

# Remedial Investigation Data Quality Objectives Summary Report for the 200-PW-4 Operable Unit

Prepared for the U.S. Department of Energy  
Assistant Secretary for Environmental Management  
Project Hanford Management Contractor for the  
U.S. Department of Energy under Contract DE-AC06-96RL13200

**Fluor Hanford**

P.O. Box 1000  
Richland, Washington

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## EXECUTIVE SUMMARY

This data quality objective summary report supports site characterization decisions for remedial investigation at treatment, storage, and disposal units in the 200-PW-4 General Process Waste Group Operable Unit. The 200-PW-4 operable unit consists of 13 *Resource Conservation and Recovery Act of 1976* (RCRA) past-practice waste sites (consisting mostly of cribs and trenches), 2 RCRA treatment, storage, and disposal units, and 1 unplanned release site. The operable unit designation and waste site assignments are defined in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (hereinafter referred to as the Implementation Plan). Waste sites in the 200-PW-4 operable unit received mostly process drainage, process distillate discharge, and miscellaneous condensates from the T and U Plants, the Reduction-Oxidation Plant, the Plutonium-Uranium Extraction Plant, the Hot Semiworks Facility, and several contributing tank farms. Data collected during the remedial investigation will be used to determine if the waste sites are contaminated above levels that will require remedial action, to support evaluation of remedial alternatives and/or closure strategies, and to verify or refine the preliminary conceptual contaminant distribution models.

Described in DOE/RL-2000-60, Rev. 0, *200-PW-2 Uranium-Rich Process Waste Group Operable Unit RI/FS Work Plan and Process Waste RCRA TSD Unit Sampling Plan*, and as a result of recent discussions with the regulators regarding streamlining the 200 Area assessment process, the assessment of the two 200-PW-4 operable unit RCRA treatment, storage, and disposal units has been integrated into the remedial investigation/ feasibility study process as part of the 200-PW-2 operable unit. By adding the assessment of these two treatment, storage, and disposal units to the scope of the 200-PW-2 operable unit, it will be possible to accelerate the investigation of all process waste-type related RCRA treatment, storage, and disposal units. The planned implementation of field activities for the 200-PW-4 operable unit will be integrated with the 200-PW-2 remedial investigation. Subsequent documentation such as the remedial investigation report will incorporate these two treatment, storage, and disposal units.

This data quality objective effort follows the concepts developed in the Implementation Plan (DOE/RL-98-28) for using analogous site contaminant data to reduce the amount of characterization required to support remedial investigation/feasibility study decisions. These concepts involve grouping sites with similar process histories, structures, and contaminants and then choosing one or more representative sites for comprehensive field investigation, including sampling during remedial investigation activities. Findings from the remedial investigation at representative sites then are used to make remedial action decisions for all of the waste sites in the operable unit. Analogous sites for which field data have not been (or will not be) collected are assumed to have chemical characteristics similar to the representative sites that are characterized. A record of decision for the operable unit will be obtained through the remedial investigation/feasibility study process using the data collected during the remedial investigation. This record of decision will be supplemented with a RCRA permit modification for the two treatment, storage, and disposal units. The analogous sites (those not sampled during the remedial investigation) will be addressed during the confirmatory sampling phase to ensure that the remedial action specified in the record of decision is appropriate and to provide design data as needed. Following remedial actions, verification samples will be collected to support site closeout.

For the 200-PW-4 operable unit, two treatment, storage, and disposal units have been identified. The goals of the remedial investigation are to provide the data needed to support remedial decisions and to refine the preliminary conceptual contaminant distribution and exposure models for this operable unit. The data will be generated mainly through soil sampling and analysis.

Washington State Department of Ecology Publication No. 94-49, *Guidance on Sampling and Data Analysis Methods*, was used in developing the sampling design for the remedial investigation. Because the data will not be used to demonstrate compliance with a cleanup level, focused (biased) soil sampling of areas selected with the highest contamination potential was chosen rather than an area-wide (unbiased) sample design. The concentrations of all contaminants in each soil sample will be compared directly with the cleanup levels; a statistical analysis of the sampling data is not appropriate for focused sampling schemes and is, therefore,

not used in this report. The locations of samples exceeding the cleanup level will be used to delineate the areas of soil contamination requiring a decision on the need for remediation.

The proposed sampling locations were selected with the goal of intersecting the areas of highest contamination and determining the vertical extent of contamination. The nature (e.g., contaminant type and concentration) and the vertical extent of the contamination are the major remedial investigation data needs. In general, for sites that have not been characterized adequately, a borehole will be drilled to the groundwater table and soil samples will be collected from the entire length of the borehole. Geophysical logging of planned and existing boreholes also will be performed.

The contaminants of potential concern were identified through process history information and previous data collection efforts. Analytical performance criteria were based on WAC 173-340, "Model Toxics Control Act-Cleanup," *Washington Administrative Code*, chemical compliance criteria and other applicable or relevant and appropriate requirements. In the absence of applicable or relevant and appropriate requirements, other preliminary action levels were identified to determine analytical performance criteria. These levels provide the basis for identifying the laboratory or field screening detection limits required to support remedial action decisions. A modified version of the U.S. Environmental Protection Agency's data quality objectives guidance (EPA/600/R-96/005, *Guidance for the Data Quality Objectives Process*) was used to identify project data quality needs, evaluate sampling and analysis options, and document project data quality decisions.

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## TERMS

AEA	alpha energy analysis
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BHI	Bechtel Hanford, Inc.
CAS	Chemical Abstract Service
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CFR	<i>Code of Federal Regulations</i>
CHI	CH2M Hill Hanford, Inc.
CHG	CH2M Hill Hanford Group, Inc.
COC	contaminant of concern
COPC	contaminant of potential concern
CVAA	cold vapor atomic absorption
DOE	U.S. Department of Energy
DQO	data quality objective
DR	decision rule
DS	decision statement
Ecology	Washington State Department of Ecology
EMI	electromagnetic imaging
EPA	U.S. Environmental Protection Agency
FS	feasibility study
GC	gas chromatograph
GCMS	gas chromatography/mass spectrometry
GEA	gamma energy analysis
GPC	gas proportional counter
GPR	ground-penetrating radar
HPGe	high-purity germanium
IC	ion chromatography
ICP	inductively coupled plasma
ICPMS	inductively coupled plasma mass spectrometer
IDW	investigation-derived waste
OU	operable unit
PCB	polychlorinated biphenyl
PRG	preliminary remediation goal
PSQ	principal study question
PUREX	Plutonium-Uranium Extraction (Plant)
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RDR/RAWP	remedial design report/remedial action work plan
REDOX	Reduction-Oxidation (Plant)
RESRAD	RESidual RADioactivity (dose model)
RFI	RCRA facility investigation
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision

SAP	sampling and analysis plan
SGL	spectral gamma logging
SVOC	semivolatile organic compound
TOC	total organic carbon
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i>
TSD	treatment, storage, and disposal
UNH	uranyl nitrate hexahydrate
UO <sub>3</sub>	uranium trioxide
URP	uranium recovery process
VOA	volatile organic analysis
WAC	<i>Washington Administrative Code</i>

**METRIC CONVERSION CHART**

<b>Into Metric Units</b>			<b>Out of Metric Units</b>		
<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>	<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>
<b>Length</b>			<b>Length</b>		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	Meters	meters	3.281	feet
yards	0.914	Meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
<b>Area</b>			<b>Area</b>		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
<b>Mass (weight)</b>			<b>Mass (weight)</b>		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
<b>Volume</b>			<b>Volume</b>		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
<b>Temperature</b>			<b>Temperature</b>		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
<b>Radioactivity</b>			<b>Radioactivity</b>		
picocuries	37	millibecquerel	millibecquerel	0.027	picocuries

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## 1.0 STEP 1 -- STATE THE PROBLEM

The purpose of data quality objective (DQO) Step 1 is to clearly and concisely state the problem to ensure that the focus of the study will be unambiguous.

### 1.1 INTRODUCTION

This summary report has been developed to support the remedial investigation/feasibility study (RI/FS) and remedial action decision-making processes for the 200-PW-4 Operable Unit (OU). The 200-PW-4 OU is being remediated under a *Resource Conservation and Recovery Act of 1976* (RCRA) approach. The 200-PW-4 OU consists of 2 RCRA treatment, storage, and disposal (TSD) units, 1 unplanned release site, and 11 RCRA past-practice disposal sites. The TSD units include one retention basin and one crib. This DQO summary report focuses on the development of sampling designs for the TSD units in this OU, in accordance with agreements reached with the regulatory agencies.

The Washington State Department of Ecology (Ecology) Publication No. 94-49, *Guidance on Sampling and Data Analysis Methods*, was used during this DQO process to support the selection of an appropriate sampling approach. Table 1 of the Ecology guidance summarizes approaches for sampling and data analysis considered acceptable to Ecology. This guidance shows that a focused sampling approach may be used to investigate a site that is known to be contaminated, and contaminated regions may be identified for sampling and analysis.

The 200-PW-4 OU waste sites received mostly process drainage, process distillate discharge, and miscellaneous condensates from the T Plant, U Plant, the Reduction-Oxidation (REDOX) Plant (i.e., S Plant), the Plutonium-Uranium Extraction (PUREX) Plant (i.e., A Plant), the Hot Semiworks Facility (i.e., C Plant), and several other contributing tank farm-related facilities such as the 242-A Evaporator. The waste was disposed to the vadose zone through cribs, trenches, and a french drain. A map of the Hanford Site is provided in Figure 1-1 and depicts the 200 Areas and vicinity (i.e., the location of the 200-PW-4 OU). Figures 1-2 through 1-4 identify the locations of the 200-PW-4 OU waste sites and the associated source facilities. In parallel with the development of this DQO summary report, a formal evaluation of the consolidation of the 200-PW-2 and 200-PW-4 OU waste sites was performed against the conceptual models in the 200-PW-2 work plan. This resulted in the development of a series of tables to document the evaluation process. These tables and a more detailed explanation of the logic used for this evaluation are presented in an appendix to the work plan (DOE/RL-2000-60, Rev. 0).

The goal of this evaluation was to align the consolidated OU waste sites with the appropriate representative waste sites and TSD units based on the potential nature and vertical extent of contamination, so that remedial alternative(s) chosen for the sites would be an effective and reasonable choice. At the conclusion of this evaluation, it was determined that the 216-C-3 Crib, which previously was identified as a representative waste site for the 200-PW-4 OU, was adequately addressed by the contaminant distribution model for the 216-B-12 Crib from the 200-PW-2 OU. This was based on waste site physical configuration, liquid effluent volumes, soil pore volumes, and contaminant concentrations. As a result of this evaluation it was confirmed that only the two RCRA TSD units within the 200-PW-4 OU required characterization.

Figure 1-1. Location of the Hanford Site and 200-PW-4 Operable Unit Waste Sites.

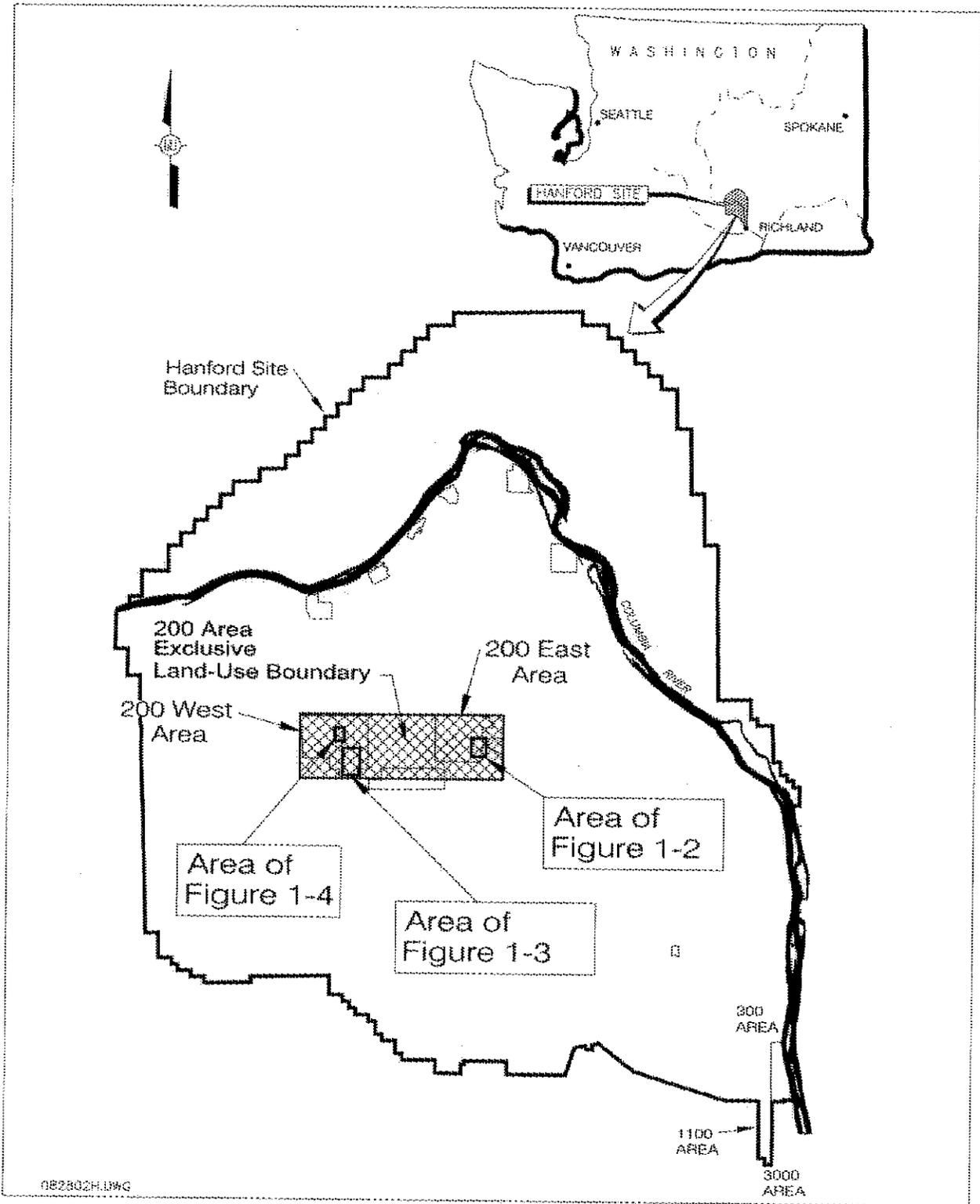
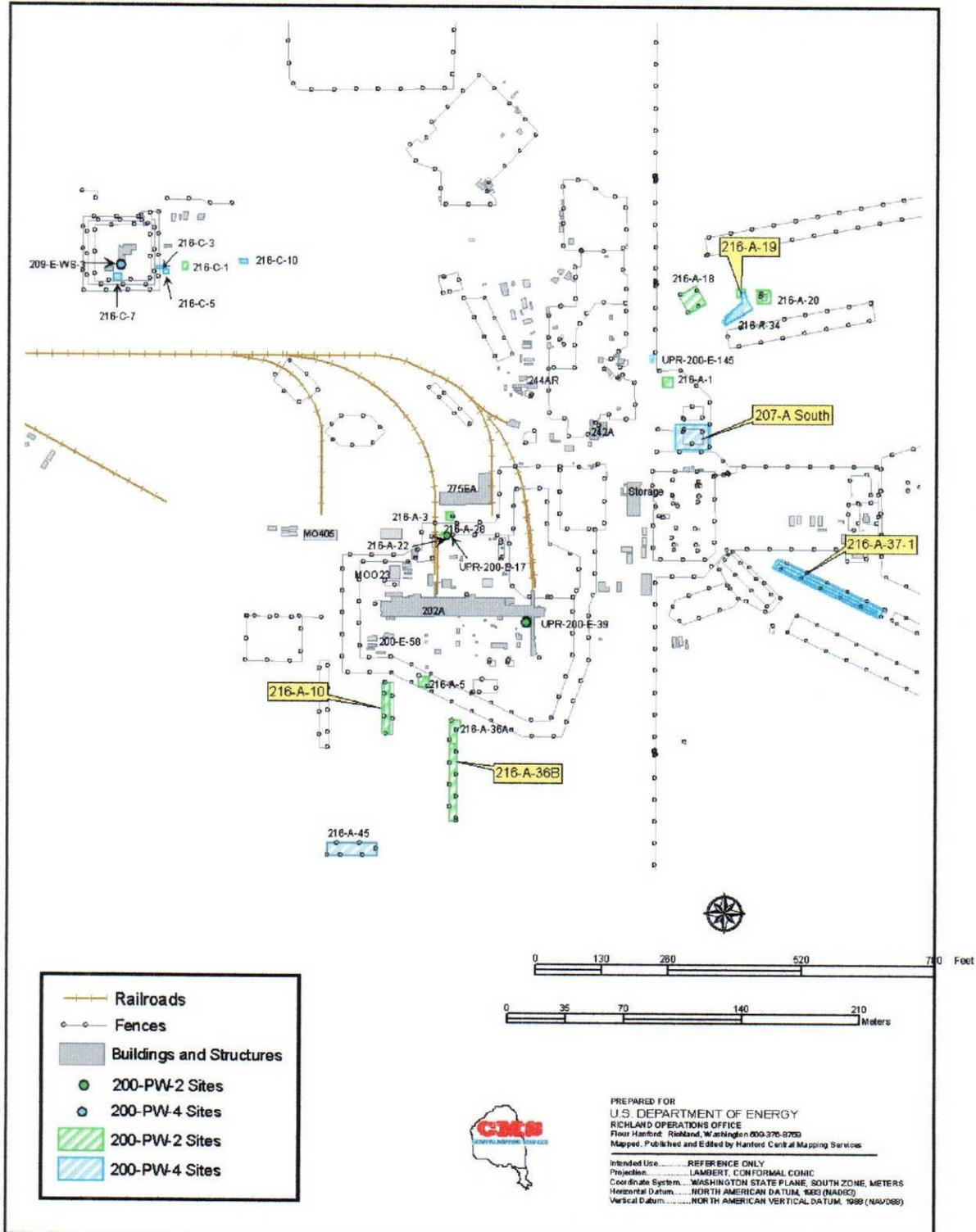
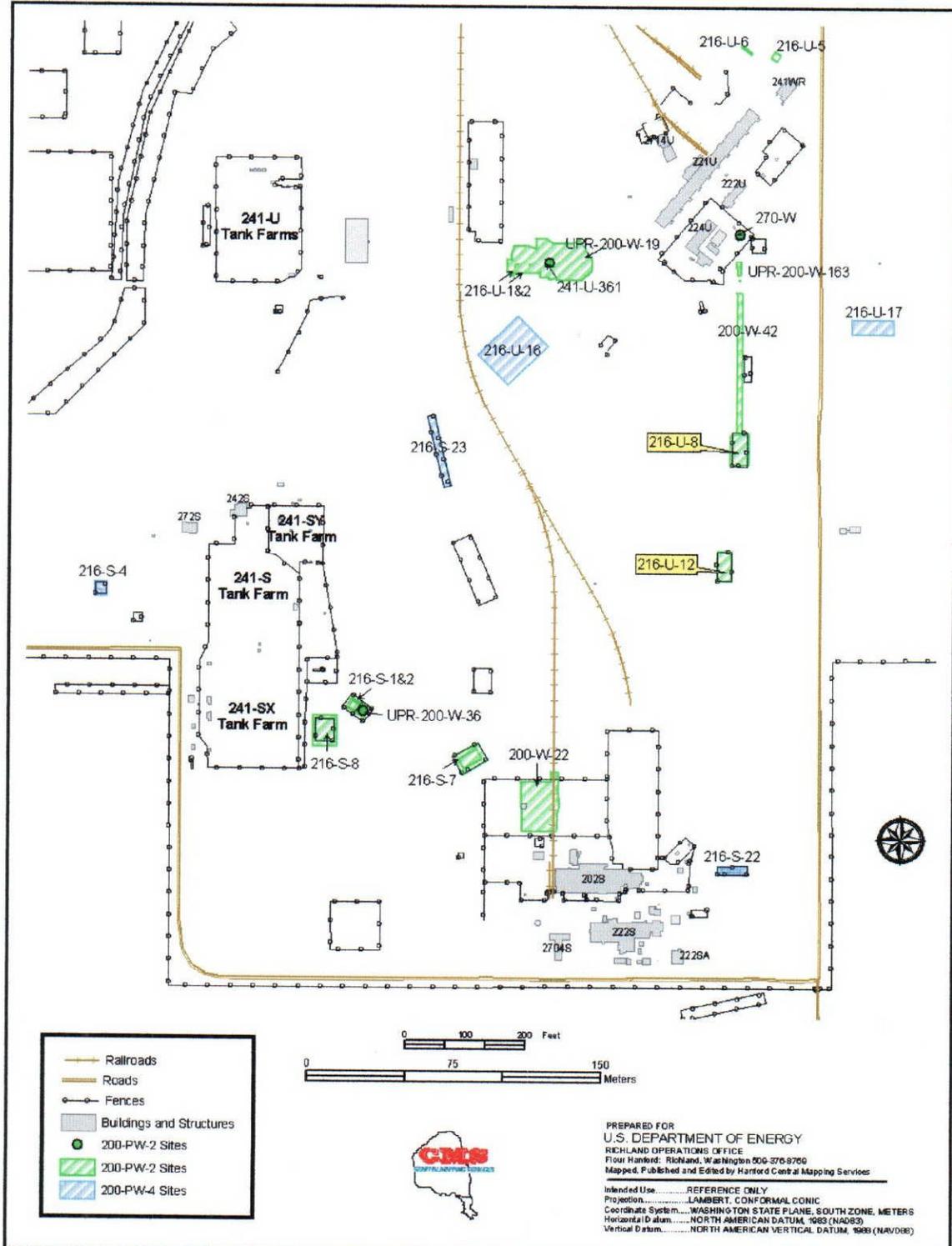


Figure 1-2. 200-PW-4 Operable Unit Waste Sites Located in the 200 East Area.



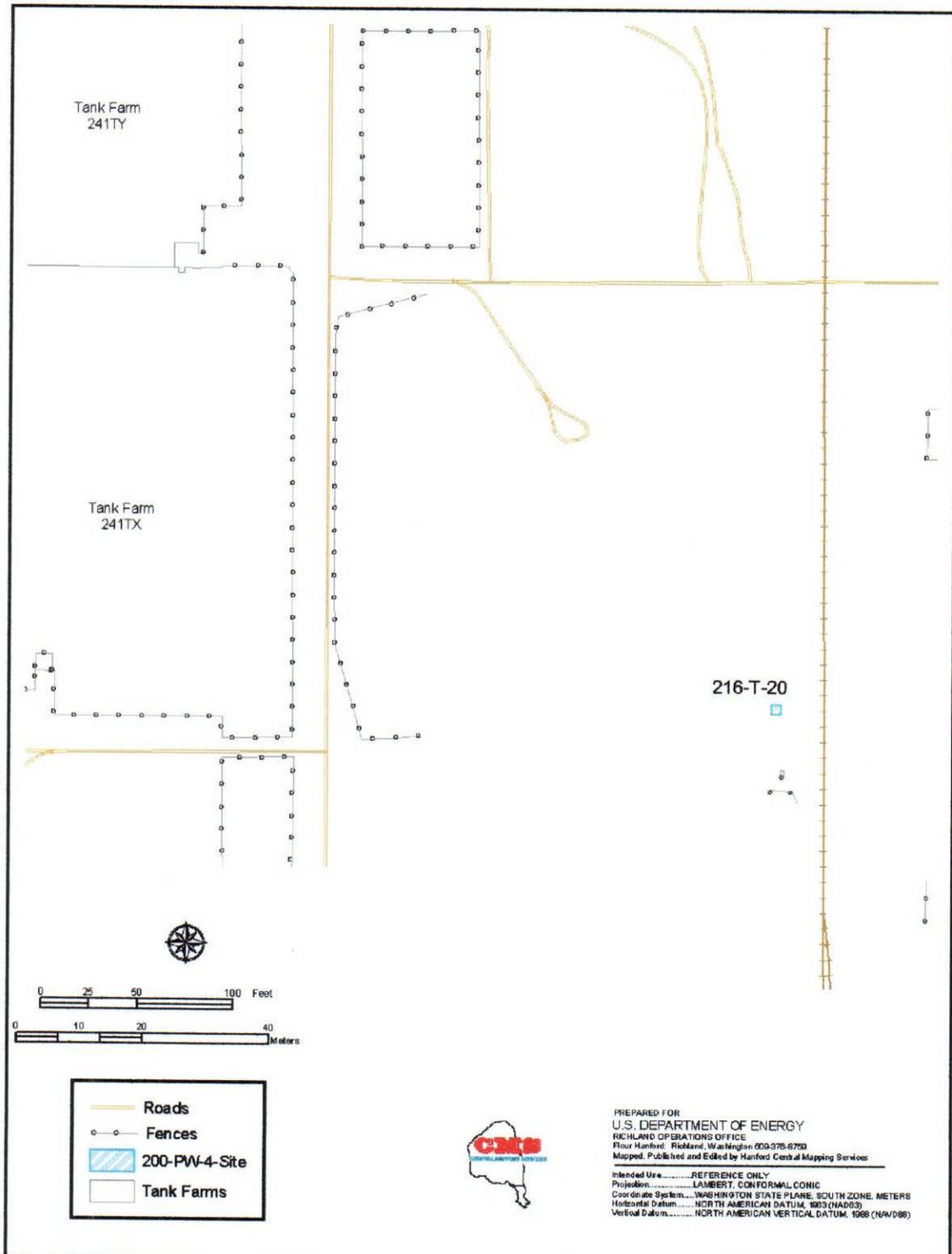
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Figure 1-3. 200-PW-4 Operable Unit Waste Sites Located in the 200 West Area.



