 depleted uranium fuel elements, composed of 0.15% uranium-235, were found to be improperly discarded near burial ground No. 4 (UPR-600-15). An area of approximately 400 ft^2 was contaminated with radiation. The elements were removed, along with the contaminated surface soils, and disposed in the 200 West Area of the Hanford Site within two months of being discovered (Stenner et al. 1988).

2.1.4.3.2 Burial Ground No. 5 (618-5). This landfill is outside the 300 Area perimeter fence in the north end of the operable unit, just east of the northern end of the process trenches and is approximately 30,000 ft^2 in area. This facility was a trash burning pit from 1945 through 1962. Some of the trash was contaminated with uranium (Stenner et al. 1988).

2.1.4.3.3 North Process Pond Scraping Disposal Area (618-12). This facility is adjacent to the south side of the north process pond. It was used from 1949 through 1964 to dispose of sediments from the pond, and flyash from the ash pits (Stenner et al. 1988).

2.1.4.4 Radioactive Liquid Waste Transfer and Storage Facilities.

2.1.4.4.1 Retired Radioactive Sewer System. This pipeline, installed around 1954, received radioactive wastes from various buildings in the 300 Area, including the fuel fabrication and research and development laboratories. The wastes--primarily water with small quantities of various laboratory chemicals, decontamination solutions, fuel fabrication solutions, acids, and bases--were transferred through this system to the 340 complex for tank storage (DOE 1989a).

The piping system is constructed of stainless steel and is buried 10 ft below the ground surface. The total length of the system is 4,000 ft, but not all of the system is located within 300-FF-1 (DOE 1989a). This system was deactivated in 1975, and liquids within the pipes were drained prior to retirement. However, the pipes do contain residual radioactive contamination (DOE 1989a).

An unplanned release (UPR-300-1) occurred from this system in 1969. A carbon steel transition pipe corroded and failed between the 307 basins and the 340 complex, spilling radioactive materials into the soils 5 ft below

ground surface. Only the top 7 ft of contamination were removed, to avoid jeopardizing the integrity of the adjacent structures (Stenner et al. 1988).

2.1.4.4.2 Radioactive Sewer System. Constructed in 1975 to replace the inactive system described above, this system consists of a double-encased sewer pipe of stainless steel surrounded by fiberglass-reinforced plastic. Continuous leak detection systems are in place between the inner and outer pipes. Flow rates through the system average about 300 gal/d (DOE 1989a).

A radioactive spill from this system occurred in 1977 near the 340 complex (UPR-300-11). A connection to the sewer was found leaking, and the top 8 ft of contaminated soils were removed for disposal in a burial ground in the 200 Area (Stenner et al. 1988).

2.1.4.4.3 340 Complex. The 340 complex was constructed in 1954 to receive wastes from the retired radioactive liquid waste sewer system. The complex still operates in conjunction with the new radioactive liquid waste sewer system, which was installed in 1975. In addition to the 300 gal/d waste stream received through the sewer, an additional 800 gal/d of similar wastes were trucked in from N Reactor fuel fabrication activities (DOE 1989a).

Wastes transferred to the 340 complex are accumulated in stainless steel tanks. Two of these tanks are located below ground and have 15,000 gal capacities; six are aboveground and have 8,000 gal capacities. The underground tanks are enclosed in a concrete vault with leak detection systems. The aboveground tanks are enclosed in a building and situated in a concrete catchment basin. All tanks are continuously monitored for leaks and are alarmed to a constantly manned control panel (DOE 1989a).

Wastes are stored for less than 90 d before being transported to the 200 West Area for storage or disposal. Tank car loading takes place in an enclosed building with spill protection and containment systems (DOE 1989a). Before a rail spur was constructed to the complex, wastes were hauled out by truck. An unplanned release of decontamination wastes occurred from this facility in 1954 (UPR-300-2). A spill of phosphoric acid, on an unspecified date, is also known to have occurred at the 340 complex (Stenner et al. 1988).

2.1.4.5 Hazardous Waste Storage Facilities.

2.1.4.5.1 340 Complex Hazardous Waste Staging Area. This active (less than 90 d) staging area is located outside the 340 complex. It is used for temporary storage of about 20 to 30 empty drums each month. Some of these drums have contained hazardous materials. Drummed, nonregulated waste oils are also stored here. There have been no known releases from this area (DOE 1989a).

2.1.4.5.2 332 Hazardous Waste Staging Area. This active staging area is located in the central part of the operable unit, adjacent to the southwest corner of the north process pond scraping disposal area and outside the 300 Area fenced perimeter. The facility was put into use in 1983 (DOE 1989a).

Containers in storage are no more than 15 gal in volume and typically consist of laboratory quantities of hazardous, nonradioactive, flammable liquids and solids, corrosives, reactives, extraction procedure toxics, toxics, and carcinogens. Wastes are stored either inside the small building or outside on a concrete pad. No known releases have occurred from this facility (DOE 1989a).

2.1.5 Unplanned Releases

Details of documented unplanned releases to, at, or near waste facilities in 300-FF-1 are presented in Appendix A. All unplanned releases, except UPR-300-14, have been associated with an operable unit waste facility in the above descriptions. As UPR-300-14 was a fully contained acid spill that occurred in 1975, did not result in a release to the environment, and was not associated with a 300-FF-1 waste facility (Stenner et al. 1988), it is given no further consideration with respect to this operable unit.

2.1.6 Interactions with Other Operable Units

Operable unit 300-FF-1 is bordered on the west and south by operable units 300-FF-2, the 300 Area Solid and Buried waste operable unit, and by 300-FF-3, the central 300 Area operable unit (Plate 2-1). Operable unit 300-FF-5, the 300 Area groundwater, surface water and sediment, and aquatic biota operable unit, underlies 300-FF-1, 300-FF-2, and 300-FF-3.

Operable unit 300-FF-2, located west of 300-FF-1, is comprised predominantly of radioactive waste burial grounds. Most of the other sites within the unit are unplanned releases within the 300 Area perimeter. Sites in this operable unit are considered to be sources of mixed wastes. There is no documentation of observed releases from 300-FF-2 facilities, but isolated instances of groundwater contamination have been detected in adjacent monitoring wells which cannot be linked directly to any specific facility (WHC 1989). Contaminated groundwater emanating from this operable unit would have the potential to migrate beneath 300-FF-1 toward the Columbia River.

The central 300 Area operable unit, 300-FF-3, borders 300-FF-1 on the south and west. The 300-FF-3 unit contains some unplanned releases and several hazardous materials handling facilities. Releases to the groundwater from this operable unit are similar in nature to, and probably not easily separated from, the contamination contributed from 300-FF-1 (WHC 1989).

The 300-FF-5 encompasses all groundwater and surface water and sediments within the Columbia River contaminated by releases from waste facilities within 300-FF-1, 300-FF-2, and 300-FF-3. The creation of this operable unit eliminates problems associated with designating project boundaries that would result from the overlapping plumes of groundwater, surface water, and sediment contamination known to be emanating from the three source operable units.

Operable unit 300-FF-4, the Fast Flux Test Facility or 400 Area, is separated geographically from the 300 Area (see Figure 3). Therefore, no significant interactions between this and the other four 300 Aggregate Area operable units are anticipated. The 300-FF-4 may therefore be regarded as a distinct waste site, administratively connected to the 300 Area with respect to CERCLA.

Because of the overlapping of contaminant extent within 300 Area operable units (300-FF-1, 300-FF-2, 300-FF-3, and 300-FF-5), a high degree of interaction between these operable units is anticipated. The RI/FSs for these operable units will not be scoped or implemented concurrently. Therefore, the last operable unit RI/FS implemented will need to ensure that all significant interactions are considered in selecting a final, overall remedy for the 300 Area.

2.1.7 Resource Conservation and Recovery Act Facility Interactions

Two of the active facilities in 300-FF-1 fall under the jurisdiction of RCRA. A RCRA Part A permit application for the 332 hazardous waste staging area has been submitted to Ecology. A Part A permit application has been submitted to Ecology for the 300 Area process trenches, and Ecology has also requested that closure/postclosure permitting be conducted and physical closure of this facility be initiated.

A closure/postclosure plan already exists for the process trenches (DOE 1985), and is being updated. On February 1, 1985, administrative controls were implemented by Westinghouse Hanford to restrict disposal of dangerous or hazardous wastes to this facility. Westinghouse Hanford plans to cease discharge to the process trenches as soon as practicable and is proceeding with an engineering study to identify the best available technology to replace the trenches. This facility will be closed under interim status.

A groundwater investigation in connection with the trenches (PNL 1986) is underway. The process trenches appear to be responsible for most of the groundwater contamination emanating from 300-FF-1 (Schalla et al. 1988). The RCRA groundwater investigation will be incorporated into the 300-FF-5 operable unit RI/FS. Additional source, geological, soil, air, and terrestrial biological data, pertinent to the process trenches operations or closure, will also be generated during the 300-FF-1 RI/FS. Data obtained from the RCRA groundwater investigation, and the 300-FF-1 and 300-FF-5 RI/FSs, will be evaluated to determine the most feasible closure and corrective action options for the process trenches. The goal is to integrate the RCRA closure of the trenches with the remedies selected under CERCLA for the 300-FF-1 and 300-FF-5 operable units. In accordance with the Tri-Party Agreement (Ecology et al. 1989), the provisions of WAC-173-303-610 are deemed applicable to the closure of the process trenches. The appropriate permitting documents prepared pursuant to these provisions will incorporate by reference much of the RI/FS documentation to avoid a duplication of work effort.

2.2 OPERABLE UNIT SETTING

2.2.1 Topography

The 300 Area lies within the regional topographic low of the Pasco syncline, a broad depression in the southeastern portion of the Pasco Basin (Figures 6 and 10). The site is situated immediately west of the free-flowing section of the Columbia River, below Priest Rapids Dam and above the headwaters of Lake Wallula behind McNary Dam. The elevation of the site is approximately 380 to 390 ft above mean sea level (amsl). Surface topography at the site is generally flat and slightly irregular. The land surface slopes downward very gradually to the east and south. The Columbia River lies at an elevation of approximately 340 ft amsl, forming a steep river embankment at the river's edge of approximately 40 ft in height.

2.2.2 Geology

A general stratigraphic column of the Hanford Site is presented in Figure 7. This discussion, derived from Schalla et al. (1988), focuses on the principal lithologic units, distribution, and thicknesses of the geologic formations beneath the 300 Area.

The three uppermost stratigraphic formations beneath the 300 Area, in ascending order, are the Saddle Mountains Basalt, Ringold Formation, and the Hanford formation. The general, uppermost stratigraphy of the 300 Area is shown in Figure 8. Geologic cross sections of the 300 Area are shown in Figure 9.

2.2.2.1 Saddle Mountains Basalt. The Saddle Mountains Basalt is the uppermost formation of the Columbia River Basalt Group. This formation is characterized as dark gray to black basalt mixed with gray clay and caliche. The basalt exhibits a scoriacious texture with surface stains of iron and sulfide mineralization. The uppermost basalt flows in the area are the Goose Island flow of the Ice Harbor Member in the north and the Martindale flow of the Ice Harbor Member in the south.

2.2.2.2 Ringold Formation. The Saddle Mountains Basalt is overlain by the Ringold Formation. In the 300 Area, the Ringold Formation is composed of the basal, lower, and middle units, the upper unit having been largely removed by erosion subsequent to its deposition.

2.2.2.2.1 Basal Ringold. The basal Ringold Formation is chiefly characterized as a well-consolidated clayey sand to a gravelly sand that varies in thickness from 2 to 17 ft beneath the 300 Area. The clay fraction of this unit appears to be transitional from the overlying clay-dominated lower Ringold unit. The sand is primarily basaltic with some quartz and feldspar, and ranges from very fine to medium sized grains. The gravel fraction, only found locally, is dominantly basaltic with some granitic, quartzitic, and other metamorphic clasts. Calcium carbonate in the form of caliche is found locally at the basal Ringold-basalt contact.

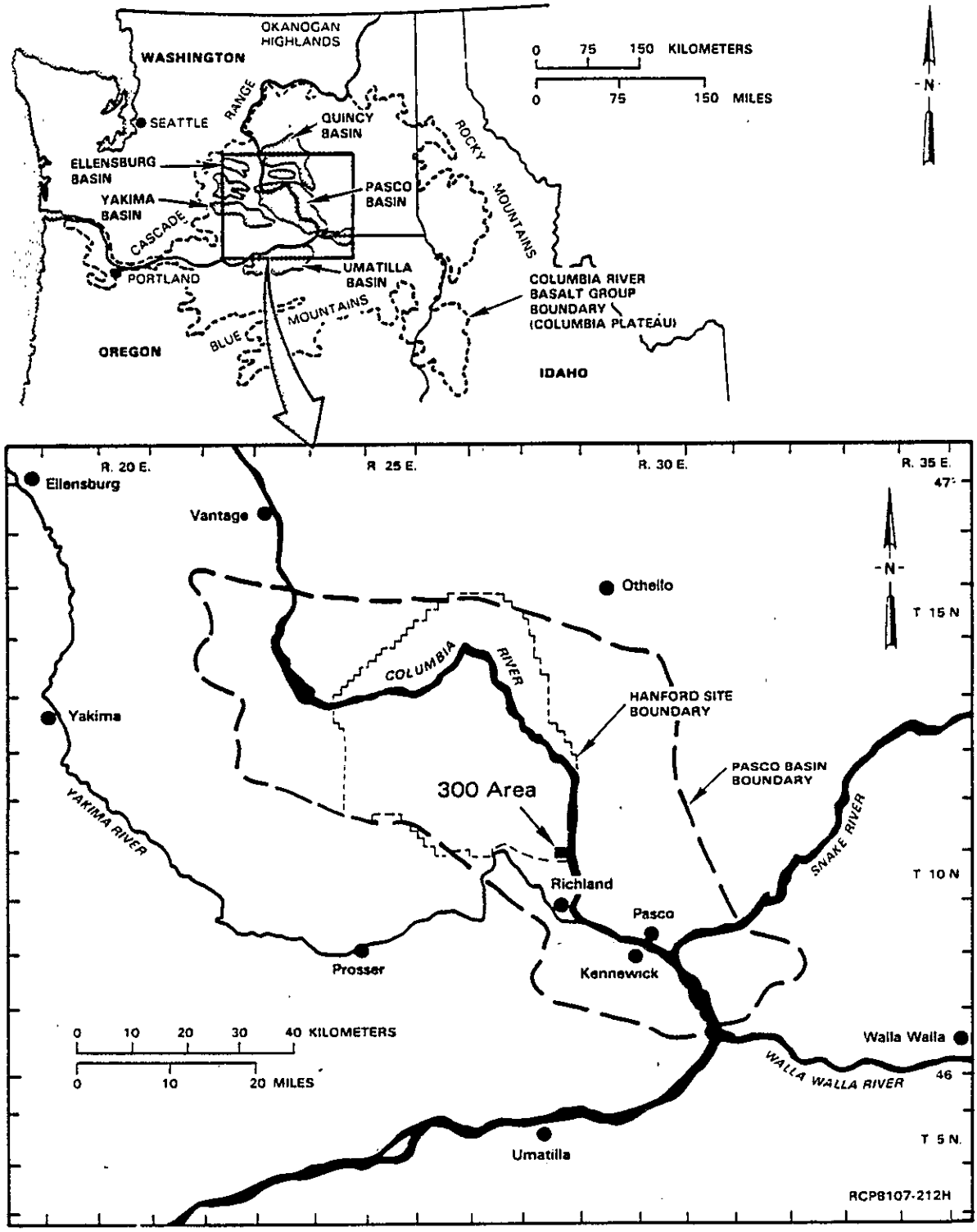
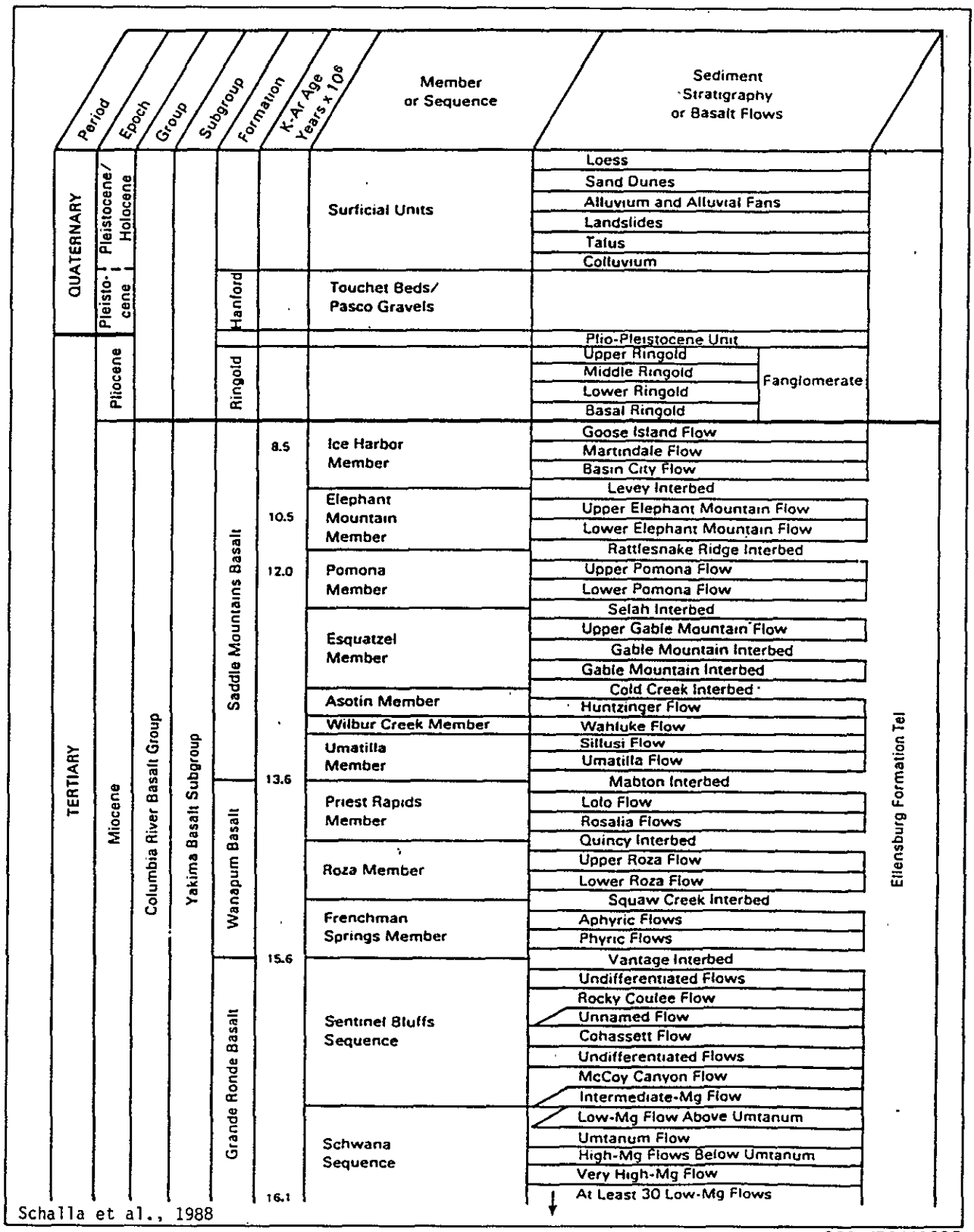


Figure 6. Location of the 300 Area and the Hanford Site Relative to the Pasco Basin.



Schalla et al., 1988

883-1729/9925

Figure 7. General Stratigraphic Column for the Hanford Site.

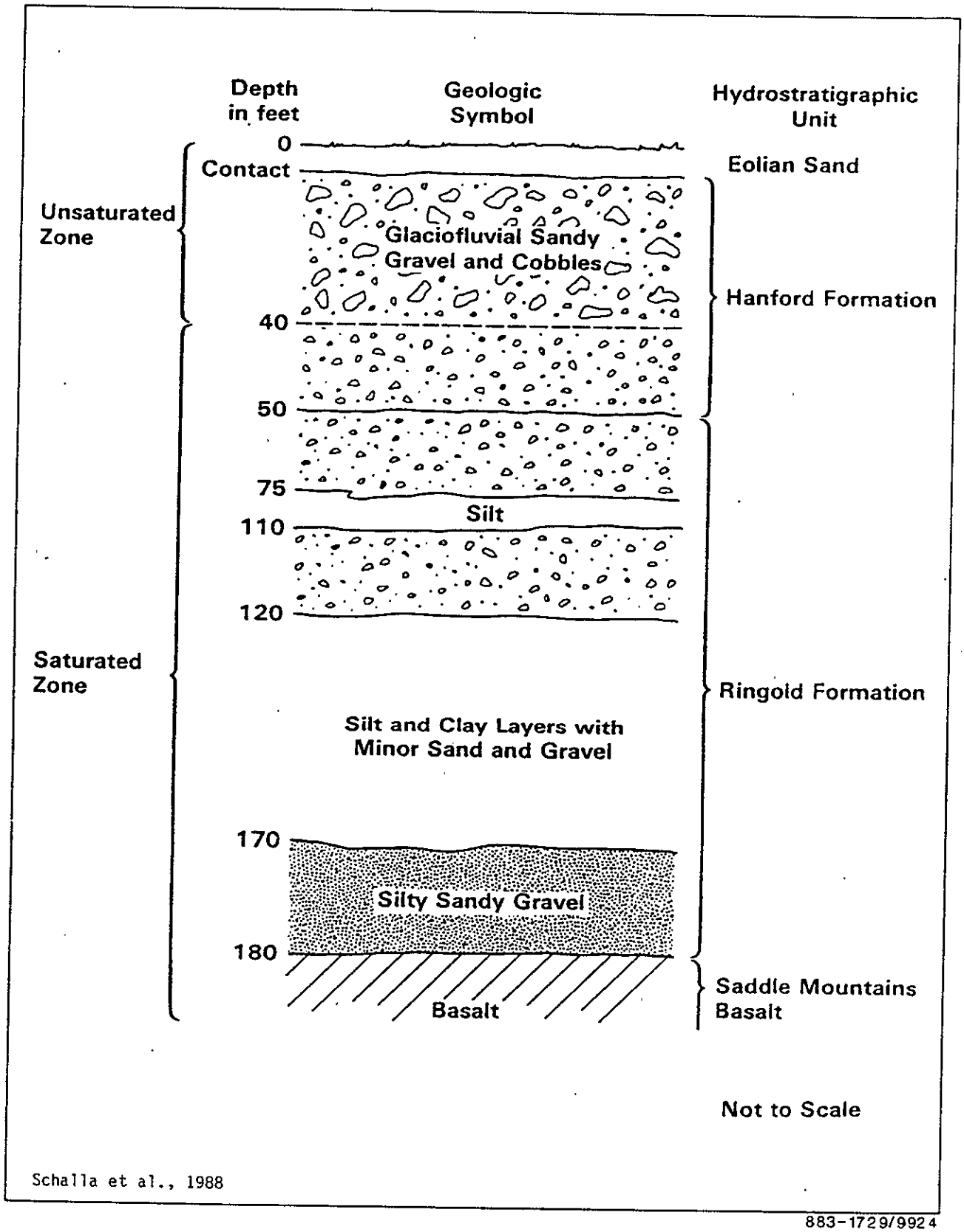


Figure 8. General Stratigrapny of the 300 Area.

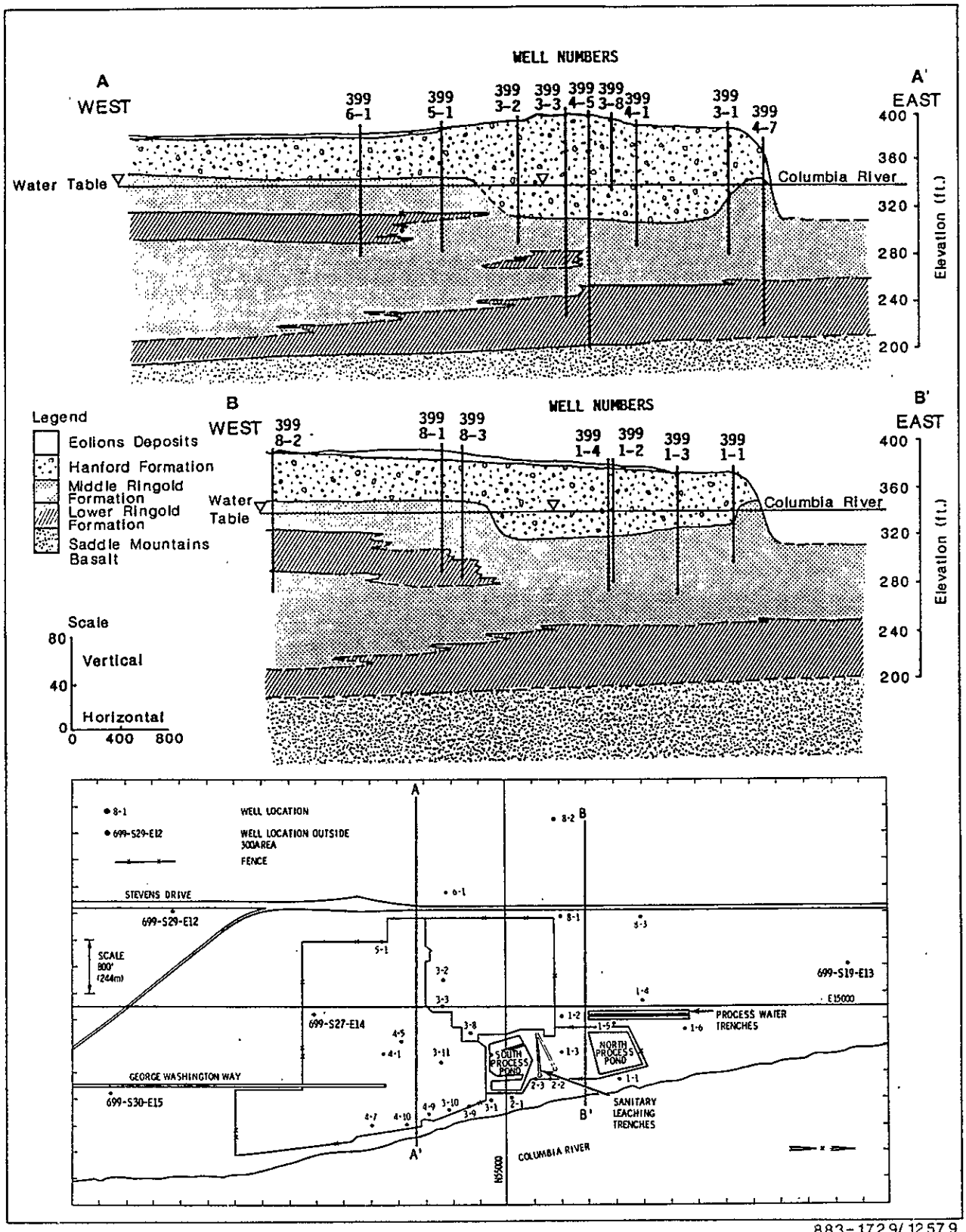


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Figure 9. Geologic Cross-Sections of the 300 Area.

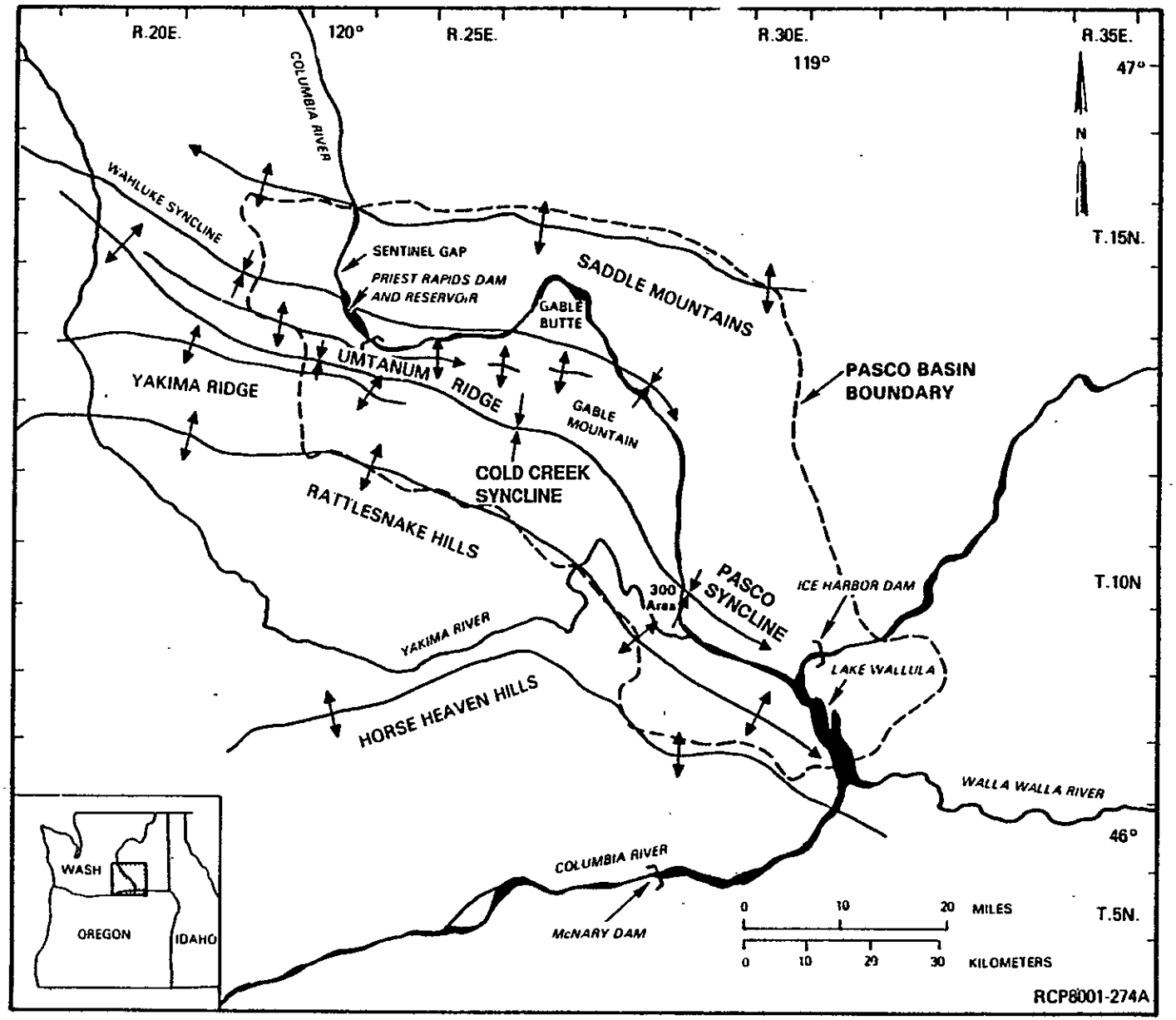


Figure 10. Location of Pasco Syncline.

2.2.2.2.2 Lower Ringold. The overlying lower Ringold unit consists of bluish-green clay, which gradually changes with depth to brown clay/silt. Very fine-grained sand and silt stringers are locally encountered. The unit varies from 17 to 60 ft in thickness at the 300 Area.

2.2.2.2.3 Middle Ringold. The middle Ringold unit forms the top of the Ringold Formation beneath the 300 Area. This unit is characterized as moderately- to well-consolidated, brown-to-gray sandy gravel with local silt and sand lenses. The gravel fraction is represented by subangular-to-subrounded, pebble-to-cobble-sized clasts of basaltic, granitic, and metamorphic compositions. Although it appears to be a variable phenomena, a decrease in the percentage of basalt clasts is generally a useful tool in marking the contact between this unit and the overlying Hanford formation. Clast surfaces are moderately altered, showing evidence of chloritization. The sand and silt are composed of quartz, feldspar, and mica with some basaltic and metamorphic rock fragments. The sand fraction is dominantly very fine to very coarse grained. This basaltic sedimentary unit is relatively consistent over the 300 Area, varying only from 65 to 86 ft in thickness. The surface of the middle Ringold unit appears to be an irregularly shaped erosional surface.

2.2.2.3 Hanford Formation. Overlying the Ringold Formation is the unconsolidated, poorly sorted sediments of the Hanford formation. The composition of this formation is characterized as dark grayish-brown to dark olive-gray sandy gravel with some silt and local sand stringers. The upper portion of the unit generally exhibits a pebble-to-boulder gravel, which grows finer with depth, to a very fine-to-medium pebble gravel. The gravels of this unit are composed mainly of subangular-to-rounded basaltic clasts and also include a few quartz-rich and metamorphic clasts. The sands vary highly in composition but are predominantly basaltic. Calcium carbonate deposits are found on clast surfaces especially in the upper portion of the unit. Lenses of gravelly sand and pure sand occur locally. The thickness of the unit is quite varied, ranging from 21 to 81 ft.

The contact with the middle Ringold unit is determined by using particle size and by evidencing a predominance of basaltic sediments. Newcomb et al. (1972) summarized the main distinctions between the Pasco gravels of the Hanford formation and the underlying Ringold Formation. The Pasco gravels are basaltic in both the sand and the gravel fractions; generally less compacted, less indurated, and more permeable than the Ringold Formation; and the gravels show no appreciable alteration. The Ringold Formation sands, however, are composed primarily of quartz; the gravels include such exotic rock types as granite, volcanic porphyry, and quartzite, and may show alteration rinds up to 0.125 in. thick. In general, the Ringold Formation sediments contain more silt and clay, even in the gravels.

2.2.2.4 Eolian Deposits. Overlying the Hanford formation in most areas of the 300 Area is a thin veneer of fine-to-coarse-grained, eolian (wind transported) sand deposits. The thickness of this deposit is quite varied, ranging from 0 to 15 ft. The lack of these deposits at some locations is a result of their removal during construction activities over the last several

decades. The geologic contact between the eolian deposits and the underlying Hanford formation is quite distinct.

2.2.2.5 Structure of the 300 Area. The 300 Area lies above the axis of the northwest-southeast trending Pasco syncline shown in Figure 10. The syncline plunges gently northwestward toward the structural low of the Pasco Basin about 10 mi to the northwest of the 300 Area. The basaltic bedrock surface along the synclinal axis beneath the 300 Area dips toward the northwest at a gradient of 25 ft/mi or about 0.25°. Part of this dip may be related to the thinning and pinching out of the basalt flows, and the true dip of the individual flows may be slightly less than 0.25°. Ringold Formation sediments generally have dips similar to the underlying basalt; however, slightly lower dips prevail upward in the section.

Excavation in the 300 Area in 1958 disclosed the presence of a paleochannel incised into the Ringold Formation beneath the 300 Area (Lindberg and Bond 1979). The channel is filled with glaciofluvial sediments and separated from the present channel by a levee of relatively less permeable Ringold sediments. More recent investigations have confirmed the presence of the paleochannel, which merges with the Columbia River somewhere north of the 300 Area and exits near the south end of the 300 Area.

2.2.3 Hydrogeology

Unconfined and numerous confined aquifers are present beneath the 300 Area. The uppermost aquifer is unconfined; underlying aquifers are contained in the basal member of the Ringold Formation and the basalts, and are confined. The following discussion of the uppermost aquifer systems in the 300 Area is derived from Schalla et al. (1988), unless otherwise indicated. Additional details on the 300 Area hydrogeology will be provided in the 300-FF-5 work plan.

2.2.3.1 Confined Aquifer Systems. The confined aquifers in the basalts consist primarily of permeable zones at the contacts between basalt flows. The permeable zones, or interflow zones, are zones of fractured, jointed, brecciated vesicular basalt that occur at the upper and/or lower surfaces of the individual basalt flows and are the primary conduits for groundwater. Sand or gravel interbeds may also be present in the interflow zones and serve as conduits for groundwater. These aquifers are confined by the largely impermeable central or interior part of the basalt flows and by the low permeability siltstones and claystones of the interbedded sediments. The confined aquifer in the 300 Area referred to in this report is the sandy gravels of the basal member of the Ringold Formation that are probably hydraulically interconnected to the uppermost confined basalt aquifer.

Much of the area near the axis of the Pasco syncline is considered to be a discharge area for the confined aquifers, with groundwater flowing upward from the uppermost basalt aquifers into the overlying unconfined sedimentary aquifer (Gephart et al. 1979). Measured hydraulic head differences across the confining lower Ringold, between the uppermost confined aquifer and the

unconfined aquifer, range between 20 to 35 ft, thus indicating a large upward gradient.

Transmissivities of the basalt member vary from 1.6 to 100 ft^2/d. Hydraulic conductivity and specific storage of the flow tops within the upper sequences of basalt (Saddle Mountains member) range from 0.01 to 1,000 ft/d and from 1 by 10^{-7} to 1 by 10^{-5}/ft, respectively. The dense interiors of the basalt flows are both considerably less permeable and thicker than the flow contacts, and form confining layers. Sedimentary interbeds between successive lava flows generally consist of silts and clays with intermittent sand or gravel stringers. The majority (80%) of sedimentary interbeds within the upper basalts have moderate hydraulic conductivities ranging from 1 to 10 ft/d (DOE 1988).

2.2.3.2 Unconfined Aquifer System. In the 300 Area, the water table (the upper surface of the unconfined aquifer) is in the glaciofluvial sediments of the Hanford formation. The lower part of the unconfined aquifer is the middle member of the Ringold Formation and may be partially confined by the thin interbeds of silt and clay. The water table is at a depth of about 40 ft below the land surface, and the top of the Ringold Formation is at a depth of 35 to 65 ft.

The Hanford formation in the 300 Area consists of unsaturated sandy gravel with few cobbles and boulders in the upper half of the unit and saturated sandy gravel with more cobbles and boulders in the lower half. These sediments vary from 30 to 85 ft in thickness. The transmissivity is consistently high, varying from 40,000 to 102,000 ft^2/d. Most of the transmissivity in the unconfined aquifer in the 300 Area has been attributed to the sediments of the Hanford formation; however, recent tests indicate that the transmissivity attributable to the uppermost middle Ringold sediments is similar, varying from 10,000 to 200,000 ft^2/d.

The sandy gravels of the lower Ringold are probably semiconfined beneath some portions of the area due to layers of silt and clay acting as aquitards. Transmissivities in the lowermost portion of the middle Ringold range from 8 to 200 ft^2/d.

Hydraulic properties of the water table aquifer vary considerably with location due to changes in local stratigraphy. The hydraulic conductivity of the unconfined aquifer generally decreases with depth. The very broad ranges of measured hydraulic conductivity and storativity within the principal stratigraphic horizons at the Hanford Site are summarized in Table 4. A large scale effective porosity of 0.11 has been estimated for the Ringold Formation in the vicinity of the 200 Area (Newcomb et al. 1972).

Table 4. Hydraulic Properties of Unconfined Aquifer in Pasco Basin.

Stratigraphic horizon	Hydraulic conductivity (ft/d)	Storage coefficient
Hanford formation	500 - 20,000	0.03 - 0.20
Undifferentiated Hanford and Middle Ringold	100 - 7,000	--
Middle Ringold	20 - 600	0.0002 - 0.05
Lower Ringold	0.1 - 10	0.002 - 0.05

Source: DOE (1987).

Natural recharge of the unconfined aquifer beneath the Hanford Site occurs at the northwest margin of the Pasco Basin. An artificial recharge occurs at the 200 Area near the center of the Hanford Site. Groundwater flows from these recharge areas toward the 300 Area in a general southeasterly direction. In the southeast corner of the Hanford Site, groundwater recharge is mainly from the Yakima River. The 300 Area is located approximately at the point where these two groundwater sources meet. As a result, groundwater enters the 300 Area from the northwest, west, and southwest (Lindberg and Bond 1979). A contour map of the water table surface for the Hanford Site is shown in Figure 11.

In the 300 Area groundwater generally flows toward the river to the southeast (Figures 12 and 13). The exact direction of groundwater flow at any given time, however, is determined by both natural and man-made influences. The primary influence is the level of water in the Columbia River. Lindberg and Bond (1979) verified that when the river stage rises during spring run-off, bank storage occurs and causes a reversed water table gradient in the 300 Area. During these times, groundwater tends to flow in a more southerly direction, roughly subparallel to the river as shown in Figure 14. When the river level drops, the predominant gradient is restored and groundwater flows more easterly in a direction nearly perpendicular to the river.

Effect of river fluctuations have been measured up to 2.5 mi from the river, but are dampened with distance from the river. A 4-ft increase in river elevation between May 20 and 27, 1977, was of sufficient duration to create a gradient reversal, resulting in the groundwater levels over much of the central portion of the 300 Area being lower than the surrounding areas (Lindberg and Bond 1979). Measurements of changes in groundwater elevation during and subsequent to that period are shown in Figures 15 to 18. These changes are merely illustrative of the magnitude and timing of changes that can be anticipated. Measurements of groundwater temperature during this period, however, suggest that the amount of river water that invaded the aquifer was probably small, indicating that the increase in elevation of the river creates a hydraulic barrier.

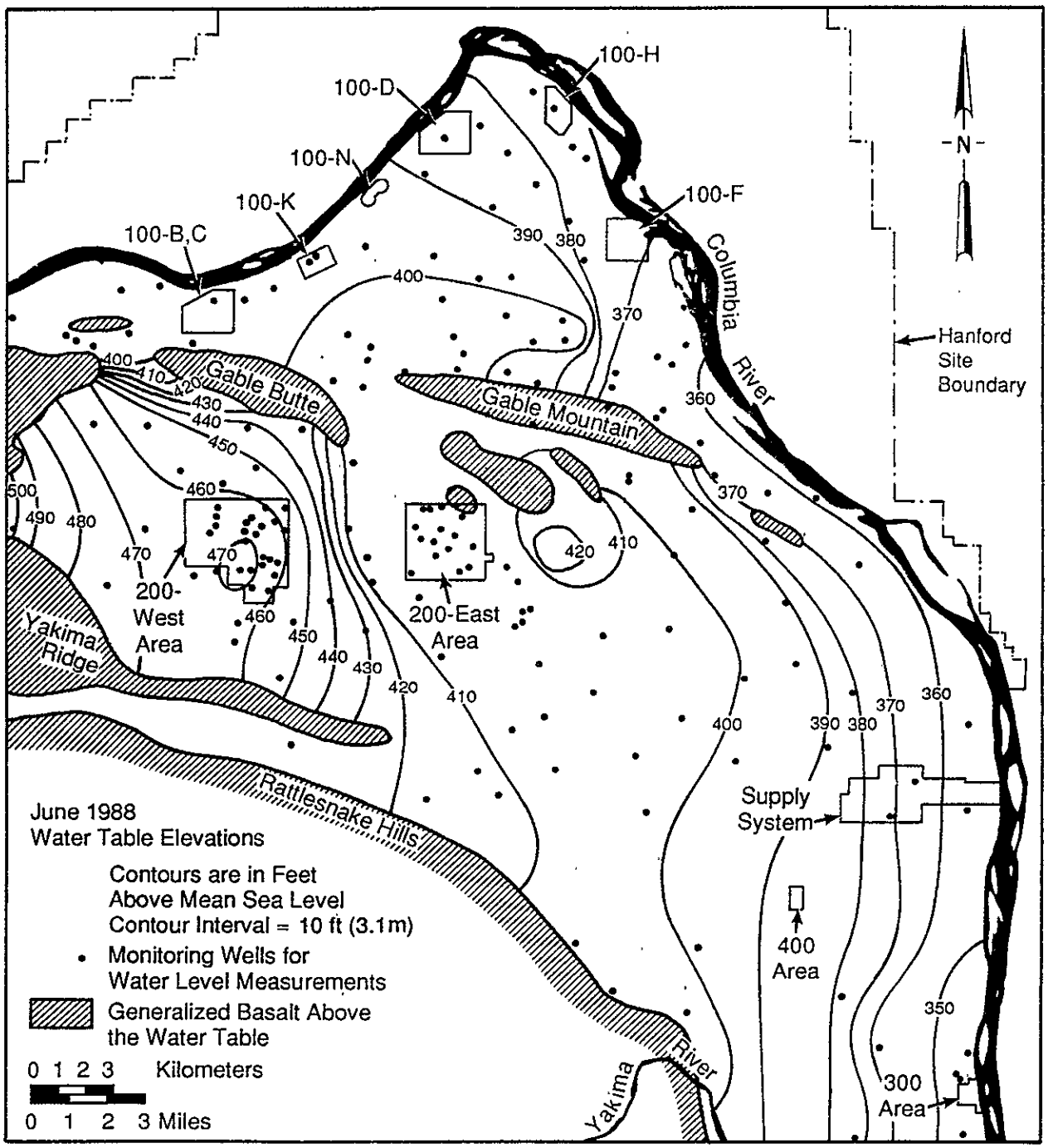


Figure 11. Unconfined Aquifer Water Table Map, June 1988 (Evans et al. 1988).

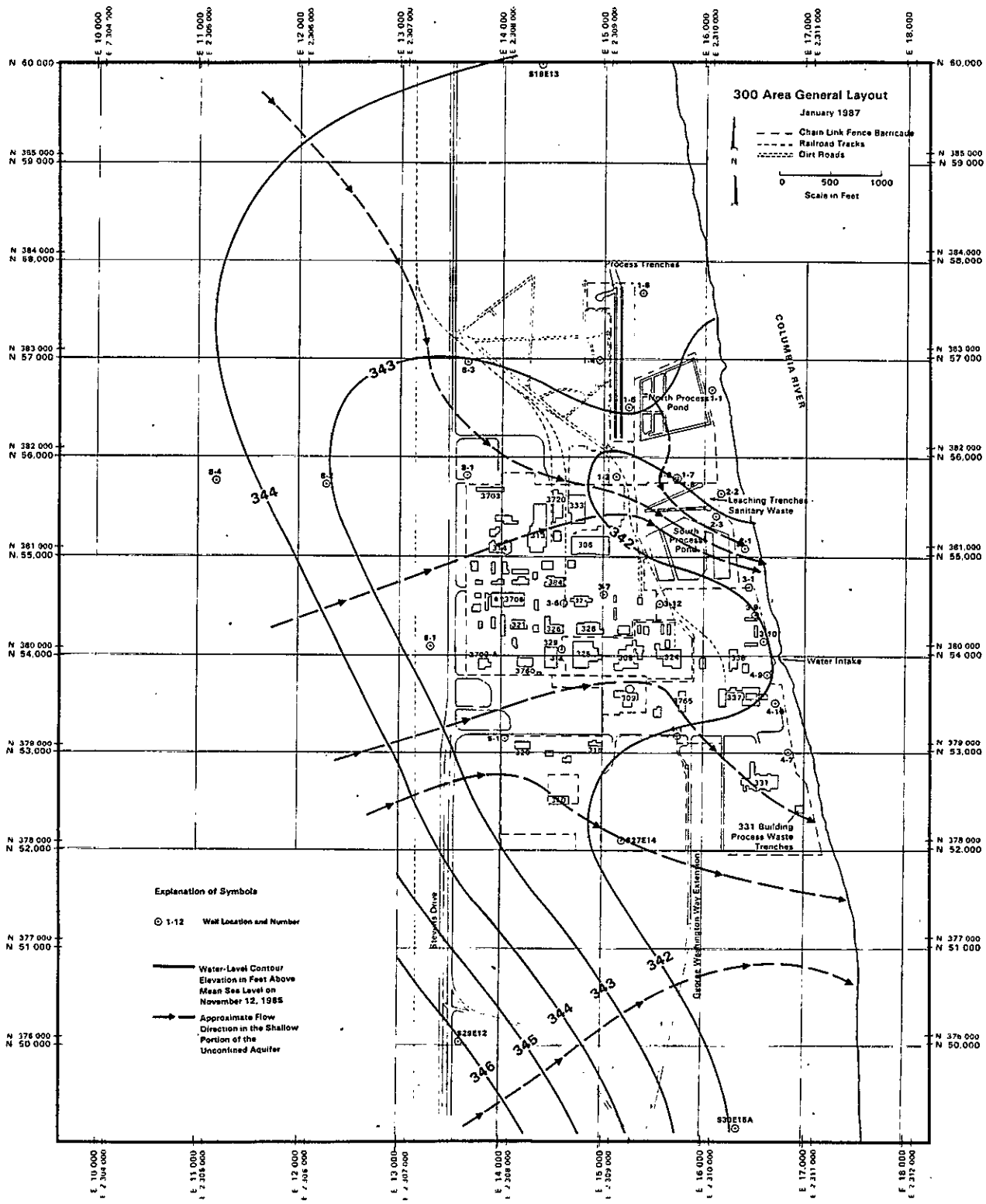


Figure 12. 300 Area Water Table Map, November 1985 (Schalla et al. 1988).

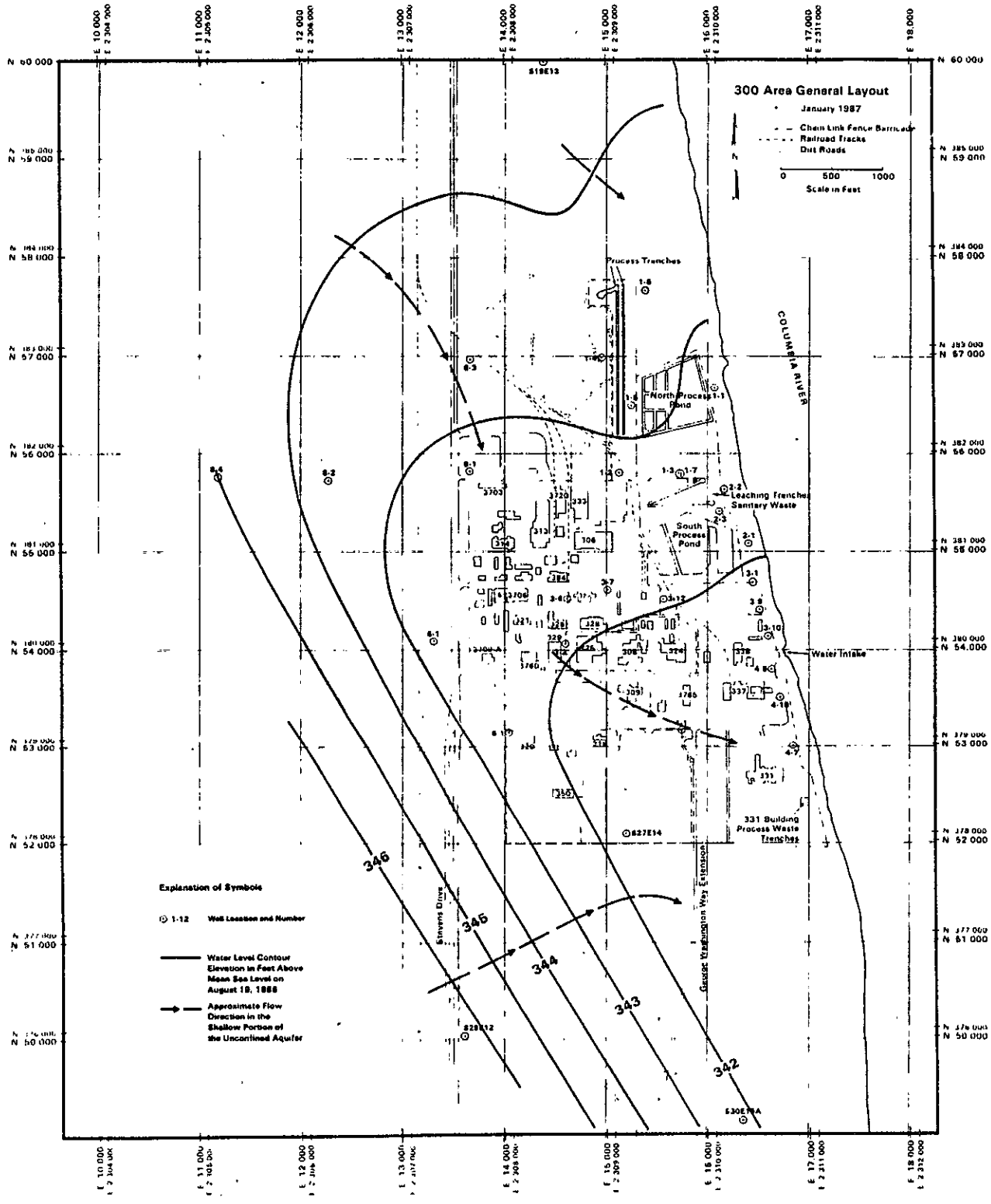


Figure 13. 300 Area Water Table Map, August 1986 (Schalla et al. 1988).

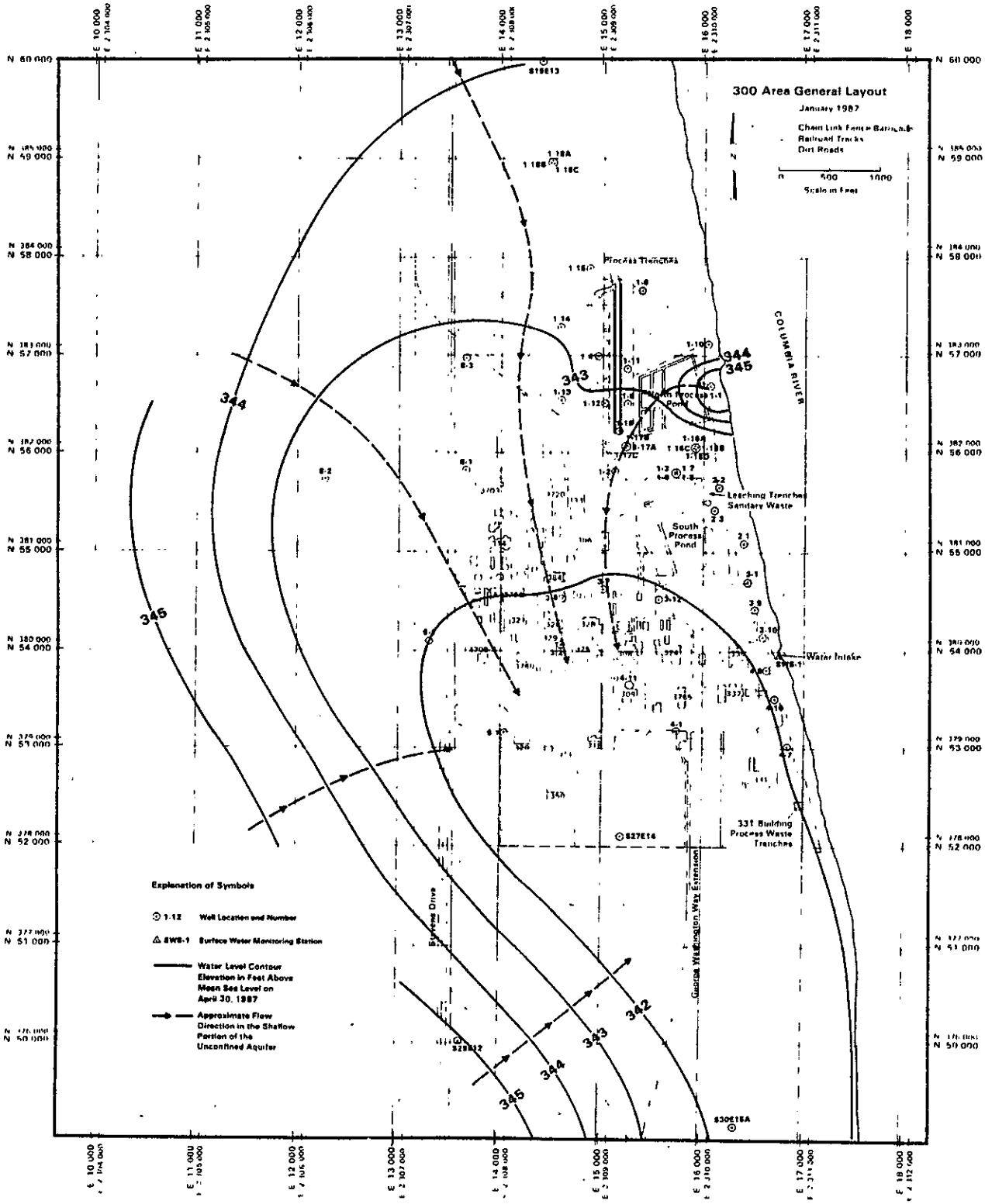
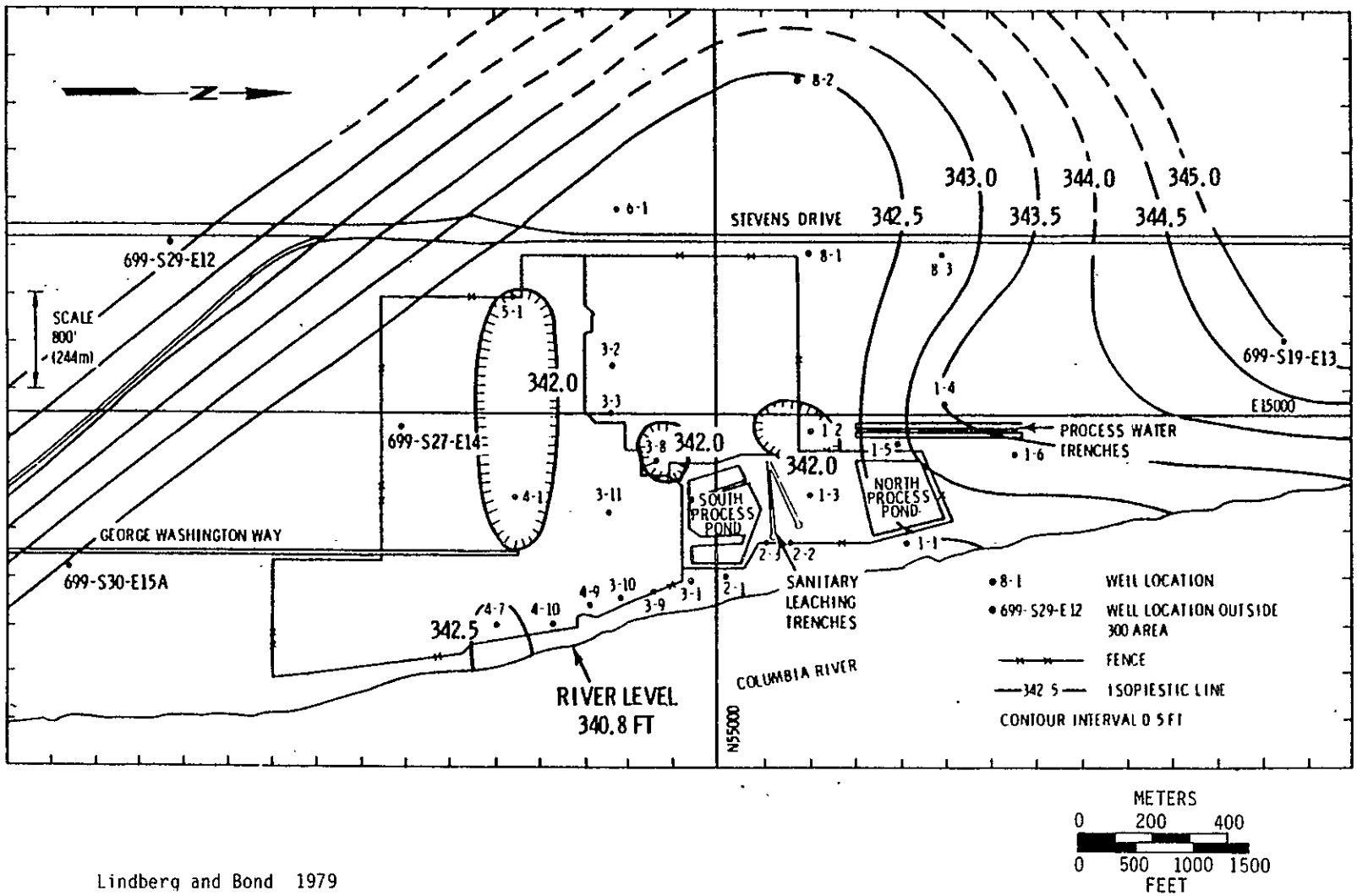
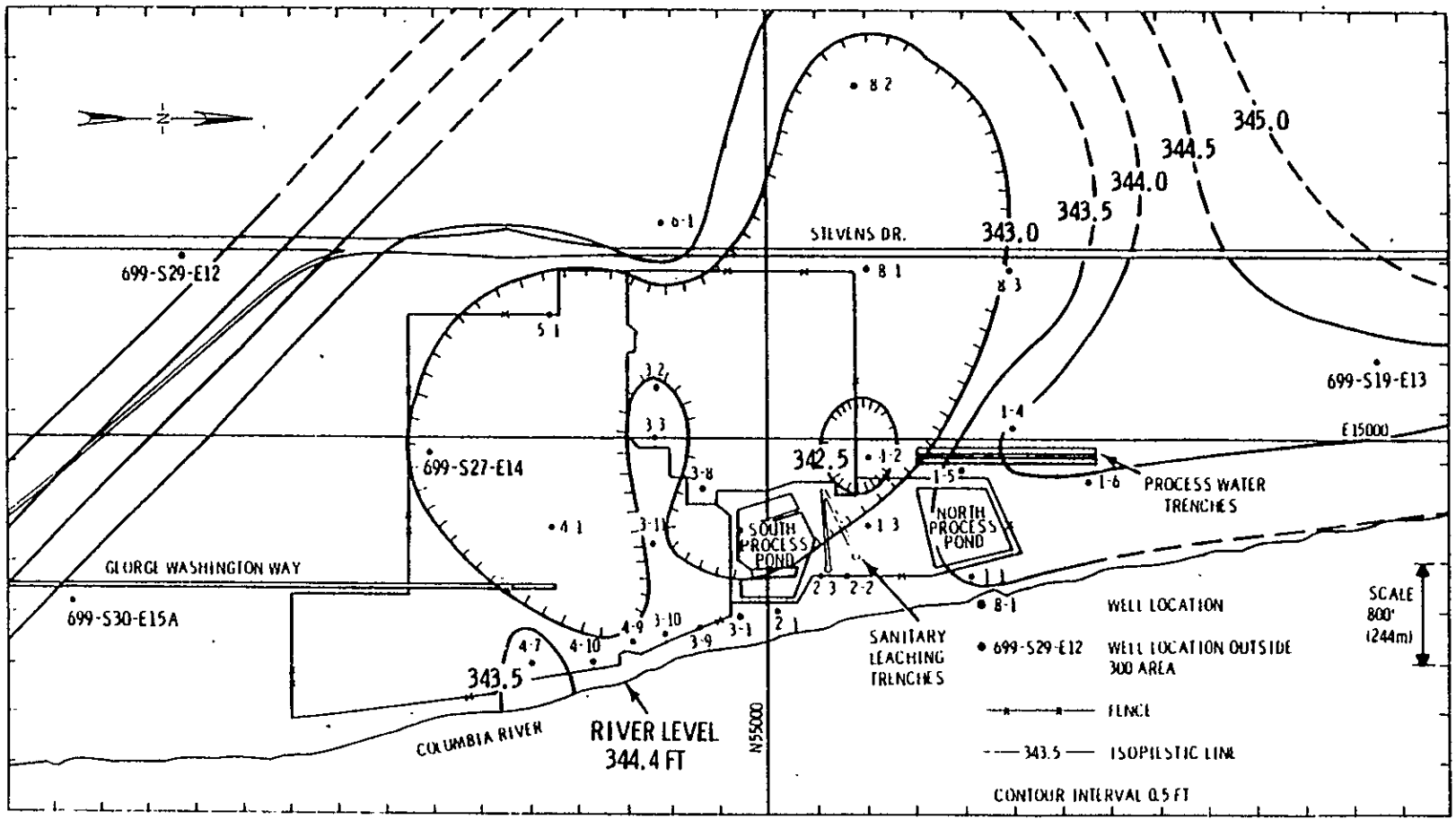


Figure 14. 300 Area Water Table Map, April 1987 (Schalla et al. 1988).



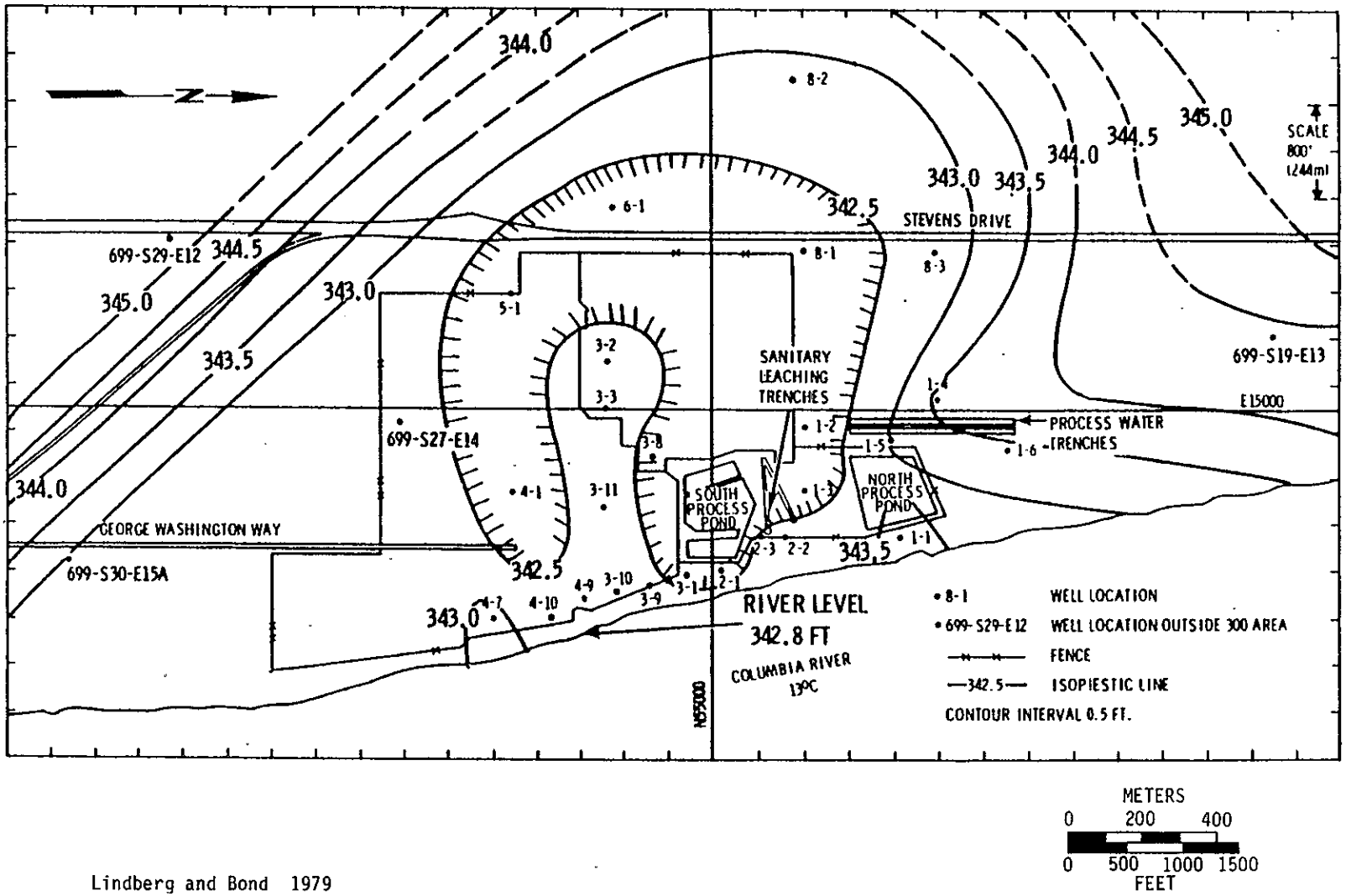
Lindberg and Bond 1979

Figure 15. 300 Area Water Table Map, May 20, 1977.



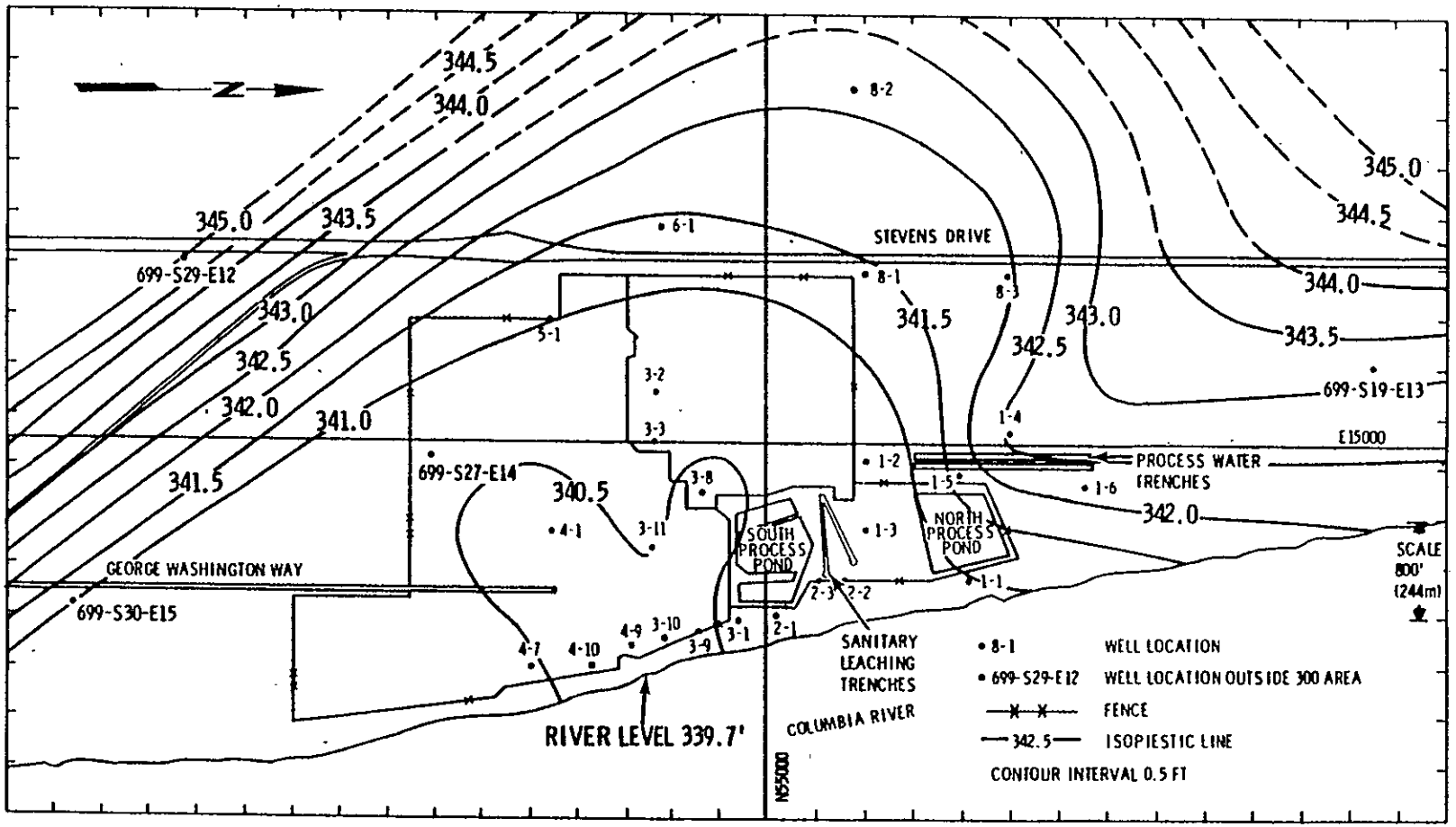
Lindberg and Bond 1979

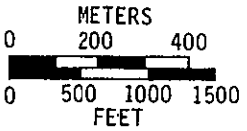
Figure 16. 300 Area Water Table Map, May 27, 1977.



Lindberg and Bond 1979

Figure 17. 300 Area Water Table Map, June 3, 1977.





Lindberg and Bond 1979

Figure 18. 300 Area Water Table Map, July 1, 1977.

A channel incised into the Ringold Formation was discovered running under the 300 Area in 1958. This channel, which can be seen in Figure 9, is filled with glaciofluvial sediments, and runs from about 2 mi north to about 1 mi south of the 300 Area. It is separated from the present Columbia River channel by a natural levee of relatively impermeable sediments of the Ringold Formation. A breach in the levee is suspected to be responsible for a high flow rate in the area between the two process ponds. This breach admits cooler Columbia River water and is also responsible for a spring along the Columbia River bank that releases warm, uranium-contaminated groundwater during low river stages (Lindberg and Bond 1979). Probably many breaches and few barriers separate the channels as evidenced by irregular water level contours along the river bank, shown in Figure 12 at lower water levels and Figure 14 at higher water levels.

The primary man-made influence on groundwater levels and flow directions in the 300 Area is from the process trenches. Discharge to the trenches is up to 3,000,000 gal/d. Discharge to the nearby sanitary trenches range up to 500,000 gal/d. These large volumes of water percolate quickly to the groundwater and create small groundwater mounds on the water table surface. The mounds increase the water table gradient and produce divergent flow, particularly around the process trenches.

2.2.3.3 Vadose Zone. The thickness of the vadose zone ranges from less than 1 ft near the Columbia River to over 450 ft in the eastern portion of the Pasco Basin. Water contents at depth in vadose zone sediments at the Hanford Site are generally low, ranging from 2 to 7% by weight in coarse- and medium-grained soils and 7 to 15% in silts (Gee and Heller 1985). Measurements of matric potential--the energy required to extract water from a soil against the capillary and adsorptive forces of the soil matrix--at depths greater than 30 ft suggest that water in the deeper sediments is slowly draining to the water table (Hseih et al. 1973).

Beneath the 300 Area, the vadose zone is generally about 40 to 50 ft thick and lies almost entirely within the Pasco Gravels of the Hanford formation. Data indicate that sparsely vegetated, coarse-textured soils typical of much of the Hanford Site, including the 300 Area, may drain a significant portion of annual precipitation which may eventually reach the unconfined aquifer. However, soils with deep-rooted plants appear to be more effective in removing precipitation and significantly reducing recharge (Gee et al. 1989). The amount of recharge at a specific site depends on rainfall intensity and distribution, surface conditions, soil texture, and layering (Gee 1987).

A number of lysimeter studies have been conducted at the 300 and 200 Areas on the Hanford Site between 1971 and 1988. The 300 Area lysimeter data indicate that water is moving downward at a depth below the plant root zone, whereas some of the 200 Area data indicate that little to no natural recharge is occurring on the 200 Area plateau (Routson et al. 1988).

Estimates of recharge rates are 1 to 3 in./y for grass-covered soils (Kirkham and Gee 1984) and in one lysimeter, over 4 in./y (Gee et al. 1989). In contrast, no drainage occurred at a lysimeter at the same location with deep-rooted vegetation (Gee et al. 1989). Course-grained soils, shallow-rooted plants, and above-normal precipitation during the measurement period have enhanced recharge estimates at this location (Gee and Heller 1985).

2.2.4 Hydrology

Apart from the Columbia River and man-made impoundments, no surface water exists at 300-FF-1. Normal precipitation is insufficient to generate surface run-off, with the possible exception of paved areas. Small groundwater seeps are observed along the river embankment.

The free-flowing section of the Columbia River adjacent to the 300 Area ranges in width from 1,200 to 1,800 ft and has a maximum depth of 10 to 40 ft. Average annual flow is 120,000 ft^3/s with daily flows ranging from 36,000 to 550,000 ft^3/s. Peak flows occur during spring run-off periods. The discharge of this reach of the river is controlled mostly by Priest Rapids Dam. The McNary Dam, located downstream, also has some minimal influence.

Much of the bed of the Columbia River is heavily armored, with numerous cobbles and boulders lying on the surface of the substrata. Additional details on the hydrology of the Columbia River near the 300 Area will be provided in the 300-FF-5 work plan.

2.2.5 Meteorology

Climatological data for the Hanford Site are published in Stone et al. (1983). Meteorological measurements have been made at the Hanford Meteorology Station (HMS) (located between the 200 Areas in the central portion of the site) since 1945, and temperature and precipitation data from a nearby location are also available for the period from 1912 through 1943. Beginning in the late 1970's, automated monitoring stations were deployed at selected locations on the Hanford Site. As part of this program, a 30-ft instrumented tower was erected several hundred meters southwest of the 300 Area. In 1983, the 30-ft tower was replaced by a 200-ft instrumented tower. Wind direction, wind speed, and air temperatures are measured at three levels on the 200-ft tower. Data are transmitted from the tower to the HMS every 15 min for processing and storage.

2.2.5.1 Wind. Prevailing wind directions at the 300 Area are from the southwest and northwest (Figure 19). During the spring, summer, and fall, winds from the southwest occur most frequently. During the winter, winds with components from the northwest occur most frequently. The average annual wind speed is approximately 7.5 mi/h; monthly average wind speeds are lowest during the fall and highest in the spring. The highest wind speeds are

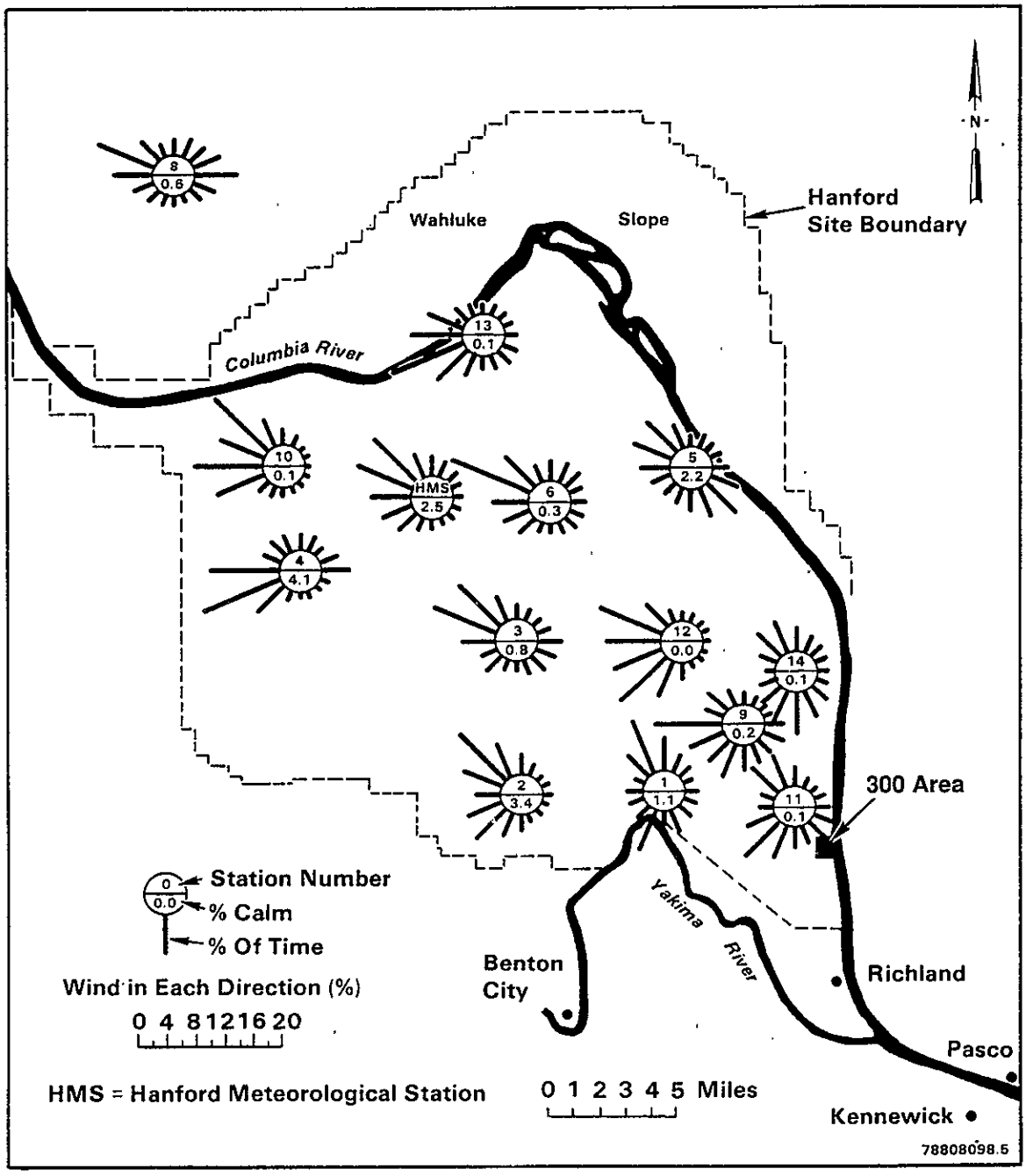


Figure 19. Wind Roses for the Hanford Telemetry Network (1979-1982).

usually associated with winds from the southwest. In the summer, high speed winds from the southwest are responsible for most of the dust storms in the region.

High winds are also associated with afternoon drainage winds and thunderstorms. The summertime drainage winds are generally northwesterly and frequently reach 31 mi/h. An average of 10 thunderstorms occur each year, usually during the summer, and the winds associated with them do not display a directional preference (DOE 1987).

2.2.5.2 Temperature and Humidity. Average monthly temperatures at the HMS range from a low of 24 °F in January to a high of 76 °F in July. The lowest recorded monthly average winter temperature is 21 °F, and the highest recorded monthly average winter temperature is 44 °F; both of these records were set during February. The highest recorded monthly average summer temperature is 82 °F, which occurred during July. The coolest summer month on record is June at 63 °F.

The annual average relative humidity at the HMS is 54%. Humidity is higher than the annual average during the winter (averaging about 75%), and lower than the annual average during the summer (averaging about 35%) (DOE 1987). Average relative humidities may be slightly higher in the 300 Area because of the proximity of the Columbia River and irrigated farm land.

2.2.5.3 Precipitation. The Hanford Site is located within a rain shadow formed by the Cascade Mountains to the west. The average annual precipitation at the HMS is 6.3 in. The total annual precipitation ranges (0.01 to 0.99 quantiles) from 3 to 11 in. Most of the precipitation takes place during the winter, with nearly half of the annual amount occurring from November through February.

Winter monthly average snowfall ranges from 0.3 in. in March to 5.3 in. in January. The record snowfall of 24 in. occurred in February 1916, but the second highest snowfall is less than half this amount.

Days with precipitation events greater than 0.50 in. of precipitation occur with a frequency of less than 1% during the year. Rainfall intensities of 0.50 in./h persisting for one hour are expected once every 10 yr. Rainfall intensities of 1 in./h for one hour are expected only once every 500 yr.

2.2.5.4 Evapotranspiration. The mean annual pan and lake evaporation values for the Tri-Cities region near the Hanford Site are approximately 55 in. and 40 in., respectively. Approximately 79% of annual evaporation occurs in the six month period from May to October (Weather Bureau 1966).

Mean annual potential evapotranspiration for the region has been estimated to be about 29 in. The actual evapotranspiration rate is estimated to be about 7 in. (Weather Bureau/Department of Agriculture 1962). The evapotranspiration rate for the 300 Area may be less, due to the porous soils and sparse vegetative cover.

2.2.6 Environmental Resources

The flora, fauna, sensitive environments and critical habitats, land use characteristics, and water use characteristics for the 300-FF-1 environment are discussed below. Additional details on the aquatic biology of the Columbia River near the 300 Area will be provided in the 300-FF-5 work plan.

2.2.6.1 Flora. The semiarid bench above the Columbia River, on which most of 300-FF-1 lies, has been subjected to various landscape manipulations as a result of 300 Area construction and operation activities. The natural vegetation consists mostly of a sparse covering of desert shrubs and drought-resistant grasses. The predominant vegetation type is the big sagebrush/cheatgrass/bluegrass community. Bitterbrush and rabbitbrush are also common shrubs (PNL 1987; DOE 1987). A narrow riparian zone, consisting of herbs interspersed with a few scattered deciduous shrubs and trees, exists along the Columbia River. Asparagus grows wild within the riparian zone and is known to be harvested for human consumption.

Table 5 includes the federal designated threatened flora species, the Thompson's sandwort, that could potentially occur in or near 300-FF-1. Two proposed threatened plants, Hoover's desert parsley and the Columbia milk-vetch, and a proposed endangered riparian species, persistent sepal yellowcress, are also included in the table.

2.2.6.2 Fauna. Predominant fauna of the sagebrush/grass community that could potentially reside in or near 300-FF-1 are the cottontail, jackrabbit, Great Basin pocket mouse, horned lark, and the western meadowlark. Mule deer, coyotes, and various species of raptors forage in this habitat type, and grasshoppers are the most conspicuous insects in the community (DOE 1987). Dominant riparian fauna include muskrat, porcupine, racoon, quail, pheasant, and waterfowl. Waterfowl have been known to seek refuge in the 300 Area process trenches (PNL 1987), and Great Basin Canada geese frequent the islands in the Columbia River, which are located near 300-FF-1.

The Columbia River provides a habitat for a wide diversity of fish. Important game species are chinook salmon, steelhead, coho salmon, sockeye salmon, smallmouth bass, largemouth bass, sturgeon, walleye, yellow perch, and channel catfish. The Hanford reach of the Columbia River sustains a spawning population of fall chinook salmon. Increases in this population over the years are responsible for attracting numerous bald eagles to the area in the fall and winter to feed on the dead salmon (DOE 1987).

Table 5 includes endangered and threatened fauna that could frequent the areas near 300-FF-1. These include the endangered American white pelican, peregrine falcon, threatened Townsend's big-eared bat, bald eagle, and ferruginous hawk. The proposed endangered Columbia River tiger beetle may also inhabit the riparian zone of this area.

Table 5. Endangered and Threatened Species[a] Potentially Associated with the 300 Area.

Species	Notes
Endangered Species	
American white pelican *Pelecanus erythrorhyncus*	Forages on the Hanford reach of the Columbia River in fall and winter.
Peregrine falcon *Falco peregrinus*	An erratic visitor.
Proposed Endangered Species	
Columbia River tiger beetle *Cincindela columbica*	Believed to inhabit the sandy shores of the Hanford reach of the Columbia River.
Persistent sepal yellowcress *Rorippa columbiae*	This plant inhabits the wetted shoreline of the Hanford reach of the Columbia River.
Threatened Species	
Townsend's big-eared bat *Plecotus townsendii*	Potential inhabitant of caves or abandoned buildings.
Bald eagle *Haliaeetus leucocephalus*	A regular winter visitor to the Hanford reach of the Columbia River.
Ferruginous hawk *Buteo regalis*	An occasional forager in sagebrush/grassland habitats on the Hanford Site.
Thompson's sandwort *Arenaria franklinii thompsonii*	Exists as *A. franklinii* on stabilized sand dunes on the Hanford Site; taxonomic status of the Hanford form is under evaluation.
Proposed Threatened Species	
Hoover's desert parsley *Lomativum tuberosum*	Columbia milk-vetch *Astragalus columbianus* A regional endemic plant.

