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Rev. 0

Data Quality Objectives Summary Report for the 200-CW-5 U Pond/ Z Ditches System Waste Sites

Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Environmental Restoration

Submitted by: Bechtel Hanford, Inc.

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Data Quality Objectives Summary Report for the 200-CW-5 U Pond/ Z Ditches System Waste Sites

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Date Published

December 1999

EXECUTIVE SUMMARY

This data quality objective (DQO) summary report supports site characterization decisions for remedial investigation (RI) and remedial action decisions for representative waste sites in the 200-CSW-5 U Pond/Z Ditches Cooling Water Operable Unit (OU). This OU consists of 17 waste sites, as defined in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan -- Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) (DOE-RL 1999a), that received cooling water and steam condensate effluents from the Uranium Trioxide Plant, U Plant, the 284-W Powerhouse, the 2723-W and 2724-W Laundry Facilities, the 242-S Evaporator, and Z Plant (including the Plutonium Finishing Plant), as well as other smaller facilities. These effluent streams carried chemicals and radionuclides that contaminated the waste sites.

This DQO effort followed the concepts developed in the Implementation Plan (DOE-RL 1999a) for the use of analogous site contaminant data to reduce the amount of characterization required to support remedial action decisions. The Implementation Plan's concepts involve grouping sites with similar process histories, structures, and contaminants and then choosing one or more representative sites for comprehensive field investigations, including sampling during RI activities. Findings from the RI at representative sites are then used to make remedial action decisions for the waste sites that are not characterized. Sites for which field data have not been collected are assumed to have chemical characteristics similar to the sites that are characterized. For the 200-CW-5 U Pond/Z Ditches Cooling Water OU, one representative waste site will be characterized. The goals of the RI are to provide the data needed to support remediation decisions and to refine the preliminary conceptual contaminant distribution models for the OU.

The proposed sampling locations were selected with the goal of intersecting the highest areas of 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 RI data needs. Up to three shallow boreholes will be used to sample soils from the surface to about 8 m (25 ft) below the local ground surface elevation. A single borehole will be used to sample the vadose zone to groundwater; however, no groundwater samples are proposed.

The contaminants of potential concern were identified through process history information and previous data collection efforts. Analytical performance criteria were based on *Model Toxics Control Act* chemical compliance criteria (*Washington Administrative Code* 173-340) and preliminary remediation goals selected in the absence of applicable or relevant and appropriate requirements. These preliminary action 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 DQO workbook (EPA 1994a) was used to identify project data quality needs, evaluate sampling and analysis options, and document project data quality decisions.

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ACRONYMS

AAMS	aggregate area management study
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BHI	Bechtel Hanford, Inc.
CERCLA	*Comprehensive Environmental Response, Compensation and Liability Act of 1980*
COC	contaminant of concern
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
EMI	electromagnetic imaging
EPA	U.S. Environmental Protection Agency
FS	feasibility study
GPR	ground-penetrating radar
HCP EIS	*Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*
HPGe	high-purity germanium
KPA	kinetic phosphorescence analysis
MCL	maximum contamination level
MDL	minimum detection level
MTCA	*Model Toxics Control Act*
NaI	sodium iodide
OU	operable unit
OU_3	Uranium Trioxide (Plant)
PRG	preliminary remediation goal
PSQ	principal study question
RCRA	*Resource Conservation and Recovery Act of 1976*
RESRAD	RESidual RADioactivity dose model
RFI	remedial field investigation
RI	remedial investigation
ROD	Record of Decision
SAP	sampling and analysis plan
SGL	spectral gamma logging
TCLP	toxicity characteristic leachate procedure
TIC	tentatively identified compound
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU (waste)	waste materials contaminated with 100 nCi/g of transuranic materials having half-lives above 20 years
UCL	upper confidence limit
WAC	Washington Administrative Code
WIDS	Waste Information Data System

METRIC CONVERSION CHART

The following conversion chart is provided to aid reader with conversions.