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Figure 1-4. Additional 200-PW-4 Operable Unit Waste Sites Located in the 200 West Area.



## 1.2 PROJECT SCOPE

This DQO summary report focuses on RI characterization for two TSD units associated with the 200-PW-4 General Process Waste Group OU. The DQO summary report and sampling and analysis plan (SAP) (to be issued) will provide the basis for the RI for the 200-PW-4 RCRA past-practice sites and the RCRA facility investigation (RFI) for the 200-PW-4 TSDs. The Implementation Plan (DOE/RL-98-28) presents a consistent approach to data collection activities associated with 200 Areas assessment and remediation activities. The activities include all phases of sampling required to support the completion of the integrated RCRA/*Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) process outlined in Section 2.3 and depicted in Figure 2-2 of the Implementation Plan (DOE/RL-98-28). Specific activities include the following:

- Data collection at TSDs defined for the waste group-specific OU work plan, with an emphasis on verifying the conceptual models. This will support preparation of a focused FS and remedial action decision-making
- Data collection after the record of decision (ROD) to confirm that all other sites in the specific waste group OU meet the conceptual models that have been developed for the Site. In addition, data collection activities will be included as part of the remedy selected for the waste group and will provide site-specific information for preparation of the remedial design report/remedial action work plan (RDR/RAWP)
- Verification sampling will be performed to determine that remedial objectives have been met. For the remove, treat, and dispose alternative, the RDR/RAWP will identify data collection requirements to verify that remedial action objectives have been met. For sites where wastes have been contained in place, an operations and maintenance plan will be prepared to demonstrate the adequacy of the remedial action. For example, this plan would specify barrier performance monitoring activities
- Data collection defined as part of the postclosure monitoring plan section in a closure plan for a RCRA TSD unit.

This DQO process supports the data collection (from the first bullet) that will support the evaluation of remedial alternatives and RI/FS decision-making. Additional DQO processes will be conducted to define the sampling requirements for the other phases of data collection.

An RI/FS work plan for the 200-PW-2 OU (DOE/RL-2000-60, Rev. 1) has been prepared to satisfy, in concert with the Implementation Plan (DOE/RL-98-28), the requirements of both the RI and the RFI. The details for the waste sites from the 200-PW-4 OU will be added to this work plan to consolidate the approach to characterization of these two OUs. The data acquired during the RI will support the RI/FS and RFI/corrective measures study processes for these OUs. For ease of preparation and readability (and as described in the Implementation Plan [DOE/RL-98-28]), the RI/FS terminology will be used throughout the DQO summary report and work plan documents.

### 1.3 PROJECT OBJECTIVES

The objective of the DQO process for the 200-PW-4 General Process Waste Group OU is to determine the environmental measurements necessary to support the RI/FS process and remedial decision making, including refinement of the preliminary conceptual contaminant distribution model. Additionally, the DQO process supports development of an SAP for the RI, which will be included as an appendix to the consolidated RI/FS work plan for the 200-PW-2 and 200-PW-4 OUs (DOE/RL-2000-60, Rev. 1).

Possible alternatives identified in the Implementation Plan (DOE/RL-98-28) include the following:

- No action alternative (no institutional controls)
- Engineered multimedia barrier
- Excavation and disposal of waste
- In situ vitrification of soil
- In situ grouting or stabilization
- Monitored natural attenuation (with institutional controls).

### 1.4 PROJECT ASSUMPTIONS

Project assumptions for the RI include the following.

- The DQO process used for this project follows U.S. Environmental Protection Agency (EPA) EPA/600/R-96/055, *Guidance for the Data Quality Objectives Process*, and Section 6.1 of the Implementation Plan (DOE/RL-98-28).
- The 200-PW-4 OU waste group is a source waste group, and the investigations will focus on vadose zone soil contamination.
- The Implementation Plan (DOE/RL-98-28) outlines the assessment and remediation approach to be followed for the OU:
  - Defines the regulatory framework
  - Generally identifies the characterization approach
  - Provides background information on 200 Areas site conditions, operational history, and secondary plans (e.g., quality assurance, health and safety, information management, waste management)
  - Provides governing assumptions, including preliminary applicable or relevant and appropriate requirements (ARAR), land-use considerations, remedial action objectives, and remedial action alternatives.
- The analogous site approach will be used. The DQO effort and characterization will be limited to two TSD units. However, the characterization data will be used to reach remedial decisions for all waste sites within the OU.

One representative waste site originally was selected in DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*, for the 200-PW-4 OU:

- 216-C-3 Crib (typical site).

The TSD units in the 200-PW-4 OU are as follows:

- 216-A-37-1 Crib
- 207-A South Retention Basin.

Sixteen specific waste sites and unplanned releases within the OU are listed in Appendix G of the Implementation Plan (DOE/RL-98-28). Sites identified in the 200-PW-4 OU, in addition to the representative and TSD sites shown above, are listed below:

- |            |              |                  |
|------------|--------------|------------------|
| • 216-A-34 | • 209-E-WS-3 | • 216-T-20       |
| • 216-A-45 | • 216-S-4    | • 216-U-16       |
| • 216-C-5  | • 216-S-22   | • 216-U-17       |
| • 216-C-7  | • 216-S-23   | • UPR-200-E-145. |
| • 216-C-10 |              |                  |
- Characterization of the 216-U-16 Crib area was conducted as part of the 200-UP-2 OU RI of the 216-U-1 and U-2 Cribs in the early 1990s (DOE/RL-95-13, *Limited Field Investigation for the 200-UP-2 Operable Unit*).
  - Existing characterization data from waste sites within the OUs and analogous data (i.e., borehole logging results from the vicinity of the waste sites) will be used to support the DQO process and to prepare the work plan. Based on historical site uses and current contaminant of potential concern (COPC) information, it is expected that waste site contaminants of concern (COC) will exceed action levels and that remediation will be required at most sites. However, it is possible that COC action levels will not be exceeded. In this instance, follow-up verification sampling during the confirmatory, design, and verification phases would be conducted to ensure that site closeouts without remediation are adequately supported. These activities would be conducted under separate DQO processes.
  - This DQO will be used to generate the details for the 200-PW-4 OU that will be inserted into the SAP, which will be an appendix to DOE/RL-2000-60, Rev. 1.
  - Preliminary conceptual contaminant distribution models have been developed for both the 207-A South Retention Basin and the 216-A-37-1 Crib. Both models are presented in this DQO.
  - Remedial actions likely will be required to achieve ARARs, including the soil cleanup standards of *Washington Administrative Code* WAC 173-340 for chemical contaminants and radiological dose limits to be determined in the future. For the purposes of this DQO process, a dose limit range of 15 to 500 mrem/yr above natural background for

radionuclides in soil under an industrial exposure scenario is assumed as a reasonable representation of an acceptable range of dose limits. In accordance with 10 CFR 20, "Standards for Protection Against Radiation," and 10 CFR 835, "Radiation Protection for Occupational Workers," the total effective dose equivalent for members of the public entering a controlled area is 100 mrem/yr. Because the waste sites in this OU are contained within the exclusive land-use boundary for the 200 Areas, an industrial land-use scenario is assumed.

- Potential data uses that need to be considered when developing DQOs include preliminary conceptual contaminant distribution model refinement; evaluation of remedial action alternatives, remedial action decisions, and risk assessment; and worker health and safety.
- The data collected will support investigation-derived waste (IDW) disposal. A subsequent DQO process will be conducted to designate the wastes that are generated during RI/FS characterization sampling. IDW will be designated by Fluor Hanford Waste Management after analytical data, process knowledge, and other inputs such as groundwater listed waste code requirements have been evaluated.
- Wastes with mobile contaminants were disposed of at these sites and have impacted groundwater in the past at the 216-A-37-1 Crib. However, evaluation of groundwater contamination and remediation is not included in the scope of the work plan.
- At this point in time, and based on the available information reviewed for this DQO process, the wastes that were discharged from the 242-A Evaporator to the two TSD units are regulated as mixed waste, because the waste was derived from a waste containing spent halogenated and nonhalogenated solvents (F001, F002, F003, F004, and F005), and because of the toxicity of ammonia (WT02, state-only, toxic, dangerous waste). Characteristic heavy metal constituents will be evaluated based on total analytical results. Toxicity characteristic leaching procedures may be conducted if the total results exceed 20 times the regulatory standards in WAC 173-303-090, "Dangerous Waste Regulations," "Preparing Dangerous Waste for Transport," *Washington Administrative Code*.
- Supplemental sampling requirements that result from integration efforts with other projects are not addressed in this DQO summary report but will be incorporated in the SAP, which will be issued following the issuance of this DQO report, as an appendix of DOE/RL-2000-60, Rev. 1.
- Ecological DQOs will be addressed under a 200 Areas-wide strategy. The strategy is phased and supports both 200 Areas-wide and OU-specific evaluations. Phase I of the strategy consists of compiling existing 200 Areas ecological data into an ecological summary report (DOE/RL-2001-54, *Ecological Evaluation of the Hanford 200 Areas – Phase I: Compilation of Existing 200 Areas Ecological Data*, Draft A), which is scheduled to be completed in fiscal year 2003. Specific requirements for Phase II will be developed based on the results of the Phase I evaluation. For the 200-PW-4 OU, an ecological SAP will be prepared if waste site-specific soil samples are required to support an OU-specific ecological evaluation. The Phase II DQO is planned to be completed in

fiscal year 2003, at which time the 200-PW-4 ecological SAP will be prepared and implemented, if necessary.

The RI (i.e., initial OU characterization) will validate or provide the basis to refine the preliminary conceptual contaminant distribution models for the two RCRA TSD units in the OU. The other waste sites in the 200-PW-4 OU will be aligned with 200-PW-2 OU representative waste site conceptual contaminant distribution models as detailed in the 200-PW-2 work plan (DOE/RL-2000-60, Rev. 0) or with contaminant distribution models defined in other OUs, as presented in Appendix C of the work plan. The preliminary conceptual contaminant distribution models and the preliminary exposure model will be used to develop and evaluate remedial action alternatives applicable to the OU in an FS/closure plan. The RI/FS will form the basis for selecting a preferred remedial action in a proposed plan for the waste sites. The TSD units will be incorporated into the RCRA permit through the permit modification process.

## **1.5 PROJECT ISSUES**

Project issues include both the global issues that transcend the specific DQO process and the technical issues that are unique to the project. Both global and project technical issues have the potential to impact the sampling design or the DQOs for the project.

### **1.5.1 Global Issues**

One global issue was identified during the interview meeting between Ecology, the EPA, and the U.S. Department of Energy, Richland Operations Office (RL), which was the preliminary action level for exposure to radionuclides. Current activities to evaluate cleanup levels are under way for the 100 and 300 Areas, and similar activities also will be conducted for the 200 Areas. For the purposes of this DQO summary report, a preliminary action level of 500 mrem for annual dose exposure to radionuclides will be used to evaluate appropriate analytical requirements. This level falls in the representative range of potential cleanup standards based on current land-use assumptions, regulatory requirements, and other requirements. The final cleanup standards will be proposed in the FS and proposed plan and will be approved in the ROD for the OU.

### **1.5.2 Project Technical Issues**

The 216-C-3 Crib was identified as a representative waste site for the 200-PW-4 OU in the Implementation Plan (DOE/RL-98-28). However, the consolidation of the 200-PW-4 OU waste sites into the 200-PW-2 OU work plan resulted in an assessment of the 200-PW-4 OU waste sites against the 200-PW-2 OU conceptual contaminant distribution models. Consequently, the 216-B-12 waste site was identified as an appropriate conceptual contaminant distribution model for the 216-C-3 Crib, based on waste site physical configuration, liquid effluent volumes, soil pore volumes, and contaminant concentrations. Therefore, the 216-C-3 Crib will not be retained as a representative waste site for the 200-PW-4 OU. Instead, the information obtained from the investigation of the 216-B-12 waste site and the two 200-PW-4 TSD units, as well as other information from the 200-PW-2 OU investigation, will serve as the characterization data for the 200-PW-4 OU.

## 1.6 WASTE SITES AND OPERATING HISTORY

The 200-PW-4 General Process Waste Group OU consists of 16 waste sites located in the Hanford Site 200 East and 200 West Areas. Figures 1-1 through 1-4 depict the locations of the study areas relative to the 200 Areas. The 200-PW-4 OU waste sites and one unplanned release site received mostly process drainage, process distillate discharge, and miscellaneous condensates. Most of the waste discharged to the soil column in this OU was generated at U Plant, REDOX Plant, PUREX Plant, the 242-A Evaporator, and the Hot Semiworks Facility (C Plant) from 1952 through 1994.

### 1.6.1 Plant History

The U Plant was constructed in 1944, based on the design of T and B Plants and initially was used to train personnel for the uranium/plutonium separation and purification operations conducted in T and B Plants. During the training phase, only water was used in the plant systems and no waste streams were generated. However, in 1951 U Plant was modified for the uranium recovery process (URP). From 1952 to 1958, U Plant was used to recover unprocessed uranium stored in single-shell tanks for reuse in the reactor plants and for waste volume reduction at T and B Plants. A later operation conducted at U Plant was the "scavenging" or precipitation of long-lived fission products from the settling process before the waste was discharge to the soil column. The final operation of U Plant was the conversion of uranyl nitrate hexahydrate (UNH) to uranium trioxide ( $UO_3$ ). This operation was accomplished by calcinating the UNH in a batch process within the 224-U Building. In 1957, the batch conversion of UNH to  $UO_3$  was renovated. The two calcinators previously used were removed and replaced with six newer calcinators. The operation was updated to a continuous flow and the 224-U Building became known as the  $UO_3$  Plant.

The  $UO_3$  Plant operated from 1958 until 1972 when the PUREX Plant was placed in stand-down mode. During that time, the  $UO_3$  Plant converted UNH from the PUREX Plant and REDOX Plant to  $UO_3$  powder. The powder was packaged at the  $UO_3$  Plant, stored, and sent offsite to Oak Ridge National Laboratory in Tennessee, and later to Fernald, Ohio, where the  $UO_3$  powder was converted to uranium metal and returned to the Hanford Site's 300 Area for fuel extrusion rework. The  $UO_3$  Plant resumed operations in 1984 to process UNH from the PUREX Plant. Because the feed lines from the REDOX Plant and 221-U Building were no longer in use, they were disconnected and capped in the  $UO_3$  Plant. Operations of the  $UO_3$  Plant ceased in 1988.

The REDOX Plant (S Plant) was the first continuous plutonium-separation operation at the Hanford Site. Not only did the REDOX Plant separate weapons-grade plutonium from the irradiated fuel rods, but it also recovered unspent uranium. The REDOX Plant employed the solvent extraction process, which used hexone (methyl isobutyl ketone) and aluminum nitrate nanohydrate in nitric acid, to complete these separations within the anionic resin columns. The REDOX Plant operations began in 1952 and continued until 1967.

The PUREX Plant replaced the REDOX Plant's separation process. The PUREX Plant process used a recoverable salting agent, proving to be economically more feasible, generating less waste, and operating more safely than the REDOX Plant's process. The construction of the PUREX Plant was completed in late 1955. The PUREX Plant operated continuously from

November 1955 until 1972, separating weapons-grade plutonium and depleted uranium products from irradiated fuel. The PUREX Plant was placed in standby mode from 1972 until 1983 and then restarted in 1983, continuing operations until 1985 when it was deactivated. Since the initial operation of the PUREX Plant, it has been modified to reprocess several types of fuel to obtain various products, including zirconium alloy- (zircaloy-) clad fuel with several different enrichments, ranging from 0.72% to 2.1% of uranium-235 exposed at various durations (300 to approximately 3,000 megawatt days/ton of uranium) to obtain fuel-grade plutonium; slightly enriched uranium and neptunium; uranium metals; uranium and plutonium oxides; and several thorium targets.

The 242-A Evaporator is the primary waste concentrator for the Hanford Site mixed wastes that are stored and treated in the double-shell tank system. Treatment of the wastes removes water and most volatile organics. The 242-A Evaporator started operations in September 1977 and was originally designed for a useful life of 10 years. Subsequent upgrades have extended that service life. Two waste streams leave the 242-A Evaporator following the treatment process. The first waste stream, the concentrated slurry, is pumped back into the double-shell tank system (the AN, AW, and/or AP Tank Farms). The second waste stream, process condensate, originally was routed through condensate filters for treatment before release to the 207-A Retention Basins and the 216-A-37-1 Crib. Following cessation of discharge to these facilities in April 1989, when it was determined that the effluent contained mixed waste regulated under WAC 173-303, the 242-A Evaporator facility was upgraded and discharges were rerouted to the Liquid Effluent Retention Facility, where the discharge receives final treatment at the Effluent Treatment Facility.

The Hot Semiworks aggregate area was composed of two primary facilities: the 201-C Process Building and the Critical Mass Laboratory (209-E Building). The 201-C Process Building was constructed in 1949 as a pilot plant for reprocessing reactor fuel, first using the REDOX Plant's chemical process and then using the PUREX Plant's chemical process in 1954. In 1961, the building was again converted to recover strontium from fission product waste. This facility operated until 1967 and remained in safe-storage mode until decommissioning began in 1983. The Critical Mass Laboratory operated in the 209-E Building from 1960 to 1983, conducting criticality experiments with plutonium nitrate and enriched uranium solutions. Criticality research also was conducted with solid special nuclear materials and fuels. The Critical Mass Laboratory averaged 15 such experiments per year with a maximum of 50 per year. Currently, the Critical Mass Laboratory is closed but not decommissioned. No research has occurred there since 1983.

Liquid wastes generated at U Plant, PUREX Plant, REDOX Plant, C Plant, and T Plant were routed to underground storage tanks (e.g., various REDOX Plant, PUREX Plant, and U and T Plant tank farms) through an underground transfer system. The liquid waste then was evaporated (concentrated) and often neutralized before being routed for various disposal options. The storage tanks were used to settle the heavier constituents out of the liquid effluents, forming sludge. The liquid supernatants in the tanks ultimately were discharged to the soil column via cribs, drains, trenches, and injection/reverse wells. Process distillate and drainage liquids also were sent to cribs and trenches via this underground network (Waste Information Data System).

Cribs and drains were designed to inject or percolate wastewater into the soil column. French drains generally were constructed of steel or concrete pipe. Cribs are shallow excavations that

either are backfilled with permeable material or are voids created by wooden or concrete structures. The cribs and drains typically received low-level radioactive waste for disposal, and most cribs were designed to receive liquid until a specific retention, volume, or radionuclide capacity was met.

Trenches are shallow, long, narrow, unlined excavations and often were located adjacent to other trenches. Some of the trenches have been backfilled and marked as a single group of trenches.

### 1.6.2 Process Information

The processes at U Plant, REDOX Plant, PUREX Plant, and the Hot Semiworks Facility that generated the primary waste streams to the 200-PW-4 OU waste sites included the following:

- U Plant: Waste generated in the 221-U and 224-U Buildings as part of the URP and  $UO_3$  plant operations. Waste streams included aqueous and organic solvent extraction wastes from uranium-recovery operations of original bismuth phosphate/lanthanum fluoride separation-process wastes, process drainage, process distillate drainage, and miscellaneous off-gas/steam condensates from the 291-U-1 Stack, waste treatment condensers, nitric acid and solvent recoveries, 241 and 244 vaults (waste treatment/storage), and 224-U chemical sewer and storm drainage waste streams.
- REDOX Plant: Waste generated in the 202-S and 293-S Buildings. Waste streams were mainly aqueous and organic solvent extraction wastes from several REDOX Plant operations, including process drainage, process distillate drainage, and miscellaneous off-gas condensates from the silver filter, air sparger, ruthenium tetroxide scrubber, nitric acid recovery and radioiodine off-gas treatment, and waste treatment condensers, solvent recovery, and 240 and 241 vaults (waste treatment/storage) waste streams.
- PUREX Plant: Waste generated in 202-A, 203-A, 206-A, 293-A, 294-A, and 295-A Buildings. Waste streams were mainly aqueous and organic solvent extraction wastes from several PUREX Plant operations, including process drainage, process distillate drainage, and miscellaneous off-gas condensates from the acid absorbers, ammonia scrubber, nitric acid fractionalization, waste treatment condensers, solvent recoveries, nitric acid storage, and waste treatment/storage waste streams.
- Hot Semiworks Facility: Until September 1955, cribs received REDOX and PUREX Plant high-salt waste, process condensate from the 201-C Process Building, and material described as "cold-run" waste from the REDOX and PUREX processes. From September 1955 to June 1957, the cribs also received high-salt, cold-run waste from the 201-C Process Building (WHC-SD-EN-TI-019, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*). After June of 1957, the Hot Semiworks Facility was converted to an experimental strontium, cerium, promethium, and technetium recovery facility in the 1960s. Before the actual pilot recovery activities were begun, extensive "cold-run" trials were conducted routinely using nonradioactive materials to verify the operational status of the equipment. From 1960 to 1983, the Critical Mass Laboratory (housed in the 209-E Building) also was in operation. Criticality experiments were

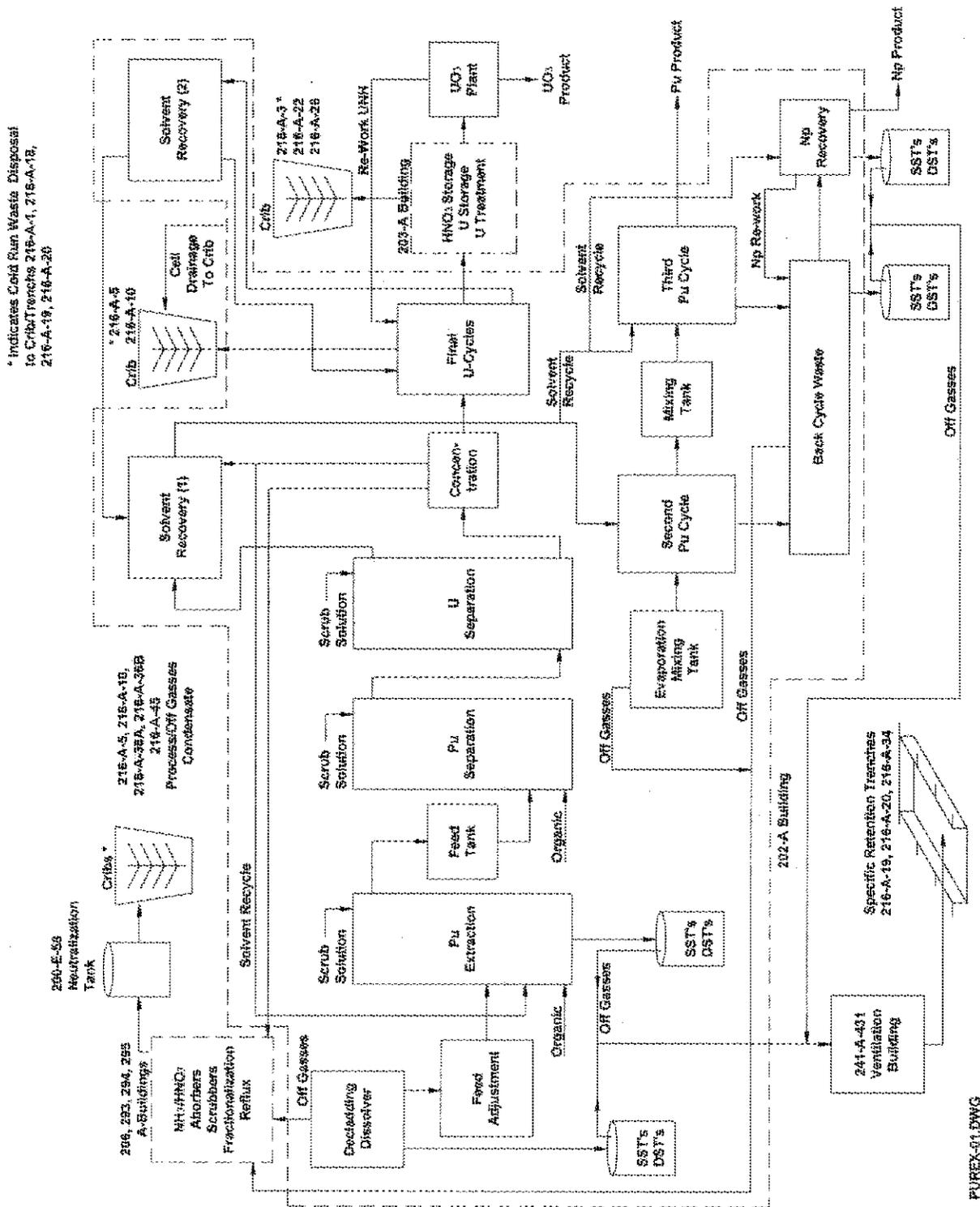
conducted with plutonium nitrate and enriched uranium solutions. Experiments also were performed using solid special nuclear materials and fuels.