Source: DOE (1987).
[a]Includes both federal and state designations.

2.2.6.3 Sensitive Environments and Critical Habitats. Because there are no 5 acre wetlands near 300-FF-1 (EPA 1987b), no sensitive environments, as defined by 40 CFR Part 300, Appendix A, Section 4.5 (EPA 1988d), exist. The Columbia River, however, could be regarded as an important environment with respect to this operable unit. The river's importance as a source of drinking and irrigation water in the region, as well as being a productive habitat for waterfowl, economically important fish species, and transitory endangered white pelicans and threatened bald eagles, could merit special concern for this environment during implementation of the remedial response. The Hanford reach is also the only stretch of the Columbia River within the United States that is not impounded by a dam (PNL 1988). The Hanford reach has also been designated a Class A (excellent) surface water by the State of Washington [WAC 173-201-080(20)]. This designation requires that water quality be maintained for domestic, industrial, and agricultural water supply, stock watering, fish migration, and fish and shellfish rearing, spawning, and harvesting, wildlife habitat, recreation (including primary contract), and commerce and navigation uses [WAC 173-201-045(2)(b)].

Information as to whether the proposed-endangered Columbia River tiger beetle and the persistent sepal yellowcress actually reside on the banks of the river, along and immediately downstream of the operable unit, is lacking. If one of these species does exist here, the shoreline along 300-FF-1 would be regarded as a critical habitat for that species.

2.2.6.4 Land Use. For reasons of national security, as well as to ensure public health and safety, access to the entire Hanford Site is administratively controlled and is expected to remain controlled for the foreseeable future. Access to most of the 300 Area is restricted even further (DOE 1987).

Land use in the area surrounding the Hanford Site consists primarily of irrigated and dry-land farming, livestock grazing, and urban and industrial development. Principal agricultural crops include hay, hops, wheat, potatoes, corn, other vegetables, apples, grapes, and other fruits. Most industrial activities in the area are associated with agriculture and energy production (DOE 1987). People, primarily onsite workers, are known to harvest the wild asparagus that inhabits the riparian zone adjacent to the operable unit.

2.2.6.5 Water Use. Water use at and near 300-FF-1 can be discussed in terms of surface water and groundwater uses.

2.2.6.5.1 Surface Water. The Hanford reach of the Columbia River is used for multiple purposes: drinking water, industrial process water, irrigation, fishing, hunting, boating, and swimming (DOE 1987; EPA 1987b). Downstream intakes from the river within 4 mi of the operable unit include the 300 Area process and drinking water intake, the Battelle Farm Operations irrigation water intake, the Tri-Cities University Center irrigation water intake, and the City of Richland drinking water intake, which is about 3 mi below the 300 Area. Up to 68,000 people could be supplied with drinking water from Richland's Columbia River source (EPA 1987b). Additional details on the uses of the Columbia River near the 300 Area will be provided in the 300-FF-5 work plan.

2.2.6.5.2 Groundwater. Groundwater in the immediate vicinity of the 300 Area is utilized by the Life Science Laboratory, located about 1,100 ft south of the 300-FF-1 boundary. The life science research activities entail the continuous use of one well to supply the fisheries laboratory, and the use of a well south of the facility to provide irrigation water during the growing season. In addition, an old reactor building in the 300 Area has a well that is sometimes used for fire protection.

There are several wells used for drinking or irrigation water within 4 mi of 300-FF-1. Fifteen such private wells are located on the east side of the Columbia River, across from the 300 Area; the Hanford Patrol Training Academy has a drinking water well 1.9 mi to the southwest; Battelle Farm Operations has an irrigation well 2 mi south of the operable unit; and the City of Richland operates a recharge system 4 mi south of 300-FF-1 that is comprised of 14 wells. Richland's recharge system supplements the river supply system and operates by pumping Columbia River water into unlined holding ponds, having the water infiltrate to the aquifer, then pumping the aquifer during periods of peak water demand (EPA 1987b; Stenner et al. 1988).

2.2.7 Human Resources

The demography, historical resources, and archeological resources of the 300 Area vicinity are discussed below.

2.2.7.1 Demography. Based on 1980 census data, 53,000 people live within 10 mi of the 300 Area (PNL 1987). There is only one residence within a 1 mi radius of 300-FF-1, approximately 0.9 mi east across the Columbia River. The City of Richland corporate boundary is about 1.2 mi to the south, and the nearest residences are about 3 mi from the operable unit (Stenner et al. 1988). In 1980, Richland had a population of 34,000 (DOE 1987). The working population in the 300 Area is approximately 3,000 (Stenner et al. 1988).

2.2.7.2 Historical Resources. No designated historical sites are known to exist in the vicinity of the 300 Area.

2.2.7.3 Archeological Resources. Archeological resources are known to be present in the vicinity of the 300 Area. Artifacts have been found on the land surface, and significant archeological sites could be buried beneath the ground surface.

3.0 INITIAL EVALUATION

3.1 KNOWN AND SUSPECTED CONTAMINATION

3.1.1 Sources

3.1.1.1 Types and Quantities. Estimated, nonradiological, chemical waste inventories are available for the south process pond, the north process pond, the 307 trenches, and the process trenches (DOE 1985; Stenner et al. 1988), and are presented in Tables 6, 7, 8, and 9, respectively. No radionuclide inventories are available for any of these facilities.

3.1.1.2 Waste Characteristics. With the large number and wide variety of waste types known to have been disposed in 300-FF-1, it becomes necessary to focus on those which are of primary importance from the standpoint of posing a potential threat to human health or the environment. Table 10 presents all the known waste constituents that were disposed in greater than kilogram quantities at 300-FF-1. Those constituents that are designated as hazardous substances pursuant to CERCLA are so indicated.

Table 11 indicates which of the 300-FF-1 hazardous substances are known or suspected to have exceeded the reportable quantities promulgated under CERCLA. The waste inventories presented in Section 3.1.1.1, the documented unplanned releases in Appendix A, and the knowledge of facility operations as recorded in Section 2.1.4 were consulted in the preparation of Table 11.

Reportable quantities have no direct regulatory significance in this situation; however, the comparison of waste inventory values to reportable quantities is used as a gross toxicity screening. This analysis indicates that concern should be focused on the following waste constituents at the 300-FF-1 operable unit:

- Chromium
- Copper
- Hydrofluoric acid
- Lead
- Nickel
- Nitric acid
- Sodium hydroxide
- Sodium nitrite
- Tetrachloroethylene
- Uranium
- Zinc.

These waste constituents can, in turn, be grouped by chemical characteristics.

Table 6. Estimated Nonradiological Chemical Waste Inventory for the South Process Pond.

Chemical	Quantity (kg)
Beryllium	40
Cadmium	80
Chromium	5,000
Copper	60,000
Fluoride	7,000
Lead	4,000
Mercury	60
Nickel	10,000
Nitrate	1,000,000
Nitrite	900,000
Nitric acid	1,000,000
Silver	1,000
Sodium	2,000,000
Sodium aluminate	2,000,000
Sodium hydroxide	1,000,000
Sodium silicate	100,000
Trichloroethylene	100,000
Uranium	40,000
Zinc	5,000
Total Volume of Liquids Disposed: 10,000,000,000 L	

Source: Stenner et al. (1988).

3.1.1.2.1 Metals. Chromium, copper, lead, nickel, uranium, and zinc all persist in the environment, as they are not subject to biodegradation or chemical decomposition. Metal mobility within the environment is highly dependent on the exact chemical form of the element, which in turn is dependent on environmental conditions. Because many metals bind ionically to soils or form insoluble precipitates, their environmental mobility is generally somewhat retarded.

Chromium, copper, lead, nickel, and zinc are known to display a tendency for bioaccumulation. Their bioconcentration factors for fish tissue range from 16 for chromium to 200 for copper (EPA 1986b).

3.1.1.2.2 Corrosives. Corrosive wastes of interest in 300-FF-1 are hydrofluoric acid, nitric acid, sodium hydroxide, and sodium nitrite. These compounds would not persist in the environment because they rapidly dissociate into their constituent ions once in contact with water. As a result, they are relatively mobile and have the ability to affect the pH of the environment.

Table 7. Estimated Nonradiological Chemical Waste Inventory for the North Process Pond.

Chemical	Quantity (kg)
Beryllium	30
Cadmium	60
Chromium	3,000
Copper	50,000
Fluoride	5,000
Lead	2,000
Mercury	40
Nickel	8,000
Nitrate	800,000
Nitrite	700,000
Nitric acid	900,000
Silver	900
Sodium	1,000,000
Sodium aluminate	2,000,000
Sodium hydroxide	800,000
Sodium silicate	90,000
Trichloroethylene	100,000
Uranium	30,000
Zinc	3,000
Total Volume of Liquids Disposed: 10,000,000,000 L	

Source: Stenner et al. (1988).

Table 8. Estimated Nonradiological Chemical Waste Inventory for the 307 Trenches.

Chemical	Quantity (kg)
Beryllium	10
Cadmium	20
Chromium	1,000
Copper	20,000
Fluoride	2,000
Lead	600
Mercury	10
Nickel	3,000
Silver	300
Uranium	10,000
Zinc	1,000
Total Volume of Liquids Disposed: 1,000,000,000 L	

Source: Stenner et al. (1988).

Table 9. Estimated Nonradiological Chemical Waste Inventory for the Process Trenches (Prior to Implementation of Administrative Controls on February 1, 1985).

Intermittent discharges		Larger discharges[a]	
<g	<kg		
Ammonium bifluoride	Benzene	Copper	~30 kg/mo[b]
Antimony	Carbon tetrachloride	Detergents	≤30 kg/mo[b]
Arsenic	Chromium	Ethylene glycol	≤200 L/mo
Barium	Chlorinated benzenes	Heating oil	~300 L[c]
Cadmium	Degreasing solvents	Hydrofluoric acid	~100 kg/mo
Dioxane	Formaldehyde	Nitrates	≤2,000 kg/mo[b]
Dioxin[d]	Formic acid	Nitric acid	≤300 L/mo
Hydrocyanic acid	Hexachlorophene	Paint solvents	≤100 L/mo
Pyridine	Kerosene	Tetrachloroethylene	~450 L[c]
Selenium and compounds	Lead	Photo chemicals	≤700 L/mo
Thiourea	Methyl ethyl ketone	Sodium chloride	~75 ton/yr[b]
Miscellaneous laboratory chemicals	Mercury	Sodium hydroxide	≤300 L/mo
	Naphthalene	Uranium	~20 kg/mo[b]
	Nickel		
	Phenol		
	Silver		
	Sulfuric acid		
	Tetrachloroethylene		
	Toluene		
	Tributylphosphate (paraffin hydrocarbon solvents)		
	1,1,1-trichloroethane		
	Trichloroethylene		
	Xylenes		

Source: DOE (1985).
[a]These discharges, except for the spills, were relatively continuous.
[b]These materials are still discharged.
[c]Known spills.
[d]Included only because of the potential for dioxin to exist as trace impurity in chlorinated benzenes.

Table 10. List of Known Waste Constituents Disposed in Greater Than Kilogram Quantities[a] in Operable Unit 300-FF-1. (sheet 1 of 2)

Waste constituent	Listed hazardous substance[b]
Chemical	
Aluminum	
Beryllium	X
Cadmium	X
Chromic acid	X
Chromium	X
Chromium trioxide	X
Copper	X
Copper sulfate	X
Detergents	
Ethylene glycol	
Fluoride	
Heating oil	
Hydrofluoric acid	X
Lead	X
Mercury	X
Nickel	X
Nitrate	
Nitrite	
Nitric acid	X
Oxalic acid	
Paint solvents	X[c]
Phosphoric acid	X
Potassium nitrite	
Silicon	
Silver	X
Sodium	
Sodium aluminate	
Sodium carbonate	
Sodium dichromate	X
Sodium fluorosilicate	
Sodium gluconate	
Sodium hydroxide	X
Sodium nitrate	
Sodium nitrite	X
Sodium pyrophosphate	
Sodium silicate	
Tetrachloroethylene	X
Trichloroethylene	X
Zinc	X
Zirconium	

Table 10. List of Known Waste Constituents Disposed in Greater Than Kilogram Quantities[a] in Operable Unit 300-FF-1. (sheet 2 of 2)

Waste constituent	Listed hazardous substance[b]
Radiological	
Cesium-137	X
Chromium-51	X
Cobalt-58	X
Cobalt-60	X
Iron-59	X
Plutonium isotopes	X
Scandium-46	X
Thorium-234	X
Uranium isotopes	X
Zinc-65	X
Zirconium/niobium isotopes	X

[a]Except for radionuclides.
[b]40 CFR Part 302.4 (EPA 1988a).
[c]Common components of paint solvents (e.g., methyl ethyl ketone, methyl isobutyl ketone, toluene, and xylenes are listed hazardous substances).

3.1.1.2.3 Volatile Halogenated Aliphatic Hydrocarbons. Tetrachloroethylene is a chlorinated, volatile organic compound which is heavier than, and only slightly soluble in, water. Because of its volatile nature, however, it can be very mobile. It has a bioconcentration factor for fish tissue of 31 (EPA 1986b).

With a half life that ranges from 1 to 30 d in water (EPA 1986b), tetrachloroethylene decomposes in the biologically active environment. Tetrachloroethylene is therefore less persistent than for example, metals. Degradation products from this process include other chlorinated compounds such as trichloroethylene, trans-1,2-dichloroethylene, and vinyl chloride.

3.1.1.2.4 Radionuclides. In addition to being a metal, uranium is radioactive. It is a high-energy alpha emitter with the major isotopes having half lives on the order of one billion years. Natural uranium consists of approximately 99.3% uranium-238, 0.7% uranium-235, and a very small portion of miscellaneous isotopes.

Table 11. Hazardous Substances Disposed in Greater Than Kilogram Quantities[a] in Operable Unit 300-FF-1.

Hazardous substance	RQ (lb/d)[b]	Known or suspected to have exceeded RQ[c]
Chemical		
Beryllium and compounds	1[d]	
Cadmium and compounds	1[d]	
Chromium and compounds	1[d]	X
Copper and compounds	1[d]	X
Hydrofluoric acid	100	X
Lead and compounds	1[d]	X
Mercury and compounds	1[d]	
Methyl ethyl ketone	5,000	
Methyl isobutyl ketone	5,000	
Nickel and compounds	1[d]	X
Nitric acid	1,000	X
Phosphoric acid	5,000	
Silver and compounds	1[d]	
Sodium hydroxide	1,000	X
Sodium nitrite	100	X
Tetrachloroethylene	1	X
Toluene	1,000	
Trichloroethylene	1,000	
Xylenes	1,000	
Zinc and compounds	1[d]	X
Radiological		
Chromium-51	1[e]	
Cobalt-58	1[e]	
Cobalt-60	1[e]	
Iron-59	1[e]	
Plutonium isotopes	1[e]	
Promethium-147	1[e]	
Scandium-46	1[e]	
Thorium-234	1[e]	
Uranium isotopes	1[e]	X
Zinc-65	1[e]	
Zirconium/niobium isotopes	1[e]	

[a]Except for radionuclides.
[b]RQ=reportable quantity per 40 CFR Part 302.4 (EPA 1988a).
[c]Based on waste volume inventories presented in Section 3.1.2 and unplanned release documentation in Appendix A.
[d]Reportable quantities have not been assigned by regulation to generic classes of hazardous substances; however, the statutory RQ for these generic classes is 1 lb/d [40 CFR Part 302.4 (EPA 1988a)].
[e]Reportable quantity for all radionuclides is 1 lb/d [40 CFR Part 302.4 (EPA 1988a)].

3.1.2 Soil

3.1.2.1 Background Soil Quality. Preliminary background soil quality information is available from five soil samples obtained from a vertical boring (S-7) near the south process pond (Dennison et al. 1989). Preliminary background concentrations determined from these samples are listed in Table 12. In addition to being restricted to a single location, the available background soil analyses are limited both in number and in analytical parameters. The high levels of uranium-235 found in borehole 5-7 show that it is not representative of the true background levels for this, and possibly other, contaminants. It is, however, the best background data available at this time. Additional background values reported for the process trenches (Zimmerman and Kossick 1987) were not included due to uncertainties in quality of the historical data used for this purpose.

In order to allow for preliminary comparisons with measured soil concentrations and identify parameters that significantly exceed the distributions of background concentrations, a statistical description of the background data was conducted. This description assumed the background data to be lognormally distributed. A lognormal distribution is the most commonly employed probability density model for the assessment of environmental contaminants (Gilbert 1987). The upper 95% confidence limits for the 0.95 and 0.99 quantiles of background concentrations for each detected parameter were calculated (Gilbert 1987). If any analysis resulted in a value less than the reported detection limit, a value of one half the detection limit was substituted for the statistical calculations (Gilbert 1987). While the false positive error rate is controlled at the 5% level for the calculations, the low number of sample results available (5) results in a rather high false negative error rate. However, the statistical description of the preliminary background data will be used only to determine the most elevated contaminants in an operable unit acknowledged to be highly contaminated.

3.1.2.2 Soil Contamination.

3.1.2.2.1 South and North Process Ponds. North process pond soil samples were obtained from one location in 1970, at depths of up to 4 ft below the bottom of the pond. Fifteen additional surface soil samples were obtained from the south process pond, at increasing distances from the pond inlet, in 1974.

A recent (1987) sampling program resulted in an extensive characterization of the south and north process pond soils. Soil samples were obtained from 14 excavations in and adjacent to the ponds. In each pond, six sampling locations were excavated with a bulldozer to a depth of approximately 15 ft. One additional sampling location was excavated to the same depth, adjacent to each pond. The location adjacent to the north pond was chosen to collect samples in a natural depression used to dispose of some of the soils dredged from the pond.

Table 12. Summary of Preliminary Background Soil Quality Data for Operable Unit 300-FF-1. (Sheet 1 of 3)

Parameters[a] detected	Units	Detection limit	Geometric mean	Geometric standard deviation	Upper 95% confidence limit for the 0.95 quantile	Upper 95% confidence limit for the 0.99 quantile	Detections / analyses
Gross alpha	pCi/g	6	4.62	1.81	56.2	140	2/5
Gross beta	pCi/g	3	21.3	1.14	37.0	45.2	5/5
Aluminum	mg/kg	15	9,690	1.27	26,500	38,300	5/5
Arsenic	mg/kg	0.5	2.66	1.87	37.1	97.2	5/5
Barium	mg/kg	0.6	93.0	1.36	339	545	5/5
Beryllium	mg/kg	0.5	0.37	1.69	3.4	7.6	2/5
Cadmium	mg/kg	0.2	0.24	2.57	12.8	54.6	3/5
Calcium	mg/kg	5	7,010	1.64	56,300	120,000	5/5
Chromium	mg/kg	1	9.73	1.15	17.5	21.7	5/5
Copper	mg/kg	1	17.6	1.42	77.0	132	5/5
Iron	mg/kg	5	27,300	1.18	54,800	70,700	5/5
Lead	mg/kg	0.5	4.99	1.24	12.3	17.2	5/5
Magnesium	mg/kg	5	6,090	1.23	14,600	20,000	5/5
Manganese	mg/kg	0.5	391	1.19	813	1,060	5/5
Nickel	mg/kg	1	7.53	1.17	14.6	18.6	5/5
Potassium	mg/kg	10	1,590	1.24	3,930	5,480	5/5
Sodium	mg/kg	10	287	1.66	2,420	5,290	5/5
Strontium	mg/kg	30	23.2	1.49	124	230	3/5
Vanadium	mg/kg	0.5	59.6	1.13	99.7	120	5/5
Zinc	mg/kg	0.5	49.5	1.21	110	148	5/5
Chloride	mg/kg	1	1.08	2.07	23.1	70.8	3/5
Fluoride	mg/kg	1	0.91	2.39	35.7	136	2/5
Nitrate	mg/kg	1	0.58	1.40	2.4	4.0	1/5
Sulfate	mg/kg	1	6.61	4.24	2,890	26,700	4/5
Cesium-137	pCi/g	0.5-0.6	0.08	3.40	13.8	90.9	3/3
Uranium-235b	pCi/g	0.3-0.5	1.1	23.0	*	*	2/3
Uranium-238	pCi/g	7	2.5	1.55	15.8	13.1	1/3

Source: Dennison et al. (1989).

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See footnotes on the following page.

Table 12. Summary of Preliminary Background Soil Quality Data for Operable Unit 300-FF-1. (sheet 2 of 3)

[a]The following parameters were analyzed for five times and never detected at standard SW-846 detection limits: Antimony: Mercury; Selenium; Silver; Thallium; Osmium; 1-acetyl-2-thiourea; 1-(o-chlorophenyl) thiourea; Diethylstilbesterol; Ethylenethiourea; 1-napthyl-2-thiourea; Nphenylthiourea; Thiourea; Arochlor 1016; Arochlor 1221; Arochlor 1232; Arochlor 1242; Arochlor 1248; Arochlor 1254; Arochlor 1260; Aldrin; Chlorobenzilate; Chlorodane; DDD; DDE; DDT; Dieldrin; Endosulfan I; Endosulfan II; Hepchlor epoxide Heptachlor; 1,1,1-trichloroethane; 1,1,2 trichloroethane; Chloroform; Hexone; Xylene-m; Methly ethyl ketone; Xyleneo,p; Perchloroethylene; Carbon tetrachloride; 1,1-dichloroethane; 1,2 dichloroethane; 1,1,2,2-tetrachloroethane; 1,1,1,2-tetrachloroethane; 1,2,3 trichloropropane; Acrolein; Acrylonitrile; Methylene chloride; Trichloroethylene; Benzene; Bis(chloromethly) ether; Bromoacetone; Bromoform; Carbon disulfide; Chlorobenzene; 2-chloroethyl vinyl ether; Chloromethyl methyl ether; Crotonaldehyde; 1,2-dibromo-3-chloropropane; 1,2-dibromoethane; Dibromomethane; 1,4-dichloro-2-butane; Dichlorodifluoromethane; 1,1 dichloroethylene; 1,2-dichloropropane; 1,3-dichloropropane; Diethylarsine; Dioxane; Ethyl methacrylate; Formalin; Hydrogen sulfide; Iodomethane; Methyl methacrylate; Methacrylonitrile; Methyl bromide; Methyl chloride; Methanethiol; N,n-diethylhydrazine; Pentachlorlethane; Pyridine; Toluene; Trans-1,1-dichlorodthene; Trichloromethanethiol; Trichloromonofluoromethane; Trichloropropane; Vinyl chloride; 1,2-dichlorobenzene; 1,2,3,4-tetrachloro benzene; 1,2,3,5-tetrachlorobenzene; 1,2,3-trichlorobenzene; 1,3 dichlorobenzene; 1,3,5-trichlorobenzene; 1,4-dichlorobenzene; Hexachlorophene; Hexachlorobenzene; Kerosene; Napthalene; Pentachlorobenzene; Phenol; 1,2,4,5-tetrachlorobenzene; Tributylphosphoric acid; 1,2,4 trichlorobenzene; Butylbenzylphthalate; Diethylphthalate; Bis(2 ethylhexyl)phthalate; 1-napthylamine; 2-napthylamine; 2,4-dichlorophenol; 2,4-dinitrophenol; 2,4,5-trichlorophenol; 2,4,6-trichlorophenol; 2,6 dichlorophenol; 2,6-dinitrotoluene; 2-acetylaminofluorene; Acetophenone; 5 aminomethyl)-3-isoazolol; 4-aminobyphenyl; Amitrole; Aniline; Aramite; Auramine; Dichloromethyl benzene; Benzidine; Benzenethoil; Benz[a]anthracene; Benzo[b]fluoranthene; Benzyl chloride; Benzo[j]fluoranthene; Benzo[a] pyrene; Bis(2-chloroethyl) ether; Bis(2-chloroethoxy) methane; Bis(2-chloroisopropyl) ether; 4-bromophenyl phenyl ether; 2-sec-butyl-4,6-dinitrophenol; Chloroalkyl ethers; P-chloroaniline; P-chloro-m-cresol; 1-chloro-2,3-epoxypropane; 2 chloronaphthalene; Chlornaphazine; 2-chlorophenol; Chrysene; Cresols; 2 cyclohexyl-4,6-dinitrophenol; Dibenzo[a,e]pyrene; Dibenz[a,h]acridine; Dibenz[a,h]anthracene; Dibenzo[a,h]pyrene; Dibenzo[a,i]pyrene; Dibenz[a,j]acridine; 7H-dibenzo[c,g]carbazole; Di-n-butyl phthalate; 3-3′ dichlorobenzidine; Dihydrosafrole; 7,12-dimentylbenz[a]anthracene; Pdimentylaminoazobenzene; 3,3′-dimethoxybenzidine; 3,3′-dimethylbenzidine; Alpha, alpha-dimethylphenethylamine; 2,4-dimethylphenol; Dimethyl phthalate; Dinitrobenzene; 4,6-dinitro-o-cresol and salts; 2,4-dinitrophenol; Di-n-octyl phthalate; Diphenylamine; 1,2-diphenylhydrazine; Di-n-propylnitrosamine; Ethyl methanesulfonate; Ethyleneimine; Fluoranthene; Hexachloropropane;

Table 12. Summary of Preliminary Background Soil Quality Data for Operable Unit 300-FF-1. (sheet 3 of 3)

Hexachlorobutadiene; Hexachloroethane; Indeno(1,2,3-cd)pyrene; Isosafrole; Maleic hydrizide; Malononitrile; Melphalan; 2-methyllactonitrile; 2 methylaziridine; 4,4'-methylenebis(2-chloroaniline); 3-methylcholanthrene; Methapyrilene; Methylthiouricil; Metholonyl; Methyl methanesulfonate; 2-methyl-2-(methylthio) propionaldehyde-; 1,4-naphthoquinone; Nicotinic acid; Nitrobenzine; 4-nitrophenol; P-nitroaniline; Nitrosopyrrolidine; 5-nitro-otoluidine; N-nitrosodi-n-butylamine; N-nitrosodiethanoamine; Nnitrosodiethylamine; N-nitrosodiomethylamine; N-nitrosomethylethylamine; Nnitrosomorpholine; N-nitrosonornicotine; N-nitrosopiperidine; N-nitroso-n methylurethane; N-nitrosomethylvinylanime; O-toluidine hydrochloroide; P benzoquinone; Pentachloronitrobenzene; Pentachlorophenol; Phenylenediamine; Phenacetin; Phthalic adic esters; 2-picoline; Pronamide; Reserpine; Resorcinol; Safrol; Strychnine; Sym-trinitrobenzene; 2,3,4,6 tetrachlorophenol; Thilfanox; Thiuram; Toluenediamine; ,0,0-triethyl phosphgorothioate; Tris(2,3-dibromoprophyl phosphate; Warfarin; Endrin; Methoxychlor; Toxaphene; Alpha-bhc; Beta-bhc; Delta-bhc; Gamma-bhc; Carbophenothion; Dimethoate; Disulfoton; Methyl parathion; Parathion; Tetraethylpyrophosphate; Total organic halide; Total organic carbon; Cyanide; Perchlorate; Sulfide; Phosphate; Ammonium; Ethylene Glycol; Coliform bacteria; Radium-226; Cobalt-60; Dioxin; Citrus Red #2; 1,1 dimethylhydrazine; 1,2-dimethylydrazine; Acetonitrile; Acrylamide; Allyl alcohol; Chloroacetaldehyde; Chloral; 3-chloropropionitrile; Cyanogen bromide; Cyanogen chloride; Cyanogen; Dichloropropanol; Ethyl carbamate; Ethyl cyanide; Ethylene oxide; Fluoroacetic acid; Glycidylaldehyde; Hydrazine; Isobutyl alcohol; Methylhydrazine; Paraldehyde; N-propylamine; 2 propyn-1-ol; 2,4,5-TP silvex; and 2,4-D; 2,4,5-T.

[b]Value calculated is meaninglessly high.

The sampling locations within each pond were chosen to assess changes in contamination between successive settling ponds with increasing distance from each pond inlet. An average of five samples were taken from each excavation, beginning at the pond surface down to a maximum depth of between 9.4 and 16.5 ft. Sample depths varied between holes in order to obtain samples from distinctive (disturbed or greenish color) horizons. Higher readings were noted for radiological scans of the greenish colored soils. Samples from less distinctive horizons were also collected. Many of the soils were covered or mixed with flyash.

Each of the analytical parameters detected in the pond soils during any of the three investigations described above is presented in Table 13. The table also indicates the maximum concentration encountered for each parameter, and whether or not this value exceeds the upper 95% confidence limits for the 0.95 and 0.99 quantiles for the corresponding background distributions. Any parameter found in excess of the upper 95% confidence limit for the 0.99 quantile can be regarded as a contaminant with a high degree of certainty.

Nearly all of the detected metals were found in concentrations highly elevated above background, where background soil concentrations are available for comparison. Two metals, antimony and thallium, were detected only once. Elevated gross alpha and gross beta indicate that radionuclides are present. Analyses for specific radionuclides indicated the presence of both uranium and cobalt-60 in highly elevated concentrations.

All of the anions detected were elevated to some extent. Organic compounds were generally detected less frequently. Polychlorinated biphenyls (PCB), specifically Arochlors 1248 and 1254, and methylene chloride were the only organic compounds detected in more than two samples.

In general, contaminant concentrations decreased with increasing distance from the pond inlets and with depth. For the most part, the depth of contaminant penetration was limited to within 3 to 4 ft of the pond surfaces. Contamination, in excess of background levels, was encountered as deep as 16.5 ft (the maximum depth sampled) near the north pond inlet.

3.1.2.2.2 307 Trenches. Limited information on soil contamination is available for the 307 trenches. The bulk of the contaminated soils were removed from 300-FF-1 when the trenches were retired in 1963. Contaminated soils from the south process pond were subsequently disposed of in the 307 trenches and covered with flyash from the 300 Area ash pits. The area is currently backfilled with clean soil.

A portion of the 307 trenches was recently excavated, thereby exposing visibly contaminated soils. Five samples of these soils were analyzed, and a summary of the results for the detected parameters is presented in Table 14.

Table 13. Summary of Soil Quality Data for the South and North Process Ponds. (sheet 1 of 3)

Parameters detected[d]	Units	Detection limit	Maximum value detected	Detections/ analyses
Gross alpha[c]	pCi/g	6	1,960	44/70
Gross beta[c]	pCi/g	3	2,140	70/70
Aluminum[c]	mg/kg	15	81,800	70/70
Antimony[c]	mg/kg	10	20.0	1/70
Arsenic[c]	mg/kg	0.5	148	70/70
Barium[c]	mg/kg	0.6	994	70/70
Beryllium	mg/kg	0.5	7.0	69/85
Cadmium[b]	mg/kg	0.2	13.0	76/85
Calcium	mg/kg	5	55,100	70/70
Chromium[c]	mg/kg	1	30,000	92/92
Copper[c]	mg/kg	1	87,000	95/95
Iron	mg/kg	5	44,400	74/74
Lead[c]	mg/kg	0.5	390	85/85
Magnesium	mg/kg	5	12,100	70/70
Manganese	mg/kg	0.5	746	70/70
Mercury[c]	mg/kg	0.1	16.0	45/85
Nickel[c]	mg/kg	1	3,100	85/85
Potassium	mg/kg	10	2,320	70/70
Selenium[c]	mg/kg	0.5	8.25	4/70
Silver[c]	mg/kg	1	349	34/85
Sodium[b]	mg/kg	10	2,940	70/70
Strontium[c]	mg/kg	30	410	32/70
Thallium[c]	mg/kg	0.5	2.8	1/70
Uranium[a]	mg/kg	100	23,000	22/25
Vanadium[b]	mg/kg	0.5	107	70/70
Zinc[c]	mg/kg	0.5	770	85/85
Zirconium[a]	mg/kg	<25,000	36,000	6/6
Chloride[c]	mg/kg	1	405	23/73
Fluoride[c]	mg/kg	1	200,000	65/88
Nitrate[c]	mg/kg	1	8,000	64/73
Phosphate[c]	mg/kg	2	8.3	3/70
Sulfate[b]	mg/kg	1	4,400	70/73
Arochlor 1248[c]	mg/kg	0.1	42.0	20/70
Arochlor 1254[c]	mg/kg	0.1	0.44	3/70
Butylbenzylphthalate[c]	mg/kg	1	1.8	2/70
Diethylphthalate[c]	mg/kg	1	2.1	1/70
Bis(2-ethylhexyl)phthalate[c]	mg/kg	1	1.1	1/70
Methylene chloride[c]	mg/kg	0.01	0.089	8/70
Trichloroethylene[c]	mg/kg	0.01	0.050	1/70

Table 13. Summary of Soil Quality Data for the South and North Process Ponds. (sheet 2 of 3)

Parameters detected[d]	Units	Detection limit	Maximum value detected	Detections/ analyses
Cesium-137	pCi/g	~0.5	1.72	22/27
Cobalt-60[c]	pCi/g	~0.2	87.7	13/27
Uranium-235	pCi/g	~0.3	114	20/27
Uranium-238[c]	pCi/g	~7	1,270	24/27

Source: Dennison, et al. (1989).

[a]No background data available.

[b]Maximum value detected exceeds the upper 95% confidence limit for the 0.95 background quantile.

[c]Maximum value detected exceeds the upper 95% confidence limit for the 0.99 background quantile.

[d]Note: The following parameters were analyzed for 70 times and never detected at standard SW-846 detection limits: Osmium; 1-acetyl-2-thiourea; 1-(ochlorophenyl) thiourea; Diethylstilbesterol; Ethylenethiourea; 1-napthyl-2-thiourea; N-phenylthiourea; Thiourea; Arochlor 1016; Arochlor 1221;Arochlor 1232; Arochlor 1242; Arochlor 1260; Aldrin; Chlorobenzilate; Chlorodane; DDD; DDE; DDT; Dieldrin; Endosulfan I; Endosulfan II; Hepchlor epoxide Heptachlor; 1,1,1-trichloroethane; 1,1,2-trichloroethane; Chloroform; Hexone; Xylene-m; Methly ethyl ketone; Xylene-o,p; Perchloroethylene; Carbon tetrachloride; 1,1-dichloroethane; 1,2-dichloroethane; 1,1,2,2-tetrachloroethane; 1,1,1,2-tetrachloroethane; 1,2,3-trichloropropane; Acrolein; Acrylonitrile; Benzene; Bis(chloromethly) ether; Bromoacetone; Bromoform; Carbon disulfide; Chlorobenzene; 2-chloroethyl vinyl ether; Chloromethyl methyl ether; Crotonaldehyde; 1,2-dibromo-3-chloropropane; 1,2-dibromoethane; Dibromomethane; 1,4-dichloro-2-butane; Dichlorodifluoromethane; 1,1-dichloroethylene; 1,2-dichloropropane; 1,3-dichloropropane; Diethylarsine; Dioxane; Ethyl methacrylate; Formalin; Hydrogen sulfide; Iodomethane; Methyl methacrylate; Methacrylonitrile; Methyl bromide; Methyl chloride; Methanethiol; N,n-diethylhydrazine; Pentachlorlethane; Pyridine; Toluene; Trans-1,1-dichlorodthene; Trichloromethanethiol; Trichloromonofluoromethane; Trichloropropane; Vinyl chloride; 1,2-dichlorobenzene; 1,2,3,4-tetrachloro benzene; 1,2,3,5-tetrachlorobenzene; 1,2,3-trichlorobenzene; 1,3-dichlorobenzene; 1,3,5-trichlorobenzene; 1,4-dichlorobenzene; Hexachlorophene; Hexachlorobenzene; Kerosene; Napthalene; Pentachlorobenzene; Phenol; 1,2,4,5-tetrachlorobenzene; Tributylphosphoric acid; 1,2,4-trichlorobenzene; 1-napthylamine; 2-napthylamine; 2,4-dichlorophenol; 2,4-dinitrophenol; 2,4,5-trichlorophenol; 2,4,6-trichlorophenol; 2,6 dichlorophenol; 2,6-dinitrotoluene; 2-acetylaminofluorene; Acetophenone; 5-aminomethyl)-3-isoazolol; 4-aminobyphenyl; Amitrole; Aniline; Aramite; Auramine; Dichloromethyl benzene; Benzidine; Benzenethoil; Benz[a]anthracene; Benzo[b]fluoranthene; Benzyl chloride; Benzo[j]fluoranthene; Benzo[a] pyrene; Bis(2-chloroethyl) ether; Bis(2-chloroethoxy) methane; Bis(2-chloroisopropyl) ether; 4-bromophenyl phenyl ether; 2-sec-butyl-4,6-dinitrophenol; Chloroalkyl ethers; P-chloroaniline; P-chloro-m-cresol; 1-chloro-2,3-epoxypropane; 2-chloronaphthalene; Chlornaphazine; 2-chlorophenol; Chrysene; Cresols;

Table 13. Summary of Soil Quality Data for the South and North Process Ponds. (sheet 3 of 3)

2-cyclohexyl-4,6-dinitrophenol; Dibenzo[a,e]pyrene; Dibenz[a,h]acridine; Dibenz[a,h]anthracene; Dibenzo[a,h]pyrene; Dibenzo[a,i]pyrene; Dibenz[a,j]acridine; 7H-dibenzo[c,g]carbazole; Di-n-butyl phthalate; 3-3'-dichlorobenzidine; Dihydrosafrole; 7,12-dimentylbenz[a]anthracene; Pdimentylaminoazobenzene; 3,3'-dimethoxybenzidine; 3,3'-dimethylbenzidine; Alpha, alpha-dimethylphenethylamine; 2,4-dimethylphenol; Dimethyl phthalate; Dinitrobenzene; 4,6-dinitro-o-cresol and salts; 2,4-dinitrophenol; Di-n-octyl phthalate; Diphenylamine; 1,2-diphenylhydrazine; Di-n-propylnitrosamine; Ethyl methanesulfonate; Ethyleneimine; Fluoranthene; Hexachloropropane; Hexachlorobutadiene; Hexachloroethane; Indeno(1,2,3-cd)pyrene; Isosafrole; Maleic hydrizide; Malononitrile; Melphalan; 2-methyllactonitrile; 2-methylaziridine; 4,4'-methylenebis(2-chloroaniline); 3-methylcholanthrene; Methapyrilene; Methylthiouricil; Metholonyl; Methyl methanesulfonate; 2-methyl-2-(methylthio) propionaldehyde-; 1,4-naphthoquinone; Nicotinic acid; Nitrobenzine; 4-nitrophenol; P-nitroaniline; Nitrosopyrrolidine; 5-nitro-otoluidine; N-nitrosodi-n-butylamine; N-nitrosodiethanoamine; N-nitrosodiethylamine; N-nitrosodiomethylamine; N-nitrosomethylethylamine; N-nitrosomorpholine; N-nitrosonornicotine; N-nitrosopiperidine; N-nitroso-N methylurethane; N-nitrosomethylvinylanime; O-toluidine hydrochloroide; P benzoquinone; Pentachloronitrobenzene; Pentachlorophenol; Phenylenediamine; Phenacetin; Phthalic adic esters; 2-picoline; Pronamide; Reserpine; Resorcinol; Safrol; Strychnine; Sym-trinitrobenzene; 2,3,4,6-tetrachlorophenol; Thilfanox; Thiuram; Toluenediamine; 0,0,0-triethyl phosphgorothioate; Tris(2,3-dibromoprophyl phosphate; Warfarin; Endrin; Methoxychlor; Toxaphene; Alpha-BHC; Beta-BHC; Delta-BHC; Gamma-BHC; Carbophenothion; Dimethoate; Disulfoton; Methyl parathion; Parathion; Tetraethylpyrophosphate; Total organic halide; Total organic carbon; Cyanide; Perchlorate; Sulfide; Ammonium; Ethylene Glycol; Coliform bacteria; Radium 226; Dioxin; Citrus Red #2; 1,1-dimethylhydrazine; 1,2-dimethylydrazine; Acetonitrile; Acrylamide.; Allyl alcohol; Chloroacetaldehyde; Chloral; 3-chloropropionitrile; Cyanogen bromide; Cyanogen chloride; Cyanogen; Dichloropropanol; Ethyl carbamate; Ethyl cyanide; Ethylene oxide; Fluoroacetic acid; Glycidylaldehyde; Hydrazine; Isobutyl alcohol; Methyl hydrazine; Paraldehyde; N-propylamine; 2-propyn-1-ol; 2,4,5-TP silvex; and 2,4-D; 2,4,5-T.

Table 14. Summary of Soil Quality Data for the 307 Process Trenches. (sheet 1 of 2)

Detection Parameters detected[c]	Maximum value Units	limit	Detections/ detected	analyses
Gross alpha[b]	pCi/g	6	234	4/5
Gross beta[b]	pCi/g	3	378	5/5
Aluminum[a]	mg/kg	15	26,700	5/5
Barium	mg/kg	0.6	133	5/5
Beryllium[b]	mg/kg	0.5	8	5/5
Cadmium	mg/kg	0.2	1	5/5
Calcium	mg/kg	5	33,200	5/5
Chromium[b]	mg/kg	1	259	5/5
Copper[b]	mg/kg	1	2,850	5/5
Iron	mg/kg	5	33,500	5/5
Magnesium	mg/kg	5	11,600	5/5
Manganese	mg/kg	0.5	396	5/5
Mercury[b]	mg/kg	0.1	2.77	5/5
Nickel[b]	mg/kg	1	221	5/5
Potassium	mg/kg	10	1,830	5/5
Silver[b]	mg/kg	1	18.0	3/5
Sodium	mg/kg	10	401	5/5
Strontium	mg/kg	30	67.0	2/5
Vanadium	mg/kg	0.5	73.0	5/5
Zinc	mg/kg	0.5	97.0	5/5
Chloride	mg/kg	1	1.1	1/5
Fluoride	mg/kg	1	2.0	4/5
Nitrate[b]	mg/kg	1	30.4	5/5
Sulfate	mg/kg	1	52.0	5/5
Arochlor 1248[b]	mg/kg	0.1	9.90	5/5

[a]Maximum value detected exceeds the upper 95% confidence limit for the 0.95 background quantile.

[b]Maximum value detected exceeds the upper 95% confidence limit for the 0.99 background quantile.

[c]Note: The following parameters were analyzed for five times and never detected at standard SW-846 detection limits: Antimony; Arsenic; Lead; Osmium; Selenium; Thallium; 1,1,1-trichloroethane;1,1,2-trichloroethane; Chlorofom; Hexone; Xylene-m; Methyl ethyl ketone; Methylene chloride; Xyleneo,p; Perchloroethylene; Carbon tetrachloride; trichloroethylene; 1,1-dichloroethane; 1,2-dichloroehtane; 1,1,2,2-tetrachloybethane; 1,1,1,2 tetrachloroethane; 1,2,3-trichloropropane; Acrolein; Acrylonitrile; Benzene; Bis(chloromethyl) ether; Bromoacetone; Bromogorm; Carbon disulfide; Chlorobenzene; 2-chloroethyl vinyl ether; Chloromethyl methyl ether; Crotonaldehyde; 1,2-dibromo-3-chloropropane; 1,2-dibromoethane; Dibromomethane; 1,4-dichloro-2-butane; Dichlorodifluoromethane; 1,1 dichloroethylene; 1,2-dichloropropane; 1,3-dichloropropane; Diethylarsine; Dioxane; Ethyl methacrylate; Formalin; Hydrogen sulfide; Iodomethane; Methyl

Table 14. Summary of Soil Quality Data for the 307 Process Trenches. (sheet 2 of 2)

methacrylate; Methacrylonitrile; Methyl bromide; Methyl chloride; Methanethiol; N,n-diethylhydrazine; Pentachlorlethane; Pyridine; Toluene; Trans-1,1-dichlorodthene; Trichloromethanethiol; Trichloromonofluoromethane; Trichloropropane; Vinyl chloride; 1,2-dichlorobenzene; 1,2,3,4-tetrachloro benzene; 1,2,3,5-tetrachlorobenzene; 1,2,3-trichlorobenzene; 1,3-dichlorobenzene; 1,3,5-trichlorobenzene; 1,4-dichlorobenzene; Hexachlorophene; Hexachlorobenzene; Kerosene; Napthalene; Pentachlorobenzene; Phenol; 1,2,4,5-tetrachlorobenzene; Tributylphosphoric acid; 1,2,4-trichlorobenzene; 1-napthylamine; 2-napthylamine; 2,4-dicclorophenol; 2,4-dinitrophenol; 2,4,5-trichlorophenol; 2,4,6-trichlorophenol; 2,6-dichlorophenol; 2,6-dinitrotoluene; 2-acetylaminofluorene; Acetophenone; 5-(aminomethyl)-3 isoazolol; 4-aminobyphenyl; Amitrole; Aniline; Aramite; Auramine; dichloromethyl benzene; Benzidine; Benzenethoil; Benz[a]anthracene; Benzo[b]fluoranthene; Benzyl chloride; Benzo[j]fluoranthene; Benzo[a] pyrene; Bis(2-chloroethyl) ether; Bis(2-chloroethoxy) methane; Bis(2-ethylhexyl) phthalate; Bis(2-chloroisopropyl) ether; 4-bromophenyl phenyl ether; Butyl benzyl phthalate; 2-sec-butyl-4,6-dinitrophenol; Chloroalkyl ethers; Pchloroaniline; P-chloro-m-cresol; 1-chloro-2,3-epoxypropane; 2-chloronapthalene; Chlornaphazine; 2-chlorophenol; Chrysene; Cresols; 2-cyclohexyl-4,6-dinitrophenol; Dibenzo[a,e]pyrene; Dibenz(a,h]acridine; Dibenz(a,h]anthracene; Dibenzo[a,h]pyrene; Dibenzo[a,i]pyrene; Dibenz(a,j)acridine; 7H-dibenzo[c,g]carbazole; Di-n-butyl phthalate; 3,3'-dichlorobenzidine; Diethyl phthalate; Dihydrosafrole; 7,12-dimentylbenz[a)anthracene; P-dimentylaminoazobenzene; 3,3'-dimethoxybenzidine; 3,31-dimethylbenzidine; Alpha, alpha-dimethylphenethylamine; 2,4-dimethylphenol; Dimethyl phthalate; Dinitrobenzene; 4,6-dinitro-o-cresol and salts; 2,4-dinitrophenol; Di-n-octyl phthalate; Diphenylamine; 1,2-diphenylhydrazine; Di-n-propylnitrosamine; Ethyl methanesulfonate; Ethyleneimine; Fluoranthene; Hexachloropropene; Hexachlorobutadiene; Hexachloroethane; Indeno(1,2,3-cd)pyrene; Isosafrole; Maleic hydrizide; Malononitrile; Melphalan; 2-methyllactonltrile; 2-methylaziridine; 4,4'-methylenebis(2-chloroaniline); 3-methylcholanthrene; Methapyrilene; Methylthiouricil; Metholonyl; Methyl methanesulfonate; 2-methyl-2-(methylthio) propionaldehyde-; 1,4-naphthoquinone; Nicotinic acid; Nitrobenzine; 4-nitrophenol; P-nitroaniline; Nitrosopyrrolidine; 5-nitro-o-toluidine; Nnitrosodi-n-butylamine; N-nitrosodiethanoamine; N-nitrosodiethylamine; Nnitrosodiomethylamine; N-nitrosomethylethylamine; N-nitrosomorpholine; Nnitrosonornicotine; N-nitrosopiperidine; N-nitroso-n-methylurethane; N-Nitrosomethylvinylanime; O-toluidine hydrochloroide; P benzoquinone; Pentachloronitrobenzene; Pentachlorophenol; Phenylenediamine; Phenacetin; Phthalic adic esters; 2-picoline; Pronamide; Reserpine; Resorcinol; Safrol; Strychnine; Sym-trinitrobenzene; 2,3,4,6-tetrachlorophenol; Thilfanox; Thiuram; Toluenediamine; 0,0,0-triethyl phosphgorothioate; Tris(2,3-dibromopropyl) phosphate; Warfarin; Arochlor 1016;.Arochlor 1221; Arochlor 1232; Arochlor 1242; Arochlor 1254; Arochlor 1260; Phosphate.

Total concentrations of several metals including aluminum, beryllium, chromium, copper, mercury, nickel, and silver were significantly elevated above background levels. Gross alpha and beta levels were also significantly elevated, indicating the presence of uranium and other radionuclides. Nitrate was the only anion detected at highly elevated concentrations, and the only organic compound detected was Arochlor 1248. All of these contaminants are also associated with the process pond sediments from which they were derived.

3.1.2.2.3 Process Trenches. A large number of soil samples from the process trenches have been analyzed for potential contaminants. The earliest sampling consisted of six composited samples obtained from the west trench. These samples were composited from three depths from the trench bottom: 0, 1, and 2 ft. These samples were analyzed for a complete range of metals, including many for which background characteristics are unknown.

A more extensive sampling program was implemented in 1986 (Zimmerman and Kossick 1987). Soil samples were obtained at 100-ft intervals along the bottom of each trench at three depths: 0, 0.3, and 1.5 ft. All of these samples were analyzed for screening parameters (metals, gross alpha and beta, total organic halogen, and total organic carbon). Seventeen samples were subjected to a more complete analytical characterization, and six surface samples were tested for extraction procedure toxicity.

Six exploratory borings were also drilled on 300-ft centers along the berm separating the process trenches during the 1986 investigation. Soil samples were taken from bailed cuttings at depth intervals of 5 ft to a maximum depth of 40 to 45 ft. The 45 samples thus obtained were analyzed for the screening parameters, and nine of the samples were subjected to the more complete characterization. A list of all analytical parameters which have ever been detected in the process trenches soils is presented in Table 15.

Several metals, including antimony, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc, were all detected at levels which are highly elevated above background. Other metals (e.g., uranium) probably also exist at highly elevated concentrations; however, background distributions for several such metals have not been established.

Extraction procedure toxicity results are shown in Table 16. These data suggest that many of the metals contained in the sediments are not highly mobile. They also indicate that the surface soils do not exceed criteria for dangerous waste designation.

Gross beta and lo alpha (lo alpha is apparently synonymous with gross alpha) are highly elevated, thus indicating the presence of radionuclides. Based on the estimated volumes of waste constituents discharged to the process trenches (see Table 9), uranium is known to be the dominant radionuclide present.

Table 15. Summary of Soil Quality Data for the Process Trenches (sheet 1 of 3).

Parameters detected[e]	Units	Detection limit	Maximum value detected	Detections/ analyses
Lo alpha[a,c,d]	pCi/g	NR	1,870	113/113
Gross beta[c]	pCi/g	NR	27,600	108/113
Aluminum	mg/kg	15	19,500	119/119
Antimony[c]	mg/kg	10	140	90/119
Arsenic[c]	mg/kg	0.5	221	29/32
Barium[b]	mg/kg	0.6	485	119/119
Beryllium[c]	mg/kg	0.5	6.0	42/119
Bismuth[a]	mg/kg	<28.9	37.2	6/6
Boron[a]	mg/kg	<43.8	100	6/6
Cadmium[c]	mg/kg	0.2	6,440	114/119
Calcium	mg/kg	5	17,600	118/119
Cerium[a]	mg/kg	<1,320	2,270	6/6
Chromium[c]	mg/kg	1	551	115/119
Cobalt[a]	mg/kg	<16.7	19.8	6/6
Copper[c]	mg/kg	1	8,470	119/119
Iron	mg/kg	5	36,400	119/119
Lanthanum[a]	mg/kg	<79.8	182	6/6
Lead[c]	mg/kg	0.5	486	119/119
Magnesium	mg/kg	5	5,800	51/119
Manganese[c]	mg/kg	0.5	6,740	118/119
Mercury[c]	mg/kg	0.1	825	72/119
Molybdenum[a]	mg/kg	<18.5	34.0	6/6
Nickel[c]	mg/kg	1	4,700	117/119
Phosphorus[a]	mg/kg	<1,250	3,080	6/6
Potassium	mg/kg	10	2,060	117/119
Selenium[c]	mg/kg	0.5	135	7/32
Silicon[a]	mg/kg	<244	385	6/6
Silver[c]	mg/kg	1	245	50/113
Sodium	mg/kg	10	1,440	119/119
Strontium[b]	mg/kg	30	175	30/119
Thallium[c]	mg/kg	1	7,460	3/26
Tin[a]	mg/kg	<283	375	6/6
Titanium[a]	mg/kg	<1,170	2,370	6/6
Tungsten[a]	mg/kg	<78.0	96.9	6/6
Uranium[a]	mg/kg	<2,740	4,210	6/6
Vanadium[c]	mg/kg	0.5	207	108/115
Zinc[c]	mg/kg	0.5	895	115/119
Zirconium[a]	mg/kg	<128	425	6/6
Ammonium[a]	mg/kg	0.5	570	13/26
Chloride[b]	mg/kg	1	25.2	18/31
Cyanide[a]	mg/kg	1	1.3	2/26
Fluoride	mg/kg	1	33.1	15/26
Nitrate[c]	mg/kg	1	467	14/26

Table 15. Summary of Soil Quality Data for the Process Trenches. (sheet 2 of 3)

Parameters detected[e]	Units	Detection limit	Maximum value detected	Detections/ analyses
Sulfate	mg/kg	1	66.3	23/26
Sulfide[a]	mg/kg	1	500	5/26
Benzo[a]pyrene[c]	mg/kg	1	25.0	1/26
Benzo[b]fluoranthene[c]	mg/kg	1	14.0	1/26
Butylbenzyphthalate[c]	mg/kg	1	3.3	1/26
Chrysene[c]	mg/kg	1	12.0	1/26
Trans-1,2-dichloroethylene[c]	mg/kg	0.01	0.04	1/26
Methylene chloride[c]	mg/kg	0.01	0.04	2/26
Tetrachloroethylene[c]	mg/kg	0.01	0.011	4/26
Toluene[c]	mg/kg	0.01	0.02	1/26
Meta-Xylene[c]	mg/kg	0.01	0.02	1/26
Ortho-and para-xylene[c]	mg/kg	0.01	0.03	1/26
Radium[a]	pCi/g	NR	11.4	26/26

Source: DOE (1985); Zimmerman and Kossick (1987).
NR = Not reported.
[a]No background data available.
[b]Maximum value detected exceeds the upper 95% confidence limit for the 0.95 background quantile.
[c]Maximum value detected exceeds the upper 95% confidence limit for the 0.99 background quantile.
[d]Lo alpha is apparently a synonym for gross alpha.
[e]Note: The following parameters were analyzed for 26 times and never detected at standard SW-846 detection limits: Osmium; 1,1,1-trichloroethane; 1,1,2 trichloroethane; Chloroform; Hexone; Methyl ethyl ketone; Carbon tetrachloride; Trichloroethylene; 1,1-dichloroethane; 1,2-dichloroehtane; 1,1,2,2-tetrachloroethane; 1,1,1,2-tetrachloroethane; 1,2,3-trichloropropane; Acrolein; Acrylonitrile; Benzene; Bis(chloromethyl) ether; Bromoacetone; Bromogorm; Carbon disulfide; Chlorobenzene; 2-chloroethyl vinyl ether; Chloromethyl methyl ether; Crotonaldehyde; 1,2-dibromo-3-chloropropane; 1,2-dibromoethane; Dibromomethane; 1,4-dichloro-2-butane; Dichlorodifluoromethane; 1,1-dichloroethylene; 1,2-dichloropropane; 1,3-dichloropropane; Diethylarsine; Dioxane; Ethyl methacrylate; Fomalin; Hydrogen sulfide; Iodomethane; Methyl methacrylate; Methacrylonitrile; Methyl bromide; Methyl chloride; Methanethiol; N,n-diethylhydrazine; Pentachlorlethane; Pyridine; trichloromethanethiol; Trichloromonofluoromethane; Trichloropropane; Vinyl chloride; 1,2-dichlorobenzene; 1,2,3,4-tetrachloro benzene; 1,2,3,5-tetrachlorobenzene; 1,2,3-trichlorobenzene; 1,3-dichlorobenzene; 1,3,5-trichlorobenzene; 1,4-dichlorobenzene; Hexachlorophene; Hexachlorobenzene; Kerosene; Napthalene; Pentachlorobenzene; Phenol; 1,2,4,5-tetrachlorobenzene; Tributylphosphoric acid; 1,2,4-trichlorobenzene; 1-napthylamine; 2-napthylamine; 2,4-dicclorophenol; 2,4-dinitrophenol; 2,4,5-trichlorophenol; 2,4,6-trichlorophenol; 2,6-dichlorophenol; 2,6-dinitrotoluene; 2-acetylaminofluorene; Acetophenone; 5-(aminomethyl)-3-isoazolol;

Table 15. Summary of Soil Quality Data for the Process Trenches. (sheet 3 of 3)

4-aminobyphenyl; Ainitrole; Aniline; Aramite; Auramine; dichloromethyl benzene; Benzidine; Benzenethoil; Benz[a]anthracene; Benzyl chloride; Benzo[j]fluoranthene; Bis(2-chloroethyl) ether; Bis(2-chloroethoxy) methane; Bis(2-ethylhexyl) phthalate; Bis(2-chloroisopropyl) ether; 4-bromophenyl phenyl ether; 2-sec-butyl-4,6-dinitrophenol; Chloroalkyl ethers; Pchloroaniline; P-chloro-m-cresol; 1-chloro-2,3-epoxypropane; 2-chloronapthalene; Chlornaphazine; 2-chlorophenol; Cresols; 2-cyclohexyl-4,6-dinitrophenol; Dibenzo[a,e)pyrene; Dibenz[a,h]acridine; Dibenz[a,h]anthracene; Dibenzo[a,h]pyrene; Dibenzo[a,i]pyrene; Dibenz[a,j)acridine; 7H-dibenzo(c,g)carbazole; Di-n-butyl phthalate; 3,31-dichlorobenzidine; Diethyl phthalate; Dihydrosafrole; 7,12-dimentylbenz[alanthracene; Pdimentylaminoazobenzene; 3,3′-dimethoxybenzidine; 3,31-dimethylbenzidine; Alpha, alpha-dimethylphenethylamine; 2,4-dimethylphenol; Dimethyl phthalate; Dinitrobenzene; 4,6-dinitro-o-cresol and salts; 2,4-dinitrophenol; Di-n-octyl phthalate; Diphenylamine; 1,2-diphenylhydrazine; Di-n-propylnitrosamine; Ethyl methanesulfonate; Ethyleneimine; Fluoranthene; Hexachloropropene; Hexachlorobutadiene; Hexachloroethane; Indeno(1,2,3-cd)pyrene; Isosafrole; Maleic hydrizide; Malononitrile; Melphalan; 2-methyllactonitrile; 2-methylaziridine; 4,41-methylenebis(2-chloroaniline); 3-methylcholanthrene; Methapyrilene; Methylthiouricil; Metholonyl; Methyl methanesulfonate; 2-methyl-2-(methylthio) propionaldehyde-; 1,4-naphthoquinone; Nicotinic acid; Nitrobenzine; 4-nitrophenol; P-nitroaniline; Nitrosopyrrolidine; 5-nitro-otoluidine; N-nitrosodi-n-butylamine; N-nitrosodiethanoamine; Nnitrosodiethylamine; N-nitrosodiompthylamine; N-nitrosomethylethylamine; Nnitrosomorpholine; N-nitrosonornicotine; N-nitrosopiperidine; N-nitroso-nmethylurethane; N-nitrosomethylvinylanime; O-toluidine hydrochloroide; P benzoquinone; Pentachloronitrobenzene; Pentachlorophenol; Phenylenediamine; Phenacetin; Phthalic adic esters; 2-picoline; Pronamide; Reserpine; Resorcinol; Safrol; Strychnine; Sym-trinitrobenzene; 2,3,4,6-tetrachlorophenol; Thilfanox; Thiuram; Toluenediamine; 0,0,0-triethyl phosphgorothioate; Tris(2,3-dibromopropyl) phosphate; Warfarin; Arochlor 1016; Arochlor 1221; Arochlor 1232; Arochlor 1242; Arochlor 1248; Arochlor 1254; Arochlor 1260; Aldrin; Chlorobenzilate; Chlorodane; DDD; DDE; DDT; Dieldrin; Endosulfan I; Endosulfan II; Hepchlor epoxide Heptachlor; Endrin; Methoxychlor; Toxaphene; Alpha-BHC; Beta-BHC; Delta-BHC; Gamma-BHC-, Carbophenothion; Dimethoate; Disulfoton; Methyl parathion; Parathion; Tetraethylpyrophosphate; Cyanide; Perchlorate; Ethylene Glycol; Coliform bacteria; Radium-226; Dioxin; Citrus Red #2; 1,1-dimethylhydrazine; 1,2-dimethylhydrazine; Acetonitrile; Acrylamide; Allyl alcohol; Chloroacetaldehyde; Chloral; 3-chloropropionitrile; Cyanogen bromide; Cyanogen chloride; Cyanogen; Dicholropropanol; Ethyl carbamate; ethyl cyanide; Ethylene oxide; Fluoroacetic acid; Glycidylaldehyde; Hydrazine; Isobutyl alcohol; Methyl hydrazine; Paraldehyde; N-propylamine; 2-propyn-1-ol; 2,4,5-TP silvex; and 2,4-D; 2,4,5-T.

Table 16. Extraction Procedure Toxicity Results for Process Trenches Soils.

	Regulatory criterion[a] (mg/L)	Mean (mg/L)	Upper 95% confidence limit (mg/L)
Arsenic	5.0	0.10	0.10
Barium	100	9.10	11.14
Cadmium	1.0	0.03	0.05
Chromium	5.0	0.02	0.04
Lead	5.0	0.21	0.32
Mercury	0.2	0.04	0.06
Selenium	1.0	0.13	0.13
Silver	5.0	0.01	0.01

Source: Zimmerman and Kossick (1987).
NOTE: One-half the detection limit was substituted for results reported as being below the detection limit, the sample size was six.
[a]WAC-173-303-100(d)

Of the detected nonmetallic ions, only nitrate and chloride were found in highly elevated amounts. Background concentrations have not been established for three of the detected nonmetallic ions: ammonium, cyanide, and sulfide.

Several organic compounds were identified within the soils; however, only two compounds--methylene chloride and tetrachloroethylene--were detected in more than one sample. Tetrachloroethylene is the only detected organic compound known to have been disposed in the trenches in greater than kilogram (pound) quantities.

A summary of the parameters detected in the deep borings is presented in Table 17. Beryllium and mercury are the only compounds identified at concentrations that are highly elevated above background conditions. Mercury, however, was detected in fewer than 5% of the deeper soil samples.

It is possible that the deeper soil samples are not representative of the actual vertical extent of soil contamination. These samples were obtained along a line offset from the trench bottoms by approximately 15 ft. Given the coarse-grained nature of the soils underlying the trenches, little lateral dispersion of contaminants by capillary diffusion would be expected.

Therefore, the maximum contamination within the deeper soils is expected to lie directly beneath the trenches. The results from the deep, offset borings do, however, indicate quite strongly the lateral extent of contamination is limited within the soil column.

Table 17. Summary of Vadose Zone Soil Quality Data for the Process Trenches.

Parameters detected	Units	Detection limit	Maximum concentration	Number of detections	Number of analyses
Aluminum	mg/kg	15	8,470	48	48
Arsenic	mg/kg	0.5	7.13	9	9
Barium	mg/kg	0.6	118	48	48
Beryllium[a]	mg/kg	0.5	4	14	48
Cadmium	mg/kg	0.2	9	48	48
Calcium	mg/kg	5	8,560	48	48
Chromium	mg/kg	1	10	48	48
Copper	mg/kg	1	37	48	48
Iron	mg/kg	5	2,740	48	48
Lead	mg/kg	0.5	5.99	48	48
Manganese	mg/kg	0.5	346	48	48
Mercury[b]	mg/kg	0.1	0.11	2	48
Nickel	mg/kg	1.0	8	48	48
Potassium	mg/kg	10	1,030	48	48
Sodium	mg/kg	10	747	48	48
Strontium	mg/kg	30	31	1	9
Vanadium	mg/kg	0.5	83	48	48
Zinc	mg/kg	0.5	50	48	48
Ammonium[c]	mg/kg	0.5	15	6	9
Chloride	mg/kg	1	10.6	7	9
Fluoride	mg/kg	1	2.02	7	9
Nitrate	mg/kg	1	1.56	2	9
Sulfate	mg/kg	1	21.2	3	9
Lo alpha[d]	pCi/g	NR	10.5	48	48
Gross beta	pCi/g	NR	24.5	48	48
Total radium[c]	pCi/g	NR	1.41	10	10
TOX[c]	mg/kg	1	7.2	28	48
TOC[c]	mg/kg	10	43.7	8	48
Coliform	mpn	3.0	110	4	9

Source: Zimmerman and Kossick (1987).
NOTE: NR = Not reported.
[a]Maximum value detected exceeds the upper 95% confidence limit for the 0.95 background quantile.
[b]Maximum value detected exceeds the upper 95% confidence limit for the 0.99 background quantile.
[c]No background data available.
[d]Lo alpha is apparently a synonym for gross alpha.

3.1.2.2.4 Burial Grounds. Three burial grounds are located within 300-FF-1: No. 4, No. 5, and the north process pond scraping disposal area. Burial grounds No. 4 and No. 5 are known only to contain materials that are contaminated with uranium (Stenner et al. 1988); no sampling has been reported for these two facilities.

The north process pond scraping disposal area was used to dispose of dredged soils from the north process pond, as well as flyash (Stenner et al. 1988). Soil contamination within this disposal area is known to be similar to that described previously for the north process pond, because samples have been taken in this area in conjunction with the north pond soil investigation discussed previously.

3.1.2.2.5 Retired Radioactive Sewer System. A leak from the retired radioactive sewer system was discovered in 1969. The leak occurred at a corroded pipe connection about 5 ft below ground surface. Grossly contaminated soil above and immediately in the vicinity of the leak was excavated and removed. Based upon the radionuclides present, the leak was determined to have existed for at least two years.

The leak from the radioactive waste sewer system was investigated in two stages. As part of an emergency assessment, two holes were dug in the vicinity of the leak: the first to a depth of 9 ft below the leak and the second to a depth of 11 ft below ground surface, 10 ft east of the leak. Samples from the first hole were analyzed for radionuclides. No radioactivity was detected within the second hole using a Geiger-Mueller (G-M) detector in the field.

Following the initial assessment of contamination, additional holes were drilled to between 15 and 20 ft in depth along a single radial line oriented in a southeast direction from the leak. These holes were located at distances of 5, 6.5, 10, and 15 ft from the leak. Samples were collected at 2-ft intervals below a depth of 6 ft and screened for radioactivity in the field.

Selected samples were sent to the laboratory for radionuclide analysis. The radionuclides detected and their maximum concentrations are summarized in Table 18. All of the detected radionuclides generally exhibited a significant decline in concentration below a depth of 15 to 20 ft. Promethium-147 was the principal radionuclide present, accounting for about 800 Ci of the estimated 900 Ci of total activity from all radionuclides detected. Over 90% of the total radionuclide contamination was estimated to exist above a depth of 25 ft and within a radius of 12 ft from the detected leak.

Table 18. Summary of Radionuclide Data in Soils for Radioactive Sewer Leak.

Parameter	Minimum detection limit (pCi/g)	Maximum value detected (pCi/g)	Number of detections	Number of analyses
^{241}Am	180	$5.4x10^4$	11	21
^{141}Ce	2	$2.4x10^3$	10	12
^{144}Ce	17	$1.9x10^6$	16	18
^{134}Cs	2	$3.6x10^4$	7	10
^{137}Cs	0.9	$1.6x10^6$	10	15
^{95}Nb	2	$1.5x10^4$	11	13
^{147}Pm	135	$3.8x10^7$	16	23
^{106}R	27	$9.5x10^5$	13	15
^{103}Ru	1	$6.8x10^3$	4	10
^{90}Sr	4,500	$2.9x10^5$	14	23
^{95}Zr	2	$1.5x10^4$	11	13

3.1.3 Groundwater

The following is a preliminary evaluation of the known nature and extent of contamination in groundwaters beneath 300-FF-1. A more extensive evaluation of the existing data will be contained within the 300-FF-5 (the 300 Area groundwater operable unit) work plan.

3.1.3.1 Background Groundwater Quality. Background characteristics for groundwater were based on measured concentrations within the 3-1-18 well cluster during the period of January 1985 to June 1988. Additional wells may also be suitable for assessment of background conditions; however, these data were not available for this analysis. The 3-1-18 well cluster is located to the north of 300-FF-1 (Figure 20).

The 3-1-18 well cluster includes three wells completed at three different depths. These completion depths correspond to the three aquifer zones beneath the 300 Area identified by Schalla et al. (1988): shallow, intermediate, and deep.

Shallow wells are completed within the upper unconfined aquifer, between a depth of about 40 to 80 ft below land surface. This zone corresponds to the highly permeable sands and gravels of the Hanford formation and the upper portion of the middle member of the Ringold Formation.

Intermediate wells are completed within the relatively less permeable lower portion of the middle member of the Ringold Formation, between a depthof about 110 to 120 ft. This lower zone is part of the unconfined aquifer but is locally semiconfined by thin silt lenses within the middle member of the Ringold Formation.

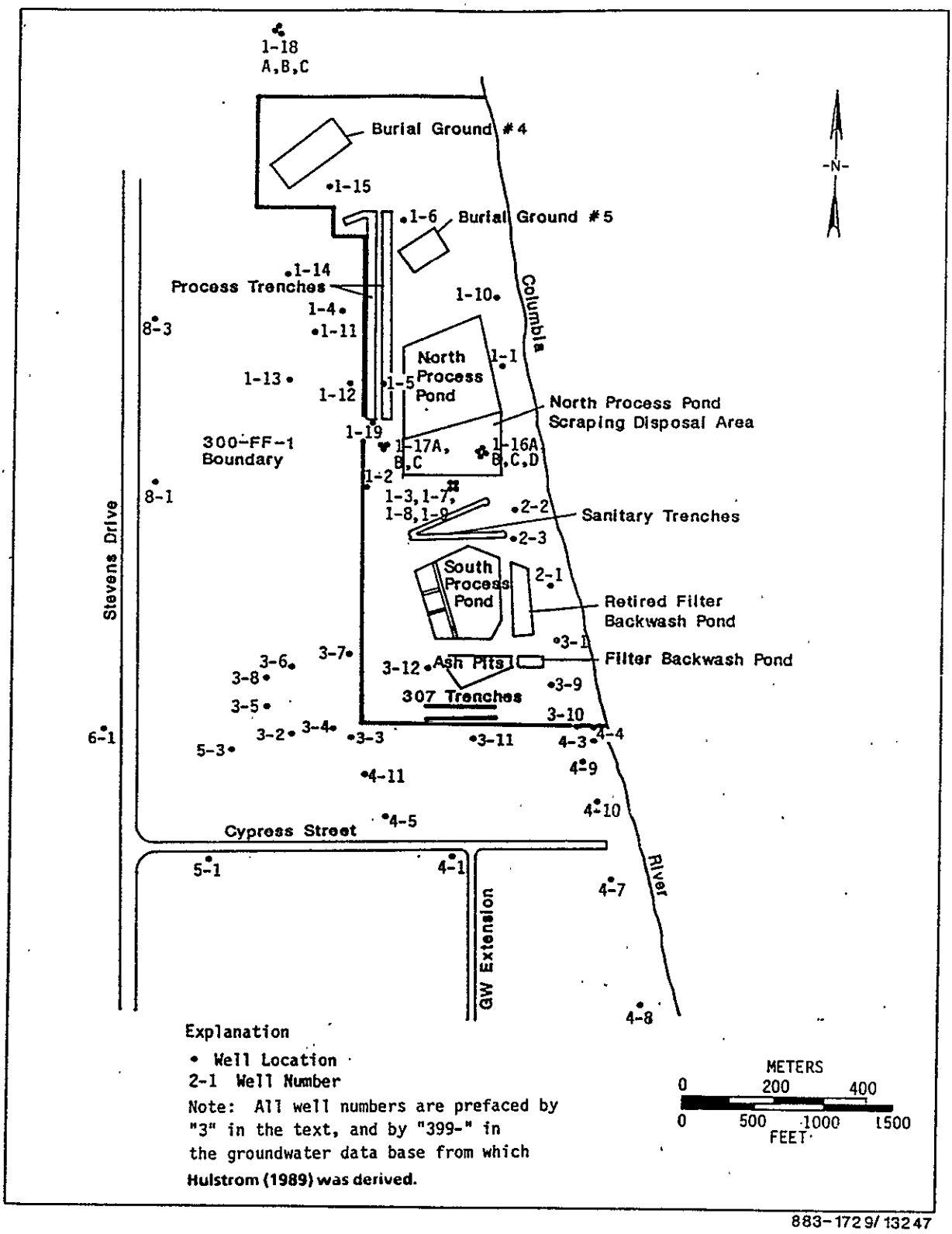

Figure 20. Well Locations for 300-FF-1 Operable Unit.

Deep wells are completed within the basal member of the Ringold Formation, usually between a depth of about 170 to 180 ft. However, basalt was encountered in deep well 3-1-18C at a depth of only about 140 ft. The basal member is associated with the uppermost confined aquifer under the 300 Area.

Backgroundwater quality data for the shallow, intermediate, and deep zones are summarized in Tables 19, 20, and 21, respectively. The same statistical description employed for background soils, as described in Section 3.1.2.1, is also employed for background groundwater.

3.1.3.2 Groundwater Contamination. Numerous monitoring wells are located within and adjacent to 300-FF-1. The location of these wells is shown in Figure 20. A summary of the completion characteristics of these wells is presented in Table 22. Data are available for all three of the principal aquifer zones identified in Chapter 3.1.3.1. Most of the wells, however, are completed within the shallow zone. Data for the intermediate and deep zones are available at four well clusters: 3-1-16A,B,C,D; 3-1-17A,B,C; 3-1-18A,B,C (preliminary background wells); and 3-1-3,7,8,9. Wells 3-4-5, 3-4-9, and 3-5-2 are also completed within the deep zone.

Groundwater quality data were obtained from three sources: Schalla et al. (1988), Hulstrom (1989), and Pacific Northwest Laboratory (PNL) (1988). Schalla et al. have summarized contaminant distributions for a couple of parameters in the groundwater, based on the results of RCRA monitoring. Hulstrom (1989) provides a complete range of measured groundwater parameters. That portion of the database downloaded for the development of this document is limited to selected wells, and provided data from January 1985 to June 1988. The data available from PNL (1988) provide information for a greater number of wells.

Comparison of the water quality data obtained from Hulstrom (1989) indicates that the maximum concentrations of some of the parameters identified in Tables 23, 24, and 25--for the shallow, intermediate, and deep groundwater zones, respectively--are highly elevated above preliminary background levels. The intermediate and deep groundwater zones have a different water chemistry than the shallow zone, with the bulk of the contamination being restricted to the shallow zone (Schalla et al. 1988).

The distributions of selected elevated parameters were evaluated to preliminarily determine the extent of groundwater contamination within the shallow zone, evaluate potential contaminant sources, and to identify contaminants of concern. The 300-FF-5 work plan will present a detailed evaluation of all existing groundwater data.

Table 19. Preliminary Background Water Quality for Shallow Groundwater at Operable Unit 300-FF-1. (sheet 1 of 2)

Parameters detected		Units	Minimum contract detection limit	Geometric mean	Geometric standard deviation	Upper 95% confidence limit for the 0.95 quantile	Upper 95% confidence limit for the 0.99 quantile	Detections/ analyses
Gross alpha		pCi/L	4	3.2	1.24	6.7	8.7	7/7
Gross beta		pCi/L	8	11.5	1.40	36.1	54.8	7/7
pH		std. units	0.1	7.61[a]	0.16[a]	7.07, 8.15[a]	6.87, 8.35[a]	7/7
Specific conductance		µmho/cm	1	425	1.08	552	608	7/7
Total organic carbon		µg/L	1,000	324	1.64	1,740	3,220	7/7
Total organic halogen		µg/L	20	5.8	----	-----	----	1/1
Arsenic	(total)	µg/L	5	3.3	1.60	16.3	29.3	2/7
	(filtered)	µg/L	5	3.8	1.69	22.6	43.4	3/7
Barium	(total)	µg/L	6	47.1	1.05	55.6	59.1	7/7
	(filtered)	µg/L	6	46.8	1.04	53.5	56.1	7/7
Calcium	(total)	µg/L	50	42,900	1.08	55,700	61,300	7/7
	(filtered)	µg/L	50	42,600	1.07	53,600	58,300	7/7
Carbon	(total)	µg/L	?	29,500	----	----	----	1/1
Chromium	(total)	µg/L	10	6	1.59	29	52	1/7
Iron	(total)	µg/L	50	64	2.21	949	2,540	5/7
	(filtered)	µg/L	50	30	1.57	139	244	1/7
Magnesium	(total)	µg/L	?	12,200	1.04	13,900	14,600	7/7
	(filtered)	µg/L	?	12,000	1.03	13,300	13,800	7/7
Potassium	(total)	µg/L	100	6,150	1.05	7,260	7,710	7/7
	(filtered)	µg/L	100	6,020	1.04	6,880	7,220	7/7
Sodium	(total)	µg/L	100	23,100	1.03	25,500	26,500	7/7
	(filtered)	µg/L	100	22,500	1.03	24,900	25,800	7/7
Strontium	(total)	µg/L	300	230	----	----	----	1/1
	(filtered)	µg/L	300	220	----	----	----	1/1
Uranium	(total)	µg/L	0.725	4.28	----	----	----	1/1
Vanadium	(total)	µg/L	5	12.3	1.16	20.4	24.5	7/7
	(filtered)	µg/L	5	11.6	1.18	20.4	25.0	7/7
Zinc	(total)	µg/L	5	2.9	1.48	11.0	17.9	1/7

Table 19. Preliminary Background Water Quality for Shallow Groundwater at Operable Unit 300-FF-1. (sheet 2 of 2)

Parameters detected	Units	Minimum contract detection limit	Geometric mean	Geometric standard deviation	Upper 95% confidence limit for the 0.95 quantile	Upper 95% confidence limit for the 0.99 quantile	Detections/ analyses
Ammonium	μg/L	50	29	1.42	96	148	1/7
Chloride	μg/L	500	19,400	1.13	29,400	34,200	7/7
Fluoride	μg/L	500	350	1.83	2,730	5,790	2/7
Nitrate	μg/L	500	21,500	1.04	24,600	25,800	7/7
Sulfate	μg/L	500	48,400	1.03	53,500	55,500	7/7
Methyl ethyl ketone	μg/L	10	7	2.29	117	328	1/7
Radium	pCi/L	1	0.08	2.05	0.92	2.24	7/7

Source: PNL (1988b) (well 3-1-18A).

[a]The arithmetic mean and standard deviation are presented for pH. The lower 95% confidence limits for the 0.05 and 0.1 quantiles, respectively, are also given in addition to those indicated.

Table 20. Preliminary Background Water Quality for Intermediate Depth Groundwater at Operable Unit 300-FF-1. (sheet 1 of 2)

Parameters detected		Units	Minimum contract detection limit	Geometric mean	Geometric standard deviation	Upper 95% confidence limit for the 0.95 quantile	Upper 95% confidence limit for the 0.99 quantile	Detections/ analyses
Gross beta		pCi/L	8	9.4	1.34	27.8	41.4	6/6
pH		std. units	0.1	7.62[a]	0.48[a]	5.84, 9.40[a]	5.19, 10.05[a]	6/6
Specific conductance		µmho/cm	1	356	1.09	503	551	6/6
Total organic carbon		µg/L	1,000	325	1.27	789	1,090	6/6
Total organic halogen		µg/L	20	0.6	--	--	--	1/1
Barium	(total)	µg/L	6	40.5	1.10	57.7	65.6	6/6
	(filtered)	µg/L	6	41.3	1.05	49.5	52.9	6/6
Calcium	(total)	µg/L	50	11,800	1.06	14,600	15,900	6/6
	(filtered)	µg/L	50	11,800	1.09	16,200	18,300	6/6
Carbon	(total)	µg/L	?	42,400	--	--	--	1/1
Chromium	(total)	µg/L	10	16	2.04	226	592	5/6
	(filtered)	µg/L	10	6	1.61	35	67	1/6
Iron	(total)	µg/L	50	243	1.31	662	954	6/6
	(filtered)	µg/L	50	161	1.08	214	238	6/6
Magnesium	(total)	µg/L	?	5,270	1.06	6,540	7,080	6/6
	(filtered)	µg/L	?	5,220	1.03	5,830	6,060	6/6
Maganese	(total)	µg/L	5	46.8	1.10	66.7	75.8	6/6
	(filtered)	µg/L	5	44.4	1.07	57.1	62.5	6/6
Nickel	(total)	µg/L	10	7	1.67	47	94	2/6
Potassium	(total)	µg/L	100	6,540	1.08	8,700	9,660	6/6
	(filtered)	µg/L	100	6,530	1.03	7,290	7,580	6/6
Sodium	(total)	µg/L	100	64,600	1.06	80,200	86,800	6/6
	(filtered)	µg/L	100	63,900	1.02	68,800	70,600	6/6
Strontium	(total)	µg/L	300	80	--	--	--	1/1
	(filtered)	µg/L	300	80	--	--	--	1/1

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Table 20. Preliminary Background Water Quality for Intermediate Depth Groundwater at Operable Unit 300-FF-1. (sheet 2 of 2)

Parameters detected		Units	Minimum contract detection limit	Geometric mean	Geometric standard deviation	Upper 95% confidence limit for the 0.95 quantile	Upper 95% confidence limit for he 0.99 quantile	Detections / analyses
Uranium	(total)	µg/L	0.725	0.043	--	--	--	1/1
Zinc	(total)	µg/L	5	6.3	2.10	98.9	270	4/6
	(filtered)	µg/L	5	3.9	1.99	50.1	127	2/6
Ammonium		µg/L	50	82	1.81	741	1,660	5/6
Chloride		µg/L	500	11,600	1.12	17,700	20,600	6/6
Fluoride		µg/L	500	1,540	1.27	3,740	5,170	6/6
Sulfate		µg/L	500	300	1.52	1,420	2,500	1/6
Methyl ethyl ketone		µg/L	10	6	1.80	53	118	1/6
Cesium-137		pCi/L	20	0.4	1.65	b	b	1/2
Cobalt-60		pCi/L	22.5	1.1	2.84	b	b	1/2
Radium		pCi/L	1	0.03	5.87	b	b	1/2
Strontium-90		pCi/L	5	0.4	1.59	b	b	1/2
Uranium		pCi/L	0.5	0.06	1.09	0.58	1.47	1/2

Source: PNL (1988b) (well 3-1-18B).

[a]The arithmetic mean and standard deviation are presented for pH. The lower 95% confidence limits for the 0.05 and 0.01 quantiles, respectively, are given in additon to those indicated.

[b]Value calculated is meaninglessly high.

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Table 21. Preliminary Background Water Quality for Deep Groundwater at Operable Unit 300-FF-1. (sheet 1 of 2)

Parameters detected		Units	Minimum contract detection limit	Geometric mean	Geometric standard deviation	Upper 95% confidence limit for the 0.95 quantile	Upper 95% confidence limit for the 0.99 quantile	Detections / analyses
Gross alpha		pCi/L	4	0.2	1.21	0.4	0.5	6/6
Gross beta		pCi/L	8	8.2	1.14	13.3	15.9	6/6
pH		std. units	0.1	7.85	0.39	6.40, 9.30[a]	5.87, 9.83[a]	6/6
Specific conductance		µmho/cm	1	361	1.12	550	641	6/6
Total coliforms		mpn/100 mL	2.2	1.72	2.98	98.9	434	1/6
Total organic carbon		µg/L	1,000	359	1.43	1,350	2,200	6/6
Total organic halogen		µg/L	20	6	--	--	1/1	
Barium	(total)	µg/L	6	67.3	1.05	80.7	86.2	6/6
	(filtered)	µg/L	6	67.3	1.06	83.5	90.4	6/6
Calcium	(total)	µg/L	50	12,100	1.08	16,100	17,900	6/6
	(filtered)	µg/L	50	12,200	1.10	17,400	19,800	
Carbon	(total)	µg/L	?	40,800	--	--	--	1/1
Chromium	(total)	µg/L	10	14	2.22	270	795	4/6
Iron	(total)	µg/L	50	154	1.27	374	517	6/6
	(filtered)	µg/L	50	89	1.18	164	206	6/6
Magnesium	(total)	µg/L	?	5,260	1.02	5,660	5,810	6/6
	(filtered)	µg/L	?	5,210	1.03	5,810	6,050	6/6
Maganese	(total)	µg/L	5	51.4	1.07	66.1	72.4	6/6
	(filtered)	µg/L	5	47.6	1.07	61.2	67.1	6/6
Nickel	(total)	µg/L	10	7	1.57	37	69	2/6
Potassium	(total)	µg/L	100	6,740	1.04	7,800	8,220	6/6
	(filtered)	µg/L	100	6,490	1.03	7,240	7,540	6/6
Sodium	(total)	µg/L	100	66,500	1.01	69,000	69,900	6/6
	(filtered)	µg/L	100	65,400	1.04	75,600	79,800	6/6

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Table 21. Preliminary Background Water Quality for Deep Groundwater at Operable Unit 300-FF-1. (sheet 2 of 2)

Parameters detected		Units	Minimum contract detection limit	Geometric mean	Geometric standard deviation	Upper 95% confidence limit for the 0.95 quantile	Upper 95% confidence limit for the 0.99 quantile	Detections / analyses
Strontium	(total)	µg/L	300	80	--	--	--	1/1
	(filtered)	µg/L	300	80	--	--	--	1/1
Uranium	(total)	µg/L	0.725	0.071	--	--	--	1/1
Zinc	(total)	µg/L	5	6.0	2.25	122	365	4/6
	(filtered)	µg/L	5	3.2	1.90	34.6	82.6	1/6
Ammonium		µg/L	50	114	1.31	311	448	6/6
Chloride		µg/L	500	11,700	1.12	17,800	20,800	6/6
Fluoride		µg/L	500	1,670	1.23	3,600	4,770	6/6
Sulfate		µg/L	500	1,840	1.25	4,210	5,700	6/6
Methyl ethyl ketone		µg/L	10	6	1.80	53	118	1/6
Hydrogen-3		pCi/L	500	2	9.36	b	b	2/2
Radium		pCi/L	1	0.1	2.28	2.1	6.5	6/6
Uranium		pCi/L	0.5	0.08	1.51	4,010	348,000	2/2

Source: PNL (1988b) (well 3-1-18C).