Into Metric Units

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	millimeters
inches	2.54	centimeters
feet	0.305	meters
yards	0.914	meters
miles	1.609	kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	metric ton
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius
Radioactivity		
picocuries	37	millibecquerel

Out of Metric Units

If You Know	*Multiply By*	*To Get*
Length		
millimeters	0.039	inches
centimeters	0.394	inches
meters	3.281	feet
meters	1.094	yards
kilometers	0.621	miles
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.76	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.4	sq. miles
hectares	2.47	acres
Mass (weight)		
grams	0.035	ounces
kilograms	2.205	pounds
metric ton	1.102	ton
Volume		
milliliters	0.033	fluid ounces
liters	2.1	pints
liters	1.057	quarts
liters	0.264	gallons
cubic meters	35.315	cubic feet
cubic meters	1.308	cubic yards
Temperature		
Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity		
millibecquerel	0.027	picocuries

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 action decision-making process for the 200-CW-5 U Pond/Z Ditch System Operable Unit (OU) waste sites. The sites within the scope of this DQO process are being remediated under a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) approach. The 200-CW-5 OU includes 17 waste sites that are CERCLA past-practice sites. Of these waste sites, the 216-U-10 Pond, the 216-U-14 Ditch, and the 216-Z-11 Ditch were selected as representative (typical and worst-case) sites in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan -- Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) (DOE-RL 1999a). The 216-U-10 Pond was chosen as the worst-case representative site because of its reported high contaminant inventory, the large quantities of liquid discharged to the site, and its current level of characterization. The 216-U-14 Ditch was selected as a representative site for its suspected high contaminant inventory, laundry waste discharges, and its current level of characterization. The 216-Z-11 Ditch was chosen to document its suspected high contamination inventory. The characterization data collected for the representative sites will be used to make remedial decisions for the entire OU.

The waste sites in the 200-CW-5 OU received predominantly cooling water. Other major sources of waste were steam condensate, chemical sewer waste, and laundry wastewater. Effluent from source facilities was ultimately discharged to the 216-U-10 Pond for evaporation/percolation by means of the 216-U-14 and 216-Z-11 Ditches.

A map of the Hanford Site is provided in Figure 1-1 and depicts the 200 West Area (i.e., the location of the 200-CW-5 OU). Figure 1-2 identifies the location of the 200-CW-5 OU waste sites and the associated source facilities.

1.2 PROJECT SCOPE

This DQO summary report initially focused on the waste sites associated with the U Pond/Z Ditch System OU, which are identified as representative sites. The scope of this project includes the DQO process and development of a sampling and analysis plan (SAP). The DQO summary report and SAP will provide the basis for the remedial investigation (RI), the data from which will support OU remedial action decision making.

During performance of the DQO process, it was recognized that the 216-U-10 Pond and 216-U-14 Ditch were characterized as part of the 200-UP-2 OU and by Lindsay and Singleton (1994). The 200-UP-2 characterization activities were conducted under an approved work plan (DOE-RL 1993) and the results were compiled in a limited field investigation report (DOE-RL 1995). A focused feasibility study (FS) (DOE-RL 1996) that evaluated immediate action requirements was submitted for regulatory review. The FS was never finalized because the

Figure 1-1. Hanford Site Map.