- Tanks 241-S-101 and 241-S-104: Tanks 241-S-101 and 241-S-104 received REDOX cladding wastes and high-level wastes from 1953 to 1956. This waste often was self-boiling. Vapors were collected and routed through condensers. The condensates then were routed to the 216-S-4 Crib.
- 242-A Evaporator Facility: Waste from the A Tank Farms was routed to Tank 241-AW-102, which fed the 242-A Evaporator. Waste sent to the 242-A Evaporator included dilute noncomplexed radioactive waste, PUREX dilute miscellaneous waste, PUREX cladding removal waste, and complexed radioactive waste. The 242-A Evaporator also received quantities of 204-AR (tank car) wastes, 300 and 400 Laboratory wastes, 100 N wastes, B Plant aging wastes, United Nuclear Corporation fuel fabrication, and Plutonium Finishing Plant wastes. These wastes may have contained spent solvents. Hazardous chemicals used include sodium nitrate used to regenerate ion-exchange columns, sodium hydroxide used for decontamination applications, and the antifoam agent used in the evaporator vessel.
- 241-TX-155 Diversion Box: The 216-T-20 Trench received contaminated nitric acid from the 241-TX-155 Diversion Box Catch Tank. In 1952, the catch tank was used to transfer T Plant wastes to cribs and trenches. The T Plant was constructed in 1944. From 1945 to 1956, T Plant operations consisted of a batch-wise, inorganic chemical separation (bismuth phosphate/lanthanum fluoride process) of weapons-grade plutonium from irradiated uranium, fission, and activation products.

Figures 1-5, 1-6, and 1-7 show graphical representations of the U Plant, PUREX Plant, and REDOX Plant processes and the corresponding waste streams that were discharged to the 200-PW-4 OU waste sites. Figure 1-8 shows the graphical representation of the process condensate process in the 242-A Evaporator.

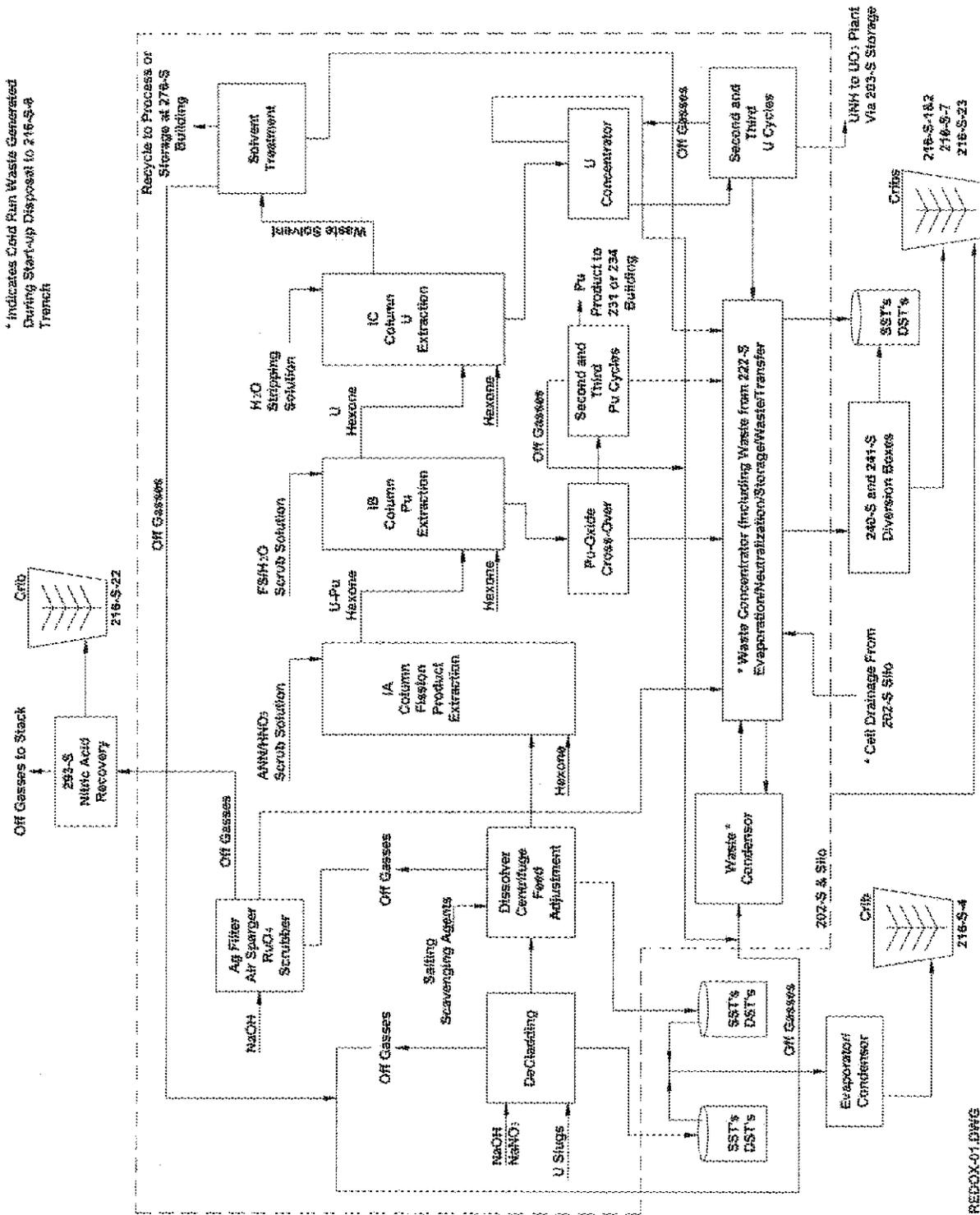


Figure 1-6. Plant Processes and Waste Streams at the Plutonium Uranium Extraction Plant.



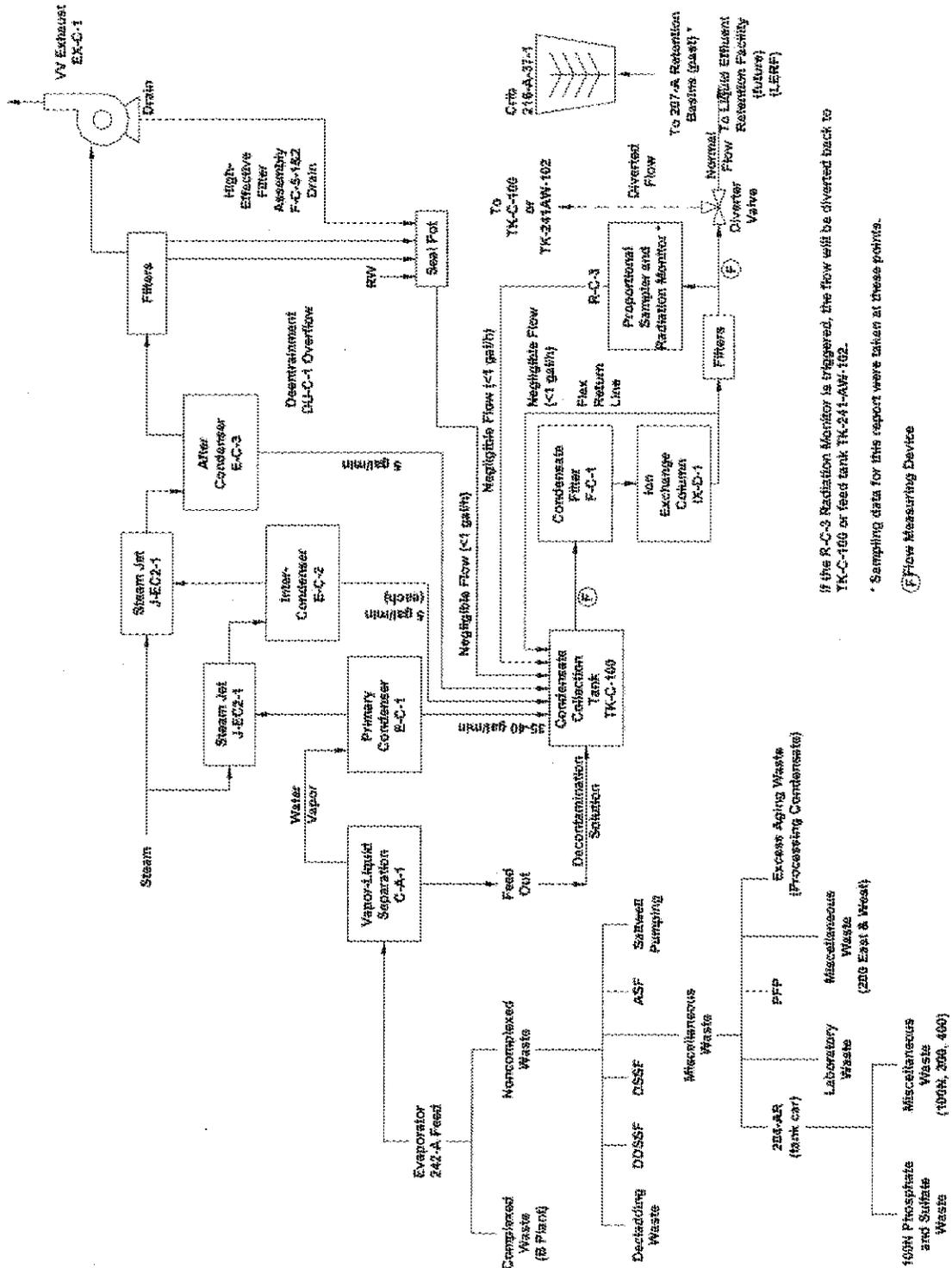
PUREX-61.DWG

Figure 1-7. Plant Processes and Waste Streams at the Reduction Oxidation Plant.



REDOX-01.DWG

Figure 1-8. Plant Processes and Waste Streams at the 242-A Evaporator.



PW2\_4.DWG

If the R-C-3 Radiation Monitor is triggered, the flow will be diverted back to TK-C-100 or feed tank TK-241-AW-102.  
 \* Sampling data for this report were taken at these points.  
 (F) Flow Measuring Device

## 1.7 WORKSHEETS FOR STEP 1 -- STATE THE PROBLEM

Tables 1-1, 1-2, and 1-3 identify the DQO scoping team members, DQO workshop team members, and DQO key decision makers, respectively. The scoping team members listed below are those individuals who contributed to the development of the 200-PW-2 OU DQO process. For the 200-PW-4 OU DQO process, it was not necessary to involve all of the identified team members to develop the DQO checklist and binder before the internal seven-step process began. These team members are available on an as-needed basis. The DQO workshop team members participated in the seven-step DQO process, and the DQO key decision makers provided external review of the results of the process.

Table 1-1. Data Quality Objective Scoping Team Members.

Name	Organization	Area of Expertise (Role)
Roy Bauer	FH Waste Site Remedial Actions	DQO workbook/facilitator
Lorna Dittmer	FH Regulatory Support	Regulatory
Craig Swanson	FH Technical Support	Project manager
Bruce Ford	FH Waste Site Remedial Actions	Project manager
Steve Landsman	FH Radiological Engineering	Manager
Larry Hulstrom	FH Waste Site Remedial Actions	200-PW-4 task lead, author
Bill McMahon	CHG Geosciences	Technical staff, author
Michelle Yates Mandis	CHG Environmental Engineering	Technical staff, author
Jennifer Linville	CHI Regulatory Support/ Environmental Science	Cultural/biological issues
Kevin Singleton	CHI	Technical staff, author
Wendy Thompson	BHI Environmental Technologies	Sampling/field analysis
Rich Weiss	CHI Sample/Data Management	Radiochemical and analytical, data management
Curt Wittreich	CHG Environmental Engineering	CHG technical staff

BHI = Bechtel Hanford, Inc.

CHG = CH2M Hill Hanford Group, Inc.

CHI = CH2M Hill Hanford, Inc.

DQO = data quality objective.

FH = Fluor Hanford.

Table 1-2. Data Quality Objective Workshop Team Members.

Name	Organization	Area of Expertise (Role)
Roy Bauer	FH Waste Site Remedial Actions	DQO workbook/facilitator
Bruce Ford	FH Waste Site Remedial Actions	FH project manager
Larry Hulstrom	FH Waste Site Remedial Actions	200-PW-4 task lead/author
Kevin Singleton	CHI	Technical staff/author
Michelle Yates Mandis	CHG Environmental Engineering	Technical staff, author

CHG = CH2M Hill Hanford Group, Inc.

CHI = CH2M Hill Hanford, Inc.

DQO = data quality objective.

FH = Fluor Hanford.

Table 1-3. Data Quality Objective Key Decision Makers.

Name	Organization	Area of Expertise (Role)
Bryan Foley	DOE	DOE project manager
Brenda Jentzen	Ecology*	Ecology project manager

\* Regulatory lead for 200-PW-4 OU.

DOE = U.S. Department of Energy

Table 1-4 lists the key sources of existing documents and data collected from previous investigations that were reviewed by the DQO team.

Table 1-4. Existing Documents and Data Sources for 200-PW-4 Operable Unit. (7 Pages)

Reference*	Summary
<i>200-PW-2 Uranium-Rich Process Waste Group Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan, DOE/RL-2000-60</i>	Contains information on waste discharge, contaminants of concern, and disposal sites in the vicinity of U Plant, PUREX, REDOX, and other 200 Area operations.
<i>Remedial Investigation Data Quality Objectives Summary Report for the 200-PW-2 Uranium-Rich Process Waste Group Operable Unit, BHI-01411</i>	Contains information on waste, contaminants of concern, and disposal sites in the vicinity of U Plant, PUREX, REDOX, and other 200 Area operations.
<i>200 Areas Waste Sites Handbook, Vols. I and II, RHO-CD-673</i>	Waste site descriptions, releases, waste discharge information, and management reports.
<i>200-UP-2 Operable Unit Technical Baseline Report, WHC-EP-0400</i>	Technical baseline information for the 200-UP-2 OU. Contains information on liquid waste disposal sites in the vicinity of and related to U Plant operations.

Table I-4. Existing Documents and Data Sources for 200-PW-4 Operable Unit. (7 Pages)

Reference*	Summary
<i>Limited Field Investigation for the 200-UP-2 Operable Unit, DOE/RL-95-13 (DOE-RL 1995b)</i>	Summarizes the data collection and analysis activities conducted during the limited field investigation and presents the associated qualitative risk assessment.
<i>Radioactive Contamination in Liquid Wastes Discharged to Ground at Separations Facilities Through June 1958, HW-57649</i>	Summary of radioactive wastes discharged to major disposal sites in the 200 East Area through June 1958.
<i>Index of CPD Crib Building Numbers Designs of CPD Radioactive Liquid Waste Disposal Sites, HW-55176</i>	References to PUREX liquid waste disposal sites that include design sketches.
<i>Tabulation of Radioactive Liquid Waste Disposal Facilities, HW-43121</i>	Brief descriptions of liquid waste sites that include name, dimensions, coordinates, surface elevation, waste source, dates used, and drawing numbers.
<i>Laboratory Studies of Hanford Waste Cribs, HW-63121</i>	Brief descriptions of waste disposal cribs that include names, depth to water, size of soil column, and waste volume received per year.
<i>Radioactive Contamination in Liquid Wastes Discharged to Ground at Separations Facilities Through June 1956, HW-44784</i>	Summary of radioactive wastes discharged to major disposal sites in the 200 East Area through June 1956.
<i>PUREX Plant Source Aggregate Area Management Study Report, DOE/RL-92-04</i>	Waste unit descriptions including cribs, french drains, septic tanks, and drain fields, trenches and ditches, ponds, catch tanks, settling tanks, diversion boxes, underground tank farms designed for high-level liquid wastes, and the lines and encasements that connect them. Waste sites are described separately.
<i>REDOX Plant Source Aggregate Area Management Study Report, DOE/RL-91-60</i>	Waste unit descriptions including cribs, french drains, septic tanks, and drain fields, trenches and ditches, ponds, catch tanks, settling tanks, diversion boxes, underground tank farms designed for high-level liquid wastes, and the lines and encasements that connect them. Waste sites are described separately.
<i>Semiworks Plant Source Aggregate Area Management Study Report, DOE/RL-92-18</i>	Well and operational history information for the 216-C-1 Crib. Waste unit descriptions including cribs, french drains, septic tanks, drain fields, trenches and ditches, ponds, catch tanks, settling tanks, diversion boxes, underground tank farms designed for high-level liquid wastes, and the lines and encasements that connect them. Waste sites are described separately.
<i>U Plant Source Aggregate Area Management Study Report, DOE/RL-91-52</i>	Well and operational history information for the 216-U-8 and 216-U-12 Cribs. Waste unit descriptions including cribs, french drains, septic tanks, drain fields, trenches and ditches, ponds, catch tanks, settling tanks, diversion boxes, underground tank farms designed for high-level liquid wastes, and the lines and encasements that connect them. Waste sites are described separately.

Table 1-4. Existing Documents and Data Sources for 200-PW-4 Operable Unit. (7 Pages)

Reference*	Summary
<i>T Plant Source Aggregate Area Management Study Report</i> , DOE/RL-91-61	Contains information on waste discharge information, contaminants of concern, and disposal sites in the vicinity of T Plant.
<i>Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford</i> , PNL-6456, Vol. 2	Historical data on individual CERCLA sites.
<i>PUREX Plant Final Safety Analysis Report</i> , Revisions 3, 4, and 5, SD-HS-SAR-001	Chronology of significant events that took place at PUREX.
<i>Information on Hanford Site Cribs and Septic Systems</i> , DOE/RL-88-19	Historical data for cribs and septic systems. Data for this report were obtained from the Waste Information Data System (WIDS) and the Hanford Environmental Compliance Records database.
<i>Isolation of Abandoned or Depleted Waste Disposal Sites</i> , HW-57830	Historical data for known liquid waste sites that include number, type, use, status, references, and isolation measures.
<i>Hanford Facility Dangerous Waste Part A Permit Application</i> , DOE/RL-88-21	Waste site information.
<i>Radioactive Liquid Waste Disposal Facilities</i> , HW-33305	Information describing physical characteristics of numerous waste sites.
<i>Summary of Liquid Radioactive Wastes Discharged to the Ground -- 200 Areas July 1952 Through June 1954</i> , HW-33591	Summarizes radioactive contamination discharged to the ground from separation facilities. Detailed data for individual waste sites.
<i>Radioactive Contamination in Liquid Wastes Discharged to Ground at Separations Facilities Through December 1956</i> , HW-8518	Summarizes radioactive contamination discharged to the ground from separation facilities through December 1956. Detailed data for individual waste sites.
<i>Radioactive Contamination in Liquid Wastes Discharged to Ground Separation Facilities Through December 1957</i> , HW-55593	Summarizes radioactive contamination discharged to the ground from separation facilities through December 1957. Detailed data for individual waste sites.
<i>Radioactive Contamination in Liquid Wastes Discharged to Ground at the Separations Facilities Through December 1959</i> , HW-64375	Summarizes radioactive contamination discharged to the ground from separation facilities through December 1959. Detailed data for individual waste sites.

Table 1-4. Existing Documents and Data Sources for 200-PW-4 Operable Unit. (7 Pages)

Reference*	Summary
<i>Radioactive Contamination in Liquid Wastes Discharged to Ground at Separations Facilities Through December 1958</i> , HW-59359	Summarizes radioactive contamination discharged to the ground from separation facilities through December 1958. Detailed data for individual waste sites.
<i>Unconfined Underground Radioactive Waste and Contamination in the 200 Areas</i> , HW-41535	Historical information on waste sites in the 200 Areas.
<i>Focused Feasibility Study of the 200-UP-2 Operable Unit</i> , DOE/RL-95-106	Information on waste site conditions.
<i>Uranium Recovery Technical Manual</i> , HW-19140	Process information on U Plant facilities, chemicals used or stored, and operations and maintenance information including process effluent sampling/analysis methods and theory behind the materials, chemicals, and equipment utilized during the URP campaign. Results of references include general designation of waste streams generated and conclusive evidence that the URP separation and the supplementary purification processes were strictly inorganic in chemical nature with the exception of tributyl phosphate diluted in normal hydrocarbon paraffin.
<i>Waste Site Grouping for 200 Areas Soil Investigations</i> , DOE/RL-96-81	Summarizes site names, locations, type status, site and process descriptions, known and suspected contamination, preliminary contaminant distribution conceptual model (see Section 4.12 and Figure 4-14 in DOE/RL-96-81), site conditions that may affect COC fate and transport, COC mobility in Hanford Site soils, COC distribution and transport to groundwater, and hazards associated with COCs. Provides soil porosity information for each waste site.
<i>200 Areas Disposal Sites for Radioactive Liquid</i> , ARH-947	Waste site and COC information.
<i>An Introduction to the TBP and UO<sub>3</sub> Plants</i> , HW-19400	Process information on U Plant facilities, chemicals used or stored, and operations and maintenance information including process effluent sampling/analysis methods and theory behind the materials, chemicals, and equipment used during the URP campaign. Reference includes general designation of waste streams generated and conclusive evidence that the URP separation and the supplementary purification processes were strictly inorganic in chemical nature, with the exception of tributyl phosphate diluted in normal hydrocarbon paraffin.
<i>REDOX Technical Manual</i> , HW-18700-DEL	Process information on S Plant facilities, chemicals used or stored, and operations and maintenance information including process effluent sampling/analysis methods and theory behind the materials, chemicals, and equipment used during the REDOX process.
<i>PUREX Technical Manual</i> , HW-31000-DEL	Process information on PUREX Plant facilities, chemicals used or stored, and operations and maintenance information including process effluent sampling/analysis methods and theory behind the materials, chemicals, and equipment used during the PUREX process.

Table 1-4. Existing Documents and Data Sources for 200-PW-4 Operable Unit. (7 Pages)

Reference*	Summary
<i>Iodine-129 Contamination: Nature, Extent, and Treatment Technologies</i> , DOE/RL-95-89, Rev. 0	Nature and extent of I-129 contamination in groundwater; process information resulting in iodine-129 contamination.
<i>200-CW-1 Operable Unit Borehole/Test Pit Summary Report</i> , BHI-01367	Contains 200 East Area physical property testing data.
<i>200 Areas Remedial Investigation/Feasibility Study Implementation Plan-Environmental Restoration Program</i> , DOE/RL-98-28	Background waste site information and generic strategy for 200 Area waste site investigations.
<i>Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement</i> , DOE/EIS-0222-F	Land-use plan for the Hanford Site.
<i>Hanford Site Groundwater Monitoring for Fiscal Year 2001</i> , PNNL-13788	Description of groundwater monitoring activities on the Hanford Site. Contains plume and water table maps.
<i>Chemical Information on Tank Supernatants, Cs Adsorption from Tank Liquids onto Hanford Sediments, and Field Observations of Cs Migration from Past Tank Leaks</i> , PNNL-11495	Describes mobility of cesium-137 from tank waste in Hanford Site sediments.
<i>Hanford Engineer Works Technical Manual</i> , HW-10475 (Parts A, B, and C)	Process information on B, T, and U Plant facilities, chemicals used or stored, and operations and maintenance information including process effluent sampling/analysis methods and theory behind the materials, chemicals, and equipment used during the bismuth phosphate campaign. Reference includes general designation of waste streams generated and conclusive evidence that the bismuth phosphate separation and the lanthanum fluoride purification process were strictly inorganic in chemical nature.
<i>Hanford Tank Chemical and Radionuclide Inventories: HDW Model</i> , LA-UR-96-3860, Rev. 4	Scavenged and URP process waste and COC comparisons.
<i>200 East Groundwater Aggregate Area Management Study Report</i> , DOE/RL-92-19	Hydrogeology report.
<i>B Plant Process Condensate Stream-Specific Report</i> , WHC-EP-0342, Addendum 17	Process information on B Plant facilities, chemicals used or stored, and operations and maintenance information, including process effluent sampling/analysis methods and results for the 216-B-12 Crib.

Table 1-4. Existing Documents and Data Sources for 200-PW-4 Operable Unit. (7 Pages)

Reference*	Summary
<i>PUREX Plant Process Condensate Stream-Specific Report</i> , WHC-EP-0342, Addendum 12	Process information on PUREX Plant facilities, chemicals used or stored, and operations and maintenance information, including process effluent sampling/analysis methods and results for the 216-A-10 Crib.
<i>UO<sub>2</sub> Plant Process Condensate Stream-Specific Report</i> , WHC-EP-0342, Addendum 19	Process information on UO <sub>2</sub> Plant facilities, chemicals used or stored, and operations and maintenance information, including process effluent sampling/analysis methods and results for the 216-A-12 Crib.
<i>PUREX Plant Ammonia Scrubber Condensate Stream-Specific Report</i> , WHC-EP-0342, Addendum 14	Process information on PUREX Plant facilities, chemicals used or stored, and operations and maintenance information, including process effluent sampling/analysis methods and results for the 216-A-36B Crib.
<i>242-A Evaporator Process Condensate Stream-Specific Report</i> , WHC-EP-0342, Addendum 15	Process information on 242-A Evaporator facilities, chemicals used or stored, and operations and maintenance information, including process effluent sampling/analysis methods and results relating to the 207-A-South Retention Basin and the 216-A-37-1 Crib.
<i>Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Crib</i> s, PNNL-11523	Contains the current RCRA groundwater monitoring program for these 3 sites, background information, and groundwater chemistry discussions.
<i>Listed Waste History at the Hanford Facility TSD Units</i> , WHC-MR-0517	Contains waste discharge information, contaminants of concern, listed waste codes, and disposal sites in the 200 Area.
<i>Waste Stream Characterization Report</i> , WHC-EP-0287	Contains waste discharge information, contaminants of concern, and disposal sites in the 200 Area.
<i>Status of Groundwater Quality and Monitoring Program at the 216-A-37-1 Crib</i> , CCN 9553466	Groundwater quality and monitoring program at the 216-A-37-1 Crib. Geology, process information, and COPC listing
PNLATLAS/LG-ARCHV/200 EAST & WEST	PNNL database for geophysical logging.
<i>Hanford Site Atlas</i> , BHL-01119, Rev. 2	Site maps.
WIDS reports for 200-PW-4:  207-A-South Retention Basin, 209-E-WS-3 Valve Pit and Catch Tank, 216-A-34 Crib, 216-A-37-1 Crib, 216-A-45 Crib, 216-C-3 Crib, 216-C-5 Crib, 216-C-7 Crib, 216-C-10 Crib, 216-S-4 Crib, 216-S-22 Crib, 216-S-23 Crib, 216-T-20 Trench, 216-U-16 Crib, 216-U-17 Crib, UPR-200-E-145; Waste Information Data System (database)	Summarizes site names, locations, types, status, site and process descriptions, associated structures, cleanup activities, environmental monitoring description, access requirements, references, regulatory information, and waste information (e.g., type, category, physical state, description, and stabilizing activities).