[a]The arithmetic mean and standard deviation are presented for pH. The lower 95% confidence limits for the 0.05 and 0.01 quantiles, respectively, are also given in addition to those indicated.

[b]Value calculated is meaninglessly high.

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Table 22. Well Completion Summary. (sheet 1 of 2)

Well number	Date installed	Drilled depth (ft)	Completion interval (ft)	Groundwater zone monitored	Depth to water[a] (ft)	Completion type
3-1-1[b]	11/48	77	20-75	S	42	Perforated steel casing
3-1-2[b]	4/50	101	25-75	S	45	Perforated steel casing
3-1-3[b]	4/50	102	25-70	S	37	Perforated steel casing
3-1-4[b]	5/50	101	23-70	S	42	Perforated steel casing
3-1-5[b]	2/75	45	23-45	S	35	Stainless steel wire wrap screen
3-1-6[b]	2/75	44	22-44	S	33	Stainless steel wire wrap screen
3-1-7[b]	3/85	75	25-75	S	37	Stainless steel wire wrap screen
3-1-8[b]	8/85	108	85-105	I	--	Stainless steel wire wrap screen
3-1-9[b]	2/87	181	170-180	D	42.9	Stainless steel wire wrap screen
3-1-10[b]	12/86	45	24.5-39.5	S	29	Stainless steel wire wrap screen
3-1-11[b]	11/86	47	27-47	S	37	Stainless steel wire wrap screen
3-1-12[b]	11/86	65	45-60	S	39.1	Stainless steel wire wrap screen
3-1-13[b]	11/86	56	38-53	S	43	Stainless steel wire wrap screen
3-1-14[b]	11/86	50	31-46	S	36.5	Stainless steel wire wrap screen
3-1-15[b]	11/86	48	29-44	S	33.3	Stainless steel wire wrap screen
3-1-16A[b]	12/86	48	32.5-47.5	S	37.3	Stainless steel wire wrap screen
3-1-16B[b]	2/87	118	105-115	I	37.9	Stainless steel wire wrap screen
3-1-16C[b]	1/87	178	167.5-177.5	D	39	Stainless steel wire wrap screen
3-1-16D[b]	1/87	180	106-116	I	40.5	Stainless steel wire wrap screen
3-1-17A[b]	11/86	41	25-40	S	31.9	Stainless steel wire wrap screen
3-1-17B[b]	12/86	115	100-110	I	32.9	Stainless steel wire wrap screen
3-1-17C[b]	1/87	173	161-171	D	33	Stainless steel wire wrap screen
3-1-18A[b]	11/86	63	39-54	S	44.2	Stainless steel wire wrap screen
3-1-18B[b]	1/87	125	108-118	I	45.5	Stainless steel wire wrap screen
3-1-18C[b]	1/87	153	130-140	D	42.8	Stainless steel wire wrap screen
3-1-19[b]	5/86	45	35-45	S	38.0	Stainless steel wire wrap screen
3-2-1[b]	11/48	77	18-75	S	40	Perforated steel casing
3-2-2[b]	10/76	65	35-55	S	39	Stainless steel wire wrap screen
3-2-3[b]	10/76	65	35-55	S	40	Stainless steel wire wrap screen
3-3-1[b]	10/48	74	20-65	S	43	Perforated steel casing
3-3-2	10/47	102	40-75	S	53	Perforated steel casing
3-3-3	1/48	175	52-81	S	52	Perforated steel casing

Table 22. Well Completion Summary. (sheet 2 of 2)

Well number	Date installed	Drilled depth (ft)	Completion interval (ft)	Groundwater zone monitored	Depth to water[a] (ft)	Completion type
3-3-4	5/51	40	--	--	--	Abandoned
3-3-5	5/51	40	--	--	--	Abandoned
3-3-6	8/43	85	42-55	S	48	?
3-3-7	1/44	86	45-60	S	63	?
3-3-8	3/70	48	28-48	S	43	Perforated steel casing
3-3-9	8/76	70	45-55	S	45	Stainless steel wire wrap screen
3-3-10[b]	9/76	67	34-49	S	40	Stainless steel wire wrap screen
3-3-11	9/76	72	47-70	S	47	Stainless steel wire wrap screen
3-3-12	9/80	65	35-49	S	46	Perforated steel casing
3-4-1	2/51	101	25-80	S	52	Perforated steel casing
3-4-2	5/51	42	--	--	--	Abandoned
3-4-3	4/58	100	--	--	--	Abandoned
3-4-4	5/58	40	--	--	--	Abandoned
3-4-5	8/58	196	110-195	I/D	50	Perforated steel casing
3-4-6	7/58	134	--	--	--	Abandoned
3-4-7	11/61	155	21-82	S	35	Perforated steel casing
3-4-8	10/71	72	35-53	S	41	Perforated steel casing
3-4-9	9/76	65	38-58	S	32	Stainless steel casing
3-4-10	9/76	60	37-50	S	33	Stainless steel casing
3-4-11	11/86	95	55-70	S	59.9	Stainless steel casing
3-5-1	2/51	102	23-95	S/I	52	Perforated steel casing
3-5-2	7/54	424	192-424	D	40	Perforated steel casing
3-5-3	5/51	36	--	--	--	Abandoned
3-6-1	5/50	101	25-62	S	42	Perforated steel casing
3-8-1	4/50	102	35-83	S	57	Perforated steel casing
3-8-2	5/50	119	43-106	S/I	53	Abandoned
3-8-3	3/51	102	25-99	S	50	Abandoned
3-8-4	9/79	65	42-60	S	45	Abandoned

Source: Schalla et al. (1988).
D = Deep.
I = Intermediate.
S = Shallow.
[a]Depth to water measured at the time of installation.
[b]Wells included in that portion of the Hanford Site groundwater database (PNL 1988b) made available for the preparation of this document.

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Table 23. Shallow Groundwater Quality in Operable Unit 300-FF-1. (sheet 1 of 2)

Parameters detected		Units	Minimum Contract Detection limit	Maximum value detected[c]	Detections/ analyses
Gross alpha[a]		pCi/L	4	208	317/324
Gross beta[a]		pCi/L	8	121	351/421
pH[a]		std. units	0.1	6.4, 8.5	405/412
Specific conductance		mho/cm	1	456	404/413
Total coliform[a]		mpn/100mL	2.2	43	161/319
Total organic carbon[a]		g/L	1,000	8,030	63/272
Total organic halogen[a]		µg/L	100	24,500	32/272
Aluminum	(total)[a]	µg/L	150	1,210	25/287
	(filtered)[a]	µg/L	150	700	2/173
Arsenic	(total)[a]	µg/L	5	17	8/287
Barium	(total)[a]	µg/L	6	719	323/323
	(filtered)[a]	µg/L	6	66	173/173
Cadmium	(total)[a]	µg/L	2	6.6	10/323
Carbon	(total)[b]	µg/L	?	25,700	15/15
Chromium	(total)[a]	µg/L	10	257	17/322
	(filtered)[a]	µg/L	10	21	1/173
Copper	(total)[a]	µg/L	10	516	148/287
	(filtered)[a]	µg/L	10	48	84/173
Iron	(total)[a]	µg/L	50	8,300	172/287
	(filtered)[a]	µg/L	50	4,870	18/173
Lead	(total)[a]	µg/L	5	173	35/356
	(filtered)[a]	µg/L	5	6.1	2/147
Magnesium	(total)	µg/L	?	11,800	160/160
	(filtered)	µg/L	?	13,200	173/173
Manganese	(total)[a]	µg/L	5	191	20/287
	(filtered)[a]	µg/L	5	53	10/173
Mercury	(total)[a]	µg/L	0.1	8.9	9/287
Nickel	(total)[a]	µg/L	10	95	8/287
	(filtered)[a]	µg/L	10	39	6/173
Potassium	(total)	µg/L	100	6,040	287/287
	(filtered)	µg/L	100	5,910	173/173
Silver	(total)[a]	µg/L	10	19	1/287
Sodium	(total)[a]	µg/L	100	29,700	287/287
	(filtered)[a]	µg/L	100	25,800	173/173
Strontium	(filtered)[a]	µg/L	300	310	1/23
Uranium	(total)[a]	µg/L	0.725	446	136/136
Vanadium	(total)[a]	µg/L	5	30	63/287
	(filtered)[a]	µg/L	5	11	29/173
Zinc	(total)[a]	µg/L	5	260	104/185
	(filtered)[a]	µg/L	5	47	44/173

Table 23. Shallow Groundwater Quality in Operable Unit 300-FF-1. (sheet 2 of 2)

Parameters detected	Units	Minimum Contract Detection limit	Maximum value detected[c]	Detections/ analyses
Ammonium[a]	µg/L	50	1,630	90/290
Chloride[a]	µg/L	500	122,000	385/386
Cyanide[a]	µg/L	10	11	1/283
Fluoride	µg/L	500	1,870	184/479
Nitrate[a]	µg/L	500	82,000	495/497
Phosphate[a]	µg/L	1,000	3,240	2/386
Sulphate	µg/L	500	47,900	386/386
Sulfide[a]	µg/L	1,000	3,000	4/269
Chloroform[a]	µg/L	10	42	340/402
Bis(2-Ethyl hexyl) phthalate[a]	µg/L	10	50	2/33
Methylene chloride[a]	µg/L	10	3,040	40/329
Methyl ethyl ketone	µg/L	10	18	4/417
Tetrachloroethylene[a]	µg/L	10	39	15/427
Cobalt-60[a]	pCi/L	22.5	64	5/142
Hydrogen-3[a]	pCi/L	500	6,480	34/131
Strontium-90[a]	pCi/L	5	5.6	2/22
Technetium-99[a]	pCi/L	15	55	5/9
Uranium[a]	pCi/L	0.5	120	172/174

Source: Hulstrom (1989).
[a]Maximum value detected exceeds the upper 95% confidence limit for the 0.95 background quantile.
[b]Only one background data point.
[c]Contaminant-specific ARARs are provided in Table 40.

3.1.3.2.1 Radionuclides. Radionuclides have previously been identified as contaminants within soils of 300-FF-1. The extent of radionuclide contamination within the groundwater is preliminarily evaluated by examining the distribution of uranium in the shallow aquifer zone.

A recent delineation of the plume of uranium contamination beneath the 300 Area is presented in Figure 21 (Schalla et al. 1988). The highest levels are found in those areas near the process trenches, particularly the south end of the trenches. The plume emanates from the trenches in a southeasterly direction, corresponding to the average local groundwater flow direction. The higher concentrations of uranium near the south end of the process trenches are consistent with generally higher soil concentrations of lo alpha towards the southern end of the trenches (Zimmerman and Kossick 1987).

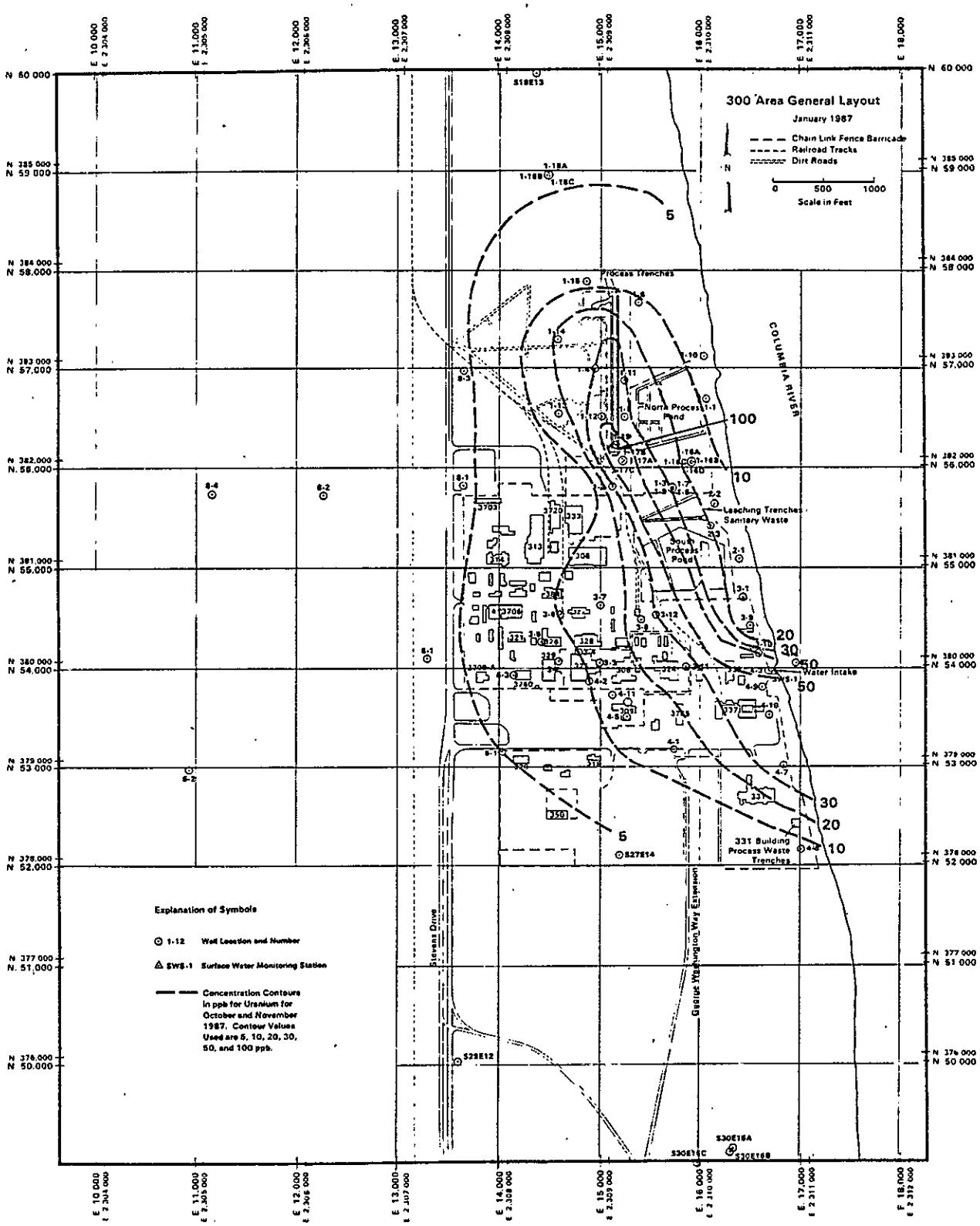

Figure 21. Uranium Distribution in the Shallow Portion of the Unconfined Aquifer in the 300 Area, October through November 1987 (Schalla et al. 1988).

Table 24. Intermediate Depth Groundwater Quality in Operable Unit 300-FF-1. (sheet 1 of 2)

Parameters detected		Units	Minimum Contract Detection limit	Maximum value detected[d]	Detections/ analyses
Gross alpha[b]		pCi/L	4	47.3	22/35
Gross beta[a]		pCi/L	8	29.9	29/35
pH		std. units	0.1	6.7, 8.3	38/39
Specific conductance		µmho/cm	1	370	38/39
Total coliform[b]		mpn	2.2	3	9/35
Total organic carbon[b]		µg/L	1,000	3,850	4/35
Total organic halogen[b]		µg/L	100	2,940	3/35
Aluminum	(total)[b]	µg/L	150	180	1/35
Cadmium	(total)[b]	µg/L	2	9	2/35
Calcium	(total)[b]	µg/L	50	24,300	26/26
	(filtered)[b]	µg/L	50	24,900	24/24
Carbon	(total)[c]	µg/L	?	40,700	3/3
Chromium	(total)	µg/L	10	19	7/35
Copper	(total)[b]	µg/L	10	42	8/35
	(filtered)[b]	µg/L	10	11	1/24
Barium	(total)[b]	µg/L	6	80	35/35
	(filtered)[b]	µg/L	6	69	24/24
Iron	(total)[b]	µg/L	50	1,130	21/35
	(filtered)[b]	µg/L	50	140	11/24
Lead	(total)[b]	µg/L	5	5.6	1/35
Magnesium	(total)[a]	µg/L	?	7,060	26/26
	(filtered)[b]	µg/L	?	7,220	24/24
Manganese	(total)[b]	µg/L	5	91	35/35
	(filtered)[b]	µg/L	5	96	24/24
Mercury	(total)[b]	µg/L	0.1	0.2	1/35
Nickel	(total)	µg/L	10	16	1/35
Potassium	(total)	µg/L	100	6,650	35/35
	(filtered)	µg/L	100	6,120	24/24
Sodium	(total)	µg/L	100	61,400	35/35
	(filtered)	µg/L	100	54,200	24/24
Uranium	(total)[c]	µg/L	0.725	24.8	2/2
Vanadium	(total)[b]	µg/L	5	8	1/35
	(filtered)[b]	µg/L	5	6	1/24
Zinc	(total)	µg/L	5	53	13/26
	(filtered)	µg/L	5	18	7/24
Ammonium		µg/L	50	595	22/35
Chloride[b]		µg/L	500	38,500	35/35
Fluoride		µg/L	500	1,770	25/35
Nitrate[b]		µg/L	500	17,600	22/35
Sulfate[b]		µg/L	500	18,900	35/35

Table 24. Intermediate Depth Groundwater Quality in Operable Unit 300-FF-1. (sheet 2 of 2)

Parameters detected	Units	Minimum Contract Detection limit	Maximum value detected[d]	Detections/ analyses
Chloroform[b]	µg/L	10	16	3/34
Trans-1,2-dichloroethylene[b]	µg/L	10	72	14/18
Methylene chloride[b]	µg/L	10	1,500	4/33
Methyl ethyl ketone	µg/L	10	23	1/39
Trichloroethylene[b]	µg/L	10	24	8/39
Strontium-90	pCi/L	5	5.3	1/4
Uranium[b]	pCi/L	0.5	30.9	4/9

Source: Hulstrom (1989).
[a]Maximum value detected exceeds the upper 95% confidence limit for the 0.95 background quantile.
[b]Maximum value detected exceeds the upper 95% confidence limit for the 0.99 background quantile.
[c]Only one background data point.
[d]Contaminant-specific ARARs are provided in Table 40.

Measurements of uranium within soils of the south and north process ponds indicated that uranium concentrations decreased rapidly with increasing distance from the pond inlets. Contaminants in particulate form would be expected to rapidly settle upon entering the waste disposal facilities. This settling should be particularly true for uranium because of its high density.

Figure 22 is a plot of the distribution of maximum uranium concentrations within the shallow groundwater zone during 1987. Plots of maximum annual values do not precisely delineate groundwater plumes; however, they do provide preliminary indications of contaminant extent. Such plots are routinely used in Hanford Site groundwater data presentations (see, for example, Evans et al. 1988). This less representative figure seems to indicate the possibility of a second source of groundwater contamination within the southern portion of the operable unit. Potential sources within this area are the 307 retention basins, or the leakage from the radioactive or process sewer pipelines. A documented spill from the radioactive sewer has been recorded in this area.

Other radiation parameters found in elevated levels beneath the operable unit include gross alpha, gross beta, and tritium. The amount of gross alpha contamination can be attributed to the uranium present (Schalla et al. 1988).

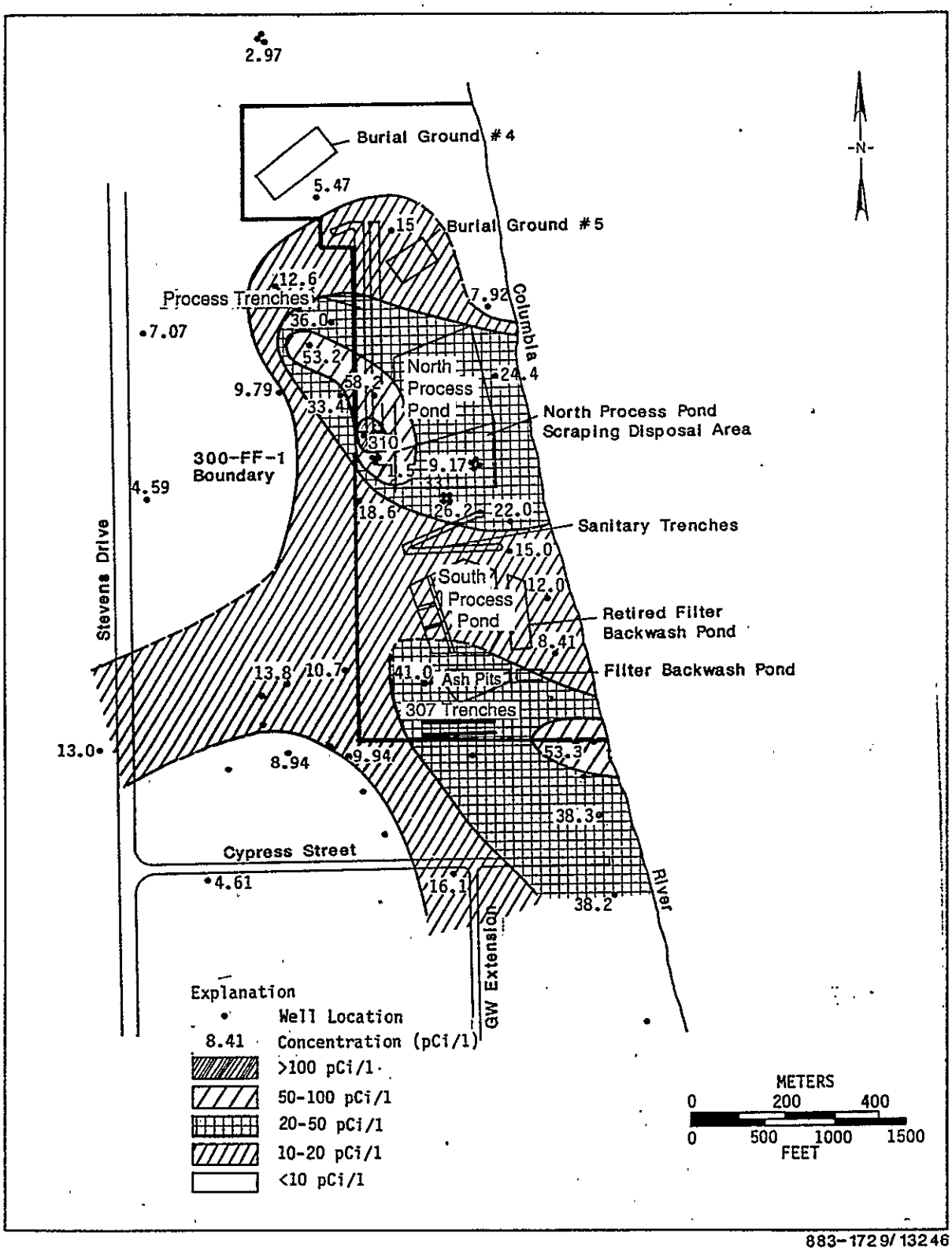

Figure 22. Maximum Uranium Concentrations in Shallow Groundwater (1985-1987).

Table 25. Deep Groundwater Quality in Operable Unit 300-FF-1.

Parameters detected		Units	Minimum Contract Detection limit	Maximum value detected[d]	Detections/ analyses
Gross alpha[b]		pCi/L	4	4.2	1/18
Gross beta[b]		pCi/L	8	54.7	14/18
pH		std. units	0.1	6.7, 8.3	21/21
Specific conductance		µmho/cm	1	517	21/21
Aluminum	(total)[b]	µg/L	150	540	3/18
Barium	(total)[b]	µg/L	6	129	17/18
	(filtered)[b]	µg/L	6	125	17/18
Calcium	(total)[b]	µg/L	50	21,200	17/18
	(filtered)[b]	µg/L	50	19,200	17/18
Chromium	(total)	µg/L	10	64	9/18
Iron	(total)[b]	µg/L	50	1,380	16/18
	(filtered)[b]	µg/L	50	560	12/18
Magnesium	(total)[b]	µg/L	?	7,860	17/18
	(filtered)[b]	µg/L	?	7,600	17/18
Manganese	(total)[b]	µg/L	5	90	17/18
	(filtered)[b]	µg/L	5	80	17/18
Nickel	(total)	µg/L	10	32	3/18
	(filtered)[b]	µg/L	10	11	1/18
Potassium	(total)[b]	µg/L	100	11,300	17/18
	(filtered)[b]	µg/L	100	11,100	17/18
Sodium	(total)	µg/L	100	68,300	17/18
	(filtered)	µg/L	100	71,400	17/18
Uranium	(total)[c]	µg/L	0.725	2.51	1/2
Zinc	(total)	µg/L	5	60.0	11/18
	(filtered)[a]	µg/L	5	41.0	3/18
Ammonium		µg/L	50	158	17/18
Chloride		µg/L	500	16,200	17/18
Fluoride		µg/L	500	2,080	17/18
Nitrate[b]		µg/L	500	1,800	4/18
Sulfate[b]		µg/L	500	12,000	10/18
Trans-1,2-dichloroethylene[b]		µg/L	10	20	1/8
Uranium		pCi/L	0.5	2.66	2/8

Source: Hulstrom (1989).

[a]Maximum value detected exceeds the upper 95% confidence limit for the 0.95 background quantile.

[b]Maximum value detected exceeds the upper 95% confidence limit for the 0.99 background quantile.

[c]Only one background data point.

[d]Contaminant-specific ARARs are provided in Table 40.

Minimum Contract Detection Limit not provided in the database.

3.1.3.2.2 Volatile Halogenated Aliphatic Hydrocarbons. Only a few organic compounds have been detected within the groundwater under 300-FF-1. Specific compounds identified are methylene chloride, tetrachloroethylene, trichloroethylene, trans-1,2-dichloroethylene, and chloroform. Chloroform is apparently derived from the chlorinated water disposed in the process trenches. Given the presence of chloroform, other trihalomethanes, formed as a result of the chlorination process, could also be present. The remaining compounds are all chlorinated solvents known to have been used within the 300 Area. Analyses have also detected total organic carbon (TOC) and total organic halogen (TOX) at elevated levels.

Analyses for organic compounds in groundwater are summarized in Table 26. Methylene chloride is found more frequently and in higher concentrations (up to 1,650 µg/l) than the other chlorinated solvents. Methylene chloride, tetrachloroethylene, TOC, and TOX are usually detected at elevated concentrations at the same location, though not during every sampling round. With the exception of intermediate well 3-1-8, these compounds are also only detected in the shallow wells.

The chloroform plume for the 300 Area is presented in Figure 23 (Schalla t al. 1988). Maximum concentrations for chloroform generally range between 20 and 40 µg/l. As is apparent from the plume, the distribution of this contaminant is directly related to the process trenches.

The distribution of maximum detected concentrations of methylene chloride in shallow groundwater is shown in Figure 24. Elevated concentrations are generally found in the vicinity of the process trenches, suggesting this facility as a possible source. Both methylene chloride and tetrachloroethylene have been detected in process trenches soils. Elevated concentrations are also observed in the southern portions of 300-FF-1, but not in the central portion. The source of methylene chloride in the southern wells is not readily identifiable based on the limited data available, but could possibly be related to discharges of cleaning solvents from the sanitary trenches. Some Hanford Site scientists question the validity of the methylene chloride data, attributing them to sampling or laboratory contamination (Schalla et al. 1988).

Referring again to Table 26, it can be seen that trichloroethylene and trans-1,2-dichloroethylene occur at entirely separate locations than do the other detected organic parameters. Both of these compounds occur only in the intermediate and deep wells downgradient of the process trenches and north process pond. With the exception of the deep well (3-1-16C), these parameters have been consistently detected at these locations. The existence of these parameters only at depth indicates that these compounds were probably the result of a previous and significant solvent spill. These compounds may have migrated to the unconfined aquifer base as a separate, dense, nonaqueous phase liquid (DNAPL). A release of approximately 260 lb of tetrachloroethylene to the process sewer has been documented. As both trichloroethylene and trans-1,2-dichloroethylene are degradation products of tetrachloroethylene, this spill and others like it could account for the observed concentrations at depth. The extent of contamination within the

Table 26. Summary of Chlorinated Organic Parameters Detected in Groundwater Within the 300-FF-1 Operable Unit. (sheet 1 of 2)

Well number	Completion interval (ft)	Methylene chloride		Tetrachloroethylene		Trichloroethylene		trans-1,2 dichloroethylene		Total organic carbon		Total organic halogen	
		Maximum[a]	D/A[b]	Maximum[a]	D/A[b]	Maximum[a]	D/A[b]	Maximum[a]	D/A[b]	Maximum[a]	D/A[b]	Maximum[a]	D/A[b]
3-1-1	20-75	630	5/21	<10	0/37	<10	0/37	<10	0/1	3,140	6/31	421	4/30
3-1-2	25-75	860	4/18	13	2/37	<10	0/37	<10	0/1	3,340	6/31	24,500	3/30
3-1-3	25-70	280	2/12	14	1/23	<10	0/23	--	--	4,320	5/22	119	1/22
3-1-4	23-70	3,040	4/15	<10	0/26	<10	0/26	<10	0/1	2,190	10/25	4,470	3/24
3-1-5	23-45	1,600	8/25	19	6/30	<10	0/30	<10	0/15	8,030	13/28	2,310	2/28
3-1-6	22-44	1,150	5/19	<10	0/27	<10	0/27	<10	0/1	1,480	7/25	1,620	3/24
3-1-7	25-75	1,650	4/17	39	3/25	<10	0/25	<10	0/3	4,670	6/24	2,210	3/23
3-1-8	85-105	1,500	4/17	<10	0/23	<10	0/23	<10	0/2	3,850	4/22	2,940	2/21
3-1-9	170-180	<10	0/7	<10	0/7	<10	0/7	<10	0/1	<1,000	0/6	<100	0/5
3-1-10	24.5-39.5	<10	0/8	<10	0/8	<10	0/8	<10	0/1	<1,000	0/7	<100	0/6
3-1-11	27-47	18	1/44	<10	0/44	<10	0/44	<10	0/1	1,180	1/7	<100	0/6
3-1-12	45-60	<10	0/8	<10	0/8	<10	0/8	<10	0/1	<1,000	0/7	<100	0/6
3-1-13	38-53	<10	0/12	<10	0/12	<10	0/12	<10	0/2	<1,000	0/6	<100	0/6
3-1-14	31-46	500	2/8	<10	0/8	<10	0/8	<10	0/1	<1,000	0/7	513	1/6
3-1-15	29-44	47	1/8	<10	0/8	<10	0/8	<10	0/1	<1,000	0/7	<100	0/6
3-1-16A	32.5-47.5	<10	0/11	<10	0/11	<10	0/11	<10	0/6	<1,000	0/6	<100	0/5
3-1-16B	105-115	<10	0/8	<10	0/8	24.1	8/8	72	8/8	<1,000	0/6	<100	0/5
3-1-16C	167.5-177.5	<10	0/8	<10	0/8	<10	0/8	20	1/8	<1,000	0/6	<100	0/5
3-1-16D	106-116	<10	0/1	<10	0/1	<10	0/1	<10	0/1	<1,000	0/1	<100	0/1

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Table 26. Summary of Chlorinated Organic Parameters Detected in Groundwater Within the 300-FF-1 Operable Unit. (sheet 2 of 2)

Well number	Completion interval (ft)	Methylene chloride		Tetrachloroethylene		Trichloroethylene		trans-1,2 dichloroethylene		Total organic carbon		Total organic halogen	
		Maximum[a]	D/A[b]	Maximum[a]	D/A[b]	Maximum[a]	D/A[b]	Maximum[a]	D/A[b]	Maximum[a]	D/A[b]	Maximum[a]	D/A[b]
3-1-17A	25-40	<10	0/45	<10	0/45	<10	0/45	<10	0/4	1,090	1/7	<100	0/1
3-1-17B	100-110	<10	0/7	<10	0/7	<10	0/7	31	6/7	<1,000	0/6	<100	0/5
3-1-17C	161-171	<10	0/7	<10	0/7	<10	0/7	<10	0/3	<1,000	0/6	<100	0/5
3-1-18A	39-54	<10	0/7	<10	0/7	<10	0/7	<10	0/1	<1,000	0/7	<100	0/6
3-1-18B	108-118	<10	0/6	<10	0/6	<10	0/6	<10	0/1	<1,000	0/6	<100	0/5
3-1-18C	130-140	<10	0/6	<10	0/6	<10	0/6	<10	0/1	<1,000	0/6	<100	0/5
3-1-19	35-45	<10	0/42	<10	0/42	<10	0/42	<10	0/15	1,650	2/6	<100	0/5
3-2-1	55-70	750	4/16	18	1/26	<10	0/26	<10	0/1	5,460	6/25	1,030	2/24

Source: PNL (1988b).

Note: See Table 22 for the groundwater zone monitored in each well.

[a]Maximum detected concentration in µg/L.

[b]Number of detections/number of analyses.

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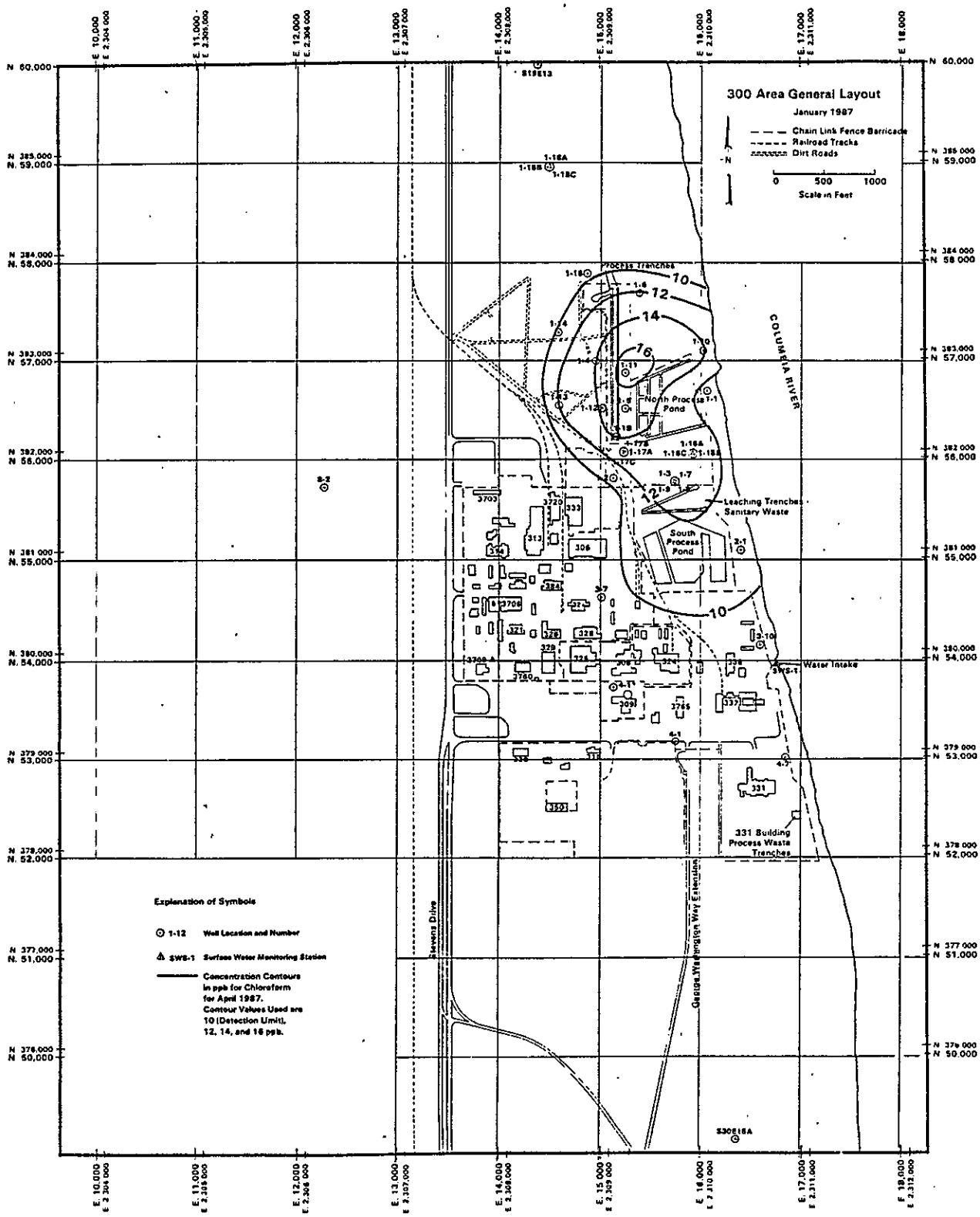
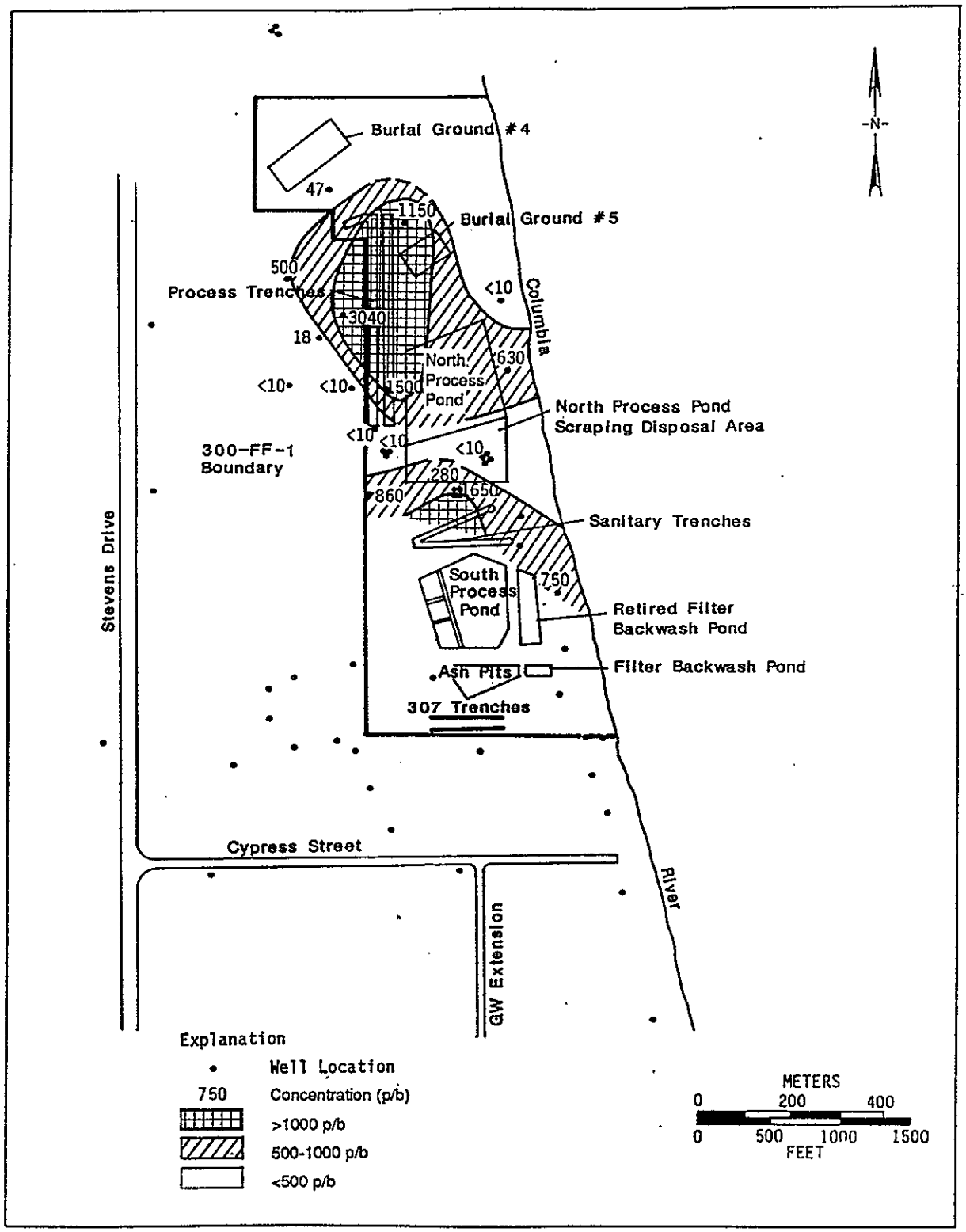


Figure 23. Concentration Contours for Chloroform in Shallow Groundwater for April 1987 (Schalla et al. 1988).



883-1729/13245

Figure 24. Maximum Methylene Chloride Concentrations in Shallow Groundwater (1985-1987).

lower portion of the unconfined aquifer (the intermediate zone) can not be assessed without data from additional sampling points.

3.1.3.2.3 Metals. A large number of metals have been detected at elevated concentrations within the soils of the process sewage disposal facilities in 300-FF-1. A few metals are also found in the groundwater at concentrations highly elevated above preliminary background conditions. Copper distributions are used to illustrate the approximate extent of metals contamination in groundwater. Copper has been shown to be associated with high levels of radioactivity in the soils of the process ponds (Dennison et al. 1989).

The distribution of maximum filtered copper concentrations in shallow groundwater between 1985 and 1987 is shown in Figure 25. Elevated copper concentrations are closely associated with the process trenches, and are more uniformly distributed beneath the trenches than uranium. Other elevated metals found in the groundwater beneath 300-FF-1 include aluminum, arsenic, and iron (Schalla et al. 1988).

3.1.3.2.4 Nonmetallic Ions. The distribution of maximum chloride concentrations in shallow groundwater is shown in Figure 26. Elevated concentrations of chloride appear to be closely associated with the process trenches. Table 9 indicates that about 75 tons of sodium chloride are discharged to the process trenches annually.

The approximated extent of the contamination is very similar to that observed previously for uranium, although the southern extent is poorly defined. Slightly elevated concentrations of chloride to the northwest are also indicated. These may be due to gradient reversals or perhaps an upgradient source. Other important nonmetallic ionic contaminants in 300-FF-1 groundwaters include nitrate and fluoride (Schalla et al. 1988).

3.1.4 Surface Water and Sediments

3.1.4.1 Background Surface Water Quality. Background values for selected radionuclides and water quality parameters have been reported for the Columbia River water (PNL 1988). Background has been determined at two upstream locations--the Priest Rapids Dam and the Vernita Bridge--and are presented in Tables 27 and 28. These values, however, are not suitable for use at the 300 Area, as the upstream stations are located far upstream and many other Hanford-related and agricultural activities have the potential to impact the quality of the Columbia River as well.

3.1.4.2 Surface Water Contamination. Average values measured at the 300 Area and City of Richland water intakes are presented in Tables 29 and 30. Those parameters which exceed the average background values plus two standard errors of the mean are denoted as significantly elevated. Because of the location of the background stations, the elevation of the parameters can not be strictly attributed to operable unit 300-FF-1.

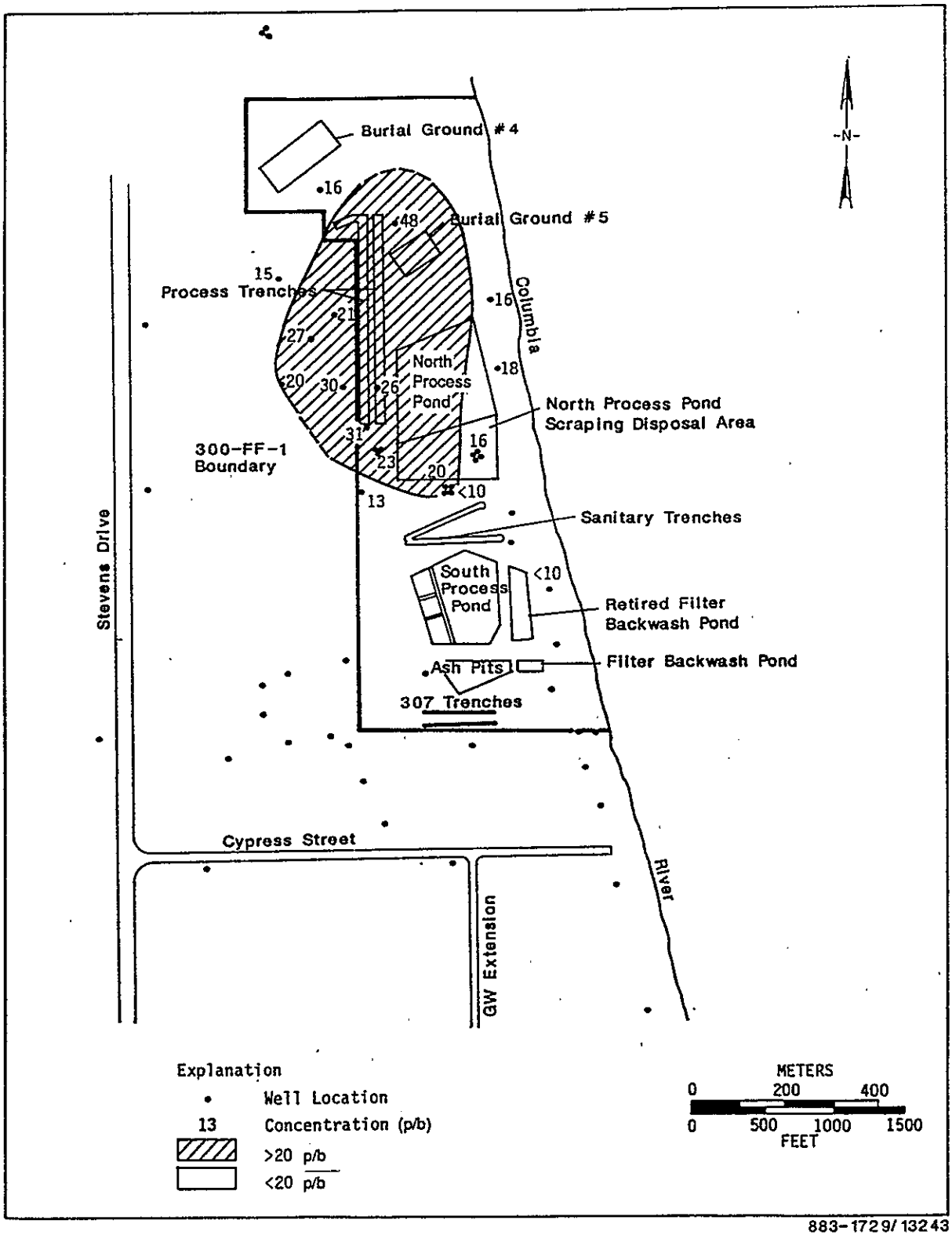


Figure 25. Maximum Filtered Copper Concentrations in Shallow Groundwater (1985-1987).

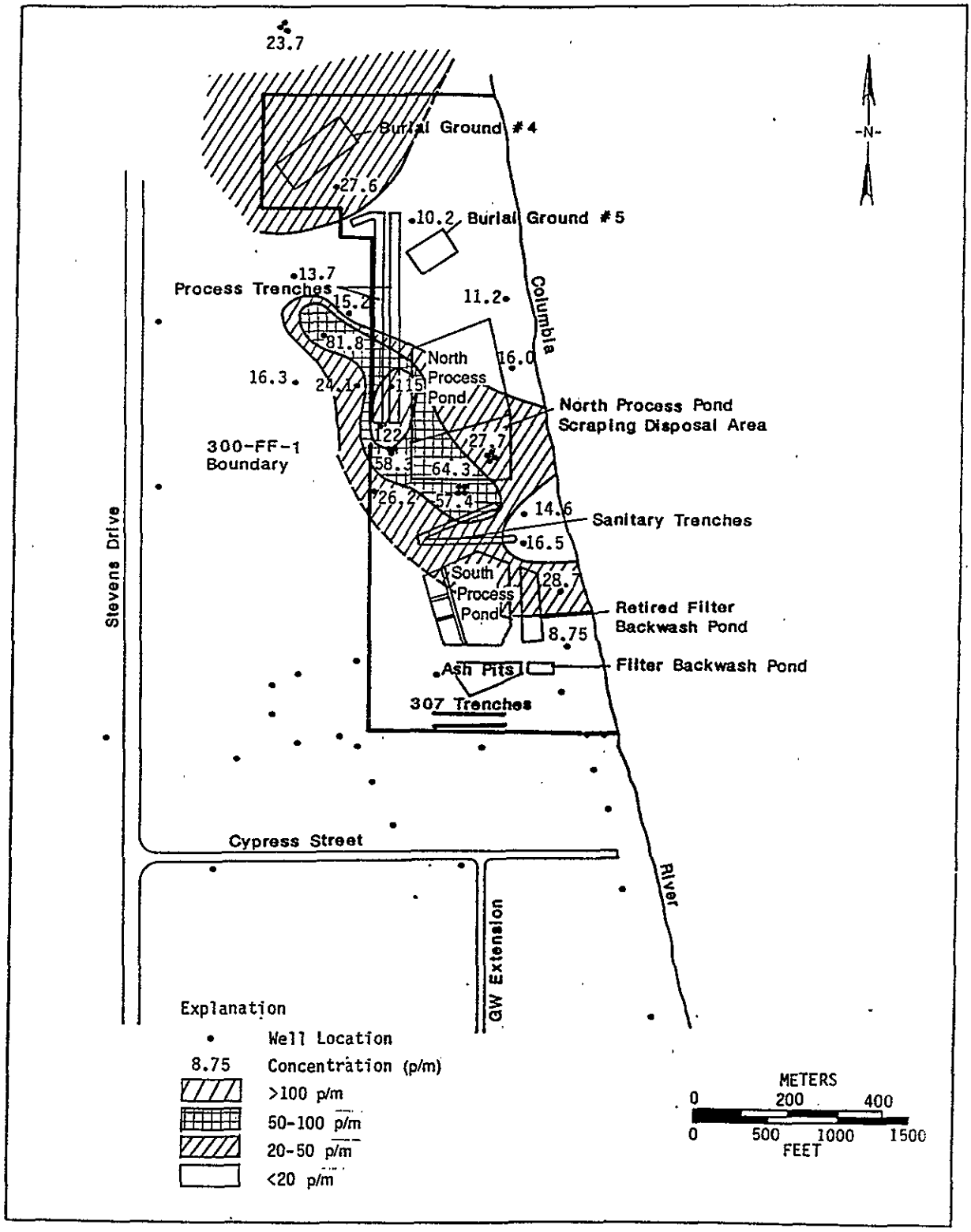


Figure 26. Maximum Chloride Concentrations in Shallow Groundwater (1985-1987).

Table 27. Upstream Water Quality Data for the Vernita Bridge.

Analysis	Units	Concentration[a]				
		No. of samples	Maximum	Minimum	Annual average[b]	
pH	std. units	12	8.3	7.3	NA	
Fecaz coliform	No./100 mL	12	64	2	5*	
Total coliform	No./100 mL	12	2400	2	110*	
Biological oxygen demand	mg/L	12	8.3	0.4	2.48	±1.25
Nitrate	mg/L	12	0.17	0.02	0.09	±0.03
Temperature	#	365[c]	20.2[c]	3.0	11.7	
Dissolved oxygen	mg/L	6	13.3	9.6	11.2	±1.4
Turbidity	NTU[d]	6	2.6	0.1	1.2	±0.8
pH	std. units	6	8.4	7.9	NA	
Fecal coliform	No./100 mL	6	7	<1	1.5*	
Suspended solids, 105#C	mg/L	4	16	7	7.8	±6.2
Dissolved solids, 180#C	mg/L	6	92	70	77	±7
Specific conductance	µmho/cm	6	161	127	138	±11
Hardness, as $CaCO_3$	mg/L	6	76	59	67	±7
Phosphorus, total	mg/L	6	0.03	0.01	0.02	±0.01
Chromium, dissolved	µg/L	3	1	<1	<1	
Nitrogen, Kjeldahl	mg/L	6	0.7	<0.02	0.4	±0.1
Total organic carbon	mg/L	4	40	1.2	11.2	±19.2
Iron, dissolved	µg/L	4	11	3	5.3	±3.9
Ammonia, dissolved (as N)	mg/L	6	0.07	<0.01	0.03	±0.02

Source: PNL (1988).

[a]Contaminant-specific ARARs are provided in Table 40.

[b]Average value ±2 standard errors of the calculated mean (* = annual median).

[c]Daily averages.

[d]NTU = nephalometric turbidity unit.

Table 28. Upstream Water Quality Data for the Priest Rapids Dam.

Radionuclide		No. of samples	Concentration (pCi/L)[a] Maximum[b]		Minimum[b]		Average[c]	
Gross alpha		12	0.92	± 0.46	0.19	± 0.28	0.44	± 0.16
Gross beta		12	2.1	± 1.4	0.19	± 0.92	0.92	± 0.52
^{3}H		12	110	±10	50	±10	70	±10
^{89}Sr		12	0.10	± 0.08	-0.06	± 0.12	0.015	± 0.041
^{90}Sr		12	0.18	± 0.04	0.10	± 0.03	0.14	± 0.02
^{234}U		12	0.29	± 0.05	0.17	± 0.04	0.24	± 0.02
^{235}U		12	0.028	± 0.022	0.004	± 0.006	0.013	± 0.006
^{238}U		12	0.37	± 0.06	0.15	± 0.04	0.21	± 0.03
U-Total		12	0.57	± 0.07	0.33	± 0.05	0.46	± 0.04
^{60}Co	P[d]	24	0.0038	± 0.009	-0.0070	± 0.007	-0.0006	± 0.0015
	D[d]	24	0.0074	± 0.008	-0.0066	± 0.013	-0.0004	± 0.0026
^{95}Nb	P	24	0.0043	± 0.003	-0.004	± 0.004	0.0007	± 0.0012
	D	24	0.0071	± 0.013	-0.0072	± 0.0072	0.0006	± 0.0024
^{95}Zr	P	24	0.0043	± 0.0034	-0.004	± 0.004	0.0007	± 0.0012
	D	24	0.0010	± 0.021	-0.012	± 0.019	-0.0010	± 0.0037
^{106}Ru	P	24	0.020	± 0.065	-0.054	± 0.046	-0.013	± 0.010
	D	24	0.034	± 0.064	-0.10	± 0.095	-0.032	± 0.021
^{129}I	D	4	0.000012	± 0.000001	0.000004	± 0.0000004	0.000007	± 0.0000004
^{131}I	P	24	0.011	± 0.007	-0.005	± 0.007	0.008	± 0.002
	D	24	0.039	± 0.031	0.001	± 0.0096	0.013	± 0.006
^{134}Cs	P	24	0.0023	± 0.0035	-0.004	± 0.0057	-0.0004	± 0.0011
	D	24	0.0052	± 0.0074	-0.005	± 0.011	0.0006	± 0.0021
^{137}Cs	P	24	0.0026	± 0.0018	-0.010	± 0.006	0.0017	± 0.0016
	D	24	0.0085	± 0.010	-0.012	± 0.012	-0.0014	± 0.0026
^{144}Ce	P	24	0.0081	± 0.017	-0.057	± 0.051	-0.011	± 0.006
	D	24	0.056	± 0.071	-0.085	± 0.069	-0.013	± 0.012
^{238}Pu	P	4	0.0000008	± 0.0000020	-0.0000006	± 0.0000036	0.0000002	± 0.0000014
	D	4	0.00003	± 0.00004	-0.000005	± 0.00005	0.000012	± 0.000024
$^{239,240}Pu$	P	4	0.000028	± 0.000007	0.000004	± 0.000002	0.000019	± 0.000012
	D	4	0.00014	± 0.00007	0.00007	± 0.00004	0.00011	± 0.00004

Source: PNL (1988).
[a]Contaminant-specific ARARs are provided in Table 40.
[b]Value ± 2 standard deviations of the counting error.
[c]Average value ± 2 standard errors of the calculated mean (* = annual median).
[d]P = particulate fraction, D = dissolved fraction.

Table 29. Downstream Water Quality Data for the Richland Pumphouse.

Analysis	Units	Concentration[a]				
		No. of samples	Maximum	Minimum	Annual average[b]	
pH	std. units	12	8.3	7.2	NA	
Fecal coliform	No./100 mL	12	240	2	22*	
Total coliform	No./100 mL	12	240	2	49*	
Biological oxygen demand	mg/L	12	3.0	0.5	2.0	± 0.5
Nitrate[c]	mg/L	12	0.77	0.05	0.2	± 0.1
Temperature	°C	365	2.8[d]	12.0		
Dissolved oxygen	mg/L	4	13.6	9.5	11.3	± 2.0
Turbidity[c]	NTU	4	10.0	0.7	3.8	± 4.3
pH	std. units	4	8.2	8.0		NA
Fecal coliform	No./100 mL	4	5	1	1.5*	
Suspended solids, 105 °C	mg/L	4	11	<1	6.5	± 5.8
Dissolved solids, 180 °C	mg/L	4	95	61	76	±14
Specific conductance	µho/cm	4	150	127	134	±11
Hardness, as $CaCO_3$	mg/L	4	75	59	65	± 7
Phosphorus, total[c]	mg/L	4	0.03	0.01	0.025	± 0.01
Chromium, dissolved	µg/L	3	<10	<1	<7	
Nitrogen, Kjeldahl	mg/L	4	0.8	<0.2	0.5	± 0.25
Total organic carbon[c]	mg/L	4	97	1.4	35	±45
Iron, dissolved	µg/L	4	14	4	8	± 4.5
Ammonia, dissolved (as N)	mg/L	4	0.04	<0.01	0.02	± 0.01

Source: PNL (1988).

[a]Contaminant-specific ARARs are provided in Table 40.

[b]Average value ± 2 standard errors of the calculated mean (* = annual median).

[c]Average value exceeds upstream average by greater than 2 standard error of the upstream mean value.

[d]Daily averages.

Table 30. Downstream Water Quality Data for the 300 Area Intake.

Radionuclide		No. of samples	Concentration (pCi/L)[a] Maximum[b]		Minimum[b]		Average[c]	
Gross alpha		4	0.79	± 0.41	0.43	± 0.35	0.59	± 0.26
Gross beta[d]		4	2.8	± 1.5	1.2	± 1.3	2.1	± 1.0
^{3}H[d]		4	200	±10	130	±10	170	±40
^{89}Sr[d]		4	0.20	± 0.12	-0.011	± 0.12	0.097	± 0.12
^{90}Sr		4	0.15	± 0.03	0.092	± 0.044	0.13	± 0.04
^{234}U[d]		4	0.33	± 0.05*	0.25	± 0.05	0.30	± 0.05
^{235}U		4	0.021	± 0.013	0.004	± 0.007	0.009	± 0.010
^{238}U[d]		4	0.26	± 0.05	0.24	± 0.05	0.25	± 0.03
U-Total[d]		4	0.61	± 0.07	0.49	± 0.07	0.56	± 0.07
^{60}Co	P[e]	24	0.0048	± 0.0053	-0.0026	± 0.0046	0.00017	± 0.0012
	D[e]	24	0.021	± 0.015	-0.0047	± 0.009	0.0032	± 0.0030
^{95}Nb	P	24	0.0047	± 0.0053	-0.0037	± 0.0038	0.00075	± 0.0010
	D	24	0.0072	± 0.007	-0.0060	± 0.0085	0.0010	± 0.0019
^{95}Zr	P	24	0.0048	± 0.008	-0.0053	± 0.0059	0.0002	± 0.0016
	D	24	0.013	± 0.019	-0.015	± 0.011	0.0024	± 0.0034
^{106}Ru	P	24	0.0098	± 0.017	-0.028	± 0.043	-0.0099	± 0.0074
	D	24	0.043	± 0.046	-0.087	± 0.067	-0.022	± 0.018
^{129}I	D[d]	4	0.00013	± 0.00001	0.000079	± 0.000007	0.00011	± 0.00003
^{131}I	P	24	0.0079	± 0.0061	0.00009	± 0.0034	0.0033	± 0.0013
	D	24	0.017	± 0.020	0.0013	± 0.0160	0.0083	± 0.0031
^{134}Cs	P	24	0.0035	± 0.0056	-0.0024	± 0.0020	0.00024	± 0.00094
	D	24	0.0050	± 0.0068	-0.012	± 0.0094	-0.00035	± 0.0021
^{137}Cs	P	24	0.00093	± 0.0023	-0.0058	± 0.0054	-0.0015	± 0.0010
	D	24	0.0031	± 0.0039	-0.014	± 0.010	-0.0019	± 0.0022
^{144}Ce	P	24	0.0028	± 0.04	-0.016	± 0.015	-0.0054	± 0.0034
	D	24	0.045	± 0.051	-0.041	± 0.081	-0.85	± 0.0087
^{238}Pu	P	4	0.000001	± 0.000004	0.0000005	± 0.0000035	0.0000007	± 0.0000017
	D	4	0.000009	± 0.00002	-0.00001	± 0.00005	-0.0000003	± 0.00002
$^{239,240}Pu$	P	4	0.000033	± 0.000008	0.000008	± 0.000006	0.00002	± 0.00001
	D	4	0.00006	± 0.00005	0.00004	± 0.00002	0.00005	± 0.00002

Source: PNL (1988).

[a]Contaminant-specific ARARs are provided in Table 40.

[b]Value ± 2 standard deviations of the counting error.

[c]Average value ± 2 standard errors of the calculated mean (* = annual median).

[d]Average value exceeds upstream average by greater than 2 standard error of the upstream mean value.

[e]P = particulate fraction, D = dissolved fraction.

Downstream levels of nitrate, TOC, and phosphorous, although low, exceed upstream averages by greater than two standard errors of the upstream mean. Average downstream concentrations of gross beta, tritium, strontium-89, uranium (isotopes 234, 238, and total uranium), and iodine-129 are all greater than average background concentrations plus two standard errors of the background average. Concentrations of all of these radionuclides are below drinking water standards by at least an order of magnitude.

A cross-sectional survey of uranium concentrations in the Columbia River, upstream and adjacent to the 300 Area, has been conducted. Because this survey was conducted in 1957, the results are probably not indicative of current conditions. The data were obtained along five cross-sections and indicated a uranium plume emanating from the river bank at the 300 Area. The plume had a maximum concentration of 4.80 pCi/L at its head, dissipating to a maximum concentration of 1.05 pCi/L, 4,500 ft downstream. The plume concentrations were highest in shallow waters adjacent to the river bank and decreased rapidly with increasing distance from the shore. Data obtained from the survey are summarized in Table 31.

Site-specific measures of coliform bacteria and biochemical oxidation demand (BOD) in river water adjacent to the 300 Area have been reported (Douglas United Nuclear 1967). These measurements were made upstream and within the seepage area of the 300 Area. Upstream measurements of coliform and BOD were 3.5/100 ml and 3.7 mg/L, respectively. Downstream measurements of 6/100 ml and 3.0 mg/L were not discernably higher than the upstream values.

Concentrations of selected metals, anions, and radionuclides have been reported for bank seepage along the 300 Area during 1967 (Douglas United Nuclear 1967). These analyses are summarized in Table 32. The measured bank seepage concentrations were shown, not surprisingly, to be very comparable to concentrations within groundwater in neighboring wells.

Table 31. Columbia River Cross-Sectional Uranium Survey.[a]

Transect number	Downstream distance[b]	Number of samples	Concentration (pCi/L) Maximum	Minimum	Average
1	0	51	0.73	0.51	0.61
2	350	34	4.80	0.51	0.60
3	850	31	4.54	0.51	0.72
4	1,350	30	1.93	0.51	0.74
5	1,850	35	1.05	0.43	0.65

NOTE: Transect No. 2 was located approximately due east of the center of the north process pond; transect No. 3 was located approximately due east of the northern portion of the south process pond.

[a]Survey conducted 1957.

[b]From regional monitoring mile No. 37 in yards.

Table 32. Concentration of Selected Parameters Within Bank Seepage at the 300 Area in 1967.

Parameter	Units	Number of samples	Average concentration	Maximum concentration
Uranium	mg/L	11	0.36	0.50
Chromium(VI)	mg/L	10	0.34	0.70
Nitrate	mg/L	18	129	181
Fluoride	mg/L	8	5.1	10.0
Zinc-65	pCi/L	1	91	91
Cobalt-60	pCi/L	1	88	88
Chromium-51	pCi/L	1	910	910
Neptunium-239	pCi/L	1	56,000	56,000
Gross beta	pCi/L	1	280	280

Source: Douglas United Nuclear (1967).

3.1.4.3 Sediments. No information is available on sediment quality within the Columbia River immediately upstream or downstream of 300-FF-1.

3.1.5 Air

3.1.5.1 Background Air Quality. Background concentrations for airborne radionuclides have been measured at several distant communities in eastern Washington. The average values for these distant communities are indicated in Table 33.

3.1.5.2 Air Contamination. Concentrations of airborne radionuclides have been extensively monitored both on and off the Hanford Site. Data for the 300 Area are available from three monitoring stations. One of the monitoring stations, the 300 pond, is located in 300-FF-1, at the southwest corner of the process trenches. The available 1987 monitoring data are summarized in Table 33.

Average concentrations of gross beta, gross alpha, krypton-85, uranium, and plutonium-240 exceed the measured average background concentrations by greater than two standard errors of the background mean. Given the number of possible sources for airborne radionuclide contamination at the Hanford Site, these data are not strictly representative of contamination directly associated with 300-FF-1.

3.1.6 Biota

3.1.6.1 Background Biota Quality. Background concentrations of selected radionuclides in native vegetation have been measured at numerous offsite locations. Average background values are included in Table 34. No background data for fauna are available.

Table 33. Airborne Radionuclide Concentrations for the 300 Area.

Parameters	Location	Number of samples	Concentration (pCi/m^3)			
			Maximum	Minimum	Average	Offsite[a]
Gross beta	300 Pond 300 South Gate 3614-A Building	26 26 26	59 E-03 59 E-03 59 E-03	14 E-03 11 E-03 12 E-03	30 E-03[b] 26 E-03 28 E-03[b]	24 E-03 24 E-03 24 E-03
Gross alpha	300 Pond 300 South Gate	26 26	6.3 E-03 1.7 E-03	0.2 E-03 0.3 E-03	2.3 E-03[b] 0.9 E-03[b]	0.7 E-03 0.7 E-03
^{14}C	300 Pond	6	1.4	1.2	1.3	1.3
^{85}Kr	300 Pond	10	230	20	58[b]	28
^{131}I	300 South Gate	26	6.9 E-03	-6.7 E-03	0.2 E-03	-0.7 E-03
^{137}Cs	Composite[c]	12	0.4 E-03	-0.5 E-03	0.1 E-03	0.3 E-03
U (total)	Composite[c]	4	1.95 E-03	0.25 E-03	1.18 E-03[b]	0.05 E-03
^{238}Pu	Composite[c]	4	1.2 E-06	0.2 E-06	0.7 E-06	0.3 E-06
$^{239,240}Pu$	Composite[c]	4	3.7 E-06	0.1 E-06	1.4 E-06[b]	0.3 E-06

Source: PNL (1988).

Note: Negative values are the result of subtracting instrument background values from analytical results.

[a]Average from distant Washington communities (Moses Lake, Washtucna, Walla Walla, McNary Dam, Sunnyside, Yakima).

[b]Measured average exceeds background average plus two standard errors of the background average.

[c]Composite from 300 Pond, 300 South Gate, and the 3614-A Building.

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Table 34. Fauna and Flora Radionuclide Concentrations for the 300 Area.

Sample description	Number of samples	Concentration (pCi/g)			
		Maximum	Minimum	Average	Offsite[a]
Pheasant muscle tissue[b]					
^{60}Co	1	--	--	0.002	--
^{137}Cs	1	--	--	0.002	--
Mallard duck muscle tissue[b]					
^{137}Cs	4	0.93	0.01	0.41	--
Native vegetation[c]					
^{90}Sr	6	0.93	0.008	0.23	0.10
^{137}Cs	6	0.17	0.009	0.048	0.12
$^{239,240}Pu$	6	0.003	0.00021	0.001	0.00042
U (total)	6	0.082	0.01	0.026	0.019

Source: PNL (1988).

[a]Average of offsite locations.

[b]Based on 1987 data.

[c]Based on 1982 through 1987 data from north of the 300 Area.

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3.1.6.2 Biota Contamination. Limited data exists on radionuclide contamination of flora and fauna within the 300 Area. The existing data are summarized in Table 34.

Radionuclide concentrations within the muscle tissue of birds killed within the 300 Area are the only data currently available. Interpretation of this data is difficult in the absence of background data. It is interesting to note, however, that cesium-137 levels are considerably higher within ducks than in pheasants.

Concentrations of radionuclides are generally higher within vegetation onsite than offsite. Because of concerns about human consumption of asparagus along the operable unit, asparagus sampling and analysis were undertaken. Results of this effort, however, are not yet available.

3.2 POTENTIAL LEGALLY APPLICABLE, OR RELEVANT AND APPROPRIATE, ENVIRONMENTAL STANDARDS, REQUIREMENTS, CRITERIA, AND LIMITATIONS

3.2.1 Identification of Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations

Section 121(d) of CERCLA requires that remedial actions at NPL sites comply with federal and state environmental laws, promulgated standards, requirements, criteria, and limitations that are legally applicable or relevant and appropriate under the circumstances presented by the release or threatened release of hazardous substances, pollutants, or contaminants at the site. These ARARs can be grouped into three types; chemical-specific, location-specific, and action-specific [52 FR 32496, Aug. 27, 1987 (EPA 1987c)].

Included in Table 35 is a list and assessment of potential federal ARARs for 300-FF-1. Potential Washington State ARARs are included in Table 36. Normally, only chemical-specific and location-specific ARARs are identified during scoping of an RI/FS. Potential action-specific ARARs, however, are included in these tables to illustrate those that may be evaluated during remedial alternative screening in the FS.

Also included in these tables is an assessment of whether the ARAR is applicable, potentially relevant and appropriate, or to be considered. Applicable requirements are defined as those that would be legally applicable to a remedial action if that action were not taken pursuant to CERCLA. Relevant and appropriate requirements are those that apply in circumstances similar to those encountered at NPL sites, where their application would be appropriate, although not legally required.

Tables 37 and 38 include a comparison of 300-FF-1 contaminant levels for the known waste constituents with chemical-specific ARARs for chemical and radiological contaminants, respectively.

Table 35. Potential Federal Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations for Operable Unit 300-FF-1. (sheet 1 of 2)

Requirements	Applicable	Potentially relevant and appropriate	To be considered	Rationale
1. Contaminant-Specific				
1.1 Safe Drinking Water Act - Maximum contaminant levels (MCL) - Maximum contaminant level goals (MCLG)		X X		Groundwater is not used for drinking and institutional controls can prevent future use. However, contaminated groundwater is discharged to the Columbia River which is used for drinking water.
1.2 Health advisories, EPA Office of Drinking Water			X	Chemicals identified for which health advisories are listed.
1.3 Clean Water Act (PL 92-500) - Federal Water Quality Criteria		X		Contaminated groundwater discharges to the Columbia River.
1.4 RCRA Groundwater Protection Standards (40 CFR Part 264 Subpart F) (1988j) - Alternate concentration limits (ACL)		X		ACLs may be relevent and appropriate in accordance with CERCLA 12 (d) (2) (B) (ii).
1.5 Health effects assessment			X	Baseline risk assessment will be conducted for contaminants of concern by all routes of exposure.
1.6 Clean Air Act (41 USC 7401) - Standards for Protection Against Radiation (10 CFR Parts 20 and 61 [NRC 1988a, 1988b]) - National Emission Standard for Hazardous Air Pollutants for Fadionuclides (40 CFR Part 61 [EPA 1988f])	X X			Remedial alternatives may result in air emissions.
1.7 Environmental Radiation Protection Standards (U.S. DOE Order 5400.3 [DOE 1989b] and 40 CFR Part 191 Subpart F [EPA 1988e])	X			Radiaton standards for protection of the public in the vicinity of DOE facilities.
1.8 Toxic Substances Control Act (15 USC 2601)		X		Polychlorinated biphenyls (PCB) have been detected in contaminated soils.
2. Location-Specific				
2.1 Historic Sites, Buildings, and Antiquities Act (16 USC 461)	X			Applicability will be determined during Remedial Investigation and in evaluation of remedial alternatives.

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Table 35. Potential Federal Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations for Operable Unit 300-FF-1. (sheet 2 of 2)

Requirements	Applicable	Potentially relevant and appropriate	To be considered	Rationale
2.2 National Historic Preservation Act (16 USC 470) - Protection of Archeological Resources	X			Applicability will be determined during Remedial Investigation and in evaluation of remedial alternatives.
2.3 Endangered Species Act of 1973 (16 USC 1531)		X	X	Considered in the baseline risk assessment.
2.4 Fish and Wildlife Coordination Act (16 USC 661)	X			Applicable if remedial alternatives affect wetlands and protected habitats.
2.5 Fish and Wildlife Improvement Act (16 USC 742)	X			Applicable if remedial alternatives affect wetlands and protected habitats.
2.6 Fish and Wildlife Conservation Act (16 USC 2901)	X			Applicable if remedial alternatives affect wetlands and protected habitats.
3. Action-Specific				
3.1 Hazardous Waste Requirements (RCRA Subtitle C, 40 CFR,Part 264 [EPA 1988k])	X	X		May be applicable for remedial alternatives involving the generation, transportation, storage, and offsite disposal waste. May be relevant or appropriate for containment alternatives.
3.2 Clean Water Act of 1977 (PL 92-500) - National Pollutant Discharge Elimination System (NPDES) permit - Underground Injection Control Regulations (40 CFR Parts 144-147 [EPA 1988i, 1988j, 1988l, 1988m])	 X X			Remedial actions may include discharge to the Columbia River. Remedial actions may include injection of treated groundwater.
3.3 Occupational Safety and Health Act (29 USC 651) - Occupational Safety and Health Administration (OSHA) Standards (29 CFR Part 1910 [OSHA 1988])	X			Occcupational health and safety requirements.

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Table 36. Potential State Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations for Operable Unit 300-FF-1. (sheet 1 of 2)

Requirements	Applicable	Potentially relevant and appropriate	To be considered	Rationale
1. Contaminant-Specific				
1.1 Water Pollution Laws and Regulations				Do not contain numeric standards. Require surface and groundwaters of the state to be protected to maximize beneficial uses. Require all known available and reasonable treatment for discharges.
- Water Pollution Control Act (Ch. 90.46 RCW)	X	X		
- Regulation of Public Groundwaters (Ch. 90.44 RCW)		X		
- Water Resources (Ch. 90.54 RCW)		X		
- Water Quality Standards for Waters of the State of Washington (Ch. 173-201 WAC)	X			Contain water quality standards for the Hanford reach of the Columbia River.
- Public Water Supplies (Ch. 248-54 WAC)		X		Contain standards for public drinking water.
1.2 Solid & Hazardous Waste Laws and Regulations				
- Hazardous Waste Cleanup Act (Ch. 70.105B RCW)	X			Require remedial actions to attain a degree of cleanup protective of human health and the environment. Guidance on cleanup levels in preparation.
- Department of Ecology Final Clean-up Policy-Technical (July 10, 1984)			X	Nonpromulgated policy to be considered.
- Dangerous Waste Regulations (Ch. 173-303 WAC)	X	X		Contain requirements equivalent to RCRA for groundwater protection standards.
1.3 State Radiation Standards (Ch. 70.98 RCW and WAC Title 402)		X		Contain state radiation standards.
2. Location-Specific				
2.1 Washington Shoreline Management Act (Ch. 90.58 RCW)		X		Controls the development of riparian habitat.
3. Action-Specific				
3.1 Washington Clean Air Act (Ch. 70.94 RCW and Ch. 173-480 WAC)	X	X		Contain air emissions standards. Applicable to the extent federal laws are applicable. May be relevant and appropriate to the extent they are more stringent than federal law.
3.2 Hazardous Waste Management Act (Ch. 70.105 RCW) and Dangerous Waste Regulations (Ch. 173-303 WAC)	X	X		Establish priorites for hazardous waste management. May be applicable to alternatives that include generation, treatment, storage or disposal of waste. May be relevant and appropriate for containment alternatives.

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Table 36. Potential State Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations for Operable Unit 300-FF-1. (sheet 2 of 2)

Requirements	Applicable	Potentially relevant and appropriate	To be considered	Rationale
3.3 Solid Waste Management. Recovery and Recycling Act (Ch 70.95 RCW) and Minimum Functional Standards for Solid Waste Handling (Ch 173-304 WAC)	X	X		May be applicable for alternatives requiring management of solid waste. To extent they are more stringent than federal law, may be relevant and appropriate.
3.4 Washington State Water Code (Ch. 90.03 RCW)		X		Water rights law. May be relevant and appropriate for alternatives that include extraction and treatment of groundwater.
3.5 Minimum Standards for Construction and Maintenance of Water Wells (Ch. 173-160 WAC)		X		May be relevant and appropriate for monitoring wells during RI and alternatives that include extraction wells.
3.6 State Waste Discharge Program (Ch. 173-216 WAC)		X		May be relevant and appropriate to alternatives that include discharges to ground.
3.7 Underground Injection Control Program (Ch. 173-218 WAC)	X	X		May be applicable to alternatives that include underground injection to the extent federal laws are applicable. May be relevant and appropriate to the extent they are more stringent than federal law.
3.8 National Pollution Discharge Elimination System Permit Program (Ch. 173-220 WAC)	X	X		May be applicable to alternatives which include discharges to the Columbia River to the extent federal laws are applicable. May be relevant and appropriate to the extent they are more stringent than federal law.

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Table 37. Potential Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations for Nonradiological Contaminants at Operable Unit 300-FF-1 (μg/L).

Contaminant	1·MCL[a]	2·MCL[b]	MCLG[c]	QCFW-A[d]	QCFW-C[e]	QCHH-W/F[f]	QCHH-F[g]
Arsenic	50	--	--	360	--	--	--
Barium	1,000	--	--	--	--	--	--
Cadmium	10	--	--	2.4[h]	0.81[h]	10	--
Chromium	50	--	---	16[i]	11[i]	50[i]	i
Copper	--	1,000	--	12[h]	8.2[h]	--	--
Iron	--	300	--	--	1,000	300	--
Lead	50	-	-	47[h]	1.8[h]	50	--
Manganese	--	50	--	--	--	50	100
Mercury	2	--	--	2.4	0.012	0.144	0.146
Nickel	--	--	--	1,300[h]	69[h]	13.4	100
Selenium	10	--	--	260	35	10	--
Silver	50	--	--	1.9[h]	0.12	50	--
Zinc	--	5,000	--	220[h]	47	--	--
Chloride	--	250,000	--	--	--	--	--
Cyanide	--	--	--	22	5.2	200	--
Fluoride	4,000	2,000	--	--	--	-	--
Nitrate	45,000	--	--	--	--	45,000	--
Sulfate	--	250,000	--	--	--	--	--
pH	--	6.5-8.5	--	--	6.5-9.0	--	--
Chloroform	100	--	--	--	--	--	--
Polychlorinated biphenyls	--	--	--	2.0	0.014	--	--
Tetrachloroethylene	--	--	--	--	--	--	--
Trichloroethylene	5	--	0	--	--	--	--

[a]Primary maximum contaminant level for drinking water to protect public health (40 CFR 141 [EPA 1988g] and WAC 248).

[b]Secondary maximum contaminant level for drinking water to protect public welfare (40 CFR 143 [EPA 1988h] and WAC 248).

[c]Maximum contaminant level goal for drinking water to protect public health (50 FR 46936, November 13, 1985 [EPA 1985a]).

[d]Quality criterion for ambient surface water to protect freshwater aquatic life (acute) (EPA 1986a).

[e]Quality criterion for ambient surface water to protect freshwater aquatic life (chronic) (EPA 1986a).

[f]Quality criterion for ambient surface water to protect human health (ingestion of water and aquatic organisms) (EPA 1986a).

[g]Quality criterion for ambient surface water to protect human health (ingestion of aquatic organisms only) (EPA 1986a).

[h]Hardness-dependent criterion, the average value of 65 mg/L for the Columbia River is used.

[i]Value for chromium (IV), corresponding values for chromium (III) are 1,200, 150, 170,000, and 3,433,000 μg/L, respectively.

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Table 38. Potential Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations for Radionuclides at Operable Unit 300-FF-1.

Contaminant	Site contaminant levels in groundwater[a] (pCi/L)	Federal and state drinking water standards (MCL) (pCi/L)	Federal air quality standards	10 CFR 20[b] emission limits		Environmental radiation protection[c] standards for radioactive waste disposal (all pathways)		Concentration guides (DCG)	
				Air soluble/insoluble (µCi/mL)	Water soluble/insoluble (µC/mL)	40 CFR 191 (Ci/unit of waste)	40 CFR 193	Water (pCi/L)	Air (pCi/m³)
Gross alpha	208	15[d]	--	-- --	-- --	--	--	--	--
Gross beta and gross gamma	121	50[e]	--	-- --	-- --	--	--	--	--
Cesium-137	15	200[e]	--	2 E09 5 E10	2 E05 4 E05	1,000	--	3,000	400
Cobalt	64	100[e]	--	1 E08 3 E10	5 E05 3 E05	--	--	5,000	80
Ruthenium	80.3	30[e]							
Strontium-90	5.63	8[e]	--	3 E11 2 E10	3 E7 4 E05	1,000	--	1,000	9
Technitium-99	55.2	900[e]							
Tritium	6,480	20,000[e]							
Uranium (natural)	446 µg/L	--	--	2 E11 4 E12	3 E05 3 E05	100	--	600	0.1
Uranium	120	--	--	3 E12 5 E12	4 E05 4E05	100	--	600	0.1
All radionuclides		4 mrem/yr[e]	whole body: 25 mrem/yr critical organ: 75 mrem/yr alternate standards continuous exposure: 100 mrem/yr noncontinuous exposure: 500 mrem/yr			whole body: 25 mrem/yr critical organ: 75 mrem/yr alternate standards continuous exposure: 100 mrem/yr noncontinuous exposure: 500 mrem/yr			

[a]Values are maximum levels reported from 1985 through June 1985 groundwater monitoring program for wells in the vicinity of the 300-FF-1 operable unit.

[b]NRC radiation protection standards at boundary of restricted area (NRC 1988a).

[c]40 CFR 191 has been invalidated by the courts and remanded back to EPA on groundwater protection issues. Release limits for radionuclides may be deleted from these regulations.

[d]40 CFR 141.15-141.16 (EPA 1988g) excludes radon and uranium. The WAC 248-54-375 (B) excludes uranium only.

[e]Annual average concentrations shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 mrem/yr. For known mixtures of radionuclides, the sum of the ratios of the observed concentrations of each radionuclide and its corresponding MCL must not exceed 1.0.

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Groundwater monitoring data obtained from 1985 through June 1988 indicate several chemicals have been detected at levels exceeding potential ARARs.

3.2.2 Point of Applicability of Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations

A significant factor for evaluation of remedial alternatives at the Hanford Site will be determining the point of applicability for compliance with the ARARs. Points of applicability are the boundaries that will be used to assess the effectiveness of remedial alternatives. Determining the point of applicability of ARARs concerning groundwater quality is especially significant for 300-FF-1.

For water that is or may be used for drinking, the maximum contaminant levels (MCL) set under the Safe Drinking Water Act are generally the applicable or relevant and appropriate standard. The EPA's interim guidance on compliance with ARARs states:

> MCLs are applicable at the tap where the water will be provided directly to 25 or more people or will be supplied to 15 or more service connections. Otherwise, where surface water or groundwater is or may be used for drinking, MCLs are generally relevant and appropriate as cleanup standards for the surface water or the groundwater [52 FR 32496, Aug. 27, 1987 (EPA 1987c)].

Groundwater affected by 300-FF-1 is not currently used for drinking water at the Hanford Site, and there is no evidence of offsite consumption of groundwater affected by this operable unit. The MCLs would not be applicable, but may be relevant and appropriate, cleanup standards for the 300-FF-1 groundwaters.

The groundwater protection standards for the RCRA program promulgated under 40 CFR Parts 264 and 265, Subparts F, provide EPA and Ecology with the option of establishing alternate concentration limits (ACL) at hazardous waste facilities. Section 121 (d)(2)(B)(ii) of CERCLA states that ACLs may only be used to establish standards for cleanup of groundwater under the following conditions:

- There are known and projected points of entry of such groundwater into surface water
- On the basis of measurements or projections, there is or will be no statistically significant increase of such constituents from such groundwater in such surface water at the point of entry or at any point where there is reason to believe accumulation of constituents may occur downstream

- The remedial action includes enforceable measures that will preclude human exposure to the contaminated groundwater at any point between the facility boundary and all known and projected points of entry of such groundwater into surface water.

If these conditions are met, the assumed point of human exposure (point of applicability) may then be at such known or projected points of entry. Based on these criteria, ACLs could be relevant for evaluation of groundwater remedial alternatives for the 300-FF-1 operable unit.

The EPA has also published draft guidance on remedial actions for contaminated groundwater at NPL sites that is useful in determining cleanup standards and points of applicability (EPA 1988b). The guidelines discuss EPA's groundwater protective strategy and procedure for classifying groundwater within a prescribed area around a facility or activity based upon the value, use, and vulnerability of the groundwater. The groundwater protection strategy establishes three classifications of groundwater, each requiring different levels of protection. These include:

- Class I--special groundwaters (i.e., sole source aquifers)
- Class IIa--current and potential sources of drinking water, and waters having other beneficial uses
- Class IIb--potential, but not currently used, source of drinking water, and waters having other potential beneficial uses
- Class III--groundwater that is not a potential source of drinking water and is of limited potential use due to salinity or widespread contamination.

Drinking water standards are applicable or relevant and appropriate cleanup standards for class I and class II groundwaters. Drinking water standards are not applicable or relevant and appropriate for class III waters.

Groundwater in 300-FF-1 would probably be classified as class IIb. However, establishment of ACLs could be appropriate, depending on whether institutional controls over groundwater use in the area will continue.

With respect to the Columbia River, MCLs are applicable at the taps in both the 300 Area and the City of Richland, where the river serves as the source of drinking water. In addition, MCLs may be relevant and appropriate cleanup standards for the ambient water column in the river. Federal water quality criteria promulgated under the Clean Water Act may be relevant and appropriate standards to achieve for the Columbia River. State water quality standards (WAC 173-201) may also be applicable cleanup standards for the river.