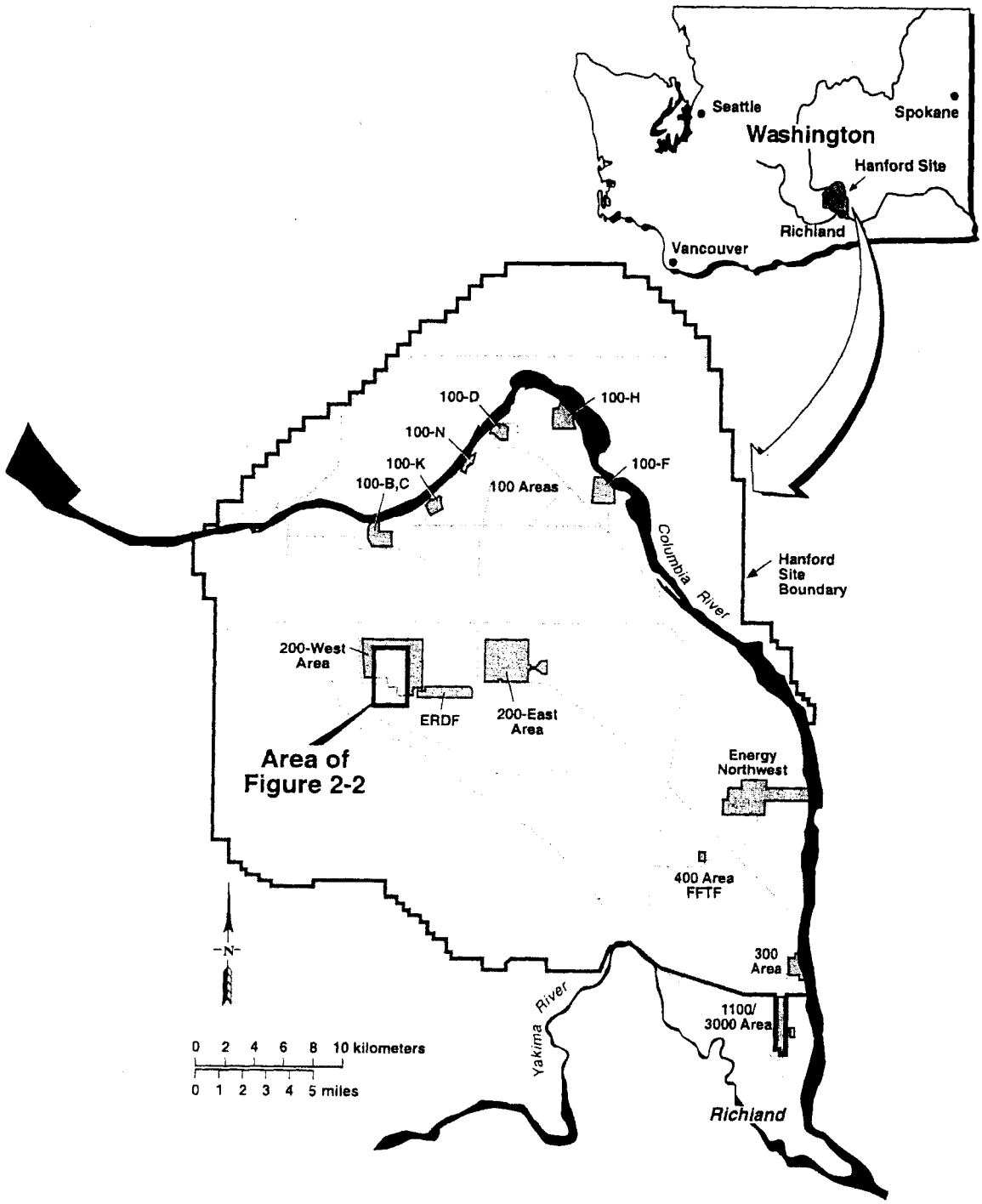

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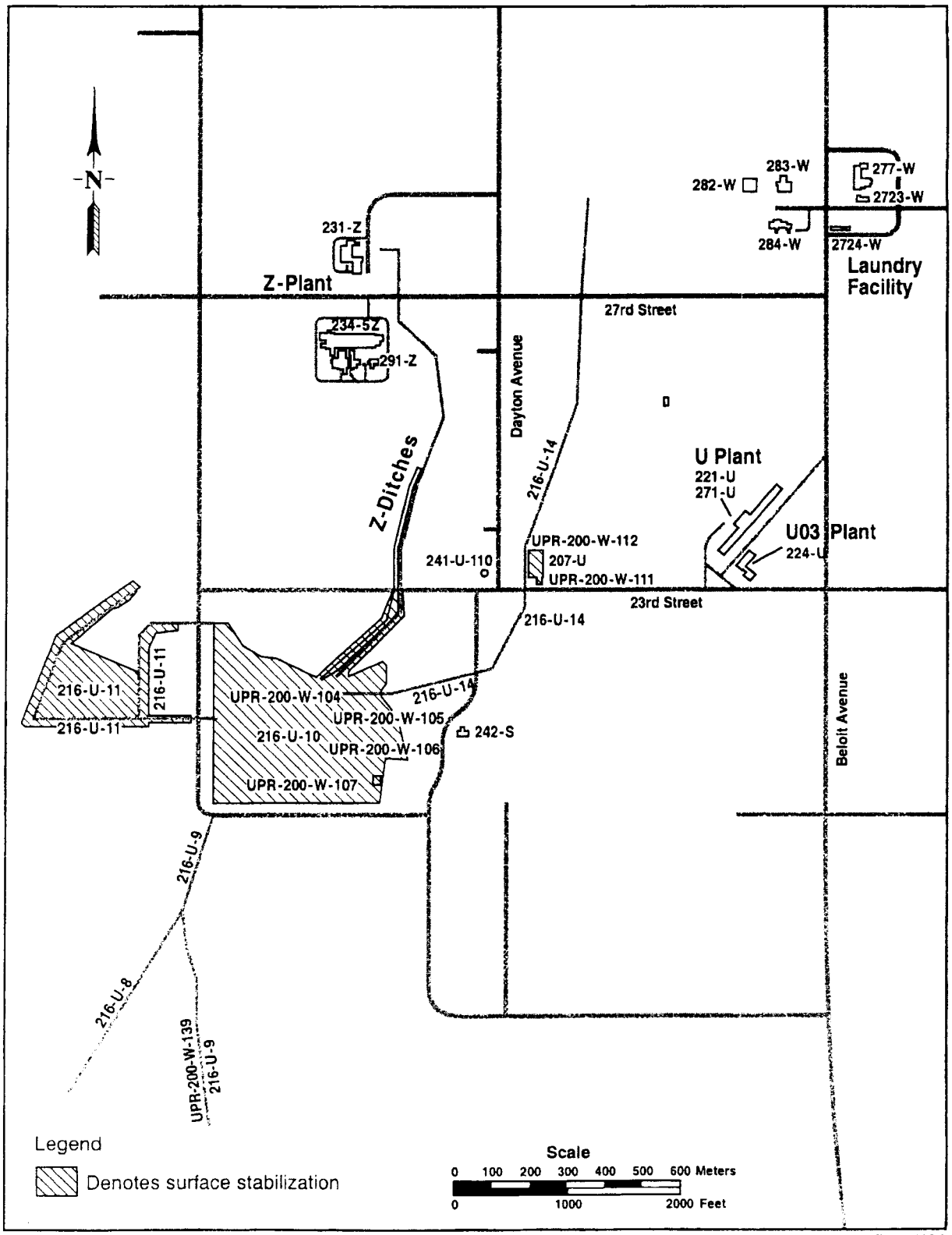
Figure 1-2. Location of 200-CW-5 Operable Unit Waste Sites and Associated Source Facilities.



E9911098.3

near-term risks were low for the evaluated waste sites and interim actions beyond institutional controls were not required. Therefore, these sites have been characterized but not fully evaluated for appropriate final remedial actions. When the OUs were reorganized in accordance with the Implementation Plan (DOE-RL 1999a), these two sites were assigned to the 200-CW-5 OU for completion of their RI/FS process. The characterization data previously obtained for these sites are sufficient to support the 200-CW-5 RI/FS process. Therefore, the characterization aspects of this DQO (e.g., contaminants of concern [COCs], analytical requirements, and sampling design) focus solely on the 216-Z-11 Ditch. The 216-U-10 Pond and the 216-U-14 Ditch were retained throughout the balance of the DQO process to support completion of the remedial decision-making process for those sites.

1.3 PROJECT OBJECTIVES

The first objective of the DQO process for the 200 Area U Pond/Z Ditches is to determine the environmental measurements necessary to support remedial decision making. Possible alternatives under consideration include the following:

- No-action alternative (no institutional controls)
- Capping
- Excavate and dispose of waste
- In situ vitrification
- In situ grouting and stabilization
- Monitored natural attenuation (with institutional controls).

The second objective of the U Pond/Z Ditches DQO process is to obtain the environmental data needed to refine the preliminary conceptual contaminant distribution models for the OU

The third objective is to identify the environmental measurements that will form the basis for a SAP, which is included in the 200-CW-5 OU work plan (DOE-RL 1999b).

1.4 PROJECT ASSUMPTIONS

The following assumptions have been developed for the 200-CW-5 OU RI:

- The DQO process will follow the guidelines found in BHI-EE-01, *Environmental Investigations Procedures*, Procedure 1.2, "Data Quality Objectives," and Section 6.1 of the Implementation Plan (DOE-RL 1999a).

- The 200-CW-5 OU waste group is a source waste group consisting only of CERCLA past-practice waste sites and will focus on surface and vadose zone soil contamination.