Table 1-4. Existing Documents and Data Sources for 200-PW-4 Operable Unit. (7 Pages)

Reference*	Summary
242-A Evaporator/Crystallizer Campaign Run/Post Run Reports: FY1980 for Run 80-1, Document RHO-CD-80-1045 1 FY1980 for Run 80-5, Document RHO-CD-80-1045 5 FY1980 for Run 80-6, Document RHO-CD-80-1045 6 FY1980 for Run 80-8, Document SD-WM-PE-004 FY1980 for Run 80-9, Document SD-WM-PE-005 FY1982 for Run 82-1, Document SD-WM-PE-002 FY1985 for Run 85-3, Document SD-WM-PE-023 FY1985 for Run 85-4, Document SD-WM-PE-027 FY1986 for Run 86-4, Document SD-WM-PE-031 FY1987 for Run 87-3, Document SD-WM-PE-033	Contains waste feed information such as origin of waste and routing of waste from Hanford and off-site processes through tanks to the 242-A Evaporator.
<i>Tank Characterization Database</i> at <a href="http://twins.pnl.gov:8001/TCD/main.html">http://twins.pnl.gov:8001/TCD/main.html</a>	Tank Sampling efforts of feed tanks to the 242-A Evaporator.
Site visit	Site visit
Hanford Site Drawings H-2-62876, H-2-62877, H-2-69262	Contains construction drawings for 216-A-37-1.
Hanford Site Drawing H-2-69292	Contains construction drawing for 207-A-South.

\* Full reference citations are provided in Chapter 8.0.

Table 1-5 represents the complete unconstrained set of COPCs that were, or could have been, discharged to the 200-PW-4 OU waste sites. The master COPC list was evaluated against a set of exclusion rationale to determine a final list of project COCs. The COPCs that were excluded, and the rationale for their exclusions, are listed in Table 1-6.

Based on a review of process, operational, waste discharge, and sampling and analysis information from various sources (Table 1-4), the chemical behavior of the constituents was evaluated. Process knowledge indicates that the 200-PW-4 OU waste streams were predominantly liquid effluent discharges from the U/UO<sub>3</sub> Plant, PUREX Plant, REDOX Plant, T Plant, the 242-A Evaporator, and the Hot Semiworks Facility. In general, the majority of the

waste generated by operations associated with these waste sites can be described as a variety of liquid effluents, all containing low inventories of radionuclides and mostly low-salt neutral/basic liquids. The waste contains various constituents that include radionuclides, metals, inorganic chemicals, and semivolatile and volatile organic chemicals.

Table I-5. Sources of Contamination, Contaminants of Potential Concerns, and Affected Media for the 200-PW-4 Operable Unit. (2 Pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)		Affected Media
Tank waste discharges from U Plant, T Plant, PUREX, REDOX, 242-A Evaporator, and the experimental processes conducted at the Hot Semiworks Facility.	Various acidic, neutral, and basic waste streams containing, mixed fission products, activation products, inorganic chemicals, metals, semivolatile, and volatile organic chemicals.		Shallow soils, deep zone soils associated with the waste sites, and potentially the groundwater beneath the waste sites.
<i>Radloactive Contaminants of Potential Concern</i>			
Americium-241 Americium-242 Americium-243 Antimony-123 Antimony-125 Barium-137 Barium-137m Barium-140 Cadmium-113m Carbon-14 Cerium-141 Cerium-144 Cesium-134 Cesium-135 Cesium-137 Cobalt-60 Curium-242 Curium-243	Curium-244 Curium-245 Europium-152 Europium-154 Europium-155 Iodine-129 Iodine-131 Lanthanum-140 Neodymium-147 Neptunium-237 Neptunium-239 Nickel-59 Nickel-63 Niobium-93m Niobium-95 Niobium-96 Niobium-98 Palladium-107	Plutonium-238 Plutonium-239/240 Plutonium-241/242 Praseodymium-143 Praseodymium-144 Promethium-147 Radium-226 Radium-228 Rhodium-106 Ruthenium-103 Ruthenium-106 Samarium-149 Samarium-151 Selenium-79 Strontium-89 Strontium-90 Technetium-99	Tellurium-129m Tellurium-129 Thorium-232 Tin-113 Tin-123m Tin-123 Tin-125 Tin-126 Tritium (Hydrogen-3) Uranium-232 Uranium-233/234 Uranium-235/236 Uranium-238 Yttrium-90 Yttrium-91 Zirconium-93 Zirconium-95
<i>Inorganic Contaminants of Potential Concern</i>			
Aluminum Aluminum fluoride Aluminum nitrate Aluminum nitrate nonahydrate (ANN) Aluminum nitrate (mono basic) Aluminum silicate Aluminum sulfate Ammonia Ammonium cerium nitrate Ammonium hydroxide Ammonium iron fluoride Ammonium iron sulfate Ammonium lanthanum nitrate Ammonium oxalate Ammonium fluoride/ammonium nitrate (AFAN) Ammonium fluorosilicate Ammonium sulfate	Anionic resins (sulfates) Antimony Arsenic Barium Beryllium Bismuth Bismuth subnitrate/oxynitrate Bismuth orthophosphate Borate(s) Cadmium Calcium Calcium carbonate (lime) Calcium nitrate Cerium Cerium phosphate Cesium nitrate Cesium phosphate Chloride Chromic acid	Chromium Chromium nitrate Copper Cyanide(s) Ferric ammonium sulfate Ferric hydroxide Ferric nitrate Ferrous ammonium sulfate Ferro/ferric cyanide Ferrous sulfamate Fluoride Hydrazine Hydrochloric acid Hydrofluoric acid Hydroiodic acid Hydrogen Hydrogen peroxide Hydroxide Hydroxylamine hydrochloride Hydroxylamine nitrate (HN)	Iron Iron sulfate Lanthanum Lanthanum fluoride Lanthanum hydroxide Lanthanum nitrate Lead Lead oxide Magnesium Magnesium nitrate Manganese Manganese oxide Manganese nitrate Mercury Molybdenum Nickel Nickel sulfate Nitrate Nitrite Nitric acid

Table 1-5. Sources of Contamination, Contaminants of Potential Concerns, and Affected Media for the 200-PW-4 Operable Unit. (2 Pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)		Affected Media
Tank waste discharges from U Plant, T Plant, PUREX, REDOX, 242-A Evaporator, and the experimental processes conducted at the Hot Semiworks Facility.	Various acidic, neutral, and basic waste streams containing, mixed fission products, activation products, inorganic chemicals, metals, semi-volatile, and volatile organic chemicals.		Shallow soils, deep zone soils associated with the waste sites, and potentially the groundwater beneath the waste sites.
<i>Inorganic Contaminants of Potential Concern (cont)</i>			
Ozone Peroxide Phosphate Phosphoric acid Phosphotungstic acid (PTA) Plutonium Plutonium fluoride Plutonium dioxide Plutonium nitrate Plutonium peroxide Potassium Potassium carbonate Potassium chloride Potassium dichromate Potassium hydroxide Potassium fluoride	Potassium nitrate Potassium permanganate Ruthenium oxide Selenium Silicon Silver Sodium Sodium aluminate Sodium bicarbonate Sodium carbonate Sodium chloride Sodium dichromate Sodium fluoride Sodium hexametaphosphate (Calgon) Sodium hydroxide	Sodium metabisulfate Sodium nitrate Sodium nitrite Sodium oxalate Sodium silicate Sodium sulfate Sodium hydrogen sulfate Sodium phosphate Disodium phosphate Sodium pyrophosphate Sodium uranyl carbonate Disodium uranyl oxide Strontium (metal) Strontium carbonate Strontium nitrate Sulfamic acid	Sulfate Sulfite Sulfuric acid Tin Tungsten Uranium Uranium dioxide Uranium trioxide Uranyl nitrate Vanadium Zinc Zinc nitrate Zinc phosphate Zirconium Zirconium carbonate gel Zirconyl nitrate
<i>Organic Chemical Contaminants of Potential Concern</i>			
Acetic acid Acetone AMSCO Benzene Benzaldehyde Benzyl alcohol Bromodichloromethane Butanol (butyl alcohol) 2-butanone (methyl ethyl ketone/MEK) 2-Butoxyethanol Butoxydiglycol Butoxyglycol Butoxytriethylene glycol Butyraldehyde (butanal) Carbon tetrachloride Cis/trans-1,2-dichloroethylene Chlorobenzene Chloroform (trichloromethane) Citrate di(2-ethylhexyl) phosphoric acid Dibutyl phosphate (DBP) Dibutyl butyl phosphonate (DBBP)	1,1-dichloroethane (1,1-DCA) 1,2-dichloroethane (1,2-DCA) 1,1-dichloroethylene (1,1-DCE) Dimethylnitrosamine 3,5-Dimethylpyridine Dodecane Ethoxytriethylene glycol Ethyl ether (ethanol) Ethylene diamine tetraacetate (EDTA) Ethylene glycol Ethylbenzene Heptadecane Hexadecane Hexanoic acid (caproic acid) Hydraulic fluids (greases) Hydroxyacetic acid Hydroxyquinoline Isopropyl alcohol (2-Propanol) Kerosene Lard Oil Methanol Methylene chloride	Methyl iso butyl ketone (MIBK/hexone) Methoxydiglycol Methoxytriglycol Methyl n-butyl ketone (MBK 2-Hexanone) 2-Methylnonane Methyl n-propyl ketone (MPK 2-Pentanone) Mono-2-ethylhexyl phosphoric acid Monobutyl phosphate n-butyl benzene n-Nitrodimethylamine Normal paraffin hydrocarbons Oxalate p-Dichlorobenzene Pentadecane Pentasodium diethylene triamine penta acetate (DTPA) Phenol Polychlorinated biphenyls (PCBs) Pyridine	Sodium gluconate Sodium tetraphenyl boron Sugar Sulfonic acid (Chloro) Super gel hyflo Tartaric acid Tetrachloroethylene (PCE) Tetradecane Tetrahydrofuran (THF) Thenoyltrifluoroacetone Thymolphthalein Toluene Tributyl phosphate (TBP) 1,1,1-trichloroethane (1,1,1-TCA) Trichloroethylene (TCE) Tridecane Triglyme Tris (hydroxymethyl) amino methane Trisodium nitro triacetate (NTA) Trisodium hydroxyethyl ethylene - diamine triacetate (HEDTA) Vinyl chloride Xylene

The first step in the evaluation process involved extracting known toxic materials from the master COPC list for placement on the final COC list. Inorganic salts represent a large group of constituents in the waste sites being evaluated. Because the constituents were discharged in an aqueous medium, and laboratory analyses generally are not compound specific, the acids and inorganic salts were excluded from further consideration. Instead, the readily detected anions (e.g., fluorides, nitrates) associated with the acids and inorganic salts serve as the target constituents for those compounds. This logic recognizes the small volumes of wastes released into moderate-to-large-volume aqueous discharges.

No known pesticides were discharged directly into the waste sites as waste streams. During sampling and analysis efforts conducted throughout the 200 Areas including the BY cribs, the 216-A-29 Ditch, the 216-T-26 Crib, and the 216-B-38 Trench, pesticides and herbicides either have not been present or have been detected at concentrations slightly above detection limits, but far less than action levels (persistent concentrations or greater than 1% for endosulfan II and 0.01% for 4,4'-DDT and aldrin) in the waste sites. Based on past analytical results (e.g., HEIS numbers B12682, B12684), pesticides and herbicides are excluded from further sampling in the 200-PW-2 and 200-PW-4 OU characterization efforts (DOE/RL-92-70, *Phase I Remedial Investigation Report for 200-BP-1 Operable Unit*).

The analytical approach employed for this project generally targets the significant risk drivers that are representative of the waste constituents present. The general suite-type analytical techniques yield results on many metals and organic compounds, providing a cost-effective approach for the known toxic materials that could be present.

The COPCs in the following categories were dropped from further consideration:

- Short-lived radionuclides with half-lives less of than 3 years
- Radionuclides that constitute less than 1% of the fission product inventory and for which historical sampling indicates nondetection
- Naturally occurring isotopes that were not created as a result of Hanford Site operations
- Constituents with atomic mass numbers greater than 242 that represent less than 1 percent of the actinide activities
- Progeny radionuclides that build insignificant activities within 50 years and/or for which parent/progeny relationships exist that permit progeny estimation
- Constituents that would be neutralized and/or decomposed by facility processes
- Chemicals in a gaseous state that cannot accumulate in soil media
- Chemicals used in minute quantities relative to the bulk production chemicals consumed in the normal processes; these chemicals have no suspected introduction to the waste streams except in incidental quantities
- Chemicals that are not persistent in the environment, because of volatilization, biological degradation, or other natural mitigating features
- Chemicals that are not persistent in the vadose zone, because of high mobility and previous confirmatory sampling/analysis activities
- Chemical substances that are not found on the tables in Ecology Publication No. 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1*, and therefore are not regulated by WAC 173-340.

Table 1-6 includes the list of COPCs that were excluded and the specific rationale of exclusions for each radionuclide/nonradionuclide.

Table 1-6. 200-PW-4 Operable Unit Contaminant of Potential Concern Exclusions and Justifications. (10 Pages)

COPC*	Rationale for Exclusion
<b>Radionuclides</b>	
Americium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Americium-243	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Antimony-123	Stable.
Antimony-125	Short-lived radionuclide (half-life <3 years).
Barium-137	Stable.
Barium-137m	Short-lived daughter of Cs-137 (which is a final COC).
Barium-140	Short-lived radionuclide (half-life <3 years).
Cadmium-113m	Less than 1% of Sr-90/Cs-137 activity (based on ORIGIN2 modeling of Hanford reactor production).
Cerium-141	Short-lived radionuclide (half-life <3 years).
Cerium-144	Short-lived radionuclide (half-life <3 years).
Cesium-134	Short-lived radionuclide (half-life <3 years).
Cesium-135	Constituent generated at less than 5E-05 times the Sr-90/Cs-137 activity (based on ORIGIN2 modeling of Hanford reactor production).
Curium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Curium-243	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Curium-244	Constituent with atomic mass number greater than or equal to 242 that represents less than 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production). May be reported via americium isotopic analysis.
Curium-245	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Iodine-131	Volatile gas emission; short-lived radionuclide (half-life <3 years).
Lanthanum-140	Short-lived radionuclide (half-life <3 years).
Neodymium-147	Short-lived radionuclide (half-life <3 years).
Neptunium-239	Short-lived radionuclide (half-life <3 years).
Nickel-59	Activity will be <5% of Ni-63 (final COC) activity and (based on ORIGIN2 modeling of Hanford reactor production) and may be estimated from that isotope.

Table 1-6. 200-PW-4 Operable Unit Contaminant of Potential Concern Exclusions and Justifications. (10 Pages)

COPC*	Rationale for Exclusion
Niobium-93m	Constituent generated at less than 5E-05 times the Sr-90/Cs-137 activity (based on ORIGEN2 modeling of Hanford reactor production).
Niobium-95	Short-lived radionuclide (half-life <3 years).
Niobium-96	Short-lived radionuclide (half-life <3 years).
Niobium-98	Short-lived radionuclide (half-life <3 years).
Palladium-107	Constituent generated at less than 5E-05 times the Sr-90/Cs-137 activity (based on ORIGEN2 modeling of Hanford reactor production).
Plutonium-241	Not detected by normal Pu analysis, can infer from final COCs Am-241, Pu-238, and Pu-239/240 results.
Plutonium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Praseodymium-143	Short-lived radionuclide (half-life <3 years).
Praseodymium-144	Short-lived radionuclide (half-life <3 years).
Promethium-147	Short-lived radionuclide (half-life <3 years).
Rhodium-106	Short-lived radionuclide (half-life <3 years).
Ruthenium-103	Short-lived radionuclide (half-life <3 years).
Ruthenium-106	Short-lived radionuclide (half-life <3 years).
Samarium-149	Stable.
Samarium-151	Less than 1% of Cs-137 activity (based on ORIGEN2 modeling of Hanford reactor production).
Selenium-79	Constituent generated at less than 5E-05 times Cs-137 activity (based on ORIGEN2 modeling of Hanford reactor production).
Strontium-89	Short-lived radionuclide (half-life <3 years).
Tellurium-129m	Short-lived radionuclide (half-life <3 years).
Tellurium-129	Short-lived radionuclide (half-life <3 years).
Tin-113	Short-lived radionuclide (half-life <3 years).
Tin-123m	Short-lived radionuclide (half-life <3 years).
Tin-123	Short-lived radionuclide (half-life <3 years).
Tin-125	Short-lived radionuclide (half-life <3 years).
Tin-126	Constituent generated at less than 5E-05 times the Sr-90/Cs-137 activity (based on ORIGEN2 modeling of Hanford reactor production). (GEA will be reported if detected)
Uranium-232	Less than 2E-03 times the U-238 (final COC) activity (based on ORIGEN2 modeling of Hanford reactor production).
Uranium-233	Measurement cannot resolve U-233 + U-234 isotopes, reported as final COCs U-234 or U-233/234.
Uranium-236	Measurement cannot resolve U-235 + U-236 isotopes, reported as final COCs U-235.

Table 1-6. 200-PW-4 Operable Unit Contaminant of Potential Concern Exclusions and Justifications. (10 Pages)

COPC*	Rationale for Exclusion
Yttrium-90	Short-lived daughter of Sr-90 (which is a final COC).
Yttrium-91	Short-lived radionuclide (half-life <3 years).
Zirconium-93	Constituent generated at less than 5E-05 times the Sr-90/Cs-137 activity (based on ORIGEN2 modeling of Hanford reactor production).
Zirconium-95	Short-lived radionuclide (half-life <3 years).
<b>Inorganics</b>	
Aluminum	The CLARC 3.1 Tables (Ecology 94-145), regulated by WAC 173-340, list only a method to calculate the soil concentration protective of groundwater. 45.2 mg Al/kg soil is the calculated number. However, the background concentration far exceeds this value. Thus, WAC 173-340 defers to the soil background concentration of this inorganic substance. It is doubtful that the concentration of Al will exceed 11,000 mg Al/kg soil (DOE/RL-94-24, <i>Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes</i> ). Routine analyte reported by ICP analysis.
Bismuth	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Borate	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Calcium	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Carbonate(axb)	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Cerium	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Cesium	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Hydrazine	Extremely reactive, soluble and very likely to have degraded and not be present within the waste stream after thermal treatment through the evaporator. "Contained-ins" for this compound have been approved in both 200 East (200-CW-1) and 200 West (200-CS-1) Characterization efforts.
Hydrogen	Gas.
Hydroxylamine	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Hydroxylamine was used during the PRF process. Extremely reactive, very likely to have degraded and be present within the waste stream. Used as a reducing agent for its highly reactive properties. Because it is very reactive, unlikely to be present in large quantities. Decomposes to ammonium hydroxide, nitrogen, and water.
Hydroxylamine hydrochloride	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Hydroxylamine was used during the PRF process. Extremely reactive, very likely to have degraded and be present within the waste stream. Used as a reducing agent for its highly reactive properties. Because it is very reactive, unlikely to be present in large quantities. Decomposes to ammonium hydroxide, nitrogen, and water.

Table 1-6. 200-PW-4 Operable Unit Contaminant of Potential Concern Exclusions and Justifications. (10 Pages)

COPC*	Rationale for Exclusion
Hydroxylamine nitrate	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Hydroxylamine was used during the PRF process. Extremely reactive, very likely to have degraded and be present within the waste stream. Used as a reducing agent for its highly reactive properties. Because it is very reactive, unlikely to be present in large quantities. Decomposes to ammonium hydroxide, nitrogen, and water.
Hydroxide	Assessed via pH determination.
Iodine	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Iron	The CLARC 3.1 Tables (Ecology 94-145) regulated by WAC 173-340 lists only a method to calculate the soil concentration protective of groundwater. 1320 mg Fe/kg soil is the calculated number. However, the background concentration far exceeds this value. Thus, WAC 173-340 defers to the soil background concentration of this inorganic substance. It is unlikely that the concentration of Fe will exceed 32,600 mg Fe/kg soil. (DOE/RL-94-24) Routine analyte reported by ICP analysis.
Lanthanum	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Magnesium	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Manganese	The CLARC 3.1 Tables (Ecology 94-145) regulated by WAC 173-340 lists a Method C noncarcinogen value of 4.9E+05 mg Mn/kg soil. The CLARC 3.1 Tables also lists a method to calculate the soil concentration protective of groundwater. 50.2 mg Mn/kg soil is the calculated number. However, the background concentration far exceeds this value. Thus, WAC 173-340 defers to the soil background concentration of this inorganic substance. It is doubtful that the concentration of Mn will exceed 512 mg Mn/kg soil. (DOE/RL-94-24) Routine analyte reported by ICP analysis.
Molybdenum	The CLARC 3.1 Tables (Ecology 94-145) regulated by WAC 173-340 lists a Method C noncarcinogen value of 1.75E+04 mg Mo/kg soil. The CLARC 3.1 Tables also lists a method to calculate the soil concentration protective of groundwater. 16.3 mg Mo/kg soil is the calculated number. However, the background concentration far exceeds this value. Thus, WAC 173-340 defers to the soil background concentration of this inorganic substance. It is doubtful that the concentration of Mo will exceed 0.33 mg Mo/kg soil. (DOE/RL-94-24) Routine analyte reported by ICP analysis.
Ozone	Gas.
Peroxide	Has degraded to oxygen gas.
Phosphotungstic acid (PTA)	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. PTA has degraded to phosphate (final COC) and will be measured as such.
Plutonium	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Potassium	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.

Table 1-6. 200-PW-4 Operable Unit Contaminant of Potential Concern Exclusions and Justifications. (10 Pages)

COPC*	Rationale for Exclusion
Ruthenium	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Radiological ruthenium oxide compounds were formed and released during fuel dissolution at all separations plants. This gas was captured by silver reactors in REDOX and PUREX. As ruthenium has a half-life less than 2 years, and oxide is a gas, the compound has degraded and would not be present on an analysis.
Silicon	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Sodium	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Strontium	The CLARC 3.1 Tables (Ecology 94-145) regulated by WAC 173-340 lists a Method C noncarcinogen value of 2.1E+06 mg Sr/kg soil. The CLARC 3.1 Tables also lists a method to calculate the soil concentration protective of groundwater. 2920 mg Sr/kg soil is the calculated number. It is unlikely that the concentration of nonradioactive Sr will exceed this value. This is a routine analyte reported by ICP analysis which will be evaluated as part of the overall RI data analysis.
Sulfamates	Has degraded to sulfate which is retained as a COC. This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340
Sulfite	Used in minimal quantities at Hanford. Reactive material with minimal lifetime in Hanford environment. Degraded to sulfate which is retained as a COC.
Tin	The CLARC 3.1 Tables (Ecology 94-145) regulated by WAC 173-340 lists a Method C noncarcinogen value of 2.1E+06 mg Sn/kg soil. The CLARC 3.1 Tables also lists a method to calculate the soil concentration protective of groundwater. 2.5E+04 mg Sn/kg soil is the calculated number. It is unlikely that the concentration of nonradioactive Sr will exceed this value. This is a routine analyte reported by ICP analysis which will be evaluated as part of the overall RI data analysis.
Tungsten	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Uranium	Radiological analysis will supercede any chemical analysis performed for this constituent.
Vanadium	The CLARC 3.1 Tables (Ecology 94-145) regulated by WAC 173-340 lists a Method C noncarcinogen value of 2.45E+04 mg V/kg soil. The CLARC 3.1 Tables also lists a method to calculate the soil concentration protective of groundwater. 2.24E+03 mg V/kg soil is the calculated number. However, the background concentration far exceeds this value. Thus, WAC 173-340 defers to the soil background concentration of this inorganic substance. It is doubtful that the concentration of V will exceed 85.1 mg V/kg soil. (DOE/RL-94-24) Routine analyte reported by ICP analysis.
Zinc	The CLARC 3.1 Tables (Ecology 94-145) regulated by WAC 173-340 lists a Method C noncarcinogen value of 1.05E+06 mg Zn/kg soil. The CLARC 3.1 Tables also lists a method to calculate the soil concentration protective of groundwater. 5.97E+03 mg Zn/kg soil is the calculated number. However, the background concentration far exceeds this value. Thus, WAC 173-340 defers to the soil background concentration of this inorganic substance. It is doubtful that the concentration of Zn will exceed 67.8 mg Zn/kg soil. (DOE/RL-94-24) Routine analyte reported by ICP analysis.