3.2.3 Consideration of Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations During Remedial Action

Evaluation of ARARs is an iterative process that will be conducted at multiple points throughout the RI/FS, namely:

- During the RI, when the baseline risk assessment is conducted, chemical-specific ARARs and advisories, and location-specific ARARs will be identified more comprehensively
- During development of remedial alternatives in phases I and II of the FS, action-specific ARARs will be identified for each of the proposed alternatives and considered along with other ARARs and advisories
- During the detailed analysis of alternatives in the phase III FS, all the ARARs and advisories for each alternative will be examined as a package to determine what is needed to comply with other laws and be protective of human health and the environment.

Following completion of the RI/FS, the remedial alternatives selected must be able to attain all ARARs unless one of the five potentially applicable statutory waivers, provided in Section 121 (d)(4)(A) through (F) of CERCLA, is invoked. The five reasons ARARs could potentially be waived at the Hanford Site are:

- The remedy is an interim measure where the final remedy will attain ARARs upon completion (particularly relevant when a site has been divided into operable units)
- Compliance will result in greater risk to human health and the environment than other options
- Compliance is technically impracticable
- The remedy selected will attain a standard of performance equivalent to that required under an ARAR
- For state ARARs, the state has not consistently applied (or demonstrated the intention to consistently apply) the ARAR in similar circumstances.

During the design phase of the remedial action, the technical specifications of construction must ensure attainment of ARARs. Environmental monitoring during and after implementation of the selected remedy will also help to ensure ARAR compliance.

3.3 POTENTIAL IMPACTS TO PUBLIC HEALTH AND THE ENVIRONMENT

3.3.1 Conceptual Exposure Pathway Model

Based on information presented thus far, a conceptual model of contaminant exposure pathways for 300-FF-1 was developed. The model is presented in Figure 27. The purpose of the conceptual model is to present hypotheses of unit-specific contaminant exposure pathways. Each exposure pathway must contain the following (EPA 1986b):

- A contaminant source
- A contaminant release mechanism
- An environmental transport medium
- An exposure route
- A receptor.

During the RI, the conceptual model hypotheses are tested and refined in an iterative manner until the understanding of the operable unit is sufficient to support subsequent decisions regarding remediation. By conducting the RI in this manner, the project becomes more efficient as the investigation is kept focused on unit-specific objectives.

3.3.2 Preliminary Toxicity Assessment

Potential contaminants of concern for 300-FF-1 are presented in Table 39. The list was based on the previous evaluation of waste volumes and characteristics and the known nature and extent of contamination. The list contains all waste constituents of primary importance, as identified in Section 3.1.1.2. Those parameters that are known to be both highly elevated above background levels (values found above the upper 95% confidence limit for the 0.99 quantile) and commonly found (present in at least 10% of the samples) in the 300-FF-1 soil and groundwater environments, as presented in Sections 3.1.2 and 3.1.3, are also included as target contaminants.

The preliminary toxicity assessment is performed to further focus attention on the those parameters that are most toxic to human and environmental receptors. The assessment compares critical toxicity values for each parameter, where available, to the levels found within the environment. Those parameters that meet or exceed their critical levels will be focused on during the RI/FS. The assessment also provides a means by which to select the level of analytical quality needed for the RI--the lower the parameter's critical toxicity value, the more sensitive the analytical method must be to provide meaningful data for the baseline risk assessment.

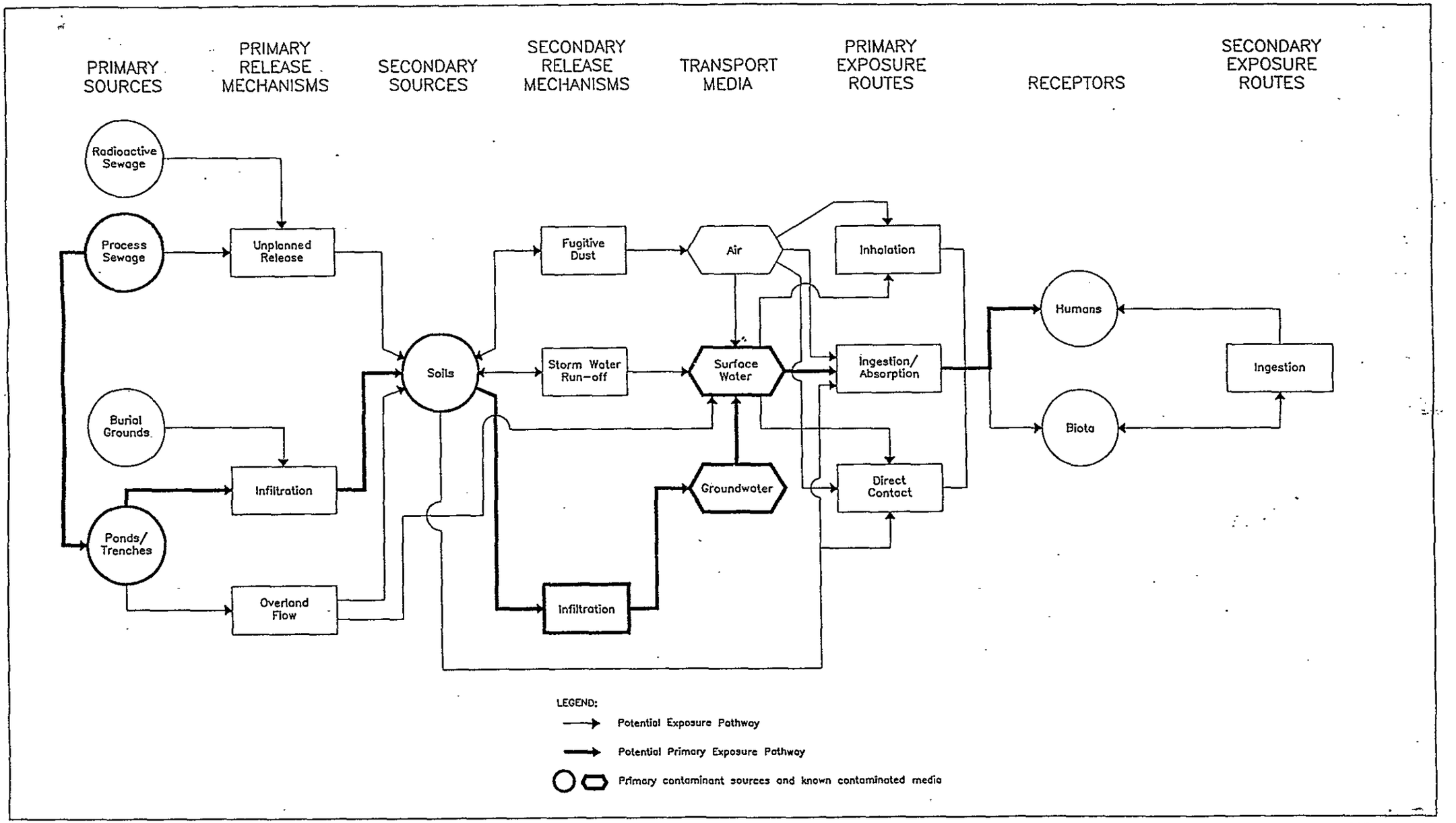

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Figure 27. Contaminant Exposure Pathway Model for the 300-FF-1 Operable Unit.

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Table 39. Potential Contaminants of Concern[a] for Operable Unit 300-FF-1.

Gross alpha	Strontium
Gross beta	Thallium
pH	Vanadium
Total coliform	Zinc
Total organic carbon	
Total organic halogen	Ammonium
	Chloride
Aluminum	Fluoride
Antimony	Nitrate
Arsenic	Nitrite
Barium	Sulfate
Beryllium	
Cadmium	Arochlor 1248
Calcium	Chloroform
Chromium	1, 2-Dichloroethylene
Copper	Methylene chloride
Iron	Tetrachloroethylene
Lead	Trichloroethylene
Magnesium	
Manganese	Cesium-137
Mercury	Cobalt-60
Nickel	Hydrogen-3
Potassium	Strontium-40
Selenium	Technetium-99
Silver	Uranium-235
Sodium	Uranium-238

[a]Parameters that occur above the upper 95% confidence limit for the 0.99 background quantiles in soil or groundwater and are found in at least 10% of the environmental samples in either medium.

Table 40 lists the critical toxicity value for each of the 300-FF-1 target parameters. The value chosen, when available, is the strictest potential ARAR for human and wildlife exposures in water (Section 3.2). If no potential ARAR is established for a particular target parameter, the critical toxicity value is calculated from available reference dose or carcinogenicity information, as appropriate. Critical toxicity values for carcinogens are expressed as concentrations that would result in a 10^{-6} incremental lifetime cancer risk. The EPA has yet to establish acceptable exposure levels for carcinogens, but a 10^{-6} risk level is generally regarded as being insignificantly small compared to natural background exposures. Critical toxicity values for noncarcinogens are expressed as concentrations that would result in the reference dose, the estimated daily exposure that is likely to result in no deleterious effects over a lifetime.

Table 40. Preliminary Toxicity Assessment for 300-FF-1 Operable Unit Groundwater. (sheet 1 of 2)

Substance or parameter	Strictest ARAR	Critical toxicity value	Maximum value detected[a]
Gross alpha	15 pCi/L (excluding 208 uranium and radon)		
Gross beta	50 pCi/L	121 pCi/L	
pH	6.5 - 8.5 std. units	6.4, 8.5 std. units	
Total coliform	1 mpn/100 mL	--	43 mpn
Total organic carbon	--	--	8,030 µg/L
Total organic halogen	--	--	24, 500 µg/L
Aluminum	--	--	700 µg/L
Antimony	--	14 µg/L[b]	<100 µg/L
Arsenic	50 µg/L	--	<5 µg/L
Barium	1,000 µg/L	125 µg/L	
Beryllium	--	0.0068 µg/L[c]	<5 µg/L
Cadmium	0.81 µg/L[d]	--	<2 µg/L
Calcium	--	24,900 µg/L	--
Chromium	11 µg/L	--	21 µg/L
Copper	8.2 µg/L[d]	--	48 µg/L
Iron	300 µg/L	--	4,870 µg/L
Lead	1.8 µg/L[d]	--	6.1 µg/L
Magnesium	--	--	13,200 µg/L
Manganese	50 µg/L	--	96 µg/L
Mercury	0.012 µg/L	--	<0.1 µg/L
Nickel	13.4 µg/L[d]	--	39 µg/L
Potassium	--	--	11,100 µg/L
Selenium	10 µg/L	--	<5 µg/L
Silver	0.12 µg/L	--	<10 µg/L
Sodium	--	--	258,000 µg/L
Strontium	--	--	310 µg/L
Thallium	----	13 µg/L[e]	<5 µg/L
Vanadium	--	700 µg/L[b]	11 µg/L
Zinc	47 µg/L	--	47 µg/L
Ammonium	--	--	1,630 µg/L
Chloride	250,000 µg/L	--	122,000 µg/L
Fluoride	2,000 µg/L	--	2,080 µg/L
Nitrate	44,000 µg/L	--	82,000 µg/L
Nitrite	--	200 µg/L[f]	NT
Sulfate	250,000 µg/L	--	47,900 µg/L
Arochlor 1248 (PCBs)	--	0.000079 µg/L[c]	<1 µg/L
Chloroform	100 µg/L	42 µg/L	
1,2-dichloroethylene	--	--	72 µg/L
Methylene chloride	--	5 µg/L[g]	3,040 µg/L
Tetrachloroethylene	--	0.7 µg/L[g]	39 µg/L
Trichloroethylene	--	0 µg/L	24 µg/L

Table 40. Preliminary Toxicity Assessment for 300-FF-1 Operable Unit Groundwater. (sheet 2 of 2)

Substance or parameter	Strictest ARAR	Critical toxicity value	Maximum value detected[a]
Cobalt-60	100 pCi/L	--	64 pCi/L
Hydrogen-3	20,000 pCi/L	--	6,480 pCi/L
Technetium-99	900 pCi/L	--	55 pCi/L
Uranium	--	--	120 pCi/L

NOTE: NT = Never tested.
[a]Filtered values reported for metals analyses.
[b]Concentration at the reference dose for human consumption of water Integrated Risk Information System [EPA 1989a (IRIS)].
[c]Concentration at the 10^{-6} incremental cancer risk level for human consumption of water and aquatic organisms (EPA 1989a).
[d]Hardness dependent freshwater quality criterion; the average hardness of 65 mg/L for the Columbia River was used.
[e]Threshold toxicity protection for human consumption of water and aquatic organisms (EPA 1989a).
[f]Concentration protective of salmonid fishes (EPA 1986a).
[g]Concentration at the 10^{-6} incremental cancer risk level for human consumption of water (EPA 1989a).

The assessment in Table 40 was limited to groundwater because of the restricted spatial distribution of soil contamination within 300-FF-1 and the fact that access to the unit is controlled.

There is some potential risk associated with the exposed contaminated soils in the process trenches and ponds through inhalation and ingestion exposure routes. The concentration of chromium (VI) in air which corresponds to a 10^{-6} incremental lifetime cancer risk, for example, is only 0.08 ng/m^3. This, however, is a risk level based on lifetime, not occupational, exposures. Because the trenches and ponds are situated below the land surface (and are thus less vulnerable to wind erosion), the nearest residence is 0.9 mi away, and certain pond soil stabilization measures have already been undertaken (Sections 2.1.4.1.2 and 2.1.4.1.3), there is no significant risk associated with these soils except, perhaps, to those people involved in fugitive dust-generating occupational activities occurring within the contaminated areas.

Table 40 shows that no critical toxicity values are available from EPA CERCLA related sources for:

- Total organic carbon
- Total organic halogen
- Aluminum

- Calcium
- Magnesium
- Potassium
- Sodium
- Strontium
- Ammonium
- 1,2-Dichloroethylene
- Uranium.

The first two parameters, total organic carbon and halogen, are gross indicators of contamination. Thus, they would not be expected to have specific toxicity values. Calcium, magnesium, potassium, and sodium are essential nutrients, and for all practical purposes are nontoxic. The lack of standards and toxicity information on strontium also indicates that it is relatively nontoxic.

Aluminum has no current potential ARAR, but water quality criteria development is pending (EPA 1986a). Aluminum is known to be toxic to aquatic life in certain forms.

Ammonium, while not particularly toxic, is present in equilibrium with ammonia, the principal toxic form of this substance. Ammonia has been reported to be acutely toxic to freshwater organisms at concentrations as low as 530 µg/L, depending on the pH and temperature of the water (EPA 1986a).

No standards exist for 1,2-dichloroethylene; however, EPA has proposed a maximum contaminant level goal of 70 µg/L each for trans- and CIS-1,2-dichloroethylone (50 FR 46936, November 13, 1985).

There are no relevant existing EPA standards for uranium. Uranium is, however, a high-volume waste constituent, and is perhaps the contaminant of most concern for the operable unit. The EPA is currently developing standards for uranium. A value of 3.3 pCi/L is low end of those under consideration (ICF Northwest 1987).

3.3.3 Contaminants of Concern

Table 41 lists those parameters that are known to approach or exceed their critical toxicity values in the 300-FF-1 groundwater. Because groundwater flow is the primary contaminant transport mechanism at the operable unit, these are the parameters upon which the baseline risk assessment and, therefore, the RI/FS should focus.

Table 41. Preliminary List of Contaminants of Concern for Operable Unit 300-FF-1.

Gross alpha	Arochlor 1248
Gross beta	
pH	1,2-Dichloroethylene
	Methylene chloride
Aluminum	Tetrachloroethylene
Antimony	Trichloroethylene
Beryllium	
Cadmium	Cesium-137
Chromium	Cobalt-60
Copper	Hydrogen-3
Iron	Strontium-90
Lead	
Manganese	Uranium-235
Mercury	Uranium-238
Nickel	
Silver	
Zinc	
Ammonium	
Fluoride	
Nitrate	
Nitrite	
Sulfate	

Aluminum, ammonium, nitrite, 1,2-dichloroethylene, and uranium (two isotopes) are retained in this list for the reasons specified in Section 3.3.2. Arochlor 1248 is also retained, even though it has never been detected in the groundwater. The extremely low critical toxicity value provides the rationale for this decision.

Even though no gamma-emitting radionuclides met the criteria for being designated as a contaminant of concern, a gamma scan is added because of the general nature of wastes disposed of within the operable unit. In conjunction with measurements of gross alpha and gross beta, all radiation contamination will be accounted for.

Although total coliforms has exceeded an ARAR in groundwater, it is excluded as a contaminant of concern due to its nonspecificity as an indicator of environmental contamination (Laws 1981).

3.3.4 Imminent and Substantial Endangerments to Public Health and the Environment

Based on the extensive amount of environmental data available, including a recent radiation risk assessment for the Hanford Site as a whole (PNL 1988), 300-FF-1 does not appear to pose any imminent or substantial endangerment to

public health or the environment. The preliminary toxicity assessment does, however, demonstrate that health and safety monitoring and control procedures, with respect to fugitive dust, are appropriate in the immediate vicinity of the exposed soils of the process trenches and ponds. If interim measures are needed to eliminate the fugitive dust pathway, dust suppressants could be utilized to stabilize these soils until remedial action is undertaken.

Because very limited data suggests that waterfowl having access to the process trenches may be contaminated (Section 3.1.6.2), a simple expedited response action to inhibit such access may be advisable. This response action could consist merely of flagging the trenches to discourage waterfowl from landing on the trench water.

Contaminant analysis of wild asparagus growing along the operable unit has been undertaken. Regardless of the results of this analysis, an expedited response action may be needed to eliminate this potential human exposure pathway and to discourage trespassing. Such an action could consist of either posting, fencing, or eradicating the asparagus beds.

3.4 PRELIMINARY REMEDIAL ACTION OBJECTIVES, PRELIMINARY TECHNOLOGIES, AND ALTERNATIVES

Media-specific remedial action objectives for 300-FF-1 have been developed based on the preliminary data regarding the contaminants present, potential exposure pathways, and remediation goals. General response actions have been developed for each medium that will be evaluated and implemented to satisfy the remedial action objectives. Technologies applicable to each general response action have been considered for preliminary screening based on available data. These technologies have been assembled into alternatives for soil, sediment, and groundwater remediation in the 300 Area.

Preliminary remedial alternatives have been developed to address contamination associated with the use of process liquid waste disposal facilities, radioactive liquid waste transfer and storage facilities, burial grounds, and hazardous waste storage facilities. Information regarding historical treatment and disposal activities in the 300 Area has been used to determine possible waste constituents in the soils, sediments, surface water, and groundwater. Additional data will be developed during the RI that may impact the technologies and alternatives that are considered for the operable unit. Groundwater objectives and technologies may be refined in the 300-FF-5 work plan.

3.4.1 Remedial Action Objectives

The contaminants determined to be present and of interest in the operable unit include metals, corrosives, halogenated hydrocarbons, and radionuclides. Additional environmental data gathered during the remedial investigations may expand the list of contaminant types.

Media-specific remedial action objectives and general response actions developed for screening are presented in Table 42. The general response actions are developed to provide for human health and environmental protection. The potential media of concern for the operable unit include: soils beneath and near the process liquid disposal and transfer facilities, burial grounds, and radioactive liquid waste transfer and storage facilities; groundwater; surface water and sediment in the Columbia River; air; and biota.

3.4.2 Preliminary Remedial Technologies

General remedial technologies included for preliminary screening for 300-FF-1 are presented in Table 43. These technologies address the waste constituents expected to be present in soils, sediments, and groundwater. Applicable technologies will be better defined as additional RI data is obtained.

Although remedial response objectives were developed for surface water, air, and biota, no specific remedial technologies and subsequent remedial alternatives have been identified for these media. If any of these media are determined to be substantially impacted during the RI, the source of this impact would be either the soils, sediments, or groundwater. Therefore, remediation of the latter media would achieve the response objectives for the others.

3.4.3 Preliminary Remedial Alternatives

The preliminary identification of remedial alternatives for soils, sediments, and groundwater are presented in Table 44. They include no action with institutional controls, containment, removal/treatment, removal/disposal and in situ treatment alternatives for soils and sediments and no action containment, collection/treatment and disposal alternatives for groundwater. Several technologies will be considered for each remedial alternative. Various combinations of technologies preliminarily listed in Table 31 can be used to form an alternative. Onsite and offsite treatment and disposal options will be considered for each medium, as appropriate. Treated water reuse will also be addressed as an option or in conjunction with discharge to the Columbia River.

Table 42. Preliminary Remedial Action Objectives and General Response Actions for Operable Unit 300-FF-1.

Environmental medium	Remedial action objectives	General response actions
Soil	For human health: Prevent ingestion, inhalation, or direct contact with contaminated soils.	No action: No action with institutional action, such as deed restriction, for land use.
	For environmental protection: Prevent migration of soil contaminants that would result in groundwater or surface water contamination.	Additional site access restrictions. Long-term monitoring.
Biota	For human health: Prevent ingestion of contaminated biota.	No action: No action with monitoring.
	For environmental protection: Prevent adverse environmental impacts on local biota.	Institutional controls: Asparagus posting, fencing, or eradication. Containment action: Capping of contaminated soil/sediment areas to prevent biota exposure to wastes. Containment of contaminate groundwater to prevent migration to surface water and subsequent biota exposure to contaminated water and/or sediments.
Air	For human health: Prevent inhalation of airborne contaminants, and exposure to radiation shine.	No action: No action with institutional actions, such as deed restrictions. Containment actions: Cap or cover soils and/or sediments to prevent airborne migration and volatilization of constituents.

Table 43. Preliminary Remedial Technologies for Operable Unit 300-FF-1 Media. (sheet 1 of 2)

Environmental media	General response actions	Remedial technologies
Soils/sediments	Excavation	Physical removal of waste materials for treatment or disposal.
	Capping	Barrier placed on top of waste materials.
	Chemical stabilization/ solidification	Process to mix chemical wastes with materials (e.g., cement, lime kiln dust, cement kiln dust, fly ash, or proprietary agents) to fix the waste solubility and leachability in a dry aggregate or solid material.
	Landfill	Waste materials are disposed of in an area designed to receive the wastes. Materials may be drummed or disposed of in bulk form.
	Incineration	Combustion/oxidation of organic waste materials at high temperatures.
	Biodegradation	Onsite or in situ treatment of wastes by enhancing the growth of microbes specially adapted to degradation of PCBs and waste constituents.
	Dehalogenation (KPEG process)	Treatment of PCB wastes in which potassium, polyethylene glycol (KPEG) is utilized to dechlorinate the PCB molecule.
	In situ steam stripping	Removes volatile organic constituents from contaminated soils and waste. Dissolved gases are transferred to air streams. Steam is used as the stripping gas.

Table 43. Preliminary Remedial Technologies for Operable Unit 300-FF-1 Media. (sheet 2 of 2)

Environmental media	General response actions	Remedial technologies
Soils/sediments (cont)	Vapor extraction	Removes volatile organic constituents from contaminated soils and wastes. Dissolved gases are transferred to air streams.
	Flushing	Use of water and/or surfactants to enhance elutriation of organic or inorganic contaminants from soil. Used in conjunction with other treatment steps.
	Vitrification	Incorporation of waste materials into a glass matrix by the introduction of electric currents.

Table 44. Preliminary Remedial Alternatives for Operable Unit 300-FF-1.

Environmental medium	Remedial alternative	General response actions
Soils	No action	Deed restrictions for future land use
		Long-term monitoring
		Additional site access restrictions
	Containment	Capping--clay cap, RCRA cap
		Vertical barrier--slurry wall
		Horizontal barrier--synthetic liners, grout injection
	Removal/treatment	Excavation, stabilization
		Excavation, physical treatment (leaching, etc.)
		Excavation, biological treatment
		Excavation, incineration (onsite or offsite)
	Removal/disposal	Excavation, stabilization/fixation, landfill disposal (onsite or offsite)
		Excavation, landfill disposal (onsite or offsite)
	In situ treatment	Solidification
		Biological
		Air stripping (vapor extraction)
		Steam stripping
		Flushing
		Vitrification

4.0 WORK PLAN RATIONALE

The preceding chapters set forth the overall goals and process for the RI/FS, describe the operable unit and its surroundings, and define a conceptual contaminant exposure pathway model for 300-FF-1. The purpose of this chapter is to specify data quality objectives for the RI/FS, and to discuss the approach that will be used to gather and process the information required to satisfy the project goals.

4.1 DATA QUALITY OBJECTIVES

Data quality objectives are specific project data needs:

- Who will use the data
- Why the data are required
- What types of data are needed
- How much data are necessary
- How good must the data be.

These needs are specified, to the extent practicable, to provide objectives which will keep the RI/FS focused on project goals. Table 45 provides a summary of data quality objectives by environmental medium. The groundwater medium will be addressed in the 300-FF-5 work plan.

4.1.1 Data Users

Data users can be grouped into two general categories: primary and secondary. Primary data users are those individuals directly involved in performing the RI/FS project. They include:

- DOE, EPA, and Ecology remedial project managers
- Westinghouse Hanford, EPA, and Ecology unit managers
- The RI and FS coordinators
- The technical contributors.

Secondary data users are those individuals who rely mainly on outputs from the RI/FS to support their activities. Secondary data users also have the opportunity to provide inputs to the primary data users. Inputs may be given during the report review process and through community relations activities. Secondary data users include:

- The Secretary of DOE

Table 45. Data Quality Objectives Summary for Operable Unit 300-FF-1.

Environmental medium	Data uses	Data types	Data quantity	Data quality
Source	Site characterization Occupational health and safety Evaluation of alternatives Design of alternatives Monitoring during remedial action	Facility type Facility location Facility integrity Facility security Waste type Waste quantity Waste concentration Waste properties	Sufficient data exists Operable unit topographic map showing facility locations to be developed Process and retired radioactive sewers to be assessed Sufficient data exists To be assessed in burial ground No. 4 and No. 5 (3 borings in each) Sufficient data exists, except for burial grounds No. 4 and No.5 Sufficient data exists except for burial grounds No. 4 and No. 5 To be further assesssed in the baseline risk assessment	Not applicable Third order precision and accuracy; 2 ft elevational contours; 1:2,400 scale Not applicable Not applicable Level I Levels I and III Levels I and II Not applicable
Geology	Site characterization Evaluation of alternatives Risk assessment Design of alternatives Monitoring during remedial action	Geological structure Lithology Geological unit locations, dimensions, and orientations	Location and structure of paleolevee to be determined Sufficient data exists Sufficient data exists	Not applicable Not applicable Not applicable
Soil	Site characterization Occupational health and safety Risk assessment Evaluation of alternatives Design of alternatives Monitoring during remedial action	Soil type Biological activity Engineering properties Variabliity Permeability Porosity Moisture content Grain size distribution Soil quality Leachability Absorptability	Sufficient data exists Sufficient data exists at each drive sample To be determination during evaluation of soil soildata One determination per boring per geological unit encountered One determination pr boring per geological unit encountered One determination pr boring per geological unit encountered One determination pr boring per geological unit encountered Approximately 44 vertical and 6 horizontal borings Dependent on contaminant distribution results Dependent on contaminant distribution results	Not applicable Not applicable Not applicable Not applicable Not applicable Not applicable Not applicable Not applicable Levels I and II Not applicable Not applicable
Terrestrial biota	Site characterization Risk assessment Evaluation of alternatives Monitoring during remedial action	Potentially impacted fauna and flora Presence of critical habitats of endangered species Biocontamination	Operable unit survey to be performed Operable unit survey to be performed Sufficient data exists	Not applicable Not applicable Not applicable

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- The Regional Administrator of EPA
- The Director of Ecology
- Other federal and state agencies
- Members of the potentially impacted community
- Special interest groups
- The general public.

Due to the general nature of this category of data quality objectives, data users are not identified in Table 45.

4.1.2 Data Uses

Data generated during the RI generally are put to use in one or more of the following categories:

- Site characterization
- Occupational health and safety
- Risk assessment
- Evaluation of alternatives
- Design of alternatives
- Monitoring during remedial action.

Each of these categories of data uses is discussed below in further detail. Table 45 gives an indication of how data gathered on each environmental medium will be applied in the context of these categories.

4.1.2.1 Site Characterization. Site characterization refers to the determination and evaluation of the physical and chemical properties of the site, in this case the 300-FF-1 operable unit. Characterization also includes the development and refinement of the conceptual contaminant exposure pathway model, and the evaluation of the nature and extent of contamination.

4.1.2.2 Occupational Health and Safety. To ensure the health and safety of workers involved in the RI/FS field activities, data are collected on an activity-specific basis. This type of ongoing monitoring data is used--in conjunction with proper safe working practices and utilization of personal protection, as appropriate--to prevent onsite workers from being exposed to harmful amounts of contaminants. This data is also used to determine if there is any immediate concerns for offsite worker and residential populations. The specific data needs for this category, and methods to be

used to satisfy them, are addressed in the health and safety plan (HSP)(Attachment 2).

4.1.2.3 Risk Assessment. Data collected to conduct the baseline risk assessment include input parameters for various performance assessment models, site characteristics, and contaminant information required to evaluate the threats to human and environmental receptors posed by releases of hazardous substances from the operable unit. These needs usually overlap with site characterization needs; however, higher quality data is often needed for risk assessment purposes.

4.1.2.4 Evaluation of Alternatives. Information used to evaluate remedial alternatives during the FS includes site characteristics and engineering data required for the development, screening, and detailed evaluation of such alternatives. Sufficient information is needed only for feasibility-level designs.

4.1.2.5 Design of Alternatives. Once an alternative is selected for implementation, much of the data collected during the RI/FS can be used for the final engineering design. As a specific RI/FS objective, collection of information for use in the detailed, final design is often not cost effective. It is often much more effective to gather such specific information after the record of decision, during a predesign investigation.

4.1.2.6 Monitoring During Remedial Action. The RI/FS data can be used to establish a preremediation baseline data set. Environmental monitoring, after implementation of the selected remedial action, can be performed to allow for comparisons with the baseline data to evaluate the effectiveness of the remedial action. RI/FS data can also be consulted to determine the needs and best methods for any postremediation monitoring that may be needed.

If the selected remedial action has the potential to cause adverse environmental impacts during the construction or operations phases, monitoring will be essential. Obtaining information during the RI/FS to specifically compile a baseline is not, however, an appropriate project objective. Sufficient information will be generated to establish contaminant-specific action levels upon which remedial action monitoring efforts can be focused.

4.1.3 Data Types

The types of data needed to satisfy the project goals are discussed below by medium. Table 45 summarizes the types of data required under each of the following categories.

4.1.3.1 Source Data. The types of source data required to perform the FS are (EPA 1988):

- Facility characteristics
  - Source locations
  - Types of waste containment

- Integrity of waste containment structures
- Nonwaste related engineered structures
- Facility security
- Discharge points

- Waste characteristics

  - Waste types
  - Waste quantities
  - Waste concentrations
  - Waste properties.

4.1.3.2 Geological Data. Pertinent types of geological data needed for the FS are (EPA 1988c):

- Lithology
- Geological unit locations, dimensions, and orientations
- Geological structure.

4.1.3.3 Soil Data. Soil data types required for the FS include (EPA 1988c):

- Soil type
- Holding capacity
- Biological activity
- Engineering properties
- Variability
- Permeability
- Porosity
- Moisture content
- Grain size distribution
- Soil quality (including background conditions)
- Leachability
- Absorptability.

4.1.3.4 Groundwater Data. Data types needed to characterize the groundwater beneath the operable unit will be discussed in the 300-FF-5 work plan.

4.1.3.5 Surface Water and Sediment Data. Data types needed to characterize the surface water and sediments of the Columbia River in the vicinity of the 300 Area will be discussed in the 300-FF-5 work plan.

4.1.3.6 Air Data. The types of atmospheric data needed to perform the FS are (EPA 1988c):

- Precipitation
- Temperature
- Wind velocity
- Evapotranspiration
- Atmospheric stratification
- Magnitudes and frequencies of extreme weather events
- Air quality (including background conditions).

4.1.3.7 Biological Data. The types of biological and ecological data required for the FS are (EPA 1988c):

- Potentially impacted flora and fauna
- Presence of critical habitats
- Biocontamination (including background conditions)
- Land use characteristics
- Water use characteristics.

4.1.4 Data Quantity

The following is a conceptual discussion of the quantities of data that must be obtained during the initial phase of the 300-FF-1 RI. By evaluating data as they become available, phasing the RI/FS, and providing for close interaction between the RI and FS coordinators, data quantity adequacy can be continually assessed, and the scope of the initial phase of the RI altered as required.

If additional data needs are identified late in the first RI phase, additional characterization activities can be scheduled during the treatability investigation. The RI is terminated only when a sufficient amount of information is available to allow for the completion of the FS.

4.1.4.1 Source Data. Much information on facility and waste characteristics for 300-FF-1 are already available. At this point, only selected 300-FF-1 waste transfer, storage, and disposal facilities are targeted for direct

characterization during the RI. Several of the facilities handled only nonhazardous wastes, some have had no documented releases of hazardous substances, and certain facilities can be effectively combined to focus the investigation. Table 46 indicates which of the operable unit facilities, or combination of facilities, will be the focus of the 300-FF-1 RI/FS. Facilities that will not be directly characterized are also indicated, along with a rationale for this decision. The groundwater investigation that will be conducted under 300-FF-5, will provide for at least an indirect characterization of all 300 Area facilities.

Table 46. List of Facilities in Operable Unit 300-FF-1 Which Do and Do Not Require Further Direct Investigation During the Remedial Investigation/Feasibility Study.

Facilities targeted for further investigation
Retired portions of the process sewer and 307 pipeline systems (active portions will be investigated in the 300 Area treated effluent study)
South process pond (including the retired filter backwash pond)
North process pond (including the north process pond scraping disposal area)
307 trenches
Process trenches
307 retention basins
Burial ground No. 4
Burial ground No. 5
Retired radioactive sewer system
340 complex
Sanitary sewer system
Ash pits
Filter backwash ponds
Facilities not requiring further investigation (plus rationale)
Radioactive sewer system (leak detection system in place)
340 complex hazardous waste staging area (no documented releases)
332 hazardous waste staging area (no documented releases)

A general search for and evaluation of any existing facility plans and operations reports will be undertaken to obtain as much information as possible to avoid unnecessary field data collection activities. A series of meetings and site visits with current and past 300 Area employees, familiar with past operations, will also be conducted to assess the completeness of the current understanding of the operable unit.

Source locations for 300-FF-1 facilities are generally well known. Refinements on all locations are needed, but this is especially true in regard to the buried process and retired radioactive sewer pipelines. The depths of the fill in burial grounds No. 4 and No. 5 also need to be determined. Information regarding the specific location of the spill of

phosphoric acid at the 340 complex also needs to be found and evaluated to determine if specific activities need to be undertaken to characterize this release.

Facility locations will be documented by mapping the operable unit--something which will also have to be done for all sampling locations established during the RI. A topographic baseline map of the operable unit, with 2 ft elevational contours, 1:2,400 scale, and third-order accuracy and precision, needs to be developed. Locations of buried pipelines need to be determined by geophysical method over their entire routes, which lie within the operable unit boundaries, if appropriate facility plans are not found. The depth--and perhaps the content, to some extent--of the burial grounds will also be determined by geophysical techniques performed over a relatively tight grid pattern of 20 ft.

Types of waste containment facilities present within the operable unit are well known. Because the major facilities (the south and north process ponds, the 307 trenches, and the process trenches) were designed and operated as soil column disposal facilities for process sewage, their integrities are not in question (i.e., contamination is known to have reached the groundwater). There are no data to suggest that there have been releases of contaminants from burial grounds No. 4 and No. 5, but this will have to be assessed by sampling the underlying soils. The retired portions of the process sewer and 307 pipelines are suspected of leaking; therefore, locations of major leaks will be determined through geophysical methods. Active portions of the process sewer pipelines will be investigated in the 300 Area treated effluent study. It is also possible that the retired radioactive sewer pipelines could have leaked. Due to uncertainties relating to the integrity of the flange gaskets and the stainless steel pipelines used for this system several "in-pipe" remote inspection techniques will be explored as methods for locating suspected points of leakage.

Two of the possible "in-pipe" techniques include electromagnetic induction (also known as eddy-current) and remote camera inspection. In both methods instruments are placed inside the pipeline and moved along the pipe to determine the locations of suspected leaks. Upon completion of the process and retired radioactive sewer surveys, followup characterization of soils in areas of leakage will be conducted under the soil investigation.

The 307 retention basins may have leaked. This likelihood will be assessed by sampling soil columns adjacent to the basins so that their operations will not be impacted.

Information available on nonwaste related engineered structures, facility security, and discharge points for 300-FF-1 is sufficient and adequate for purposes of the FS.

Much information on waste characteristics associated with operable unit facilities and operations is already known, except for burial grounds No. 4 and No. 5. Information on the nature of the contaminants in these landfills is limited to knowing that some uranium-contaminated materials are present. Therefore, characterization of the sources of contamination in these burial

grounds is necessary, even though existing data does not indicate any releases from either of these facilities. Sampling of fill material will be performed in conjunction with the sampling of the underlying soils, as mentioned above. Due to the lack of information regarding what was disposed in these burial grounds, analyses for a spectrum of contaminants broader than the contaminants of concern for the operable unit is indicated. Required information on properties of all significant operable unit wastes will be compiled in a baseline risk assessment task during the RI.

Nonhazardous facilities, which include the sanitary sewer trenches, two ash pits and the water treatment filter backwash pond, will be assessed by sampling to characterize the source. Surface grab samples will be obtained due to lack of information regarding the materials disposed of in these facilities.

4.1.4.2 Geological Data. The geology of 300-FF-1 is generally sufficiently well known to allow the FS to proceed. Many geological data needs overlap with needs for the soil and groundwater media. Additional geological data will be obtained while collecting soil data during this project, and while collecting groundwater data during the 300-FF-5 RI. Such data will be evaluated and incorporated into the project to allow the current understanding of the operable unit geology to be refined.

More recent geological literature may be available to refine the conceptual model. Therefore, a literature survey for the 300 Area geology will be conducted.

4.1.4.3 Soil Data. Information on soil types, holding capacity, and biological activities--or sufficient estimations of these parameters--can be obtained from existing Hanford Site literature on descriptive soil studies.

Engineering and physical data will be obtained from existing borehole and well logs, and from the installation of new boreholes during this project and from the installation of new groundwater monitoring wells during implementation of 300-FF-5. Engineering data (soil density) will be obtained on new borehole and well installations. A discrete sample for the analysis of physical parameters (permeability, porosity, moisture content, and grain size distribution) needs to be obtained at a frequency of one sample per borehole location, at a depth determined by random allocation, in each geological stratum encountered. Only the Hanford formation and the upper portion of the middle Ringold are expected to be encountered during drilling to obtain soil samples for 300-FF-1. One sample per geologic stratum per borehole will provide sufficient information to physically characterize each stratum beneath the operable unit.

The three boreholes that will be placed in the north process pond infiltration basin will be used for comparative purposes. The Hanford formation stratum samples for physical analysis will be taken from a depth of 10 ft below the surface in these boreholes. To test for any differences in sampling method results, the chemical and physical results of these samples will be compared to samples analyzed for the same physical and chemical

parameters obtained from a depth of 10 ft below the surface in existing, adjacent trenches.

Due to the nature of facility types and operations, the flat ground surface at the operable unit, the porous nature of the soils, and existing soil quality data, soil contamination is expected to be confined to areas directly underneath or adjacent to the waste containment, transfer, or disposal structures, except, perhaps, for the south and north process ponds. The failure of south pond berm, resulting in an overland flow event to the Columbia River, is a release event which could have extended the limits of soil contamination. Also, both ponds were periodically dredged, and dredged materials were placed on top of the berms. Such contaminated materials could have been dispersed by surface water runoff or by wind. Because radionuclides are a major group of contaminants associated with the process sewage, the areal extent of such potential surface contamination can be determined with a surface radiation survey. A surface radiation survey will be conducted over the entire surface of the operable unit to detect any contamination outside of the pond basins due to past dredging activities. Transects will be spaced no further than 25 ft apart.

Once the horizontal extent of soil contamination is defined, the vertical extent of such contamination needs to be determined at each waste facility and any other areas found to be contaminated. Previous soils studies within and near the operable unit waste facilities have indicated that contamination generally decreases with depth. In most cases, however, a definitive lower boundary of each significantly contaminated zone has not been determined. Limited information is also available to suggest that contamination is attenuated horizontally rather rapidly. Soil sampling boreholes will be installed within and near waste facilities and in background locations to satisfy these needs.

The nature of soil contamination must be determined below burial grounds No. 4 and No. 5, and be verified in the soils associated with the other targeted facilities. Information on the vertical extent of soil contamination is needed for all targeted facilities to assess the need for, and potential degree of, partial removals of contaminated materials. Because it is assumed that each disposal basin (pond, trench, or distinct subpart thereof) will be remediated as a whole, rather than in portions, the numbers of boreholes proposed for each basin is limited to that necessary to provide an average characterization of the extent of contamination with depth. Depending on the size of the basin, one, two, or three borings should be sufficient. If the process sewer is leaking, or if leaks are found in the retired radioactive sewer, characterization of the soils near the leaks will be conducted through borehole sampling. It is assumed that five such boreholes will be needed, and that an additional three will be required to follow up the surface radiation survey around the south and north process ponds.

Accurate characterization of background conditions is critical for determining what is and is not contaminated. The existing background data is limited in terms of areal coverage and number of samples. Therefore, sufficient background information from five relatively undisturbed locations

within the operable unit will be gathered to allow for meaningful comparisons. This will generate approximately 40 background data points which will provide for an adequate statistical description of conditions. Such samples will be of use, not only for this RI/FS, but for the subsequent investigations and studies that will be conducted for the two remaining 300 Area source operable units.

At each soil station, visual sampling and onsite field screening (for radiation and volatile organics) need to be performed continuously with depth. Discrete samples for contaminant analysis need to be obtained at various depth intervals, depending on the nature of the facility. Because of the hypothesis of rapid vertical attenuation, the sampling interval with depth, for laboratory analysis of contaminant parameters, should be short within the upper portion of each borehole. In general, continuous sampling (1.5-ft intervals) through the first 6 ft immediately below the facility, and samples obtained at 5-ft intervals thereafter--to the water table--should provide the required detail. Sampling intervals will be appropriately adjusted for facilities, such as the burial grounds in the 307 trenches, that contain fill material. In addition to this minimum sampling frequency, discrete samples are required at any changes in lithology and within any zones of apparent contamination that are encountered. Samples of source materials within burial grounds No. 4 and No. 5 will be obtained from the soil sampling stations established within these particular facilities.

Limited information on horizontal contaminant extent is required to verify the hypothesis of no significant lateral contaminant migration within the operable unit soils. Six horizontal boreholes to 3 ft, with samples at 1-ft intervals (to be extended outward if level I screening, see Section 4.1.5, indicates that significant contamination still exists), are proposed for the process trenches. In addition, vertical soil borings will be placed adjacent to the 307 retention basins to determine if they have ever leaked. If vertical borings near the 307 basins do not locate contamination, an angled boring will be installed to characterize the vadose zone directly beneath the basins. These borings are being placed outside of the actual basins so that operations are not disturbed. These borings will also provide information pertaining to lateral contaminant extent. The data obtained from these two facilities will be regarded as analogous for the remaining 300-FF-1 process liquid facilities in regard to lateral contaminant extent within the vadose zone.

Leachability and absorptability testing on the operable unit soils may be required, depending on the vertical distribution of contaminants in the soil column. Duplicate archive samples will be retained, whenever a discrete contaminant sample is obtained, to provide representative material for such testing if it becomes apparent that it is necessary.

A comparison testing program will be established to test the difference in results between borehole versus trench sampling. Existing trench locations will be used in the north process pond. Boreholes will be located next to three of these trenches. Samples will be obtained from a depth of 10 ft below the surface in each borehole and trench for comparative purposes. Samples will be analyzed for contaminants of concern (Table 41) and physical

analysis will be performed to allow a t-test between the means to be conducted for each analytical parameter.

4.1.4.4 Groundwater Data. These data will be gathered during the 300-FF-5 RI.

4.1.4.5 Surface Water and Sediment Data. These data will be gathered during the 300-FF-5 RI.

4.1.4.6 Air Data. Climatological data are available from the HMS, the wind tower at the 300 Area, and nearby weather stations at the Pasco and Richland airports. These data will be compiled to allow for an up-to-date climatic summary for the 300 Area. The summary will provide 30-yr climatic averages (from those stations where sufficient data exists) and frequencies of extreme climatic events.

Because of the potential for fugitive dust emissions, air is a potential pathway of concern in the immediate vicinity of the south and north process ponds and the process trenches (when one is dry). However, extensive air monitoring for the Hanford Site as a whole, and the 300 Area in particular, has demonstrated this pathway to be insignificant under current operating conditions with respect to offsite radiological impacts. Thus, it is highly unlikely that 300-FF-1, which is a small portion of the entire Hanford Site, can significantly impact offsite populations.

Therefore, a limited ambient air investigation will be conducted in conjunction with the ongoing PNL environmental surveillance project for the 300 Area. The current project includes gross beta and gamma counts every two weeks, monthly composite gamma scans, and quarterly composite radiochemical separations and counting for strontium, plutonium and uranium. These data will be obtained for purposes of establishing pre-existing conditions, conducting the no action risk assessment, and assessing the level of 300 Area worker and offsite exposure during characterization. Real-time monitoring fugitive dust for the purpose of controlling offsite exposures is not part of the current program. This will be added to quantify fugitive dust concentrations and control dust generating activities due to characterization.

Because there is a potential for onsite occupational exposure to fugitive dust, while conducting response activities in the immediate vicinity of the process ponds and trenches, health and safety monitoring and personnel protection procedures are appropriate. These procedures are noted in the HSP (Attachment 2).

If either monitoring program demonstrates an unacceptable level of fugitive dust emissions from the process ponds or trenches, dust suppressants could provide interim control until the final remedy is implemented.

4.1.4.7 Biological Data. Because of the nature of the division between 300-FF-1 and 300-FF-5 operable units, the 300 Area biology is divided into the terrestrial and aquatic realms.

4.1.4.7.1 Terrestrial Biological Data. No significant biological receptors, other than human asparagus foragers, are known to inhabit or use the 300-FF-1 ground surface habitat. This, however, needs to be confirmed. Presence and use of this habitat by species need to be determined qualitatively, by means of a literature search and onsite biological survey. This effort should be limited to those species which are endangered, threatened, economically important, or a significant component of the human food chain.

The EPA (1987b) has already determined the absence of critical habitat in the 300 Area vicinity. Confirmation of species presence and use of 300-FF-1 habitat will confirm or deny this determination.

Terrestrial vegetation within the 300 Area has generally higher radionuclide levels than does offsite vegetation. Limited data suggest that waterfowl that visit the process trenches contain elevated levels of radionuclides. No route of exposure from onsite vegetation to the human food chain, other than asparagus consumption, is likely, and the contaminant transport pathway via waterfowl, while undoubtedly minor, can be easily eliminated by deterring their use of the process trenches by flagging or other similar means. Therefore, a general terrestrial biological investigation, beyond the scope of a qualitative literature search and onsite survey, is not necessary. A characterization of the wild asparagus will, however, be performed.

Sufficient information exists on the restricted nature of land use in the vicinity of the operable unit.

4.1.4.7.2 Aquatic Biological Data. These data, including surface water use characteristics, will be gathered during the 300-FF-5 RI.

4.1.5 Data Quality

The EPA has devised a classification of analytical levels for contaminant data. The classification provides for data of better quality as the scale increases (EPA 1987a). Level I consists of field screening methods; Level II entails more advanced onsite analytical techniques; Level III, standard laboratory procedures; Level IV, EPA contract laboratory program (CLP) procedures; and Level V, specially developed procedures to provide a high degree of analytical sensitivity.

As data quality goes up on this scale, costs and turnaround times also increase substantially. Table 47 provides a further definition of these analytical levels.

Table 45 indicates which analytical levels will be used to obtain data of an acceptable quality for the RI/FS. All laboratory analyses will be performed by a laboratory capable of generating results of suitable quality for this project. Any samples containing radioactivity in excess of

Table 47. Analytical Levels.

Level	Description
Level I	Field screening or analysis using portable instruments. Results are often not compound specific and not quantitative, but they are available in real time. This is the least costly of the analytical options. Instruments may not respond to all compounds and may not be able to identify compounds. If the instruments are calibrated properly and data are interpreted correctly, level I techniques can provide an indication of contamination.
Level II	Field analyses using more sophisticated portable analytical procedures such as gas chromatography (GC) for organics and atomic absorption (AA) or x-ray fluorescence (XRF) for metals. The instruments may be set up in a mobile laboratory onsite. Results are available in real time or within several hours and may provide tentative identification of compounds or be analyte specific. Data are typically reported in concentration ranges, and detection limits may vary from low parts per million (p/m) to low parts per billion (p/b). Data quality depends on the use of suitable calibration standards, reference materials, sample-handling procedures, and on the training of the operator. In general, level II techniques and instruments are mostly limited to volatiles and metals.
Level III	All analyses performed at an analytical laboratory. Level III analyses may or may not use contract laboratory program (CLP) procedures but do not usually use the validation or documentation procedures required of CLP level IV analysis. Detection limits and data quality are similar to Level IV, but results will generally be available in a shorter time.
Level IV	Contract laboratory program routine analytical services (RAS). All analyses are performed in an offsite CLP analytical laboratory followed CLP protocols. Generally low part per billion detection limit for substances on the Hazardous Substance List (HSL) but may also provide identification of non-HSL compounds. Sample results may take several days to several weeks, and additional time may be required for data validation. Level IV results have known data quality supported by rigorous quality-assurance and quality control protocols and documentation.
Level V	Analysis by nonstandard methods. All analyses are performed in an offsite analytical laboratory that may or may not be a CLP laboratory. Method development or method modification may be required for specific constituents or detection limits, and additional lead time may be required. Detection limit and data quality are method specific. The CLP special analytical services (SAS) are level V.

200 counts/min will be analyzed in a suitable, qualified, onsite laboratory to prevent such material from leaving the Hanford Site. The sampling equipment and sampling techniques selected for this project will be those proven effective in controlling errors due to sampling.

Three general levels of analysis will be employed for the 300-FF-1 RI. Surveying-type methods (e.g., radiation, geophysics, soil gas) will be used, when appropriate, to locate areas of contamination or potential contamination. Further characterization of such areas will be conducted with standard laboratory methods. Standard laboratory methods will also be used to characterize areas not subjected to surveying-type analysis. In addition, screening methods (e.g., x-ray fluorescence, specific conductance, ion selective electrodes, head space/gas chromatography, solvent extraction/gas chromatography, beta/gamma radiation) will be tested and compared to standard laboratory results. Any useful screening methods will be used extensively in the operable unit characterization process, to reduce costs and provide rapid turnaround.

4.2 WORK PLAN APPROACH

How data will be collected and analyzed is now discussed in general terms to provide an overview of the types of activities needed for the project. These activities are set forth in detail in Chapter 5.0, and further detail is provided in the field sampling plan (FSP) (Attachment 1a).

The RI/FS tasks will be conducted in a phased manner to optimize project efficiency.

4.2.1 Investigation Methodologies

The initial phase of the RI will include the following, integrated, subcomponent investigational tasks:

- A source investigation
- A soil investigation
- An air investigation
- A terrestrial biological investigation.

Each of the interrelated Phase I RI tasks and subtasks is briefly outlined below. Table 48 summarizes the activities that will occur during this phase. Specific Phase II RI activities will be determined later on in the project. These needs, which could include either additional operable unit characterization activities, will be spelled out in the Phase II FS report.

Table 48. Phase I Remedial Investigation Field Tasks for the 300-FF-1 Operable Unit.

Source Investigation

Ground penetrating radar survey--at burial grounds No. 4 and No. 5 on a 20-ft grid.

Electromagnetic survey--along the retired portions of the process and retired radioactive sewer pipeline routes within the operable unit.

Topographic base map development--encompassing the entire operable unit and all groundwater wells outside of the operable unit which are included in the project.

An "in-pipe" inspection--along the entire length of the retired radioactive sewer pipeline, within the operable unit.

Soil gas survey--at burial grounds No. 4 and No. 5 on a 50-ft grid.

Non-hazardous source characterization--at sanitary trenches, two ash pits, and the water treatment filter backwash pond.

Soil Investigation

Surface radiation survey--over the entire operable unit surface (areas covered by sagebrush and scrubgrasses); along transects spaced no greater than 25 ft apart; also, at a minimum of 30 discrete locations on a grid within a background plot.

Soil sampling and analysis--approximately 50 vertical and six horizontal borings (continuous radiation and volatile and ionizable organic screening, and approximately 600-700 discrete downhole sample locations).

A compilation of the most recent information on the geology of the 300 Area.

Soil sampling research--a small-scale effort to compare results of borehole versus trench sampling.

Air Investigation

Use of 300 Area radiological air monitoring data from the established PNL environmental surveillance project, continuous real-time fugitive dust monitoring; short-term upwind/downwind measurements of volatile and semi-volatile organics, particulate borne metals and radionuclides, and meteorological conditions during selected intrusive activities and following characterization.

Terrestrial Biological Investigation

Biological survey--over the entire operable unit surface.

Asparagus characterization--along the entire operable unit riparian zone and in an appropriate background area.

4.2.1.1 Source Investigation. Subtasks to be performed during the source investigation include the following:

- Source data compilation to determine, more precisely, the locations of the process and retired radioactive sewers and to uncover additional information regarding the phosphoric acid spill at the 340 complex; a general search for any other engineering plans and environmental reports related to the operable unit, which were not included in the scoping effort to date, will also be conducted; in addition, this subtask will include a series of meetings and on-site visits with current and past personnel having knowledge of former site operations

- A ground-penetrating radar survey of burial grounds No. 4 and No. 5, to determine the depths and gross nature of the fill materials

- An electromagnetic survey of the retired portions of the process sewer and 307 pipelines (and along the retired radioactive sewer, if necessary) to locate leaks in the sewer system (and to precisely locate the retired radioactive sewer)

- The preparation of an operable unit topographic base map to precisely define the locations of sources and, subsequently, sampling stations

- An "in-pipe" inspection technique along the retired radioactive sewer pipelines, to locate potential leaks within the system

- Surface grab sampling of non-hazardous facilities to characterize the source. Facilities include: sanitary sewer system trenches, ash pits, and water treatment filter backwash pond.

Source sampling and analysis within burial grounds No. 4 and No. 5 is also required. For logistical reasons, this activity will be performed under the soil investigation.

4.2.1.2 Geological Investigation. The 300-FF-1 operable unit geological investigation will consist of two subtasks:

- A compilation of most recent information on the geology of the 300 Area.

Other geological information will be gathered under the soil investigation, and the 300-FF-5 groundwater investigation.

4.2.1.3 Soil Investigation. The 300-FF-1 soil investigation will consist of two subtasks:

- A surface radiation survey conducted over the entire operable unit (areas of sagebrush and scrubgrasses), to determine if soil contamination has spread beyond the boundaries of facilities

- Borehole sampling, and subsequent soil analysis, to determine the nature and extent of contamination and the physical characteristics of the vadose zone.

Where possible, the latter subtask will be combined with groundwater monitoring well installations under 300-FF-5 to reduce drilling costs.

An additional and optional soil investigation activity that may need to be performed, but is not likely to be required, is a leach test. The need and design of such a test is deferred to later phases of the project when soil contaminant profiles are available for evaluation.

4.2.1.4 Air Investigation. The 300-FF-1 air investigation will consist of the following:

- An air data compilation subtask, to compile meteorological data and evaluate the current ambient air monitoring program

- An ambient air sampling and analysis subtask to utilize radiological data from the existing PNL environmental surveillance project and to incorporate continuous real-time fugitive dust monitoring, and short-term nonradiological and meteorological monitoring during selected activities and after characterization for contaminants of concern.

4.2.1.5 Terrestrial Biological Investigation. The biological investigation for the operable unit will consist of a literature search and an onsite, terrestrial biological survey. The purpose of these surveys is to determine the presence within, and use of, the 300-FF-1 habitat by any endangered, threatened, economically important, or significant human food chain component species, and to increase the unit-specific understanding of the terrestrial ecosystem structure and function. The asparagus characterization, initiated during scoping activities, will be completed during this investigation.

4.2.2 Data Evaluation Methodologies

During the RI, data will be evaluated as soon as they become available. This evaluation will allow for the data obtained to be used in rescoping and focusing the RI/FS, as appropriate. The data evaluation task will provide summaries and interpretations of the collected information that will be used to verify contaminant-specific ARARs, develop the baseline risk assessment, perform the FS, and complete the RI report.

Contaminant data for each environmental medium will be plotted so as to facilitate the understanding of the areal or volumetric extent of contamination. Statistical comparisons with background conditions will be performed to determine which contaminants, attributable to the operable unit, are present in elevated concentrations. Although empirical observation will provide the basis for estimating contaminant transport through environmental media, several computer models and codes are available at the

Hanford Site for the analysis of such transport and environmental exposures. Appendix C provides a list of these models and codes.

Once the list of contaminants of concern for the operable unit is well refined, a task will be undertaken to verify contaminant- and location-specific ARARs for 300-FF-1. Regulatory agency participation in this task will be important.

A separate task for the development of the baseline risk assessment is set forth. This task will include the subtasks of contaminant identification, exposure assessment, toxicity assessment, and risk characterization.

The development, screening, and evaluation of remedial alternatives in the FS will be performed using RI data in conjunction with standard costing and technical procedures, knowledge of prior technical applications, and engineering judgement.

4.2.3 Integration of the Remedial Investigation and the Feasibility Study

The RI and FS will proceed concurrently in an interactive manner. The results of the RI allow for the assessment of alternatives in the FS, and the results of the FS focus and define the data needs for the RI. This process is illustrated in Figure 28. The tasks developed for each phase of the project, along with their corresponding subtasks and activities, are discussed in detail in Chapter 5.0.

4.2.4 Integration of the 300 Area Process Trenches Closure Plan with RI/FS Activities

Closure plan development for the 300 Area process trenches is linked to the RI/FS work done for the rest of the 300-FF-1 operable units to ensure that work for both is done efficiently and timely.

4.2.5 Community Relations

The community relations program for the operable unit, set forth in the community relations plan (CRP) (Attachment 5), will be the formal mechanism for incorporating the concerns of secondary data users. Final RI and FS reports will be made available for formal review and comment. The CRP will ensure that all comments and concerns received are adequately and appropriately addressed before the selection of a final remedy.

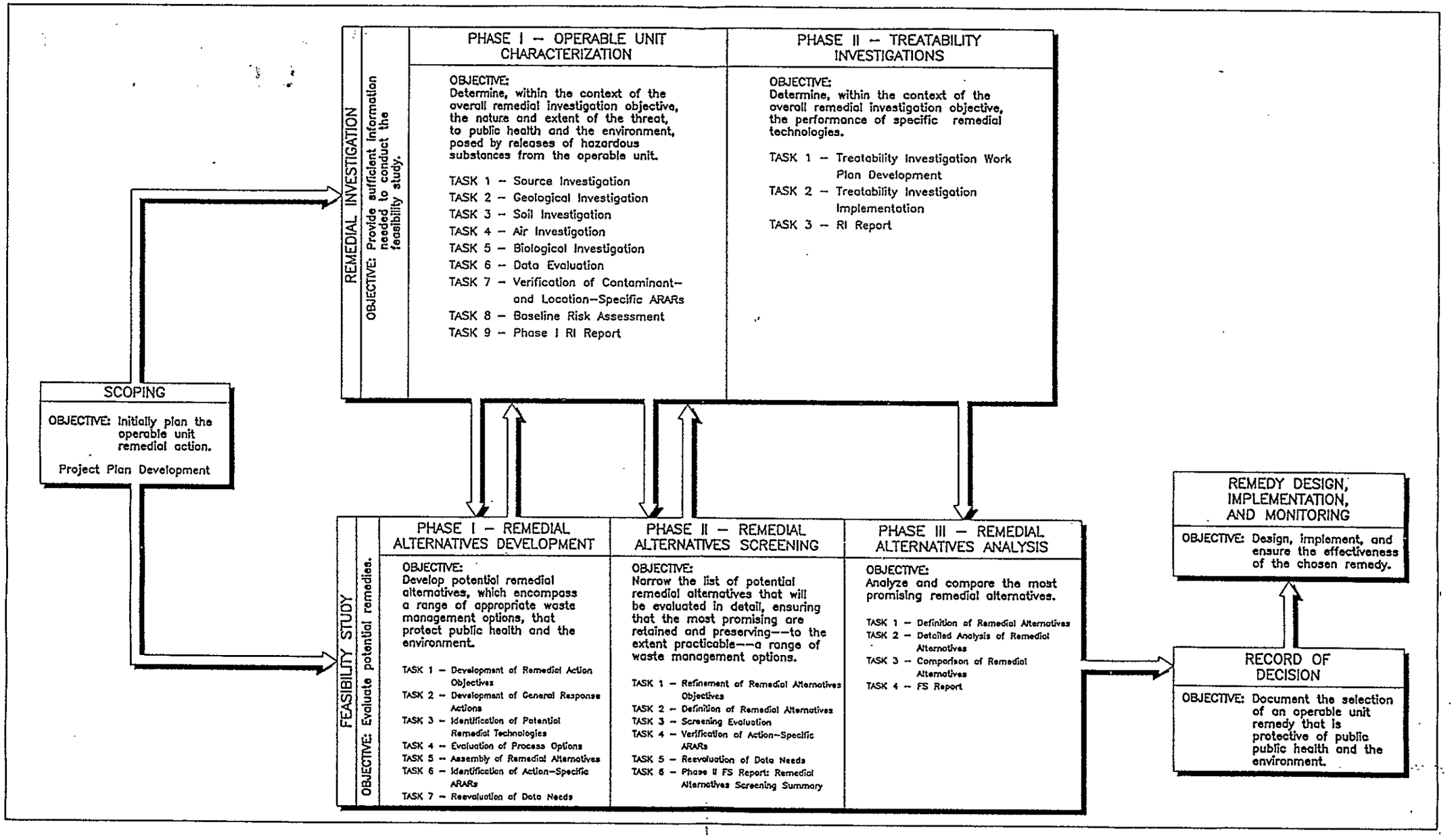

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Figure 28. Remedial Action Process Showing RI/FS Study Tasks for the 300-FF-1 Operable Unit.

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5.0 RI/FS TASKS

The purpose of this chapter is to set forth the various tasks to be implemented during the course of the project. The specified tasks are designed to provide information to meet the data quality objectives identified in Chapter 4.0. Detailed information on sampling locations and frequencies and sample designation are presented in the FSP. Equipment and procedures needed to carry out investigation tasks are specified in the QAPP. Environmental monitoring requirements for the purpose of ensuring the health and safety of onsite investigators are set forth in the HSP.

It will be necessary to update this chapter during the course of the project. Depending on the results of certain tasks, others may need to be created, supplemented, or deleted. As such, this portion of the work plan, and the associated attachments, are meant to function as a living document. Revisions will be made and distributed, as appropriate.

5.1 PROJECT MANAGEMENT

Project management is needed throughout the course of the RI/FS to direct and document project activities and to secure the data and evaluations generated. The initial project management activity will be to assign individuals to roles established in the project management plan (PMP) (Attachment 3). Other tasks that will occur throughout the RI/FS include:

- Task 1--General Management
- Task 2--Meetings
- Task 3--Cost Control
- Task 4--Schedule Control
- Task 5--Data Management
- Task 6--Progress Reports.

Each of these tasks is described below in further detail.

5.1.1 Task 1--General Management

This task includes the day-to-day supervision of, and communication with, project staff and subcontractors. Throughout the project, daily communications between office and field personnel are required, along with periodic communications with subcontractors, to assess progress and to exchange information.

5.1.2 Task 2--Meetings

Meetings will be held, as necessary, with members of the project staff, subcontractors, regulatory agencies, and other appropriate entities to communicate information, assess project status, and resolve problems. A kickoff meeting will be held with appropriate project personnel; project staff meetings will be held on a weekly basis. The frequency of other meetings will be determined based upon need.

5.1.3 Task 3--Cost Control

Project costs will be regularly tracked. Labor, other direct costs, and subcontractor expenses will be tracked on a weekly basis. The budget tracking activity will be computerized, and will provide the basis for invoice preparation and review.

5.1.4 Task 4--Schedule Control

Scheduled milestones will be tracked weekly for each task of each phase of the project.

5.1.5 Task 5--Data Management

The project file will be kept organized, secured, and accessible to the appropriate project personnel. All field reports, field logs, health and safety documents, quality assurance/quality control (QA/QC) documents, laboratory data, memoranda, correspondence, and reports will be logged into the file upon receipt or transmittal. This task is also the mechanism for ensuring that data management procedures, documented in the data management plan (DMP) (Attachment 4), are carried out appropriately.

5.1.6 Task 6--Progress Reports

Monthly progress reports will be prepared, distributed to the appropriate personnel and entities (project and unit managers, coordinators, contractors, subcontractors, etc.), and entered into the project file. These reports will summarize the work completed, present data generated, and provide evaluations of the data as they become available. Progress, anticipated problems and recommended solutions, upcoming activities, key personnel changes, status of deliverables, and budget and schedule information will be included.

5.2 COMMUNITY RELATIONS

Community relations activities will occur throughout the course of the RI/FS. These activities are specified in the CRP (Attachment 5).

5.3 PHASE I REMEDIAL INVESTIGATION--OPERABLE UNIT CHARACTERIZATION

To satisfy the data quality objectives specified in Chapter 4.0, the following tasks will be performed during the initial phase of the RI:

- Task 1--Source Investigation
- Task 2--Geological Investigation
- Task 3--Soil Investigation
- Task 4--Air Investigation
- Task 5--Terrestrial Biological Investigation
- Task 6--Data Evaluation
- Task 7--Verification of Contaminant- and Location-Specific ARARs
- Task 8--Baseline Risk Assessment
- Task 9--Phase I RI Report: Preliminary Operable Unit Characterization Summary.

Each task, and their component subtasks and activities, are outlined below. Sufficient information is provided on each task to allow for the estimation of the project schedule (see Chapter 6.0) and costs. Details regarding specific sampling objectives, locations, and frequencies are provided in the FSP (Attachment 1a). Sampling and analytical procedures are specified in the QAPP (Attachment 1b).

5.3.1 Task 1--Source Investigation

The source investigation for 300-FF-1 is composed of the following subtasks:

- Task 1a--Source Data Compilation
- Task 1b--Ground-Penetrating Radar Survey
- Task 1c--Electromagnetic Survey
- Task 1d--Topographic Base Map Development
- Task 1e--"In-Pipe" Remote Inspection Survey
- Task 1f--Soil Gas Survey
- Task 1g--Non-Hazardous Source Characterization.

5.3.1.1 Task 1a--Source Data Compilation. The source data compilation subtask will consist of two activities that involve the gathering of additional existing information on 300-FF-1 facilities. The activities under this subtask are:

- Task 1a-1--Engineering Plan and Environmental Report Search
- Task 1a-2--Meetings and Site Visits with Former and Current Site Personnel.

The process and retired radioactive sewers are targeted for further investigation. The 340 complex may not need further attention during the RI, but additional information needs to be evaluated before confirming this decision. The first investigation will hopefully obtain such information, and both activities will verify the results of project scoping to date.

5.3.1.1.1 Task 1a-1--Engineering Plan and Environmental Report Search. An attempt will be made to locate additional engineering plans and environmental reports pertinent to 300-FF-1 that have not been reviewed during the scoping process. Any relevant information will be used to refine the operable unit conceptual model and to modify the scope of work, as appropriate. Engineering plans will be reviewed specifically to attempt to precisely locate the buried retired portions of the process sewer and the 307 pipeline within the operable unit. This information will be used to focus the scope of the subsequent EM survey over this structure. Engineering plans will also be reviewed specifically to locate the buried, stainless steel, retired radioactive sewer lines. If insufficient information is available, an EM survey will be conducted along this facility to determine its location, and assist in the subsequent "in-pipe" remote inspection survey.

Two releases associated with the 340 complex are known to have occurred. One, in 1954 (UPR-300-2), was mitigated, and another involved a spill of phosphoric acid. No information on the phosphoric acid spill was available during the development of this work plan; therefore, a search will be conducted to obtain any existing information.

Any information found will be used to develop additional operable unit characterization activities, if necessary. Because phosphoric acid would dissociate upon contact with water in the environment, and phosphate is not a hazardous substance, additional activities are not anticipated.

5.3.1.1.2 Task 1a-2--Meetings and Site Visits with Former and Current Site Personnel. An attempt will be made to identify and locate former and current 300 Area personnel having knowledge of past waste disposal practices. A series of meetings and site visits will be held to obtain further information that may be relevant and useful in refining the operable unit conceptual model. The scope of work for this project may be modified, if necessary, depending on the information obtained.

5.3.1.2 Task 1b--Ground-Penetrating Radar Survey. This subtask is divided into two activities:

- Task 1b-1--Geodetic Survey
- Task 1b-2--Ground-Penetrating Radar Sampling and Analysis.

The scope of this subtask is limited to burial grounds No. 4 and No. 5.

5.3.1.2.1 Task 1b-1--Geodetic Survey. A grid will be established by geodetic survey over the surfaces of burial grounds No. 4 and No. 5. The ground penetrating radar survey will then be conducted along the transects thus established. The grids will be set up at 20-ft intervals.

5.3.1.2.2 Task 1b-2--Ground-Penetrating Radar Sampling and Analysis. The ground penetrating radar survey will be conducted along the transects established in Task 1b-1. The results of the survey will be used to determine the depth of fill, location of any burial trenches within the boundaries of each facility, and locations of any buried objects detectable with this technique. Results will be used to help site boreholes to be installed under Task 3b.

5.3.1.3 Task 1c--Electromagnetic Survey. The electromagnetic survey consists of three activities, two of which focus on the facilities to be investigated:

- Task 1c-1--Retired portions of the process sewer and the 307 pipeline
- Task 1c-2--Retired Radioactive Sewer
- Task 1c-3--Geodetic Survey.

The EM survey will be conducted to screen large areas for possible contamination, or for the purpose of precisely locating the buried structure, in a cost-effective manner. Areas identified as having the potential for being contaminated will be demarcated for further investigation.

5.3.1.3.1 Task 1c-1--Process Sewer. An EM survey will be conducted along the retired portion of the process sewer system that lies within the operable unit boundaries. The survey will also be conducted along the length of the retired 307 pipeline located between the basins and trenches. The purpose of this survey is to determine locations where the pipeline is leaking. At least some of the leaks encountered will be targeted for later soil sampling. If the EM survey is not successful due to local interferences an alternative method, such as a television scan, will be considered.

The survey will be conducted along the retired portions of the process sewer and the 307 pipeline. Variations in resistivity may be caused by changes in soil moisture content, presence of ionic species, or the presence of metallic objects. Because the retired portions of the process sewer are constructed of clay pipe, anomalies detected along the pipeline route should be attributable to pipeline leaks. These anomalies will be identified in the field by staking and flagging the locations of occurrence.

The locations of these anomalies will be geodetically surveyed during Task 1c-3. If Task 1a-1 is unsuccessful in precisely locating the process sewer, the path of the structure will be staked and flagged (in a manner different from that used to demarcate potential leaks) to allow the location of the pipeline to be determined during the geodetic survey.

5.3.1.3.2 Task 1c-2--Retired Radioactive Sewer. Because the retired radioactive sewer is stainless steel, anomalies due to variations in ground resistivity, which may be present from past leaks, may be masked by the presence of the pipe. Therefore, the purpose of conducting an EM survey on this facility is to determine the sewer location precisely (within approximately 10 ft) for the subsequent "in-pipe" remote inspection survey. This EM survey will not be conducted if, during the implementation of Task 1a-2, all portions of this sewer system are located within the operable unit.

If performed, this survey will be conducted in the same manner as that indicated under Task 1c-1. The location of the pipeline will be staked and flagged for the subsequent geodetic survey.

5.3.1.3.3 Task 1c-3--Geodetic Survey. The locations of anomalies found during Task 1c-1, and, if necessary, the locations of the sewer lines as determined during Tasks 1c-1 and 1c-2, will be geodetically surveyed for N-S/E-W coordinates. This information will be used in the preparation of the 300-FF-1 topographic base map (Task 1d).

5.3.1.4 Task 1d--Topographic Base Map Development. The operable unit map will be prepared to show elevation contours at 2-ft intervals at a scale of 1:2, 400. Specific 300-FF-1 features, such as the operable unit boundary, fence lines, gates, buildings, restricted areas, pipelines, other facilities, and existing sampling locations (e.g., groundwater monitoring wells and air monitoring stations) will be included.

The map will extend at least 330 ft beyond the 300-FF-1 boundary. The topographic map will be compatible with the N-S/E-W coordinate system used for the existing operable units maps for the 300 Area. Third-order precision and accuracy will be used in developing the map. The map will be periodically updated during the course of the RI/FS to incorporate sampling locations established under other subtasks.

5.3.1.5 Task 1e--"In-pipe" Remote Inspection Survey. The purpose of this subtask is to detect leaks within the retired radioactive sewer system. The "in-pipe" remote inspection subtask is, in turn, comprised of four activities:

- Task 1e-1--Mobilization
- Task 1e-2--"In-pipe" Remote Inspection
- Task 1e-3--Data Analysis
- Task 1e-4--Geodetic Survey.

5.3.1.5.1 Task 1e-1--Mobilization. Several matters must be handled during the "in-pipe" remote inspection mobilization activity. First, the feasibility of accessing the retired radioactive sewer system through cleanouts and the ability to safely place equipment into the pipeline, with subsequent removal of the equipment, must be determined.

The most feasible "in-pipe" technique for this activity must also be determined. Presently there are at least two techniques that may prove worthy of further consideration. The first is an electromagnetic induction technique (also known as the eddy-current inspection). In this technique, the excitation source and the receiver are both enclosed in a remote probe that is fed into the pipe. Having both units in the pipe greatly reduces interference from other nearby pipes and cables, and greatly simplifies data interpretation. This technique works well in the presence of murky water and other obstructions to vision.

The second method is a remote television camera inspection technique. If viewing conditions are good, this method provides the most unambiguous evidence of leaks. Each of these methods, and other methods to be considered, must be tested in environments similar to that anticipated or proof from previous experience must be documented.

Thirdly, a decision will have to be made as to whether the entire retired radioactive sewer will be inspected or whether only the portion of the pipeline in the 300-FF-1 operable unit will be inspected. If only the 300-FF-1 portion is to be surveyed, then the extent and number of excavations at the boundary locations must be determined, or alternatively, the number and location of cleanouts nearest the 300-FF-1 boundary must be determined.

5.3.1.5.2 Task 1e-2--"In-Pipe" Remote Inspection. After preliminary tests have been completed to ascertain which method will be used, the instruments will be installed in the pipeline and the survey will be performed. The instruments must have the capability of determining its exact location within the pipeline relative to the starting location to assist in locating possible cracks or leaks that it encounters.

5.3.1.5.3 Task 1e-3--Data Analysis. Data analysis will take place either as the survey is being conducted or after the conclusion of the test to determine the presence or absence of cracks or leaks. If a possible leak is detected, its position shall be determined relative to the surface. Flags will be posted at surface locations along the pipeline to determine locations that will be excavated or where soil samples will be taken later in Task 3b.

5.3.1.5.4 Task 1e-4--Geodetic Survey. Locations of potential cracks or leaks in the pipeline will be surveyed as to location on N-S/E-W coordinates.

5.3.1.6 Task 1f--Soil Gas Survey. The purpose of this subtask is to determine the areal extent of specific operable unit volatile contaminants of concern at the burial ground No. 4 and burial ground No. 5. The soil gas survey subtask is, in turn, comprised of four activities:

- Task 1f-1--Mobilization

- Task 1f-2--Gas Probe Installation
- Task 1f-3--Soil Gas Sampling and Analysis
- Task 1f-4--Geodetic Survey.

5.3.1.6.1 Task 1f-1--Mobilization. Several matters must be handled during the soil gas mobilization activity. First, the feasibility of driving soil gas probes in the soils of 300-FF-1 must be demonstrated. If this can not be readily accomplished, temporary gas wells will have to be installed at the soil gas points. If gas wells need to be installed in lieu of driven probes, coordination with the drilling subcontractor must also take place.

5.3.1.6.2 Task 1f-2--Gas Probe Installation. To maximize the sensitivity of the soil gas survey, probes or wells must be installed deep enough to prevent the influence of atmospheric pressure on the variability of soil gas readings. All sampling will be conducted during periods of falling barometric pressure. If driving probes to the required depth is not feasible (Task 1f-1) polyvinyl chloride gas wells will be installed with auger drilling techniques.

Probes or wells will be installed on a 50-ft grid spacing at burial grounds No. 4 and No. 5.

5.3.1.6.3 Task 1f-3--Soil Gas Sampling and Analysis. Once the gas probes or wells are installed at each defined grid point, the soil gas sampling and analysis will be performed. Sampling points will be staked for identification during the subsequent surveying to be performed under Task 1f-4. Sampling points where operable unit volatile organic contaminants of concern are detected will be targeted for standard laboratory volatile organic analysis during the soil sampling and analysis (Task 3b).

5.3.1.6.4 Task 1f-4--Geodetic Survey. Locations of the gas probes or wells, installed under Task 1f-2, will be surveyed as to location and elevation on N-S/E-W coordinates.

5.3.1.7 Task 1g--Non-Hazardous Source Characterization. The purpose of this subtask is to determine if further investigations will be necessary at the non-hazardous facilities that include the sanitary trenches, ash pits, and water treatment filter backwash pond.

Surface grab samples will be obtained in the following numbers; three along the length of the sanitary trenches (the dry trench, if the trenches are alternated); three from each of the two ash pits; and three from the water treatment filter backwash pond.

5.3.2 Task 2--Geological Investigation

The geological investigation for the operable unit consists of one subtask: Task 2a--Geological Data Compilation. This subtask encompasses the collection of existing geological information pertinent to the 300 Area.

Additional geological data will be collected under the soil and 300-FF-5 groundwater investigations during drilling activities.

5.3.2.1 Task 2a--Geological Data Compilation. A literature review will be conducted under this activity to gather the most recent geological information pertaining to the 300 Area. This information will be used to characterize the geology of 300-FF-1 in the final RI report.

5.3.3 Task 3--Soil Investigation

The 300-FF-1 soil investigation consists of two subtasks:

- Task 3a--Surface Radiation Survey
- Task 3b--Soil Sampling and Analysis.

5.3.3.1 Task 3a--Surface Radiation Survey. The surface radiation survey for the operable unit is divided into two activities:

- Task 3a-1--Surface Radiation Sampling and Analysis
- Task 3a-2--Geodetic Survey.

This survey will be conducted over the entire operable unit (area of sagebrush and scrubgrasses).

5.3.3.1.1 Task 3a-1--Surface Radiation Sampling and Analysis. The surface of the operable unit will be surveyed for gamma and beta activity. Portable beta/gamma radiation detectors, of the type normally used for such surveys at the Hanford Site, will be employed. An operable unit-specific background plot will first be established by conducting the survey on land surfaces west of the operable unit boundary on a grid established at about 25-ft intervals.

The ground surface will be continuously surveyed in those areas outside established radiation zones. Areas with radiation statistically greater than area background will be staked and flagged for the geodetic survey under Task 3a-2 and for more detailed soil inspection under Task 3b-4.

5.3.3.1.2 Task 3a-2--Geodetic Survey. Areas where elevated radiation is encountered under Task 3a-1 will be geodetically surveyed to establish the N-S/E-W coordinate locations on the operable unit map.

5.3.3.2 Task 3b--Soil Sampling and Analysis. The purpose of this subtask is to characterize the type and extent of soil contamination at areas of known and suspected contamination. This characterization is designed to supplement the existing database in areas that have been partially characterized, provide background soils data for use in the assessment of soil contamination, and provide data in areas of known but uncharacterized contamination.

This subtask is divided into six phases, each of which will be conducted as a separate activity:

- Task 3b-1--Mobilization
- Task 3b-2--Soil Sampling
- Task 3b-3--Soil Sampling Research
- Task 3b-4--Soil Sample Analysis
- Task 3b-5--Geodetic Survey
- Task 3b-6--Borehole Abandonment.

The sampling of source materials within burial grounds No. 4 and No. 5 is included in the second activity.

5.3.3.2.1 Task 3b-1--Mobilization. Matters to be addressed in this mobilization activity include an evaluation of drilling and soil sampling methodologies, an evaluation of archeological resources within the operable unit, and coordination with the drilling subcontractor.

Before proceeding with the installation of soil boreholes, existing drilling and soil sampling methodologies, which are approved for use at the Hanford Site, will be evaluated to select the respective methods that are most efficient and effective.

A file and field survey of all proposed drilling sites will be conducted to ensure that no significant archeological resources are disturbed during the implementation of Task 3b.

Coordination with the drilling subcontractor will occur to prepare for the upcoming drilling activities.

5.3.3.2.2 Task 3b-2--Soil Sampling. Borehole soil sampling will proceed in three parts: characterization of background conditions, characterization of contaminated soils associated with specific 300-FF-1 waste facilities, and characterization of soils potentially contaminated as interpreted from the electromagnetic, "in-pipe" remote inspection, and surface radiation surveys. All boreholes installed under this activity will be properly abandoned in accordance with regulatory requirements (Task 3b-6) upon completion of the geodetic survey (Task 3b-5).

Background Soil Characterization. Background levels have not been sufficiently characterized to assess contamination within soils of the 300-FF-1 operable unit. A total of five randomly located borings will be drilled in areas not impacted by operational activities at the 300 Area, to obtain vadose zone samples for soil background analysis. During drilling, soil samples will be collected for standard laboratory analysis of the contaminants of concern (see Table 41). The soil samples will be analyzed by the following screening methods for the contaminants listed; x-ray

fluorescence (XRF) - aluminum, antimony, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, zinc, sulfur, and uranium; specific conductance; ion selective electrode - ammonium, pH, fluoride, and nitrate; head space/gas chromatography (GC) - trans-1,2-dichloroethylene, methylene chloride, tetrachloroethylene, and trichloroethylene; solvent extraction/gas chromatography (GC) - arochlor 1248; and beta/gamma radiation. The soil samples will also be analyzed by standard laboratory analysis methods for the operable unit contaminants of concern (Table 41). The results will be compared to determine if a correlation exists between the results from screening methods and standard laboratory analysis methods. Statistical values for each constituent of concern will be calculated from these data for the purposes of determining any correlation and the determination of the distribution of contaminants in the background area. If the results of the laboratory screening methods are comparable to the standard analytical procedures, screening of all samples collected on the 300-FF-1 project will be conducted.

Based on the results of the surface radiation survey conducted in Task 3a-1, and known operable unit-specific engineering information, potential background areas from within the operable unit will be delineated. The following areas will be excluded from consideration: areas of elevated surface radiation, waste management units, areas impacted by unplanned release events, areas where fill has been deposited or obtained, and all areas within a distance of 50 ft of any engineered facilities. The vertical sampling in each of these boreholes will be initiated 5 ft below the surface to preclude eolian sands from being utilized for background vadose zone characterization. Therefore, the characterization will focus on the Pasco Gravels of the Hanford formation.

Samples will be obtained within all background borings at 5-ft intervals from 5 ft below the ground surface to the water table. The data generated from the background investigation will be used to determine the background levels for constituents of concern for the subsequent investigation at 300-FF-1. Physical samples will be randomly obtained at a rate of one per geologic stratum encountered per borehole. A determination of cation exchange capacity will be included with the physical parameters.

All background borehole locations and surface elevations will be surveyed upon completion of drilling activities (see Task 3b-5).

Facility Soil Characterization. This activity entails the characterization of contaminated or potentially contaminated soils directly associated with the south process pond, the north process pond, the 307 trenches, 307 retention basins, the process trenches, and burial grounds No. 4 and No. 5. Soil characterization at other locations within the operable unit will be driven by the results of the EM survey conducted on the process sewer (Task 1c-1), the "in-pipe" remote inspection survey (Task 1e), and the surface radiation survey (Task 3a). A soil gas survey will be conducted at burial grounds No. 4 and No. 5 (Task 1f).

Vertical borings will be drilled in the following facilities; burial grounds No. 4 and No. 5; north process pond; south process pond; 307 retention basin; 307 trenches; and, process trenches. Vertical borings and analysis will occur in two stages.

Stage I requires one vertical boring be drilled in each of the above facilities. Each boring will be sampled at intervals described below. The samples will be analyzed by screening methods XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation) and standard laboratory analysis methods for operable unit contaminants of concern (Table 41). The results will be compared to determine if a correlation exists between the results from screening methods and standard laboratory analysis methods. If the results of the screening methods are comparable to standard analytical procedures, screening of all samples collected in stage II will be conducted.

Stage II requires that vertical borings be drilled and sampled in each facility as described below. Samples will be analyzed by screening methods determined for use in stage I. When and if screening methods are used, a minimum of five percent of the samples analyzed will be verified by standard laboratory analysis for the operable unit contaminants of concern (Table 41).

South Process Pond. Samples have been collected to depths of approximately 10 to 15 ft beneath the south process pond. Additional sampling is required to characterize the vertical extent of soil contamination beneath the pond basins.

Vertical borings will be drilled in each of the pond basins. One boring will be centered in each of the three settling basins. An additional two borings will be drilled in each of the two infiltration basins. These borings will be located in the south central and north central portion of the basins.

Each boring will be sampled for contaminant analysis (samples analyzed by screening methods and/or standard laboratory analysis) at a minimum of 1.5-ft intervals to a depth of 6 ft; and, thereafter, at intervals of 5 ft to 10 ft below the natural water table. Any changes in lithology will also be sampled. Sample parameters selected for laboratory analysis will include the operable unit contaminants of concern (see Table 41); screening methods may include XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation. Physical samples will be randomly obtained at a rate of one per geologic stratum encountered per borehole. A determination of cation exchange capacity will be included with the physical parameters.

All borehole locations and surface elevations will be surveyed upon completion of drilling activities (see Task 3b-5).

North Process Pond. Samples have been collected to depths of approximately 10 to 15 ft beneath the north process pond. Additional sampling is required to characterize the vertical extent of vadose zone contamination

beneath the pond basins and in the adjacent north process pond scraping disposal area.

Vertical borings will be drilled in each of the process pond basins and in the neighboring disposal area. One boring will be centered in each of the settling basins. There are six settling basins in the north process pond. An additional three borings will be drilled in the infiltration basin. These borings will be located next to existing trenches within the basin. Two borings will also be drilled within the adjacent north process pond disposal area.