- The Implementation Plan (DOE-RL 1999a) outlines the assessment and remediation approach to be followed for the OU:

  - Defines the regulatory framework

  - Identifies the characterization approach

- Provides background information on 200 Area site conditions and operational history, as well as secondary plans (e.g., quality assurance, health and safety, information management, and waste management)

- Provides governing assumptions including preliminary applicable or relevant and appropriate requirements (ARARs), land-use considerations, remedial action objectives, and remedial action alternatives.

- The *Final Hanford Comprehensive Land-Use Plan Environmental Statement* (HCP EIS) (DOE 1999a) establishes the expected land-use scenario for the 200-CW-5 OU as "Industrial-Waste Management Exclusive."

- The analogous site approach will be used, limiting characterization to the representative waste sites. The data from the representative sites will be used to reach remedial decisions for the entire OU. The DQO effort will focus on three representative waste sites within the OU. Preliminary representative waste sites have been identified in Section 6.1 of the Implementation Plan (DOE-RL 1999a). The representative waste sites for the 200-CW-5 OU are as follows:

  - 216-U-10 Pond
  - 216-U-14 Ditch
  - 216-Z-11 Ditch.

- The 216-U-10 Pond was selected to represent worst-case conditions in the OU. The 216-U-14 Ditch and 216-Z-11 Ditch were chosen as sites to represent typical contamination conditions for the OU. Large amounts (8 kg) of plutonium were reportedly released to the 216-Z-11 Ditch. Because plutonium is a heavy element and is relatively immobile, the accumulations on the ditch bottom may exceed the transuranic waste (TRU) concentration definition (100 nCi/g) approximately 6 ft below the current stabilized surface of the ditch.

- Existing characterization data from waste sites within the OU and other analogous data can be used. Based on historical site uses and current contaminant of potential concern (COPC) information, it is expected that waste site COCs will exceed action levels and that remediation will be required.

- Physical contaminant distribution models for the group, developed in the *Waste Site Grouping for 200 Area Soil Investigations* report (DOE-RL 1997) and the focused feasibility study for the 200-UP-2 OU (DOE-RL 1996), provide an initial prediction of the nature and extent of the primary COPCs for this OU.

- The *Model Toxics Control Act* (MTCA) (*Washington Administrative Code* [WAC] 173-340) for chemical contaminants and the U.S. Environmental Protection Agency (EPA) standard of 15 mrem/yr above background for radionuclides in soil are ARARs for this DQO process.

- Potential uses of representative site environmental data to be considered in developing the DQOs include contaminant distribution model refinement, evaluation of remedial action decisions, risk assessment, and worker health and safety.

- The majority of contaminants are expected within 2 m (7 ft) of the sites' former ditch/pond bottoms.

- The primary questions to be answered by the RI are as follows:

  - What is the physical contaminant distribution model for the OU?
  - Does the OU require remedial action, and if so, what type of action?

The RI (i.e., initial OU characterization) will be used to validate the preliminary contaminant distribution conceptual model for the OU from the characterization of representative waste sites. This conceptual model will be used to develop and evaluate remedial action alternatives applicable to the OU in a FS/closure plan. The Implementation Plan (DOE-RL 1999a) will form the basis for selecting a preferred remedial action in a proposed preferred alternative plan (see Figure 1-3).

1.5 PROJECT ISSUES

Project issues include both the global issues that transcend the specific DQO project 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 DQOs for the project.

1.5.1 Global Issues

The global issues for the 200-CW-5 OU focus on establishing radiological cleanup levels that complement the 200 Area land-use decisions reached in the HCP EIS (DOE 1999a). These had not been developed for this OU in time for inclusion in this DQO summary report. It is also recognized that non-Hanford workers may be employed in the 200 Areas at some time in the future. The need for unique exposure limits for non-Hanford employees will be addressed on a case-by-case basis and was not considered within the scope of this DQO summary report.