Table 1-6. 200-PW-4 Operable Unit Contaminant of Potential Concern Exclusions and Justifications. (10 Pages)

COPC*	Rationale for Exclusion
Zirconium	This inorganic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
<i>Organics</i>	
Acetate	Food-grade chemical (vinegar). The pH will be determined in the laboratory. This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Benzyl alcohol	Should it be present above detectable limits, it will be represented by a "tentatively identified compound" or TIC by the analytical laboratory during analysis 8260 (volatile organics). Very soluble in water; likely to have migrated; reasonably biodegradable. Not likely to be present in toxic and/or flammable concentrations.
Benzylaldehyde	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Bromodichloromethane	This organic was used in minimal quantities during laboratory operations. Should it be present above detectable limits, it will be represented by a TIC by the analytical laboratory during analysis 8260 (volatile organics).
Butanol (butyl alcohol)	Degradation product of TBP used in various processes and experiments including URP and PUREX operations. (HW-19140, WHC 1990, Addendum 12). Should this organic compound be present above detectable limits, it will be represented by a TIC by the analytical laboratory during analysis 8260 (volatile organics).
2-Butoxyethanol	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Butoxydiglycol	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Butoxyglycol	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Butoxytriethylene glycol	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Butyraldehyde (butanal)	This organic substance is not found on the CLARC 3.1 Tables Ecology 94-145) and therefore is not regulated by WAC 173-340.
Citrate	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexants.
di(2-ethylhexyl) phosphoric acid	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexants.
Dibutyl butyl phosphonate (DBBP)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. DBBP was widely used as a solvent during the PRF and americium recovery operations. Will degrade to phosphate and be detected in those analytical measurements.

Table 1-6. 200-PW-4 Operable Unit Contaminant of Potential Concern Exclusions and Justifications. (10 Pages)

COPC*	Rationale for Exclusion
Dibutyl phosphate (DBP)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. This compound is a degradation product of tributyl phosphate and is unlikely to be present in toxic or high concentrations. Will degrade to phosphate and be detected in those analytical measurements.
Dimethylnitrosamine	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
3,5-Dimethylpyridine	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-1451) and therefore is not regulated by WAC 173-340.
Ethanol (ethyl alcohol)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Very soluble in water; likely to have migrated or vaporized if exposed; reasonably biodegradable. Available and used as food-grade materials and not likely to be present in toxic and/or flammable concentrations.
Ethoxytriethylene glycol	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Ethylene-diamine tetraacetic acid (EDTA)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexants.
Ethylene glycol	Miscible with water (completely dissolves), thus it is subject to biodegradation, and somewhat mobile in soil (Wade 1991, <i>Organic Chemistry</i> ). Extremely unlikely to be detected in soil samples due to large volume water dilution and dispersion.
Ethyl ether	Very soluble in water; likely to have migrated or vaporized if exposed; reasonably biodegradable. Should it be present above detectable limits, it will be represented by a TIC by the analytical laboratory during analysis 8015 nonhalogenated VOA).
Heptadecane	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Degradation products would be identified by TPH analyses.
Hexadecane	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Degradation products would be identified by TPH analyses.
Hexanoic acid (caproic acid)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Hydroxyacetic acid	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Has degraded to acetate and hydroxides. Acetate is a food-grade chemical (vinegar). The pH will be determined in the laboratory. Has dissolved into a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicated the presence of complexing agents. Hydroxide will be assessed via pH.
Hydroxyquinoline	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicated the presence of complexants.

Table 1-6. 200-PW-4 Operable Unit Contaminant of Potential Concern Exclusions and Justifications. (10 Pages)

COPC*	Rationale for Exclusion
Isopropyl alcohol (2-propanol)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Very soluble in water; likely to have migrated or vaporized if exposed; reasonably biodegradable.
Lard oil	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Food-grade chemical with no applicable regulatory action levels.
Methanol	Very soluble in water; likely to have migrated or vaporized if exposed; reasonably biodegradable. Should it be present above detectable limits, it will be represented by a TIC by the analytical laboratory during analysis 8015M (nonhalogenated VOA).
Methoxydiglycol	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Methoxytriglycol	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Methyl n-butyl ketone (MBK/2-hexanone)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
2-Methylnonane	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Methyl n-propyl ketone (MPK/2-pentanone)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Mono-2-ethylhexyl phosphoric acid	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexants. Will degrade to phosphate and be detected in those analytical measurements.
Monobutyl phosphate	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. This compound is a degradation product of tributyl phosphate and is unlikely to be present in toxic or high concentrations. Will degrade to phosphate and be detected in those analytical measurements.
n-Nitrodimethylamine	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Oxalate	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexants.
p-Dichlorobenzene	This organic was used in minimal quantities during laboratory operations. Should it be present above detectable limits, it will be represented by a TIC by the analytical laboratory during analysis 8260 (volatile organics).
Pentadecane	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Degradation products would be identified by TPH analyses.

Table 1-6. 200-PW-4 Operable Unit Contaminant of Potential Concern Exclusions and Justifications. (10 Pages)

COPC*	Rationale for Exclusion
Pentasodium diethylene triamine penta acetate (DTPA)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Has dissolved to a complexing agent (acetate) that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexants.
Pyridine	This organic was used in minimal quantities during laboratory operations. Should it be present above detectable limits, it will be represented by a TIC by the analytical laboratory during analysis 8260 (volatile organics).
Sodium gluconate	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Available as a food-grade material. Minimum potential for presence in toxic level quantities. Has dissolved to a complexing agent that could have affected the mobility of COCs. Unexpected mobility of COCs will indicate the presence of complexants.
Sodium tetraphenyl boron	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Sugar	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. This is a food-grade material with no applicable regulatory action levels.
Sulfonic acid (chloro)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. This chemical has degraded to sulfate and chlorine, which are both listed as COCs.
Super gel hyflo	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. A chromatography medium that was utilized in determining if samples collected from various steps of the bismuth phosphate and URP processes had successfully reacted, separated, etc. This organic substance is unlikely to be present in toxic concentrations.
Tartaric acid	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexants.
Tetradecane	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Degradation products would be identified by TPH analyses.
Tetrahydrofuran	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. This compound is unlikely to be present in toxic or high concentrations.
Thenoyltrifluoroacetone	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. This compound is unlikely to be present in toxic or high concentrations. No direct standard analytical technique available.
Thymoiphthalein	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Laboratory indicator. Typically used in drop quantities as <1% solutions. No analytical or toxicity issues identified.

Table 1-6. 200-PW-4 Operable Unit Contaminant of Potential Concern Exclusions and Justifications. (10 Pages)

COPC*	Rationale for Exclusion
Tridecane	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Degradation products would be identified by TPH analyses.
Triglyme	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340.
Tris (hydroxymethyl) amino methane	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. Very soluble. Available and used as pharmaceutical-grade materials. Minimal potential for presence in toxic level quantities. No direct standard analytical technique available.
Trisodium nitrilo triacetate (NTA)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexants.
Trisodium hydroxyethyl ethylene-diamine triacetate (HEDTA)	This organic substance is not found on the CLARC 3.1 Tables (Ecology 94-145) and therefore is not regulated by WAC 173-340. No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexants.

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| * COC = contaminant of concern.               | REDOX = Reduction-Oxidation (Plant).   |
| COPC = contaminant of potential concern.      | RI = remedial investigation.           |
| GEA = gamma energy analysis.                  | TIC = tentatively identified compound. |
| ICP = inductively coupled plasma.             | TPH = total petroleum hydrocarbons.    |
| PRF = Plutonium Reclamation Facility.         | URP = uranium recovery process.        |
| PUREX = Plutonium-Uranium Extraction (Plant). | VOA = volatile organic analysis.       |

Table 1-7 includes the lists of final COCs for the 200-PW-4 OU and the rationale for inclusion for each of the COCs.

Table 1-7. 200-PW-4 Operable Unit Final Contaminants of Concern List. (5 Pages)

Final COCs*	Rationale for Inclusion
<b>Radioactive Constituents</b>	
Americium-241	Reactor product and listed via tank farm integration (LA-UR-96-3860, WHC-SD-WM-ER-133, <i>An Assessment of the Inventories of the Ferrocyanide Watchlist Tanks</i> ).
Carbon-14	Fission/activation product and listed via tank farm integration (LA-UR-96-3860, WHC-SD-WM-ER-133).
Cesium-137	Known fission product (HW-10475, Sections A, B, and C; WHC-SD-WM-ER-133).
Cobalt-60	Known activation product (HW-10475, Sections A, B, and C; WHC-SD-WM-ER-133; WHC-MR-0270, <i>200-BP-5 Operable Unit Technical Baseline Report</i> ).

Table 1-7. 200-PW-4 Operable Unit Final Contaminants of Concern List. (5 Pages)

<b>Final COCs*</b>	<b>Rationale for Inclusion</b>
Europium-152	Known fission product (HW-10475, Sections A, B, and C; HNF-01744, <i>Radionuclide Inventories of Liquid Waste Disposal Sites on the Hanford Site</i> ).
Europium-154	Known fission product (HW-10475, Sections A, B, and C; HNF-01744).
Europium-155	Known fission product (HW-10475, Sections A, B, and C; WHC-SD-WM-ER-133).
Hydrogen-3 (tritium)	Fission/activation product and listed via tank farm integration (LA-UR-96-3860, WHC-SD-WM-ER-133).
Iodine-129	Reactor product HW-10475, Sections A, B, and C).
Neptunium-237	Reactor product and listed via tank farm integration (LA-UR-96-3860, WHC-SD-WM-ER-133).
Nickel-63	Activation product and listed via tank farm integration (LA-UR-96-3860, WHC-SD-WM-ER-133).
Plutonium-238	Reactor product (HW-10475, Sections A, B, and C).
Plutonium-239/240	Reactor product (HW-10475, Sections A, B, and C).
Radium-226	Known production from fission reaction and listed via tank farm integration (LA-UR-96-3860, WHC-SD-WM-ER-133).
Radium-228	Known production from fission reaction and listed via tank farm integration (LA-UR-96-3860, WHC-SD-WM-ER-133).
Strontium-90	Known fission product (HW-10475, Sections A, B, and C; WHC-SD-WM-ER-133).
Technetium-99	Known fission product (HW-10475, Sections A, B, and C; WHC-MR-0270).
Thorium-232	Reactor feed HW-10475, Sections A, B, and C; HNF-01744).
Uranium-233/234	Reactor feed (HW-10475, Sections A, B, and C).
Uranium-235/236	Reactor feed (HW-10475, Sections A, B, and C).
Uranium-238	Reactor feed (HW-10475, Sections A, B, and C).
<b>Chemical Constituents – Metals</b>	
Antimony	Metal byproduct from uranium fuel rod (HW-19140).
Arsenic	RCRA treatment, storage, and disposal unit analyte.
Barium	Metal byproduct from uranium fuel rod (HW-19140).
Beryllium	Metal used in braze to seal end of fuel rod (HW-19140).
Cadmium	Metal used in lead-dipped cladding and thus cladding waste stream (1952 to 1956) (HW-10475, Section A).
Chromium	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth phosphate process (HW-10475, Section C; WHC-MR-0132, <i>History of the 200 Area Tank Farms</i> ).

Table 1-7. 200-PW-4 Operable Unit Final Contaminants of Concern List. (5 Pages)

Final COCs*	Rationale for Inclusion
Chromium (VI)	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth phosphate process (HW-10475, Section C; WHC-MR-0132).
Copper	Metal used in triple-dip process of cladding and thus cladding waste stream (1944 to 1952) (HW-10475, Section A).
Lead	Metal used in lead-dipped cladding and thus cladding waste stream (1952 to 1956) (HW-10475, Section A) lead oxide was added as an oxidizing agent to the first- and second-cycle decontamination operations of bismuth phosphate process (HW-10475, Section C).
Mercury	Several uses in bismuth phosphate campaign including addition to cladding and metal waste streams to prevent gaseous generations and miscellaneous laboratory uses. Listed by the basis of knowledge gained by interviews and via tank farm integration (LA-UR-96-3860).
Nickel	Experimental additions of nickel sulfate added during the bismuth phosphate process to serve as a scavenging agent. Listed as a result of tank farm integration (LA-UR-96-3860, WHC-SD-WM-ER-133) and extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes (WHC-SD-WM-ER-133).
Selenium	Several uses in bismuth phosphate campaign including filtering of gases generated in the 1950s and miscellaneous laboratory uses. Listed by the basis of knowledge gained by previous sampling efforts in the 200 Areas.
Silver	Several uses in bismuth phosphate campaign, including filtering of gas generated in the 1950s and miscellaneous laboratory uses. Listed by the basis of knowledge gained by interviews.
<b>Chemical Constituents -- General Inorganics</b>	
Ammonia/ammonium	Several compounds contained ammonium the most widely used included ammonium silica fluoride which was used as a cleaning and decontamination compound based on ability to dissolve metals and fission products (HW-10475, Section C; WHC-SD-WM-ER-133; OUT-1462, <i>History of Operations (1 January 1944 to March 1945)</i> ).
Chloride	Several compounds contained chloride the most widely used included ferrous chloride, which was used as a carrier and potassium/sodium chloride used as salting agents during the bismuth phosphate process (HW-10475, Section C; WHC-SD-WM-ER-133; OUT-1462).
Cyanide	Extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes listed as a result of tank farm integration (LA-UR-96-3860, WHC-SD-WM-ER-133).
Fluoride	Several compounds contained fluoride the most widely used included lanthanum fluoride, which was used during the concentration operations of the bismuth phosphate process, and ammonium silica fluoride, which was used as a cleaning and decontamination compound based on the ability to dissolve metals and fission products (HW-10475, Section C; WHC-SD-WM-ER-133; OUT-1462).

Table 1-7. 200-PW-4 Operable Unit Final Contaminants of Concern List. (5 Pages)

Final COCs*	Rationale for Inclusion
Nitrate/nitrite	Several compounds contained nitrates/nitrites. The most widely used included sodium nitrite, a salting agent during the cladding removal, nitric acid, which was used throughout the bismuth phosphate and uranium recovery processes, and bismuth subnitrate, which was used to create the bismuth phosphate/ plutonium solid during the first- and second-cycle decontamination process (HW-10475, Section C; WHC-SD-WM-ER-133; OUT-1462).
Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth phosphate process (HW-10475, Section C; OUT-1462).
Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in the dissolving of the fuel rod during the bismuth phosphate process (HW-10475, Section C; WHC-SD-WM-ER-133; OUT-1462). Many other sulfate complexes were used as carriers for various metals.
<b><i>Volatile Organics</i></b>	
1,1-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248, <i>1994 Conceptual Model of the Carbon Tetrachloride Contamination in the 200 West Area at the Hanford Site</i> ).
1,2-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
1,1,1-trichloroethane (TCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
Acetone	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
Benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
Carbon tetrachloride	Carbon tetrachloride was widely used as a dilutant for TBP and DBBP in the RECUPLEX, PRF, and americium-241 recovery processes. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (WHC-SD-EN-TI-248).
Cis/trans-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
Chlorobenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
Chloroform	Chloroform is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose (WHC-SD-EN-TI-248).
Ethylbenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
Ethylene glycol	Antifreeze component used as a coolant for equipment.
Methyl ethyl ketone (MEK, 2-butanone)	Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone (WHC-SD-EN-TI-248).

Table 1-7. 200-PW-4 Operable Unit Final Contaminants of Concern List. (5 Pages)

Final COCs*	Rationale for Inclusion
Methyl iso butyl ketone (MIBK, hexone)	Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone (WHC-SD-EN-TI-248). Used as a solvent for solvent extraction of uranium and plutonium from fission products. Present in process drainage and possibly in process condensate. (HW-19140).
Methylene chloride	Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone (WHC-SD-EN-TI-248).
n-butyl benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
Tetrachloroethylene (PCE)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
Trichloroethylene (TCE)	TCE is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (WHC-SD-EN-TI-248).
Toluene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
Xylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
<b>Semi-Volatile Organics</b>	
AMSCO <sup>a</sup>	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for tributyl phosphate in the uranium recovery processes (WHC-SD-WM-ER-133).
Dodecane <sup>a</sup>	Use (1953 to 1957) in solvent extraction operation as the dilutant for tributyl phosphate in the uranium recovery processes (WHC-SD-WM-ER-133).
Hydraulic fluids (Greases)	Used for equipment in laboratory. Only an oil/grease separation analysis will be performed.
Kerosene <sup>a</sup>	Use (1953 to 1957) in solvent extraction operation as the dilutant for tributyl phosphate in the uranium recovery processes (WHC-SD-WM-ER-133).
Normal paraffin hydrocarbons <sup>a</sup>	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for tributyl phosphate in the uranium recovery processes (WHC-SD-WM-ER-133).
Phenol	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (WHC-SD-EN-TI-248).
Polychlorinated biphenyls (PCBs)	Various types of normal paraffins were used as milling, cutting, and washing solutions during the production of plutonium buttons/rods. These solutions almost always contained PCBs (CCN 092730, "Discussion Notes with PFP Personnel"). Analytical results from sediment samples collected within the 241-Z-361 tank (FH-000279, "Submittal of Documentation in Fulfillment of Milestone M-15-37B").

Table 1-7. 200-PW-4 Operable Unit Final Contaminants of Concern List. (5 Pages)

Final COCs*	Rationale for Inclusion
Tributyl phosphate and derivatives (mono, di)	Extensive use (1953 to 1957) in solvent extraction in the uranium recovery and PUREX processes (WHC-SD-WM-ER-133, HW-31000-DEL).

\* Analyzed as kerosene total petroleum hydrocarbons

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| * COC = contaminant of concern.         | RCRA = <i>Resource Conservation and Recovery Act of 1976.</i> |
| DBBP = dibutyl butyl phosphonate.       | RECUPLEX = Recovery of Uranium and Plutonium by               |
| PRF = Plutonium Reclamation Facility.   | Extraction.   |
| PUREX = plutonium-reduction extraction. | TBP = tributyl phosphate.                                     |

Table 1-8 defines the ARARs and preliminary remediation goals (PRG) for each of the COCs.

Table 1-8. List of Preliminary Applicable or Relevant and Appropriate Requirements and Preliminary Remediation Goals.

Contaminant of Concern	Preliminary Applicable or Relevant and Appropriate Requirements	Preliminary Remediation Goal
<b>Radionuclides Inside the 200 Area Land-Use Boundary<sup>a</sup></b>		
Shallow zone (0 to 4.6 m [0 to 15 ft] bgs)	500 mrem/yr above background via industrial land-use scenario while under DOE control; 15 mrem/yr above background at the end of the exclusive-use period if DOE control is relinquished; 4 mrem/yr above background to groundwater; or no additional groundwater degradation. <sup>b</sup>	Contaminant-specific; RESRAD modeling <sup>c</sup>
Deep zone (>4.6 m [>15 ft] bgs)	4 mrem/yr above background to groundwater; or no additional groundwater degradation. <sup>b</sup>	Maximum contamination levels, state and Federal ambient water quality control criteria; alternatively, site-specific modeling
<b>Nonradiological Constituents Inside the 200 Area Land-Use Boundary</b>		
Shallow zone (0 to 4.6 m [0 to 15 ft] bgs)	WAC 173-340 Method C	Chemical-specific
Deep zone (>4.6 m [>15 ft] bgs)	WAC 173-340 criteria	Alternatively, site-specific modeling using STOMP model

<sup>a</sup> The *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement* (DOE/EIS-0222-F) (see Figure 1-1, above) identifies the actual land use within the 200 Area land-use boundary as industrial (exclusive) and would center mainly around waste management activities.

<sup>b</sup> Radionuclide standards are not final and will be agreed upon in the ROD. A radionuclide standard of 25 mrem/yr above background was adopted by the Washington State Department of Health in February 2000.

<sup>c</sup> The RESidual RADioactivity dose model (RESRAD) use has been used for similar waste sites and will be used as a minimum for direct exposure. If more appropriate models are developed, they will be evaluated for use.

bgs = below ground surface.

STOMP = PNNL-11216, *STOMP -- Subsurface Transport Over Multiple Phases: Application Guide*.

Table 1-9 lists the general exposure scenarios.

Table 1-9. General Exposure Scenarios.

Scenario No.	General Exposure Scenario Description
1	<p>Industrial land-use scenario (inside the 200 Area land-use boundary)<sup>a</sup>:</p> <p>The source of contamination in the 200-PW-4 OU is the liquid effluent disposed to the waste sites. The release mechanism is direct radiation exposure to occupational workers in the vicinity of the waste sites (although shielded by stabilizing cover). Ingestion and inhalation of surface or subsurface soils in an occupational scenario does not represent a substantial exposure due to waste site surface stabilization and the limited soil ingestion and inhalation anticipated during excavation activities in an industrial setting (use of dust control measures limits exposures). Downward migration of mobile constituents into the groundwater would not affect occupational workers because their drinking water source would not be the underlying aquifers. However, the protection of groundwater is a requirement and must be addressed by evaluating potential future impacts.</p> <p>The exposure time is divided into time spent inside and outside an industrial facility:</p> <ul style="list-style-type: none"> <li>• Building occupancy: 8 hours/day x 0.6 (building occupancy factor), 5 days/week, 50 weeks/yr, for 20 years (of a 75-year lifetime).</li> <li>• Outdoor exposure: 8 hours/day x 0.4 (outdoor exposure factor), 5 days/week, 50 weeks/yr, for 20 years (of a 75-year lifetime).</li> </ul> <p>In addition, the building occupancy exposure includes a factor of 0.4 to reduce the ingested dust component due to building ventilation system filtration.</p> <p>Biota that may be exposed to contaminants in this OU will be addressed through a more Hanford Site-wide evaluation. Remedial actions to address human health concerns will also serve to protect biota.</p>

<sup>a</sup> The *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement* (DOE/EIS-0222-F) (see Figure 1-1, above) identifies the actual land use within the 200 Area land-use boundary as industrial (exclusive) and would center mainly around waste management activities.

Table 1-10 provides the regulatory milestones and regulatory drivers associated with this project.

Table 1-10. Regulatory Milestones.

Milestone	Due Date	Regulatory Driver
M-015-43B	June 30, 2004	Tri-Party Agreement milestone to submit the RI report for the 200-PW-2/4 OU ( <i>Hanford Federal Facility Agreement and Consent Order; Hanford Federal Facility Agreement and Consent Order Handbook</i> )
M-015-43C	December 31, 2005	Tri-Party Agreement milestone to submit the 200-PW-2/4 FS and Proposed Plan/Proposed RCRA Permit Modification
M-20-33	December 31, 2005	Tri-Party Agreement milestone to submit 216-A-10 Crib, 216-A-36B Crib, 216-A-37-1 Crib, and 207-A-South Retention Basin closure/postclosure plans to Ecology

The project milestones and their drivers are listed in Table 1-11.

Table 1-11. Project Milestones.

Milestone	Due Date	Driver
Internal DQO workshop	October 23, 2002	DQO schedule
External RL/regulator briefing	October 31, 2002	
Issue DQO summary report	February 14, 2003	DQO process documentation

Table 1-12 combines the relevant background information into a concise statement of the problem to be resolved.

Table 1-12. Preliminary Conceptual Contaminant Distribution Model Discussion and Concise Statement of the Problem. (2 Pages)

**Preliminary Conceptual Contaminant Distribution Model<sup>1</sup>:**

The liquid effluents associated with the uranium and plutonium recovery processes at T Plant, U Plant, PUREX Plant, REDOX Plant, 242-A Evaporator, and Hot Semiworks Facility were discharged to the 200-PW-4 OU waste sites. The effluents from these various chemical operations contained uranium, plutonium, fission products, nitrates, metals, and semi-volatile organic, and volatile organic chemicals. Immobile contaminants accumulated in the soils below the release point over time, while the mobile contaminants may have reached groundwater. Geophysical logging of boreholes in the vicinity of the waste sites, along with sampling data from boreholes near some of the waste sites, provided the basis for the preliminary conceptual contaminant distribution models.

A number of the cribs in this OU are similar to those in the 200-PW-2 OU. One of the cribs in the 200-PW-4 OU and several of the cribs in the 200-PW-2 OU were sampled as part of the 200-UP-2 RI conducted in 1994 through 1995 (DOE/RL-95-13). Data from this investigation indicated a zone of higher contamination extending up to 30 m (100 ft) below the bottom of the cribs and trenches. Contamination continued below this zone but generally decreased with depth. More mobile contaminants were distributed throughout the soil column and are present at residual concentrations. In at least one instance at the 216-U-8 Crib in the 200-PW-2 OU there is evidence that elevated levels of contamination are present, associated with the caliche layer that exists at a depth of 57 m (187 ft).

Volatile organics were not a major part of the processes associated with 200-PW-4 OU waste sites. However, some organics may have been processed through the 242-A Evaporator and discharged via the 207-A-South Retention Basin to the 216-A-37-1 crib. Because of the volume of liquid and contaminants received by the 200-PW-4 OU waste sites, groundwater impacts are generally assumed at the majority of the sites. Groundwater monitoring has indicated chemical and radionuclide constituents in the groundwater beneath some of the waste sites; however, contributions from individual waste sites have not been fully evaluated. While some data exist for several of the 200-PW-4 OU waste sites (e.g. 216-U-16 crib), limited chemical and radiological data are available for the majority of the other 200-PW-4 OU sites.