Each boring will be sampled for contaminant analysis (samples analyzed by screening methods and/or standard laboratory analysis) at a minimum of 1.5-ft intervals to a depth of 6 ft; and, thereafter, at intervals of 5 ft to 10 ft below the natural water table. Any changes in lithology will also be sampled. Sample parameters selected for laboratory analysis will include the operable unit contaminants of concern (see Table 41); screening methods may include XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation. Physical samples will be randomly obtained at a rate of one per geologic stratum encountered per borehole. Physical samples obtained from three boreholes located in the infiltration basin next to existing trenches are involved in a small-scale research program. Samples of the stratum will be obtained from a depth of 10 ft below the surface in each borehole and trench for comparative purposes. A determination of cation exchange capacity will be included with the physical parameters.

All borehole locations and surface elevations will be surveyed upon completion of drilling activities (see Task 3b-5).

307 Trenches. Only a few samples have been collected from one end of the 307 trenches. Additional samples are required to characterize soils disposed of in the trenches, as well as the extent of vadose zone contamination beneath the trenches. A total of three vertical borings will be drilled in each trench. These borings will be evenly spaced within the accessible portion of the trenches (some 300 Area structures overlie portions of the backfilled trenches).

Each boring will be sampled for contaminant analysis (samples analyzed by screening methods and/or standard laboratory analysis) at a minimum of 1.5-ft intervals to a depth of 6 ft below the former trench bottoms. Thereafter, such samples will be taken at intervals of 5 ft to 10 ft below the natural water table. Any changes in lithology will also be sampled. Sample parameters selected for laboratory analysis will include the operable unit contaminants of concern (see Table 41); screening methods may include XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation. Physical samples will be randomly obtained at a rate of one per geologic stratum encountered per borehole. A determination of cation exchange capacity will be included with the physical parameters.

All borehole locations and surface elevations will be surveyed upon completion of drilling activities (see Task 3b-5).

307 Retention Basins. Samples are required adjacent to the 307 retention basins to determine whether or not these basins have leaked. Such samples must be obtained in a manner that will not interfere with the operations or damage the integrity of this facility. Three vertical borings will be drilled immediately adjacent to the walls of the structure, one each along the west, east, and south walls. This boring configuration will provide coverage at opposite ends of the two major subbasins and at the juncture of these subbasins.

Each boring will be sampled for contaminant analysis (samples analyzed by screening methods and/or standard laboratory methods) at a minimum of 1.5-ft intervals to a depth of 6 ft below the former trench bottoms. Thereafter, such samples will be taken at intervals of 5 ft to 10 ft below the natural water table. Any changes in lithology will also be sampled. Sample parameters selected for laboratory analysis will include the operable unit contaminants of concern (see Table 41); screening methods may include XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation. Physical samples will be randomly obtained at a rate of one per geologic stratum encountered per borehole. A determination of cation exchange capacity will be included with the physical parameters.

All borehole locations and surface elevations will be surveyed upon completion of drilling activities (see Task 3b-5).

Process Trenches. Both trench bottom and vadose zone sampling has been conducted for the process trenches. Additional sampling is required to determine the extent of subsurface soil contamination directly below and laterally adjacent to the process trenches.

A total of three borings will be drilled beneath the west process trench, at evenly spaced intervals to evaluate the extent of contamination below the process trenches. Two horizontal borings, one in each trench side, will be placed at each vertical boring location. Following analysis of the results from the initial borings, a minimum of one additional boring will be drilled within the east trench to confirm spatial uniformity of results between the trenches. Additional borings within the east trench may be added if results from the initial three borings in the west trench indicate a need for further data.

Each vertical boring will be sampled for contaminant analysis (samples analyzed by screening methods and/or standard laboratory methods) at a minimum of 1.5-ft intervals to a depth of 6 ft; and, thereafter, at intervals of 5 ft to 10 ft below the natural water table. Any changes in lithology will also be sampled. Each horizontal boring will be sampled for laboratory analysis at a minimum or 1-ft intervals to a distance of 3 ft.

Sample parameters selected for laboratory analysis will include the operable unit contaminants of concern (see Table 41); screening methods may

include XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation. Physical samples will be randomly obtained at a rate of one per geologic stratum encountered per borehole. A determination of cation exchange capacity will be included with the physical parameters.

All borehole locations and surface elevations will be surveyed upon completion of drilling activities (see Task 3b-5).

Burial Ground No. 4. Burial ground No. 4, located in the northern portion of 300-FF-1, has not been previously sampled. This unit was used to dispose of a variety of materials containing uranium. Initially, a 60-point soil gas survey will be conducted at burial ground No. 4 on a 50-ft grid.

Three vertical borings will be drilled within the burial ground. Exact locations will be determined upon completion of the ground-penetrating radar and soil gas survey, at which time it may be decided to install more than three borings. The borings will be randomly located, excluding potential hazard zones such as buried drums, identified in Task 1b-2. Zones could be characterized by less destructive and safer techniques such as excavation should the need arise.

Core samples and drill cuttings obtained from the borings will be continuously sampled and analyzed with hand-held instruments for radiation and volatile organic compounds. Core samples for contaminant analysis (samples analyzed by screening methods and/or standard laboratory methods) will be collected at a minimum of 1.5-ft depth intervals through the fill material, to a depth of 6 ft below the fill. Sampling will continue from this point at 5-ft intervals to 10 ft below the water table. Changes in lithology encountered will also be sampled. Sample parameters selected for laboratory analysis will include the operable unit contaminants of concern (see Table 41); screening methods may include XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation. Physical samples will be randomly obtained at a rate of one per geologic stratum encountered per borehole. A determination of cation exchange capacity will be included with the physical parameters.

All borehole locations and surface elevations will be surveyed upon completion of drilling activities (see Task 3b-5).

Burial Ground No. 5. Burial ground No. 5 has not been previously sampled. This facility was used to burn materials, some of which contained uranium. Initially, a 20-point soil gas survey will be conducted at burial ground No. 5 on a 50-ft grid.

Three vertical borings will be drilled within the burial ground. Exact locations will be determined upon completion of the ground-penetrating radar and soil gas surveys. If the surveys indicate that more than three borings will be required, additional sampling locations will be allocated. The borings will be randomly located excluding potential hazard zones, such as buried drums, identified in Task 1b-2. Zones could be characterized by

less destructive and safer techniques such as excavation should the need arise.

Core samples for contaminant analysis (samples analyzed by screening methods and/or standard laboratory methods) will be collected at a minimum of 1.5-ft depth intervals through the fill material, to a depth of 6 ft below the fill. Sampling will continue from this point at 5-ft intervals to 10 ft below the water table. Changes in lithology encountered will also be sampled. Sample parameters selected for laboratory analysis will include the operable unit contaminants of concern (see Table 41); screening methods may include XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation. Physical samples will be randomly obtained at a rate of one per geologic stratum encountered per borehole. A determination of cation exchange capacity will be included with the physical parameters.

All borehole locations and surface elevations will be surveyed upon completion of drilling activities (see Task 3b-5).

Survey Followup Soil Characterization. The purpose of this activity is to determine the nature and extent of soil contamination in areas of the operable unit identified as being potentially contaminated, as indicated by the results of the EM, "in-pipe" remote inspection, soil gas, and surface radiation surveys (Tasks 1c-1, 1e, 1f, and 3a, respectively).

Boreholes will be installed and sampled in representative areas, along the retired portions of the process sewer found to be leaking, during the implementation of Task 1c-1. Potential leaks found in the retired radioactive sewer, during Task 1e, will also be sampled in this manner, and soil samples will be obtained in areas where the radiation survey has detected statistically elevated radiation levels.

Although borehole locations can not be determined at this time, it is assumed that eight boreholes will be sampled under this portion of the soil sampling activity. Core samples will be obtained for laboratory analysis at a minimum of 5-ft intervals to a depth of approximately 10 ft below the water table. Changes of lithology and areas of elevated contamination, as determined by field screening results or visual observation, will also be sampled in this manner. Core samples will be obtained at 1.5-ft intervals to a depth of 6 ft from boreholes installed where ground surfaces are determined to be contaminated by the surface radiation survey. Boreholes installed along the buried pipelines will have core samples obtained at 1.5-ft intervals to a depth of 6 ft below the elevation of the pipe. In both types of locations, sampling will continue to the water table at 5-ft intervals. Sample parameters selected for laboratory analysis will include the operable unit contaminants of concern (see Table 41); screening methods may include XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation. Physical samples will be randomly obtained at a rate of one per geologic stratum encountered per borehole. A determination of cation exchange capacity will be included with the physical parameters.

All borehole locations and surface elevations will be surveyed upon completion of drilling activities (see Task 3b-5).

5.3.3.2.3 Task 3b-3--Soil Sampling Research. The borehole locations in the north process pond infiltration basin will be located next to three existing trenches. Samples will be obtained from a depth of 10 ft below the surface in each borehole and trench for comparative purposes. Samples will be analyzed for contaminants of concern (see Table 41) and physical parameters. Pending results, additional samples may be taken.

The three boreholes sampled in the task will also be samples per Task 3b-2, Soil Sampling.

5.3.3.2.4 Task 3b-4--Soil Sample Analysis. Soil samples obtained for laboratory analysis under Task 3b-2 will be analyzed in a qualified laboratory.

5.3.3.2.5 Task 3b-5--Geodetic Survey. Boreholes sampled under this subtask will be surveyed to establish their surface elevations and N-S/E-W coordinates.

5.3.3.2.6 Task 3b-6--Borehole Abandonment. Upon completion of each boring installed under Task 3b-2, the borehole will be properly abandoned in accordance with regulatory requirements. A marker will be placed at each station after abandonment to allow for the geodetic survey (Task 3b-5).

Upon completion of trench sampling under Task 3b-3, the trenches established in 1988 will be backfilled.

5.3.4 Task 4--Air Investigation

The 300-FF-1 air investigation consists of two subtasks:

- Task 4a--Air Data Compilation
- Task 4b--Ambient Air Sampling and Analysis.

5.3.4.1 Task 4a--Air Data Compilation

This subtask is separated into two activities:

- Task 4a-1--Meteorological Data Compilation
- Task 4a-2--Ambient Air Monitoring Program Evaluation.

5.3.4.1.1 Task 4a-1--Meteorological Data Compilation. Existing climatic data from the HMS will be compiled. Information describing averages and extremes of precipitation, temperature, barometric pressure, wind velocity, and evapotranspiration are required. These parameters should be averaged over the past 30 yr to allow for an accurate description of average climatic

conditions and variations. Frequencies and magnitudes of extreme weather events will be derived from all available information.

5.3.4.1.2 Task 4a-2--Ambient Air Monitoring Program Evaluation. The existing ambient air monitoring program for the 300 Area will be evaluated to augment the parameter list with soil contaminants of concern for the operable unit. The additional parameters will be incorporated into the ongoing monitoring program, which will then be implemented as Task 4b. The parameters added to the program will be those not currently included in sample analyses. The focus will be on those contaminants that are most toxic and most prevalent in the surface soils of the south and north process ponds and the process trenches (e.g., chromium). Such compounds pose the greatest threat in an air pathway due to fugitive dust emissions.

As a part of this activity, revisions to the FSP and QAPP will be made as needed, to take into account additional parameter analyses and any adjustments to the sampling procedures, locations, or frequencies that may be deemed necessary.

For scheduling and costing purposes, it is assumed that three additional parameters will be added to the ongoing program, and that no changes will be required in sampling locations, frequencies, and procedures or in analytical procedures, other than the addition of procedures to allow for added parameter analyses.

5.3.4.2 Task 4b--Ambient Air Sampling and Analysis. The ambient air sampling and analysis will be performed under two activities:

- Task 4b-1--Ambient Air Sampling
- Task 4b-2--Ambient Air Sample Analysis.

This subtask will consist of the utilization of data from the ongoing PNL environmental surveillance project ambient air monitoring effort for the 300 Area, supplemented to include real-time fugitive dust and nonradiological monitoring.

5.3.4.2.1 Task 4b-1--Ambient Air Sampling. Radiological air sampling results from the ongoing PNL environmental surveillance project for the 300 Area and adjacent public exposure locations will be summarized for the 2 yr prior to characterization as the basis for a no action alternative risk assessment, and throughout characterization activities. The data collected during characterization activities can be used to place an upper bound on the effects of these activities. Long-term real-time fugitive dust sampling will be conducted during all intrusive characterization activities as a means of quantifying dust concentrations and controlling dust generating activities to levels in compliance with radiological and chemcial exposure ARARs. Short-term volatile and semi-volatile organics, and particulate borne metals and radionuclide measurements will be made upwind and downwind once during a selected characterization activity and once after characterization for each of three subzones in the operational unit. Short-term onsite meteorological monitoring will also be conducted.

5.3.4.2.2 Task 4b-2--Ambient Air Sample Analysis. Radiological data utilized from the PNL environmental surveillance project will have been collected under the existing procedures for that project. Short-term monitoring of nonradiological and meteorological parameters will be in accordance with ongoing procedures established, updated to include short-term radiological sampling and aspects unique to this operable unit. New procedures will be developed for collecting real-time fugitive dust and short-term particulate borne radionuclide data.

5.3.5 Task 5--Terrestrial Biological Investigation

The terrestrial biological investigation, as currently planned, consists of two subtasks--an onsite biological survey (Task 5a) and asparagus sampling and analysis (Task 5b).

5.3.5.1 Task 5a--Biological Survey. This subtask consists of two activities:

- Task 5a-1--Hazardous Substances Biological Uptake Assessment
- Task 5a-2--Species Survey.

5.3.5.1.1 Task 5a-1--Hazardous Substances Biological Uptake Assessment. A visual, onsite biological survey will be performed by biologists with field experience on the Hanford Site. Any evidence of uptake of toxic substances by plants or animals will be documented, along with locations of such occurrences.

5.3.5.1.2 Task 5a-2--Species Survey. A qualitative species survey will be conducted within the operable unit boundaries. This survey will take the form of a literature search and will be followed up with an actual onsite survey of the operable unit surface by qualified Hanford Site terrestrial biologists. The focus of this survey will be on those species which are either endangered, threatened, economically important, or a significant component of the human food chain.

5.3.5.2 Task 5b--Asparagus Sampling Analysis. Wild asparagus growing in the riparian zone will be located, sampled, and analyzed. Edible portions will be sampled in the spring of the year for lab analysis for contaminants of concern (Table 41). Analysis for technetium-99 (Tc-99) may also be performed to confirm uptake of contaminants from groundwater.

5.3.6 Task 6--Data Evaluation

Data generated during the phase I RI will be evaluated in an ongoing manner in order to allow decisions to be made regarding rescoping during the course of the project. The results of these evaluations will be incorporated into the monthly progress reports to make them available to project decision makers.

Data evaluation will be undertaken in subtasks corresponding to the various subcomponent investigations:

- Task 6a--Source Data Evaluation
- Task 6b--Geological Data Evaluation
- Task 6c--Soil Data Evaluation
- Task 6d--Air Data Evaluation
- Task 6e--Terrestrial Biological Data Evaluation.

The information developed in this task will be used in Task 7, the baseline risk assessment, to evaluate the overall risk posed by the operable unit to public health and the environment.

5.3.6.1 Task 6a--Source Data Evaluation. Information compiled under Task 1a, on the locations of the retired portions of the buried process and retired radioactive sewers, the nature and location of the phosphoric acid spill at the 340 Complex, additional engineering plans and environmental reports, and interviews with former and current site personnel, will be evaluated under this subtask. Ground-penetrating radar survey results from Task 1b will be graphically evaluated and used to determine borehole locations for source and soil sampling, within and beneath burial grounds No. 4 and No. 5, for Task 3b-2.

Electromagnetic survey results (Task 1c) will be plotted to determine pipeline locations and possible locations of leaks along the retired portions of the process sewer. Results of the "in-pipe" remote inspection survey (Task 1e) will be similarly plotted to determine locations of potential leaks along the retired radioactive sewer system. Results of the soil gas survey for volatile contaminants of concern will be plotted and evaluated to determine if standard laboratory analyses for volatile organics will be required during Task 3b-3.

Surface grab samples obtained in Task 1g will be analyzed to determine if the materials sampled are classified as dangerous waste under WAC 173-303-100.

Source data evaluation will include the periodic updating of the topographic base map developed under Task 1d to incorporate sampling locations established under other investigation tasks. The updated maps produced under this subtask will be made available for plotting data generated during the project.

5.3.6.2 Task 6b--Geological Data Evaluation. Recent geological data compiled from existing sources, under Task 2a, will be formatted to provide an up-to-date description of the geological setting for the operable unit.

Existing well and borehole logs, and logs from new installations put in under Tasks 3b and 4b, will be graphically formatted and used to refine

existing geological and hydrostratigraphic cross sections and fence diagrams, as needed, for 300-FF-1.

5.3.6.3 Task 6c--Soil Data Evaluation. Physical soil characteristics obtained from Tasks 3b and 4b will be evaluated to provide numerical descriptions of each of the geological units present at the operable unit. Background data will be examined by probability plots and goodness of fit tests, and an appropriate probability function will be selected to fit the distribution. Contaminant data determined by standard laboratory methods and screening methods will be correlated to determine the feasibility of using the screening methods to reduce analytical costs. Contaminant data will be statistically compared to background values to determine what soil contaminants are present at elevated levels. Contaminant data will also be plotted with respect to reveal aerial and depth distributions. Contaminant data determined by standard laboratory methods and laboratory screening methods will also be statistically compared to background values to determine the feasibility of using the screening methods to reduce analytical costs. Analytical results below detection limits will be handled in accordance to methods specified by EPA (1989b). Contaminant and physical analysis will be performed to allow a t-test to be conducted for each parameter result from the comparative samples obtained from borehole and trench locations in the north process pond (Task 3b-3).

5.3.6.4 Task 6d--Air Data Evaluation. Meteorological data compiled from HMS will be formatted and analyzed to present numerical descriptions of average climatic conditions, showing seasonal variations, and frequencies of extreme weather events. Justifications for modifications made to the ongoing ambient air monitoring program for the 300 Area will be documented under this subtask.

Results of the ambient air sampling and analysis (Task 4b) will be correlated with meteorological conditions and statistically and graphically evaluated to determine the characteristics of any atmospheric contaminant releases from the operable unit. If such releases are shown to occur in a manner that poses an imminent and substantial threat to public health or the environment, an expedited response action will be planned to address the threat.

5.3.6.5 Task 6e--Terrestrial Biological Data Evaluation. Areas determined under Task 5a-1 to show evidence of biological uptake of hazardous substances will be plotted. Any such evidence will be evaluated to determine the need for additional RI data.

Results of the species survey (Task 5a-2) will be graphically evaluated to classify 300-FF-1 habitats in terms of the presence or absence of endangered, threatened, economically important, or significant human food chain component species. Recommendations regarding points of applicability for target cleanup levels will be made to provide protection for any habitats determined to harbor such species.

Locations of asparagus within the operable unit will be plotted. Contaminant concentrations in asparagus sampled within the operable unit will be compared to background levels found in asparagus sampled across the

river. Contaminant concentrations will be plotted to determine spatial variability. Results of analysis will be used in Task 8, Baseline Risk Assessment. Analysis for technetium-99 may be performed to confirm uptake of contaminants from groundwater.

5.3.7 Task 7--Verification of Contaminant- and Location-Specific Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations

Once the nature and extent of contamination attributable to the operable unit are well defined, EPA and Ecology will be asked to verify the potential contaminant- and location-specific ARARs. Project staff will work with the regulatory agencies and, taking unit-specific conditions into account, will decide which promulgated environmental standards, requirements, criteria, and limitations are applicable or relevant and appropriate to 300-FF-1.

5.3.8 Task 8--Baseline Risk Assessment

The baseline risk assessment will provide an evaluation of the potential threats to human health and the environment in the absence of any remedial action. It will provide the basis for determining whether or not remedial action is necessary and the justification for determining cleanup levels. The assessment will be developed in accordance with EPA (1986b), and will be divided into four subtasks:

- Task 8a--Contaminant Identification
- Task 8b--Exposure Assessment
- Task 8c--Toxicity Assessment
- Task 8d--Risk Characterization.

5.3.8.1 Task 8a--Contaminant Identification. The objective of this activity is to screen the RI data regarding the nature and extent of contamination so that target substances for the risk assessment can be identified. Target substances are selected on the basis of intrinsic toxicological properties, waste volumes, and environmental occurrence.

It may be useful to proceed further and select indicator contaminants as a part of this process. Indicator contaminants are selected for each of the various contaminant types present by focusing on those which are most toxic, abundant, mobile, persistent, have the greatest tendency to bioaccumulate, and for which the best information is available.

5.3.8.2 Task 8b--Exposure Assessment. The exposure assessment will identify actual or potential exposure pathways, to characterize the potentially exposed receptor (human and environmental) populations and to determine the extent of

any exposure. Potentially exposed populations will be analyzed in terms of numbers and locations, and exposure levels will be estimated based upon knowledge of the nature and extent of contamination along each exposure pathway identified.

The contaminant source, transport medium, receptor exposure point, and receptor exposure route will be identified for each exposure pathway. For each potential receptor population, the frequencies, modes, and magnitudes of exposures will be assessed. This analysis will include exposures that may occur in the future if no remedial action is undertaken, as appropriate, in addition to current exposures.

The final step of the exposure assessment will be to develop a qualitative or quantitative estimate of total exposure levels for each receptor population.

5.3.8.3 Task 8c--Toxicity Assessment. To assess the risks associated with the release of contaminants, a comparison is performed between the acceptable levels of contamination and the actual levels identified in the exposure assessment. Contaminant-specific ARARs, when available, will be used to determine the acceptable levels. When ARARs are not available, acceptable levels will be based on environmental concentrations that will yield exposures no greater than:

- The reference dose for noncarcinogens
- A 10^{-7} to 10^{-4} excess lifetime cancer risk for carcinogens.

Priority will be given to the acceptable environmental concentrations thus determined in establishing contaminant-specific cleanup levels for the final remedial action.

5.3.8.4 Task 8d--Risk Characterization. The final activity of the baseline risk assessment involves characterization of risks whenever the potential for adverse human health or environmental impacts are predicted for a receptor population. A summary of the risks posed by the operable unit will be generated. Such factors as the weight-of-evidence associated with toxicity information, estimated uncertainties associated with the previous activities, and assumptions contained within the estimates will be incorporated into the summary.

5.3.9 Task 9--Phase I Remedial Investigation Report: Preliminary Operable Unit Characterization Summary

An interim report will be prepared at the end of phase I RI activities. This report will consist of a preliminary operable unit characterization summary. While a provision is made for presenting information on the baseline risk assessment, the assessment can not be expected to be finalized for this report. Treatability investigation information will also not be available for this report.

5.4 PHASE I FEASIBILITY STUDY--REMEDIAL ALTERNATIVES DEVELOPMENT

Section 3.4 of this document presented a preliminary identification of remedial action objectives, general response actions, remedial technologies, and a range of remedial alternatives for the various environmental media in 300-FF-1. These items were identified after a review of available data on environmental conditions within the unit.

The alternatives identified in Section 3.4 of the initial evaluation are broad in scope. The purpose of the first phase of the FS process is to further develop and refine the initial evaluation based on the data obtained during the RI. This refinement is accomplished through a series of steps as described below.

5.4.1 Task 1--Development of Remedial Action Objectives

Preliminary remedial action objectives for 300-FF-1 were identified in Section 3.4. These objectives were medium-specific, and consist of goals for protecting human health and the environment. Media initially considered were soil, groundwater, surface water and sediments, air, and biota. Of these six, soils, surface water, and groundwater are known to be contaminated from operation of the facilities used for process waste disposal.

Data generated during the initial portion of the first phase of the RI will allow the preliminary remedial action objectives to be more fully developed. The development will involve the identification of specific contaminants of concern, exposure pathways, and acceptable contaminant levels or ranges of levels for each exposure route.

5.4.2 Task 2--Development of General Response Actions

Preliminary general response actions for 300-FF-1 were identified in Section 3.4. These response actions are medium-specific, and describe the general activities that satisfy each of the remedial action objectives. Since the response actions relate directly to the remedial action objectives, any substantial changes in the objectives, as discussed in Section 5.4.1, will require that the response actions be refined.

Volumes of contaminated soil and the areal extent of groundwater contamination will be defined based on the early results of the RI. Other media, such as air or surface water, will be considered if identified as being a source of unacceptable risk to human health or the environment.

5.4.3 Task 3--Identification of Potential Remedial Technologies

The first activity to occur during this step of the FS will be to review the list of potentially applicable remedial technology types and process options presented in Section 3.4, in light of the initial results of the RI. Technologies and process options initially not considered may be added to the list based on available operable unit characterization data.

Once the final list of technology types and process options has been developed, a screening step will take place. During this screening step, process options and entire technology types are eliminated from further consideration on the basis of technical implementability. Technical implementability refers to the ability of the technology or process option to meet the general response action with which it is associated, given specific site conditions. At this point, an analysis will not be performed to assess the ability of the technology or process option to meet cleanup goals. For example, interceptor trenches do not accomplish the desired response action of collection if the depth to groundwater is too great. Another example is that air stripping does not accomplish treatment if volatile contaminants are not present.

5.4.4 Task 4--Evaluation of Process Options

This step of the alternatives development process will consider those process options (specific processes within given technology types) considered to be technically implementable, and attempt to select one process to represent each technology type. This simplifies the subsequent development and evaluation of alternatives without limiting flexibility during remedial design.

During this step, the final list of process options will be evaluated during three subtasks with respect to effectiveness, implementability, and cost. The focus of this evaluation will be on effectiveness. A representative process will be selected for those groups of process options determined to be similar in terms of effectiveness, implementability, and cost. If two or more processes are sufficiently different in their performance or effect that one would not adequately represent the other, they will all be retained for further consideration.

Because of the presence of mixed waste, it is expected that innovative technologies will be especially applicable at the Hanford Site. However, it is likely that detailed data on their effectiveness and cost will not be available. Therefore, the evaluation of these technologies will be somewhat more liberal than would be normal. Innovative technologies will be retained based primarily on their implementability. Effectiveness and cost will not be the basis for elimination of innovative technologies from consideration unless there is clear evidence that one of these factors are limiting.

5.4.4.1 Task 4a--Effectiveness Evaluation. The effectiveness evaluation will focus on: (1) the potential effectiveness of the process options in

handling the estimated areas or volumes of contaminated media and meeting the contaminant reduction goals identified in the general response action; (2) the effectiveness of the process options in protecting human health and the environment during the construction and implementation phase; and (3) how proven and reliable the process is with respect to the contaminants and conditions at the operable unit.

Sufficient information to evaluate the effectiveness of process options for the various media will be collected during the RI. It is expected that a limited conceptual design of treatment processes will be required, mainly because of the probable consideration of multiple innovative technologies.

5.4.4.2 Task 4b--Implementability Evaluation. Both technical and institutional implementability are considered as part of this evaluation. Since technical implementability has already been established at this point, the emphasis will be on institutional factors. These factors are of particular importance at the Hanford Site because of numerous unresolved issues with respect to regulatory control of mixed wastes. It is expected that assumptions regarding some of these issues will be necessary. A basis for the conceptual design of these facilities may also be developed to allow unit disposal costs to be estimated.

5.4.4.3 Task 4c--Cost Evaluation. Cost may not be the deciding factor in the evaluation of process options. Relative capital and operations and maintenance costs will be developed to the extent possible, and will be largely based on engineering judgement and experience. Processes will be evaluated as to whether costs are high, low, or medium relative to other process options in the same technology type.

5.4.5 Task 5--Assembly of Remedial Alternatives

Preliminary remedial alternatives for 300-FF-1 were identified in Section 3.4. These alternatives were developed by assembling general response actions for each environmental medium under consideration. This step of the FS will involve redefining these general alternatives based on the results of the activities discussed under the previous tasks. This redefining will mainly involve specifying the process options which comprise each alternative. For example, the preliminary soil alternative of containment could become containment by capping with long-term monitoring and maintenance.

Another example could be the redefining of groundwater collection, treatment, and disposal as groundwater collection with extraction wells, treatment via chemical precipitation, and disposal by discharge to the Columbia River.

The alternatives will be kept medium-specific at this point. Although the process water disposal facilities are a source of groundwater contamination, additional sources exist both inside and outside the operable unit. This makes development of alternatives for the entire operable unit very difficult at this stage of the study.

5.4.6 Task 6--Identification of Action-Specific Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations

Action-specific ARARs have been preliminarily identified in Section 3.2. Once remedial alternatives have been assembled during this phase of the FS, the preliminary list of action-specific ARARs will be reviewed and refined, if necessary. These will provide feasibility-level design goals for the next phase of the FS.

5.4.7 Task 7--Reevaluation of Data Needs

In the process of performing the phase I FS, additional data needs may be determined. The FS coordinator will communicate these needs to the RI coordinator so that the phase I RI can be modified, if necessary. If major additional data needs are identified, the necessary information can be obtained during the phase II RI. The phase I FS report, generated under Task 8, will serve as the formal means of documenting the data needs identified under this task.

5.5 PHASE II FEASIBILITY STUDY--REMEDIAL ALTERNATIVES SCREENING

The screening of alternatives follows the development of alternatives and precedes the detailed analysis of alternatives. The objective of alternative screening is to reduce the list of potential alternatives that will be evaluated in detail, based on their effectiveness, implementability, and cost. This screening ensures that the most promising alternatives are being considered.

Three distinct steps are conducted during the screening of alternatives. First, the alternatives selected in phase I are further refined, based on the quantities or areas of environmental media affected, the sizes and capacities of process options, and other pertinent factors obtained from the RI. Second, the refined alternatives are evaluated on a general basis to determine their effectiveness, implementability and cost. Third, the alternatives best able to meet the remediation objectives of protection of human health and the environment are retained for detailed analysis in phase III of the FS.

5.5.1 Task 1--Refinement of Remedial Action Objectives

Alternatives are developed in phase I of the FS to meet remedial action objectives for each medium of interest. However, exposure may occur through more than one pathway and involve several environmental media. The assembled alternatives are thus evaluated to ensure that they protect human health and the environment from all potential pathways at the operable unit. If it is

found that an alternative is not fully protective, a reduction in exposure levels may need to be made for one or more media, or it may be determined that a specific alternative is unable to meet a target risk level and would, therefore, not be retained. Conversely, it may be determined that certain media do not pose an unacceptable risk, and treatment alternatives could then possibly be eliminated from further evaluation. An example of a medium for which remediation may be unnecessary is air.

Information obtained in the RI will be used to refine the objectives to consider media interactions so that alternatives are fully protective of public health and the environment.

5.5.2 Task 2--Definition of Remedial Alternatives

Prior to beginning the screening, alternatives must be further defined to identify individual process options, process sizing requirements, and remediation time frames. Results from the RI will be used to determine interactions among environmental media, which may influence remediation activities. Alternatives will be redefined, as necessary, to provide for protectiveness for the entire operable unit.

The information collected during the RI will be used to refine the extent or volume of contaminated material and the size of major technology and process options in order to allow differentiation among alternatives with respect to effectiveness, implementability, and cost.

Media interactions will be evaluated to determine if ongoing releases (such as from contaminated soils) significantly affect contaminant levels in other media (such as groundwater). This is necessary because source control actions affect remediation levels and time frames for other media. For example, source removal of contaminated soils would reduce the rates and volumes of groundwater extraction needed to achieve the target remediation levels.

After defining the alternatives, the technology process options will be further defined with respect to effectiveness, implementability, and costs in order to identify differences among alternatives. The following information will be developed for the technology process options used in an alternative:

- Size and configuration of onsite extraction and treatment systems
- Time frame in which treatment, containment, or removal goals can be achieved
- Rates or flows of treatment
- Special requirements for construction
- Distances for disposal technologies

- Required permits and imposed limitations.

5.5.3 Task 3--Screening Evaluation

In the screening evaluation, information assembled in the further definition of alternatives is used to evaluate the alternatives with regard to the short- and long-term aspects of effectiveness, implementability, and cost. During this screening, comparisons will be made between similar alternatives, with the most promising carried forward for further analysis.

Alternatives with the most favorable composite evaluation of all factors will be retained for further consideration during the detailed analysis. Alternatives selected, to the extent practicable, will preserve the range of treatment and containment technologies initially developed. No more than ten alternatives will be retained. Unselected alternatives may be reconsidered at a later step in the detailed analysis if information is developed that identifies an additional advantage not previously apparent. However, it is expected that alternatives eliminated during this phase will not be reconsidered for selection.

5.5.3.1 Task 3a--Effectiveness Evaluation. Each alternative will be evaluated with respect to the level of protectiveness to human health and the environment it will provide through reductions of waste in terms of toxicity, mobility, or volume. The short-term component, occurring during the construction and operation period, and the long-term component, occurring after the remedial action alternative has been completed, will be evaluated. Levels obtained in reduction of toxicity, mobility, or volume will be compared to contaminant-specific ARARs or to target risk levels.

5.5.3.2 Task 3b--Implementability Evaluation. Implementability is a measure of both the technical and institutional feasibility of constructing, operating, and maintaining a remedial action alternative with respect to a specific site. Technical feasibility refers to the ability to construct, operate, and meet technology-specific regulations for process options. Institutional feasibility refers to the ability to obtain approvals from federal, state, and local agencies, and to procure required services and equipment.

5.5.3.3 Task 3c--Cost Evaluation. Comparative cost estimates will be made with relative accuracy. Cost estimates will be based on cost curves, generic unit costs, vendor information, conventional cost-estimating guides, and prior similar estimates. Both capital and operating and maintenance costs will be considered where appropriate. Present worth analyses will be used to evaluate expenditures that occur over different time periods, so that costs for different remedial action alternatives can be compared on the basis of a single figure for each alternative.

5.5.3.4 Task 3d--Evaluation of Innovative Alternatives. Innovative technologies are those technologies that are fully developed but lack sufficient cost or performance data for routine use at hazardous waste sites. Therefore, it will most likely not be possible to evaluate alternatives

incorporating innovative technologies on the same basis as available technologies. However, innovative technologies will be carried through the screening phase if there is reason to believe that they offer significant advantages. It is anticipated that innovative technologies may be attractive alternatives at the Hanford Site due to the presence of mixed wastes.

5.5.4 Task 4--Verification of Action-Specific Legally Applicable, or Relevant and Appropriate, Environmental Standards, Requirements, Criteria, and Limitations

At the conclusion of screening, sufficient information will exist on the technologies and configurations of greatest interest to perform a more definitive identification of action-specific ARARs. Action-specific ARARs previously identified will be refined with input from the federal and state environmental regulatory agencies.

5.5.5 Task 5--Reevaluation of Data Needs

Once the field of alternatives have been narrowed, the need for treatability tests can be determined. This testing will occur during the phase II RI. Additional data needs may also be identified during the screening phase. However, it is expected that the nature and extent of contamination will be well defined by the end of the RI. Therefore, any additional field investigations will focus on better defining the effect of operable unit conditions on the performance of the technology processes of greatest interest. Data quality objectives will be the same as those discussed in Chapter 4.0 for any additional investigations.

5.5.6 Task 6--Phase I and II Feasibility Study Report: Remedial Alternatives Development and Screening Summary

The results of the initial screening of alternatives will be incorporated into an interim FS. The procedures for evaluating, defining, and screening the alternatives will be well documented. The following types of information will also be included:

- Definition of each alternative including extent of remediation, volume of contaminated material, sizes of major treatment processes, process parameters, cleanup time frames, transportation distances, and special considerations
- Notation of process options that were initially screened out and are being represented by the processes comprising the alternative
- Screening evaluation summaries of each alternative.

A reevaluation of data needs for the phase II RI will be included in this report.

5.6 PHASE II REMEDIAL INVESTIGATION-- TREATABILITY INVESTIGATION

As operable unit information is collected during the RI and alternatives are being developed, additional data needs necessary to adequately evaluate alternatives during the detailed analysis may be identified. Activities may include the collection of additional necessary operable unit characterization data, or the performance treatability studies to better evaluate technology performance.

Some of the technologies selected for detailed analysis at the Hanford Site may be well developed, proven, and documented such that site-specific information collected during the RI is adequate for evaluation without conducting treatability testing. However, it is expected that some technologies, particularly those dealing with mixed waste, will not have been sufficiently demonstrated to predict treatment performance or to estimate the size and cost of treatment units. Some treatment processes, particularly innovative technologies, are not sufficiently understood for performance to be predicted, even with a complete characterization of the wastes. When treatment performance is difficult to predict, actual testing of the process may be the most cost-effective means of obtaining the necessary data.

The purpose of the treatability investigation is to provide information needed for the detailed analysis of alternatives and to allow selection of remedial actions to be made with a reasonable certainty of achieving the response objectives. The results of bench and pilot tests can be used to ensure that conventional and innovative technologies are evaluated during the detailed analysis portion (phase III) of the FS.

Information collected during treatability studies can also aid in the detailed design of the selected remedial technology. However, the limitations of the bench- or pilot-scale test must be compensated for in a full-scale application. Therefore, an evaluation that includes a sensitivity analysis to identify the key parameters and unknowns, which could affect a full-scale system, would be conducted. In the case of innovative technologies, full-scale systems may not be in wide use. Therefore, the potential need for process modifications during design or operation must be considered.

If and when it becomes apparent that it will be necessary to implement a second phase of the RI, this portion of the work plan will be expanded by amendment to provide details of the phase II activities. The accompanying volumes of the overall RI/FS project plan, and pertinent portions of this work plan, will also be amended as appropriate.

The need for any additional characterization of the operable unit will be apparent once phase II of the FS is completed. The phase II RI will focus on obtaining information to support the phase III FS. The phase I RI,

phase I FS, and phase II FS reports will provide interim evaluations of further data needs for the phase II RI.

Prior to initiating the phase II RI, this work plan and accompanying sampling and analysis and health and safety plans will be amended, as appropriate, to provide guidance for the required work.

5.6.1 Task 1--Treatability Investigation Work Plan Development

Data collected during operable unit characterization may not be adequate for assessing the feasibility of remedial technologies, and the need for detailed data from treatability tests may not become apparent until the initial screening of alternatives has been completed. Additional data may also be required for innovative technologies.

A literature survey will be conducted to identify additional data needs. The objectives of the survey are:

- Determine whether the performance of those technologies under consideration have been sufficiently documented on similar wastes considering the scale, e.g., bench, pilot or full, and determine the number of times the technologies have been successfully used
- Gather information on relative costs, applicability, removal efficiencies, operations and maintenance requirements, and implementability of the candidate technologies
- Determine testing requirements for bench or pilot studies.

Treatability testing to support the remedial alternative evaluation and design process can be performed by using bench-scale or pilot-scale techniques. In general, treatability studies will include the following steps:

- Preparation of a work plan for the bench or pilot studies
- Performance of the field investigations, bench, or pilot testing
- Evaluation of data from field investigations, bench, or pilot testing
- Incorporation of the results of the testing into the RI report.

Bench-scale testing may be performed to determine if a process is technically feasible for some alternatives involving treatment or destruction technologies. Prior to initiating bench-scale treatability tests, the following information will be collected or developed:

- Test procedures
- A waste sampling plan

- Waste characterization
- Treatment goals
- Data requirements for estimating the cost of the technology being evaluated
- Required test services, equipment chemicals, and analytical services.

Bench tests can be used to test for a wide variety of operating conditions, and can be used to determine broad operating conditions to allow optimization during additional bench- or larger-scale pilot tests. The objectives of bench-scale testing are to determine the following:

- Effectiveness of the treatment alternative on the waste
- Differences in performance between competing manufacturers
- Differences in performance between alternative chemicals
- Sizing requirements for pilot-scale studies
- Screening of technologies to be pilot tested
- Sizing of those treatment units that would affect the cost of the technology sufficiently to affect the feasibility study evaluation process
- Compatibility of materials with the waste.

For a technology that is well developed and tested, bench studies are usually sufficient to evaluate performance on new wastes. For innovative technologies, however, pilot tests may be required since information necessary to conduct full-scale tests is either limited or nonexistent.

Pilot units are intended to more accurately simulate the operation of the full-scale process than would bench-scale testing. However, pilot tests require significant time and can be quite costly. Therefore, the need for pilot testing must be determined by comparing the potential for improved performance or savings in time or money during implementation against the additional time and expense for the pilot testing. Innovative technologies will be considered if they offer the potential for more permanent treatment destruction of the waste, or significant savings in time or money required to complete a remedial action.

5.6.2 Task 2--Treatability Investigation Implementation

This task is reserved for the actual implementation of any treatability investigation, or additional operable unit characterization, activities deemed

necessary. The results of this task will be integrated into the preliminary site characterization summary to create the final RI report.

5.6.3 Task 3--Remedial Investigation Report

The treatability investigation results will describe the testing that was performed, the results of the tests, and an interpretation of how the results would affect the evaluation of the remedial alternatives considered for the site. The report will contain a discussion of the effectiveness of the treatment technology for the wastes onsite, and will contain an evaluation of how test results affect treatment costs developed during the detailed analysis of alternatives. These results will be combined with the operable unit characterization results and published as the final report documenting all investigation activities for the project.

5.7 PHASE III FEASIBILITY STUDY--REMEDIAL ALTERNATIVES ANALYSIS

The detailed analysis of alternatives follows the development and screening of alternatives and precedes the actual selection of the remedial action alternative to be implemented at the operable unit. The results of the detailed analysis provide the basis for identifying a preferred alternative and preparing the proposed operable unit plan. The detailed analysis of alternatives consists of the following components:

- Further definition of each alternative, if appropriate, with respect to the volumes or areas of contaminated environmental media to be addressed, the technologies to be used, and any performance requirements associated with those technologies
- An assessment and a summary of each alternative against nine evaluation criteria
- A comparative analysis among the alternatives to assess the remedial action.

5.7.1 Task 1--Definition of Remedial Alternatives

The alternatives that remain after screening may need to be defined more completely prior to the detailed analysis. During the detailed analysis, each alternative will be reviewed to determine if additional definition is required to apply the evaluation criteria consistently and to develop order-of- magnitude cost estimates (-30 to +50%). Information developed to further define alternatives at this stage may include preliminary design calculations, process flow diagrams, sizing of key process components, preliminary site layouts, and a discussion of limitations, assumptions, and uncertainties concerning each alternative. Information collected from treatability investigations, if conducted, will also be used to further define alternatives.

5.7.2 Task 2--Detailed Analysis of Remedial Alternatives

Nine evaluation criteria will serve as the basis for conducting the detailed analysis and for subsequent selection of an appropriate remedial action. The evaluation criteria are:

- Short-term effectiveness analysis
- Long-term effectiveness analysis
- Reduction in waste toxicity, mobility, and volume
- Implementability analysis
- Cost analysis
- Analysis of compliance with ARARs
- Analysis of overall protection of human health and the environment
- Environmental agency acceptance
- Analysis of community acceptance

These criteria encompass technical, cost, and institutional considerations, compliance with specific statutory requirements, and community relations concerns. Each criterion will be analyzed under a separate subtask.

5.7.2.1 Task 2a--Short-Term Effectiveness Analysis. This evaluation criterion addresses the effects of the alternative during the construction and implementation phase until remedial action objectives are met. The following factors relating to effects on human health and the environment will be addressed for each alternative:

- Protection of the community during construction and implementation
- Protection of workers during construction and implementation
- Environmental impacts during construction and implementation
- Time until remedial action objectives are achieved.

The evaluation of these factors will include a discussion of increased risk posed by the remedial alternative being investigated and of the effectiveness and reliability of protective measures that could be taken for worker protection or environmental impact mitigation. These factors are of particular concern at the Hanford Site because of the inherent problems concerning mixed wastes.

5.7.2.2 Task 2b--Long-Term Effectiveness Analysis. The evaluation of alternatives using this criterion will address the results of a remedial

action in terms of the risk remaining at the operable unit after response objectives have been met. The following components will be addressed to evaluate the extent and effectiveness of controls that may be required to treat residuals or untreated wastes:

- Magnitude of remaining risk
- Adequacy of controls
- Reliability of controls.

The evaluation of these components will include an assessment of residual risk, the adequacy of containment systems and institutional controls, and the potential need to replace components of the remedial alternative.

5.7.2.3 Task 2c--Analysis of Reduction in Waste Toxicity, Mobility, and Volume. This evaluation criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of a hazardous substance as their principal element [CERCLA 121 (b)(1)]. The following specific factors will be addressed:

- The treatment processes, the remedies they will employ, and the materials they will treat
- The amount of hazardous materials that will be destroyed or treated
- The degree of expected reduction in toxicity, mobility, or volume as a percentage of reduction
- The degree to which treatment will be irreversible
- The type and quantity of treatment residuals that will remain.

Alternatives which treat a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volumes of contaminated media will satisfy the preference for permanent treatment.

5.7.2.4 Task 2d--Implementability Analysis. The implementability criterion addresses the technical and institutional feasibility of implementing an alternative and the availability of various services and materials required during its implementation. In evaluating this criterion, the following factors will be analyzed:

- Technical feasibility including construction and operation, reliability of technology, ease of undertaking additional remedial actions, and monitoring considerations
- Institutional feasibility
- Availability of services and materials.

Concerns at the Hanford Site regarding implementability are related to the presence of mixed wastes. Assumptions may be necessary with respect to future mixed waste regulations and guidelines.

5.7.2.5 Task 2e--Cost Analysis. Cost considerations will be an important evaluation criteria at the Hanford Site because funding is distributed by the U.S. Congress. Costing procedures outlined in the *Remedial Action Costing Procedures Manual* (EPA 1985b) will be used in the alternatives evaluation. Both capital costs and annual operation and maintenance costs will be considered. Cost will be developed within accuracy of -30 to +50% (EPA 1985b; EPA 1988b). In addition, a present worth analysis will be conducted so that all alternatives can be compared on the basis of a single figure in a common base year. A discount rate of 5% will be used along with a period of performance of 30 yr.

5.7.2.6 Task 2f--Analysis of Compliance with Legally Applicable, or Relevant and Appropriate, Environmental Standards Requirements, Criteria, and Limitations. This evaluation criterion is used to determine how each alternative complies with ARARs. The detailed analysis will summarize which federal and state environmental standards, requirements, criteria, or limitations are applicable or relevant and appropriate to an alternative. How the alternative meets these requirements will be described.

5.7.2.7 Task 2g--Analysis of Overall Protection of Public Health and the Environment. This evaluation criterion provides a final check to assess whether each alternative meets the requirement that it is protective of human health and the environment. The overall assessment of protection is based on a composite of factors discussed under long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. The analysis will address how each specific alternative achieves protection over time and how operable unit risks are reduced. A discussion will be included of how each source of contamination is to be eliminated, reduced, or controlled for each alternative.

5.7.2.8 Task 2h--Analysis of Environmental Agency Acceptance. Because EPA and Ecology will have an opportunity to review and comment on the FS report, this analysis will be limited to formal comments made by the agencies during previous phases of the RI/FS. Agency comments on the remedial alternatives analysis phase will be specifically addressed in a responsiveness summary prior to finalization of a record of decision.

Therefore, the analysis of this criterion will focus on those features of alternatives that EPA or Ecology have reservations about or oppose. A brief discussion of what processes were used to incorporate environmental agency inputs to the project will be included.

5.7.2.9 Task 2i--Analysis of Community Acceptance. The potentially impacted community, special interest groups, the general public, and other interested governmental agencies will have an opportunity to review and comment on the FS report as well. Before the record of decision is developed, community concerns will also be addressed in the responsiveness summary. Thus, this

analysis will also be confined to community concerns formally transmitted to project management personnel earlier in the RI/FS. A discussion of the processes used to solicit and address such concerns will be included.

5.7.3 Task 3--Comparison of Remedial Alternatives

Once the alternatives have been individually assessed against the nine criteria, a comparative analysis will be conducted to evaluate the relative performance of each alternative in relation to each specific evaluation criterion. The key trade-offs or concerns among alternatives will generally be based on the evaluations of short-term effectiveness; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume; implementability; and cost. Overall protectiveness and compliance with ARARs will generally serve as a threshold determination in that they either will or will not be met.

The comparative analysis will include a narrative discussion describing the strengths and weaknesses of the alternatives relative to one another with respect to each criterion. The potential advantages in cost or performance of innovative technologies and the degree of uncertainty in their expected performance will also be discussed. The differences between all the alternatives will be summarized in tabular form. At this point, the separate alternatives for each of the environmental media will be combined to present a comprehensive partial remedy that addresses all the potential threats posed by the operable unit.

5.7.4 Task 4--Feasibility Study Report

The analysis of individual alternatives against the nine criteria will be presented as a narrative discussion accompanied by a summary table. The alternatives discussion will include data on technology components, quantity of hazardous materials handled, time required for implementation, process sizing, implementation requirements, and assumptions. The key ARARs for each alternative will also be incorporated into those discussions. The discussion will focus on how, and to what extent, the various factors within each of the nine criteria are addressed. A summary table will highlight the assessment of each alternative with respect to each of the nine criteria.

5.8 INTEGRATION OF THE 300 AREA PROCESS TRENCHES CLOSURE PLAN WITH RI/FS ACTIVITIES

Closure plan development for the 300 Area process trenches is linked to the RI/FS work done for the rest of the 300-FF-1 operable unit to ensure that work for both is done efficiently.

6.0 SCHEDULE

The anticipated schedule for completing the RI/FS is presented in Plate 6-1. Assumptions that were used in developing this schedule include:

- It will not be feasible to drive gas probes for Task 1e-2
- Two drill rigs will be used during Tasks 1e-2 and 3b-2
- Drilling contractors will be prequalified, thereby eliminating the need to undertake a competitive bid process immediately prior to drilling
- Laboratory analysis of samples will take 6 to 8 wk
- It will take 2 months to develop procedures for activities for which there are none currently approved
- Westinghouse Hanford and DOE reviews of draft documents will take 6 wk
- Regulatory review of the phase II RI and phase II FS reports will take 7 mo
- Existing groundwater monitoring wells to be incorporated into the RI are adequately constructed and are useable for the intended purposes. There is a high degree of uncertainty associated with the anticipated schedule for the phase II RI. Specific tasks are not now identified, because the actual scope of this phase will be dependent on the results of the phase I RI and the phase I and phase II FS.

7.0 PROJECT MANAGEMENT

Details on the management structure, organization, and responsibilities for the RI/FS project are provided in the PMP (Attachment 3).

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APPENDIX A

DOCUMENTED, UNPLANNED RELEASES ASSOCIATED WITH OPERABLE UNIT 300-FF-1*

*Source: Hanford Site Waste Management Units Report, DOE/RL 88-30, U.S. Department of Energy, Richland, Washington (except as noted).

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APPENDIX A.1

UNPLANNED RELEASES ASSOCIATED WITH THE PROCESS SEWER SYSTEM

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APPENDIX A.1.1

ULTIMATE DISPOSAL IN THE NORTH OR SOUTH PROCESS POND

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Unit Name: UPR-300-32

Occurrence Date: August 1974

Location: 300 Area; 333 Building, Uranium Bearing Acid System.

Waste Types and Amount:

Leak testing of system revealed one leak in piping, three leaking transfer pumps, and five leaks in the uranium mill tank.

Unit Name: UPR-300-33

Occurrence Date: August 1974

Location: 300 Area; 333 Building, Waste Acid System.

Waste Types and Amount:

Leak testing of PVC acid drain system showed 16 leaks. Additionally, five leaks were found in the incoming acid fill lines (presumabley nitric or sulfuric acid system).

Unit Name: UPR-300-30

Occurrence Date: January 30, 1975

Location: 300 Area; 333 Building, Waste Acid System.

Waste Types and Amount:

A chemical reaction occurred when a carbonate bearing solutions was added to the waste acid solution. This caused foaming, which eventually caused an overflow of process tanks which discharged to the process sewer.

Unit Name: UPR-300-31

Occurrence Date: October 1974

Location: 300 Area; between the 311 Tank Farm and the 303-F Building.

Waste Types and Amount:

Inspection of the pipe trench system revealed that extensive repairs were needed, apparently from a previous spill in the system. Drain connections leading to the process sewer system were found broken in various locations, allowing possible ground discharge rather than discharge into the process sewer.

Unit Name: UPR-300-34

Occurrence Date: August 1973

Location: 300 Area; 333 Building, Waste Acid System.

Waste Types and Amount:

Failure of limestone neutralization tank resulted in discharge to ground. As a consequence of the tank failure, routine operations involved discharging spent waste acids directly into the process sewer system. This practice continued until about January 1975.

Unit Name: UPR-300-35

Occurrence Date: June 1973

Location: 300 Area; 333 Building, Uranium Bearing Acid Facility.

Waste Types and Amount:

Leak discovered in overflow alarm system in uranium mill tank. Also, uranium acid transfer pump discovered leaking.

Unit Name: UPR-300-36

Occurrence Date: June 1973

Location: 300 Area; 333 Building, Waste Acid System.

Waste Types and Amount:

Leak testing of PVC acid drain system showed nine leaks. Additionally, four leaks were found in the incoming PVC nitric acid lines.

Unit Name: UPR-300-37

Occurrence Date: January 1972

Location: 300 Area; 333 Building, Waste Acid System.

Waste Types and Amount:

Leak testing of PVC waste line revealed several large and numerous small leaks which discharged directly to the process sewer. During inspection it was also discovered that the nitric-sulfuric-chromic acid stream was not connected to the neutralization tank but instead was discharging directly to the process sewer.

APPENDIX A.1.2

ULTIMATE DISPOSAL IN THE PROCESS TRENCHES

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Unit Name: UPR-300-8

Occurrence Date: September 22, 1980

Location: 300 Area; 311 Tank Farm, Caustic Storage Tank.

Waste Types and Amount:

A defective valve in the storage tank steam sparge line allowed steam condensate to overflow the storage tank into the process sewer system.

Unit Name: UPR-300-9

Occurrence Date: July 3, 1976

Location: 300 Area

Waste Types and Amount:

847 gal of nitric acid solution, containing 121.5 kg of depleted uranium, drained from a storage tank in Room 120 of the 306-N Building into the 300 Area process drainage system.

Unit Name: UPR-300-15

Occurrence Date: August 19, 1980

Location: 300 Area

Waste Types and Amount:

Uranium-bearing acid Storage Tanks No. 3 and 4 overflowed the catch barrel and trickled over into the process sewer. Further inspection revealed that Tank No. 3 had discharged downward into Tank No. 4 through interconnected discharge lines. The discharge line for Tank No. 4 was wide open.

Unit Name: UPR-300-19

Occurrence Date: September 30, 1980

Location: 300 Area; 313 Building floor trenches.

Waste Types and Amount:

Two drums of incoming deoxidization chemicals were found to be leaking. After discovery, the floor was washed off, resulting in discharge to the process sewer. It appears that this washing solution resulted in a dissolution of ammonium bifluoride and sodium hydroxide in the 313 Building floor trenches. The process sewer showed high No-3, F, and pH values as a result of this incident.

Unit Name: UPR-300-20

Occurrence Date: August 19, 1980

Location: 300 Area; 313 Building Storage Tank.

Waste Types and Amount:

Overflow of a storage tank in the 313 Building resulted in an overflow of the catch barrel into the process sewer system.

Unit Name: UPR-300-21

Occurrence Date: August 5, 1980

Location: 300 Area; 333 Building Chemical Bay Area.

Waste Types and Amount:

Nitric acid fill lines to Tanks 13, 15, and 16 in the 333 Building were removed. Apparently some residual nitric acid from these lines was discharged into the process sewer.

Unit Name: UPR-300-22

Occurrence Date: July 21 and 28, 1980

Location: 300 Area; 333 Building Chemical Bay Area.

Waste Types and Amount:

Acid Etch Tanks No. 13 and 15 were leaking, resulting in acid discharge into the process sewer.

Unit Name: UPR-300-23

Occurrence Date: August 1980

Location: 300 Area; 333 Building Trench Piping System.

Waste Types and Amount:

Leak inspection revealed two leaks in the nitric and sulfuric acid fill lines.

Unit Name: UPR-300-24

Occurrence Date: August 1980

Location: 300 Area; 333 Building Waste Acid System.

Waste Types and Amount:

Leak inspection revealed two small drip leaks around newly installed etch tank.

Unit Name: UPR-300-25

Occurrence Date: February 15, 1980

Location: 300 Area; 333 Building, Uranium Mill Tank.

Waste Types and Amount:

Leaks in steam coils in the uranium mill tank caused acid to be siphoned in upon cooling of coils at nightly shut off. During startup in morning, steam discharged acid in coils into process sewer system. This situation was in evidence for several weeks.

Unit Name: UPR-300-26

Occurrence Date: January 12, 1980

Location: 300 Area; 311 Tank Farm, Caustic Storage Tank.

Waste Types and Amount:

Condensate from steam heating line in the storage tank caused overflow to process sewer.

Unit Name: UPR-300-27

Occurrence Date: October 30, 1979

Location: 300 Area; 333 Building, Uranium Bearing Acid Storage Tank.

Waste Types and Amount:

Failure of check valve in piping system resulted in discharge of a stream of uranium-bearing acid into the process sewer system. Operator noticed leakage and immediately shut down the transfer pump, stopping the release.

Unit Name: UPR-300-28

Occurrence Date: June 2, 1978

Location: 300 Area; 334A Building, Spent Waste Acid Storage Tanks.

Waste Types and Amount:
Open water fill line in the 333 Building caused the process tank to overflow into the 334A Storage Tanks, which overflowed into the containment pit. The pit then overflowed into the process sewer system. Overflow to the process sewer apparently began at 7:30 a.m. on June 3, and was discovered on the morning of June 5. Due to water input, overflow to the process sewer was primarily water with some acid content.

Unit Name: UPR-300-29

Occurrence Date: June 1975

Location: 300 Area; 333 Building, Waste Acid System.

Waste Types and Amount:

Leak testing of system revealed three leaks in PVC piping system. In addition, one leak was found in the incoming nitric acid supply line.

APPENDIX A.2

UNPLANNED RELEASE ASSOCIATED WITH BURIAL GROUND NUMBER FOUR

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Unit Name: UPR-600-15

Occurrence Date: September 20, 1979

Alias Name: UN-600-15

Location: 600 Area; an area ~7 ft by 60 ft running north and south outside the boundary fence for the 618-4 Burial Ground.

Waste Types and Amount:

Depleted uranium fuel elements improperly discarded at the 618-4 Burial Ground.

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APPENDIX A.3

UNPLANNED RELEASE ASSOCIATED WITH THE RETIRED RADIOACTIVE SEWER SYSTEM

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Operable Unit: 300-FF-1

Unit Name: UN-300-1
Unit Types: Unplanned Release
Coordinates: N54445 E15405
Waste Category: Mixed Waste
Unit Status: Inactive

Occurrence Date: January 7, 1970

Release Potential:

Waste Types and Amounts:

A leak was discovered in the transfer line from retention basins to crib waste system. Crib waste was backed up and the bottom half of a short carbon steel transition piece was eroded away, and contaminated waste leaked to the soil about 5 ft below grade.

Known Releases:

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APPENDIX A.4

UNPLANNED RELEASE ASSOCIATED WITH THE RADIOACTIVE SEWER SYSTEM

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Operable Unit: 300-FF-1

Unit Name: UN-300-11

Unit Types: Unplanned Release

Coordinates: N54453 E15404

Waste Category: Mixed Waste

Unit Status: Inactive

Occurrence Date: October 21, 1977

Release Potential:

Waste Types and Amounts:

Leaking flanges in the radioactive liquid waste line resulted in soil contamination near the 340 Building.

Known Releases:

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APPENDIX A.5

UNPLANNED RELEASE ASSOCIATED WITH THE 340 COMPLEX

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Operable Unit: 300-FF-1

Unit Name: UN-300-2

Unit Types: Unplanned Release

Coordinates: N54445 E15405

Waste Category: Mixed Waste

Unit Status: Inactive

Occurrence Date: January 1954

Release Potential:

Waste Types and Amounts:

No description of release in reference.

Known Releases:

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APPENDIX A.6

UNPLANNED RELEASE NOT ASSOCIATED WITH A 300-FF-1 FACILITY

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Operable Unit: 300-FF-1

Unit Name: UN-300-14

Unit Types: Unplanned Release

Coordinates: N55060 E15000

Waste Category: Mixed Waste

Unit Status: Inactive

Occurrence Date: July 18, 1975

Release Potential:

Waste Types and Amounts:

A line break in fill Tank No. 32 caused the loss of 1,200 gal of sulfuric acid to a limestone pit.

Known Releases:

9 0 1 1 7 3 1 5 6 9

Table A-1. Unplanned Releases to the Process Sewer After 1980. (sheet 1 of 3)

Date	Spill origination point	Waste type	Hazardous components	Quantity	Description of event	Cleanup action[a]	Reference	Comments
September 22, 1980	Caustic storage tank in 311 tank farm	50% sodium hydroxide	50% sodium hydroxide	290 gal of approximately 50% solution	A defective valve in the storage tank steam sparge line allowed steam condensate to overflow the storage tank into the process sewer system	None. A second steam valve was closed, stopping overflow	Unusual Event Report No. SO-80-11	Weekly composite process sewer sample showed pH of 11.9. 290 gal of 50% sodium hydroxide corresponds to 1,860 lb (as NaOH). The current CERCLA RQ for sodium hydroxide is 1,000 lb
January 5, 1981	Pipe trench between 333 and 303-F Buildings	Degreasing solvent	Perchloro-ethylene	371 gal total, of which 255 gal were recovered. Release to process sewer was well less than 116 gal, and could have been insignificant	Spill occurred when attempting to transfer perchloroethylene between buildings. Transfer line failed at hose connection point, resulting in discharge into pipe trench which could discharge into the process sewer. Additionally, some small quantity could have discharged to the ground via a drain in the bottom of the piping trench; although the drain appeared to have been blocked by dirt and debris	Solvent sitting in bottom of pipe trench was removed by pumping or by absorbtion	Occurrence Report No. UO 81-1	Based upon the fact that the process sewer monitoring system continued to function, it is believed that the amount of perchloro-ethylene actually released to the process sewer system was minimal (if any). The sewer sampling system has seals which are quickly destroyed by even low concentrations of solvent materials. The "unrecovered" 116 gal is disconcerting and difficult to explain based upon the known effects on the process sewer sampler. The current CERCLA RQ for perchloroethylene (tetrachloroethylene) is 1 lb
Week ending August 10, 1981	333 Building heat treat salt area	Heat treat salt	Sodium nitrate, sodium nitrite, and potassium nitrite	Approximately 7,200 lb of heat treat salt per year	Rather than bailing out the heat treat quench bath (as was done in previous years), the material was dissolved in water and flushed into the process sewer. This became standard practice during the annual outage until halted in 1984	None. Discharge became standard practice until 1984	Undesirable Event Report No. SO-81-7	Discharge of quench bath salt to process sewer (rather than bailing) was done due to safety concerns relative to bailing operation. Weekly composite process sewer sample showed much elevated levels of NO_3 (490 ppm) and NO_2 (380 ppm). The current CERCLA RQ for sodium nitrite is 100 lb in a 24-h period
February 8, 1982	333 Building chemical processing area	Uranium acid etch solution	Nitric acid sulfuric acid with uranium in solution	55 lb of uranium in acid solution	Steam coil leak in uranium mill tank resulted in acid dripping from the tank (along with steam condensate) into the process sewer	None. Steam line leak was blocked to prevent further discharge	Undesirable Event Report No. SO-82-4	Weekly process sewer composite did not show substantially increased levels of NO_3^-. Uranium concentration was 3.4 ppm, which was much higher than the normal value (about 0.4 ppm). This event could have been near the current 100 lb CERCLA RQ limit for uranyl nitrate
Week ending September 13, 1982	333 Building chemical processing area	Waste etch acid	Nitric, hydro-fluoric, chromic acids containing uranium, copper, and zirconium in solution	1,100 lb of HNO_3 and 280 lb of copper in solution(?)	The 333 weekly process sewer sample showed elevated levels of copper (17.5 ppm) and nitrate (128 ppm). An investigation revealed that a drain valve in the waste acid transfer piping was not fully seated, allowing solution to leak to the process sewer	None. Valve was closed to prevent further release	Undesirable Event Report No. SO-82-17	Weekly process sewer composite sample levels indicated a release of approximately 1,110 lb of HNO_3 and 280 lb of copper in solution, based upon normal average concentrations (approximately 66 ppm of NO_3 an 0.3 ppm of copper). These values indicate that the releases may have been in excess of the current CERCLA RQ's of 1,000 lb for HNO_3 and 100 lb for copper nitrate
September 16, 1982	Pipe trench between 334-A Building and 313 Building	Waste etch acid	Nitric, hydro-fluoric chromic acids containing uranium, copper, and zirconium in solution	Estimated 82 lb of copper in a nitric acid solution	The PVC waste acid transfer line broke, resulting in discharge to the process sewer. Weekly process sewer sample for 333 Building showed elevated copper levels (3.9 ppm)	None. Pipe was repaired	Undesirable Event Report No. SO-82-18	Comparing the copper content in the weekly process sewer sample with a normal average concentrate (0.3 ppm), it appears that 82 lb of copper could have been released in this event. This would indicate that the current CERCLA RQ for copper nitrate (100 lb) may have been exceeded with this spill

[a]"Cleanup action" refers to immediate response to spill event. Trench cleanup plans are described in the Closure/Post Closure Plan.

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Table A-1. Unplanned Releases to the Process Sewer After 1980. (sheet 2 of 3)

Date	Spill origination point	Waste type	Hazardous components	Quantity	Description of event	Cleanup action[a]	Reference	Comments
November 22, 1982	334A Building storage tanks	Waste etch acid	Nitric, hydrofluoric, chromic acids with copper, uranium, and zirconium metals in solution	Exact quantities unknown (see comments)	In attempting to backflush transfer line, water was discharged into storage tanks, causing overflow. Weekly 333 process sewer sample showed elevated level of fluoride (4.1 ppm)	None. Spilled solution was flushed into process sewer	Undesirable Event Report No. SO-82-24	Based on average F- content of 1.4 ppm (weekly process sewer composite sample), 75 lb of HF could have been involved in this spill. Copper content in weekly composite sample was also elevated (1.7 ppm vs. 0.4 ppm in a normal week), indicating that 35 lb of copper ion could have been discharged in the spill event. The process sewer stream pH was 1.3 to 2.0 for approximately 45 min during the course of the spill. This would indicate a release of up to 350 lb of HNO_3 (assuming a process sewer stream flow of 500 gal/min). The current CERCLA RQ's are: HF - 100 lb; $Cu(NO_3)_2$ - 100 lb; HNO_3 - 1,000 lb; 35 lb of copper ion, if expressed in terms of $Cu(NO_3)_2$, amounts to 105 lb
Weeks of January 24 to January 31, 1983 and January 31 to February 7, 1983	333 Building chemical processing area	Copper etch bath solution	Nitric acid with copper and uranium in solution	Exact quantities unknown (see comments)	Etch acid solution was discharged to the process sewer via siphoning through the tank overflow piping. The 333 weekly process sewer sample showed elevated levels of copper for weeks of January 24, 1983 to January 31, 1983 (2.9 ppm) and January 31, 1983 to February 7, 1983 (3.4 ppm)	None. Vent hole drilled in overflow pipe to serve as siphon-break and prevent future occurrences	Undesirable Event Report No. SO-83-5	Based upon an average weekly process sewer composite sample Cu content of 0.6 ppm, and total process sewer flows of 4,082,000 gal (week ending January 31, 1983) and 4,228,600 gal (week ending February 7, 1983), these spills could have involved 78 lb (January 31, 1983) and 98 lb (February 7, 1983) of copper. These values correspond to 230 and 290 lb expressed as $Cu(NO_3)_2$. Inasmuch as the spills may have represented several events on different days, it is possible (but not certain) that the CERCLA RQ of 100 lb $Cu(NO_3)_2$ in a 24-h period was not violated
August 15, 1983	334A Building storage tank	Waste etch acid	Nitric, hydrofluoric, chromic acids with copper, uranium, and zirconium in solution	Estimated 45 lb of copper	333 Building process sewer analyses showed elevated levels of copper (2.2 ppm). Apparent cause was clean out of storage tanks in 334A Building. Pump used to transfer material from tanks was leaking; leakage was discharged into process sewer	None	Undesirable Event Report No. FP-83-16	Based on normal average copper content in weekly process sewer sample of 0.3 ppm, and using a total process sewer flow of 2,874,700 gal, it is estimated that 45 lb of copper could have been involved in this release. This corresponds to 135 lb expressed as copper nitrate. The current CERCLA RQ for copper nitrate is 100 lb
October 27, 1983	334A Building storage tank area	Waste etch acid	Nitric, chromic, hydrofluoric acid with copper, uranium, and zirconium metals in solution	See comments for estimated quantities	Following desludging of the 334A storage tanks, leak testing with water is routinely pursued. The water used for this effort is then discharged to the process sewer. In the October 27, 1983 effort, apparently one of the tanks had not been desludged, and the leak test solutions (containing the waste acid and crystalline sludge) was mistakenly discharged to the process sewer. The weekly 333 process sewer sample showed elevated levels of fluoride (15.8 ppm) and copper (3.6 ppm), and a low pH (2.87)	None. When operator recognized that acidic solution was being discharged, the release was halted	Undesirable Event Report No. FP-83-17	Based on the weekly process sewer composite sample, and using normal average values for fluoride (1.2 ppm), copper (0.3 ppm), and pH (3.8), the release could have involved as much as 500 lb of HF, 110 lb of copper; and 860 lb of nitric acid. (Total weekly process sewer flow of 3,940,900 gal.) Current CERCLA RQ's for these materials are: HF - 100 lb; copper nitrate (expressed as copper) - 34 lb; nitric acid - 1,000 lb

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[a]"Cleanup action" refers to immediate response to spill event. Trench cleanup plans are described in the Closure/Post Closure Plan.

Table A-1. Unplanned Releases to the Process Sewer After 1980. (sheet 3 of 3)

Date	Spill origination point	Waste type	Hazardous components	Quantity	Description of event	Cleanup action[a]	Reference	Comments
January 2, 1986	334 tank farm	Waste etch acid	Nitric, hydrofluoric, and chromic acids with uranium, copper, and zirconium metals in solution	Approximately 350 gal of solution containing 170 lb of hydrofluoric acid	Failure of liner in waste acid storage tank resulted in corrosion of carbon steel shell, followed by acid leakage to the process sewer	None. The tank contents were removed to prevent further discharge. Approximately 60 gal of 50% NaOH was discharged to the process sewer in an attempt to maintain a caustic pH at the process trenches. Special groundwater monitoring was initiated at 300 Area wells to determine impact of release	Unusual Occurrence Report No. UO 86-01	Release was reported as CERCLA RQ event due to HF quantity, which exceeded CERCLA RQ of 100 lb. Based upon comparison average weekly process sewer composite sample levels with levels measured for the week of the spill, it is estimated that the release also involved 700 lb of HNO_3 (79 ppm vs. 57.5 ppm in a typical week); 16 lb of copper (0.7 ppm vs. 0.2 ppm typical); and 20 lb of uranium (0.9 ppm vs. 0.27 typical). (Estimates based upon process sewer flow of 3,893,000 gal for the week.)

[a]"Cleanup action" refers to immediate response to spill event. Trench cleanup plans are described in the Closure/Post Closure Plan.

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APPENDIX B

EVALUATION OF AVAILABLE CODES FOR REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY

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APPENDIX B

1.0 EVALUATION OF AVAILABLE CODES FOR REMEDIAL INVESTIGATIONS/FEASIBILITY STUDY

1.1 PURPOSE

Computer models and codes provide a framework to incorporate the processes that are active at a waste disposal site, thereby permitting assessment and evaluation of various waste management options for a given site. The time frames, ranging from decades to thousands of years, associated with the evaluation of waste isolation potential for a given site also necessitate the use of models and codes.

Because of the importance of the computer models relative to the performance assessment and risk assessment of a waste disposal site, a procedure for independent evaluation of reliability and these models and codes is required. Codes must be evaluated to determine the limitations of theories, and reliability of supporting empirical relations and laboratory tests used for evaluation of long-term waste isolation potential.

The purpose of this section is to provide an evaluation of a variety of codes that are possible candidates for use in the remedial investigation and feasibility study (RI/FS) of a given site. The groundwater, air, biotic, direct contact, and surface water pathways are considered for transport of contaminants. Such an evaluation can be used for the following:

- To facilitate a comparison of codes
- To provide a screening mechanism (i.e., to determine which codes are applicable to a specific requirement at a given site)
- As an indication of potential deficiencies of the codes
- To evaluate the necessity of additional codes that do not currently exist, but might be required in the future for RI/FS of a site
- To provide a basis for gathering additional field data for site characterization and RI/FS.

1.2 SCOPE OF WORK

The codes evaluated in this report were selected as part of a two-step process. The first step in evaluating the codes was to assemble the list of relevant codes that can potentially be used in an RI/FS of a waste disposal site. The second step was to prepare a table describing the important features of selected codes. As part of the second step, a detailed evaluation of the selected codes was performed and a comparison table was developed.

The criteria used in assembling the list of codes may be summarized as follows.

- Codes developed and used by the U.S. Department of Energy (DOE), Nuclear Regulatory Commission (NRC), and U.S. Environmental Protection Agency (EPA) should be selected.
- These codes should be:
  - Unclassified
  - Off-the-shelf
  - Documented sufficiently to make preparation of an evaluation feasible.
- If codes are available in several versions, the most recent should be used.
- The total number of codes reviewed must be consistent with schedule and manhours available.

Furthermore, the comparative evaluation process should address the following:

- Stage of development of the code
- Verification of benchmark status
- Validation status
- Availability of users' manual
- Acceptance by regulatory agencies (i.e., code usage by DOE, NRC, and EPA)
- Acceptance by scientific community (i.e., availability of peer-reviewed journal articles incorporating code description and verification and benchmark results)
- Operational readiness status of the code at the Hanford Site
- Cost of using the code
- Strengths of the code
- Limitations
- Input data required
- Availability of pre-and post-processors for a code

- Ability (or inability) to model Hanford Site conditions; in particular, ability to model the dry, heterogenous vadose zone soils at the Hanford Site
- Hardware requirements for a code
- Expertise required to use a code
- Marginal advantage of one code over another.

The evaluations are based on available publications and documentation of the codes, supplemented in some cases by the experience of members of the Environmental Technology group. The evaluations are not comprehensive; rather, the goal was to indicate how the codes might be used in RI/FS analysis and point out the deficiencies in the codes. These evaluations, therefore, represent a first step in the screening process for using a code for a given site.

Table B-1 provides a comparison of integrated transport codes. Table B-2 describes several groundwater pathway codes. Table B-3 describes transport codes for the air, biotic, and direct contact pathways.

Table B-1. Integrated Models for All Pathways. (sheet 1 of 2)

Computer code name	Stage of development	Verification/ benchmarking status	Validation status	Users' manual available?	Acceptance by regulatory agencies	Acceptance by scientific community	Operational readiness	Cost of utilization	Strengths	Limitations	Input data required	Pre/post processors available?	Ability to model Hanford Site conditions	Hardware requirements	Expertise required	Marginal advantage of one model/ another
RAPS/ MEPAS (model to simulate contaminant transport from a waste disposal site and to evaluate human exposure)	Fully developed	Verified and benchmarked (Whelan et al. 1987)	Not validated	Yes (Whelan et al. 1986)	U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA)	Unknown	Available on site Pacific Northwest Laboratory (PNL)	Low	Minimum knowledge of risk assessment and a minimum amount of input data; considers groundwater, overland, surface water, and atmospheric pathways	Can be used to rank or prioritize sites; but cannot be used in a predictive mode to simulate actual risks at a particular site from the release of contaminants	Dispersion coefficients, hydraulic conductivities, degradation rates, modes of exposure, and dose response information	No	Unknown	Micro/mini-computer	Familiarity with users' manual	Can be applied to rank or prioritize sites; includes simplified models for risk assessments to important receptors
PATHRAE (simulates transport from groundwater, surface water, atmospheric, and occupational pathways)	Fully developed	Unknown	Not validated	Yes (Rogers and Hung 1987)	DOE/U.S. Nuclear Regulatory Commission (NRC)	Unknown	Available on site (PNL)	Low	Minimum user knowledge of risk assessment and a minimum amount of input data; considers complex processes migration, degradation, transformation, transfer between media (air, water, etc.) and biological uptake	Can be used to rank or prioritize sites, but cannot be used in a predictive mode to simulate actual risks at a particular site from the release of contaminants	Dispersion coefficients, hydraulic conductivities, degradation rates, modes of exposure, and dose response information	No	Unknown	Micro/mini-computer	Familiarity with users' manual	Can be applied to rank or prioritize sites; includes simplified models for risk assessments to important receptors

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Table B-1. Integrated Models for All Pathways. (sheet 2 of 2)

Computer code name	Stage of development	Verification/ benchmarking status	Validation status	Users' manual available?	Acceptance by regulatory agencies	Acceptance by scientific community	Operational readiness	Cost of utilization	Strengths	Limitations	Input data required	Pre/post processors available?	Ability to model Hanford Site conditions	Hardware requirements	Expertise required	Marginal advantage of one model/ another
GEMS (EPA library of codes to model each potential transport pathway)	Fully developed	Unknown	Unknown	Yes (GSC 1982)	EPA	Unknown	Not currently available on site	Medium to high	Unknown	Unknown	Dispersion coefficients, hydraulic, conductivities, degradation rates, modes of exposure, and dose response information	Yes	Unknown	Terminal and modem to access GEMS	Limited modeling experience and familiarity with users' manual	EPA model

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Table B-2. Available Groundwater Pathway Computer Codes for Remedial Investigation/ Feasibility Study. (sheet 1 of 4)

Computer code name	Stage of development	Verification/ benchmarking status	Validation status	Users' manual available?	Acceptance by regulatory agencies	Acceptance by scientific community	Operational readiness	Cost of utilization	Strengths	Limitations	Input data required	Pre/post processors available?	Ability to model Hanford Site conditions	Hardware requirements	Expertise required	Marginal advantage of one model/ another
CHAINT (2D transport code for saturated and unsaturated media; includes radionuclide decay and adsorption for contaminants)	Fully developed	Partially verified and benchmarked	Not validated	Yes	DOE	Unknown	Available on PRIME 750	Medium	Low cost for vadose zone flow simulation, two-dimensional transport	One-dimensional, vertical, steady-state unit gradient model for vadose zone, does not allow for source/sink terms	Soil moisture characteristics for various layers	Yes	Applied to 200 Areas solid waste disposal sites	Mini/ mainframe computers	Familiarity with users' manual, theory description	Low cost of simulation, Westinghouse Hanford Company personnel familiarity with codes, less data requirements
MAGNUM (2D code for simulated groundwater flow in saturated aquifers)	Fully developed	Verified and benchmarked	Not validated	Yes	DOE	Unknown	Available on PRIME 750	Medium	Two-dimensional flow simulations	Does not allow for source/sink terms within aquifers	Hydraulic characteristics for various zones with aquifers	Yes	Extensively applied to Hanford Site basalt aquifers (flow tops and dense interiors)	Mini/ mainframe computers	Familiarity with users' manual, theory description	Low cost of simulation, Westinghouse Hanford Company personnel familiarity with code. MAGNUM was especially developed for modeling flow in basalt environment
FEMWATER/ FEMWASTE	Fully developed	Verified and benchmarked (Yeh et al. 1987)	Not validated	Yes	DOE		Not available on site	High	Two-dimensional flow and transport includes sources/ sinks	Long execution times, inability to model heterogeneous vadose zone soils	Moisture characteristic curves for various vadose zone layers	No	Unknown	Mini/ mainframe computers	High degree of familiarity with theory and users' manuals	Integrated saturated/ unsaturated zone modeling flow including sources/ sinks for unconfined aquifer

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Table B-2. Available Groundwater Pathway Computer Codes for Remedial Investigation/ Feasibility Study. (sheet 2 of 4)

Computer code name	Stage of development	Verification/ benchmarking status	Validation status	Users' manual available?	Acceptance by regulatory agencies	Acceptance by scientific community	Operational readiness	Cost of utilization	Strengths	Limitations	Input data required	Pre/post processors available?	Ability to model Hanford Site conditions	Hardware requirements	Expertise required	Marginal advantage of one model/ another
VAM2D/ SATURN (2D flow and transport code for saturated/ unsaturated media; includes decay and adsorption)	Fully developed	Verified and benchmarked (Huyakorn et al. 1984)	Not validated	Yes	U.S. Department of Energy (DOE) U.S. Nuclear Regulatory Commission (NRC)	Huyakorn et al. 1984, 1985, 1987		Medium	Includes a simplified option for modeling vadose zone; includes option sources/ sinks for aquifers	Long execution times, for the full saturated/ unsaturated flow and transport modeling	Hydraulic characteristics for various vadose zone layers and unconfined aquifers	No	Capable of modeling heterogeneous layered media (such as those existing at Hanford Site)	Mini/ mainframe computers	High degree of familiarity with theory and users' manuals	Simplified option for vadose zone modeling; option for including sources/ sinks for unconfined aquifer; integrated modeling of saturated/ unsaturated media
TRACR3D (3D code for modeling flow and transport of multiphase organics in vadose zone)	Fully developed	Currently being verified and benchmarked at Pacific Northwest Laboratory (PNL) for the Hanford Site grout program	Not validated	Yes, (Travis 1984)	DOE, NRC	Unknown	Available at PNL	High	Multidimensional modeling of flow and transport of organics	Does not include flow and transport in unconfined aquifer; limited ability to model heterogeneous vadose zone properties	Relative permeability versus saturation relationships for various multiphase organics	No	Has difficulty in simulating flow through heterogeneous layered media (such as those existing at Hanford Site)	Mini/ mainframe computers	High degree of familiarity with theory and users' manuals	Ability to model multidimensional, multiphase flow and transport in vadose zone
PORFLO (3D code for simulating flow, heat transport and mass transport saturated porous media)	Fully developed	(Eyler and Budden 1984)	Not validated	Yes, (Kline et al. 1983)	DOE	Unknown	Available onsite	Medium	Three-dimensional simulations possible; allows for sources/ sinks in unconfined aquifers	Vadose zone simulation capabilities not available but are currently being incorporated	Hydraulic properties of various heterogeneities in the saturated aquifer	Yes	Extensively applied to model flow and transport through Hanford Site basalts	Mini/ mainframe computers	High degree of familiarity with theory and users' manuals	Ability to model three-dimensional flow and transport in saturated media, Westinghouse Hanford Company familiarity with code
MODFLO (3D code for simulating flow in saturated porous media)	Fully developed	(McDonald and Harbaugh 1984)	Not validated	Yes	U.S. Geological Survey	Unknown	Not available onsite	Medium	Modular structure of various submodels	Vadose zone simulation capabilities not available	Hydraulic properties of saturated confined and unconfined aquifers	No	Unknown	Mini/ mainframe computers	Familiarity with users' manual	Ability to model three-dimensional flow in saturated media

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Table B-2. Available Groundwater Pathway Computer Codes for Remedial Investigation/ Feasibility Study. (sheet 3 of 4)

Computer code name	Stage of development	Verification/ benchmarking status	Validation status	Users' manual available?	Acceptance by regulatory agencies	Acceptance by scientific community	Operational readiness	Cost of utilization	Strengths	Limitations	Input data required	Pre/post processors available?	Ability to model Hanford Site conditions	Hardware requirements	Expertise required	Marginal advantage of one model/ another
VAM3D (3D flow and transport code for modeling flow and transport through saturated/ unsaturated media; includes decay and adsorption)	Fully developed	Verified and benchmarked (Huyakorn et al. 1985)	Not validated	Yes	DOE	Unknown	Not available on site	Verify high	Includes a simplified option for modeling vadose zone; includes option for incorporating source/ sink terms in aquifers	Very long execution times for modeling the full, 3D, saturated/ unsaturated media	Hydraulic properties for various vadose zone layers and unconfined aquifers	No	Capable of modeling heterogeneous layered media (such as those existing at Hanford Site)	Mainframe computer	Very high degree of familiarity with theory and users manuals	Ability to the fill, 3D flow and transport in an integrated saturated/ unsaturated media, with sources/ sinks in unconfined aquifers
UNSAT2	Fully developed	Verified and benchmarked	Not validated	Yes	DOE/NRC	(Neuman 1973)	Available at PNL	Medium	Two-dimensional vadose zone and unconfined aquifer simulations with sources/ sinks present in unconfined aquifer	Vadose zone flow simulation capabilities limited to simpler, smaller flow domains; does not include contaminant transport modeling option	Hydraulic properties for various vadose zone layers and unconfined aquifers	No	Has difficulty in simulating flow through heterogeneous, layered media (such as those existing at Hanford Site)	Mini/ mainframe computer	High degree of familiarity with theory and users manuals	Ability to model 2D in integrated saturated/ unsaturated media, with sources/ sinks in unconfined aquifers
UNSAT-H (1D model for simulating flow through vadose zone)	Fully developed	Verified and benchmarked	Not validated	Yes	DOE	Unknown	Available at PNL	Low	Developed specifically for Hanford Site conditions; includes a water balance subroutine	One-dimensional model, limited applicability to multidimensional, heterogeneous layered media	Soil properties, plant data for ET calculations	Unknown	Capable of simulating flow in heterogeneous layered media	Mini/ mainframe computer	Familiarity with users manual	Has been applied to Hanford Site conditions

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Table B-2. Available Groundwater Pathway Computer Codes for Remedial Investigation/ Feasibility Study. (sheet 4 of 4)

Computer code name	Stage of development	Verification/ benchmarking status	Validation status	Users' manual available?	Acceptance by regulatory agencies	Acceptance by scientific community	Operational readiness	Cost of utilization	Strengths	Limitations	Input data required	Pre/post processors available?	Ability to model Hanford Site conditions	Hardware requirements	Expertise required	Marginal advantage of one model/ another
RITZ (simulates movement fate of hazardous chemicals during land treatment of oily wastes)	Fully developed	Unknown	Not validated	Yes, (Nofziger and Williams 1988)	U.S. Environmental Protection Agency (EPA)	Unknown	Available onsite	Low	Simple model with few data requirements; can be applied in case of organics	Assumptions are highly simplistic and may not be valid in nature; cannot be used to simulate actual risks at a site	Input data on soil, pollutant, oil, environmental, and operational parameters for land treatment sites	Yes	Unknown	Micro-computer	Familiarity with users' manual	Can be applied to obtain preliminary data on transport and fate of organics in the vadose zone
SESOIL (unsaturated zone transport model)	Fully developed	Unknown	Not validated	Yes, (Bonazountas and Wagner 1981)	EPA	Unknown	Available through GEMS	Low - Medium	Models organic and inorganic species; accounts for adsorption, volatilization, degradation, and biodegradation	Only handles up to three soil layers	Hydrologic and meteorologic data, contaminant information	Yes	Unknown	Terminal and modem access to GEMS	Familiarity with users' manual	Versatile, easy to use, EPA acceptance
HELP (1-D unsaturated flow and transport model)	Fully developed	Unknown	Not validated		EPA	Unknown	Available onsite	Low	Simple model for rough calculations, models organic and inorganic species	Simple 1-D approach may not be adequate at some sites	Hydrologic and meteorologic data, contaminant information	No	Yes	IBM-PC or equivalent	Familiarity with users' manual	Easy to use, EPA acceptance

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Table B-3. Models for Air, Biotic, Direct Contact, and Surface Water Pathways. (sheet 1 of 3)

Computer code name	Stage of development	Verification/ benchmarking status	Validation status	Users' manual available?	Acceptance by regulatory agencies	Acceptance by scientific community	Operational readiness	Cost of utilization	Strengths	Limitations	Input data required	Pre/post processors available?	Ability to model Hanford Site conditions	Hardware requirements	Expertise required	Marginal advantage of one model/ another
AIR PATHWAY																
TOXBOX (basic box model)	Fully developed	Unknown	Unknown	(GSC 1982)	U.S. Environmental Protection Agency (EPA)	Unknown	Not currently accessible at Hanford Site	Low-Medium	Can represent vertical dispersion; areal source; available through GEMS	Simplified box model	Unknown	Yes	No site-specific limitations	Terminal and modem to access GEMS	Limited modeling experience	Ease of use and EPA acceptance
INDUSTRIAL SOURCE COMPLEX (Gaussian dispersion model)	Fully developed	Unknown	Unknown	(GSC 1982)	EPA	Unknown	Not currently accessible at Hanford Site	Low-Medium	Long- and short term simulations; settling and dry deposition of particles; multiple point sources; limited terrain adjustments	Unknown	Meteorological and source data	Yes	No site-specific limitations	Terminal and modem to access GEMS; mini/ mainframe computer	Limited modeling experience	Rigorous approach and EPA acceptance
SEE ALSO PATHRAE AND RAPS/ MEPAS																

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Table B-3. Models for Air, Biotic, Direct Contact, and Surface Water Pathways. (sheet 2 of 3)

Computer code name	Stage of development	Verification/ benchmarking status	Validation status	Users' manual available?	Acceptance by regulatory agencies	Acceptance by scientific community	Operational readiness	Cost of utilization	Strengths	Limitations	Input data required	Pre/post processors available?	Ability to model Hanford Site conditions	Hardware requirements	Expertise required	Marginal advantage of one model/ another
BIOTIC PATHWAY																
BIOPORT/ MAXI 1 (Radiation dose due to plants and animals	Fully developed	Planned for FY 1989	Planned for FY 1989	(McKenzie et al. 1985)	NRC	Unknown	Available at Hanford Site	Low	Radiation dose calculated for ingestion, inhalation, and direct exposure; intrusion and active physical transport are considered	Does not consider hazardous chemicals	Agricultural and water-usage practices; wildlife information	No	No site-specific limitations	Mini/ mainframe computer	Limited modeling experience	Developed at Hanford Site
SEE ALSO PATHRAE AND RAPS/ MEPAS																
DIRECT-CONTACT PATHWAY																
ONSITE/ MAXI 1 (Radiation dose due to direct intrusion)	Fully developed	Unknown	Unknown	(Kennedy et al. 1986, 1987)	NRC	Unknown	Available at Hanford Site	Low	Radiation dose calculated for direct exposure and ingestion (food and water)	Does not consider hazardous chemicals	Agricultural and water-usage practices; lifestyle characteristics of intruder/ resident	No	No site-specific limitations	Micro/mini/ mainframe computer	Limited modeling experience	Developed at Hanford Site
SEE ALSO PATHRAE AND RAPS/ MEPAS																

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Table B-3. Models for Air, Biotic, Direct Contact, and Surface Water Pathways. (sheet 3 of 3)

Computer code name	Stage of development	Verification/ benchmarking status	Validation status	Users' manual available?	Acceptance by regulatory agencies	Acceptance by scientific community	Operational readiness	Cost of utilization	Strengths	Limitations	Input data required	Pre/post processors available?	Ability to model Hanford Site conditions	Hardware requirements	Expertise required	Marginal advantage of one model/ another
SURFACE WATER PATHWAY																
EXPOSURE ANALYSIS MODELING SYSTEM (3-D compartmental model for freshwater, nontidal systems)	Fully developed	Unknown	Unknown	(Burns et al. 1982) (GSD 1982)	EPA	Unknown	Not currently accessible at Hanford	Medium-High		Unknown	Unknown	Yes	No site-specific requirements	Mini/ mainframe computer	Understanding of transport process and modeling experience	Rigorous approach and EPA acceptance
WATER QUALITY ASSESSMENT METHODOLOGY (1-D Model for lakes, rivers, and streams)	Fully developed	Unknown	Unknown	(Mills et al. 1982)	EPA	Unknown	Not currently accessible at Hanford	Low	Easy to use with desk calculator	Very simple approach	Limited data requirements	No	No site-specific requirements	Calculator	Limited modeling experience	Ease of use and EPA acceptance
SEE ALSO RAPS/ MEPAS AND PATHRAE																

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ATTACHMENT 1

SAMPLING AND ANALYSIS PLAN

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This Sampling and Analysis Plan (SAP) consists of two parts:

- Attachment 1a--Field Sampling Plan (FSP)
- Attachment 1b--Quality Assurance Project Plan (QAPP).