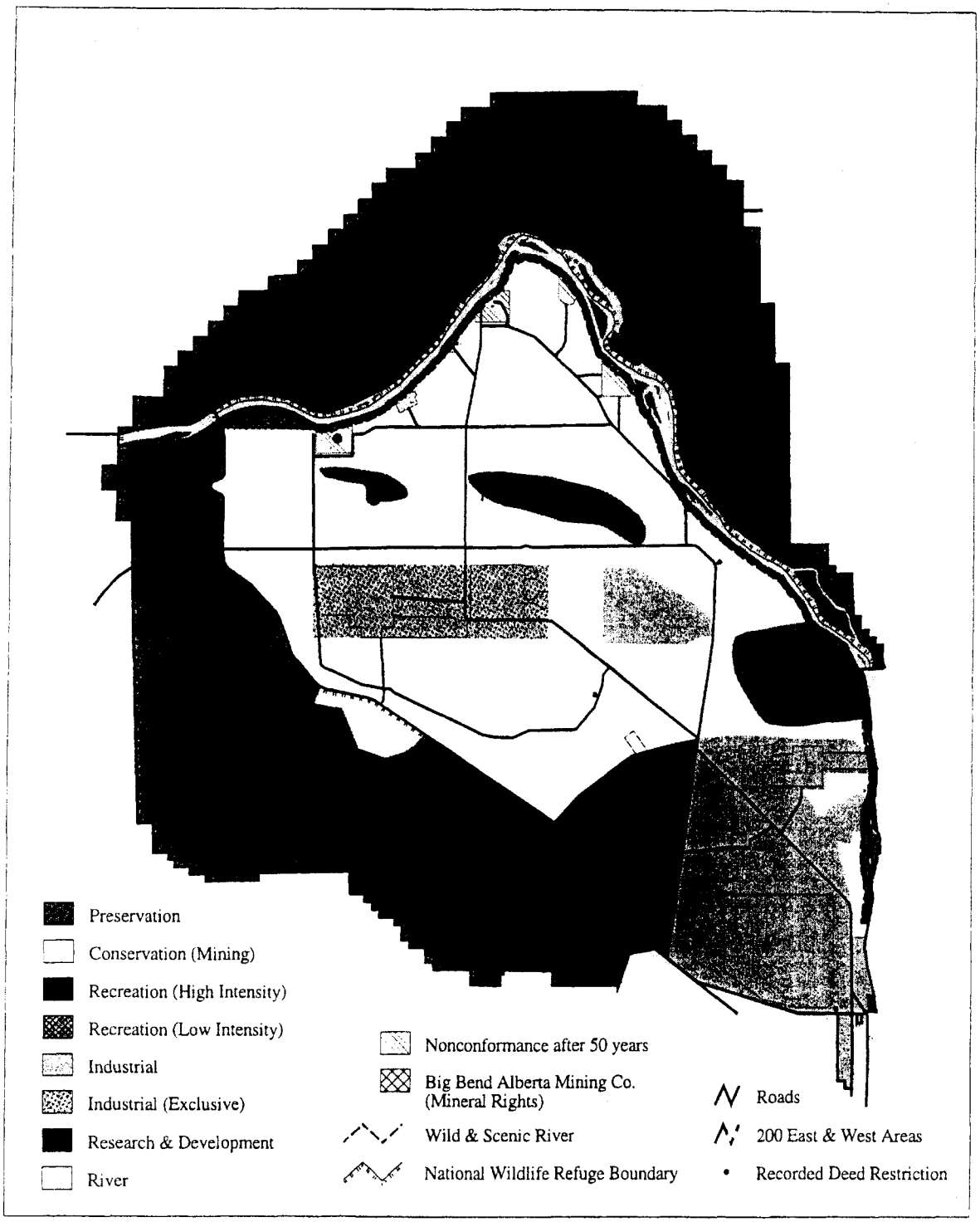
1.5.2 Project Technical Issues

The project's technical issues include the following:

1. The 216-Z-11 and 216-Z-19 Ditches are listed as TRU-contaminated waste sites (in the U Plant aggregate area management study [AAMS] report [DOE-RL 1992b]). This designation is based on sampling and analysis performed during 1979 and 1981. The Hanford Site Defense Waste Environmental Impact Statement (DOE 1987) calculated an average of 790 nCi/g of TRU waste in the contaminated soil volume (550 m^3 [719 yd^3) at the 216-Z-11 Ditch, based on the reported release of 8 kg of plutonium. If TRU contaminant concentrations exist in these ditches, the concentrations are expected to be found within 2 m (7 ft) of the historical ditch sediment layer (just below the current stabilization layer). If sampling results confirm that TRU contaminant concentrations exist, remedial action alternatives may be limited in one or both of these ditches.