Figures 1-9 through 1-11 graphically present the overall conceptual exposure model for the OU and the preliminary conceptual contaminant distribution models for each of the two RCRA TSD units.

Table 1-12. Preliminary Conceptual Contaminant Distribution Model Discussion and Concise Statement of the Problem. (2 Pages)

**DQO Approach:**

The DQO process for the 200-PW-4 OU is being performed to determine if waste sites in this OU have been contaminated to levels that require remedial action.

The outcome of the characterization being developed in this DQO process for the waste sites will be applied to the other analogous sites. A SAP will be developed after completion of the DQO process, which specifies the sampling and analyses to be performed for characterization of the two TSD units.

All of the waste sites associated with this OU are located within the 200 Area land-use boundary line and will be evaluated on the basis of future industrial uses.

**Problem Statement:**

The problem is to determine contaminant concentrations and physical parameters in the TSD units to support evaluation of remedial alternatives and remedial decision making in the FS and to verify or refine the conceptual contaminant distribution models.

<sup>1</sup> The preliminary conceptual contaminant distribution model will become the conceptual contaminant distribution model after acceptance of this DQO summary report and will then be applied to the project work plan.

Figure 1-9. Conceptual Exposure Model for the 200-PW-4 Operable Unit.

Conceptual Exposure Pathway Model

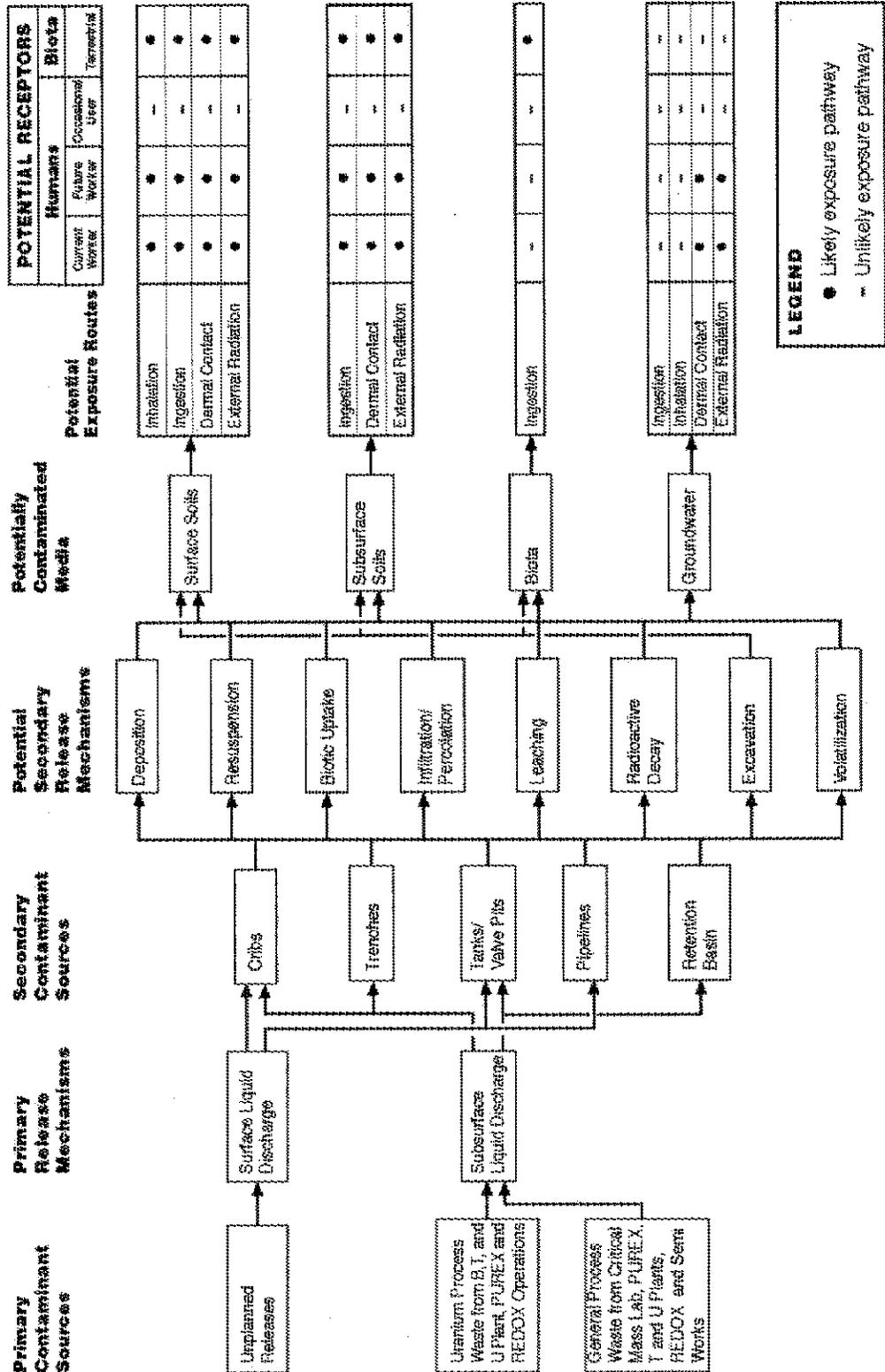
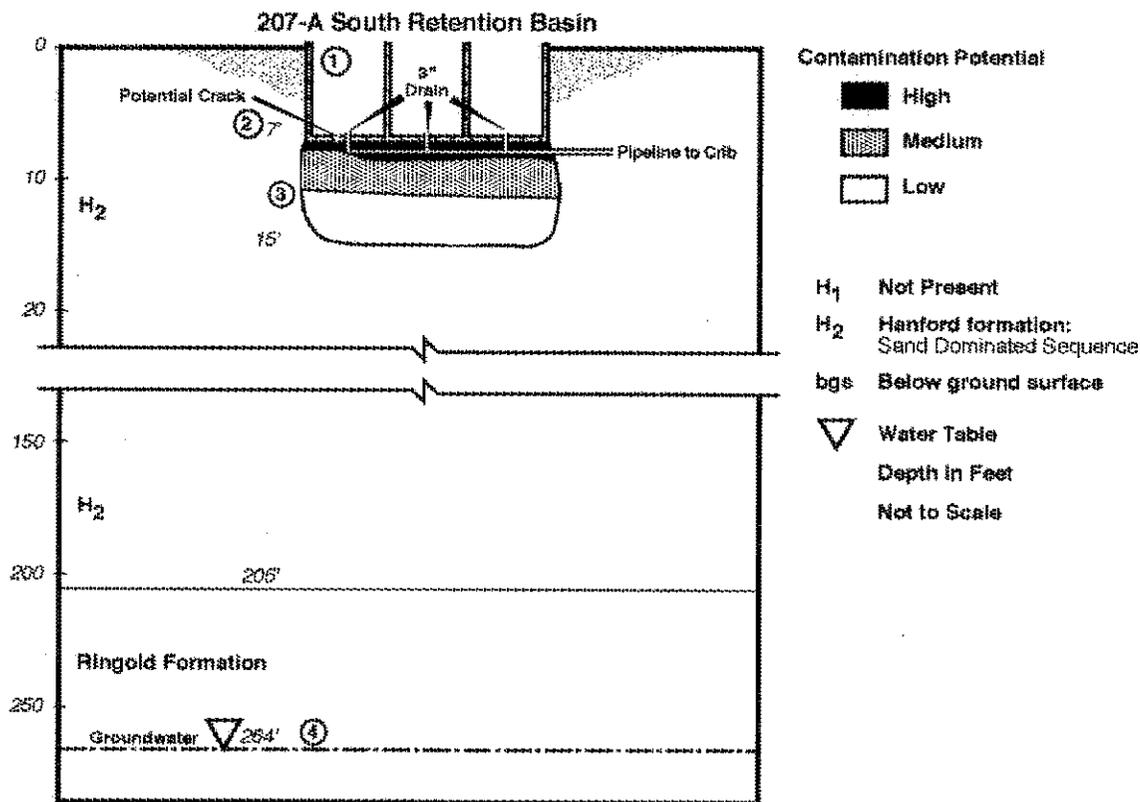


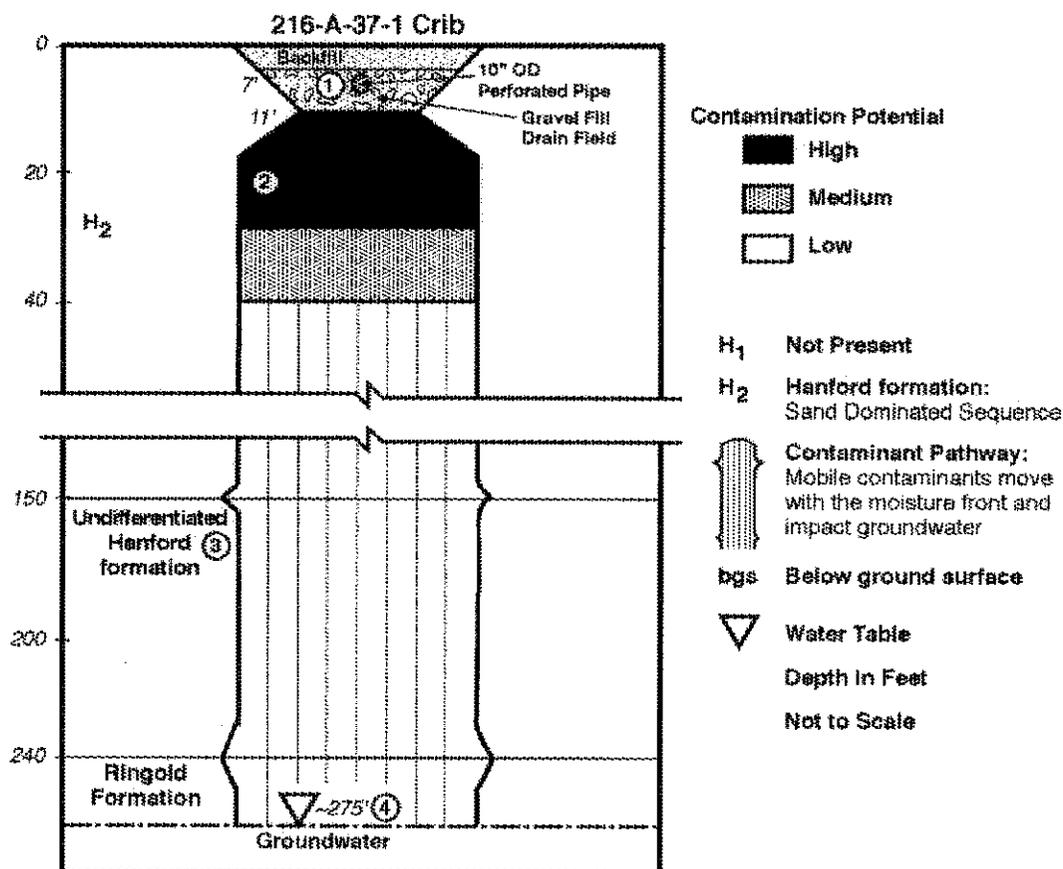
Figure 1-10. Preliminary Conceptual Contaminant Distribution Model for the 207-A-South Retention Basin.



- ① The retention basin is a concrete structure that received effluent from 1977 to 1989. It was used for the interim storage of 242-A Evaporator process condensate to allow for sampling and analysis prior to being discharged to the 216-A-37-1 Crib. The process liquid contained cesium, plutonium, strontium, uranium, acetone, and butanol. The amount of liquid passing through the basin is likely equivalent to the volume discharged [377,000,000 liters (99,528,000 gal)] to the 216-A-37-1 Crib.
- ② The basin was designed to hold liquids. There has been no evidence of leaks. Little or no contamination is expected beneath the concrete structure. Any contamination present may be located near cracks in, and drains within, the structure. No structural failures have been documented associated with the basin. Low mobility and moderately mobile contaminants such as cesium and strontium, respectively, will sorb near the bottom of the basin. Contaminant concentrations decrease with depth. Releases would impact H<sub>2</sub>.
- ③ High mobility contaminants migrate with the moisture front and may be detected in low concentrations to a depth of about 4.6 m (15 ft). Halogenated and non-halogenated solvents might be detected in the vicinity of the crib in low concentrations.
- ④ The low potential for the release of effluent to the subsurface suggest that this site has not impacted groundwater. There are no boreholes in the vicinity of the basin and no characterization has been performed.

60200024-2

Figure 1-11. Preliminary Conceptual Contaminant Distribution Model for the 216-A-37-1 Crib.



- ① The 216-A-37-1 Crib received effluent from 1977 to 1989. It received process liquid waste from the 242-A Evaporator containing cesium, plutonium, strontium, uranium, acetone, and butanol. Effluent was distributed through a 25.4 cm (10 in.) diameter perforated pipe that runs the length of the crib. The pipe is buried about 2.1 m (7 ft) below the surface. Approximately 377,000,000 liters (99,528,000 gal) of effluent were released to the crib.
- ② Once discharged, the effluent and contaminants migrate vertically down beneath the crib, within H<sub>2</sub>. Low mobility contaminants such as cesium will sorb near the point of release. Contaminant concentrations decrease with depth. Moderately mobile contaminants may be present to a depth of 12.2 m (40 ft).
- ③ High mobility contaminants migrate with the moisture front and may be detected in low concentrations throughout the vadose zone. The available data (natural gamma logs) from four groundwater monitoring wells adjacent to the crib suggest that little or no lateral spreading has occurred. Halogenated and non-halogenated solvents may be detected in the vicinity of the crib in low concentrations throughout the vadose zone.
- ④ The volume of effluent discharged ( $377,011 \text{ m}^3$ ) to the crib is greater than the soil column pore volume ( $15,879 \text{ m}^3$ ). This data suggest that groundwater has been impacted beneath the crib. Tritium and iodine-129 exceed groundwater protection standards near the crib.

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## 2.0 STEP 2 -- IDENTIFY THE DECISION

The purpose of DQO Step 2 is to define the principal study questions (PSQ) that need to be resolved to address the problems identified in DQO Step 1 and the alternative actions that would result from resolution of the PSQs. The PSQs and alternative actions are combined into decision statements that express a choice among alternative actions. Table 2-1 presents the task-specific PSQs, alternative actions, and resulting decision statements. This table also provides a qualitative assessment of the severity of the consequences of taking an alternative action if it is incorrect. This assessment takes into consideration human health and the environment (i.e., flora/fauna) and political, economic, and legal ramifications. The severity of the consequences is expressed as low, moderate, or severe.

Table 2-1. Summary of Data Quality Objectives Step 2 Information. (3 Pages)

PSQ -AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
<b>Principal Study Question #1—Do the radionuclide concentrations in vadose soils in the 200-PW-4 OU TSD unit waste sites exceed the annual radiological exposure limits for human health protection under an industrial exposure scenario?<sup>a</sup></b>			
1-1	If the radionuclide concentrations in the vadose soils do not exceed the industrial exposure limits, evaluate the site for closure with no remedial action in an FS.	The site may inappropriately be closed without remedial action, increasing risks of potential exposure to workers and the environment.	Low; additional samples will be collected in the confirmatory sampling phase to support no action closures.
1-2	If the radionuclide concentrations in the vadose soils exceed the industrial exposure limits, evaluate the need for remedial action alternatives or evaluate a streamlined approach to site closure (e.g., add to an existing ROD) in an FS.	The site may be inappropriately remediated resulting in unnecessary expenditure of funds.	Low for risk; no risk to human health or environment. Low to moderate for cost depending on remedial action.
<b>Decision Statement #1—Determine if the vadose zone radionuclide concentrations in the 200-PW-4 OU TSD unit waste sites exceed the radiological exposure limits for human health protection under an industrial exposure scenario requiring evaluation in an FS.</b>			

Table 2-1. Summary of Data Quality Objectives Step 2 Information. (3 Pages)

PSQ -AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
<b>Principal Study Question #2—Do the concentrations of nonradiological constituents in the vadose soils in the 200-PW-4 OU TSD unit waste sites exceed the nonradiological exposure limits for human health protection under an industrial exposure scenario?<sup>a</sup></b>			
2-1	If the nonradiological constituent concentrations in the vadose soils do not exceed the industrial exposure limits, evaluate the site for closure with no remedial action in an FS.	The site may inappropriately be closed without remedial action, increasing risks of potential exposure to workers and the environment.	Low; additional samples will be collected in the confirmatory sampling phase to support no action closures.
2-2	If the nonradiological constituent concentrations in the vadose soils exceed the industrial exposure limits, evaluate the need for remedial action alternatives or evaluate a streamlined approach to site closure (e.g., add to an existing ROD) in an FS.	The site may be inappropriately remediated resulting in unnecessary expenditure of funds.	Low for risk; no risk to human health or environment. Low to moderate for cost depending on remedial action.
<b>Decision Statement #2—Determine if vadose zone nonradiological constituent concentrations in the 200-PW-4 OU TSD unit waste sites exceed the nonradiological constituent exposure limits for human health protection under an industrial exposure scenario requiring evaluation in an FS.</b>			

Table 2-1. Summary of Data Quality Objectives Step 2 Information. (3 Pages)

PSQ -AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
<b>Principal Study Question #3—Do the 200-PW-4 OU conceptual contaminant distribution models properly reflect the physical characteristics and distribution of contaminants in the waste sites?</b>			
3-1	If the conceptual contaminant distribution models reflect the actual distribution of contaminants and physical characteristics, use the models for remedial alternative selection and remedial action planning.	Inappropriate or inadequate remedial alternatives could be planned in the FS and implemented during the remedial action phase.	Low to moderate; additional sampling in confirmatory phase will limit consequences.
3-2	If the conceptual contaminant distribution models do not accurately reflect the distribution of contaminants and physical characteristics, revise the models before remedial alternative selection and remedial action planning.	The site may be inappropriately remediated resulting in unnecessary expenditure of funds.	Low; no risk to human health or the environment
<b>Decision Statement #3—Determine if the 200-PW-4 OU conceptual contaminant distribution models represent the contaminant distribution conditions and physical characteristics in each waste site or if the models need to be refined.</b>			

<sup>a</sup> Refer to Table 1-8 for scenario-specific ARARs and PRGs.

- AA = alternative action.
- ARAR = applicable or relevant and appropriate requirement.
- FS = feasibility study.
- PRG = preliminary remedial goal.
- PSQ = principal study question.
- ROD = record of decision.
- TSD = treatment, storage, and disposal.

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### **3.0 STEP 3 -- IDENTIFY THE INPUTS TO THE DECISION**

The purpose of DQO Step 3 is to identify the types of data needed to resolve each of the decision statements identified in DQO Step 2. The data may already exist or may be derived from computational or surveying/sampling and analysis methods. Analytical performance requirements (e.g., practical quantitation limit, precision, and accuracy) are also provided in this step for any new data that need to be collected.

#### **3.1 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS**

Table 3-1 specifies the information (data) required to resolve each of the decision statements identified in Table 2-1 and identifies whether the data already exist. For the data that are identified as existing, the source references for the data have been provided with a qualitative assessment as to whether or not the data are of sufficient quality to resolve the corresponding decision statement.

Table 3-1. Required Information and Reference Sources. (2 Pages)

PSQ #	Required Information Category	Do Data Exist? (Y/N)	Reference Source	Are Available Data of Sufficient Quality and Quantity to Support RI/FS Process? (Y/N)		Are Additional Data Required to Support RI/FS Process? (Y/N)	
				207-A South	216-A-37-1	207-A South	216-A-37-1
1 and 3	Soil radiological data	Y	<i>PUREX Plant Source Aggregate Area Management Study Report, DOE/RL-92-04.</i>	N	N	Y	Y
2 and 3	Soil non-radiological sample data	N	Duratek geophysical logging project files, which provide borehole geophysical logging data for gamma emitting radionuclides.	Not available	N	Y	Y
N/A	GW data	Y	None available.	Not available	Not available	Y	Y
All	Physical properties moisture content, particle size distribution and lithology	Y	Refer to footnote a.	Groundwater data cannot be used to validate a vadose zone preliminary conceptual contaminant distribution model.			
			<i>Hydrogeologic Model for the 200-East Groundwater Aggregate Area, WHC-SD-EN-TI-019, Rev. 0. Presents site-specific data for 200 East Area that can be used to calculate soil density, hydraulic conductivity, and porosity.</i>	N	N	Y	Y

Table 3-1. Required Information and Reference Sources. (2 Pages)

PSQ #	Required Information Category	Do Data Exist? (Y/N)	Reference Source	Are Available Data of Sufficient Quality and Quantity to Support RI/FS Process? (Y/N)		Are Additional Data Required to Support RI/FS Process? (Y/N)	
				207-A South	216-A-37-1	207-A South	216-A-37-1
All	Distribution coefficients	Y	<p><i>Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800.</i> Provides 200 Area distribution coefficients for various waste stream types and Hanford soils.</p> <p><i>Geochemical Data Package for the Hanford Immobilized Low-Activity Tank Waste Performance Assessment (LAW PA), PNNL-13037, Rev. 1.</i> Provides 200 Area distribution coefficients for various waste stream types and Hanford soils.</p>	Y	Y	N	N
All	RESRAD input data	Y	<p><i>Phase I Remedial Investigation Report for 200-BP-1 Operable Unit, DOE/RI-92-70, Rev. 0.</i> Provides 200 Area distribution coefficients for Hanford soils and groundwater.</p> <p><i>Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 6.1, ANL-EAD-LD-2.</i> Input parameters are defined in this manual and can be determined based on existing information or RESRAD defaults.</p>	Y	Y	N	N

<sup>a</sup> Groundwater has been impacted in the past by waste sites in this OU, and mobile contaminants were disposed at the sites within this waste group. However, evaluation of groundwater contamination and remediation is not included in the scope of the work plan.

- GW = groundwater.
- N/A = not applicable.
- PSQ = principal study question.

### 3.2 BASIS FOR SETTING THE PRELIMINARY ACTION LEVEL

The preliminary action level is the threshold value that provides the criterion for choosing between alternative actions. Table 3-2 identifies the basis (i.e., regulatory threshold or risk-based) for establishing the preliminary action level for each of the COCs. The numerical value for the action level is defined in DQO Step 5.

Table 3-2. Basis for Setting Preliminary Action Level.

DS #	Contaminant of Concerns	Basis for Setting Preliminary Action Level
1	Radiological contaminants of concern	Radiological lookup values for shallow zone soils based on RESRAD analyses for the applicable scenarios. Deep zone lookup values will be determined using STOMP ((PNNL-11216) or another model.
2	Nonradiological contaminants of concern	WAC 173-340 Method C cleanup levels with contaminant-specific variations.
3	Radiological and nonradiological contaminants of concern	Preliminary action levels do not apply for preliminary conceptual contaminant distribution model evaluation. This is a judgmental assessment.

DS = decision statement.

### 3.3 COMPUTATIONAL AND SURVEY/ANALYTICAL METHODS

Table 3-3 identifies the decision statements where existing data either do not exist or are of insufficient quality to resolve the decision statements. For these decision statements, Table 3-3 presents computational and/or surveying/sampling methods that could be used to obtain the required data.

Table 3-3. Information Required to Resolve the Decision Statements.

DS #	Remedial Investigation Variable	Required Data	Computational Methods	Survey/Analytical Methods
1 and 3	Concentrations of radiological COCs in vadose zone soils	Alpha, beta, and gamma COC concentrations in soils for evaluation against ARARs and PRGs.  Location data (vertical extent of COCs within waste site boundaries).	RESRAD -- analytical modeling method for human health dose assessment.  STOMP or other analytical code -- analytical modeling through vadose zone to groundwater.	Field screening with radiological detection equipment.  Geophysical borehole logging with downhole radiological detectors.  Soil sampling and laboratory analysis.
2 and 3	Concentrations of nonradiological COCs in vadose zone soils	Nonradiological (e.g., inorganic metals and anions, and SVOCs) COC concentrations in soils for evaluation against ARARs and PRGs.  Location data (vertical extent of COCs within waste site boundaries).	WAC 173-340 Risk assessment.  STOMP or other analytical code -- analytical modeling through vadose zone to groundwater.	Soil sampling and laboratory analysis.
All	Physical properties in vadose zone soils	Moisture content, bulk density, particle size distribution	Direct comparison to existing models to determine hydraulic conductivity.	Soil sampling and laboratory analysis.

NOTE: See Table 3-5 for additional information.

ARAR = applicable or relevant and appropriate requirement.

COC = contaminant of concern.

DS = decision statement.

SVOC = semivolatile organic compound.

PRG = preliminary remediation goal.

Table 3-4 presents details on the computational methods identified in Table 3-3. These details include the source and/or author of the computational method and information on how the method could be applied to this study.

Table 3-4. Details on Identified Computational Methods.

DS #	Computational Method	Source/Author	Application to Study	Satisfy Input Req't?
1	RESRAD	Argonne National Laboratory	RESRAD will be used to estimate direct human radiation exposure to account for radioactive decay.	Yes
1 and 2	STOMP code (PNNL-11216) or other analytical codes	PNNL	Estimates the migration of all contaminants (radiological and nonradiological) through the vadose to groundwater. The model requires site-specific geohydrologic soil properties (e.g., hydraulic conductivity, and moisture). Other codes may be identified and used based on specific site conditions and requirements.	Yes

DS = decision statement.  
 PNNL = Pacific Northwest National Laboratory.