The FSP and QAPP each conform with current draft EPA guidance in terms of content and format.

The FSP contains information pertinent to activities that need to be conducted in the field. The QAPP discusses the quality assurance/quality control measures to be followed to ensure the useability and defensibility of the data collected during the remedial investigation.

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ATTACHMENT 1a

FIELD SAMPLING PLAN

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1.0 INTRODUCTION

This plan, Attachment 1a to the 300-FF-1 remedial investigation (RI/FS) work plan, is written for those who are assigned responsibility for obtaining field samples for the operable unit RI/FS. The field sampling plan (FSP), while perhaps the best plan for the field person to first study before venturing out into the field, is designed to be used in conjunction with the 300-FF-1 RI/FS work plan, other attachments to that plan, and referenced procedures.

The actual work plan contains important summaries on the background for operable unit 300-FF-1 in the first three chapters. The work plan contains a list of acronyms and abbreviations that are also used in this document. The field person should also be aware of the project schedule contained within Chapter 6 of the work plan (or the most recent available update of that schedule).

The quality assurance project plan (QAPP), Attachment 1b to the work plan, is an essential document to be familiar with because it describes, among other things, the equipment and procedures that must be used during this project to obtain good representative field samples and onsite analytical results. Knowledge of the health and safety plan (HSP) (Attachment 2) is critical because it specifies procedures to be followed to ensure the occupational health and safety of field personnel working on the project. And, because field persons must maintain field notebooks containing vital project data, familiarity with applicable data management procedures specified in the data management plan (DMP) (Attachment 4) is also necessary.

Because the operable unit characterization phase of the remedial investigation (RI) is the only phase that contains field sampling requirements at this time, the FSP is outlined in the format corresponding to the phase I RI tasks, subtasks, and activities. For completeness, those phase I RI components that do not involve any field sampling are also briefly addressed in this plan. If additional field sampling requirements are determined to be needed in the operable unit characterization or other phases of the project, this document will be amended to incorporate such requirements.

2.0 PHASE I RI TASK 1--SOURCE INVESTIGATION

This task is designed to provide necessary information regarding the locations, structure, and integrity of certain hazardous waste facilities within the operable unit, and to validate the results of project scoping efforts.

2.1 TASK 1a--SOURCE DATA COMPILATION

This subtask does not involve any field sampling.

2.2 TASK 1b--GROUND-PENETRATING RADAR SURVEY

2.2.1 Task 1b-1--Geodetic Survey

2.2.1.1 Sampling Objectives. The objective of this activity is to establish grids upon which the actual ground-penetrating radar survey will be done. The grid will serve as sampling transects for the radar survey and will provide reference points for data obtained. All surveying for this project will be tied into the Hanford Site coordinate system.

2.2.1.2 Sample Locations and Frequencies. The grids will be established on burial grounds No. 4 and No. 5. They will be grids of 20--ft intervals. The grid coordinates around the boundaries of the two burial grounds will be surveyed and staked one time to establish the transect lines for the radar survey.

2.2.1.3 Sample Designations. Not applicable.

2.2.1.4 Sampling Equipment and Procedures. Surveying equipment and procedures shall be specified in approved participant contractor, or subcontractor procedures, as described in the QAPP. Third-order precision and accuracy will be required.

2.2.1.5 Sample Handling and Analysis. This survey will locate and stake out reference points, with third-order precision and accuracy, along the boundaries of the two burial grounds. Transect lines can then be run between opposing stakes. Data will be recorded in a field notebook, which will be handled in accordance with procedures specified in the QAPP and DMP. Westinghouse Hanford Company (Westinghouse Hanford) will take administrative measures to ensure that the reference stakes are not disturbed until after Task 1b-2 is completed.

2.2.2 Task 1b-2--Ground-Penetrating Radar Sampling and Analysis

2.2.2.1 Sampling Objectives. The goals of this activity are to:

- Determine the depths of fill in burial grounds No. 4 and No. 5
- Determine and locate any subsurface structure, such as a parallel trench configuration, within the two burial grounds
- Determine whether any buried containers, such as drums, exist within the burial grounds and, if so, provide their locations.

2.2.2.2 Sample Locations and Frequencies. The actual implementation of the radar survey will be a one-time occurrence for each of the two burial grounds. A 20-ft grid will be established under Task 1b-1, and this coordinate system will provide the transect lines upon which the radar data ground at 20-ft intervals. Transects perpendicular to the first set, across the entire width of each facility, will also be sampled.

2.2.2.3 Sample Designations. The grid coordinates established under Task 1b-1 will be designated A, B, C, ... along the length of each facility, and A′, B′, C′, ... along the opposing length. The width coordinates will be designated 1, 2, 3, ... and 1′, 2′, 3′, ..., respectively. Each transect sampled will therefore be designated by the endpoint coordinates, with the starting point of the sampling run coming first (e.g., A-A′ or 2-2′).

To distinguish between the two burial grounds, the codes BG4 and BG5 will preface the transect designator (e.g., BG4A-A′ or BG52-2′).

2.2.2.4 Sampling Equipment and Procedures. The ground-penetrating radar survey will be conducted along transects run between opposing stakes sited in Task 1b-1. Results will be plotted as to location by reference back to the established grid systems.

Sampling equipment and procedures shall be specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures, as described in the QAPP. Equipment shall, at a minimum, be capable of penetrating 15 ft, the approximate anticipated depth of the burial grounds.

2.2.2.5 Sample Handling and Analysis. Radar logs and field notes will be generated onsite and will be handled in accordance with the DMP and QAPP procedures. Sample analysis will consist of interpretation of the logs and notes.

2.3 TASK 1c--ELECTROMAGNETIC SURVEY

2.3.1 Task 1c-1--Retired Portions of the Process Sewer and the 307 Pipeline

2.3.1.1 Sampling Objectives. The purpose of this activity is twofold:

- Determine the exact location of the retired portions of the buried process sewer and the 307 pipelines
- Determine which sections of the lines, if any, have leaked process or laboratory sewage.

2.3.1.2 Sample Locations and Frequencies. The approximate locations of the retired portion of the process sewer and the 307 pipeline are shown in Plate 2 in the work plan. An activity under Task 1a will compile existing plans to attempt to locate this facility more accurately. The electromagnetic sampling will occur over the entire length of the process sewer system which is located within the operable unit boundaries. This survey will be performed one time.

2.3.1.3 Sample Designations. Stakes will be used to determine both the position of the sewer line and the locations of pipeline leaks. Different colors will be used to distinguish between these two determinations to avoid confusion during the geodetic survey to be performed under Task 1c-3.

2.3.1.4 Sampling Equipment and Procedures. Details on electromagnetic sampling equipment and procedures shall be specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures, as described in the QAPP.

2.3.1.5 Sample Handling and Analysis. Results of the retired portion of the process sewer and the 307 pipeline electromagnetic survey will be demarcated in the field by two types of stakes. One will indicate the location of the sewer line route; the other will indicate leaks from the pipeline. Data will be recorded in a field notebook to supplement the staked locations. All field data will be handled in accordance with QAPP and DMP procedures. Westinghouse Hanford will implement administrative measures to ensure that the stakes are not disturbed until the completion of Task 1c-3.

2.3.2 Task 1c-2--Retired Radioactive Sewer

2.3.2.1 Sampling Objectives. A literature and plan search will be undertaken pursuant to Task 1a to attempt to accurately locate the retired radioactive sewer pipelines within 300-FF-1. The approximate locations are indicated in Plate 2 of the work plan. If necessary, this activity will be conducted to precisely locate the buried stainless steel lines.

2.3.2.2 Sample Locations and Frequencies. If this activity is conducted, it will be performed one time over the entire length of that portion of the sewer which is located within the operable unit boundaries.

2.3.2.3 Sample Designations. The location of the retired radioactive sewer pipeline route will be staked out as the electromagnetic survey proceeds. These stakes will use a color designator different from the two used in Task 1c-1.

2.3.2.4 Sampling Equipment and Procedures. Details on electromagnetic sampling equipment and procedures shall be specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures, as described in the QAPP.

2.3.2.5 Sample Handling and Analysis. Results of this survey will be displayed in the field by staking the location of the sewer line route. Data will be recorded in a field notebook to supplement the staked locations. All field data will be handled in accordance with the DMP and QAPP. Administrative precautions will be taken to ensure that the stakes are not disturbed until after Task 1c-3 is completed.

2.3.3 Task 1c-3--Geodetic Survey

2.3.3.1 Sampling Objectives. The purpose of this activity is to survey the locations of the buried process and retired radioactive sewers, as determined in Tasks 1c-1 and 1c-2, respectively. In addition, locations of leakage of process sewage from the process sewer lines will also be determined under this activity. The ultimate goal is to incorporate the locations of the two sewer

pipelines onto the topographic base map (Task 1d). Locations of leakage points will also be ultimately plotted on the base map for subsequent data interpretation. All surveying for this project will be tied into the Hanford Site coordinate system.

2.3.3.2 Sample Locations and Frequencies. This activity will take place within the operable unit boundary, along the routes of the two sewer pipelines. Stakes installed under Tasks 1c-1 and 1c-2 will cover the area of interest.

2.3.3.3 Sample Designations. Not applicable.

2.3.3.4 Sampling Equipment and Procedures. Details on the surveying equipment and procedures shall be specified in approved participant contractor, or subcontractor procedures, as described in the QAPP. Third-order precision and accuracy will be required.

2.3.3.5 Sample Handling and Analysis. Data will be recorded in a field notebook and handled in accordance with the procedures specified in the DMP and QAPP.

2.4 TASK 1d--TOPOGRAPHIC BASE MAP DEVELOPMENT

2.4.1 Sampling Objectives

The purpose of this subtask is to develop a topographic map of the operable unit, having third-order precision and accuracy, 1:2,400 scale, and 2-ft elevational contour intervals. This map will be used to:

- Accurately indicate locations of operable unit facilities
- Accurately indicate locations of RI sampling stations
- Evaluate surface run-off drainage patterns
- Plot data to evaluate areal extent of contamination
- Evaluate remedial alternatives.

2.4.2 Sample Locations and Frequencies

The map will encompass the entire operable unit, extending 330 ft past the operable unit boundaries.

Development of a comprehensive operable unit map will be somewhat of an ongoing process during the project. Geodetic control and survey activities are specified for each appropriate investigational subtask. The surveying needed to determine facility locations and surface elevations, and base map

development, will be performed under this subtask. As new sampling stations are established under other RI tasks, additional geodetic surveying and updating of the map will occur.

2.4.3 Sample Designation

Not applicable.

2.4.4 Sampling Equipment and Procedures

Details on the surveying and mapping equipment and procedures shall be specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures, as described in the QAPP.

2.4.5 Sample Handling and Analysis

All field data obtained during this activity will be recorded in a field notebook, and the notebook will be handled in accordance with the DMP and QAPP.

2.5 TASK 1e--"IN-PIPE" REMOTE INSPECTION SURVEY

2.5.1 Task 1e-1--Mobilization

This activity does not involve any field sampling.

2.5.2 Task 1e-2--"In-Pipe" Remote Inspection

2.5.2.1 Sampling Objectives. The purpose of this activity is to perform an inspection of the pipeline along the route of the retired radioactive sewer, within the boundaries of 300-FF-1, as a minimum. The ultimate goal of this activity is to accurately locate cracks in the sewer that may have resulted in contamination to surrounding soils.

2.5.2.2 Sample Locations and Frequencies. This activity will take place along the route of the retired radioactive sewer line. Depending on decisions made during Task 1e-1 this may be along the entire retired radioactive sewer line or just along that portion within the 300-FF-1 boundary.

2.5.2.3 Sample Designations. Not applicable.

2.5.2.4 Sampling Equipment and Procedures. Details on the "in-pipe" technique, equipment, and procedures to be used shall be specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures.

2.5.2.5 Sample Handling and Analysis. No physical samples will be obtained during implementation of this activity. A field notebook will be kept, however, and all pertinent details will be recorded. These notes will be handled in accordance with the DMP and QAPP.

2.5.3 Task 1e-3--Data Analysis

2.5.3.1 Sampling Objectives. The purpose of this activity is to locate sections of the retired radioactive sewer that could have leaked radioactive sewage during the time this facility was in use. Potential leakage points will be found through the detection of cracks or leaks visible during the "in-pipe" inspection.

2.5.3.2 Sample Locations and Frequencies. Not applicable.

2.5.3.3 Sample Designations. Potential cracks or leaks that become visible during the survey will be designated according to the cleanout station from which the equipment was inserted into the pipeline and the direction that the survey proceeded (e.g., A1S, A2S, B1E, B2E, C1W, C2W,....). These stakes will use a color designator different from those used in Tasks 1c-1 and 1c-2.

2.5.3.4 Sampling Equipment and Procedures. Details on the "in-pipe" technique, equipment, and procedures to be used shall be specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures.

2.5.3.5 Sample Handling and Analysis. Results of the analysis of data taken during the survey will be displayed in the field by staking the location of all potential cracks or leaks with flags along the surface of the sewer line route. Data and results of analysis will be recorded in a field logbook and will be handled in accordance with the procedures specified in the QAPP and DMP.

2.5.4 Task 1e-4--Geodetic Survey

2.5.4.1 Sampling Objectives. The objective of this activity is to determine the locations of the potential cracks or leaks determined under Task 1e-2 so that this information can be added to the operable unit topographic map. All surveying for this project will be tied into the Hanford Site coordinate system.

2.5.4.2 Sample Locations and Frequencies. This activity will be a one-time event, and will be performed to locate each of the potential cracks or leaks established along the length of the retired radioactive sewer.

2.5.4.3 Sample Designations. Not applicable.

2.5.4.4 Sampling Equipment and Procedures. Details on the surveying equipment and procedures shall be specified in approved participant contractor or subcontractor procedures, as described in the QAPP. Third-order precision and accuracy will be required.

2.5.4.5 Sample Handling and Analysis. Data obtained will be recorded in a field notebook and handled in accordance with the DMP and QAPP. Results will be used to update the topographic base map.

2.6 TASK 1f--SOIL GAS SURVEY

2.6.1 Task 1f-1--Mobilization

This activity does not involve any field sampling.

2.6.2 Task 1f-2--Gas Probe (or Well) Installation

2.6.2.1 Sampling Objectives. The purpose of this activity is to install soil gas sampling stations at burial ground No. 4 and burial ground No. 5. The soil gas locations will be used to detect any volatile organic contaminants of concern so decisions can be made as to the soil sample analytical effort required under Task 3b.

2.6.2.2 Sample Locations and Frequencies. Gas probes will be driven, or gas wells will be drilled and installed (depending on decisions made during Task 1f-1), along a 50-ft grid spacing at burial ground No. 4 and burial ground No. 5.

2.6.2.3 Sample Designation. The following codes will be used to designate samples (X is a variable number).

- Facility association:

  The BG4--burial ground No. 4
  The BG5--burial ground No. 5.

- Depth penetration:

  XX.X--to the nearest tenth of a foot.

- Disposition (the No. 2 will be appended for duplicate samples):

  SGX--soil gas sample.

- Sample Sequence Number:

  XX.

- These codes will be combined to provide such designations as:

  The BG4-7.2-SG-12 (a duplicate soil gas sample obtained from burial ground soil gas location 12, at a depth of 7.2 ft below ground surface).

If a Hanford Site-specific sampling coding system is developed prior to the initiation of this activity, it will be employed in lieu of the system presented below.

2.6.2.4 Sampling Equipment and Procedures. The soil gas sampling probes or wells will be installed in locations as defined under Section 2.6.2.2. Procedures and equipment for installing the gas probes or gas wells shall be specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures, as described in the QAPP.

2.6.2.5 Sample Handling and Analysis. No physical samples will be obtained during implementation of this activity. A field notebook will be kept, however, and soil conditions and other relevant matters will be recorded. These notes will be handled in accordance with the DMP and QAPP.

2.6.3 Task 1f-3--Soil Gas Sampling and Analysis

2.6.3.1 Sampling Objectives. The purpose of this activity is to detect and locate any volatile organic contaminants of concern in the vadose zone. Sampling points where operable unit volatile organic contaminants of concern are detected will be targeted for standard volatile organic analysis.

2.6.3.2 Sample Locations and Frequencies. Once borehole sites are selected and installed or driven, the actual soil gas sampling will occur one time at each station established under Task 1f-2.

2.6.3.3 Sample Designation. Samples will be designated according to the gas sampling station from which the sample is derived, as described in Task 1f-2.

2.6.3.4 Sampling Equipment and Procedures. Samples of soil gas will be obtained from each sampling point to allow for an onsite determination of the volatile organic contaminants of concern, via gas chromatography. Details of onsite soil gas sampling and analysis procedures and equipment will be specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures, as described in the QAPP.

2.6.3.5 Sample Handling and Analysis. All samples will be analyzed onsite immediately after they are obtained. All chromatograms and field notes will be retained and handled in accordance with the DMP and the QAPP. Results will be plotted on a copy of the operable unit base map for interpretation.

2.6.4 Task 1f-4--Geodetic Survey

2.6.4.1 Sampling Objectives. The objective of this activity is to determine the locations of the gas probes (or wells) installed under Task 1f-2, so that this information can be added to the operable unit topographic map. All surveying for this project will be tied into the Hanford Site coordinate system.

2.6.4.2 Sample Locations and Frequencies. This activity will be a one-time event, and will be performed to locate each of the soil gas sampling points that have been established.

2.6.4.3 Sample Designation. Not applicable.

2.6.4.4 Sampling Equipment and Procedures. Details on the surveying equipment and procedures shall be specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures, as described in the QAPP. Third-order precision and accuracy will be required.

2.6.4.5 Sample Handling and Analysis. Data obtained will be recorded in a field notebook and handled in accordance with the DMP and QAPP. Results will be used to update the topographic base map.

2.7 TASK 1g--NON-HAZARDOUS SOURCE CHARACTERIZATION

2.7.1 Sampling Objectives

The purpose of this activity is to determine if further sampling will be necessary at the sanitary trenches, ash pits and the water treatment filter backwash pond.

2.7.2 Sampling Locations and Frequencies

Surface grab samples from these non-hazardous facilities will be obtained in the following numbers; three along the length of one of the sanitary trenches (the dry trench, if the trenches are alternated); three from each of the two ash pits; and, three from the water treatment filter backwash pond (see Figure 1).

2.7.3 Sample Designations

Surface grab samples will be designated using the following code (X is a variable number):

- SS-X Sanitary trenches
- WAP-X West ash pit
- EAP-X East ash pit
- FBP-X Filter backwash pond

If a Hanford Site-specific sampling coding system is developed prior to the initiation of this activity, it will be employed in lieu of the system presented above.

2.7.4 Sampling Equipment and Procedures

Surface grab samples will be taken in accordance with approved Westinghouse Hanford, participant contractor, or subcontractor procedures as described in the QAPP.

2.7.5 Sample Handling and Analysis

Sample logs and field logs will be maintained for each sample and all related observations. These logs will be handled in accordance with the records procedures specified in the DMP and the QAPP.

Samples will be properly preserved and transported to a laboratory under chain-of-custody procedures described in the QAPP. Each sample obtained for this task will be analyzed to determine classification according to WAC 173-3-3 as non-hazardous, dangerous waste or extremely dangerous waste.

3.0 PHASE I RI TASK 2--GEOLOGICAL INVESTIGATION

In general, sufficient information exists to characterize the geology of the operable unit and its surroundings. This task consists of a current literature search. The results will be used to refine the current knowledge on the area geology. In addition to this information, new geological data obtained during the implementation of the soil investigation and the 300-FF-5 groundwater investigation will be evaluated and incorporated into the RI/FS under Task 8b.

3.1 TASK 2a--GEOLOGICAL DATA COMPILATION

This subtask does not involve any field sampling.

4.0 PHASE I RI TASK 3--SOIL INVESTIGATION

The purpose of this task is to further define the known vertical extent of soil contamination below hazardous waste disposal facilities in 300-FF-1. Investigation of horizontal contaminant extent will also be performed. The nature of the soil contamination will be verified. Because of logistical factors, the nature of source contamination within burial grounds No. 4 and No. 5 will be determined under the soil investigation.

4.1 TASK 3a--SURFACE RADIATION SURVEY

4.1.1 Task 3a-1--Surface Radiation Sampling and Analysis

4.1.1.1 Sampling Objectives. The purpose of this activity is to locate any areas of contaminated soil outside the waste facility boundaries within the operable unit. The survey will also be conducted over the surface of all inactive waste facilities, i.e., those not currently containing liquid waste of any form. Background surface radiation conditions will also be determined so that meaningful comparisons can be made to the data obtained in the potentially impacted areas. Impacted areas found under this activity will be further characterized through soil borehole sampling in Task 3b.

4.1.1.2 Sample Locations and Frequencies. This sampling activity will be a one time occurrence, and will be conducted over the entire operable unit (areas of sagebrush and scrubgrasses). In addition, a background plot will be sampled to determine operable unit background conditions. These locations are shown in Figure 1.

Sampling at the background plot will be conducted at intersecting points on a 25-ft grid to obtain discrete readings at each point.

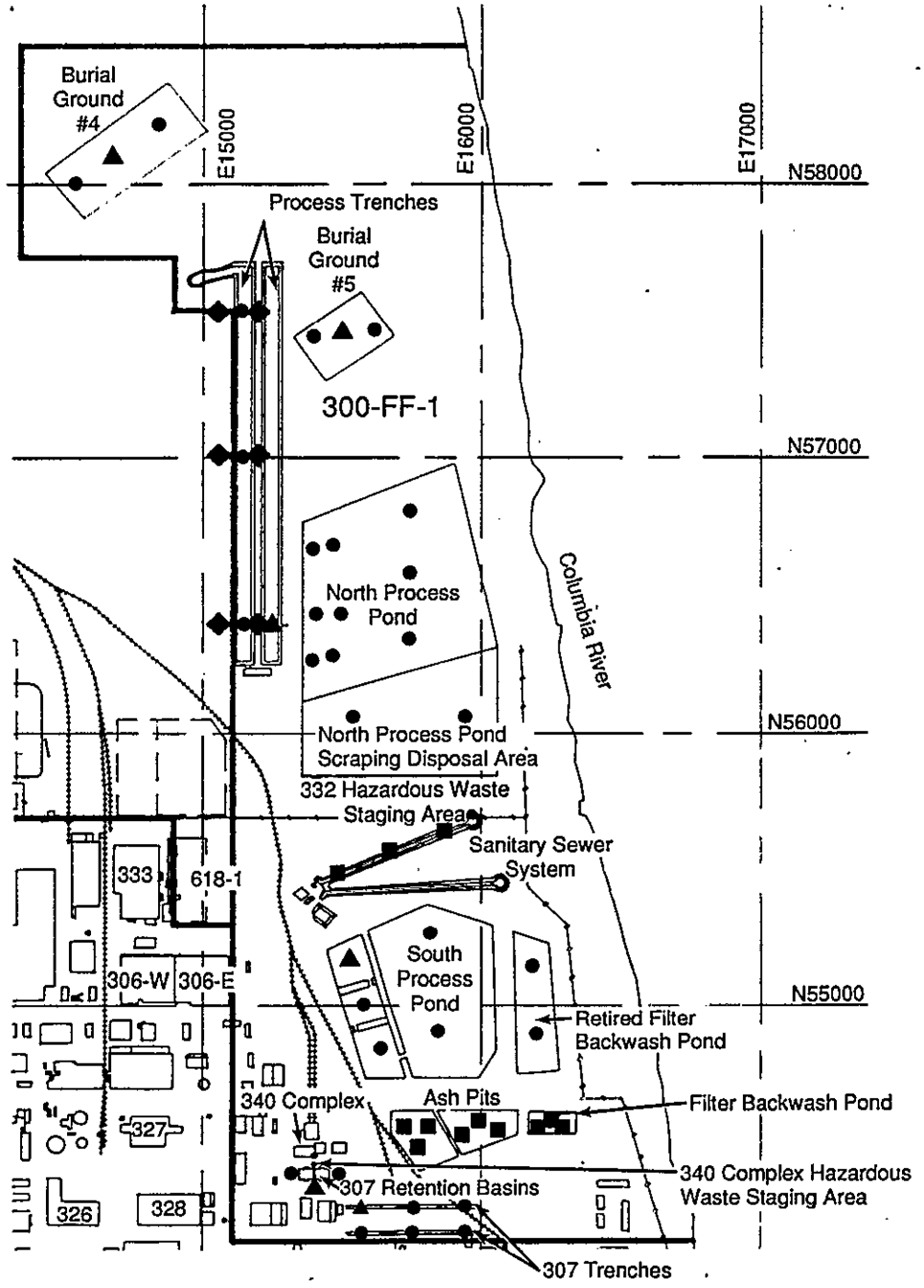
The ground surface will be continuously surveyed in those areas outside of established radiation zones.

4.1.1.3 Sample Designations. The grid coordinates established for the background plot will be designated A, B, C, ... along the length of the plot, and 1, 2, 3, ... along the width of the plot. Each plot point sampled will be designated by the combined grid coordinates (e.g., B2, C1, etc.). Points within the potentially impacted areas, which are determined to have elevated levels of radiation, will be staked for subsequent locational surveying.

4.1.1.4 Sampling Equipment and Procedures. This survey will be conducted with portable detectors for beta and gamma radiation. Discrete background values will be statistically analyzed to find the upper 95% tolerance limits of the distribution of background readings. Any values above these limits in the potentially impacted areas will be recorded, and the source locations staked for subsequent geodetic survey under Task 3a-2.

Details on surface radiation equipment and procedures--for beta and gamma radiation--shall be specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures, as described in the QAPP.

4.1.1.5 Sample Handling and Analysis. Field readings will be recorded in a field notebook and handled in accordance with the DMP and QAPP. Analysis of the data will consist of plotting the results, along with the locations of the readings, on a version of the topographic base map for the operable unit.



Key:

- ■ Proposed Surface Grab Samples
- ▲ Proposed Soil Boring - Stage I
- ● Proposed Soil Boring - Stage II
- ◆ Proposed Horizontal Soil Boring

Note: Five background borings are to be randomly allocated within the operable unit and eight additional borings are assumed to be required to characterize sewer line leaks and releases around the process ponds.

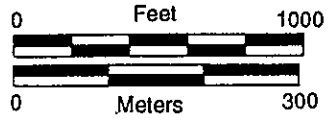


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Figure 1. Soil Boring Locations.

4.1.2 Task 3a-2--Geodetic Survey

4.1.2.1 Sampling Objectives. The two goals of this activity are:

- To establish a sampling grid in the background plot
- To determine and record the staked locations of elevated radiation readings in the potentially impacted areas.

All surveying for this project will be tied into the Hanford Site coordinate system.

4.1.2.2 Sample Locations and Frequencies. The background grid and potentially impacted areas will be surveyed one time. The background grid will be established such that a minimum of 30 discrete intersecting sampling points are created. Areas in the potentially impacted zone that are staked, thus indicating the presence of elevated radioactivity, will be surveyed.

4.1.2.3 Sample Designations. Not applicable.

4.1.2.4 Sampling Equipment and Procedures. Details on surveying equipment and procedures shall be specified in approved participant contractor or subcontractor procedures as described in the QAPP. Third-order precision and accuracy will be required.

4.1.2.5 Sample Handling and Analysis. Field data will be recorded onsite in a field notebook and handled in accordance with the DMP and QAPP. Analysis of the data will consist of plotting the locations of the background plot and the elevated radiation readings on a copy of the operable unit topographic base map.

4.2 TASK 3b--SOIL SAMPLING AND ANALYSIS

4.2.1 Task 3b-1--Mobilization

This activity does not involve any field sampling.

4.2.2 Task 3b-2--Soil Sampling

4.2.2.1 Sampling Objectives. The objectives of this activity are to:

- Confirm, or in some cases determine, the nature of the contaminants present in the soils beneath and near 300-FF-1 specific waste facilities
- Determine the nature of the contaminants within the fill material in burial grounds No. 4 and No. 5

- Determine the vertical distribution of contamination within the soils beneath specific waste facilities
- Determine the horizontal distribution of contamination within the soils next to the process trenches
- Determine physical characteristics of the soils
- Archive samples for potential future analytical purposes, including leach testing.

Results of the horizontal contaminant distribution characterization for the process trenches will be regarded as analogous for the other process liquid disposal facilities in the operable unit (i.e., the north and south ponds and the 307 trenches).

4.2.2.2 Sample Locations and Frequencies. Vertical soil borings will be located within the following 300-FF-1 facilities:

- South process pond
- North process pond
- The 307 trenches
- The 307 retention basins
- Process trenches
- Burial ground No. 4
- Burial ground No. 5.

Borings to be placed within the south and north process ponds shall not be located within existing sampling trenches. Three boreholes will be located adjacent to three existing trenches in the north process pond for purposes of borehole versus trench sampling research. Sixty soil gas measurements will be made at burial ground No. 4 on a 50-ft grid. Twenty soil gas measurements will be made at burial ground No. 5 on a 50-ft grid.

Five operable unit background boreholes will also be sampled. Samples collected from the background boreholes will be analyzed for the contaminants of concern (see Table 41 in the attached work plan) using standard analytical methods and using screening methods (XRF, specific conductance, ion specific electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation). The results from the standard analytical methods will be compared to the screening methods to determine the feasibility of using screening methods for determining extent of contamination in further sampling efforts.

The boreholes will be drilled in two stages. Stage I requires one vertical boring be drilled in each of the facilities listed in 4.2.2.2 (see Figure 1). Each boring will be sampled at intervals described below. Samples

will be analyzed by screening methods (XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation) and standard laboratory analysis methods. If results of screening methods are comparable to standard analytical procedures, screening of all samples collected in stage II will be conducted.

Stage II requires vertical borings be drilled and samples in each facility listed in Section 4.2.2.2 as described below. Samples will be analyzed by screening methods determined for use in Stage I.

The boreholes allocated to burial grounds No. 4 and No. 5 will probably be relocated upon completion of the ground-penetrating radar (Task 1b), soil gas survey or the surface radiation survey (Task 3a-1), because additional information will be available at that time. Figure 1 also shows the locations of the three horizontal borings to be installed in the process trenches.

Additional boreholes may be located along the process sewer, along the retired radioactive sewer, the perimeters of the south and north process ponds, and the area between the south pond and the river. The decisions to locate boreholes in these areas, the number of boreholes to be installed, and where to install them will be made upon completion of the electromagnetic, "in-pipe" remote inspection, and surface radiation surveys (Tasks 1c, 1e, and 3a, respectively). Therefore, these locations are not now indicated on Figure 1.

Boreholes will be continuously logged by the onsite geologist. Density measurements will be obtained during drive sampling.

Drive samples will be obtained in the vertical borings for laboratory contaminant and physical analysis. Samples will be obtained at the surface at each boring location and at least every 5-ft depth increment to 10 ft below the water table. Sampling will be obtained in changes in lithology or at any zones where obvious contamination is encountered as determined by field screening results or visual observation in lieu of the 5-ft depth sample.

To account for potential rapid vertical attenuation of contaminant concentrations, the core sampling interval will generally be decreased to 1.5 ft in the upper 6 ft for the process liquid disposal facility basins, except for the 307 trenches, which have been backfilled after being deactivated. In these trenches samples will be obtained at intervals of 1.5 ft to a depth of 6 ft below the fill.

One core sample per geologic stratum per vertical boring will be obtained for physical laboratory analysis. These samples will be randomly allocated with depth prior to initiating drilling. Three boreholes in the north process pond are involved in a small-scale research program. Stratum samples, taken from these boreholes located next to existing trenches, will be obtained from a depth of 10 ft below the surface. Because the soil borings are expected to be entirely within the Pasco gravels of the Hanford formation, one physical core sample per borehole is anticipated.

Core samples will be obtained in the six horizontal process trench borings for laboratory contaminant analysis only. Samples will be taken at the sidewall surface, and at 1-ft intervals to a distance of 3 ft. This amounts to a total of four core samples per horizontal boring. Additional samples may be taken if zones of obvious contamination are encountered, as determined by field screening or visual observation. Because the process trench sidewalls are sloped, these borings will be installed just below the mean water level, as indicated by vegetation growth.

Figures 2 through 4 show the vertical core sampling schemes for: background borings; south and north ponds; 307 retention basins, process trenches, and borings that may have to be installed in areas shown to be contaminated in the surface radiation survey; and the 307 trenches and borings that may have to be installed along buried pipelines.

Each time a core sample is obtained, a duplicate archive sample will also be obtained. In addition, duplicate quality assurance samples for laboratory analysis will be taken at a frequency of no less than 5%.

Each vertical and horizontal borehole will be sampled one time prior to being abandoned under Task 3b-6. The archived samples, however, will provide a supply of documented material for additional analytical work, if such work becomes necessary.

4.2.2.3 Sample Designations. The following codes will be used to designate samples (X is a variable number).

Boring orientation:

- V--vertical boring
- H--horizontal boring.

Facility association:

- SPX--south process pond
- NPX--north process pond
- 307TX--307 trenches
- 307RBX--307 retention basins
- PTX--process trenches
- BG4X--burial ground No. 4
- BG5X--burial ground No. 5
- PSX--process sewer
- RRSX--retired radioactive sewer.

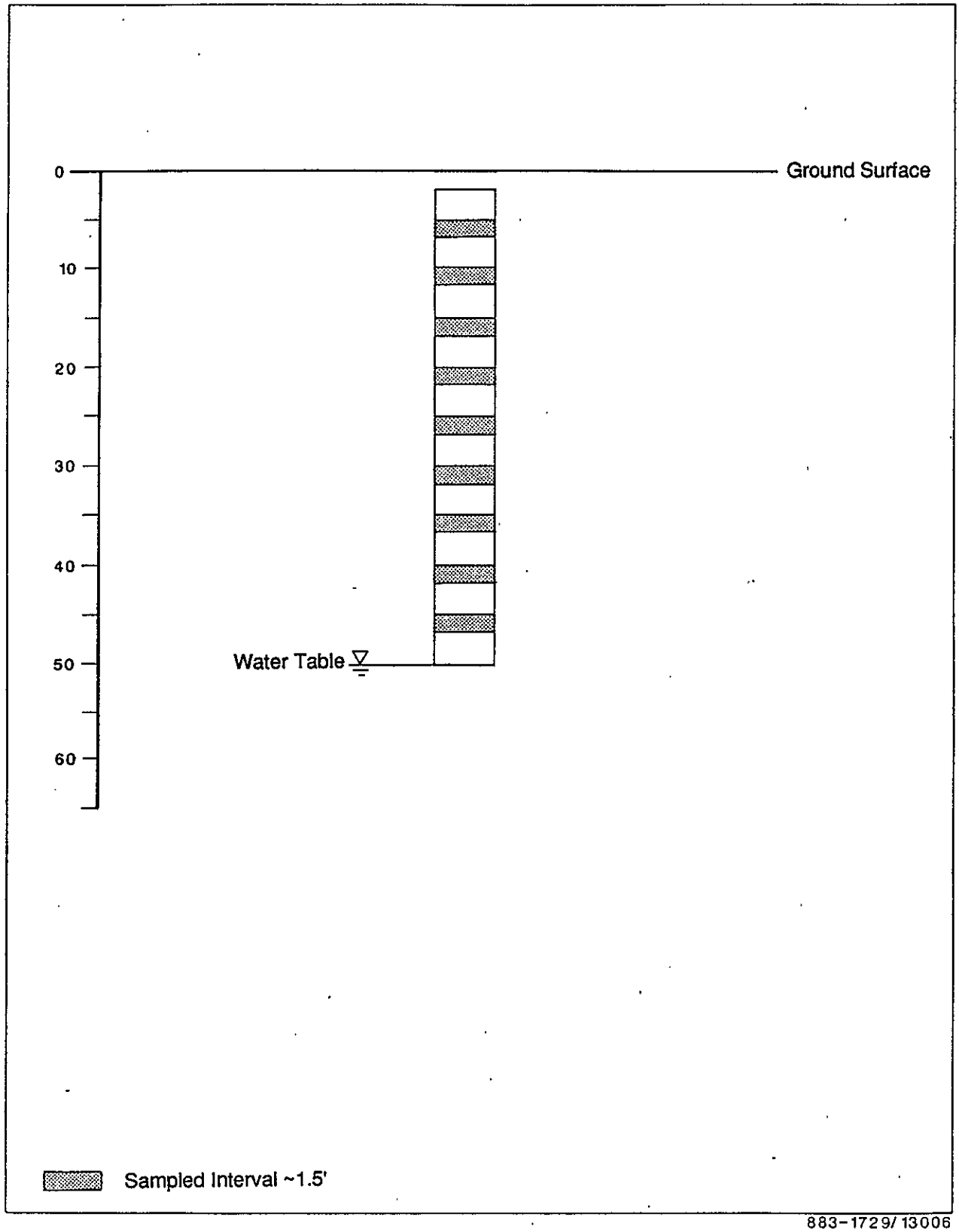

Figure 2. Background Soil Borings--Sample Locations.

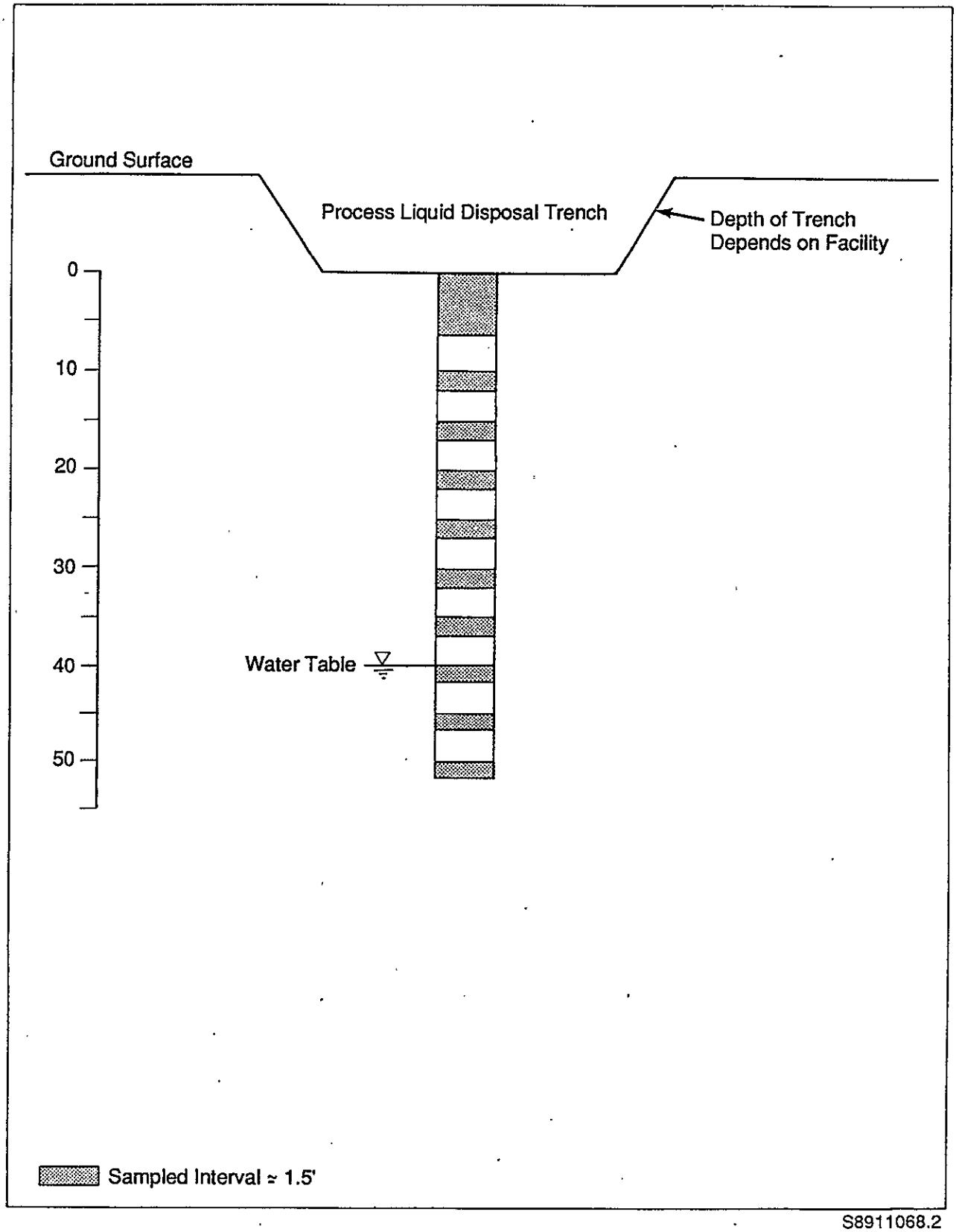

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Figure 3. Soil Borings in Process Liquid Disposal Facilities--Sample Locations.

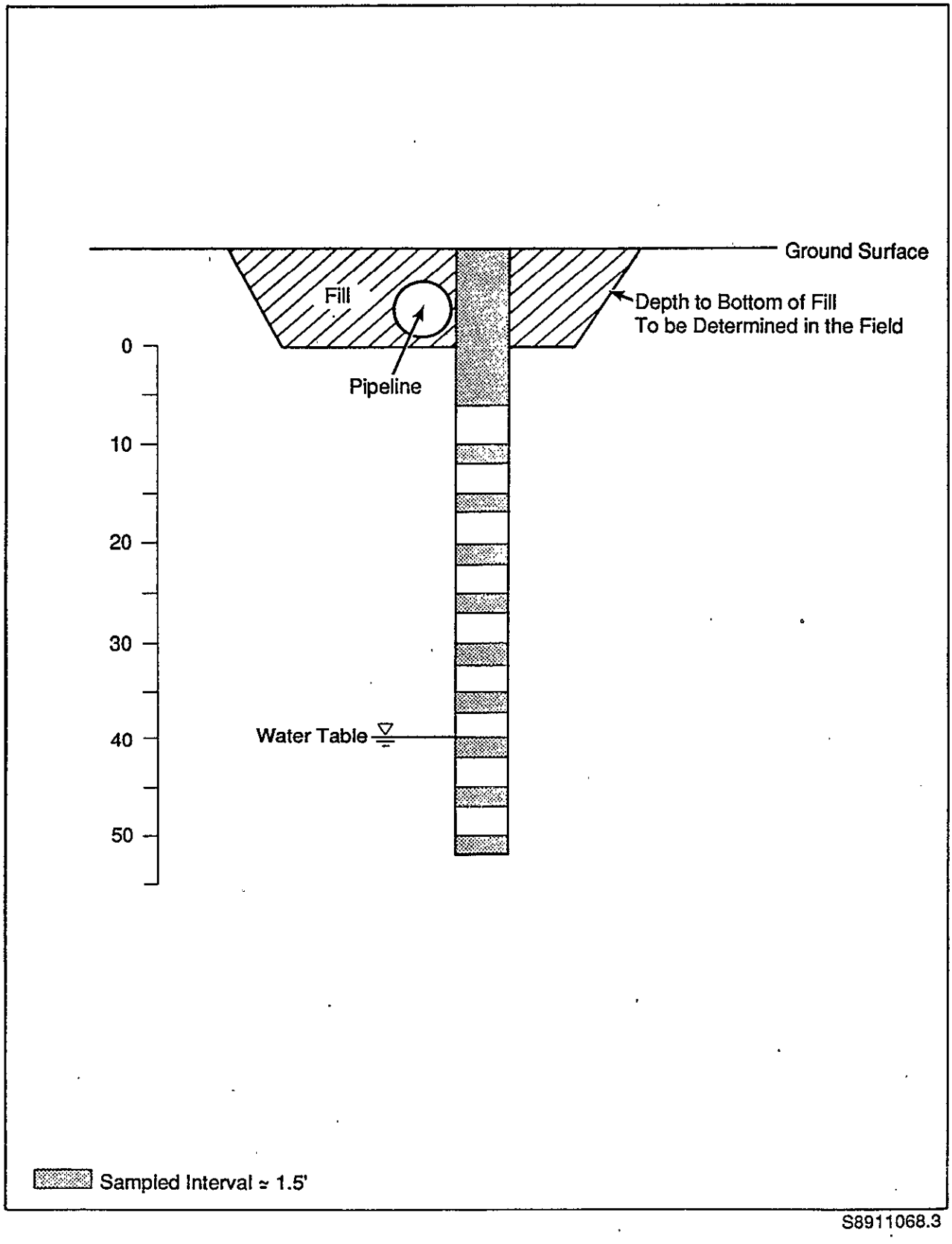

Figure 4. Soil Borings in 307 Trenches and at Pipeline Leak Locations--Sample Locations.

Depth or horizontal penetration:

- XX.X--to the nearest tenth of a foot.

Disposition (the No. 2 will be appended for duplicate samples):

- MS--metals and radiation analyses
- AS--nonmetallic ion analysis
- VS--volatile organics analysis
- TS--physical analysis
- R--archive.

These codes will be combined to provide such designations as:

- VSP2-10.2-VS2 (a duplicate volatile organics sample obtained from vertical south process pond boring No. 2, at a depth of 10.2 ft below ground surface)
- HPT4-3.0-MS (a nonduplicated metals and radiation sample obtained from horizontal boring No. 4 in the process trenches, 3 ft in from the sidewall).

If a Hanford Site-specific sample coding system is developed prior to the initiation of this activity, it will be employed in lieu of the system presented above.

4.2.2.4 Sampling Equipment and Procedures. All vertical and horizontal borings will be drilled, all samples obtained, and all field analyses performed in accordance with the procedures and equipment specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures, as described in the QAPP. For vertical borings, cable tool will be the drilling method used. During coring, in the event of drive sample refusal, cuttings will be collected for analysis. Horizontal borings will be hand augered.

Access to the process trenches bottoms will be provided by bulldozing ramps at the north ends of each trench. A protective covering of clean fill material will be provided at each boring location in the trench to minimize contact between the drilling rig, equipment, and crew and the underlying soil. Planking will also be provided along the trench bottoms to allow the drill rig and crew to move along the trenches with a minimum of contaminant contact and transport.

4.2.2.5 Sample Handling and Analysis. Borehole logs and field logs will be maintained for each boring and all related observations. These logs will be handled in accordance with records procedures specified in the DMP and the QAPP.

Field analyses will include soil density as determined by coring penetration. Soil density will be determined by penetration during coring. These readings will be recorded in the field log.

Samples for laboratory analysis will be properly preserved and transported--under chain-of-custody procedures described in the QAPP--to a laboratory. Selected samples from a specific geologic stratum in each borehole will be analyzed for the following physical parameters:

- Permeability
- Porosity
- Moisture content
- Grain size distribution
- Cation exchange capacity.

The following contaminant parameters will be analyzed in samples by screening methods (XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation) and standard laboratory analysis methods:

SCREENING METHOD PARAMETERS

XRF

Aluminum
Antimony
Cadmium
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Silver
Zinc
Sulfur
Uranium

Specific Conductance

Ion selective electrode

Ammonium
pH
Fluoride
Nitrate

Head space/GC

Trans-1,2-dichloroethylene

Methylene chloride
Tetrachloroethylene
Trichloroethylene

Solvent extraction/GC
Arochlor 1248

Beta/gamma radiation

STANDARD LABORATORY ANALYSIS PARAMETERS

Metallic inorganics
Aluminum
Antimony
Beryllium
Cadmium
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Silver
Zinc

Non-metallic inorganic
Ammonium
pH
Fluoride
Nitrate
Nitrite
Sulfate

Volatile organics
Trans-1,2-dichloroethylene
Methylene chloride
Tetrachloroethylene
Trichloroethylene

Non-volatile organics
Arochlor 1248

Radionuclides
Cesium-137
Cobalt-60
Gross alpha
Gross beta
Hydrogen-3
Strontium-90
Uranium-235
Uranium-238

4.2.3 Task 3b-3--Soil Sampling Research

4.2.3.1 Sampling Objectives. The purpose of this task is to confirm samples obtained from boreholes insure sample integrity for chemical and physical analysis.

4.2.3.2 Sample Locations and Frequencies. Three boreholes will be located in the north process pond adjacent to three existing trenches. These boreholes will be sampled and logged per Task 3b-2 with the only exception being that one core sample per geologic stratum per vertical borehole will obtained from a depth of 10 ft below the surface instead of a random depth. Corresponding samples will be obtained from existing trenches adjacent to each borehole. The samples will be obtained from 10 ft below the surface in each trench in the proximity of the borehole.

4.2.3.3 Sample Designation. The samples obtained for this task will be coded in accordance with Section 4.2.2.3, Task 3b-2, with the additional distinguishing code:

- Facility association:

  NPTX--north process pond trenches.

4.2.3.4 Sampling Equipment and Procedures. The vertical borings will be drilled, all samples obtained, and all field analysis performed in accordance with Westinghouse Hanford, participant contractor, or sub-contractor procedures, as described in the QAPP. For vertical borings, cable tool will be the drilling method used.

4.2.3.5 Sample Handling and Analysis. Borehole logs and field logs will be maintained for each boring, trench sample and all related observations. These logs will be handled in accordance with records procedures specified in the DMP and the QAPP.

Samples will be properly preserved and transported to a laboratory under chain-of-custody procedures described in the QAPP. Each sample obtained for this task will be analyzed for contaminants of concern (see Table 41 in the attached Work Plan) and the following physical parameters; permeability, porosity, moisture content, grain size distribution, and cation exchange capacity.

4.2.4 Task 3b-4--Soil Sample Analysis

Samples obtained from Stage I boreholes (one borehole drilled in each facility) will be analyzed by screening methods (XRF, specific conductance, ion selective electrode, head space/GC, solvent extraction/GC, and beta/gamma radiation) and standard laboratory analysis methods for the operable unit contaminants of concern (see Table 41 in the attached Work Plan). The results will be compared to determine if a correlation exists between the results

from screening methods and standard laboratory analysis methods. If the results of the screening methods are comparable to standard analytical procedures, screening of all samples collected in stage II will be conducted.

Samples obtained from Stage II boreholes (borehole locations as described in Section 4.2.2.2) will be analyzed by screening methods determined for use in Stage I. When and if screening methods are used, a minimum of 5 percent (EPA recommended frequency) of the samples analyzed will be verified by standard laboratory analysis for operable unit contaminants of concern (see Table 41 in the attached Work Plan). Higher rates of verification may be required if correlations between standard laboratory and screening results are weak.

4.2.5 Task 3b-5--Geodetic Survey

4.2.5.1 Sampling Objectives. The purpose of this activity is to determine the locational coordinates and surface elevations of the borings installed under Task 3b-2. All surveying for this project will be tied into the Hanford Site coordinate system.

4.2.5.2 Sample Locations and Frequencies. Each vertical and horizontal boring installed under Task 3b-2 will be surveyed once.

4.2.5.3 Sample Designations. Not applicable.

4.2.5.4 Sampling Equipment and Procedures. The surveying equipment and procedures shall be specified in approved participant contractor or subcontractor procedures as described in the QAPP. Third-order precision and accuracy will be required.

4.2.5.5 Sample Handling and Analysis. Field data will be recorded onsite in a field notebook and handled in accordance with the DMP and QAPP. Analysis of the data will consist of plotting the locations of the background plot and the elevated radiation readings on a copy of the operable unit topographic base map.

4.2.6 Task 3b-6--Borehole Abandonment

This activity does not involve any field sampling.

5.0 PHASE I RI Task 4--AIR INVESTIGATION

This task is designed to compile accessible climatological data needed to perform the feasibility study (FS). It is also meant to expand the existing ambient air monitoring program for the 300 Area to incorporate operable unit-specific contaminants of concern.

5.1 TASK 4a--AIR DATA COMPILATION

This subtask does not involve any field sampling.

5.2 TASK 4b--AMBIENT AIR SAMPLING AND ANALYSIS

5.2.1 Task 4b-1--Ambient Air Sampling

5.2.1.1 Sampling Objectives. The goal of this activity is to measure the impact, or obtain measurements that bound the impact, in the 300 Area and nearest points of public exposure, to fugitive dust bearing radionuclides or metals, fugitive volatile or semi-volatile organic air emissions from the south and north process ponds, process trenches, and burial sites. Measurements will be obtained to quantify existing conditions during intrusive characterization activities as well as after. If an impact is of such magnitude that the short-term consequences are adverse, an expedited response action, such as the application of dust suppressants, will be implemented to abate the problem until a remedy for the operable unit is selected.

5.2.1.2 Sample Locations and Frequencies. Long-term radionuclide data will be obtained from the current PNL Environmental Surveillance Project and gross beta and gamma counts every two weeks, monthly composite gamma scans, and quarterly composite radiochemical separations and counting for strontium, plutonium and uranium. Frequency of sampling by location is shown in Table 1.

Fugitive dust concentrations (milligrams/cubic meter) will be measured continuously at a nearby location downwind of intrusive characterization operations.

Short-term volatile and semivolatile organics, and particulate borne metals and radionuclides will be measured immediately upwind and downwind once during intrusive characterization and once following characterization for each of three subzones within the operable unit. Meteorological data will be monitored onsite continuously during these short-term sampling periods.

5.2.1.3 Sample Designations. No changes to the sample designations now employed under the current ambient air monitoring program for the 300 Area are anticipated, unless otherwise decided under Task 4a. Fugitive dust data will be recorded by numbered location and time. Sample designations for short-term samples will be according to procedures adapted from those for similar operations on the Hanford Site.

5.2.1.4 Sampling Equipment and Procedures. Sampling equipment and procedures currently in use for the 300 Area ambient air monitoring program will not be altered unless the need to do so is demonstrated during the implementation of Task 4a. Fugitive dust sampling will be accomplished with a portable battery powered real-time field readable respirable or total dust monitor. Procedures will be developed for calibration and field operation in accordance with the design of the device selected. Sampling procedures for short-term non-

Table 1. Sampling Locations and Frequencies for Air Monitoring.

Location	Individual samples: Sample number	Frequency	Analyses	Composite samples: Composite group	Sample number	Frequency	Analyses
300 Area locations:							
3614-A Bldg.	1793	BW	Beta		1741	W	Gamma scan
300 South Gate	8150	BW	Beta, Alpha	300 Area		Q	^{89}Sr, ^{90}Sr, Pu,[a] U[b]
300 Trench	1544	BW	Beta, Alpha				
300 NE	0022	BW	Beta, Alpha	300 NE	1740	W	Gamma scan
300 NE to No. 2	0023	BW	NRA			Q	^{89}Sr, ^{90}Sr, Pu,[a] U[b]
Nearby public locations:							
W end of Fir Road	6391	BW	Beta, Alpha	East perimeter	0603	W	Gamma scan
Pettett Farm	6361	BW	Beta, Alpha			Q	^{89}Sr, ^{90}Sr, Pu,[a] U[b]
Byers Landing	0247	BW	Beta, Alpha	Southeast perimeter	0604	W	Gamma scan
RRC CP 64	6182	BW	Beta, Alpha			Q	^{89}Sr, ^{90}Sr, Pu,[a] U[b]

[a]Isotopic Pu, including ^{239}Pu and ^{240}Pu.
[b]Isotopic U, including ^{234}U, ^{235}U, and ^{238}U.

BW = Biweekly W = Weekly Q = Quarterly

radiological monitoring will be adapted from similar procedures on the Hanford Site. Short-term radiological monitoring procedures will be adapted from the existing long-term monitoring procedures for the PNL Environmental Surveillance Project.

5.2.1.5 Sample Handling and Analysis. Sample handling will be performed in accordance with procedures set forth in the DMP and QAPP. Data provided by the PNL Environmental Surveillance Project will be from samples handled and analyzed according to the existing documented procedures for that project, except that additional operable unit contaminants of concern, as decided under Task 4a, will be included. These procedures will be reviewed and approved by Westinghouse prior to their implementation. Such additional parameters are anticipated to be nonradioactive metals that are known to exist in high concentrations in the soils within the process ponds and trenches (e.g., chromium and copper).

5.2.2 Task 4b-2--Ambient Air Sample Analysis

This activity does not involve any field sampling.

6.0 PHASE I RI TASK 5--BIOLOGICAL INVESTIGATION

This task is designed to evaluate potentially sensitive biological receptors that inhabit the operable unit environment. It is possible that the results of the surface water and sediment investigation will expand the needs of the task to include additional subtasks to define the nature and extent of biocontamination attributable to the operable unit.

6.1 TASK 5a--TERRESTRIAL BIOLOGICAL SURVEY

6.1.1 Task 5a-1--Hazardous Substances Biological Uptake Assessment

6.1.1.1 Sampling Objectives. The purpose of this activity is to locate any areas of biological disturbance within the operable unit that can be attributed to the uptake of hazardous substances. The impacted species will also be determined.

6.1.1.2 Sample Locations and Frequencies. This activity will consist of a one-time, onsite, visual reconnaissance that will cover the entire surface of the operable unit.

6.1.1.3 Sample Designations. Any areas where evidence of biological uptake of hazardous substances are found will be described by locational coordinates and types of species impacted.

6.1.1.4 Sampling Equipment and Procedures. This assessment will be performed by a biologist having field experience at the Hanford Site. The procedures and equipment are detailed in the QAPP.

6.1.1.5 Sample Handling and Analysis. Notes will be maintained in a field notebook and handled in accordance with the DMP and QAPP.

6.1.2 Task 5a-2--Species Survey

6.1.2.1 Sampling Objectives. The objective of this survey is to determine what species--which are endangered, threatened, economically important, or constitute significant components of the human food chain--inhabit 300-FF-1. In addition, the use of the operable unit habitat of each such species identified will be characterized to allow for an assessment of potential biological impacts.

6.1.2.2 Sample Locations and Frequencies. This activity will be a one-time, onsite survey performed over the entire surface of the operable unit. The onsite survey will be supplemented with a literature search.

6.1.2.3 Sample Designations. Any endangered, threatened, economically important, or significant human food chain constituent species determined to inhabit 300-FF-1 habitat will be described by both common and taxonomic nomenclature. If a given species is determined to inhabit a particular portion of the operable unit habitat, that portion will be described by locational coordinates.

6.1.2.4 Sampling Equipment and Procedures. This survey will be performed by a biologist having field experience at the Hanford Site. Procedures and equipment are described in the QAPP.

6.1.2.5 Sample Handling and Analysis. The biologist will maintain notes in a field notebook and handle these in accordance with the DMP and QAPP.

6.2 TASK 5b--ASPARAGUS SAMPLING AND ANALYSIS

6.2.1 Sampling Objectives

The purpose of this activity is to characterize the nature and extent of contamination in asparagus within the operable unit.

6.2.2 Sample Locations and Frequencies

This activity will be a one-time sampling of edible portions of wild asparagus taken during the spring of the year. The area to be sampled is the riparian zone within the operable unit. Samples will also be taken across the river from the operable unit for background analysis.

6.2.3 Sample Designations

This task requires sampling of only wild asparagus (Asparagus officinalis) that inhabit the riparian zone. The asparagus beds will be described by locational coordinates.

6.2.4 Sampling Equipment and Procedures

This task will be performed by a biologist having field experience at the Hanford site. The procedures and equipment are detailed in the QAPP.

6.2.5 Sample Handling and Analysis

The biologist will maintain notes in a field notebook and handle these in accordance with the DMP and QAPP. Lab analysis will be performed for contaminants of concern (see Table 41 in the attached Work Plan). Analysis for technetium-99 (Tc-99) may also be performed.

7.0 PHASE I RI TASK 6--DATA EVALUATION

Data gathered under the above tasks will be evaluated under this task, which does not involve any field sampling.

8.0 PHASE I RI TASK 7--VERIFICATION OF CONTAMINANT AND LOCATION-SPECIFIC LEGALLY APPLICABLE, OR RELEVANT AND APPROPRIATE, REQUIREMENTS

This task is designed to provide a focus on potential legally applicable, or relevant and appropriate, environmental standards, requirements, criteria, and limitations (ARARs) which could function as cleanup standards for the selected remedy. It does not involve any field sampling.

9.0 PHASE I RI TASK 8--BASELINE RISK ASSESSMENT

Data collected under the first seven tasks will be used to generate a baseline risk assessment for the operable unit. This task does not involve any field sampling.

10.0 PHASE I RI TASK 9--PHASE I RI REPORT: PRELIMINARY OPERABLE UNIT CHARACTERIZATION SUMMARY

This task, which consists of summarizing the results of Tasks 1 through 7 and whatever portion of the baseline risk assessment is available, does not involve any field sampling.

11.0 COORDINATION OF 300 AREA PROCESS TRENCHES CLOSURE PLAN WITH RI/FS ACTIVITIES

This task ensures that closure activities for the 300 Area process trenches will be coordinated with RI/FS activities for the rest of the operable unit. Scheduling changes for one will necessitate changes in the other.

12.0 REFERENCES

EPA, 1986, *Test Methods for Evaluating Solid Wastes*, EPA-SW-846, 3rd Edition, U.S. Environmental Protection Agency, Washington, D.C.

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ATTACHMENT 1b

300-FF-1 QUALITY ASSURANCE PROJECT PLAN

9011/91165

300-FF-1 QUALITY ASSURANCE PROJECT PLAN

Revision -0-

Westinghouse Hanford Company
Environmental Engineering and Technology Function
Richland, Washington

Approved by:

US EPA Unit Manager _____ Date: _____

US EPA QA Officer _____ Date: _____

State of Washington Department of
Ecology Unit Manager _____ Date: _____

State of Washington Department of
Ecology QA Manager _____ Date: _____

US DOE Unit Manager _____ Date: _____

US DOE QA Officer _____ Date: _____

Westinghouse Hanford/
EE&T Technical Lead: _____ Date: _____

Westinghouse Hanford QA Officer: _____ Date: _____

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GLOSSARY

Accuracy: For the purposes of environmental investigations, accuracy may be interpreted as the measure of the bias in a system. Sampling accuracy is normally assessed through the evaluation of matrix spiked samples and reference samples.

Arithmetic Mean: The arithmetic mean is the sum of a set of n values divided by n; the mathematical formula for calculating the arithmetic mean is provided in Section 2.1 of the Appendix to this Quality Assurance Project Plan (QAPP).

Audit: For the purposes of environmental investigations, audits are considered to be systematic checks to verify the quality of operation of one or more elements of the total measurement system. In this sense, audits may be of two types: (1) performance audits, in which quantitative data are independently obtained for comparison with data routinely obtained in a measurement system, or (2) system audits, involving a qualitative onsite evaluation of laboratories or other organizational elements of the measurement system for compliance with established quality assurance program and procedure requirements. For environmental investigations at the Hanford Site, performance audit requirements are fulfilled by periodic submittal of blind samples to the primary laboratory, or the analysis of split samples by an independent laboratory. System audit requirements are implemented through the use of standard surveillance procedures.

Bias: Bias represents a systematic error that contributes to the difference between a population mean of a set of measurements and an accepted reference or true value.

Blind Sample: A blind sample refers to any type of sample routed to the primary laboratory for purposes of auditing performance relative to a particular sample matrix and analytical method. Blind samples are not specifically identified as such to the laboratory; they may be made from traceable standards, or may consist of sample material spiked with a known concentration of a known compound. See the glossary entry for audit above.

Coefficient of Variation: The coefficient of variation is the standard deviation divided by the mean, and is multiplied by 100 if expressed as a percentage.

Comparability: For the purposes of environmental investigations, comparability is an expression of the relative confidence with which one data set may be compared with another.

Completeness: For the purposes of environmental investigations, completeness may be interpreted as the percentage of measurements made, which are judged to be valid measurements.

Confidence Interval: Confidence intervals are applied to bound the value of a population parameter within a specified degree of confidence (i.e., the confidence coefficient), usually 90, 95, or 99%. The form of a confidence

interval depends on the underlying assumptions and intentions. It assumes different values for different random samples, and requires specification of the number of observations on which the interval is based. See Section 2.4 of Appendix C for further discussion.

Deviation: For the purpose of environmental investigations, deviation refers to a planned departure from established criteria that may be required as a result of unforeseen field situations or that may be required to correct ambiguities in procedures that may arise in practical applications.

Equipment Blanks: Equipment blanks consist of pure deionized, distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples; they are used to verify the adequacy of sampling equipment decontamination procedures, and are normally collected at the same frequency as field duplicate samples.

Field Blanks: Field blanks consist of pure deionized, distilled water, transferred to a sample container at the site and preserved with the reagent specified for the analytes of interest; they are used to check for possible contamination originating with the reagent or the sampling environment, and are normally collected at the same frequency as field duplicate samples.

Field Duplicate Sample: Field duplicate samples are samples retrieved from the same sampling location using the same equipment and sampling technique, placed in separate identically prepared and preserved containers, and analyzed independently. Field duplicate samples are generally used to verify the repeatability or reproduceability of analytical data, and are normally analyzed with each analytical batch or every 20 samples, whichever is greater.

Geometric Mean: For a set of n positive numbers, the geometric mean is defined as the nth root of the product of their values. The geometric mean is used as a measure of central tendency for data from a log normal distribution. See Section 2.1 of the appendix to this QAPP for formulae and further discussion.

Matrix Spiked Samples: Matrix spiked samples are a type of laboratory quality control sample; they are prepared by splitting a sample received from the field into two homogenous aliquots (i.e., replicate samples), and adding a known quantity of a representative analyte of interest to one aliquot in order to calculate percentage of recovery.

Nonconformance: A nonconformance is a deficiency in characteristic, documentation, or procedure that renders the quality of material, equipment, services, or activities unacceptable or indeterminate. When the deficiency is of a minor nature, does not effect a permanent or significant change in quality if it is not corrected, and can be brought into conformance with immediate corrective action, it shall not be categorized as a nonconformance. However, if the nature of the condition is such that it cannot be immediately and satisfactorily corrected, it shall be documented in compliance with approved procedures and brought to the attention of management for disposition and appropriate corrective action.

Precision: Precision is a measure of the repeatability or reproducibility of specific measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average value. Precision is normally expressed in terms of standard deviation, but may also be expressed as the coefficient of variation (i.e., relative standard deviation) and range (i.e., maximum value minus minimum value). Precision is assessed by means of duplicate/replicate sample analysis.

Quality Assurance: For the purposes of environmental investigations, QA refers to the total integrated quality planning, quality control, quality assessment, and corrective action activities that collectively ensure that the data from monitoring and analysis meets all end user requirements and/or the intended end use of the data.

Quality Assurance Project Plan: The QAPP is an orderly assembly of management policies, project objectives, methods, and procedures that defines how data of known quality will be produced for a particular project or investigation.

Quality Control: For the purposes of environmental investigations, QC refers to the routine application of procedures and defined methods to the performance of sampling, measurement, and analytical processes.

Range: Range refers to the difference between the largest and smallest reported values in a sample, and is a statistic for describing the spread in a set of data.

Reference Samples: Reference samples are a type of laboratory quality control sample prepared from an independent, traceable standard at a concentration other than that used for analytical equipment calibration, but within the calibration range. Such reference samples are required for every analytical batch or every 20 samples, whichever is greater.

Relative Error: Relative error refers to the mean error of a set of measured data values as a percentage of the true value. See Section 2.2 of the appendix to this QAPP for the formula and further discussion.

Replicate Sample: Replicate samples are two aliquots removed from the same sample container in the laboratory and analyzed independently.

Representativeness: For the purposes of environmental investigations, representativeness may be interpreted as the degree to which data accurately and precisely represent a characteristic of a population parameter, variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter which is most concerned with the proper design of a sampling program.

Significance Tests: Significance tests refer to a variety of methods used to check statistical hypotheses. See Section 2.3 of the Appendix to this QAPP for formulae and further discussion.

Skewness: Skewness is a measure of the asymmetry of a frequency distribution; the mathematical formula is provided in Section 2.1 of the appendix to this QAPP.

Split Sample: A split sample is produced through homogenizing a field sample and separating the sample material into two equal aliquots. Field split samples are usually routed to separate laboratories for independent analysis, generally for purposes of auditing the performance of the primary laboratory relative to a particular sample matrix and analytical method. See the glossary entry for audit above. In the laboratory, samples are generally split to create matrix spiked samples; see the glossary entry above.

Standard Deviation Estimate: The standard deviation estimate is the positive square root of the variance. See Section 2.1 of the appendix to this QAPP for formulae and further discussion.

Trip Blanks: Trip blanks are a type of field quality control sample, consisting of pure deionized distilled water in a clean, sealed sample container, accompanying each batch of containers shipped to the sampling site and returned unopened to the laboratory. Trip blanks are used to identify any possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions.

Validation: For the purposes of environmental investigations, validation refers to a systematic process of reviewing a body of data against a set of criteria to provide assurance that the data are acceptable for their intended use. Validation methods may include review of verification activities, editing, screening, cross-checking, or technical review.

Variance: Sample variance is a measure of the dispersion of a set of measurements; it is further defined as the sum of the squares of the individual deviations from the sample mean divided by one less that the number of results involved. See Section 2.1 of the appendix to this QAPP for the formula and further discussion.

Verification: For the purposes of environmental investigations, verification refers to the process of determining whether procedures, processes, data, or documentation conform to specified requirements. Verification activities may include inspections, audits, surveillances, or technical review.

1.0 PROJECT DESCRIPTION

1.1 PROJECT OBJECTIVE

The primary objective of the environmental investigations in the 300-FF-1 operable unit is to further define the extent and location of sources of radioactive contamination and other inorganic and volatile and nonvolatile organic contaminants in the vadose zone and underlying aquifers. Data resulting from this investigation will be evaluated to determine the most feasible options for remediation or closure.

1.2 BACKGROUND INFORMATION

The 300-FF-1 operable unit is located in the northwest corner of the 300 Area of the Hanford Site as shown on Figure 1. Detailed background information regarding the history and present use of the unit is provided in Section 2.0 of the 300-FF-1 Work Plan.

1.3 QUALITY ASSURANCE PROJECT PLAN APPLICABILITY AND RELATIONSHIP TO THE WESTINGHOUSE HANFORD COMPANY QUALITY ASSURANCE PROGRAM

This Quality Assurance Project Plan (QAPP) applies specifically to the Phase I field activities and laboratory analyses performed as part of environmental investigations in 300-FF-1. It is an element of the Sampling and Analysis Plan (SAP) prepared specifically for this phase of investigation, and is prepared in compliance with the Westinghouse Hanford QA program plan for CERCLA RI/FS activities. This plan describes the means selected to implement the overall QA program requirements defined by the Westinghouse Hanford Company Quality Assurance Manual, WHC-CM-4-2, (WHC 1989a), as applicable to CERCLA RI/FS environmental investigations, while accommodating the specific requirements for project plan format and content agreed upon in the Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1989). It contains a matrix of procedural resources [from WHC-CM-4-2 and from the Westinghouse Hanford Environmental Investigations and Site Characterization Manual, WHC-CM-7-7 (WHC 1989b)] that have been drawn upon to support the 300-FF-1 QAPP. This plan is subject to mandatory review and revision prior to use on subsequent phases of the investigation. Distribution and revision control of this plan shall be in compliance with procedures QR 6.0, "Document Control," from WHC-CM-4-2 (WHC 1989a) and other standard Westinghouse Hanford Document Control procedures. The QAPP distribution shall routinely include all review/approval personnel indicated on the title page of the document and all other individuals designated by the Westinghouse Hanford Technical Lead. All plans and procedures referenced in the QAPP are available for regulatory review on request by the direction of the Technical Lead.

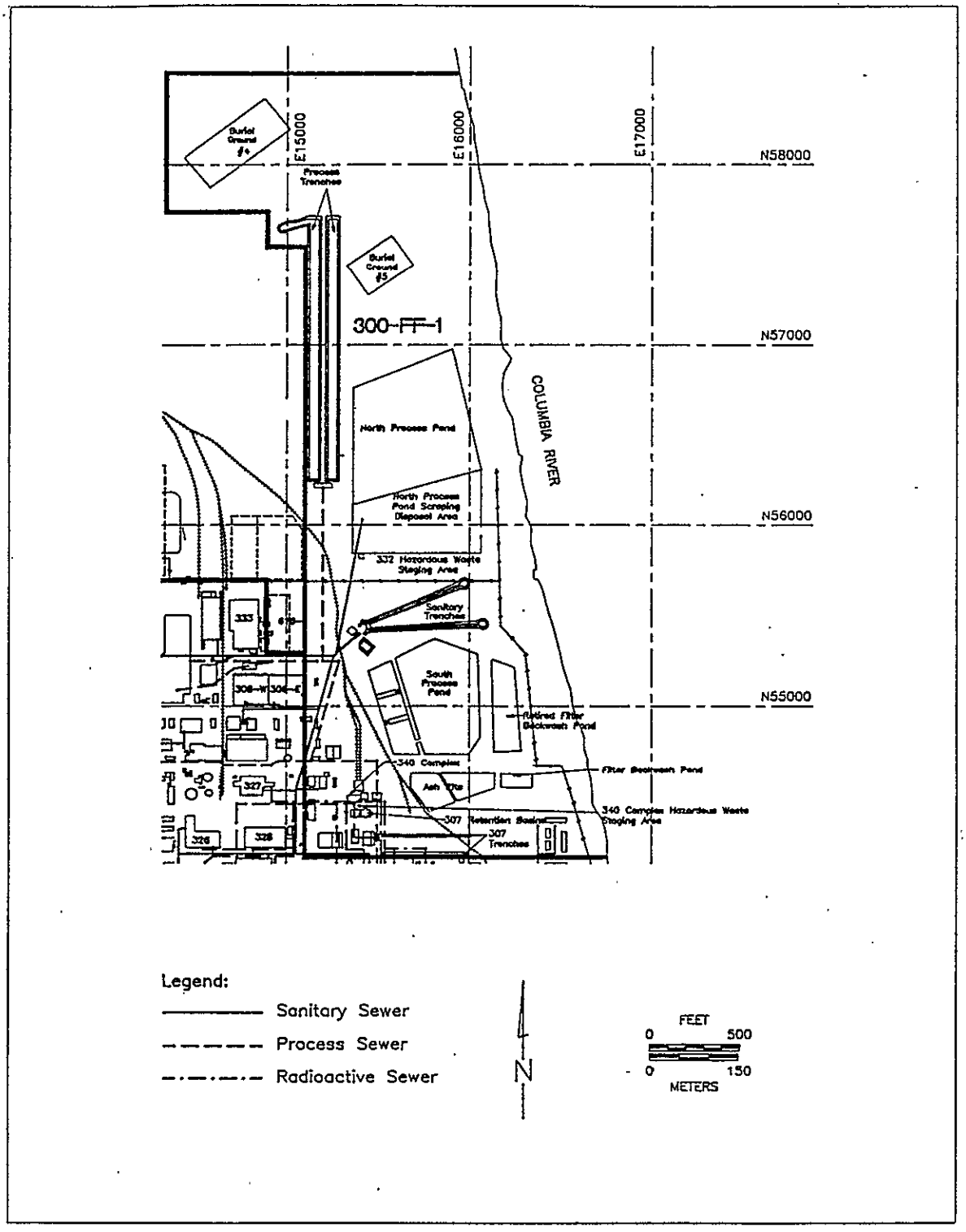

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Figure 1. Location of 300-FF-1 Operable Unit.

1.4 SCHEDULE OF ACTIVITIES

The investigations that will be conducted in 300-FF-1 will be subdivided into two or more discrete phases and a number of individual tasks. Because the results of the task activity in an individual phase may significantly affect the technical activities planned for subsequent phases, this QAPP shall undergo mandatory review after completion of each phase and shall be updated or modified to accommodate any required revisions in the scope of work. This version of the QAPP applies specifically to Phase I of the remedial investigation.

Individual task scopes for Phase I are briefly described below; more detailed discussions are contained in Section 5.3 of the Work Plan and the Field Sampling Plan. Procedures applicable to the tasks described here are discussed in Section 4.0 and Table 2. All sample analyses will be conducted as described in Section 3.0, Section 7.0, and Table 1 of this plan.

Task 1: Source Investigation. Task 1 involves gathering additional information on several facilities within 300-FF-1. Engineering plans will be reviewed and geodetic, ground penetrating radar, and electromagnetic surveys will be conducted to better characterize the location of buried objects and structures. Topographical maps will be updated. A tracer gas survey, testing, sampling, and analysis program will be conducted in an attempt to detect leaks within the retired portions of the radioactive sewer system. A soil gas survey will be conducted at burial ground No. 4, burial ground No. 5, and at all drill site locations in an attempt to determine the areal distribution of volatile organic contaminants of concern as a means of reducing costs during the analytical effort required under Task 3. Surface soil and sediment samples will be collected from the sanitary trenches, ash pits, and the water treatment filter backwash pond.

Task 2: Geological Investigation. Task 2 will entail a comprehensive literature search and review to collect all pertinent existing geological data related to 300-FF-1.

Task 3: Soil Investigation. Task 3 involves surface scintillation surveying, x-ray fluorescence (XRF) screening, headspace gas chromatography (GC) screening, geodetic surveying, subsurface soil sampling, and laboratory analysis of soil samples.

Task 4: Air Investigation. Meteorological data will be compiled, and the existing ambient air monitoring program evaluated, in order to augment the parameter list for the proposed monitoring program. Additional air samples will be collected and analyzed as indicated in the evaluation.

Task 5: Terrestrial Biological Investigation. An evaluation of biota for evidence of toxic uptake and a qualitative species survey will be conducted by qualified biologists. Recommendations will be made for appropriate biotic sampling activities in later phases of the investigation.

Task 8: Data Evaluation. Data from the investigations of Tasks 1 through 5 will be processed, and preliminary recommendations for additional investigations will be made.

Task 9: Verification of Contaminant- and Location-Specific ARARs. Project staff will verify applicable relevant and appropriate requirements (ARARs) for investigations in 300-FF-1 with representatives from the U.S. Environmental Protection Agency (EPA) and Washington Department of Ecology (Ecology).

Task 10: Baseline Risk Assessment. A study will be completed that identifies and assesses the risks associated with potential remedial measures.

Task 11: Phase I Remedial Investigation Report. An interim report will be prepared that summarizes the results of Phase I investigations, presents available results from the baseline risk assessment, and provides preliminary characterization of 300-FF-1.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 TECHNICAL LEAD RESPONSIBILITIES

The Environmental Engineering and Technology Function of Westinghouse Hanford has primary responsibilities for conducting this investigation. Organizational charts are included in the Project Management Plan (PMP) for this operable unit that define personnel assignments and individual Westinghouse Hanford field team structures applicable to the various types of tasks included in Phase I.

External participant contractors or subcontractors shall be evaluated and selected for certain portions of task activities at the direction of the Technical Lead in compliance with procedures QR 4.0, "Procurement Document Control"; QI 4.1, "Procurement Document Control"; QI 4.2, "External Services Control"; QR 7.0, "Control of Purchased Items and Services"; QI 7.1, "Procurement Planning and Control"; and QI 7.2, "Supplier Evaluation" (WHC 1989a). Major participant contractor and subcontractor resources are listed in Figure 2 of the PMP. All contractor plans and procedures shall be approved prior to use and shall be available for regulatory review after Westinghouse Hanford approval. All analytical procedures shall be reviewed and approved by the Westinghouse Hanford Analytical Laboratories organization.

2.2 ANALYTICAL LABORATORIES

A Westinghouse Hanford field sampling team will be assigned responsibility for screening all samples for gross alpha and beta/gamma radioactivity, and for separating samples into two groups for further analysis. Samples with activity greater than or equal to 200 counts per minute will be routed to a Westinghouse Hanford or another Hanford Site participant

contractor laboratory equipped and qualified to perform analysis of radioactive samples. Samples with activity below 200 counts per minute shall be routed to an approved Westinghouse Hanford, participant contractor, or subcontractor laboratory. For subcontractors or participant contractors, applicable quality requirements shall be invoked as part of the approved procurement document or work order; see Section 4.1.2 below. At the Technical Lead's direction services of alternate qualified laboratories shall be procured for radioactive samples analysis (if onsite laboratory capacity is not available) and for the performance of split sample analysis. If such an option is selected, the QA plan and applicable analytical procedures from the alternate laboratory shall be approved by Westinghouse Hanford prior to their use, as noted in 4.1.2 below. All analyses shall be coordinated through the Westinghouse Hanford Office of Sample Management and shall be performed in compliance with Westinghouse Hanford-approved laboratory quality assurance (QA) plans and analytical procedures, subject to the surveillance controls invoked by QI 7.3, "Source Surveillance and Inspection" (WHC 1989a).

2.3 OTHER SUPPORT CONTRACTORS

Procurement of all other contracted field activities shall be in compliance with standard Westinghouse Hanford procurement procedures requirements as discussed in Sections 2.1 and 4.1. All work shall be performed in compliance with Westinghouse Hanford-approved QA plans and/or procedures, subject to controls of QI 7.3, "Source Surveillance and Inspection" if the work is performed offsite (WHC 1989a). Onsite work is subject to controls identified in QI 10.4, "Surveillance" (WHC 1989a). Applicable quality requirements shall be invoked as part of the approved procurement document or work order as noted in Section 4.1.

3.0 OBJECTIVES FOR MEASUREMENTS

Data quality objectives for 300-FF-1 are summarized in Table 45 of the Work Plan. Additional analytical data based on soil and groundwater sampling activities will be obtained and evaluated to further characterize the nature and extent of radioactive and hazardous contamination and to determine the most feasible options for remediation. The analytes of interest for this operable unit are listed in Table 1, and include radionuclides, ions, metals, volatile organic compounds, and extractable organic compounds. Analytical data will be obtained at several different levels, based on the criteria provided in *Data Quality Objectives for Remedial Response Activities: Volume 1, Development Process* (EPA 1987), and are described below.

Level V: Nonstandard methods will be required for analysis of radionuclides and other analytes determined to be in a radioactive matrix by the Level I screening process described below. Depending on the level of radioactivity noted in screening, analysis will either be performed onsite by a qualified Westinghouse Hanford or participant contractor laboratory, or offsite by an approved subcontractor or participant contractor. Laboratories

may or may not be contract laboratory program (CLP) participant laboratories, and new or modified analytical methods will be required. Detection limits, precision, and accuracy will be specific to the method, which must be prepared, reviewed, and approved prior to use in compliance with applicable Westinghouse Hanford procurement control procedures as noted in Section 4.1.

Level III: Level III analyses shall be performed for selected analytes using standard EPA and ASTM methods, as shown in Table 1. Data validation requirements and intra-laboratory quality control requirements shall be invoked that, in terms of data quality, approximate the requirements of the Contract Laboratory Program (CLP) for Level IV analysis. Data validation requirements and laboratory quality control requirements are defined by Section 8.0 and 9.0, respectively.

Level II: Soil gas samples shall be obtained from locations at burial ground No. 4, burial ground No. 5 and at the drill site locations for purposes of determining the distribution of volatile organic contaminants of concern. Soil gas samples exhibiting detectable levels of the contaminants of concern will necessitate full laboratory analysis for volatile organic contaminants of concern for the soil samples collected during Task 3. Task 3 soil samples will also be analyzed using laboratory screening methods such as x-ray fluorescence, specific conductance, ion selective electrodes, headspace/gas chromatography, solvent extraction/gas chromatography, and beta/gamma radiation screening. Samples exhibiting above background levels of laboratory screening parameters will necessitate full laboratory analyses for operable unit contaminants of concern.

Level I: Soil samples shall undergo field screening to determine gross alpha and beta/gamma radiation and the presence of combustible and/or ionizable organic compounds. Samples exhibiting radioactivity greater than 200 counts per minute will be automatically routed to an appropriately equipped and qualified onsite Westinghouse Hanford or participant contractor laboratory for analysis. Screening shall be performed by qualified Westinghouse Hanford radiation protection technologists as specified in governing procedures.

As noted in Section 4.6 of *Data Quality Objectives for Remedial Response Activities: Volume I, Development Process* (EPA 1987), universal goals for precision, accuracy, representativeness, completeness, and comparability cannot be practically established at the outset of an investigation. Historical data are available, however, that may be used as minimum guidelines for selection or preparation of analytical methods appropriate for this investigation. Table 1 provides preliminary values for method detection limits, precision, and accuracy that are intended for use in initial procurement negotiations with the analytical laboratory. These preliminary values are based on the results of evaluation of the data quality objectives specified in Table 45, the reference specifications identified in Table 1, and the general performance capabilities currently expected for laboratories involved in environmental analyses. After individual laboratory statements of work are negotiated, and procedures are developed and approved as noted

in Section 4.1, Table 1 and this section shall be revised to reference approved detection limit, precision, and accuracy criteria as project requirements.

Goals for data representativeness are addressed qualitatively by the specification of sampling locations and intervals within the Field Sampling Plan (FSP). Objectives for completeness for this investigation shall require that contractually or procedurally established requirements for precision and accuracy be met for at least 90 percent of the total number of requested determinations. Failure to meet this criterion shall be documented in data summary reports as described in Section 8.1, and shall be considered in the validation process discussed in Section 8.2. Corrective action measures shall be initiated by the Technical Lead as appropriate, as noted in Section 13.0. Approved analytical procedures shall require the use of the reporting techniques and units consistent with the EPA reference methods listed in Table 1 in order to facilitate the comparability of data sets in terms of precision and accuracy.

4.0 SAMPLING PROCEDURES

4.1 PROCEDURE APPROVALS AND CONTROL

4.1.1 Westinghouse Hanford Procedures

The Westinghouse Hanford procedures cited in this QAPP have been selected from the Quality Assurance Program Index (QAPI) included in the Westinghouse Hanford quality assurance program plan for CERCLA RI/FS activities. Selected procedures include Environmental Investigations Instructions (EIIs) from the *Environmental and Site Characterization Manual* (WHC 1989b), and Quality Requirements (QR) and Quality Instructions (QI), from the *Westinghouse Hanford Quality Assurance Manual* (WHC 1989a). Procedure approval, revision, and distribution control requirements applicable to EIIs are addressed in EII 1.2, "Preparation and Revision of Environmental Investigation Instructions" (WHC 1989b); requirements applicable to QIs and QRs are addressed in QR 5.0, "Instructions, Procedures, and Drawings"; QI 5.1, "Preparation of Quality Assurance Documents"; QR 6.0, "Document Control"; and QI 6.1, "Quality Assurance Document Control" (WHC 1989a). Other procedures applicable to the preparation, review, approval, and revision of Hanford Analytical Laboratories organization procedures shall be as defined in the various procedures and manuals identified in the QA program plan for CERCLA RI/FS activities under criteria 5.00 and 6.00. All procedures are available for regulatory review on request at the direction of the Westinghouse Hanford Technical Lead.

Table 1. Analytical Level, Method Selection, Detection Limit, Precision, and Accuracy Guidelines for the 300-FF-1 Operable Unit. (Sheet 1 of 3)

Category of analysis	Analyte of interest	Analytical level[a]	Standard or reference method	Analytical method	MDC[bc]	Precision[c] (soil)	Accuracy[c] (soil)
Radiation screening	Gross beta/gamma	I	N/A	d	N/A	N/A	N/A
Soil gas screening	volatiles in soil	II	N/A	d	e	e	e
Lab Screening[f]							
XRF	(g)	II	N/A	PNL-SP-19	e	e	e
SC	relative ionic strength	II	120.1[h]	d	e	e	e
ISE	specific ionic strength (specific anions)	II	N/A	c	e	e	e
HS/GC	chlorinated volatiles	II	3810/8010[i]	d	e	± 30 RPD	± 35%
SE/GC	Arochlor 1248	II	8080[i]	d	0.1 mg/kg	± 20 RPD	± 25%
Radionuclide analysis	Gross alpha	III	9310[i]	d	6 pCi/g	N/A	N/A
	Gross beta	III	9310[i]	d	3 pCi/g	N/A	N/A
	Uranium 235	V	EERF 00.07[j]	d	1 pCi/g	± 30 RPD	± 25%
	Uranium 238	V	EERF 00.07[j]	d	1 pCi/g	± 30 RPD	± 25%
	Cesium 137	V	901.0[k]	d	1 pCi/g	± 30 RPD	± 25%
	Cobalt 60	V	901.0[k]	d	1 pCi/g	± 30 RPD	± 25%
	Tritium	V	906.0[k]	d	1 pCi/g	± 30 RPD	± 25%
	Strontium 90	V	905.0[k]	d	1 pCi/g	± 30 RPD	± 25%
Metals analysis	Aluminum	III	6010[i]	d	1.5 mg/kg	± 20 RPD	± 25%
	Antimony	III	6010[i]	d	10 mg/kg	± 20 RPD	± 25%
	Beryllium	III	6010[i]	d	0.5 mg/kg	± 20 RPD	± 25%
	Cadmium	III	6010[i]	d	0.2 mg/kg	± 20 RPD	± 25%
	Chromium	III	6010[i]	d	1 mg/kg	± 20 RPD	± 25%
	Copper	III	6010[i]	d	1 mg/kg	± 20 RPD	± 25%
	Iron	III	6010[i]	d	5 mg/kg	± 20 RPD	± 25%
	Lead	III	7420 or 7421[i]	d	0.5 mg/kg	± 20 RPD	± 25%

Table 1. Analytical Level, Method Selection, Detection Limit, Precision, and Accuracy Guidelines for the 300-FF-1 Operable Unit. (Sheet 2 of 3)

Category of analysis	Analyte of interest	Analytical level[a]	Standard or reference method	Analytical method	MDC[bc]	Precision[c] (soil)	Accuracy[c] (soil)
	Manganese	III	7460 or 7461[i]	d	0.5 mg/kg	± 20 RPD	± 25%
	Mercury	III	7470 or 7471[i]	d	0.1 mg/kg	± 20 RPD	± 25%
	Nickel	III	6010[i]	d	1 mg/kg	± 20 RPD	± 25%
	Silver	III	6010[i]	d	1 mg/kg	± 20 RPD	± 25%
	Zinc	III	7950 or 7951[i]	d	0.5 mg/kg	± 20 RPD	± 25%
Ion analysis	Ammonium	III	ASTM-D-4327[l]	d	1 µg/kg	± 15 RPD	± 25%
	Fluoride	III	ASTM-D-4327[l]	d	1 µg/kg	± 10 RPD	± 20%
	Nitrate	III	N/A	d	1 mg/kg	± 10 RPD	± 20%
	Nitrite	III	N/A	d	1 mg/kg	± 10 RPD	± 20%
	Sulfate	III	N/A	d	1 mg/kg	± 10 RPD	± 20%
Volatile organic	trans-1,2-Dichloroethylene	III	8240[i]	d	5 µg/kg	± 10 RPD	± 25%
	Methylene chloride	III	8240[i]	d	5 µg/kg	± 10 RPD	± 25%
	Tetrachloroethylene	III	8240i	d	10 µg/kg	± 10 RPD	± 25%
	Trichloroethylene	III	8240[i]	d	10 µg/kg	± 10 RPD	± 25%
PCB analysis	Arochlor 1248	III	8080[i]	d	0.1 mg/kg	± 20 RPD	± 25%
Other Analyses	Cation exchange capacity (CEC)	III	9080 or 9081[i]	d	N/A	N/A	N/A
	pH (soil)	III	9045[i]	d	N/A	N/A	N/A
	pH (water)	III	N/A	d	N/A	N/A	N/A
	air samples	III	N/A	d	e	e	e

Table 1. Analytical Level, Method Selection, Detection Limit, Precision, and Accuracy Guidelines for the 300-FF-1 Operable Unit. (Sheet 3 of 3)

Notes:

[a]Analytical levels are as defined in Section 4.3.1 of Data Quality Objectives for Remedial Response Activities: Volume 1, Development Process (EPA 1987a) and Table 45 of the work plan for this operable unit.

[b]MDC refers to minimum detectable concentration in soil.

[c]Values for detection limits, precision and accuracy are to be considered target values for use in initial procurement negotiations with the analytical laboratory. Precision is expressed as Relative Percentage Difference (RPD); accuracy is expressed as precentage recovery. This table shall be updated to reflect negotiated contractual values as specified in the procurement documents; see Section 3.0.

[d]Analytical methods shall be approved Westinghouse Hanford or Westinghouse Hanford-approved participant contractor or subcontractor procedures. All procedure reviews and approvals shall be in compliance with applicable Westinghouse Hanford procedure control or procurement procedures as noted in Sections 2.1 and 2.2.

[e]Minimum requirements for method detection levels, precision, and accuracy will be method-specific, and shall be negotiated and established in the procedure review and approval process; see QAPP Sections 2.1, 3.0, and 4.1.

[f]Laboratory screening methods include XRF (x-ray fluorescence), SC (specific conductance), ISE (ion selective electrodes), HS/GC (headspace/gas chromatography), and SE/GC (solvent extraction/gas chromatography).

[g]Elements to be determined by x-ray fluorescence are listed in Table 49 of the work plan; all screening will be performed by PNL.

[h]Standard method from Methods for Chemical Analysis of Water and Waste (EPA 1979).

[i]Standard methods are from Test Method for Evaluating Solid Wastes (SW-846), third edition (EPA 1986).

[j]Standard methods are from Eastern Environmental Radiation Facility Radiochemistry Procedures Manual (EPA 1984).

[k]Standard methods are from Prescribed Procedures for the Measurement of Radioactivity on Drinking Water (EPA 1982).

[l]Standard methods are from 1988 Annual Book of ASTM Standards (ASTM 1987).

4.1.2 Participant Contractor/Subcontractor Procedures

As noted in Section 2.1, participant contractor and/or subcontractor services shall be procured under the applicable requirements of QR 4.0, "Procurement Document Control"; QI 4.1, "Procurement Document Control"; QI 4.2, "External Services Control"; QR 7.0, "Control of Purchased Items and Services"; QI 7.1, "Procurement Planning and Control"; and/or QI 7.2, "Supplier Evaluation" (WHC 1989a). Whenever such services require procedural controls, requirements for submittal of procedures for Westinghouse Hanford review and approval prior to use shall be included in the procurement document or work order, as applicable. In addition to the submittal of analytical procedures, analytical laboratories shall be required to submit the current version of their internal QA program plans. All analytical laboratory plans and procedures shall be reviewed and approved prior to use by qualified personnel from the Westinghouse Hanford Analytical Laboratories organization, or other qualified personnel, as directed by the Technical Lead; all reviewers shall be qualified under the requirements of EII 1.7, "Indoctrination, Training, and Qualification" (WHC 1989b). All participant contractor or subcontractor procedures, plans, and/or manuals shall be retained as project quality records in compliance with EII 1.6, "Records Management" (WHC 1989b); QR 17.0, "Quality Assurance Records"; and QI 17.1, "Quality Assurance Records Control" (WHC 1989a). All such documents are available for regulatory review on request, at the direction of the Westinghouse Hanford Technical Lead.

4.2 SAMPLING PROCEDURES

4.2.1 Soil Sampling

All soil sampling shall be performed in accordance with EII 5.2, "Soil and Sediment Sampling" (WHC 1989b). All drilling activities shall be in compliance with EII 6.7, "Groundwater Well and Borehole Drilling" (WHC 1989b). All boreholes shall be logged in compliance with EII 9.1, "Geologic Logging" (WHC 1989b). Test pit sampling shall be in accordance with the auger or grab sample techniques described in EII 5.2. Sample numbers, types, location, and other site-specific considerations shall be as defined by the FSP. Documentation requirements are contained within individual EIIs and the Data Management Plan (DMP). All procedures related to soil sampling are identified in Table 2 as applicable to individual tasks.

4.2.2 Sample Container Selection

Sample container types and preservation requirements for Phase I of this investigation shall be specified by the FSP; sample container types, container preparation codes, preparation requirements, and special-handling requirements are defined by EII 5.2, "Soil and Sediment Sampling", (WHC 1989b).

4.3 OTHER PROCEDURES

Other procedures that will be required specifically for this phase of the investigation are identified in Table 2 for each individual task. Documentation requirements shall be addressed within individual procedures and/or the DMP as appropriate. Analytical procedures are discussed in detail in Section 7.0 and are listed in Table 1.

4.4 PROCEDURE CHANGES

Should deviations from established EIIs be required to accommodate unforseen field situations, they may be authorized by the field team leader in accordance with the requirements of EII 1.4, "Deviation from Environmental Investigations Instructions" (WHC 1989b). Documentation, review, and disposition of instruction change authorization forms are defined within EII 1.4. Other types of procedure change requests shall be documented as required by the Westinghouse Hanford procedures governing their preparation.

5.0 SAMPLE CUSTODY

5.1 CHAIN-OF-CUSTODY PROCEDURES

All samples obtained during the course of this investigation shall be controlled as required by EII 5.1 "Chain of Custody", (WHC 1989b) from the point of origin to the analytical laboratory. Laboratory chain-of-custody procedures shall be reviewed and approved as required by Westinghouse Hanford procurement control procedures as noted in Section 4.1, and shall ensure the maintenance of sample integrity and identification throughout the analytical process. At the direction of the technical lead, requirements for return of residual sample materials after completion of analysis shall be defined in accordance with those procedures defined in the procurement documentation to subcontractor or participant contractor laboratories. Chain-of-custody forms shall be initiated for returned residual samples as required by the approved procedures applicable within the participating laboratory. Results of analyses shall be traceable to original samples through the unique code or identifier specified in the FSP. All results of analyses shall be controlled as permanent project quality records as required by QR 17.0, "Quality Assurance Records" (WHC 1989a), EII 1.6, "Records Management" (WHC 1989b), and the DMP.

Table 2. Sampling and Investigative Procedures for RFI Phase I Investigations in the 300-FF-1 Operable Unit. (sheet 1 of 3)

Procedure title or subject[a]		Task 1 Source Investigation	Task 2 Geological Investigation	Task 3 Soil Investigation	Task 4 Air Investigation	Task 5 Terrestrial Biological Investigation	Task 6 Data Evaluation	Task 7 Verification of ARARs	Task 8 Baseline Risk Assessment	Task 9 Phase I RFI Report
EII 1.2	Preparation and Revision of Environmental Investigation Instructions	X		X		X				
EII 1.4	Deviation from Environmental Investigation Instructions	X		X		X				
EII 1.5	Field Logbooks	X	X	X		X				
EII 1.6	Records Management	X	X	X	X	X	X	X	X	X
EII 1.7	Indoctrination, Training and Qualification	X	X	X	X	X	X	X	X	X
EII 1.8	Controlled Notebooks	X	X	X	X	X	X			
EII 2.1	Preparation of Health and Safety Plans	X		X		X				
EII 2.2	Occupational Health Monitoring	X		X		X				
EII 3.1	User Calibration of Health & Safety M&TE	X		X		X				
EII 4.1	Nonradioactive Hazardous Waste Disposal	X		X		X				
EII 4.2	Interim Control of Unknown Waste	X		X						

Table 2. Sampling and Investigative Procedures for RFI Phase I Investigations in the 300-FF-1 Operable Unit. (sheet 2 of 3)

Procedure title or subject[a]		Task 1 Source Investigation	Task 2 Geological Investigation	Task 3 Soil Investigation	Task 4 Air Investigation	Task 5 Terrestrial Biological Investigation	Task 6 Data Evaluation	Task 7 Verification of ARARs	Task 8 Baseline Risk Assessment	Task 9 Phase I RFI Report
EII 5.1	Chain of Custody	X		X	X	X				
EII 5.2	Soil and Sediment Sampling	X		X						
EII 5.3	Biotic Sampling					X				
EII 5.4	Decontamination of Drilling Equipment			X						
EII 5.5	Decontamination of Equipment for RCRA/CERCLA Sampling	X		X	X					
EII 5.6	Control of Geophysical Logging			X						
EII 5.7A	Hanford Geotechnical Library Control	X		X						
EII 6.1	Activity Reports of Field Operations	X		X		X			X	
EII 6.7	Groundwater Well and Borehole Drilling			X						
EII 7.1	Pest Control Administration and Operations	X		X		X			X	
EII 9.1	Geologic Logging			X						
Geophysical Logging[b]				X						
Ground-Penetrating Radar[b]		X								

Table 2. Sampling and Investigative Procedures for RFI Phase I Investigations in the 300-FF-1 Operable Unit. (sheet 3 of 3)

Procedure title or subject[a]	Task 1 Source Investigation	Task 2 Geological Investigation	Task 3 Soil Investigation	Task 4 Air Investigation	Task 5 Terrestrial Biological Investigation	Task 6 Data Evaluation	Task 7 Verification of ARARs	Task 8 Baseline Risk Assessment	Task 9 Phase I RFI Report
Pipeline Sludge Sampling[b]	X								
EMI/MAG Surveying[b]	X								
Underground Pipeline Inspection	X								
Surface Radiation Surveying[b]			X						
Soil Gas (GC) Surveying[b]	X								
Soil Gas Probe Installation[b]	X								
Geodetic Surveying[b]	X								
Air Sampling[b]				X					
Use of Health and Safety Instruments[b]	X		X						
Calibration Coordination[b]	X		X	X					
Soil-Gas Sampling[b]	X								
Sample Numbering[b]	X		X	X	X				
Sample Packaging and Shipping[b]	X		X		X				
Radioactive and Mixed Waste Disposal[b]	X		X						
Borehole Abandonment[b]			X						

[a]Procedures are latest versions of Westinghouse Hanford Environmental Investigations Instructions (EII) selected from WHC-CM-7-7, Environmental Investigations and Site Characterization Manual (WHC 1988a), unless otherwise indicated.

[b]Procedures shall be developed by the Westinghouse Hanford Environmental Engineering Group as EIIs in compliance with EII 1.2, "Preparation and Revision of Environmental Investigation Instructions", or shall be developed by other Westinghouse Hanford participating organizations, participant contractors or subcontractors in compliance with appropriate procedures invoked by the QA program plan for CERCLA RI/FS activities; see section 4.1 of the QAPP.

6.0 CALIBRATION PROCEDURES

Calibration of all Westinghouse Hanford measuring and test equipment, whether in existing inventory or purchased for this investigation, shall be controlled as required by QR 12.0, "Control of Measuring and Test Equipment"; QI 12.1, "Acquisition and Calibration of Portable Measuring and Test Equipment" (WHC 1989a); QI 12.2, "Measuring and Test Equipment Calibration by User" (WHC 1989a); and/or EII 3.1, "User Calibration of Health and Safety Measuring and Test Equipment" (WHC 1989b). Routine operational checks for Westinghouse Hanford field equipment shall be as defined within applicable EIIs or procedures; similar information shall be provided in Westinghouse Hanford-approved participant contractor or subcontractor procedures.

Calibration of Westinghouse Hanford, participant contractor, or subcontractor laboratory equipment used for Level III analysis shall be as defined by applicable standard analytical methods, subject to Westinghouse Hanford review and approval. Calibration of Westinghouse Hanford, participant contractor, or subcontractor laboratory equipment used for Level V analysis shall be as defined by the Westinghouse Hanford-approved analytical method.

7.0 ANALYTICAL PROCEDURES

Analytical methods or procedures for each analytical level identified in Table 1 and Section 3.0 shall be selected or developed and approved prior to use in compliance with appropriate Westinghouse Hanford procedure and/or procurement control requirements as noted in Section 4.1. As noted in Section 4.6 of *Data Quality Objectives for Remedial Response Activities: Volume 1, Development Process* (EPA 1987), universal goals for precision, accuracy, representativeness, completeness, and comparability cannot be practically specified at the beginning of an investigation. Historical data for precision and accuracy are available for many analytes of interest, however, and shall be used as minimum guidelines for selection or preparation of analytical methods appropriate for this investigation. Table 1 provides general guidelines and reference sources for method detection limits, precision, and accuracy, as available, for each analyte of interest; they are sorted by the required analytical level. Where guidelines are not available, statistical guidelines appropriate for determining precision and accuracy shall be developed, included in procedures, and submitted for Westinghouse Hanford review and approval. The guidance provided in the Appendix to this QAPP ("Statistical Methods") can be used in such situations as appropriate for the development of procedural guidelines. Once individual laboratory statements of work are negotiated, and procedures are approved, Table 1 shall be revised to include actual method references and approved detection limit, precision, and accuracy criteria as project requirements.

All analytical procedures approved for use in this investigation shall require the use of standard reporting techniques and units consistent with EPA reference methods in order to facilitate the comparability of data sets in

terms of precision and accuracy. All approved procedures shall be retained in the project quality records and shall be available for regulatory review upon request at the direction of the Westinghouse Hanford Technical Lead.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

8.1 DATA REDUCTION AND DATA PACKAGE PREPARATION

All analytical laboratories shall be responsible for preparing a report summarizing the results of analysis and for preparing a detailed data package that includes all information necessary to perform data validation to the extent indicated by the minimum requirements of Section 8.2 below. Data summary report format and data package content shall be defined in the laboratories' analytical methods and/or internal QA program plans, subject to Westinghouse Hanford review and approval requirements as noted in Section 4.1 above. Data packages shall include the following:

- Sample receipt and tracking documentation, including identification of the organization and individuals performing the analysis, the names and signatures of the responsible analysts, sample holding time requirements, references to applicable chain-of-custody procedures, and the dates of sample receipt, extraction, and analysis;

- Instrument calibration documentation, including equipment type and model, with continuing calibration data for the time period in which the analysis was performed;

- Quality control data, as appropriate for the methods used, including matrix spike/matrix spike duplicate data, recovery percentages, precision data, laboratory blank data, and identification of any nonconformances that may have affected the laboratory's measurement system during the time period in which the analysis was performed; and,

- The analytical results or data deliverables, including reduced data, reduction formulas or algorithms, and identification of data outliers or deficiencies.

Other supporting information, such as initial calibration data, reconstructed ion chromatographs, spectrograms, traffic reports, and raw data, need not be included in the submittal of individual data packages unless specifically required to support validation report preparation for the CLP statements of work (EPA 1988c, 1989) methods as defined in Section 8.2.3. All sample data, however, shall be retained by the analytical laboratory and made available for systems or program audit purposes upon request by Westinghouse Hanford, DOE-RL, or regulatory agency representatives; see Section 10.0 below. Such data shall be retained by the analytical laboratory through the duration of their contractual statement of work, at which point it shall be turned over to Westinghouse Hanford for archiving.

The completed data package shall be reviewed and approved by the analytical laboratory's QA Manager prior to submittal to Westinghouse Hanford for validation as discussed in Section 8.2 The requirements of this section shall be included in procurement documentation or work orders, as appropriate, in compliance with the standard Westinghouse Hanford procurement control procedures referenced in Section 4.1 above.

8.2 VALIDATION

Validation of the completed data package may be performed by qualified Westinghouse Hanford personnel from the Office of Sample Management, other Westinghouse Hanford organizations, or a qualified independent participant contractor or subcontractor in accordance with established procedures that follow EPA guidelines (1988a,b). Selection of qualified reviewers and assignment of validation responsibilities shall be as directed by the Westinghouse Hanford Technical Lead and shall be defined in procurement documentation or work orders as appropriate.

8.2.1 Validation Report Preparation for Level II Methods

Level II screening analyses performed for this investigation are noted in Section 3.0 and Table 1. All procedures shall include specific requirements for validation report preparation that are appropriate for the particular procedure and equipment type, and shall be reviewed and approved by Westinghouse Hanford prior to implementation in compliance with the standard Westinghouse Hanford procurement control procedures referenced in Section 4.1 above.

8.2.2 Validation Report Preparation for Level III and Level V Methods

All validation report requirements for Level III and Level V analyses shall be established within individual methods requirements, subject to Westinghouse Hanford review and approval as discussed in Section 4.1 above. Validation report requirements shall be in general compliance with the guidelines provided in EPA guidelines for Level IV analyses, modified as necessary to accommodate the allowances of the applicable reference methods listed for each analyte of interest in Table 1. In general, for organic analyses, validation reports shall be prepared documenting overchecks of the following areas as recommended in *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses* (EPA 1988a):

- Data summary narrative
- Sample holding times
- Gas chromatograph/mass spectrometer tuning and mass calibration requirements

- Continuing calibration requirements
- Method blank sample requirements
- Surrogate recovery requirements
- Matrix spike/matrix spike duplicate requirements
- Internal standards performance requirements
- Target compound identification requirements
- Target compound quantitation requirements and reported detection limits
- Any tentatively identified compounds, library search, assessment, and quantitation requirements
- Overall data assessment requirements.

For inorganic analyses, validation reports shall be prepared documenting overchecks of the following areas, as recommended in *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* (EPA 1988b):

- Data summary narrative
- Sample holding times
- Continuing calibration requirements
- Method blank sample requirements
- Interference check sample requirements
- Laboratory control sample requirements
- Duplicate sample analysis
- Matrix spike sample requirements
- Atomic absorption quality control requirements
- Inductively coupled plasma serial dilution requirements
- Overall data assessment requirements.

8.3 FINAL REVIEW AND RECORDS MANAGEMENT CONSIDERATIONS

All validation reports and supporting analytical data packages shall be subjected to a final technical review by a qualified reviewer at the

direction of the Westinghouse Hanford Technical Lead, prior to submittal to the regulatory agencies or inclusion in reports or technical memoranda. All validation reports, data packages, and review comments shall be retained as permanent project quality records in compliance with EII 1.6, "Records Management" (WHC 1989b), QA 17.0, "Quality Assurance Records" (WHC 1989a), and the DMP.

9.0 INTERNAL QUALITY CONTROL

All analytical samples shall be subject to in-process quality control measures in both the field and laboratory. Unless otherwise specified in the approved Field Sampling Plan (FSP), the following minimum field quality control requirements apply for Level III and V analyses. These requirements are adapted from "Test Methods for Evaluating Solid Waste" (SW-846) (EPA 1986a), as modified by the proposed rule changes included in the "*Federal Register*," Volume 54, No. 13 (EPA 1989b).

- Field duplicate samples. For each shift of sampling activity under an individual sampling subtask, a minimum of 5% of the total collected samples shall be duplicated, or one duplicate shall be collected for every 20 samples, whichever is greater. Duplicate samples shall be retrieved from the same sampling location using the same equipment and sampling technique, and shall be placed into two identically prepared and preserved containers. All field duplicates shall be analyzed independently as an indication of gross errors in sampling techniques.

- Split samples. At the Technical Lead's direction, field or field duplicate samples may be split in the field and sent to an alternative laboratory as a performance audit of the primary laboratory. Split samples shall be analyzed by the independent laboratory compliance with approved methods based on the same reference standards that are invoked for the primary laboratory. For this investigation, performance requirements shall be met by analyzing a minimum of one split sample for each analytical method identified in Table 1.

- Blind samples. At the Technical Lead's direction, blind reference samples may be introduced into any sampling round as a performance and audit of the primary laboratory. Blind sample type shall be as directed by the Technical Lead and may be from traceable standards or from routine samples spiked with a known concentration of a known compound. For this investigation, performance requirements shall be met by analyzing a minimum of one blind sample for each analytical method identified in Table 1.

- Field blanks. Field blanks shall consist of pure deionized distilled water, transferred into a sample container at the site and preserved with the reagent specified for the analytes of interest. Field blanks are used as a check on reagent and environmental

contamination, and shall be collected at the same frequency as field duplicate samples.

- Equipment blanks. Equipment blanks shall consist of pure deionized distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. Equipment blanks are used to verify the adequacy of sampling equipment decontamination procedures, and shall be collected at the same frequency as field duplicate samples.

- Trip blanks. Trip blanks consist of pure deionized distilled water added to one clean sample container, accompanying each batch of containers shipped to the sampling activity. Trip blanks shall be returned unopened to the laboratory, and are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. In compliance with standard Westinghouse Hanford procurement procedures, requirements for trip blank preparation shall be included in procurement documents of work orders to the sample container supplier and/or preparer.

The internal quality control checks performed by analytical laboratories for Level III and Level V laboratory analyses shall meet the following minimum requirements.

- Matrix spiked samples. Matrix spiked samples require the addition of a known quantity of a representative analyte of interest to the sample as a measure of recovery percentage. The spike shall be made in a replicate of a field sample. Replicate samples are separate aliquots removed from the same sample container in the laboratory. Spike compound selection, quantities, and concentrations shall be described in the analytical procedures submitted for Westinghouse Hanford review and approval. One sample shall be spiked per analytical batch, or once every 20 samples, whichever is greater.

- Quality control reference samples and appropriate quality assurance requirements. A quality control reference sample shall be prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples are required as an independent check on analytical technique and methodology, and shall be run with every analytical batch, or every 20 samples, whichever is greater.

Other requirements specific to laboratory analytical equipment calibration are included in Section 6.0.

The minimum requirements of this section shall be invoked in procurement documents or work orders in compliance with standard Westinghouse Hanford procedures as noted in Section 4.1.

10.0 PERFORMANCE AND SYSTEM AUDITS

As noted in Section 5.12 and Appendix A of *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* QAMS-005, (EPA 1983), audits in environmental investigations are considered to be systematic checks that verify the quality of operation of one or more elements of the total measurement system. System audit requirements shall be implemented through the use of procedure QI 10.4, "Surveillance" (WHC 1989a). Surveillances will be performed regularly throughout the course of the work plan activities. All quality affecting activities are subject to surveillance.

Additional performance and system audits will be scheduled as a consequence of corrective action requirements (see Section 13.0 below), or may be performed upon request by the QA Coordinator, the Technical Lead, DOE-RL, Ecology, or the EPA. Any discrepancies observed during the evaluation of performance results during surveillance activities that cannot be immediately corrected to the satisfaction of the investigator shall be documented on a surveillance report and resolved in compliance with procedure QI 10.4, "Surveillance" (WHC 1989a). In addition, at the direction of the Westinghouse Hanford Environmental Quality Assurance Officer, all aspects of 300-FF-1 project activities may also be evaluated as part of routine environmental restoration program-wide QA audits under the procedural requirements of WHC-CM-4-2 (WHC 1989a). Program audits shall be conducted in compliance with QR 18.0, "Audits"; QI 18.1, "Audit Programming and Scheduling"; and QI 18.2, "Planning, Performing, Reporting, and Follow-up of Quality Audits" by auditors qualified in compliance with QI 2.5, "Qualification of Quality Assurance Program Audit Personnel" (WHC 1989a).

11.0 PREVENTIVE MAINTENANCE

All measurement and testing equipment used in the field and laboratory that directly affect the quality of the analytical data shall be subject to preventive maintenance measures that ensure minimization of measurement system downtime. For this investigation, such measures are confined to laboratory equipment because all field measurements are related either to the measurement of the sample interval or to the determination of radiological or other health and safety hazards. Laboratories shall be responsible for performing or managing the maintenance of their analytical equipment; maintenance requirements, spare parts lists, and instructions shall be included in individual methods or in laboratory QA plans, subject to Westinghouse Hanford review and approval. When samples are analyzed using EPA reference methods, the requirements for preventive maintenance of laboratory analytical equipment as defined by the reference method shall apply.

12.0 DATA ASSESSMENT PROCEDURES

Characterization data from this phase of the investigation will be assessed at two levels. As previously discussed in Section 8.0, analytical data shall first be compiled and reduced by the laboratory and validated in a manner appropriate for the individual analytical level. As discussed in Section 5.0 of the Work Plan, and as directed by the technical lead, various statistical and probabilistic techniques may be selected for use in the process of data comparison and analysis. Statistical methods may include one or more of the standard methods and formulae discussed in the Appendix of this QA Project Plan, or other appropriate methods at the discretion of the Technical Lead. In all cases, however, the statistical methodologies and assumptions to be used in the evaluation shall be defined by written directions that are signed, dated, and retained as project quality records in compliance with EII 1.6, "Records Management" (WHC 1989b). Applicable directions shall be documented in the final report for this phase of the characterization of 300-FF-1 produced in Task 9.

13.0 CORRECTIVE ACTION

Corrective action requests required as a result of surveillance reports, nonconformance reports, or audit activity shall be documented and dispositioned as required by QR 16,0, "Corrective Action"; QI 16.1, "Trending/Trend Analysis"; and QI 16.2, Corrective Action Reporting," (WHC 1989a). Primary responsibilities for corrective action resolution are assigned to the Technical Lead and the QA Coordinator. Other measurement systems, procedures, or plan corrections that may be required as a result of routine review processes shall be resolved as required by governing procedures or shall be referred to the Technical Lead for resolution. Copies of all surveillance, nonconformance, audit, and corrective action documentation shall be routed to the project QA records upon completion or closure.

14.0 QUALITY ASSURANCE REPORTS

As previously stated in Sections 10.0 and 13.0, project activities shall be regularly assessed by auditing and surveillance processes. Surveillance, nonconformance, audit, and corrective action documentation shall be routed to the project quality records upon completion or closure of the activity. A report such as that described in QI 16.1, "Trending/Trend Analysis" (WHC 1989a), summarizing all audit, surveillance, and instruction change authorization activity (see Section 4.4), as well as any associated corrective actions, shall be prepared by the QA Coordinator at the completion of Phase I or annually beginning 1 year after approval of the Work Plan, whichever is sooner. The report(s) shall be submitted to the Technical Lead for incorporation into the final report prepared at the end of Phase I of

the investigation. The final report shall include an assessment of the overall adequacy of the total measurement system with regard to the data quality objectives of the investigation.

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WHC, 1989b, *Environmental Investigations and Site Characterization Manual*, WHC-CM-7-7, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX

1.0 SCOPE

This attachment discusses various statistical methods and standard formulae suitable for inclusion in Westinghouse Hanford, participant contractor, or subcontractor laboratory analytical procedures for environmental investigations. Such methods are routinely used to assess the precision, accuracy, and completeness of measurement data within individual analytical procedures. The information provided by this attachment is intended for guidance only; all methods selected or proposed for the assessment of data precision, accuracy, and completeness are subject to review and approval prior to use.

2.0 STATISTICAL METHODS AND FORMULAE

2.1 CENTRAL TENDENCY AND DISPERSION

Methods for determining central tendencies and dispersion of data may include determination of various statistical values. The arithmetic mean is the sum of a set of n values divided by n:

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n} \qquad \text{(EPA 1979)}$$

Range simply refers to the difference between the highest and lowest values reported for a sample (EPA 1979). The standard deviation is the square root of the variance of the population:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} X_i^2 - \left(\sum_{i=1}^{n} X_i\right)^2 / N}{N}} \qquad \text{(EPA 1979)}$$

The standard deviation estimate is the most widely used measure to describe the dispersion of a set of data and is expressed as follows:

$$S = \sqrt{\frac{\sum_{i=1}^{n} X_i^2 - \left(\sum_{i=1}^{n} X_i\right)^2 / n}{n-1}}$$ (EPA 1979)

The relative standard deviation (coefficient of variation) is the ratio of the standard deviation estimate S of a set of numbers to their mean $\overline{X}$ expressed as a percentage. It relates the standard deviation (or precision) of a set of data to the size of the numbers:

$$\text{CV} = \text{RSD (percent)} = 100\frac{S}{\overline{X}}$$ (EPA 1979)

The coefficient of skewness is a measure of the asymmetry of a frequency distribution:

$$K = \frac{\Sigma[(x-\mu)^3]}{\sigma^3}$$ (Snedecor and Cochran 1980)

The geometric mean is a measure of central tendency for data from a positively skewed distribution (log normal):

$$\overline{X}_g = \sqrt[n]{(X_1)(X_2)\ldots(X_n)}$$

$$\overline{X}_g = \text{antilog}\,\frac{\sum_{i=1}^{n} \log X_i}{n}$$

(EPA 1979)

Median refers to the middle value of all data, ranked on ascending order. If there are two middle values, the median is the mean of these values. A mode M_0 of a sample size (EPA 1979) is a value which occurs with greatest frequency, i.e., it is the most common value (Beyer 1973).

Variance: Sample variance is a measure of the dispersion of a set of measurements; it is further defined as the sum of the squares of the individual deviations from the sample mean divided by one less that the number of results involved, as expressed by the following equation:

$$S^2 = \frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1}$$ (ASTM 1988)

where:

s = the sample variance of the measurements,
n = the number of measurements obtained,
X_i = the ith individual measurement, and
$\bar{X}$ = the sample mean of the measurements.

2.2 ASSESSMENT OF DATA QUALITY

Accuracy may be interpreted as the measure of the bias in a measurement system. Accuracy may be expressed as: (a) the difference between the measurement (X) with the reference value (T) (i.e., X-T), or (b) the difference between the two values as a percentage of the reference value (i.e., 100(X-T)/T). For the purposes of environmental investigations, precision may be interpreted as a measure of repeatability or reproducibility between individual measurements made with a common set of parameters or conditions. Precision is normally expressed in terms of the standard deviation, but may also be expressed as the relative standard deviation (coefficient of variation) or range (maximum value minus minimum value; see the discussion in Section 2.1). Relative error (RE) refers to the mean error of a series of measured data values as a percentage of the true value X_T:

$$RE = 100 \frac{|x-T|}{T}$$ (EPA 1979)

For the purposes of environmental investigations, comparability is an expression of the relative confidence with which one data set may be compared with another. Completeness is expressed as follows:

$$\text{Completeness (\%)} = \frac{\text{Number of valid analyses (for each parameter)}}{\text{Number of samples analyzed (for each parameter)}} \; 100$$

For the purposes of environmental investigations on the Hanford Site, completeness is defined as an objective of meeting established requirements for precision and accuracy for at least 90% of the requested determinations.

2.3 SIGNIFICANCE TESTS

Significance or hypothesis testing refers to the various means used to check statistical hypotheses. Such tests include the Student-t test, the chisquared test, the F-test and various other non-parametric tests. The selection of test type should suit the specific characteristics of the hypothesis being tested. Detailed discussions of these types of tests may be found in standard statistics texts such as "Probability and Statistics in Modern Engineering" (Lapin 1983) or "Probability and Statistics for Engineers" (Miller and Freund 1965), or "Statistical Methods" (Snedecor and Cochran 1980).

2.4 CONFIDENCE LIMITS

Confidence limits refer to the boundaries of a value interval with a designated probability (the confidence coefficient) of including some defined parameter of the sample population. The confidence coefficient is the probability the value interval has of including the sample population values. The confidence coefficient is normally expressed as a percentage. For a given sample size, the distance between the confidence limits increases as the coefficient increases.

2.5 TESTING FOR OUTLIERS

Statistical tests are recommended for the screening of data sets for unusually large or small data values for elimination prior to the analysis or processing of data. The guidelines, tables, formulae, and figures of Appendix F, "Outliers," from *Quality Assurance Handbook for Air Pollution Measurement Systems* (EPA 1987) are recommended for selection of appropriate methods.

3.0 MATHEMATICAL TERMS

Mathematical terms used in the formulae discussed above are as follows (EPA 1979).

K = skewness

N = population size (if finite) or lot size

n = number of items in the sample or test

S = standard deviation estimate

$\bar{X}$ = arithmetic mean

$\bar{X}_g$ = geometric mean of sample measurements

X_i = ith measurement, or the ith smallest measurement of a set of measurements arranged in ascending order

T = population standard deviation.

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ATTACHMENT 2

HEALTH AND SAFETY PLAN

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1.0 GENERAL CONSIDERATIONS AND REQUIREMENTS

1.1 INTRODUCTION

The purpose of this task-specific Health and Safety Plan (HSP) is to establish standard health and safety procedures for Westinghouse Hanford Company (Westinghouse Hanford) employees and contractors engaged in remedial investigation activities in the 300-FF-1 operable unit. These activities will include drilling and sampling boreholes, well installation, and environmental sampling in areas of known chemical and radiological contamination.

A brief prejob safety plan (PJSP) will be prepared for each work site (e.g., pond, trench, ditch, etc.) which will reiterate the following information for that specific site and task(s).

1. Inventory of suspected chemical and/or radiological hazards.
2. Discussion of existing and potential physical hazards.
3. Methods for mitigating known and potential site-specific hazards.

Each PJSP will be reviewed by the Environmental Engineering Group and Industrial Safety and Fire Protection (ISFP), and Engineering Field Services (EFS), when appropriate, before start up, and will serve as the agenda for a mandatory 'tail-gate' safety meeting. Each PJSP must be read and signed by all involved personnel.

The levels of protection and procedures specified in this plan are based on the best available information and represent the minimum health and safety requirements to be observed at all times by Westinghouse Hanford employees and contractors while engaged in tasks associated with this project. Unknown conditions undoubtedly exist, and existing conditions may change. Should any situation arise, which is obviously beyond the scope of the monitoring, personal protection, and decontamination procedures specified herein, work activities shall be halted pending discussion with the Westinghouse Hanford site safety officer and Westinghouse Hanford management, and revision of specified health and safety procedures.

All Westinghouse Hanford employees and contractors engaged in onsite activities in 300-FF-1 must read this document. Employees are encouraged to bring any questions or lingering concerns to the attention of the field team leader or the site safety officer.

- Read this document carefully.
- Follow all specified health and safety procedures.
- Do not lose sight of the 'everyday' hazards associated with all (nonhazardous) field work, i.e., falls, slips, trips, cuts, overhead hazards, moving machinery, etc.

AND ABOVE ALL

- Use common sense and exercise reasonable caution at all times.

1.2 DESIGNATED SAFETY PERSONNEL

The field team leader and site safety officer are responsible for site safety and health. Specific individuals will be assigned on a task by task basis by project management, and their names will be properly recorded before the task is initiated.

All activities on site must be cleared through the field team leader. The field team leader has responsibility for the following:

- Allocating and administering the resources to successfully comply with all technical and health and safety requirements
- Verifying that all permits, supporting documentation, and clearances are in place (i.e., electrical outage requests, welding permits, excavation permit, HSP, sampling plan, radiation work permit [RWP], onsite/offsite radiation shipping records [RSRs], etc.)
- Providing technical advice during routine operations and emergencies
- Informing the appropriate site management and safety personnel of the activities to be performed each day
- Resolving any conflicts that may arise between RWPs and implementation of the HSP
- Handling of emergency response situations as may be required
- Conducting prejob safety meeting and periodic tailgate safety meetings
- Interactions with adjacent building occupants and/or inquisitive public.

The site safety officer shall act as the site safety and health supervisor and is responsible for implementing the HSP at the site. The site safety officer shall:

- Prepare each PJSP
- Monitor chemical, physical, and (in conjunction with the RPT) radiation hazards to assess the degree of hazard present; monitoring shall specifically include organic vapor detection, radiation screening, and confined space evaluation
- Determine protection levels, clothing, and equipment needed to ensure the safety of personnel in conjunction with the RPT

- Monitor performance of all personnel to ensure that the required safety procedures are followed
- Halt operations immediately, if necessary, because of safety and/or health concerns
- Conduct safety briefings as necessary
- At the field team leader's request, prepare summary reports of health and safety activities at the conclusion of each task.

The RPT is responsible for assuring that all radiological monitoring and protection procedures are being followed as specified in the appropriate RWP. Industrial hygiene and safety personnel will provide safety with an overview during drilling operations consistent with Westinghouse Hanford policy, and provide technical advice as requested. Also, an additional industrial hygienist and HPT may be requested to provide downwind sampling for hazardous materials and radiological contaminants, respectively, and other analyses as required.

The ultimate responsibility and ultimate authority for employee health and safety lies with the employee and the employee's colleagues. Each employee is responsible for exercising the utmost care and good judgment in protecting personal health and safety and that of fellow employees. Should any employee observe a potentially unsafe condition or situation, it is the responsibility of that employee to immediately bring the observed condition to the attention of the appropriate health and safety personnel, as designated above. In the event of an immediately dangerous or life-threatening situation, the employee automatically has temporary 'stop-work' authority and the responsibility to immediately notify the field team leader or site safety officer. When work is temporarily halted because of a safety or health concern, personnel will exit the exclusion zone and meet at a predetermined place in the support zone. The field team leader, site safety officer, and HPT will determine the next course of action.

1.3 MEDICAL SURVEILLANCE

All Westinghouse Hanford personnel and contractors engaged in onsite activities on 300-FF-1 must have baseline physical examinations and be participants in Westinghouse Hanford's (or an equivalent) medical surveillance program.

Medical examinations will be designed by the Hanford Environmental Health Foundation (HEHF) to identify any pre-existing conditions that may place an employee at high risk, and will verify that each worker is physically able to perform the work required by this work plan without undue risk to personal health. The physician shall determine the existence of conditions that may reduce the effectiveness or prevent the employee's use of a self-contained breathing apparatus (SCBA). The physician shall also determine the presence of conditions that may pose undue risk to the employee while performing the physical tasks of this work plan using Level B personal protection

equipment. This would include any condition that increases the employee's susceptibility to heat stress.

The examining physician's report will not include any nonoccupational diagnoses unless directly related to the employee's fitness for the work required.

1.4 TRAINING

Before engaging in any onsite remedial investigation activities, each team member is required to have received 40 h of health and safety training related to hazardous waste site operations and at least 8 h of refresher training each year thereafter, as specified in 29 CFR 1910.120 (OSHA 1988a). At a minimum this training must include the following topics:

- Employee rights and responsibilities under the Occupational Safety and Health Administration (OSHA).
- Personal protection equipment (PPE) and clothing, use and care, particularly fitting, operation, and use of cascade breathing air systems and SCBA
- Chemical and radiological hazard recognition
- Radiation worker training
- Emergency response, self-rescue, and first aid
- Vehicle operation, mandatory rules, and regulations
- Safe use of drilling and sampling equipment
- Handling, storage, and transportation of hazardous chemical and radioactive materials
- Site control and management
- Safe sampling techniques
- Site surveillance, observation, and safety plan development
- Proper decontamination methods for personnel, protective clothing, and equipment
- Use of field test equipment for radioactivity, explosivity, and other measurements as needed
- Communication procedures.

The field team leader and site safety officer will provide site-specific instructions regarding anticipated hazards, levels of protection, site monitoring, and operation of equipment as appropriate.

In addition, each inexperienced (never having performed site characterization) employee will be directly supervised by the site safety officer or the field team leader for a minimum of 3 days of field procedures.

The field team leader and the site safety officer will receive an additional 8 hours of training (in addition to the refresher training discussed above) to cover the following topics:

- Management of restricted and safe zones
- Rules for handling untrained site visitors
- Site management
- Other environmental, safety, and health topics which relate to the sampling and characterization effort.

1.5 REQUIREMENTS FOR THE USE OF RESPIRATORY PROTECTION

All employees and subcontractors who may be required to use air-purifying or air-supplied respirators must be included in the medical surveillance program and be approved for the use of respiratory protection by a HEHF/licensed physician. Subcontractors must provide evidence to Westinghouse Hanford that their medical program complies with 29 CFR 1910.120 (OSHA 1988a). Each team member must be trained in the selection, limitations, and proper use and maintenance of respiratory protection. Existing respiratory protection training may be applicable towards the 40 h training requirement.

Finally, before using any air-purifying respirator, each employee must be fit tested (or have been fit tested within the past year) for the specific make, model, and size of respirator the individual will be using according to Westinghouse Hanford and/or PNL qualitative and/or quantitative fit testing procedures. Beards (including a few days' growth), large sideburns, or moustaches, which may interfere with a proper respirator seal, are not permitted.

2.0 GENERAL PROCEDURES

The following personal hygiene and work practice guidelines are intended to prevent injuries and adverse health effects. A hazardous waste site poses a multitude of health and safety concerns because of the variety and number of hazardous substances present. These guidelines represent the minimum standard procedures for reducing potential risks associated with this project and are to be followed by Westinghouse Hanford employees <u>at all times</u>.

2.1 GENERAL WORK SAFETY PRACTICES

2.1.1 Work Practices

- Eating, drinking, smoking, taking medications, chewing gum, etc., is prohibited within the exclusion zone. All sanitation facilities shall be located outside of the exclusion zone; decontamination is required before using such facilities.

- Personnel shall avoid direct contact with contaminated materials unless necessary for sample collection or required observation. Remote handling of casing, auger flights, etc. will be practiced whenever practical.

- Do not handle soil, waste samples, or any other potentially contaminated items unless wearing NBR (nitrile-butyl rubber) or neoprene rubber gloves.

- Whenever possible, stand upwind of excavations, boreholes, well casings, drilling spoils, etc., as indicated by an onsite windsock.

- Stand clear of the trench during excavation. Always approach the excavation from upwind.

- Be alert to potentially changing exposure conditions as evidenced by perceptible odors, unusual appearance of excavated soils, oily sheen on water, etc.

- Do not enter any test pit trench greater than 4 ft in depth unless in accordance with procedures specified below.

- Do not, <u>under any circumstances</u>, enter or ride in or on any backhoe bucket, materials hoist, or any other similar device not specifically designed for carrying human passengers.

- All drilling operations members must make a conscientious effort to remain aware of their own and other's positions in regards to rotating equipment, cat heads, u-joints, etc. Drilling operations members must be extremely careful when assembling, lifting, and carrying flights or pipe to avoid pinch-point injuries and collisions.

- Tools and equipment will be kept off the ground whenever possible to avoid tripping hazards and the spread of contamination.

- While operating in the controlled zone, personnel shall use the 'buddy system' or be in visual contact with someone outside of the controlled zone at all times.

- The buddy system will be used where appropriate for manual lifting.

- Personnel not involved in operation of the cable tool drill rig or monitoring activities shall remain a safe distance from the rig as indicated by the field team leader.

- Follow all provisions of each site-specific cutting and welding permit.

- Catalytic converters on the underside of vehicles are sufficiently hot to ignite dry prairie grass. Team members should not drive over dry grass that is higher than the ground clearance of the vehicle and should be aware of the potential fire hazard posed by catalytic converters at all times. Never allow a running vehicle to sit in a stationary location over dry grass or other combustible materials.

- Requirements of Westinghouse Hanford radiation protection and radiation work permits manuals shall be followed for all work involving radioactive materials or conducted within a radiologically controlled area.

- Team members will attempt to minimize truck tire disturbance of all stabilized sites.

- Work operations onsite shall not start before sunrise and shall cease at sunset, unless the entire control zone is adequately illuminated with artificial lighting. A new tour (shift) will man the drilling rig after completion of each shift.

- All team personnel are required to attend a prejob safety meeting before the start of the campaign.

- A mandatory 'tail-gate' meeting will be conducted before each hole drilling operation.

2.1.2 Personal Protective Equipment

- Hard hats, safety glasses, and steel toe boots will be worn when inside the exclusion zone.

- Personnel shall maintain a high level of awareness of the limitations in mobility, dexterity, and visual impairment inherent in the use of Level B and Level C personal protection equipment.

- Be alert to the symptoms of fatigue, heat stress, and cold stress and their effect on the normal caution and judgment of personnel.

- Always use an appropriate level of personal protection. Lesser levels of protection can result in otherwise preventable exposure; excessive levels of safety equipment can impair efficiency and increase the potential for accidents to occur.

- Noise may pose a health and safety hazard, particularly during drilling and construction activities. As a rule, if the voice must be raised in order to communicate at a distance of 3 ft in steady state (continuous) noise, hearing protection (disposable ear plugs) should be worn. Likewise, any impact noise from activities such as driving casing on a drilling operation, which is loud enough to cause wincing or discomfort, would also indicate the use of hearing protection. The exclusion zone around the drill rig should be posted "Hearing Protection Required." Hearing protection is available and should be included in the standard field kit along with hard hat, safety glasses, etc.

- Life jackets must be worn and employees shall use the 'buddy system' for any activities over water (e.g., water column sampling of the Columbia River). Additional rescue equipment, such as a rope or pole, shall also be available.

2.1.3 Decontamination

- Thoroughly wash hands and face before eating or putting anything in the mouth, to avoid hand-to-mouth contamination.

- At the end of each work day, or each job, disposable clothing shall be removed and placed in (chemical contamination) drums or plastic lined boxes as appropriate. Clothing that can be cleaned shall be sent to the Hanford Laundry.

- Individuals are expected to thoroughly shower before leaving the work site or Hanford Site if directed to do so by the RPT, site safety officer or field team leader.

2.1.4 Emergency Preparation

- A multipurpose dry chemical fire extinguisher, a fire shovel, a complete field first-aid kit (including bottles of eyewash solution), and a portable deluge shower shall be available at every drill site.

- Establish prearranged hand signals or other means of emergency communication when wearing respiratory equipment, since this equipment seriously impairs speech communications.

- The Hanford Fire Department will be notified of the location and nature of field work activity before the start of those activities. A site location map shall be included in this notification.

2.2 CONFINED SPACE/TEST PIT ENTRY PROCEDURES

The following procedures apply to the entry of any confined space which, for the purpose of this document, shall be defined as any space having limited egress (access to an exit) and the potential for the presence or accumulation of a toxic or explosive atmosphere. This includes manholes, certain trenches (particularly those through waste disposal areas), and all test pits greater than 4 ft in depth in potentially contaminated soil. If confined spaces are going to be entered as part of the work operations, a hazardous work permit (filled out for confined space entry) must be obtained from Industrial Safety and Fire Protection.

The identified remedial investigation activities on 300-FF-1 should not require confined space entry. Nevertheless, the hazards associated with confined spaces are of such severity that all employees should be familiar with the safe work practices discussed below.

No employee shall enter any test pit or trench greater than 4 ft in depth unless the sides are shored or laid back to a stable slope as specified in 29 CFR 1926.652 (OSHA 1988b) or equivalent State Occupational Health and Safety Regulations.

When an employee is required to enter a pit or trench 4 ft or more in depth, an adequate means of access and egress, such as a slope of at least 2:1 to the bottom of the pit, or a secure ladder or steps shall be provided.

Before entering any confined space, including <u>any test pit</u> or any trench that may have the potential for the accumulation of toxic gases or vapors, the atmosphere at the bottom of the space and at 4-ft intervals thereafter (if greater than 4 ft in depth) shall be tested for radioactivity, oxygen deficiency, hydrogen sulfide (H_2S), combustible gases, and organic vapors, in that order. If the excavation is located in an area known or suspected to contain cyanide wastes, the atmosphere shall also be tested for hydrogen cyanide. Depending on the situation, the space may require ventilation and retesting before entry.

Any employee entering a confined or partially confined space must be equipped with an appropriate level of respiratory protection in keeping with the monitoring procedures discussed above, and the action levels for airborne contaminants established in Section 5.0 below (see Warnings and Action Levels in PJSP).

No employee shall enter any test pit requiring the use of Level B (see Section 6.1) protection, unless a backup person also equipped with a pressure-demand SCBA is present. No backup person shall attempt any emergency rescue unless a second backup person equipped with a SCBA is present, or the appropriate emergency response authorities have been notified and additional help is on the way.

3.0 SITE BACKGROUND

3.1 DESCRIPTION OF FACILITIES IN OPERABLE UNIT 300-FF-1

The 300-FF-1 operable unit is located within the northeast section of the 300 Area, immediately adjacent to the Columbia River at the southeast corner of the Hanford Site. Table 1 contains a list of the facilities within 300-FF-1 and their periods of operation. All of the major past and present liquid waste disposal facilities in the 300 Area are included in 300-FF-1. Three of these facilities--the south process pond, the north process pond, and the 307 trenches--received the highest individual hazard ranking system (HRS) scores on the Hanford Site. The process trenches, which comprise the active 300 Area liquid waste disposal facility, are also located within this unit. Each of these infiltration ponds and trenches received a wide variety of hazardous wastes from reactor fuel fabrication and laboratory support activities via the 300 Area process sewer system.

Other active liquid waste disposal facilities within this unit include the sanitary sewer system for the 300 Area, pits used to retain slurried coal flyash, which is disposed of off the 300 Area once it is dried, water treatment plant backwash ponds, and the 307 Retention Basin. The retention basin is used to collect laboratory wastes for sampling to determine whether or not such wastes can be discharged to the 300 Area process sewer for disposal. Batches of waste too contaminated for disposal at the 300 Area were stored in tanks at the 340 Complex until transported by tank truck for crib disposal in the 200 West Area.

Radioactive liquid waste transport and storage facilities within 300-FF-1 include the 340 Complex tank storage facility mentioned above, and the past and present radioactive liquid waste sewer systems.

Three solid waste burial grounds are included in this unit. These sites contain uncharacterized quantities of waste including uranium-contaminated solid waste, disposal pond soils, and coal flyash.

Twenty-eight unplanned releases are known to have occurred within 300-FF-1; however, 22 of these were releases into the chemical process sewer. These latter releases, therefore, were ultimately disposed of in the liquid waste disposal facility, which was operational at the time of the incident. In addition, it is probable there have been releases as a result of leaks within the process and sanitary sewer systems, although the extent of such releases is unknown.

Table 1. Waste Disposal, Transfer, and Storage Facilities Included in Operable Unit 300-FF-1. (sheet 1 of 2)

Facilities	Periods of use	Waste sources
Process liquid waste disposal transfer		
Process Sewer System	1943-Present	Process wastes; i.e., cooling water, low-level radioactive wastes from fuel fabrication processes, laboratory and test-facility wastes, and process chemical spills.
South Process Pond (316-1)	1943-1975	Process wastes, water treatment plant filter backwash.
North Process Pond (316-2)	1948-1974	Process sewage, coal flyash.
307 Retention Basins	1953-Present	Laboratory wastes; i.e., cooling water, seal water, and laboratory and test-facility wastes.
307 Trenches (316-3)	1953-1963	Laboratory wastes, sediments from 316-1, coal flyash.
Process Trenches (316-5)	1975-Present	Process sewage.
Other liquid waste disposal and transfer		
Sanitary Sewer System	1943-Present	Sanitary sewage, cooling water, minute quantities of photochemical process wastes.
Ash Pits	1943(?)-Present	Slurried coal flyash.
Retired Filter Backwash Pond (East Basin of South Process Pond)	1975-1987	Water treatment plant filter backwash.
Filter Backwash Pond	1987-Present	Water treatment plant filter backwash.

Table 1. Waste Disposal, Transfer, and Storage Facilities Included in Operable Unit 300-FF-1. (sheet 2 of 2)

Facilities	Periods of use	Waste sources
Burial grounds		
Burial Ground No. 4 (618-4)	1955-1961	Uranium-contaminated miscellaneous materials.
Burial Ground No. 5 (618-5)	1945-1962	Burning pit for trash, including uranium-contaminated trash.
North Process Pond Scraping Disposal Area (618-12)	1949-1964	Sediments from 316-2, coal flyash.
Radioactive liquid waste transferred storage		
Retired Radioactive Sewer System	1954-1975	Radioactive wastes; i.e., radioactive wastes from fuel fabrication, laboratory, and test-facility operations.
Radioactive Sewer System	1975-Present	Radioactive wastes.
340 Complex	1954-Present	Radioactive wastes.
Hazardous waste storage		
340 Complex Hazardous Waste Staging Area	1954-Present	Drummed waste oil storage, empty hazardous waste drum storage.
332 Hazardous Waste Staging Area	1983-Present	Small-container hazardous waste storage.

Tables 2, 3, and 4 include known waste inventories as determined during past preliminary assessment/site inspection activities conducted on inactive waste sites at the Hanford Site. Waste inventories are inexact because the 300 Area process sewer receives waste from more than 50 buildings, including several research and development laboratories. Therefore, a variety of chemicals may have been discharged into the system at some point in time in at least laboratory quantities. The various unplanned releases, which found their way into the process sewer, add to the uncertainty of the inventories.

Table 5 contains estimates of the various types and quantities of substances that could have been potentially discharged into the 307 trenches. A similar list of chemicals could be expected to have been discharged into each of the other major liquid waste disposal facilities as well.

Administrative measures, taken in 1985, have eliminated routine discharges of all hazardous and dangerous wastes to the active process trenches.

Table 2. Estimated Nonradiological Chemical Waste Inventory for the South Process Pond.

Chemical	Quantity (kg)
Beryllium	40
Cadmium	80
Chromium	5,000
Copper	60,000
Fluoride	7,000
Lead	4,000
Mercury	60
Nickel	10,000
Nitrate	1,000,000
Nitrite	900,000
Nitric acid	1,000,000
Silver	1,000
Sodium	2,000,000
Sodium aluminate	2,000,000
Sodium hydroxide	1,000,000
Sodium silicate	100,000
Trichloroethylene	100,000
Uranium	40,000
Zinc	5,000
Total volume of liquids disposed:	10,000,000 m^3.

Source: PNL (1988).

Table 3. Estimated Nonradiological Chemical Waste Inventory for the North Process Pond.

Chemical	Quantity (kg)
Beryllium	30
Cadmium	60
Chromium	3,000
Copper	50,000
Fluoride	5,000
Lead	2,000
Mercury	40
Nickel	8,000
Nitrate	800,000
Nitrite	700,000
Nitric acid	900,000
Silver	900
Sodium	1,000,000
Sodium aluminate	2,000,000
Sodium hydroxide	800,000
Sodium silicate	90,000
Trichloroethylene	100,000
Uranium	30,000
Zinc	3,000
Total volume of liquids disposed:	10,000,000 m^3.

Source: PNL (1988).

Table 4. Estimated Nonradiological Chemical Waste Inventory for the 307 Trenches.

Chemical	Quantity (kg)
Beryllium	10
Cadmium	20
Chromium	1,000
Copper	20,000
Fluoride	2,000
Lead	600
Mercury	10
Nickel	3,000
Silver	300
Uranium	10,000
Zinc	1,000
Total volume of liquids disposed:	1,000,000 m^3.

Source: PNL (1988).

Table 5. An Estimate of Chemicals Potentially Discharged to the 300 Area Process Trenches Before February 1, 1985.

Intermittent discharges		Later discharges[a]	
<1 gram	<1 kg		
Amonium bifluoride	Benzene	Copper	30 kg/mo[b]
Antimony	Carbon tetrachloride	Detergents	≤30 kg/mo[b]
Arsenic	Chromium	Ethylene glycol	≤200 L/mo
Barium	Chlorinated benzenes	Hydrofluoric acid	100 kg/mo
Cadmium	Degreasing solvents	Nitrates	≤2000 kg/mo[b]
Dioxane	Formaldehyde	Nitric acid	≤300 L/mo
Dioxin[c]	Formic acid	Sodium hydroxide	≤300 L/mo
Hydrocyanic acid	Hexachlorophene	Paint solvents	≤100 L/mo
Pyridine	Kerosene	Photo chemicals	≤700 L/mo
Selenium and compounds	Lead Methyl ethyl ketone	Sodium chloride Uranium	75 ton/yr[b] 20 kg/mo[b]
Thiourea	Mercury	Perchloroethylene	450 L[d]
Misc. laboratory chemicals	Napthalene Nickel Phenol Silver Sulfuric acid Tetrachloroethylene (perchloroethylene) Toluene Tributylphosphate (paraffin hydrocarbon solvents) 1,1,1-trichloroethane (methyl chloroform) Trichloroethylene Xylene	Heating oil	300 L[d]

[a]These discharges, except for the spills, were relatively continuous.
[b]These materials are still discharged.
[c]Included only because of the potential for dioxin to exist as a trace impurity in chlorinated benzenes.
[d]Known spills.

4.0 SCOPE OF WORK AND POTENTIAL HAZARDS

While the information presented in Section 3.0 above is believed to be representative of the constituents and quantities of wastes at the time of discharge, the present chemical nature, location, extent, and ultimate fate of these wastes in and around the liquid disposal facilities are largely unknown. The emphasis of the remedial investigation in 300-FF-1 will be to characterize the nature and extent of contamination in the vadose (unsaturated subsurface soil) zone, groundwater, water sediments of the Columbia River.

4.1 WORK TASKS

Work tasks are described in Section 5.0.

4.2 POTENTIAL HAZARDS

Table 6 presents a list of known or suspected radiological hazards. Chemical contaminants and approximate quantities released were previously presented in Tables 2 through 5 above. In spite of the rather extensive list of substances known or suspected to have been released within 300-FF-1, extensive soil and groundwater sampling conducted to date indicate that chemical contaminants of potential concern are chromium, and volatile organics including trichloroethylene (TCE), tetrachloroethylene, and methylene chloride and polychlorinated biphenyls (PCB). The allowable exposure limits and hazards associated with these chemicals are shown in Table 7.

Table 6. Known Radiologic Hazards.

Radionuclide	Type of radiation
^{3}H	Soft β- (18.6 keV)
^{60}Co	312 keV β-; 1.17, 1.33 MeV gamma
^{90}Sr	540 keV β-
^{99}Tc	292 keV β-
^{137}Cs	510 keV β-; 661 keV gamma
^{238}U	4 to 6 MeV alpha

Table 7. Potential Chemical Hazards.

Substance	Threshold limit value time weighted average p/m	Threshold limit value time weighted average mg/m^3	IDLH[a] p/m	Monitoring/ sampling method	Primary hazards and symptoms	Warning properties	Protection
Chromium (VI) and chromium (VI) compounds	--	0.05	(30 mg/m^3)	(b,c)	Toxic if inhaled, ingested, or absorbed through skin. Irritation of eyes, respiratory tract, skin. Causes cancer.	None	Protection levels will be determined by: 1. The estimated site inventory 2. Onsite conditions 3. Sampling results 4. Company standards. Immediate actions will be listed in site-specific prejob.
Polychlorinated biphenyl (PCB)	--	0.5	5	(b,c)	Toxic if inhaled, ingested, or absorbed through skin. Irritation of eyes, and skin. Causes cancer.	Mild, solvent-like odor	
Methylene-chloride	50	175	5,000	11.7 HNU[d] or OVA[e]	Toxic if inhaled, ingested, or absorbed through skin. Irritation of eyes, respiratory tract, skin, nausea. Causes cancer.	Chloroform-like odor	
Trichloro-ethylene	50	270	1,000	HNU or OVA	Toxic if inhaled, ingested, or absorbed through skin. Headache, vertigo, tremors, vomitting, irritation of eyes, dermatitis. Causes cancer	Sweet, chloroform-like odor	
Tetrachloro-ethylene	50	335	500	HNU or OVA	Toxic if inhaled, ingested, or absorbed through skin. Irritation of eyes, nose, and throat; nausea, flush, vertigo, headache. May cause cancer.	Chloroform-like odor	

[a]IDLH = Immediately dangerous to life and health.
[b]Downwind sampling station by Hanford Environmental Health Foundation (HEHF), if needed.
[c]No 'real time' sampling available; however, dusty conditions during drilling or other activities may require protective upgrade. If necessary, personal air monitoring will be undertaken according to National Institute for Occupational Safety and Health (NIOSH) methods.
[d]HNU is a trademark of HNU Systems, Inc., Newton, MA.
[e]OVA = Organic vapor analyzer.

As discussed above, this project will involve the following:

- Drilling shallow boreholes directly adjacent to liquid waste disposal ponds and trenches, and soil sampling
- Drilling and well installation, and soil and groundwater sampling in areas known or suspected to contain hazardous chemical substances, toxic metals, and radioactive materials.

The degree of the potential occupational hazards are expected to be similar for each of the designated tasks. The likelihood of encountering hazardous chemical or radioactive substances will clearly be greatest during intrusions into and through the strata in the vicinity of the liquid waste disposal facilities.

Potential hazards include:

1. External radiation (gamma, and to a lesser extent, beta) from radioactive materials in the soil
2. Internal radiation due to radionuclides present in contaminated soil entering the body by ingestion or through open cuts and scratches
3. Internal radiation due to inhalation of particulate (dust) contaminated with radioactive materials
4. Inhalation of toxic vapors or gases such as volatile organics or ammonia
5. Inhalation or ingestion of particulate (dust) contaminated with inorganic or organic chemicals, and toxic metals
6. Dermal exposure to soil and/or groundwater contaminated with radionuclides
7. Dermal exposure to soil and/or groundwater contaminated with inorganic or organic chemicals, and toxic metals
8. Physical hazards such as noise, heat stress, and cold stress.
9. Slips, trips, falls, bumps, cuts, pinch points, falling objects, other overhead hazards, crushing injuries, etc., typical of every construction-related job site
10. Unknown and/or unexpected underground utilities.

4.3 ASSESSMENT AND MITIGATION OF POTENTIAL HAZARDS

The likelihood of significant exposure (100 mR/h or greater) to external radiation is remote and can be readily monitored and controlled by limiting exposure time, increasing distance, and employing shielding as required.

Internal radiation via inhalation or inadvertent ingestion of contaminated dust is a realistic concern and must be continuously evaluated by the RPT. Appropriate respiratory protection, protective clothing, and decontamination procedures will be implemented as necessary to reduce potential inhalation, ingestion, and dermal exposure to acceptable levels.

Exposure to toxic chemical substances via the dermal exposure route is not expected to pose a significant problem for the designated tasks, given the use of proper protective clothing. As specified below, at a minimum SWPs (protective coveralls) white Tyvek* coveralls and rubber gloves will be required within the control zone at all times, and outside of the control zone whenever it is necessary to contact or handle contaminated or potentially contaminated soil, groundwater, tools, etc. The appropriate level of personal protective clothing and respiratory protection may vary from B-1 for soil sampling during drilling operations, to D-3 for sampling Columbia River water. In general, all activities conducted within an exclusion zone will require a minimum Level D-2 as described in Section 6.0, and all other sampling will require D-3. These levels of protection will be upgraded as appropriate, based on real-time hazard evaluation and action levels discussed in Section 5.0.

High volume particulate samplers are in operation in and around 300-FF-1. Chemical exposure via inhalation of contaminated dust is not expected to pose a significant hazard because of the relatively low concentrations of chemicals in soil and low concentration of dust in the ambient air. Activities that result in high levels of airborne particulate (i.e., dusty operations) will require respiratory protection as discussed below.

Similarly, airborne concentrations of toxic gases/vapors are not expected to exceed applicable threshold limit values (TLVs). As mentioned above, however, the interactions and fate of these compounds are not well characterized. The site safety officer will periodically monitor airborne levels of toxic vapors and gases with an HNU-PI-101 and appropriate colorimetric detector tubes. Air monitoring with direct reading instruments will be carried out continuously in the event of the detection of breathing zone concentrations greater than background levels. Respiratory protection will be employed as appropriate. Warning levels and action levels, if different than those established in Section 5.0, will be designated in the PJSPs.

The project manager must make every effort to identify any and all underground utilities in the vicinity of all intrusive operations such as drilling or trenching. Should the work crew encounter an unanticipated underground utility, work shall be halted until the nature and status of the line is determined.

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*Tyvek is a trademark of duPont de Nemours and Company, Incorporated.

5.0 ENVIRONMENTAL AND PERSONAL MONITORING

The site safety officer shall be present at all times during work activities. Air quality monitoring equipment will be used during the field activities to quantify exposure of vapors and gases which pose risks. This equipment is intended to provide adequate warning and allow appropriate action to be taken to prevent harmful exposure to chemical and radiological contaminants released into the work environment. The air monitoring program will consist of monitoring air for contaminant vapor/gases in the vicinity of boreholes and breathing zones, and monitoring the general area for radiation. An RPT must be onsite at all times and will observe the action levels and procedures specified in the RWP and appropriate as low as reasonably achievable (ALARA) plans. Core samples will also be monitored to determine levels of radioactivity and occupational risks before actual sample collection. As indicated above, the decision to modify the level of protection will be made by the site safety officer, RPT and the field team leader. This decision will be based on, but not limited to the following:

- Interpretation of organic vapor, gas, and radiation detection instrument readings by RPTs and Health and Safety personnel
- Visual observation such as wind, dust, discoloration, etc.
- Noticeable odors by the RPTs and health and safety personnel
- Other sampling devices such as O_2 and explosive level meters
- Information specific to the individual sites (i.e., known or suspected chemical contaminants and levels of each).
- Physical characteristics of the work environment such as temperature and pH.

Air sampling may be required downwind of the referenced waste sites to monitor particulates and vapors before job start up. Siting of such sampling devices will be determined by Operational Health Physics, GEU site safety officer, and HEHF (if appropriate). Any time that personnel sampling is required to determine exposure levels, it must be done by HEHF. Discrete sampling of ambient air within the work zone and breathing zone will be conducted using an HNU* or organic vapor analyzer (OVA), radiation detectors, and other methods as deemed appropriate (e.g., pumps with tubes, O_2 meters, etc.). The following standards will be used in determining critical levels:

- Radionuclide concentrations in air, DOE Order 5480.1b Chapter XI (DOE 1986)
- Then TLVs (American Conference of Governmental Industrial Hygienists)

*HNU is a trademark of HNU Systems.

- Occupational Safety and Health Standards, 29 CFR 1910.120 (OSHA 1988a)
- National Institute for Occupational Safety and Health (NIOSH) RELs.

5.1 POLYCHLORINATED BIPHENYLS

While polychlorinated biphenyls (PCB) are not known to have been released to 300-FF-1 ponds, PCBs have been detected in soil at concentrations up to approximately 40 p/m. Further, PCBs are nonvolatile and do not constitute an inhalation hazard at concentration levels of 40 p/m in soil. For example, the time-weighted average (TWA) TLV for 54% chlorodiphenyl is 0.5 mg/m^3. Assuming an extremely conservative 8 h average airborne particulate concentration of 10 mg/m^3 and 10 p/m PCBs in soil, the maximum concentration in air may be estimated:

$$\frac{10 \text{ mg soil}}{\text{m}^3 \text{ air}} \times \frac{100 \times 10^{-6} \text{mg PCB}}{\text{mg soil}} = 0.001 \text{ mg/m}^3.$$

While this is substantially below the TWA for inhalation risks, employees must conscientiously observe the protective clothing and personal hygiene guidelines and protective clothing requirements specified in Section 2.1 above and 6.1 below.

5.2 CHROMIUM

Chromium has been detected in the south pond sediments at concentrations of 500 p/m. At this concentration chromium is not expected to be an inhalation hazard. The TWA TLV is 0.05 mg/m^3. Assuming that the entire 500 p/m is hexavalent chromium, the airborne concentrations for chromium may be estimated following the method used for PCBs above.

Again assuming 10 mg soil/m^3 air and 500 p/m hexavalent chrome in soil:

$$\frac{10 \text{ mg soil}}{\text{m}^3 \text{ air}} \times \frac{500 \times 10^{-6} \text{ mg Cr}}{\text{mg soil}} = 0.005 \text{ mg/m}^3.$$

It is expected that the levels of protection determined from monitoring airborne radioactive contamination will provide an adequate level of protection from hexavalent chrome. If environmental sampling indicates higher concentrations than expected, personal air sampling for hexavalent chrome will be conducted as necessary to fully characterize the inhalation hazard. Until actual contamination levels are determined, whenever windblown airborne fugitive dust is visible within the work area, employees within the exclusion zone shall don air-purifying respirators with dust/mist filters. If deemed necessary, work within the exclusion zone which involves disturbing the soil

surface shall temporarily cease, and employees shall leave the exclusion zone and move upwind.

5.3 VOLATILE ORGANIC COMPOUNDS MONITORING

The designated site safety officer shall have an HNU or OVA onsite at all times and will establish 'background readings' upwind of any excavation, spoils pile, borehole, etc. An 11.7 eV probe is required in the HNU to detect methylene chloride. Calibration of the HNU shall be checked daily against 100 p/m isobutylene, or as specified on the individual bottle of calibration gas.

Lamp energy (eV)	Span setting	Acceptable reading (p/m)
9.5	1.0	50-60
10.2	9.8	50-60
11.7	5.0	60-70

The calibration of the Foxboro OVA must be checked daily. The instrument shall read between 8 and 10 p/m on the "1X" scale in response to 9 p/m methane with the 'gas select' setting at 3.0.

Any consistent readings in the breathing zone that are perceptibly above the upwind background level for more than 5 min shall be the action level for donning air purifying respirators equipped with organic vapor acid gas cartridges. Cartridges will be replaced after each day of use or immediately upon any indication of 'break through', whichever is less.

Any readings consistently greater than 5 p/m above background for 10 min or greater than 10 p/m other than for a brief peak, will be the action level for either temporarily discontinuing work, or upgrading the level of respiratory protection to Level B SCBAs or air lines as appropriate. This action level is subject to revision by the site safety officer should conditions warrant such a revision.

5.4 AIRBORNE RADIOACTIVE MATERIALS AND RADIOACTIVE MONITORING

An onsite RPT will monitor airborne radioactive contamination levels and external radiation levels. Action levels will be consistent with DACs (derived air concentrations) and applicable guidelines as specified in the OHP (Operational Health Physics) radiation protection manual.

Appropriate respiratory protection shall be required when conditions are such that the airborne contamination levels may exceed an 8 h DAC (i.e., the presence of high levels of uncontained, loose contamination on exposed surfaces or operations which may raise excessive levels of dust contaminated with airborne radioactive materials, such as excavation and/or drilling under extremely dry conditions).

Specific conditions requiring the use of respiratory protection because of radioactive materials in air will be incorporated into the RWP. If, in the judgment of the RPT, any of these conditions arise, work shall cease until appropriate respiratory protection is provided.

6.0 PERSONAL PROTECTIVE CLOTHING AND RESPIRATORY PROTECTION

The following scheme will be used to designate the required level(s) of personal protective equipment and respiratory protection: the alphabetical designations 'B,' 'C,' and 'D,' shall refer to levels of respiratory protection (i.e., pressure-demand air supplying respirators with escape provisions, air-purifying respirators, and no respiratory protection, respectively). Since potential dermal exposure hazards may independently require a wide variety of personal protective clothing, regardless of an approved level of respiratory protection, the numerical designations '1,' '2,' and '3' will be used to specify the level of protective clothing that is to be employed (i.e., the level of protective equipment can be completely defined by a designation of 'C-2,' 'B-1,' etc., as described below).

6.1 PERSONAL PROTECTIVE EQUIPMENT

The level of personal protective equipment required initially at the site during excavation, drilling, and sampling activities will be D-3 which must include the following:

1. SWPs
2. Steel-toed boots or leather boots
3. Safety glasses or safety goggles
4. Hard hat
5. NBR or neoprene rubber outer gloves where appropriate
6. Leather work gloves where appropriate
7. Inner gloves of polyvinyl chloride (PVC) or latex rubber.

If employees find that there is a likelihood of being splashed with mud or groundwater, the level of protective clothing shall be upgraded to Level D-2 and shall include a waterproof one- or two-piece Saranax* or chemrel suit. Rubber outer gloves shall be worn whenever it is necessary to contact or handle wet soil, groundwater, or any other potentially contaminated implements or materials. The level of protective clothing shall be upgraded to "1" as described below if there is the likelihood of dermal exposure to unknown contaminants or to substances known to be toxic by the dermal exposure route.

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*Saranax is a trademark of The Dow Chemical Company.

Air-purifying respirators shall be immediately available and Level D respiratory protection shall be immediately upgraded to Level C as appropriate, if indicated by real-time conditions, site monitoring and the action levels specified in Section 5.0 above. No changes to the specified levels shall be made without the approval of the site safety officer, the RPT, and the field team leader.

LEVEL D-2 PROTECTION

1. SWPs, surgical gloves, canvas or rubber gloves as appropriate, rubber shoe covers
2. One-piece Tyvek suit or waterproof Saranax or Chemrel suit, as appropriate
3. Steel-toed rubber boots or steel-toed leather boots, as appropriate
4. Outer boot covers (booties)
5. Safety glasses or safety goggles if splash hazard exists
6. Hard hat
7. NBR or Neoprene rubber outer gloves
8. Inner gloves of PVC or latex rubber.

LEVEL C-2 PROTECTION

Level D-2 plus air-purifying respirator.

LEVEL B-2 PROTECTION

Level D-2 plus pressure demand supplied-air respirator. Supplied air must be Grade 'D' or better "breathing quality air."

LEVEL C-1 PROTECTION

1. Hard hat
2. SWPs or inner Tyvek suit
3. Inner gloves of PVC or latex taped to inner Tyvek
4. Hooded one-piece waterproof outer suit (Saranax, chemrel, or PVC)
5. Outer NBR gloves taped to outer suit
6. Solvent-resistant steel-toed rubber boots taped to outer suit
7. Outer boot covers (booties)
8. Full-face air purifying respirator.

LEVEL B-1 PROTECTION

Level C-1 with pressure demand supplied-air respirator in place of full-face air purifying respirator.

6.2 HEAT STRESS

Working in protective clothing can greatly increase the likelihood of heat fatigue, heat exhaustion, and heat stroke, the latter a life-threatening condition. If temperatures at the site are above 65 °F, the wet globe temperature shall be monitored to asses the potential for heat stress. Work/rest periods will be adjusted according to the standards stated in current TLVs (American Conference of Governmental Industrial Hygienists). Sufficient cool water and disposable drinking cups will be provided in the rest area. Engineering controls, such as solar shielding, also will be applied when and where appropriate.

If the wet globe temperature exceeds 77 °F, employees shall use the 'buddy system' to monitor each other's pulse rate at the start of each rest period. If the pulse rate exceeds 110 beats per minute, the employee shall take an oral temperature with a clean disposable colorimetric oral thermometer. If the oral temperature exceeds 99.6 °F, the next work period shall be shortened by one third. The pulse rate and oral temperature shall be monitored again at the beginning of the next rest period. If the oral temperature exceeds 99.6 °F, the work period shall again be shortened by one third, etc., until the oral temperature is below 99.6 °F.

All employees are to be alert to the possibility and symptoms of heat stress. Should any of the following symptoms occur--extreme fatigue, cramps, dizziness, headache, nausea, profuse sweating, pale clammy skin--the employee is to immediately leave the work area, rest, cool off, and drink plenty of cool water. If the symptoms do not subside after a reasonable rest period, the employee shall notify the project supervisor or site safety officer and seek medical assistance.

6.3 HYPOTHERMIA

Working in extreme cold and exposed areas may create a risk of hypothermia. All employees should be alert to the symptoms, which include increasing disorientation and impaired judgement, shivering, weakness, numbness, drowsiness, and low body temperature. Unconsciousness may result if the symptoms are undetected. Should any employee observe such symptoms, escort the victim out of the work area to a vehicle or other heated, protected area. Treat for shock; keep the victim warm and quiet, and seek medical assistance immediately.

7.0 SITE CONTROL

The field team leader, site safety officer and RPT are designated to coordinate access control and security on the site. Special site control measures will be necessary to restrict public access to drilling operations located outside of fenced areas of 300-FF-1. A temporary exclusion zone will be established (a minimum of a 25-ft radius) at each digging or drilling location. The exclusion zone will be clearly marked with radiation zone rope and "Controlled Area" or "Surface Contamination Area" signs. If the exclusion zone is to be established for greater than 90 days, then chain, not rope, will be used. The size and shape of the exclusion zone will be dictated by the types of hazards expected, the climatic conditions, and specific drilling and sampling operations required. The ground surface of the area immediately around the drill hole, the corridors to the command post, and the decontamination area and escape route will be covered with appropriate material to reduce contamination of personnel and equipment. Exclusion zone boundaries will be increased or decreased based upon results of field monitoring, environmental changes, or work technique changes. The site RWP and the contractor's standard operating procedures for radiation protection will also dictate the boundary size and shape. Portable sanitation facilities shall be located outside of the exclusion zone. NO unauthorized person shall be allowed within the exclusion zone and no authorized person shall be allowed within the exclusion zone unless equipped with the required level of personal protective equipment and respiratory protection. All personnel who enter the exclusion zone will be required to go through decontamination procedures (radiological and chemical) before leaving the zone. All team members must be surveyed for radioactive contamination upon leaving the exclusion zone.

The onsite command post and staging area will be established near the exclusion zone on the upwind side, as determined by an onsite windsock, if physically possible. Exact location for the command post is to be determined just before start of work. Vehicle access, availability of utilities (power and telephone), wind direction, and proximity to sample locations should be considered in establishing command post location.