Table 3-5 identifies each of the survey and/or analytical methods that may be used to provide the required information needed to resolve each of the decision statements. The possible limitations associated with each of these methods are also provided.

Table 3-5. Potentially Appropriate Survey and/or Analytical Methods. (3 Pages)

Media	Remediation Variable	Potentially Appropriate Survey/Analytical Method	Possible Limitations
<i>Field Screening</i>			
Fine-grained materials, structures	Site location; underground structures or interferences	Ground-penetrating radar (GPR)	GPR is a radar-reflection surface geophysical survey technique that detects contrasts in di-electric constants in the below-grade environments from the surface. Requires subjective interpretation of the reflected signals. Lack of reflective below-grade surfaces or the presence of interfering matrices can complicate or invalidate the findings. The presence of nearby buildings and utilities can interfere with reflected signals. Fines (e.g., clay and heavy fly ash) can act as a reflector to the radar signal.
		Electromagnetic imaging (EMI)	EMI is a surface geophysical survey technique that measures electrical conductivity in below-grade soils based on detected changes in electrical fields. The results of EMI are generally used to support the interpretation of GPR surveys. Nearby buildings and utilities can cause interferences.

Table 3-5. Potentially Appropriate Survey and/or Analytical Methods. (3 Pages)

Media	Remediation Variable	Potentially Appropriate Survey/ Analytical Method	Possible Limitations
Vadose zone soils	Gross and isotopic gamma emissions	Cone penetrometer; NaI detector logging	A closed-end rod is pushed into the soil to the desired depth. A small-diameter NaI detector (or other suitable detector) is used to log the gross gamma response with depth. The cone penetrometer is not effective in cobbly or rocky soils.
	Gross and isotopic gamma emissions	Direct push; NaI detector logging	A small-diameter casing is pushed into the soil to the desired depth. A small-diameter NaI detector (or other suitable detector) is used to log the gamma response with depth. Direct-push methods (e.g., GeoProbe™) may be ineffective in cobbly or rocky soils.
	Gamma emissions from fission products, Am-241, Pu-239, and Np-237	Borehole spectral gamma logging (SGL) with high-purity germanium (HPGe) detector	Gamma-ray logging provides the concentration profiles of gamma-emitting radionuclides such as Am-241, Pu-239, and many fission products in a borehole environment. It is considered by some to be more accurate than sampling and laboratory assay because the assay is performed in situ with less disturbance of the sample, there is higher vertical spatial resolution, and the sample size is much larger. This method may also be more economical than traditional sampling and analysis. This method does not assess radionuclides or daughter products that do not emit gamma rays. The gamma energies from these isotopes are at the low end of the spectrum, which results in high numerical minimum detectable activities and possible matrix effects from other isotopes. This technique requires the use of a single casing (installed by drilling or driving) in contact with the soil formation.
	Neutron emissions from plutonium	Borehole passive neutron logging	Passive neutron logging provides indication of the presence of neutron-emitting isotopes. Because of the very low incidence of spontaneous Pu fission and alpha-N reactions, the passive neutron profile is orders of magnitude lower than the gamma emissions.
	Active neutron emissions from transuranics	Borehole passive/active neutron-logging methods	This technique uses source materials or generators to release neutrons into the soil formation. Passive detectors measure the response to the neutron flux as a means of detecting specific transuranic constituents. Although neutron activation methods have been developed, they are not expected to be useful for this initial characterization effort. At present, these techniques are too expensive and time consuming, and logistical problems are associated with the handling of intense sources or generators.

Table 3-5. Potentially Appropriate Survey and/or Analytical Methods. (3 Pages)

Media	Remediation Variable	Potentially Appropriate Survey/ Analytical Method	Possible Limitations
	Vertical moisture profile	Borehole neutron-neutron moisture logging	N-N moisture logs can be used to determine current moisture content profiles of the subsurface through new or existing boreholes. The moisture profiles are often directly correlated to contaminant concentrations, sediment grain size, composition, or subsurface structural features. For this project, the moisture profile may be useful for helping determine the location of contamination and/or the location of the ditch and establish geologic conditions to support contaminant fate and transport modeling. It may also be correlated to reflections identified in ground-probing radar surveys.
<i>Laboratory Samples</i>			
Vadose zone soils	All COCs and physical properties	Laboratory analysis	Highly contaminated samples require use of onsite laboratories, with associated impacts (e.g., high cost, reduced analyte lists, matrix effects, degraded detection limits, and long turnaround times). Lower contamination levels allow use of offsite laboratories, avoiding these limitations. Physical property analysis will include bulk density, moisture content, and particle size distribution.

<sup>TM</sup> GeoProbe is a registered trademark of GeoProbe Systems, Salinas, Kansas.

- COC = contaminant of concern.
- EMI = electromagnetic imaging.
- GPR = ground-penetrating radar.
- HPGe = high-purity germanium.
- NaI = sodium iodide.
- SGL = spectral gamma logging.

### 3.4 ANALYTICAL PERFORMANCE REQUIREMENTS

Tables 3-6a and 3-6b define the analytical performance requirements for the data that need to be collected to resolve each of the decision statements. These performance requirements include the practical quantitation limit and the precision and accuracy requirements for each of the COCs.

Table 3-6a. Analytical Performance Requirements for Radionuclides – Shallow and Deep Zone Soils. (2 Pages)

COCs	CAS #	Preliminary Action Level			Name/Analytical Technology	Required Target Quantitation Limits				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		15 mrem/yr (pCi/g)	500 mrem/yr (pCi/g)	GW Protection (pCi/g)		Water Low Activity (pCi/L)	Water High Activity (pCi/L)	Soil-Other Low Activity (pCi/g)	Soil-Other High Activity (pCi/g)				
Americium-241	14596-10-2	335	112,000	N/A	Americium isotopic – AEA	1	400	1	4,000	±20%	80-120%	±35%	65-135%
Carbon-14	14762-75-5	33,100	1,100,000	291	Carbon-14 – liquid scintillation	200	N/A	50	N/A	±20%	80-120%	±35%	65-135%
Cesium-137	16045-97-3	23.4	780	N/A	GEA	15	200	0.1	2,000	±20%	80-120%	±35%	65-135%
Cobalt-60	10198-40-0	4.90	164	N/A	GEA	25	200	0.05	2,000	±20%	80-120%	±35%	65-135%
Europium-152	14683-23-9	11.4	388	N/A	GEA	50	200	0.1	2,000	±20%	80-120%	±35%	65-135%
Europium-154	15585-10-1	10.3	345	N/A	GEA	50	200	0.1	2,000	±20%	80-120%	±35%	65-135%
Europium-155	14391-16-3	426	14,200	N/A	GEA	50	200	0.1	2,000	±20%	80-120%	±35%	65-135%
Iodine-129	15046-84-1	3,080	103,000	N/A	Iodine-129 – Low Energy Photon Spectroscopy	5	N/A	2	N/A	±20%	80-120%	±35%	65-135%
Neptunium-237	13994-20-2	59.2	1,980	N/A	Neptunium-237 – AEA	1	N/A	1	8,000	±20%	80-120%	±35%	65-135%
Nickel-63	13981-37-5	4,026	3,008,000	N/A	Nickel-63 – liquid scintillation	15	N/A	30	N/A	±20%	80-120%	±35%	65-135%
Plutonium-238	13981-16-3	470	15,700	N/A	Plutonium isotopic – AEA	1	130	1	1,300	±20%	80-120%	±35%	65-135%
Plutonium-239/240	Pu-239/240	425	14,200	N/A	Plutonium isotopic – AEA	1	130	1	1,300	±20%	80-120%	±35%	65-135%
Radium-226	13982-63-3	7.03	234	N/A	GEA	N/A	N/A	0.1	2,000	±20%	80-120%	±35%	65-135%
Radium-228	15262-20-1	8.15	272	N/A	GEA	N/A	N/A	0.2	2,000	±20%	80-120%	±35%	65-135%
Strontium-90	Rad-Sr	2,410	80,300	N/A	Total radioactive strontium – GPC	2	80	1	800	±20%	80-120%	±35%	65-135%
Technetium-99	14133-76-7	412,000	13,700,000	171	Technetium-99 – liquid scintillation	15	400	15	4,000	±20%	80-120%	±35%	65-135%
Thorium-232	TH-232	4.8	160	N/A	Thorium isotopic – AEA (pCi) IC/PMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%



Table 3-6b. Analytical Performance Requirements for Nonradionuclides – Shallow and Deep Zone Soils. (5 Pages)

COCs	CAS#	Preliminary Action Level <sup>1</sup>		Name/Analytical Technology	Required Target Quantitation Limits <sup>2</sup>				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		WAC 175-340 Method C <sup>3</sup> (mg/kg)	ISW Method Protection <sup>4</sup> (mg/kg)		Terrestrial Biota Protection (mg/kg)	Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)				
Chromium (total)	7440-47-3	Unlimited	2,000	42	Metals – 6010 – ICP	0.01	0.01	1	2	%	%	%
Chromium VI	18540-29-9	21 <sup>1</sup>	7.7 <sup>1</sup>	42	Metals – 6010 – ICP (trace) Chromium (hex) – 7196 – colorimetric	0.01	N/A	1	N/A	%	%	%
Copper	7440-50-8	130,000	22 <sup>2</sup>	50	Metals – 6010 – ICP	0.025	0.025	2.5	2.5	%	%	%
Lead	7439-92-1	1,000 <sup>1</sup>	840 <sup>4</sup>	50	Metals – 6010 – ICP Metals – 6010 – ICP (trace)	0.1	0.2	10	20	%	%	%
Mercury	7439-97-6	1,050	0.33 <sup>4</sup>	0.33 <sup>4</sup>	Mercury – 7470 – CVAA Mercury – 7471 – CVAA	0.0005	0.0005	N/A	N/A	%	%	%
Nickel	7440-02-0	70,000 <sup>6</sup>	130.4	30	Metals – 6010 – ICP	0.04	0.04	4	4	%	%	%
Selenium	7782-49-2	17,500	1 <sup>4</sup>	0.78 <sup>4</sup>	Metals – 6010 – ICP	0.1	0.2	10	20	%	%	%
Silver	7440-22-4	17,500	9.4 <sup>4</sup>	2	Metals – 6010 – ICP Metals – 6010 – ICP (trace)	0.02	0.02	2	2	%	%	%
Uranium (total)	7440-61-1	10,500 <sup>m</sup>	115	5	Uranium total – kinetic phosphorescence analysis	0.0001	0.02	1	0.2	±20%	80-120%	±35% 65-135%
<b>Inorganics</b>												
Ammonia/ammonium	7664-41-7	Unlimited	Unlimited	N/A	Ammonia – 350 N <sup>a</sup>	0.05	800	0.5	8,000	%	%	%
Chloride	16887-00-6	N/A	N/A	N/A	Anions – 300.0 – IC	0.2	5	2	5	%	%	%
Cyanide	57-12-5	70,000	0.80	N/A	Total cyanide – 9010 – colorimetric	0.005	0.005	0.5	0.5	%	%	%
Fluoride	16984-48-8	210,000	16	N/A	Anions – 300.0 – IC	0.5	5	5	5	%	%	%
Nitrate	14797-55-8	Unlimited	40	N/A	Anions – 300.0 – IC	0.25	10	2.5	40	%	%	%
Nitrite	14797-65-0	350,000	4	N/A	Anions – 300.0 – IC	0.25	15	2.5	20	%	%	%

Table 3-6b. Analytical Performance Requirements for Nonradionuclides – Shallow and Deep Zone Soils. (5 Pages)

COCs	CAS #	Preliminary Action Level*			Name-Analytical Technology	Required Target Quantitation Limits†				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		WAC 173-340 Method C* (mg/kg)	GW Protection* (mg/kg)	Toxicity Blasts Protection* (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Phosphate	14265-44-2	N/A	N/A	N/A	Anions – 300.0 – IC	0.5	1.5	5	40	5	5	5	5
Sulfate	14808-79-8	N/A	1,000	N/A	Anions – 300.0 – IC	0.5	1.5	5	40	5	5	5	5
<b>Organics</b>													
Acetone (2-propanone)	67-64-1	350,000	3.21	N/A	Volatile organics – 8260 – GCMS	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Benzene	71-43-2	2,390	7.42	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Butanol; n-	71-36-3	350,000	6.62	N/A	GC organic – 8015	5	5	5	5	5	5	5	5
Butyl benzene; n	104-51-8	N/A	N/A	N/A	Volatile organics – 8260 – GCMS	0.005	N/A	0.005	N/A	0.005	N/A	N/A	N/A
Carbon tetrachloride	56-23-5	1,010	0.0031	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Chlorobenzene	108-90-7	70,000	1.4	40	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Chloroform	67-66-3	21,500	0.0382	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Dichloroethane; 1,1	75-34-3	350,000	4.57	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Dichloroethane; 1,2	107-06-2	1,440	0.00232	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Dichloroethylene; 1,2- (mixed isomers)	540-59-0	31,500	0.4	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Ethylene glycol	107-21-1	Unlimited	N/A	N/A	GC organic 8015	5	5	5	5	5	5	5	5
Ethylbenzene	100-41-4	350,000	6.91	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Methyl ethyl ketone (MEK; 2-butanone)	78-93-3	Unlimited	N/A	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Methyl isobutyl ketone (MIBK; hexone)	108-10-1	280,000	N/A	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table 3-6b. Analytical Performance Requirements for Nonradiomictides -- Shallow and Deep Zone Soils. (5 Pages)

COCs	CAS#	Preliminary Action Level <sup>1</sup>			Name/Analytical Technology	Required Target Quantitation Limits <sup>2</sup>				Precision Soil	Accuracy Soil						
		WAC 173-146 Method C <sup>3</sup> (mg/kg)	GW Protection <sup>4</sup> (mg/kg)	Terrestrial Biota Protection <sup>5</sup> (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)			Precision Water	Accuracy Water				
Methylene chloride (dichloromethane)	75-09-2	17,500	0.0254	N/A	Volatile organics -- 8260 -- GC/MS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Phenol	108-95-2	Unlimited	43.9	30	Semi-volatiles -- 8270 -- GC/MS	0.01	0.1	0.33	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
PCBs	1336-36-3	10 <sup>1</sup>	0.21	0.65	PCBs -- 8082 -- GC	0.0005	0.005	0.0165	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Tetrachloroethylene	127-18-4	2,570	0.0091	N/A	Volatile organics -- 8260 -- GC/MS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Toluene	108-88-3	70,000	11.6	200	Volatile organics -- 8260 -- GC/MS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Tributyl phosphate	126-73-8	N/A	N/A	N/A	Semi-volatiles -- 8270 -- GC/MS	0.1	0.5	3.3	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Trichloroethane; 1,1,1	71-55-6	Unlimited	57	N/A	Volatile organics -- 8260 -- GC/MS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Trichloroethylene	79-01-6	11,900	0.0263	N/A	Volatile organics -- 8260 -- GC/MS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Xylene (total)	1330-20-7	Unlimited	135	N/A	Volatile organics -- 8260 -- GC/MS	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Total petroleum hydrocarbons -- diesel to oil range (kerosene and normal paraffin hydrocarbons)	68334-30-5 and 8008-20-6	2,000 <sup>1</sup>	2,000 <sup>1</sup>	200	WTPH-D	0.5	0.5	5	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Total petroleum hydrocarbons -- gasoline range	8006-61-9	30 <sup>1</sup>	30 <sup>1</sup>	100	WTPH-G	0.5	0.5	5	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Hydraulic fluids (grease, heavy oils)	8008-20-6	2,000 <sup>1</sup>	2,000 <sup>1</sup>	N/A	Oil and grease (total recoverable) -- 413 N	2	N/A	200	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

Field Screening Measurements

pH	N/A	N/A	N/A	N/A	TBD												
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Table 3-6b. Analytical Performance Requirements for Nonradionuclides -- Shallow and Deep Zone Soils. (5 Pages)

COCs	CAS#	Preliminary Action Level		Name-Analytical Technology	Required Target Quantitation Limits <sup>a</sup>				Precision Soil	Accuracy Soil	
		WAC 173-340 Method C <sup>b</sup> (mg/kg)	GW Protection (mg/kg)		Terrestrial Protection (mg/kg)	Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)			Soil-Other High Conc. (mg/kg)
Bulk density	N/A	N/A	N/A	N/A	D2937, or BHL-EE-05, Procedure 3.9	N/A	N/A	w%	N/A	N/A	N/A
Li/Be/Al	N/A	N/A	N/A	N/A	BHL-EE-01, Procedure 7.0	N/A	N/A	Descriptive	N/A	N/A	N/A
Moisture content	N/A	N/A	N/A	N/A	D2216	N/A	N/A	w%	N/A	N/A	N/A
Particle size distribution	N/A	N/A	N/A	N/A	D422	N/A	N/A	w%	N/A	N/A	N/A

**Soil Physical Properties**

<sup>a</sup> The preliminary action level is the regulatory or risk-based value used to determine appropriate analytical requirements (e.g., detection limits). Remedial action levels will be proposed in the FS, and will be finalized in the record of decision, and will drive remediation of the sites.

<sup>b</sup> 15 mrem/yr = nonradiological worker industrial exposure scenario; 2,000 hrs/yr onsite, 60% indoors, 40% outdoors. 500 mrem/yr = radiological worker industrial scenario; 2,000 hr yr onsite, 60% indoors, 40% outdoors. GW = groundwater protection radionuclide values based on either RESRAD or STOMP modeling of drinking water exposure with the entire vadose zone presumed to be contaminated.

<sup>c</sup> Water values for sampling quality control (e.g., equipment blanks/rinses) or drainable liquid (if recovered). For both water and soil mediums, matrix effects may impact on specific sample basis.

<sup>d</sup> WAC 173-340 Method C industrial soil values for direct exposure from the CLARC Version 3.1 tables, updated November 2001 (Ecology 94-145).

<sup>e</sup> Calculated using WAC 173-340 Method B drinking water standards as inputs to the WAC 173-340 three-phase model for protection of drinking water (WAC 173-340-747[4], amended February 12, 2001), except as noted.

<sup>f</sup> Value is the lowest concentration for each analyte (adjusted for background) from Tables 749-2 and 749-3 of WAC 173-340-900, amended February 12, 2001.

<sup>g</sup> Precision and accuracy requirements as identified and defined in the referenced EPA procedures implemented by laboratory analysis and QA procedures.

<sup>h</sup> Cleanup value is less than Hanford Site soil background. Therefore, the soil background concentration is used as the preliminary action level.

<sup>i</sup> All four-digit numbers refer to Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (SW-846).

<sup>j</sup> Calculated using WAC 173-340 air cleanup standards from WAC 173-340-750(3)(a)(i)(B), page 210, equation 750-2, with Washington State Department of Health mass loading of particulates in air of 10<sup>-6</sup> g/m<sup>3</sup>.

<sup>k</sup> Calculated using standards for surface water protection (40 CFR 131, "Water Quality Planning and Management", and WAC 173-201A-040, "Water Quality Standards for Surface Waters of the State of Washington," "Toxic Substances") as inputs to the WAC 173-340 three-phase model for protection of drinking water (WAC 173-340-747[4], February 12, 2001).

<sup>l</sup> Based upon WAC 173-340 Method A values from Tables 740-1 and 745-1 of WAC 173-340-900, amended February 12, 2001.

<sup>m</sup> Value based upon nickel or uranium soluble salts value.

<sup>n</sup> From Methods of Analysis of Water and Waste (EPA-800/4-79-020).

BHL-EE-01, Environmental Investigations Procedures.

BHL-EE-05, Field Screening Procedures.

AEA = alpha energy analysis  
 CAS = Chemical Abstract Service  
 CV/VA = cold vapor atomic absorption  
 GC = gas chromatograph  
 GC/MS = gas chromatograph/mass spectrometry  
 GPC = gas proportional counter  
 IC = ion chromatography  
 ICP/MS = inductively coupled plasma mass spectrometer  
 N/A = not applicable  
 PCB = polychlorinated biphenyl  
 TBD = to be determined  
 TOC = total organic carbon

**4.0 STEP 4 -- DEFINE THE BOUNDARIES OF THE STUDY**

**4.1 OBJECTIVE**

The primary objective of DQO Step 4 is for the DQO team to identify the spatial, temporal, and practical constraints on the sampling design and to consider the consequences. This objective (in terms of the spatial, temporal, and practical constraints) ensures that the sampling design results in the collection of data that accurately reflect the true condition of the site and/or populations being studied.

**4.2 WORKSHEETS FOR STEP 4 -- DEFINE THE BOUNDARIES OF THE STUDY**

Table 4-1 defines the population of interest to clarify what the samples are intended to represent. The characteristics that define the population of interest are also identified.

Table 4-1. Characteristics that Define the Population of Interest.

DS #	Population of Interest	Characteristics
<i>Cribs and Trenches</i>		
All	Vadose zone soils beneath each of the individual TSDs	Concentrations of radionuclides, metals, and organic constituents; physical properties including moisture content, bulk density, and grain size distribution

DS = decision statement.

Table 4-2 defines the spatial boundaries of the decision and the domain or geographic area (or volume) within which all decisions must apply (in some cases, this may be defined by the OU). The domain is a region distinctly marked by some physical features (i.e., volume, length, width, and boundary).

Table 4-2. Geographic Boundaries of the Investigation.

DS #	Geographic Boundaries of the Investigation
All	The geographic boundaries for the investigation are the boundaries of the individual TSD unit waste sites.

DS = decision statement.

When appropriate, the population is divided into strata that have relatively homogeneous characteristics. The DQO team must systematically evaluate process knowledge, historical data, and plant configurations to present evidence of a logic that supports alignment of the population

into strata with homogeneous characteristics. Table 4-3 identifies the strata with homogeneous characteristics.

Table 4-3. Zones with Homogeneous Characteristics.

DS #	Population of Interest	Zone	Homogeneous Characteristic Logic
<i>Cribs</i>			
All	Vadose zone soils beneath the TSD unit waste sites	Clean or very low concentration stabilizing fill over waste site	Generally not expected to be contaminated. Have been stabilized with clean fill. Fill will be field-screened for contamination at all sites during characterization activities.
		Highest contaminant concentration layer <sup>a</sup>	The particulates and high distribution coefficient ( $K_d$ ) contaminants were sorbed and/or filtered out of the liquid flow via the soils at the bottom of the excavated crib/trench. This zone is expected to contain the highest concentrations of contaminants and to have decreasing concentrations with depth. May also contain residual concentrations of mobile constituents.
		Moderate to low contaminant concentration layer <sup>a</sup>	A moderate concentration layer was formed immediately beneath the expected high concentration layer. In this zone, finer particulates and moderate distribution coefficient contaminants from the liquid waste streams were filtered and sorbed. High volumes of disposed liquids may have carried some immobile constituents into this zone, and residual concentrations of mobile constituents may also be present. This zone is expected to have decreasing concentrations with depth as more immobile constituents filter and sorb out with the passing of the wetting front. <sup>b</sup>
		Low contaminant concentration layer <sup>a</sup>	This zone is expected to contain low concentrations of mobile contaminants from the source to the groundwater table. Concentrations are expected to remain fairly constant through the impacted zone because the majority of the contaminants have been flushed through the system, leaving residual concentrations.

<sup>a</sup> The thickness is not specified.

<sup>b</sup> The wetted front may have reached groundwater for crib sites. It is not known if groundwater was impacted by the discharges in the trench sites.

DS = decision statement.

TSD = treatment, storage, and disposal.

The temporal boundaries of the decision are defined in Table 4-4.

Table 4-4. Temporal Boundaries of the Investigation.

DS #	Timeframe	When to Collect Data
<b>Field Screening</b>		
All	0 to 5 years <sup>a</sup> after issuance of the SAP	Avoid extreme hot/cold months due to impacts on worker efficiency and equipment effectiveness. Inclement weather may impact sample quality.
<b>Laboratory Samples</b>		
All	0 to 5 years <sup>a</sup> after issuance of the SAP	Avoid extreme hot/cold months and inclement weather that have potential to impact sample integrity and soil sampling operations.

<sup>a</sup> Timeframe is approximate and may be impacted by changing priorities, budgets, and approval of the work plan.

DS = decision statement.

SAP = sampling and analysis plan.

### 4.3 SCALE OF DECISION MAKING

Table 4-5 defines the scale of decision making for each decision statement. The scale of decision making is defined as the smallest, most appropriate subsets of the population (sub-population) for which decisions will be made based on the spatial or temporal boundaries of the area under investigation.

Table 4-5. Scale of Decision Making.

DS #	Population of Interest	Geographic Boundary	Temporal Boundary		Spatial Scale of Decision Making
			Timeframe <sup>a</sup>	When to Collect Data	
All	Vadose zone soils beneath each of the individual TSD units	Boundaries of the individual representative waste sites: 216-A-37-1 Crib,  207-A-South Retention Basin	0 to 5 years after issuance of SAP	Avoid extreme hot/cold months and inclement weather that have potential to impact sample integrity and soil sampling operations.	Vadose soils

<sup>a</sup> Timeframe is approximate and may be impacted by changing priorities, budgets, and approval of the work plan.

DS = decision statement.