8.0 DECONTAMINATION PROCEDURES

Remedial investigation activities will require intrusion into areas of known chemical and radiological contamination. Consequently, it is likely that personnel and equipment will be contaminated with hazardous chemical and radiological substances.

During drilling and sampling activities at the site, field workers may become contaminated in various ways, many of which are not readily apparent to the individual. Potential sources of contamination include, but are not limited to, airborne vapors, gases, dust, mists and aerosols; splashes and

spills; walking through contaminated areas; and handling contaminated equipment. All personnel who enter the exclusion zone will be required to go through decontamination procedures upon leaving the zone. Decontamination areas shall be located upwind of the work area (based on the recorded predominant wind direction) and shall be sufficiently removed from the work site, so as to allow for errant wind gusts, which may occassionally blow in from the work site. The procedures discussed below are intended to be compatible with procedures specified in the Environmental Investigation Instruction (EII) for decontamination.

Decontamination procedures shall be consistent with Level B and Level C decontamination protocol. It is anticipated that most of the decontamination work will require the following equipment and facilities:

1. Decontamination garbage/dirty equipment bags
2. Decontamination pad/corridor cover (kraft paper)
3. Emergency response pressurized water tank with wand and adjustable spray nozzle
4. Bagging and taping material
5. Emergency water deluge and eyewash bottles
6. Detergent, brush, and bucket
7. Barrels
8. Step out pads
9. Sponges, wipes, and rags
10. Tables and stands.

Specific decontamination procedures will be provided in PJSPs.

8.1 PERSONNEL DECONTAMINATION

All personnel who access the exclusion and contamination reduction zones of the project will process through decontamination at the end of any given work shift. A decontamination corridor will be established within the exclusion zone for each task of the campaign. Clothing that is disposable will be removed in such a manner that outer layers are removed first and placed in sealed containers. Nondisposable clothing such as SWPs that can be cleaned will be removed, bagged, and sent to the laundry. All wash liquids used for decontamination purposes must be properly disposed of per applicable state and/or federal regulations. After removing outer protective clothing, each team member must be surveyed by qualified and authorized personnel before proceeding to an uncontrolled area. If radioactive contamination is detected, the HPT shall be notified and the individual involved shall be escorted to an appropriate decontamination area by the HPT. At the HPT's direction, nasal smears may be taken for counting and/or analysis. Health Physics Dosimetry shall also be notified, and the determination for further bioassay, if needed, will be made at that time.

8.2 EQUIPMENT DECONTAMINATION

Equipment decontamination methods will generally consist of washing or steam cleaning with a detergent/water or other decontamination solution, as specified in the Field Sampling Plan (FSP). Rinsing with a diluted nitric acid solution may be necessary to remove metal oxides and hydroxides. Field contamination of drilling equipment, where applicable, shall be performed within impoundments in the decontamination zone to ensure that all wash liquids are captured. All wash liquids used for decontamination purposes must be properly disposed of per applicable state and/or federal regulations.

Downhole drilling equipment shall be decontaminated before use on another borehole and/or as required to assure the safety of personnel and prevent cross contamination of samples.

Equipment which is radiologically contaminated beyond the limits specified in the RWP shall not be decontaminated in the field. Such equipment shall be transported to the 2705-T Building for decontamination before reuse.

8.3 SAMPLING AND MONITORING EQUIPMENT

All possible measures should be taken by personnel to prevent or limit the contamination of any sampling and monitoring equipment used. Sampling devices will become contaminated. In general, air monitoring instruments will not be contaminated by chemicals unless splashed or set down on contaminated areas. Any delicate instrument that cannot be easily decontaminated should be protected while it is being used by placing it in a bag and using tape to secure the bag around the instrument. Openings in the bag can be made for sample intake, electrical connections, etc. Personnel performing field maintenance procedures on air monitoring instruments should be aware of the fact that instruments may become contaminated internally if air containing high concentrations of radioactive particulate is drawn through the instrument.

Foreign material, which collects within the probe tip and on the face of the lamp on the HNU photoionization detector, may be chemically or radioactively contaminated and should be handled appropriately when disassembling the probe or cleaning the lamp. A similar situation exists with the readout probe and metallic frit filters in the sampling line of the OVA. All instruments and equipment must be surveyed for the purpose of radiological contamination control before removal from the exclusion zone. Items with detectable levels of contamination must be controlled as radioactive material or controlled or regulated equipment.

Sampling devices require special cleaning and decontamination [see Sampling and Analysis Plan (SAP)]. When appropriate, disposable sampling equipment will be used to eliminate the need for decontamination liquids.

8.4 RESPIRATORY PROTECTION EQUIPMENT

Respiratory protection will be used based upon the level of protection required for each job. There is a high potential for hoses to become contaminated; therefore, where possible and necessary, hoses should be covered with plastic. If grossly contaminated, they may have to be discarded. Cleaning and decontamination of face pieces will be performed by the mask cleaning station (i.e., Hanford Laundry). Maintenance of special respiratory protection equipment (i.e., SKA PAK*) is performed by Personal Protective Equipment Unit in MO-412, 200 West Area.

8.5 HEAVY EQUIPMENT

All possible measures will be taken to prevent or limit the contamination of heavy equipment. Those parts of drilling equipment that become contaminated, such as auger flights, will be double bagged and taken to the 2705-T Building for decontamination before reuse to minimize personnel contamination potential and cross contamination of samples between boreholes.

9.0 CONTINGENCY AND EMERGENCY RESPONSE PLANS

The following procedures have been established to deal with emergency situations that might occur during drilling or sampling operations. As a general rule, in the event of an unanticipated, potentially hazardous situation as indicated by instrument readings, visible contamination, unusual or excessive odors, etc., team members shall temporarily cease operations and move upwind to a predesignated safe area. Any individual leaving a radiologically controlled area needs to be released by an HPT, even if that individual is going to the First Aid Station or the hospital. If this cannot be accomplished, for whatever reason, the HPT must accompany the individual to the First Aid Station or the hospital.

A two-way radio will be operational and be manned by the field team leader to maintain contact with the team's base station. Personnel in the exclusion zone will maintain line-of-sight with the field team leader. Any failure of radio communications will require evaluation of whether personnel shall leave the exclusion zone. Communications from rig to rig or site to site will also be provided in order that the site safety officer or field team leader can respond accordingly. In addition, a series of three (3) one-second horn blasts from a truck in the support zone is the emergency signal for all personnel to the leave the exclusion zone.

*SKA PAK is a trademark of Figgie International.

The following standard hand signals will be used in all cases:

• Hand gripping throat	Out of air, can't breathe
• Grip partner's wrist or both hands around waist	Leave area immediately
• Hands on top of head	Need assistance
• Thumbs up	OK, affirmative
• Thumbs down	No, negative.

The site safety officer is directly responsible for providing safety recommendations on the site to the site emergency coordinator. The site emergency coordinator for the 300-FF-1 drilling operations will be the field team leader. The site safety officer will call the Hanford Fire Department before commencing work on each site and will provide them with a location map of the work site to expedite their finding of the location, if necessary.

The site emergency coordinator will be responsible for the evacuation, emergency treatment, emergency transport of field personnel as necessary, and for the notification of the appropriate Hanford Site facility emergency response units and management staff.

Emergency communications will be maintained during all onsite field activities by two-way radio contact. If an emergency occurs, such as fire or explosion, all onsite personnel should exit the site in an upwind direction and assemble in a predesignated area. All emergency response actions for each job will be covered in the tail gate meeting with the PJSP. If an onsite injury occurs, team members should employ the following procedures.

9.1 PROCEDURE FOR PERSONNEL INJURED IN THE EXCLUSION ZONE

If able, the injured person should proceed through decontamination to the nearest available source of first aid. If the injured party is extremely muddy, remove outer garments and if necessary, wash the injured area with soap and water.

Upon notification of a serious injury in the exclusion zone, the emergency signal of three one-second horn blasts will be sounded. All site personnel will assemble at the decontamination line. The site safety officer and field team leader should evaluate the nature of the injury and the extent of decontamination possible before moving the injured person to the support area. No person should reenter the exclusion zone until the cause of the injury is determined and measures taken to prevent recurrence.

If the victim is unable to walk, but is conscious and there is no evidence of spinal injury, escort or transport the injured person through decontamination procedures to the nearest first aid facility (Figure 1). If the

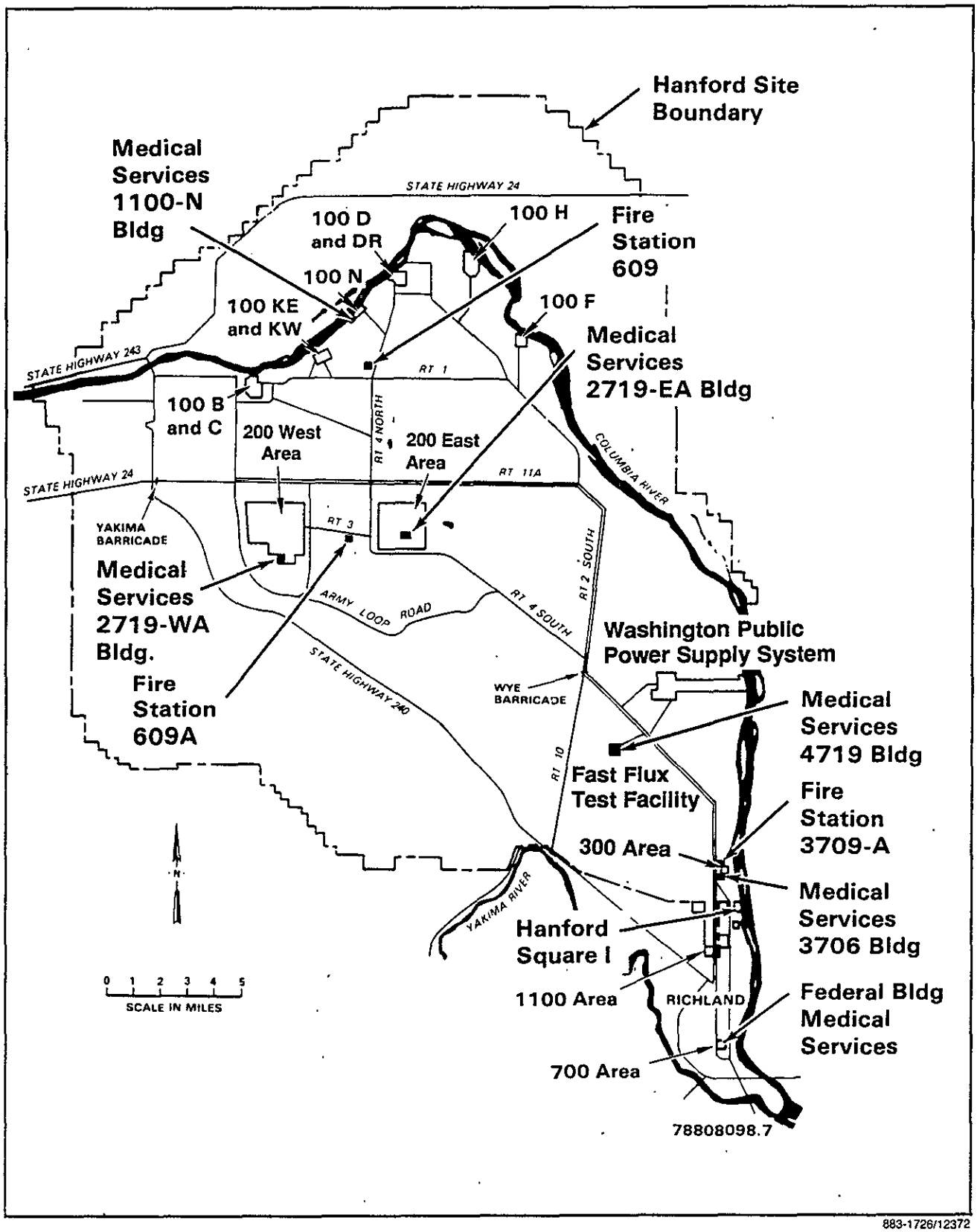

Figure 1. Location of Hanford Emergency Facilities.

victim cannot be moved without causing further injury, such as in the case of a severe compound fracture, take necessary emergency steps to control bleeding and immediately call for medical assistance as discussed below.

If the victim is unconscious or unable to move, Do Not Move the Injured Person Unless Absolutely Necessary to Save the Injured Person's Life, until the nature of the injury has been determined.

If there is any evidence of spinal injury do not move the victim unless absolutely necessary to save the victim's life. Administer rescue breathing if the victim is not breathing, control severe bleeding and immediately contact the Hanford Patrol by phone (811) or radio (Channel 2).

Should any employee exhibit erratic behavior, or fall unconscious because of apparent heat stroke, the emergency three horn blasts shall be sounded and the field team leader shall immediately call for an ambulance. All personnel within the exclusion zone shall immediately proceed through decontamination with the victim, as follows:

1. Remove victim's outer protective clothing and discard
2. Remove own outer protective clothing and discard
3. Remove victim's inner protective clothing and discard
4. Remove own inner protective clothing and discard
5. Place victim in shade, open victim's clothing and cool the victim by wetting and fanning. Place ice pack (if available) behind neck and/or on forehead of victim.

Remember, heat stroke is an immediately life-threatening situation. Treat the situation accordingly.

In extremely cold or exposed working situations, if an employee shows increasing disorientation or any other symptoms of hypothermia, follow the basic emergency procedures for heat stroke, but remove the victim to a heated vehicle or other protected area. Keep the victim warm and quiet and summon an ambulance immediately.

9.2 PROCEDURE FOR PERSONAL INJURY IN THE SUPPORT AREA

Upon notification of an injury in the support area, the field team leader and the site safety officer will assess the nature of the injury. If the cause of the injury or loss of the injured person does not affect the performance or safety of site personnel, operations may continue, with initiation of first aid and summoning of medical assistance as discussed above. If the injury increases the risk to others, the emergency signal of three one-second horn blasts will be sounded and all site personnel shall move to the decontamination area for further instructions. Activities onsite will stop until the hazardous condition (if any) is evaluated and reduced to an acceptable level.

9.3 PROCEDURES FOR FIRE AND EXPLOSIONS

The dry chemical fire extinguishers, which are required on all field vehicles, are effective for fires involving ordinary combustibles such as wood, grass, etc.; flammable liquids; and electrical equipment. They are appropriate for small, localized fires such as a drum of burning refuse, small burning gasoline spill, vehicle engine fire, etc. No attempt should be made to use the provided extinguishers for well-established fires or large areas/volumes of flammable liquids.

In the case of fire, prevention is the best contingency plan. Smoking in the exclusion zone is strictly prohibited and smoking materials, where permitted, should be extinguished with care.

In the event of a fire or explosion, the following steps are to be taken.

1. Immediately notify site emergency personnel and the local fire department by contacting the Hanford Patrol by phone (811) or by radio (station 1) to relay message.

2. If the situation can be readily controlled with available resources <u>without jeopardizing personal health and safety or the health and safety of other site personnel</u>, take immediate action to do so.

If the fire can not be readily controlled, take the following steps.

1. Isolate the fire to prevent spreading, if possible.

2. Clear the area of all personnel working in the immediate vicinity.

3. Upon notification of a fire or explosion on site, the emergency signal of three one-second horn blasts will be sounded and all site personnel will assemble upwind of the fire at the decontamination line. The fire department will be called and all personnel will move to a safe distance from the involved area. Again, based on the individual tail gate meetings, a decision to send all personnel immediately out of the exclusion area may be an option.

9.4 PROCEDURE FOR PERSONAL PROTECTIVE EQUIPMENT FAILURE

If any site worker experiences a failure or alteration of protective equipment that may jeopardize the level of protection provided by the equipment, that person and that person's buddy shall immediately proceed through decontamination and leave the exclusion zone. Reentry shall not be permitted until the equipment has been repaired or replaced, or the conditions leading to the problem are adequately evaluated and corrected.

9.5 PROCEDURE FOR FAILURE OF OTHER EQUIPMENT

If onsite monitoring equipment fails to operate properly, the field team leader and site safety officer shall be notified and then determine the effect of the failure on continuing operations. If the failure may compromise health and safety procedures or jeopardize the safety of personnel, all personnel shall leave the exclusion zone until the equipment is repaired or replaced.

9.6 EMERGENCY ESCAPE ROUTES

In the event that an emergency situation prevents exiting the exclusion zone by way of the decontamination area, exit the exclusion zone in any direction, preferably upwind, avoiding any barriers.

9.7 RESPONSE ACTION TO CHEMICAL EXPOSURE

If an injury to a worker is chemical in nature, the following first aid procedures are to be instituted as soon as possible.

- Eye exposure--if contaminated solid or liquid gets into the eyes, wash eyes at the site immediately with an emergency eye wash bottle. Proceed to the emergency eye wash station, which will be provided in the field, and wash eyes using large amounts of water. Obtain medical attention immediately by calling 811.

- Inhalation exposure--If a person breathes in large amounts of organic vapor, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. If breathing and heart have both stopped, perform cardiopulmonary resuscitation (CPR). Obtain medical attention as soon as possible by calling 811. Keep the person warm and at rest until medical help arrives.

- Skin exposure--if contaminated solid or liquid gets on the skin, promptly use the deluge water unit, then wash contaminated skin using soap or mild detergent and water. If solids or liquid penetrate through the protective clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Obtain medical attention immediately, if symptoms warrant, by calling 811. If a person is contaminated by radioactive material, first aid will be conducted by normal skin decontamination procedures.

- Ingestion--if contaminated solid or liquid has been swallowed, immediately obtain medical attention and call the Poison Control Center. If 811 is not notified in any of the above situations, the person should be taken to the nearest first aid station.

9.8 EMERGENCY TELEPHONE NUMBERS

Local Resources:	Hanford Emergency Response Team	375-2400
Ambulance:	Hanford Fire Department will dispatch the ambulance	375-2400
Hospital:	Kadlec Hospital, Richland	946-4611
Police (Local or State):	Hanford Patrol	375-2400
Fire Department:	Hanford Fire Department	375-2400
Poison Control Center:	800-572-5842	

EMERGENCY CONTACTS

Industrial Safety:	P.A. Wright (PNL)/ H.N. Bowers (WHC)	376-1634/ 373-3948
Health Physics:	J.R. Berry (PNL)/ J.B. Levine (WHC)	376-3057/ 373-1333
Field Team Leaders:	PNL or Westinghouse Hanford	
Environmental Reporting:	W.J. Bjorklund/TBD	376-4781/TBD

10.0 REFERENCES

DOE, 1986, *Environment, Safety & Health Program for DOE Operations*, DOE Order 5480.1b, U.S. Department of Energy, Washington, D.C.

OSHA, 1988a, *Occupational Safety and Health Standards*, Title 29, Code of Federal Regulations, Part 1910, Occupational Safety and Health Administration, Washington, D.C.

OSHA, 1988b, *Safety and Health Regulations for Construction*, Title 29, Code of Federal Regulations, Part 1926, Occupational Safety and Health Administration, Washington, D.C.

PNL, 1988, *Environmental Monitoring at Hanford for 1987*, PNL-6464, Pacific Northwest Laboratory, Richland, Washington.

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ATTACHMENT 3

PROJECT MANAGEMENT PLAN

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1.0 INTRODUCTION

The purpose of this Project Management Plan (PMP) is to define the administrative and institutional tasks necessary to support Resource Conservation and Recovery Act (RCRA) remedial investigation/feasibility study (RI/FS) activities in the 300-FF-1 operable unit at the Hanford Site. This plan defines the responsibilities of the various participants, the organizational structure, and the project tracking and reporting procedures.

The U.S. Environmental Protection Agency (EPA), Washington Department of Ecology (Ecology), and the U.S. Department of Energy (DOE) have entered into an agreement and consent order for remedial and corrective action on the Hanford Site. An action plan, which implements this agreement, defines EPA and Ecology regulatory integration and the methods and processes to be used to implement the agreement. This PMP is in accordance with the provisions of the action plan.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 INTERFACE OF REGULATORY AUTHORITIES AND THE U.S. DEPARTMENT OF ENERGY

The 300-FF-1 operable unit consists of active and inactive waste management units to be remedied under CERCLA. The EPA has been designated as the lead regulatory agency as defined in the agreement. Accordingly, EPA is responsible for overseeing remedial activity at this unit and ensuring that the applicable authorities of both EPA and Ecology are applied. The specific responsibilities of Ecology, EPA and DOE are detailed in the action plan.

2.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization is shown on Figure 1. The following sections describe the responsibilities of the individuals shown on this figure.

Project Managers. The EPA, DOE, and Ecology each have designated one individual as project manager, who will serve as the primary point of contact for all activities to be carried out under the agreement and action plan. The responsibilities of the project managers are given in Section 4.1 of the action plan.

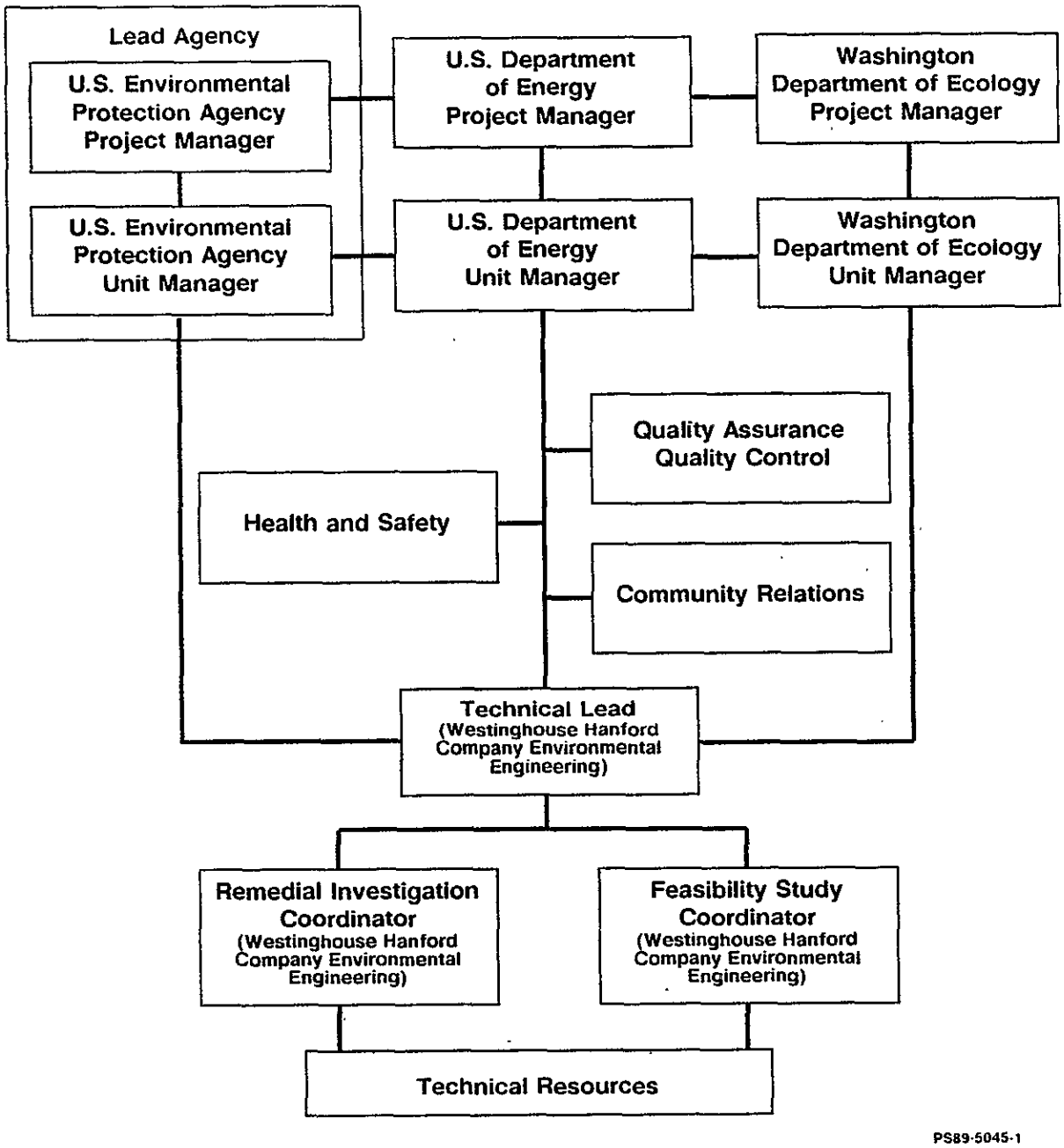

Figure 1. Project Organization.

Unit Managers. The unit manager from EPA will serve as the lead unit manager. The role of the unit manager is described in Section 4.2 of the action plan.

Quality Assurance/Quality Control Coordinator. The quality coordinator is responsible for coordinating and/or oversight of performance to the quality assurance project plan (QAPP) requirements by means of internal auditing and surveillance techniques. The quality assurance officer retains the necessary organizational independence and authority to identify conditions adverse to quality and to inform the technical lead of needed corrective action.

Health and Safety Officer (Environmental Division/Environmental Field Services). The health and safety officer is responsible for determining potential health and safety hazards from radioactive, volatile, and/or toxic compounds during sample handling and sampling decontamination activities and has the responsibility and authority to halt field activities due to unacceptable health and safety hazards.

Community Relations Coordinator. The community relations coordinator will be responsible for coordinating all community relations activities. Since there will be a single community relations plan, to be developed for and implemented by DOE, the community relations coordinator will be responsible for community relations over all 78 operable units at the Hanford Site.

Technical Lead. The technical lead will be a designated person within the Westinghouse Hanford Environmental Engineering Group. The responsibilities of the technical lead will be to plan, authorize, and control work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound.

Remedial Investigation Coordinator. The RI coordinator will be responsible for coordinating all activities related to Phases I and II of the RI, including data collection, analysis, and reporting. The RI coordinator will be from the Westinghouse Hanford Environmental Engineering Group, and will be responsible for keeping the technical lead informed on the RI work status and any problems that may arise.

Feasibility Study Coordinator. The FS coordinator will be responsible for coordinating all activities related to Phases I, II, and III of the FS, including data collection, analysis, and reporting. The FS coordinator will be from the Westinghouse Hanford Environmental Engineering Group, and will be responsible for keeping the technical lead informed on the FS work status and any problems that may arise.

Remedial Investigation Technical Resources. The various technical resources responsible for performing the RI are shown on Figure 2. These resources will be responsible for performing data collection, analysis, and reporting, for the technical activities related to the RI. Figures 3 through 6 show detailed organizational structure for specific RI tasks.

Technical Resources		
Subject/Activity	**Remedial Investigation**	**Feasibility Study**
Hydrogeology and geology	Westinghouse Hanford[a]/Geosciences PNL[b]/Earth and Environmental Sciences Center	Westinghouse Hanford/ Geosciences
Toxicology and risk/ endangerment assessment	Westinghouse Hanford/ Environmental Technology PNL/Earth and Environmental Sciences Center PNL/Life Sciences Center	Westinghouse Hanford/ Environmental Technology
Environmental chemistry	Westinghouse Hanford/Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/ Geosciences
Geophysics and field testing	Westinghouse Hanford/Geosciences (Planning) Environmental Field Services	N/A
Geotechnical and civil engineering	N/A	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Groundwater treatment engineering	N/A	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Waste stabilization and treatment	N/A	Westinghouse Hanford/ Environmental Engineering and PNL/Waste Technology Center
Surveying	Kaiser Engineers	N/A
Soil and water sampling and analysis	Westinghouse Hanford/Environmental Engineering Environmental Field Services PNL/Earth and Environmental Sciences Center PNL/Materials and Chemical Sciences Center U.S. Testing	N/A
Drilling and well installation	Westinghouse Hanford/Geosciences Environmental Field Services Kaiser Engineers	N/A
Radiation monitoring	Westinghouse Hanford/Operational Health Physics	N/A

NOTE: Qualified subcontractors may conduct all or portions of the RI/FS.
[a]Westinghouse Hanford = Westinghouse Hanford Company.
[b]PNL = Pacific Northwest Laboratory.

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Figure 2. Technical Resources for Conducting Remedial Investigations/ Feasibility Studies.

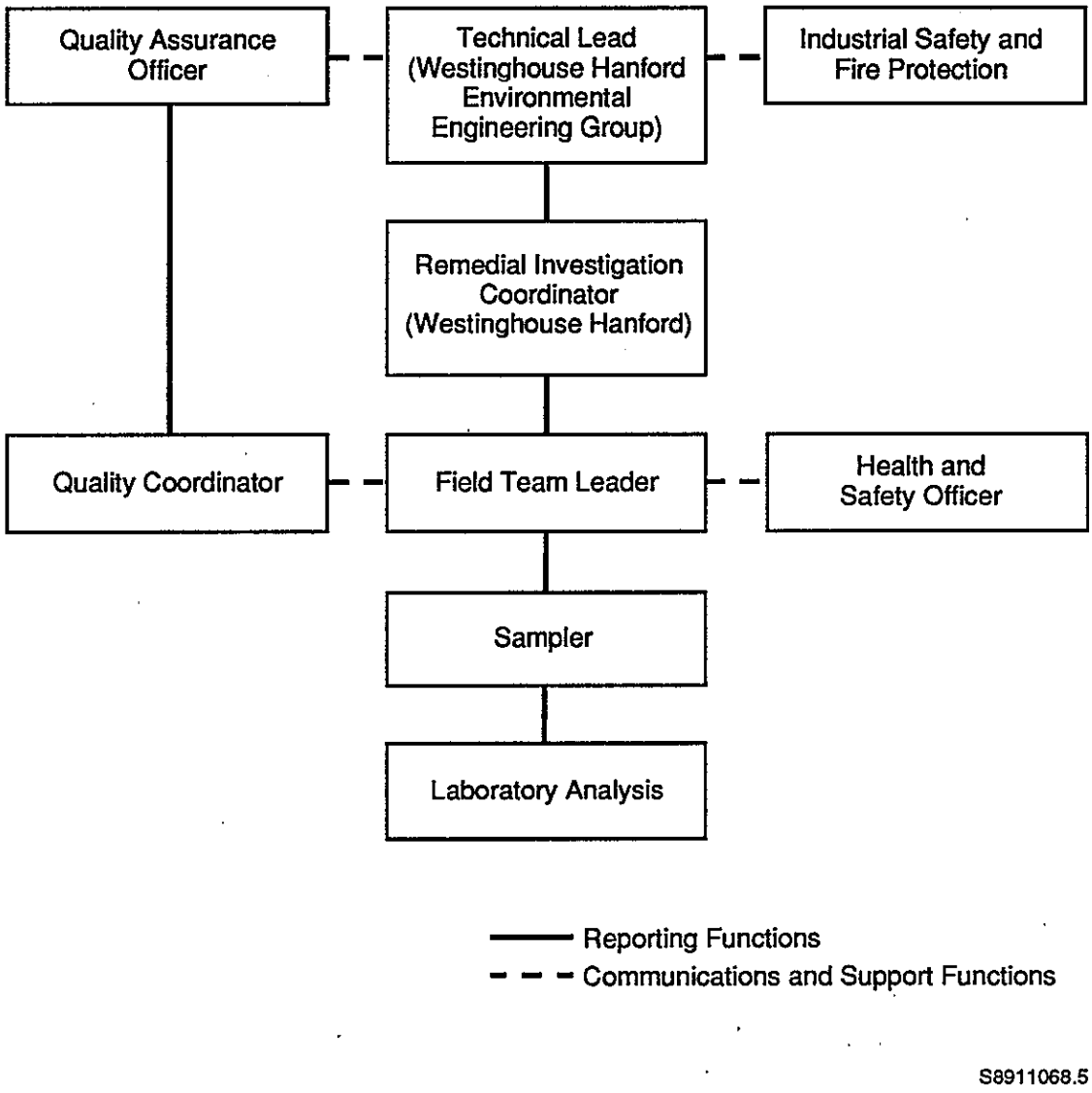

Figure 3. Soil Sampling Team.

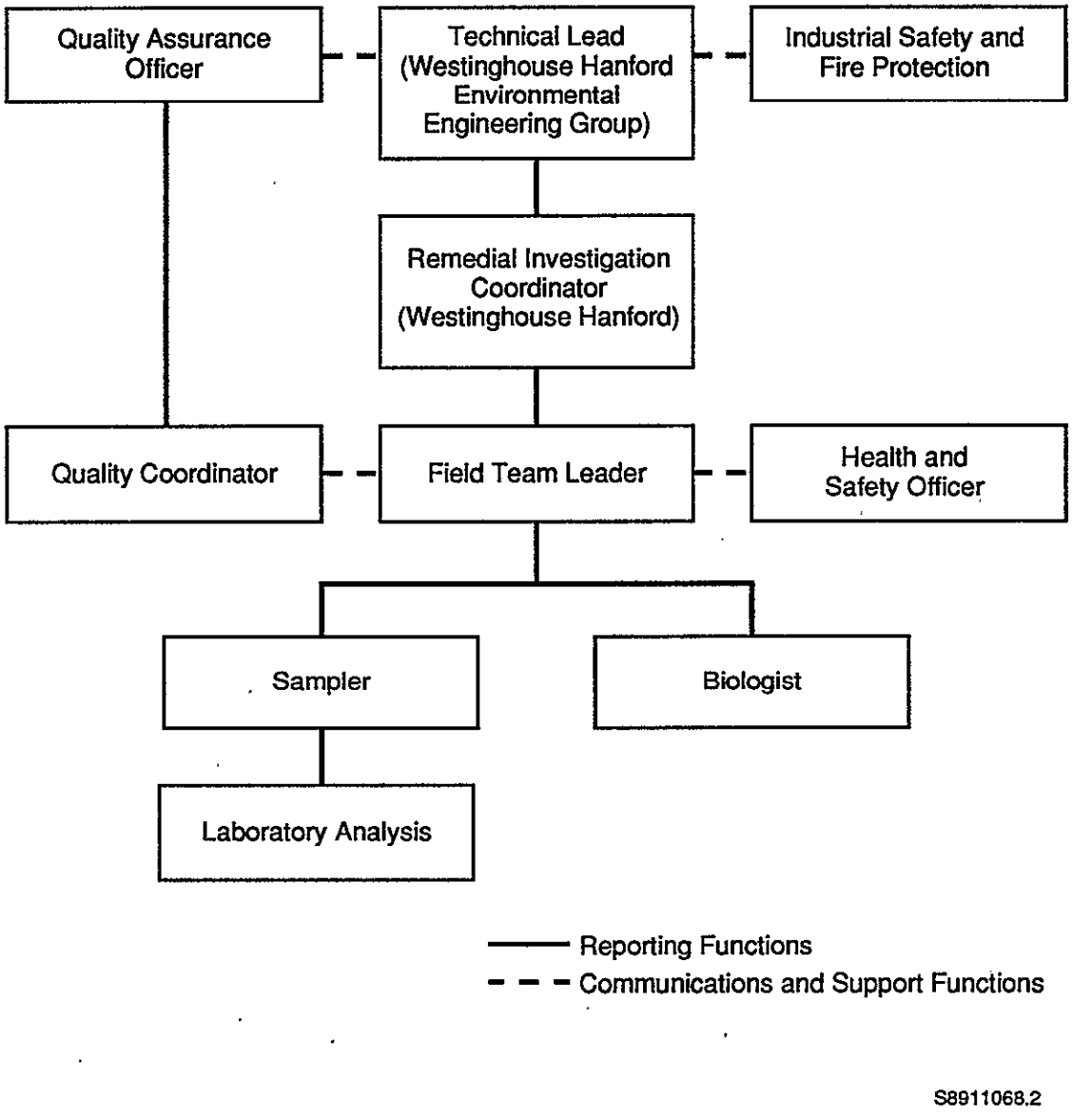

Figure 4. Biological Sampling Team.

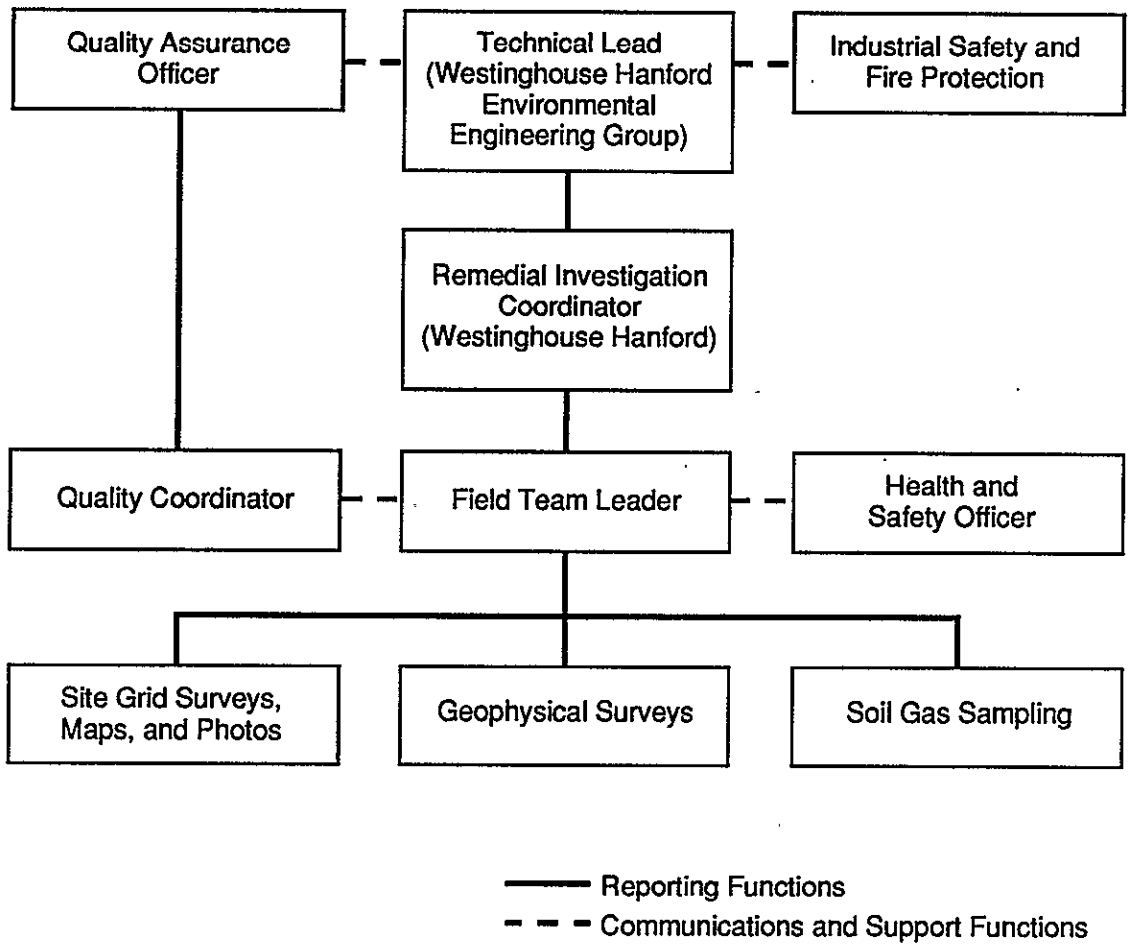

Figure 5. Physical and Geophysical Survey Team.

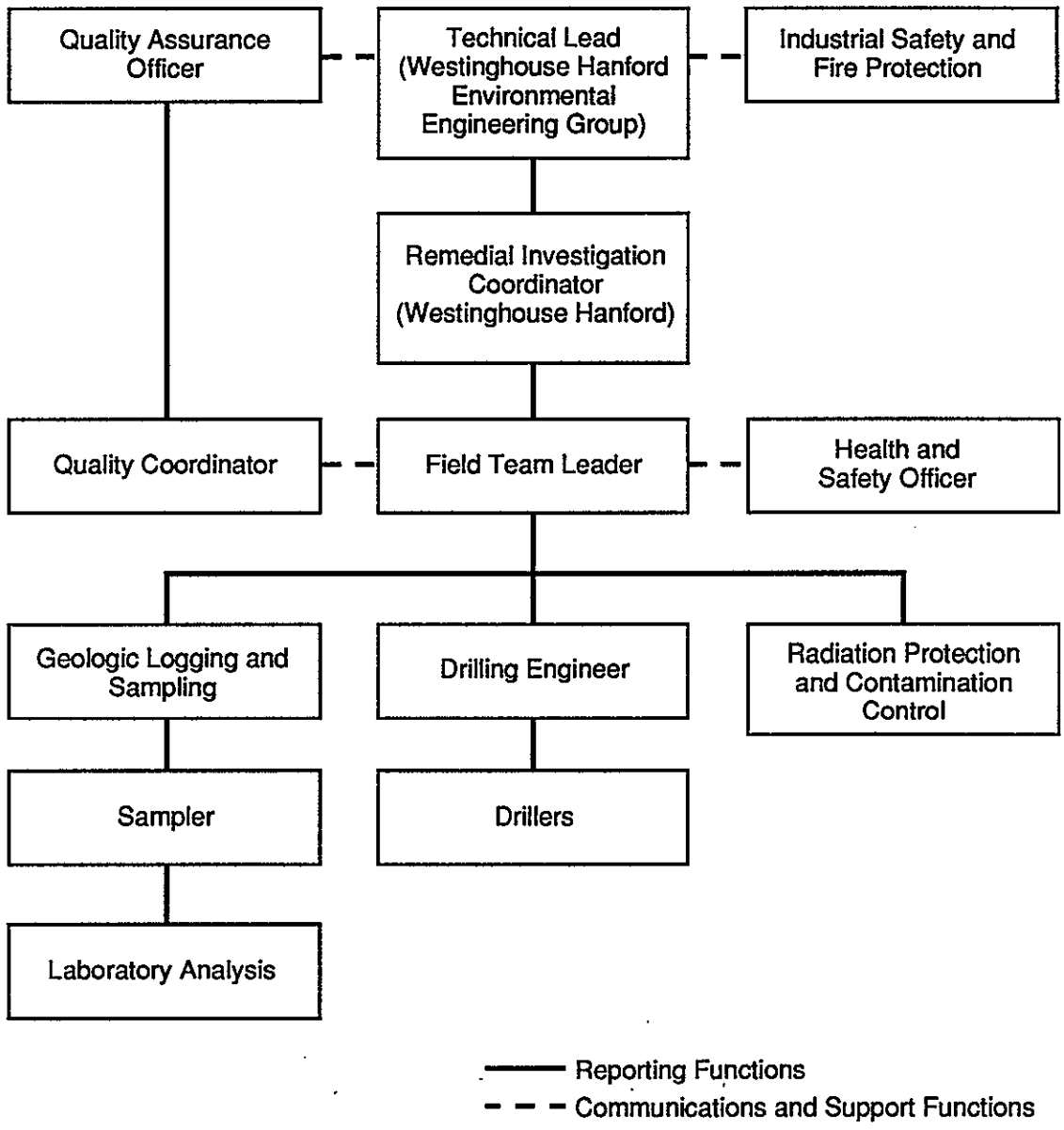

Figure 6. Vadose Zone Drilling and Sampling Team.

Internal and external work orders and subcontractor task orders will be written by the RI coordinator to use these technical resources, which are under the control of the technical lead. Statements of work will be provided that will include a discussion of authority and responsibility, a schedule with clearly defined milestones, and a task description including specific requirements. Each group will keep the RI coordinator informed on the RI work status performed by that group and of any problems that may arise.

Feasibility Study Technical Resources. The various technical resources responsible for performing the FS are also shown on Figure 2. These resources will be responsible for identifying and screening remedial alternatives, and for detailed evaluation of selected alternatives. Work teams reporting to the technical lead for various phases and types of work are shown in Figures 3 through 6.

Internal and external work orders and subcontractor task orders will be written by the FS coordinator to use these technical resources, which are under the control of the technical lead. Statements of work will be provided that will include a discussion of authority and responsibility, a schedule with clearly defined milestones, and a task description including specific requirements. Each group will keep the FS coordinator informed on the FS work status performed by that group and of any problems that may arise.

3.0 REPORTING REQUIREMENTS

All RI/FS plans and reports will be categorized as either primary or secondary documents as described by Section 9.1 of the action plan. The process for document review and comment is covered by the action plan Section 9.2. Revision, should it become necessary after finalization of any documents, is covered by Section 9.3 of the action plan. Changes in the work schedule, as well as minor field changes can be made without having to process a formal revision. The process for making these changes is covered by the action plan in Section 12.0. Administrative Records, which must be maintained to support the Hanford Site RCRA permit modification, are described in Section 9.4 of the action plan.

4.0 FINANCIAL AND PROJECT TRACKING REQUIREMENTS

4.1 MANAGEMENT CONTROL

Westinghouse Hanford will be responsible to plan and control activities and to provide effective technical, cost, and schedule baseline managements. The Westinghouse Hanford Management Control System (MCS) will be used for effective planning and control practices. The MCS meets the requirements of DOE Order 4700.1, *Project Management System* (DOE 1987) and DOE Order 2250.1B,

Cost and Schedule Control Systems Criteria for Contract Performance Measurement (DOE 1985). The primary goals of the Westinghouse Hanford MCS are to provide methods for planning, authorizing, and controlling work so that it can be completed on schedule and within budget and to ensure that all planning and work performance activities are technically sound and in conformance with management and quality requirements.

The work plan schedule and major milestones are described in Section 6.0 of the 300-FF-1 Operable Unit Work Plan. The work plan schedule will be the primary vehicle for the unit and technical leads to track progress. The work plan schedule must be consistent with the work schedule contained in the action plan for implementation of the agreement.

The work plan schedule will be updated at least annually, with the primary purpose to expand the new current fiscal year and follow-on year. In addition, any approved schedule changes (see Section 12.0 of the action plan for formal change control system) would be incorporated at this time, if not previously incorporated. This update will be performed in the fourth quarter of the previous fiscal year (e.g., July to September) for the upcoming current fiscal year. The work schedule can be revised at any time during the year if the need arises, but would be restricted to major changes that would not be suitable for the change control process.

4.2 MEETINGS AND PROGRESS REPORTS

Both project and unit managers must meet periodically to discuss progress, review plans and address any issues that have arisen. The project managers meeting will take place at least quarterly and is discussed in Section 8.1 of the action plan. The unit managers meeting will take place at least monthly. Details of the unit managers meetings are given in Section 8.2 of the action plan. The DOE shall prepare and issue a quarterly progress report to EPA and Ecology. Details of this report are given in Section 8.2 of the action plan.

5.0 REFERENCES

DOE, 1985, *Cost and Schedule Control Systems Criteria for Contract Performance Measurement*, DOE Order 2250.1B, U.S. Department of Energy, Washington, D.C.

DOE, 1987, *Project Management System*, DOE Order 4700.1, U.S. Department of Energy, Washington, D.C.

ATTACHMENT 4

DATA MANAGEMENT PLAN

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ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CMS	Corrective Measures Study
DMP	Data Management Plan
DOE	U.S. Department of Energy
Ecology	State of Washington Department of Ecology
EHPSS	Environmental Health and Pesticide Services Section
EDMC	Environmental Data Management Center
EII	Environmental Investigation Instruction
EIMP	Environmental Information Management Plan
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
HEHF	Hanford Environmental Health Foundation
HEIS	Hanford Environmental Information System
HMS	Hanford Meteorological Station
HSP	Health and Safety Plan
IRM	Information Resource Management
KEH	Kaiser Engineers Hanford
OSM	Office of Sample Management
PNL	Pacific Northwest Laboratory
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act of 1976
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
Westinghouse Hanford	Westinghouse Hanford Company
WIDS	Waste Information Data System

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1.0 INTRODUCTION AND OBJECTIVES

1.1 INTRODUCTION

An extensive amount of data will be generated over the next several years in connection with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) Remedial Investigation/Feasibility Study (RI/FS) process for the 300-FF-1 Operable Unit. The quality of these data is extremely important to the full remediation of the Operable Unit as agreed upon by the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology), and interested parties.

This Data Management Plan (DMP) addresses management of data generated from the 300-FF-1 Operable Unit Work Plan, Field Sampling Plan, Quality Assurance Project Plan, and Health and Safety Plan activities.

Development of a comprehensive plan for the management of all environmental data generated at the Hanford Site is underway. The *Environmental Information Management Plan* (EIMP) (Steward 1989), released in March 1989, describes activities in the Environmental Data Management Center (EDMC) and provides a description of the long-range goals for management of scientific and technical data. The EIMP is currently under review and is expected to be revised and expanded in fiscal year 1990.

1.2 OBJECTIVES

This DMP describes the process for accessing and tracking the receipt, storage, and control of validated data, records, documents, correspondence, and other information associated with the 300-FF-1 RI/FS.

This DMP addresses the following itemizations:

- Types of data to be collected
- Plans for managing data
- Organizations controlling data
- Databases used to store the data
- Environmental Information Management Plan
- Hanford Environmental Information System (HEIS).

2.0 TYPES OF DATA

2.1 DATA TYPES

General data types include field logbooks, verified sample analyses, historic data, chain-of-custody forms, quality assurance/quality control (QA/QC) data, reports, memoranda/meeting minutes, telephone conference memoranda, archived samples, raw sample data, videotapes, magnetic media, paper tapes, personnel training records, exposure records, respiratory protection fitting records, personnel health and safety records, and compliance and regulatory data. Table 1 lists the data types by work plan task. Table 2 lists data types and procedures for health and safety planning, as well as for regulatory compliance activities.

2.2 DATA COLLECTION

Data will be collected according to the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP). Table 1 lists controlling procedures for data collection and handling before turnover of responsibility to the organization responsible for data storage. All procedures for data collection will be approved in compliance with applicable Westinghouse Hanford Company (Westinghouse Hanford) procedures. Where Westinghouse Hanford Environmental Investigations Instructions (EII) are referenced, they will be the latest approved versions from the *Environmental Investigations and Site Characterizations Manual* (WHC 1988).

2.3 DATA STORAGE AND ACCESS

Data will be handled and stored according to procedures approved in compliance with applicable Westinghouse Hanford procedures. Data controlling organizations are listed in Table 1 and Table 2. The EDMC is the central file collection and processing facility. All files entering the EDMC will be indexed, recorded and placed into safe and secure storage. Data designated for placement into the Administrative Record will be copied, placed into the Hanford Site Administrative Record File, and distributed by the EDMC to the user community.

The following data types will reside in locations other than the EDMC.

Data type	Data location
• QA/QC laboratory data	Office of Sample Management (Westinghouse Hanford Company)
• Archived sample index	Office of Sample Management (Westinghouse Hanford Company)
• Archived samples	Laboratory performing analyses (see the archived sample index)

Table 1. Management of Site Characterization Data. (sheet 1 of 7)

Work plan task	Data type	Controlling organization		
		Procedure	EDMC[a]	Others
PHASE I -- REMEDIAL INVESTIGATION:				
Task 1 - Source Investigation				
Subtask 1a - Source Data Compilation	Historic: Engineering plans, reports	EII 1.6	X	
	Telephone conservations	EII 1.6	X	
	Memoranda/minutes	EII 1.6	X	
Subtask 1b - Ground-penetrating Radar Survey	Logbooks (see NOTE)	EII 1.5	X	
	Magnetic media	EII 1.6	X	
	Chart recordings	EII 1.6	X	
Subtask 1c - Electromagnetic Survey	Logbooks	EII 1.5	X	
	Magnetic media	EII 1.6	X	
	Chart recordings	EII 1.6	X	
Subtask 1d - Topographic Base Map Development	Aerial photographs	EII 1.6	X	
	Logbooks	EII 1.5	X	
	Magnetic media	EII 1.6	X	
	Maps	EII 1.6	X	
Subtask 1e - "In-Pipe" Remote Inspection Survey	Logbooks	EII 1.5	X	
Subtask 1f - Soil Gas Survey	Logbooks	EII 1.5	X	
Subtask 1g - Nonhazardous Source Characterization	Logbooks	EII 1.5	X	
	Chain-of-custody forms	EII 5.1	X	
	Quality assurance/quality control			OSM[b]
	Verified sample analyses	EII 1.6	X	
	Archived sample index			OSM
	Magnetic media	EII 1.6	X	

Table 1. Management of Site Characterization Data. (sheet 2 of 7)

Work plan task	Data type	Controlling organization		
		Procedure	EDMC[a]	Others
PHASE I--REMEDIAL INVESTIGATION: (cont)				
Task 2 - Geologic Investigation				
Subtask 2a - Geologic Data Compilation	Technical memos	EII 1.6	X	
Task 3 - Soil Investigation				
Subtask 3a - Surface Radiation Survey	Logbooks	EII 1.5	X	
	Verified results	EII 1.6	X	
	Quality assurance/quality control	EII 1.6	X	
Subtask 3b - Soil Sampling and Analysis	Logbooks	EII 1.5	X	
	Chain-of-custody forms	EII 5.1	X	
	Quality assurance/quality control			OSM
	Verified sample analyses	EII 1.6	X	
	Archived sample index			OSM
	Borehole logs	EII 9.1	X	
	Magnetic media	EII 1.6	X	
Task 4 - Air Investigation				
Subtask 4a - Air Data Compilation	Historic reports	PNL-6509		HMS[c]
	Technical memos	EII 1.6	X	
Subtask 4b - Ambient Air Sampling and Analysis	Logbooks	EII 1.5	X	
	Verified sample analyses	EII 1.6	X	

Table 1. Management of Site Characterization Data. (sheet 3 of 7)

Work plan task	Data type	Controlling organization		
		Procedure	EDMC[a]	Others
PHASE I -- REMEDIAL INVESTIGATION: (cont)				
Task 5 - Terrestrial Biological Investigation				
Subtask 5a - Biological Survey	Logbooks	EII 1.5	X	
	Technical memos	EII 1.6	X	
Subtask 5b - Asparagus Sampling Analyses	Logbooks	EII 1.5	X	
	Chain-of-custody forms	EII 5.1	X	
	Quality assurance/quality control			OSM
	Verified sample analyses	EII 1.6	X	
	Archived sample index			OSM
	Magnetic media	EII 1.6	X	
Task 6 - Data Evaluation				
Subtask 6a - Source Data Evaluation	Technical memos	EII 1.6	X	
Subtask 6b - Geological Data Evaluation	Technical memos	EII 1.6	X	
Subtask 6c - Soil Data Evaluation	Technical memos	EII 1.6	X	
Subtask 6d - Air Data Evaluation	Technical memos	EII 1.6	X	
Subtask 6e - Terrestrial Biological Data Evaluation	Technical memos	EII 1.6	X	
Task 7 - Verification of Contaminant- and Location-Specific Applicable, Relevant and Appropriate Requirements	Technical memos	EII 1.6	X	

Table 1. Management of Site Characterization Data. (sheet 4 of 7)

Work plan task	Data type	Controlling organization		
		Procedure	EDMC[a]	Others
PHASE I -- REMEDIAL INVESTIGATION: (cont)				
Task 8 - Baseline Risk Assessment				
Subtask 8a - Contaminant Identification	Technical memos	EII 1.6	X	
Subtask 8b - Exposure Assessment	Computer models	EII 1.6	X	
	Magnetic media	EII 1.6	X	
	Technical memos	EII 1.6	X	
Subtask 8c - Toxicity Assessment	Technical memos	EII 1.6	X	
Subtask 8d - Risk Characterization	Technical memos	EII 1.6	X	
Task 9 - Phase I Remedial Investigation Report	Report	EII 1.6	X	
PHASE I -- FEASIBILITY STUDY:				
Task 1 - Development of Remedial Action Objectives	Technical memos	EII 1.6	X	
Task 2 - Development of General Response Actions	Technical memos	EII 1.6	X	
Task 3 - Identification of Potential Remedial Technologies	Technical memos	EII 1.6	X	
Task 4 - Evaluation of Process Options				
Subtask 4a - Effectiveness Evaluation	Computer modeling	EII 1.6	X	
	Magnetic media	EII 1.6	X	
	Technical memos	EII 1.6	X	
Subtask 4b - Implementability Evaluation	Technical memos	EII 1.6	X	
Subtask 4c - Cost Evaluation	Technical memos	EII 1.6	X	

Table 1. Management of Site Characterization Data. (sheet 5 of 7)

Work plan task	Data type	Controlling organization		
		Procedure	EDMC[a]	Others
PHASE I -- FEASIBILITY STUDY: (cont)				
Task 5 - Assembly of Remedial Alternatives	Technical memos	EII 1.6	X	
Task 6 - Identification of Action-Specific Applicable, Relevant and Appropriate Requirements	Technical memos	EII 1.6	X	
Task 7 - Reevaluation of Data Needs	Technical memos	EII 1.6	X	
Task 8 - Phase I Feasibility Study Report	Report	EII 1.6	X	
PHASE II -- FEASIBILITY STUDY:				
Task 1 - Refinement of Remedial Action Objectives	Technical memos	EII 1.6	X	
Task 2 - Definition of Remedial Alternatives	Technical memos	EII 1.6	X	
Task 3 - Screening Evaluation				
Subtask 3a - Effectiveness Evaluation	Technical memos	EII 1.6	X	
Subtask 3b - Implementability Evaluation	Technical memos	EII 1.6	X	
Subtask 3c - Cost Evaluation	Technical memos	EII 1.6	X	
Subtask 3d - Evaluation of Innovative Alternatives	Technical memos	EII 1.6	X	
Task 4 - Verification of Action-Specific Applicable, Relevant and Appropriate Requirements	Technical memos	EII 1.6	X	

Table 1. Management of Site Characterization Data. (sheet 6 of 7)

Work plan task	Data type	Controlling organization		
		Procedure	EDMC[a]	Others
PHASE II -- FEASIBILITY STUDY: (cont)				
Task 5 - Reevaluation of Data Needs	Technical memos	EII 1.6	X	
Task 6 - Phase II Feasibility Study Report	Report	EII 1.6	X	
PHASE II -- REMEDIAL INVESTIGATION:				
Task 1 - Treatability Investigation Work Plan Development	Work plan	EII 1.6	X	
Task 2 - Treatability Investigation Implementation	Pilot and test study data:			
	Logbooks	EII 1.5	X	
	Sample analyses	EII 1.6	X	
	Magnetic media	EII 1.6	X	
	Technical memos	EII 1.6	X	
Task 3 - Remedial Investigation Report	Report	EII 1.6	X	
PHASE III -- FEASIBILITY STUDY:				
Task 1 - Definition of Remedial Alternatives	Technical memos	EII 1.6	X	
Task 2 - Detailed Analysis of Remedial Alternatives				
Subtask 2a - Short-Term Effectiveness Analysis	Computer modeling	EII 1.6	X	
	Magnetic media	EII 1.6	X	
	Technical memos	EII 1.6	X	
Subtask 2b - Long-Term Effectiveness Analysis	Computer modeling	EII 1.6	X	
	Magnetic media	EII 1.6	X	
	Technical memos	EII 1.6	X	

Table 1. Management of Site Characterization Data. (sheet 7 of 7)

Work plan task	Data type	Controlling organization		
		Procedure	EDMC[a]	Others
PHASE III -- FEASIBILITY STUDY: (cont)				
Subtask 2c - Analysis of Reduction in Waste Toxicity, Mobility, and Volume	Technical memos	EII 1.6	X	
Subtask 2d - Implementability Analysis	Technical memos	EII 1.6	X	
Subtask 2e - Cost Analysis	Technical memos	EII 1.6	X	
Subtask 2f - Analysis of Compliance	Technical memos	EII 1.6	X	
Subtask 2g - Analysis of Overall Protection of Public Health and the Environment	Technical memos	EII 1.6	X	
Subtask 2h - Analysis of Environmental Agency Acceptance	Technical memos	EII 1.6	X	
Subtask 2i - Analysis of Community Acceptance	Technical memos	EII 1.6	X	
Task 3 - Comparison of Remedial Alternatives	Technical memos	EII 1.6	X	
Task 4 - Feasibility Study Report	Report	EII 1.6	X	

NOTE: Completed, originalbound logbooks are retained by Westinghouse Hanford Information Resource Management. The Environmental Data Management Center will maintain copies.

[a]EDMC = Environmental Data Management Center.

[b]OSM = Office of Sample Management.

[c]HMS = Hanford Meteorological Station.

Table 2. Management of Related Administrative Data.

Data type	Controlling document or procedure	Controlling organization				
		TR[a]	HEHF[b]	PNL[c]	EDMC[d]	EHPSS[e]
Personnel:						
Personnel training and qualifications	See Section 3.3.4	X				
Occupational exposure records (nonradiologic)	EII 2.2		X			X
Radiological exposure records	See Section 3.3.3			X		
Respiratory protection fitting						X
Personnel health and safety records	EII 2.1		X			X
Compliance/regulatory:						
Applicable or relevant and appropriate requirements/screening levels	EII 1.6				X	
Guidance document tracking	EII 1.6				X	
Compliance issues	EII 1.6				X	
Problem resolution	EII 1.6				X	
Administrative record	TPA-AP-06-R0 and TPA-AP-10-R0				X	

[a]TR = Training Records (Westinghouse Hanford, PNL, and KEH).
[b]HEHF = Hanford Environmental Health Foundation.
[c]PNL = Pacific Northwest Laboratory.
[d]EDMC = Environmental Data Management Center (Westinghouse Hanford).
[e]EHPSS = Environmental Health and Pesticide Services Section (Westinghouse Hanford).

Data type	Data location
• Training records	Technical Training Support Section (Westinghouse Hanford Company)
• Meteorological data	Hanford Meteorological Station (Pacific Northwest Laboratory)
• Health and safety records	Hanford Environmental Health Foundation
• Personal protection fitting	Environmental Health and Pesticide Services Section (Westinghouse Hanford Company)
• Radiological exposure	Pacific Northwest Laboratory

2.4 DATA QUANTITY

Data quantities are described in the Work Plan and the FSP. Estimated data quantities, as shown in Table 3, are provided for the purpose of data volume and planning work load.

3.0 DATA MANAGEMENT PLAN

3.1 OBJECTIVE

A considerable amount of data will be generated through the implementation of the 300-FF-1 Operable Unit Work Plan, FSP, and Health and Safety Plan (HSP). The QAPP provides the specific procedural direction and control for obtaining and analyzing samples in conformance with requirements to ensure quality data results. The FSP provides the detailed logistical methods to be employed in selecting the location, depth, frequency of collection, etc., of media to be sampled and the methods to be employed to obtain samples of the selected media for cataloging, shipment, and analysis.

Figure 1 displays the general data management plan outline for data generated through 300-FF-1 activities.

3.2 ORGANIZATIONS CONTROLLING DATA

This section describes the organizations that will receive data generated from 300-FF-1 activities.

Table 3. Site Characterization - Estimated Data Quantity. (sheet 1 of 7)

Work plan task	Data type	Documents/ articles (No.)	Sample locations (No.)	Total samples (No.)	Analyses/ samples (No.)	Data points (No.)
PHASE I -- REMEDIAL INVESTIGATION:						
Task 1 - Source Investigation						
Subtask 1a - Source Data Compilation	Historic: Engineering plans, reports	Unknown				
	Telephone conversations	Unknown				
	Memoranda/minutes	Unknown				
Subtask 1b - Ground-Penetrating Radar Survey	Logbooks	1				
	Magnetic media	1				
	Chart recordings	Unknown				
Subtask 1c - Electomagnetic Survey	Logbooks	1				
	Magnetic media	1				
	Chart recordings	Unknown				
Subtask 1d - Topographic Base Map Development	Aerial photographs	1				
	Logbooks	1				
	Magnetic media	1				
	Maps	1				
Subtask 1e - "In-Pipe" Remote Inspection Survey	Logbooks	1				
Subtask 1f - Soil Gas Survey	Logbooks	1				
Subtask 1g - Nonhazardous Source Characterization	Logbooks	1				
	Chain-of-custody forms	3				
	Quality assurance/ quality control	1				
	Verified sample analyses		12	12	48	576
	Archived sample index	1				
	Magnetic media	1				

Table 3. Site Characterization - Estimated Data Quantity. (sheet 2 of 7)

Work plan task	Data type	Documents/ articles (No.)	Sample locations (No.)	Total samples (No.)	Analyses/ samples (No.)	Data points (No.)
PHASE I -- REMEDIAL INVESTIGATION: (cont)						
Task 2 - Geologic Investigation						
Subtask 2a - Geologic Data Compilation	Technical memos	1				
Task 3 - Soil Investigation						
Subtask 3a - Surface Radiation Survey	Logbooks	1				
Subtask 3b - Soil Sampling and Analysis	Logbooks	7				
	Chain-of-custody forms	7				
	Quality assurance/ quality control	7				
	Verified sample analyses		48	480	48	23,040
	Archived sample index	1				
	Borehole logs	48				
	Magnetic media	7				
Task 4 - Air Investigation						
Subtask 4a - Air Data Compilation	Historic reports	3				
	Technical memos	1				
Subtask 4b - Ambient Air Sampling and Analysis	Logbooks	1				
	Verified sample analyses	Unknown				
Task 5 - Terrestrial Biological Investigation						
Subtask 5a - Biological Survey	Logbooks	1				
	Technical memos	1				

Table 3. Site Characterization - Estimated Data Quantity. (sheet 3 of 7)

Work plan task	Data type	Documents/ articles (No.)	Sample locations (No.)	Total samples (No.)	Analyses/ samples (No.)	Data points (No.)
PHASE I -- REMEDIAL INVESTIGATION: (cont)						
Subtask 5b - Asparagus Sampling Analyses	Logbooks	1				
	Chain-of-custody forms	1				
	Quality assurance/ quality control	1				
	Verified sample analyses		Unknown	Unknown	Unknown	Unknown
	Archived sample index	1				
	Magnetic media	1				
Task 6 - Data Evaluation						
Subtask 6a - Source Data Evaluation	Technical memos	1				
Subtask 6b - Geological Data Evaluation	Technical memos	1				
Subtask 6c - Soil Data Evaluation	Technical memos	1				
Subtask 6d - Air Data Evaluation	Technical memos	1				
Subtask 6e - Terrestrial Biological Data Evaluation	Technical memos	1				
Task 7 - Verification of Contaminant- and Location-Specific Applicable, Relevant and Appropriate Requirements	Technical memos	1				
Task 8 - Baseline Risk Assessment						
Subtask 8a - Contaminant Identification	Technical memos	1				

Table 3. Site Characterization - Estimated Data Quantity. (sheet 4 of 7)

Work plan task	Data type	Documents/ articles (No.)	Sample locations (No.)	Total samples (No.)	Analyses/ samples (No.)	Data points (No.)
PHASE I -- REMEDIAL INVESTIGATION: (cont)						
Subtask 8b - Exposure Assessment	Computer models	4				
	Magnetic media	4				
	Technical memos	1				
Subtask 8c - Toxicity Assessment	Technical memos	1				
Subtask 8d - Risk Characterization	Technical memos	1				
Task 9 - Phase I RI Report	Report	1				
PHASE I -- FEASIBILITY STUDY:						
Task 1 - Development of Remedial Action Objectives	Technical memos	1				
Task 2 - Development of General Response Actions	Technical memos	1				
Task 3 - Identification of Potential Remedial Technologies	Technical memos	1				
Task 4 - Evaluation of Process Options						
Subtask 4a - Effectiveness Evaluation	Technical memos	1				
Subtask 4b - Implementability Evaluation	Technical memos	1				
Subtask 4c - Cost Evaluation	Technical memos	1				

Table 3. Site Characterization - Estimated Data Quantity. (sheet 5 of 7)

Work plan task	Data type	Documents/ articles (No.)	Sample locations (No.)	Total samples (No.)	Analyses/ samples (No.)	Data points (No.)
PHASE I -- FEASIBILITY STUDY: (cont)						
Task 5 - Assembly of Remedial Alternatives	Technical memos	1				
Task 6 - Identification of Action-Specific Applicable, Relevant and Appropriate Requirements	Technical memos	1				
Task 7 - Reevaluation of Data Needs	Technical memos	1				
PHASE II -- FEASIBILITY STUDY:						
Task 1 - Refinement of Remedial Action Objectives	Technical memos	1				
Task 2 - Definition of Remedial Alternatives	Technical memos	1				
Task 3 - Screening Evaluation						
Subtask 3a - Effectiveness Evaluation	Technical memos	1				
Subtask 3b - Implementability Evaluation	Technical memos	1				
Subtask 3c - Cost Evaluation	Technical memos	1				
Subtask 3d - Evaluation of Innovative Alternatives	Technical memos	1				
Task 4 - Verification of Action-Specific Applicable, Relevant and Appropriate Requirements	Technical memos	1				

Table 3. Site Characterization - Estimated Data Quantity. (sheet 6 of 7)

Work plan task	Data type	Documents/ articles (No.)	Sample locations (No.)	Total samples (No.)	Analyses/ samples (No.)	Data points (No.)
PHASE II -- FEASIBILITY STUDY: (cont)						
Task 5 - Reevaluation of Data Needs	Technical memos	1				
Task 6 - Phase I and II Feasibility Study Report	Report	1				
PHASE II -- REMEDIAL INVESTIGATION:						
Task 1 - Treatability Investigation Work Plan Development	Work plan	1				
Task 2 - Treatability Investigation Implementation	Pilot and test study data:					
	Logbooks	Unknown				
	Sample analyses	Unknown				
	Magnetic media	Unknown				
	Technical memos	Unknown				
Task 3 - Remedial Investigation Report	Report	1				
PHASE III -- FEASIBILITY STUDY:						
Task 1 - Definition of Remedial Alternatives	Technical memos	1				
Task 2 - Detailed Analysis of Remedial Alternatives						
Subtask 2a - Short-Term Effectiveness Analysis	Computer modeling	4				
	Magnetic media	4				
	Technical memos	1				

Table 3. Site Characterization - Estimated Data Quantity. (sheet 7 of 7)

Work plan task	Data type	Documents/ articles (No.)	Sample locations (No.)	Total samples (No.)	Analyses/ samples (No.)	Data points (No.)
PHASE III -- FEASIBILITY STUDY: (cont)						
Subtask 2b - Long-Term Effectiveness Analysis	Computer modeling	4				
	Magnetic media	4				
	Technical memos	1				
Subtask 2c - Analysis of Reduction in Waste Toxicity, Mobility, and Volume	Technical memos	1				
Subtask 2d - Implementability Analysis	Technical memos	1				
Subtask 2e - Cost Analysis	Technical memos	1				
Subtask 2f - Analysis of Compliance with Applicable, Relevant and Applicable Requirements	Technical memos	1				
Subtask 2g - Analysis of Overall Protection of Public Health and the Environment	Technical memos	1				
Subtask 2h - Analysis of Environmental Agency Acceptance	Technical memos	1				
Subtask 2i - Analysis of Community Acceptance	Technical memos	1				
Task 3 - Comparison of Remedial Alternatives	Technical memos	1				
Task 4 - Feasibility Study Report	Report	1				

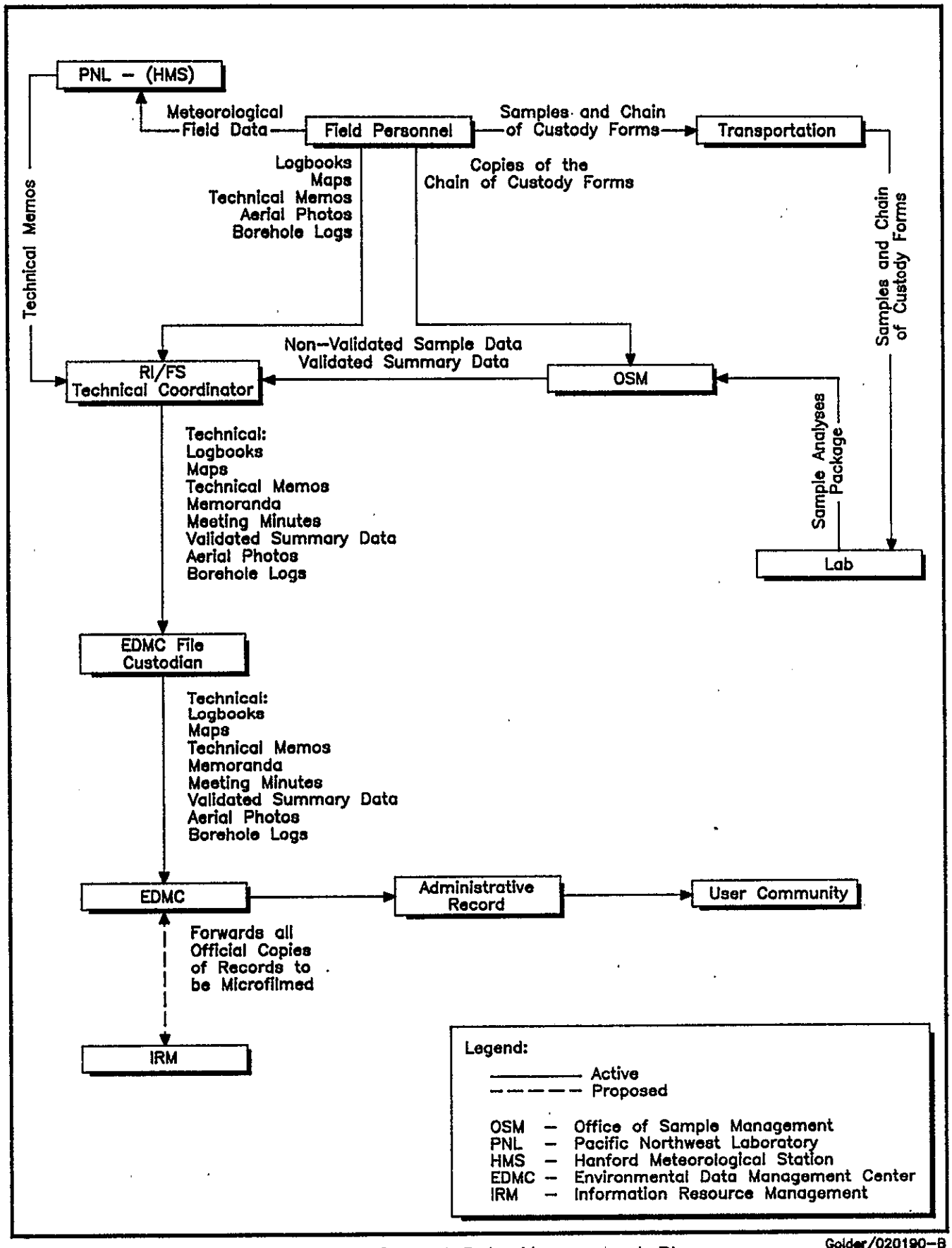

Figure 1. General Data Management Plan for 300–FF–1 Work Plan Task Data

3.2.1 Environmental Engineering Section

The Westinghouse Hanford Environmental Engineering Section provides the RI/FS Technical Coordinator. The RI/FS Technical Coordinator is responsible for maintaining and transmitting data to the designated storage facility.

3.2.2 Office of Sample Management

The Westinghouse Hanford Office of Sample Management (OSM) will validate all data packages received from the laboratory. Validated summary data will be forwarded to the RI/FS Technical Coordinator for use and submittal to the EDMC. Nonvalidated or preliminary data will be forwarded to the RI/FS Technical Coordinator upon request. Preliminary data will be clearly labeled as such. The OSM will maintain raw sample data, QA/QC laboratory data and the archived sample index. The OSM is scheduled to develop written data management procedures in 1990.

3.2.3 Environmental Data Management Center

The Environmental Data Management Center (EDMC) is the Westinghouse Hanford Environmental Division's central facility and service that provides a file management system for processing environmental information. The EDMC manages and controls the Administrative Record Public Access Room. Data transmittal to the EDMC is governed by the following procedures:

- EII 1.6, *Records Management* (WHC 1988a)
- TPA-AP-06-R0, Predecisional Draft, *Clearance and Release of Administrative Record Documentation* (DOE-RL et al. 1990b)
- TPA-AP-07-R0, Predecisional Draft, *Information Transmittals and Receipt Control* (DOE-RL et al. 1990d)
- TPA-AP-10-R0, *Administrative Record Management* (DOE-RL et al. 1990a)
- WHC-EP-0219, *Environmental Information Management Plan* (Steward 1989).

Procedures addressing record control before transmittal to EDMC will be developed in fiscal year 1990.

3.2.4 Information Resource Management

The Information Resource Management (IRM) is the designated records custodian (permanent storage) for Westinghouse Hanford. The procedural link between the EDMC and the IRM is being developed.

3.2.5 Hanford Environmental Health Foundation

The Hanford Environmental Health Foundation (HEHF) performs the analyses on the nonradiological health and exposure data and forwards summary reports to the Fire and Protection Group and the Environmental Health and Pesticide Services Section within the Westinghouse Hanford Environmental Division. Nonradiological and health exposure data are maintained also for other site contractors [Pacific Northwest Laboratory (PNL) and Kaiser Engineers Hanford (KEH)] associated with 300-FF-1 activities. The HEHF provides summary data to the appropriate site contractor. The preparation of health and safety plans addressed in EII 2.1 and occupational health monitoring is covered in EII 2.2. Data management procedures are currently under development.

3.2.6 Environmental Health and Pesticide Services Section

The Westinghouse Hanford Environmental Health and Pesticide Services Section (EHPSS) maintains personal protection equipment fitting records as well as nonradiological health and exposure summary reports provided by HEHF for Westinghouse Hanford Environmental Division and subcontractor personnel.

3.2.7 Technical Training Support Section

The Westinghouse Hanford Technical Training Support Section provides instructions on development of training programs, and maintains training records (see Section 3.3.4).

3.2.8 Pacific Northwest Laboratory

The PNL operates the Hanford Meteorological Station (HMS) that collects and maintains meteorological data (see Section 3.3.1). Additionally, PNL collects and maintains radiation exposure data (see Section 3.3.3). Data management is discussed in the *Hanford Meteorological Data Collection System and Data Base*, (Andrews 1988).

3.3 DATABASES

This section addresses databases that will receive data generated from 300-FF-1 activities.

3.3.1 Meteorological Data

The HMS, controlled by PNL, collects and maintains meteorological data. This database contains meteorological data dating from 1943 to present. The *Hanford Meteorological Data Collection System and Data Base* (Andrews 1988) is the document that explains meteorological data management.

3.3.2 Nonradiological Exposure and Medical Records

The HEHF collects and maintains data for all nonradiological exposure records and medical records.

3.3.3 Radiological Exposure Records

The PNL collects and maintains data on occupational radiation exposure. This database contains respiratory personnel protection equipment fitting records, work restrictions, and radiation exposure information.

3.3.4 Training Records

Training records for Westinghouse Hanford and subcontractor personnel are managed by the Westinghouse Hanford Technical Training Support Section. Other site contractors (PNL and KEH) maintain their own personnel training records.

3.3.5 Environmental Information/ Administrative Record

Westinghouse Hanford EDMC personnel manages the Environmental Information and the Administrative Record which provide an index and key information on all data transmitted to the EDMC. This database is used to assist in data retrieval and to produce index lists as required.

3.3.6 Sample Status Tracking

The OSM maintains the sample status tracking database. This database contains information about each sample. Information maintained includes sample number, ship data, receipt data, and laboratory identification.

4.0 ENVIRONMENTAL INFORMATION MANAGEMENT PLAN

This section briefly discusses the EIMP (Steward 1989) developed to provide an integrated approach to managing Hanford Site environmental data.

4.1 OBJECTIVE

The EIMP was issued in March 1989 and is currently under review. The EIMP is expected to be revised and expanded in fiscal year 1990. The first

part of the EIMP provides an overview of the Westinghouse Hanford Environmental Division's working files management system and addresses the management of information transmitted to the EDMC, the Environmental Division's designated file manager, in support of Environmental Restoration Program activities. An overview is presented of the EDMC's location, operating mechanics, field file support services, automated support services, and the composition and compilation of an agency-required Administrative Record.

The second part of the EIMP addresses future plans for management of scientific and technical data. The planning and control activities affecting data are discussed. These activities include data collection, analysis, integration, transfer, storage, retrieval, and presentation.

5.0 HANFORD ENVIRONMENTAL INFORMATION SYSTEM

5.1 OBJECTIVE

The Hanford Environmental Information System (HEIS) is being developed by PNL for Westinghouse Hanford as a primary resource for computerized storage, retrieval, and analysis of quality-assured technical data associated with CERCLA RI/FS activities and RCRA Facility Investigation/Corrective Measure Study (RFI/CMS) activities being undertaken at the Hanford Site. The HEIS will provide a means of interactive access to data sets. Implementation of HEIS will serve to facilitate data consistency, quality, traceability, and security within a single controlled database. The HEIS is expected to be operational by September 1990.

The following is a list of data subjects proposed to be entered into HEIS:

- Geologic
- Geophysics
- Atmospheric
- Biotic
- Site Characterization
- Soil Gas
- Waste Site Information
- Surface Monitoring
- Groundwater.

Existing databases that are proposed to be incorporated, in whole or in part, within HEIS include the Waste Information Data System (WIDS), and the Hanford Groundwater Database.

Considerable resources are being devoted to completing development and implementing HEIS in fiscal year 1990. The HEIS will be accompanied by a detailed operator and procedure manual that is being prepared by PNL for Westinghouse Hanford and that is expected to be completed by September 1990.

The discussion of HEIS in the second part of the EIMP (Steward 1989) is being revised and expanded.

5.2 INTEGRATION OF 300-FF-1 DATA INTO HANFORD ENVIRONMENTAL INFORMATION SYSTEM

All data collected before the implementation of HEIS will be handled and stored according to the Data Management Plan described in Section 3.0. Figure 2 outlines the general data management for data collected after implementation of HEIS. Data collected prior to implementing HEIS will be entered eventually into HEIS as time and resources allow.

6.0 REFERENCES

Andrews, G. L., 1988, *Hanford Meteorological Data Collection System and Data Base*, PNL-6509, Pacific Northwest Laboratory, Richland, Washington.

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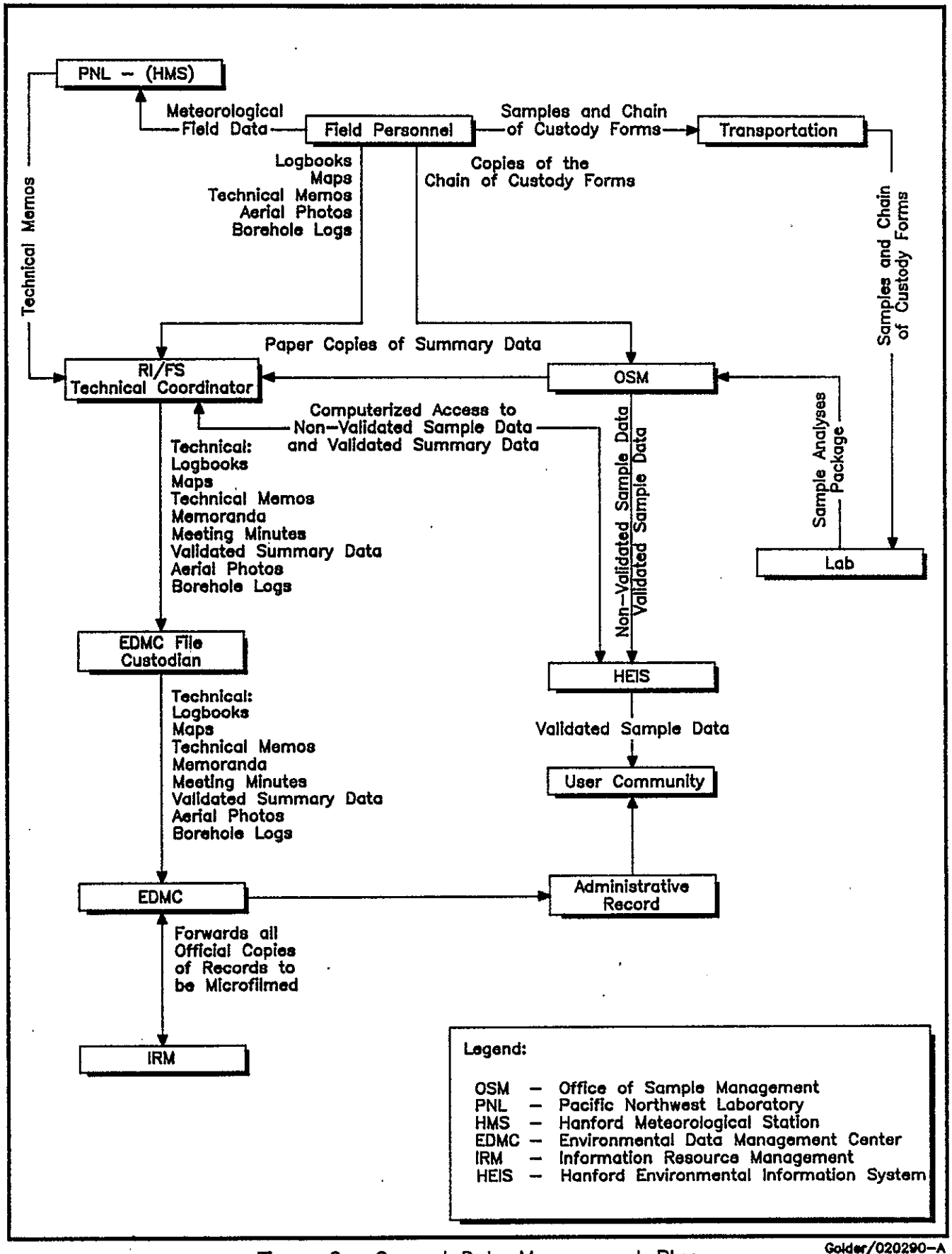

Figure 2. General Data Management Plan for 300–FF–1 Work Plan Task Data After Implementation of HEIS

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ATTACHMENT 5

COMMUNITY RELATIONS PLAN

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1.0 INTRODUCTION

A community relations plan (CRP) has been developed for the Hanford Site Environmental Restoration Program (ERP). Because community relations activities are so interrelated among operable units, a decision was made to develop a single CRP that will have the capability to address specific individual concerns associated with each operable unit, but will still provide continuity and general coordination of all the ERP activities with regard to community involvement. The site-wide CRP discusses Hanford Site background information, history of community involvement at the Hanford site, and community concerns regarding the Hanford Site. It also delineates the community relations program that the U.S. Department of Energy-Richland Operations Office, the U.S. Environmental Protection Agency-Region X Office, and the Washington Department of Ecology will cooperatively implement throughout the cleanup of all the operable units at the Hanford Site. All community relations activities associated with the 300-FF-1 operable unit work plan will be conducted under this overall Hanford Site CRP.

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