SAP = sampling and analysis plan.

TSD = treatment, storage, and disposal.

The zones of homogeneous characteristics in Table 4-3 identify various strata within the TSD unit waste site. However, the scale of decision making for this DQO process is the vadose zone soils within the geographic boundaries of the individual waste sites over the next 0 to 5 years. The homogeneous characteristics in Table 4-3 are not significant factors in remedial decision-making. The remedial decisions will focus on contaminant concentrations and depth. The depth intervals of concern are identified in Table 1-8.

#### 4.4 PRACTICAL CONSTRAINTS

Table 4-6 identifies all of the practical constraints that may impact the data collection effort. These constraints include physical barriers, difficult sample matrices, high radiation areas, or any other condition that will need to be taken into consideration in the design and scheduling of the sampling program.

Table 4-6. Practical Constraints on Data Collection.

<p><b><u>Practical Constraints:</u></b></p> <p>Boreholes may not obtain sufficient volumes of sample media if the sampled zone is 0.6-m (2-ft) thick or less. Advancement of borehole casing may smear contamination downhole.</p> <p>The soils in the vadose zone are expected to be typical Hanford Site soils. These soils should be easily recognizable and should not pose unusual sampling problems.</p> <p>Access to the soils under the 207-A South Retention Basin may be limited since drilling through the concrete basin is required. This may also limit the volume of sample material that may be recovered. The basin may also be considered as a possible confined space environment, which may pose additional constraints. A biased approach to sampling will be necessary to target the areas around the drains or cracks within the basin.</p> <p><b><u>Other Constraints:</u></b></p> <p>Health and safety constraints may be imposed during characterization sampling to ensure that as low as reasonably achievable issues are properly addressed when sampling radiologically contaminated soils.</p> <p>Laboratory constraints are expected when analyzing soil samples with high contaminant concentrations. Soil samples in this category would be analyzed in an onsite laboratory. Impacts are expected in cost, degradation of detection limits, and possible reduction in the analyte lists. Extreme weather conditions may also limit or shut down field screening operations.</p>
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## 5.0 STEP 5 -- DEVELOP A DECISION RULE

The purpose of DQO Step 5 is initially to define the statistical parameter of interest (i.e., maximum, mean, or 95% upper confidence level) that will be used for comparison against the action level. The statistical parameter of interest specifies the characteristic or attribute that a decision-maker would like to know about the population. The preliminary action level for each of the COCs is also identified in DQO Step 5. When this is established, a decision rule is developed for each decision statement in the form of an "IF...THEN..." statement that incorporates the parameter of interest, the scale of decision making, the preliminary action level, and the alternative actions that would result from resolution of the decision. Note that the scale of decision making and alternative actions were identified earlier in DQO Steps 4 and 2, respectively.

### 5.1 INPUTS NEEDED TO DEVELOP DECISION RULES

Tables 5-1, 5-2, and 5-3 present the information needed to formulate the decision rules in Section 5.2. This information includes the decision statements and alternative actions identified in DQO Step 2, the scale of decision making identified in DQO Step 4, and the statistical parameters of interest and preliminary action levels for each of the COCs.

Table 5-1. Decision Statements.

DS #	Decision Statement
1	Determine if the vadose zone radionuclide concentrations in the 200-PW-4 OU TSD unit waste sites exceed the radiological exposure limits for human health protection under an industrial exposure scenario, requiring evaluation in an FS.
2	Determine if vadose zone nonradiological constituent concentrations in the 200-PW-4 OU TSD unit waste sites exceed the nonradiological constituent exposure limits for human health protection under an industrial exposure scenario, requiring evaluation in an FS.
3	Determine if the 200-PW-4 OU conceptual contaminant distribution models represent the contaminant distribution conditions and physical characteristics in each waste site or if the models need to be refined.

DS = decision statement.

FS = feasibility study.

OU = operable unit.

TSD = treatment, storage, and disposal.

Table 5-2. Inputs Needed to Develop Decision Rules.

DS #	COCs	Parameter of Interest	Statistic	Scale of Decision Making	Preliminary Action Levels
1	Radionuclides	Population maximum	Maximum detected values	Vadose soils	Dose based limit (15 - 500 mrem/yr). Compliance determined by detected radionuclide concentrations and modeling (RESRAD, STOMP, other).
2	Nonradiological constituents				WAC 173-340 and other regulatory levels (identified in Tables 3-6a and 3-6b).
3	Radiological and nonradiological constituents and physical properties				N/A

COC = contaminant of concern.  
 DS = decision statement.  
 N/A = not applicable.

The alternative actions identified in DQO Step 2 are summarized in Table 5-3.

Table 5-3. Alternative Actions. (2 Pages)

PSQ #	AA #	Alternative Actions
1	1	If the radionuclide concentrations in the vadose soils do not exceed the industrial exposure limits, evaluate the site for closure with no remedial action in an FS.
	2	If the radionuclide concentrations in the vadose soils exceed the industrial exposure limits, evaluate the need for remedial action alternatives or evaluate a streamlined approach to site closure (e.g., add to an existing ROD) in an FS.
2	1	If the nonradiological constituent concentrations in the vadose soils do not exceed the industrial exposure limits, evaluate the site for closure with no remedial action in an FS.

Table 5-3. Alternative Actions. (2 Pages)

PSQ #	AA #	Alternative Actions
	2	If the nonradiological constituent concentrations in the vadose soils exceed the industrial exposure limits, evaluate the need for remedial action alternatives or evaluate a streamlined approach to site closure (e.g., add to an existing ROD) in an FS.
3	1	If the conceptual contaminant distribution models reflect the actual distribution of contaminants and physical characteristics, use the models for remedial alternative selection and remedial action planning.
	2	If the conceptual contaminant distribution models do not accurately reflect the distribution of contaminants and physical characteristics, revise the models before remedial alternative selection and remedial action planning.

AA = alternative action.

PSQ = principal study question.

FS = feasibility study.

ROD = record of decision.

## 5.2 DECISION RULES

The output of DQO Step 5 and the previous DQO steps are combined into "IF...THEN" decision rules that incorporate the parameter of interest, the scale of decision making, the action level, and the actions that would result from resolution of the decision. The decision rules are listed in Table 5-4.

Table 5-4. Decision Rules. (2 Pages)

DR #	Decision Rule
1 & 2	<p>If the analytical results of the vadose zone soil samples within the geographic boundaries of the individual 200-PW-4 OU TSD unit waste sites over the next 5 years meet all of the following conditions:</p> <ul style="list-style-type: none"> <li>• The RESRAD analysis of maximum detected soil sampling results for the radiological COCs in the 200-PW-4 OU TSD unit vadose zone soils do not exceed the annual exposure limits for human health protection.</li> <li>• The fate and transport analysis (TBD) of the maximum detected soil sampling results for the radiological COCs in the 200-PW-4 OU TSD unit vadose zone soils do not exceed the annual exposure limits for protection of groundwater.</li> <li>• The analytical results of the 200-PW-4 OU TSD unit vadose zone soils indicate that maximum detected values do not exceed the respective nonradiological COC preliminary action levels for direct exposure.</li> <li>• The analytical results of the 200-PW-4 OU TSD unit waste site vadose zone soils indicate that the maximum detected values do not exceed the respective nonradiological COC preliminary action levels for protection of groundwater.</li> </ul> <p>Then evaluate for site closure with no remedial action (assumes minimal institutional controls). If any of these conditions are not met, then evaluate the need for remedial action within an FS/closure plan, or evaluate a streamlined approach to site closure to be applied administratively via an existing ROD.</p>

Table S-4. Decision Rules. (2 Pages)

DR #	Decision Rule
3	<p>If the maximum detected values indicate that the contamination distribution and physical characteristics in the 200-PW-4 OU waste sites do not differ significantly from the preliminary conceptual contaminant distribution model, then the preliminary conceptual contaminant distribution model will not be revised before it is used for remedial decision making or remedial action planning.</p> <p>If the maximum detected values indicate that the contamination distribution and physical properties in the 200-PW-4 OU waste sites differ significantly from the preliminary conceptual contaminant distribution model, then the preliminary conceptual contaminant distribution model will be revised before it is used for remedial decision making or remedial action planning.</p>

<sup>4</sup> The use of the term "remedial action" is used collectively to refer to one of the alternatives described in the project objectives discussion. The selection of the appropriate alternative action is beyond the scope of this DQO summary report.

COC = contaminant of concern.

DQO = data quality objective.

DR = decision rule.

FS = feasibility study.

OU = operable unit.

ROD = record of decision.

TBD = to be determined.

TSD = treatment, storage, and disposal.

**6.0 STEP 6 -- SPECIFY TOLERABLE LIMITS ON DECISION ERRORS**

Because analytical data can only estimate the true condition of the site under investigation, decisions that are made based on measurement data could potentially be in error (i.e., decision error). For this reason, the primary objective of DQO Step 6 is to determine which decision statements (if any) requires a statistically based sample design. For those decision statements requiring a statistically based sample design, DQO Step 6 defines tolerable limits on the probability of making a decision error.

**6.1 STATISTICAL VERSUS NONSTATISTICAL SAMPLING DESIGN**

Table 6-1 provides a summary of the information used to support the selection between a statistical versus a nonstatistical sampling design for each decision statement. The factors that were taken into consideration in making this selection included the timeframe over which each of the decision statements applies, the qualitative consequences of an inadequate sampling design, and the accessibility of the site if resampling is required.

Table 6-1. Statistical Versus Nonstatistical Sampling Design.

DS #	Timeframe (Years)	Qualitative Consequences of Inadequate Sampling Design (Low/Moderate/Severe)	Resampling Access After Remedial Investigation (Accessible/Inaccessible)	Proposed Sampling Design (Statistical/Nonstatistical)
All	0 to 5	Low	Accessible	Nonstatistical

DS = decision statement.

**6.2 NONSTATISTICAL DESIGNS**

A biased (or focused) sampling approach, which targets the maximum potential contamination within a waste site, is considered appropriate for the waste sites in the 200-PW-4 OU. Contaminant distributions are expected to follow relatively predictable patterns based on process knowledge and existing environmental data.

The "gray region" and tolerable limits on decision error will not be developed in this DQO process because they only apply to statistical sampling designs. The nature of the waste sites to be investigated in the RI supports the use of focused sampling, as identified in Ecology Publication No. 94-49. This guidance document defines "focused sampling" as selective sampling of areas where potential or suspected soil contamination can reliably be expected to be found if a release of a hazardous substance has occurred. The relatively small retention basin

structure to be investigated released contaminants in a point-source fashion, if any was released. Contaminants released from the retention basin would likely impact the soil immediately beneath the basin with minimal lateral spread; therefore, the focused RI sampling in the area of the basin ensures collection of the area of greatest impact associated with the discharge. In comparison, crib/trench structures, which are longer by design, may require additional efforts to determine the worst-case location for the borehole. This will also provide additional data on gamma-emitting radionuclides to support the focused sampling regime.

## 7.0 STEP 7 – OPTIMIZE THE DESIGN

### 7.1 PURPOSE

The purpose of DQO Step 7 is to identify the most resource-effective design for generating data to support decisions while maintaining the desired degree of precision and accuracy. When determining an optimal design, the following activities should be performed.

- Review the DQO outputs from the previous DQO steps and the existing environmental data.
- Develop general data collection design alternatives.
- Select the sampling design (e.g., techniques, locations, or numbers/volumes) that most cost effectively satisfies the project's goals.
- Document the operational details and theoretical assumptions of the selected design.

### 7.2 WORKSHEETS FOR STEP 7 – OPTIMIZE THE DESIGN

Table 7-1 identifies information in relation to determining the data collection design.

Table 7-1. Determine Data Collection Design.

Decision	Statistical	Nonstatistical	Rationale
All	N/A	Nonstatistical sampling design	Judgmental data collection design is applicable to investigation as preliminary data suggest that the highest levels of contamination are located relative to release points or the bottom of waste sites. The relative size of waste sites presents a point-source-type disposal, focusing the area of investigation to the distribution of contaminants with depth. Consequences of erroneous decisions are not severe. Characterization sampling results will be verified by confirmatory sampling of analogous sites during the confirmatory and remedial design phase.

N/A = not applicable.

Table 7-2 is used to develop general data collection design alternatives. If the data collection design for a given decision will be nonstatistical, determine what type of nonstatistical design is appropriate (i.e., haphazard or judgmental).

Table 7-2. Determine Nonstatistical Sampling Design.

DR #	Haphazard	Judgmental
All	None	Professional judgmental sampling design is indicated.

DR = decision rule.

The data collection design alternatives for this project are described in Table 7-3.

Table 7-3. Methods for Collection of Data at Depth. (2 Pages)

Method	Description
Cone penetrometer or direct-push sampling	A closed-end rod is pushed into the soil to the desired depth, where a removable tip is displaced and a small volume of soil is retrieved. Due to the small volume of soil retrieved, multiple samples would be required to meet sample volume requirements for a large analyte list. The cone penetrometer and other direct-push methods are easily stopped by cobbles, rocks, or other features in the soil column. The resulting hole can be geophysically logged, providing information on gamma-emitting radionuclides and moisture content.
Auger drilling and sampling	Grab samples may be collected from the auger fitting during drilling, or split tube samples may be collected with the aid of hollow-stem auger "flights." To achieve laboratory analysis sample volume needs for large analytical lists, a 0.6-m (2-ft) core sample from a 13-cm (5-in.)-diameter sampler is typically needed. Running a sample tube down the hollow center of the flight retrieves split tube samples. This method is not well suited to drilling in soils contaminated with alpha-emitting radionuclides because of contamination control limitations. The auger split-spoon samples are typically 6 cm (2.5 in.) in diameter.
Cable tool drilling and sampling	This slow drilling method is particularly useful in highly contaminated areas because potential contamination releases can be more easily controlled. This drilling method allows collection of grab samples from the drive barrel or split-spoon. To achieve adequate laboratory analysis sample volumes for large analytical lists, a 0.6-m (2-ft)-long core sample from a 13-cm (5-in.)-diameter sampler is typically needed. DOE-owned, controlled cable tool rigs are available onsite for use in highly contaminated areas. In alpha-contaminated soils, significant contamination controls are required.
Diesel hammer drilling	The diesel hammer is a dual-string, reverse-air circulation drilling method. The potential impacts of this drilling method include degraded sample quality and increased contaminant release potential. Because of the introduction of air to the sample media, affects on analytical results for volatile organics and increased potential for dust result from this technique.

Table 7-3. Methods for Collection of Data at Depth. (2 Pages)

Method	Description
Sonic drilling and sampling	Sonic drilling can quickly advance either well casings or sample tubes. Samples are retrieved similar to split-spoon sample collection during a cable tool operation. To achieve adequate laboratory analysis sample volumes, a 0.6-m (2-ft)-long core sample is typically needed from a 13-cm (5-in.)-diameter sampler. Sonic drilling is much faster than cable tool drilling, but the technique generates a significant amount of heat, which can alter samples (e.g., liberate volatile organics from the sampled soils) and the surrounding formation. In alpha contaminated soils, significant contamination controls are required and may be difficult to implement because of the nature of the equipment and operations.
Air rotary drilling and sampling	Air rotary drilling is much faster than other drilling techniques. Grab samples and split-spoon samples may be taken using this method. In addition, most rotary drill rigs can be configured to collect core samples. To achieve adequate laboratory analysis sample volumes, a 0.6-m (2-ft)-long core sample is typically needed from a 13-cm (5-in.)-diameter sampler. This technique may introduce air into the soil, potentially altering the sample quality and formation moisture levels.

The design options are evaluated based on cost and ability to meet the DQO constraints. The results of the trade-off analyses should lead to one of two outcomes: (1) the selection of a design that most efficiently meets all of the DQO constraints, or (2) the modification of one or more outputs from DQO Steps 1 through 6 and the selection of a design that meets the new constraints.

The key features of the selected design are then documented, including (for example) the following:

- Maps outlining sample locations, strata, and inaccessible areas
- Directions for selecting sample locations, if the selection is not necessary or appropriate at this time
- Order in which samples should be collected (if important)
- Stopping rules
- Special sample collection methods
- Special analytical methods.

**7.3 SAMPLING OBJECTIVES**

The principal study questions identified in Table 2-1 result in the following characterization objectives.

- Determine if the concentrations of chemical and radiological constituents in the 207-A-South Retention Basin and 216-A-37-1 Crib exceed the exposure limits for human health protection.
- Evaluate IH monitoring data, concrete and soil sample results, geophysical logs of boreholes, and physical property analyses to determine whether the conceptual contaminant distribution models need refinement.

**7.4 SAMPLING DESIGN -- SUMMARY OF SAMPLING ACTIVITIES**

A summary of the sampling activities is presented in Table 7-4.

Table 7-4. Key Features of the 200-PW-4 Sampling Design. (5 Pages)

<b>Sample Collection Methodology</b>	<b>Key Features of Design</b>	<b>Basis for Sampling Design</b>
<i>207-A-South Retention Basin</i>		
Maintenance and inspection	Perform a radiological survey and remove and dispose of all accumulated tumbleweeds and/or trash. Sample potential standing water in each basin. Pump out and dispose to the ETF. Perform a radiological survey, sample, and remove and dispose of all accumulated sludge (i.e., shovel or vacuum out). Perform a visual inspection for notable cracks in the surface of the basin liner, noting the locations for possible future sampling locations.	These activities are designed to prepare the site for further characterization activities and assist waste designation.

Table 7-4. Key Features of the 200-PW-4 Sampling Design. (5 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Concrete sampling	<p>If cracks with significant penetration are noted in the visual inspection, sample the concrete at that specific location. Select one location that will be the worst-case location within all three basins. Collect a concrete surface sample by drilling several co-located holes to a depth of ¼ inch and collect the cuttings.</p> <p>Near the drain within each of the three basins collect a concrete surface sample by drilling several co-located holes at each location to a depth of ¼ inch.</p> <p>Collect the three to four concrete samples obtained. Each concrete sample will be labeled and provided to the laboratory for analysis.</p>	<p>Sampling at crack locations will verify the depth of penetration of contaminants into the concrete and the possibility of contamination in the soils underlying the crack.</p> <p>Concrete sampling will be performed by drilling several co-located holes to collect enough concrete debris for analysis. A rod will be fixed to the side of the drill motor to act as a physical stop, thereby limiting the depth of penetration to ¼ inch. This sampling method will be repeated at the location of the potential crack and the three drains locations.</p>
Soil vapor sampling	<p>If determined by the onsite IH technician that volatile organics (VOA) are present, a near surface soil sample will be taken for analysis.</p> <p>If VOAs continue to be present during the drives to 20 ft it will be necessary to drive a soil gas sampling probe to depth (after soil sampling has been completed) to obtain a soil gas sample for analysis.</p>	<p>Continuous monitoring for volatile organics will be performed by an IH technician. As the concrete of the basin is removed the IH technician will monitor the air space immediately below the concrete. If any detections are made, a soil sample will be taken for analysis.</p> <p>A separate soil gas sample will be necessary to determine the nature of the VOAs that are present (e.g., carbon tetrachloride).</p>

Table 7-4. Key Features of the 200-PW-4 Sampling Design. (5 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Soil sampling	<p>Following concrete surface sample collection, penetrate the concrete to the bottom of the basin. Upon removal of the concrete, measurement for possible VOAs, and exposure of the underlying gravel or soil determine (if gravel exists) whether or not it is possible to remove the gravel by hand. If this is feasible then remove the gravel and collect the first soil sample. After collection of the first soil sample the GeoProbe or similar method will be implemented. Sample the underlying soils to a depth of 20 ft below ground surface.</p> <p>Collect soil samples at approximately 7-8 ft (hand collected if possible immediately underneath the concrete basin), 9-10 ft, 14-15 ft, and 19-20 ft below ground surface (bgs). Presuming the concrete basin bottom to be at 7 ft bgs, these sample depths correspond to 1-2 ft, 3-4 ft, 8-9 ft, and 13-14 ft below the concrete basin. (Field screening will be used in conjunction with the guidance provided above to determine actual sample depths.)</p> <p>Collect bulk density and grain-size distribution samples at major changes in soil lithology. Collect soil moisture samples with the other physical property samples.</p>	<p>The area next to the drains would likely be the location of any leakage at faulty pipe connections. Install the temporary borehole for soil sampling.</p> <p>Soil samples will be used to determine COC concentrations beneath the basins and in the vadose zone. Sampling provides data for remedial action decision making, to verify the preliminary conceptual contaminant distribution model expectation that contamination levels are expected to drop off rapidly with increasing depth, and to support numerical modeling.</p> <p>The soil sample immediately underneath the basin is critical. Since contamination is not expected to be deep, the succeeding samples down to 20 ft bgs should be adequate to support the conceptual contaminant distribution model.</p> <p>Soil physical properties (e.g., moisture content, grain-size distribution, and bulk density) will be used to support contaminant transport modeling, if needed and if adequate sample material is available.</p>

Table 7-4. Key Features of the 200-PW-4 Sampling Design. (5 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
<i>216-A-37-1 Crib</i>		
Soil vapor sampling	<p>If VOAs are detected during drilling, it will be necessary to install a packer system into the borehole casing to obtain a vapor sample before the resumption of drilling. This determination will be made by the onsite geologist and/or project representative.</p>	<p>Continuous monitoring for volatile organics will be performed by an IH technician. As the borehole drilling proceeds the IH technician will monitor the air space immediately surrounding the borehole and during soil sample removal. If any detections are made, a soil gas sample will be taken for analysis.</p> <p>A separate soil gas sample will be necessary to determine the nature of the VOAs that are present.</p>
Borehole characterization	<p>Drill one borehole to groundwater at the southeast end of the crib, nearest to the incoming discharge pipe.</p> <p>Begin with a sample at 12.5-15 ft bgs. Within the remaining zone of highest contamination collect soil samples every 10 ft at 20 ft, 30 ft, and 40 ft. Within the zone of expected lower contamination the sample interval begins at 50 ft and increases at 25 ft intervals to 75 ft and 100 ft, increases to 50 ft intervals at 150 ft (transition from H2 to Undifferentiated Hanford formation), and 200 ft. The subsequent samples at 240 ft (top of Ringold Formation), and 275 ft (at the water table) are the two last samples required. (Field screening will be used in conjunction with the guidance provided above to determine actual sample depths.)</p> <p>Collect bulk density and grain-size distribution samples at major changes in lithology. Collect moisture samples with the other physical property samples.</p>	<p>The exact location of the borehole will take into account the results of drive casing installation at the analogous 216-A-10 waste site. Topographically, the southeast end is also at a lower elevation.</p> <p>Drill the borehole to allow sampling with depth and to support geophysical logging with spectral gamma and neutron moisture tools.</p> <p>Soil samples will be used to determine COC concentrations beneath the crib and in the vadose zone. Sampling provides data for remedial action decision making and to verify the preliminary conceptual contaminant distribution model.</p> <p>The soil sample at 12.5-15 ft bgs is critical. Samples at approximately 10 ft intervals in the expected zone of higher contamination is required to support the conceptual model expectation that contamination levels are expected to drop off rapidly with increasing depth. Changes in contamination levels with depth are expected to decrease, thereby allowing the sampling interval to increase with depth.</p> <p>Soil physical properties (e.g., moisture content, grain-size distribution, and bulk density) will be used to support contaminant transport modeling, if needed.</p>
	<p>Perform SGL for the entire length of the deep borehole.</p>	<p>SGL provides a continuous gamma-emitting radiological contaminant distribution profile with depth that will be used as supplemental information to soil samples. This information will be used to refine the preliminary conceptual contaminant distribution model.</p>

Table 7-4. Key Features of the 200-PW-4 Sampling Design. (5 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
	Perform neutron moisture logging for the entire length of the borehole.	Collect soil moisture data to determine the residual amount of moisture in the vadose zone, and to support numerical modeling efforts, if needed.
Borehole spectral logging in existing wells	Perform borehole spectral logging in accessible boreholes and groundwater wells near the crib. Site well status records indicate that the following wells may be accessible and are appropriately configured for geophysical logging: <ul style="list-style-type: none"> <li>• 299-E25-17</li> <li>• 299-E25-18</li> <li>• 299-E25-19</li> <li>• 299-E25-20.</li> </ul>	These wells represent data collection points in the vicinity of the waste site. Logging of these wells will provide additional current site-specific information on contaminant distribution, both laterally and vertically for comparison to previous surveys.

COC = contaminant of concern.

ETF = Effluent Treatment Facility.

IH = industrial hygiene.

SGL = spectral gamma logging.

VOA = volatile organic analysis.

## 7.5 POTENTIAL SAMPLE DESIGN LIMITATIONS

- Drilling impediments (e.g., boulders) may be encountered and/or insufficient sample volumes may be retrieved from the samplers available with the use of either the split spoon sampler or the GeoProbe sampler. The list of analytes will be prioritized in the SAP to account for insufficient sample volume.
- Work in the 207-A-South Retention Basin may be considered as confined space work. Extra precautions associated with this type of work will be required. Use of the portable GeoProbe unit will be required, as will a concrete coring or cutting apparatus.
- Geophysical logging of existing boreholes is dependent on accessibility and configuration of the boreholes. If the specified boreholes are not properly configured or available for logging, other boreholes may be considered or the logging program may be reduced.
- Vapor sampling and the need for additional samples (organics) is based on the continuous IH monitoring. However, sensitivity of IH instruments is not always reliable and is not compound specific.

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