2. The available characterization data from previous sampling do not include metals or organic chemicals for the Z Ditches.

Figure 1-3. Preferred Alternative Plan.[a]



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[a] Source: *Final Hanford Comprehensive Land-Use Plan Environmental Statement* (DOE/EIS-0222F) (DOE 1999a).

3. Characterization of the 216-Z-11 Ditch (if performed) must consider radiological control requirements for expected TRU-contaminated soils.

4. The presence of TRU-contaminated soils imposes health and safety restrictions on workers and unfavorably impacts analytical costs, detection limits, analyte lists, and sample media disposal.

5. Discrimination between the 216-Z-11, 216-Z-19, and 216-Z-1D Ditches may be difficult to accomplish due to the close proximity of each of the ditches. In certain locations, the ditches overlap and have been covered and posted as one large radiologically contaminated zone.

The regulator interview conducted with EPA on July 29, 1999, resulted in the establishment of several other project technical issues that affected the scope of the sampling effort. These issues include the following:

6. Doug Sherwood (EPA) indicated that his investigation in years past (while he was a scientist at Battelle) on the Z Ditches liquid discharge inventories led to the conclusion that the inventory estimates may be understated because of reporting secrecy and the timing of the sampling efforts relative to the facility operating periods. In addition, the Defense Waste Environmental Impact Statement (DOE 1987) estimates for the 216-Z-11 Ditch (790 nCi/g over a 550-m^3 [719-yd^3] volume) are <u>average</u> values. Localized hot spots may exist with higher concentrations. The EPA suggested that hot spot areas may exist where wastewater velocities were locally reduced (e.g., at the outside radius of turns, in the delta entrance into the U Pond, and in localized regions of reduced gradient).

   The <u>primary concern for EPA</u> is the ability to locate the TRU hot spots and to determine the TRU concentrations to support decision making, where/what material may be left in place, and the extent of removal/disposal required. The EPA expressed the opinion that it may be necessary to selectively remove the high concentrations of transuranic materials from hot spots in order to build a more cost-effective, less robust barrier.

   A discussion addressed the levels of TRU contamination in the Z Ditches and how corresponding health risks would limit sampling methods. Boreholes and indirect geophysical logging techniques were viewed as likely alternatives over test pits.

   It was agreed that the representative sites in the Implementation Plan (DOE-RL 1999a) are appropriate for this OU.

7. The EPA acknowledged the data gap in the Z Ditches for metal/organic constituents but was not overly concerned in this case because the TRU-contaminated soils will likely be the controlling factor in selecting the remedial action alternatives. The SAP could possibly evaluate the 241-Z/361 tank sampling data (due in spring of the year 2000) as a means of optimizing sampling and analysis of organics in TRU-contaminated soils.

   It was agreed that some limited borehole sampling may be required for analysis of metal/organic constituents.

   The EPA is not particularly concerned with the groundwater chloroform plume reported under these sites, as it is a degradation product of chlorinated water and from carbon

tetrachloride from other Z Cribs. Because the U Pond/Z Ditch waste sites received large aqueous discharges, it is likely that a portion of the chloroform plume near these sites originates from the large water discharges.

8. The EPA is very concerned with remedy selection, particularly for the TRU-contaminated soils. It has been observed that stabilization covers have worked for approximately 10 years, but the upward migration of contamination indicates that stabilization is not a final solution. Other stabilization techniques, such as in situ vitrification should be considered.

9. The EPA took the position that the characterization data for the 216-U-14 Ditch are sufficient for this DQO process and additional environmental measurements are not necessary.

10. The EPA suggested that the Z Ditch discharge pipelines should be sampled at locations where flow velocities allow contamination to settle out. Remediation alternatives considered for the piping should include grouting with segmentation and removal.

11. The EPA expressed the opinion that sampling in this waste group should concentrate on the "delta" region at the head end of U Pond, the Z Ditches, and the Z Ditch pipelines.

The EPA position expressed in technical issue #6 touches on remedial design issues, including (1) where/what materials may be left in place, (2) the extent of removal/disposal required, and (3) selective removal of high concentrations of TRU to support barrier construction. These matters are beyond the scope of this DQO process but are presented for completeness. The position expressed by EPA in technical issue #9 is in agreement with the project position stated in Section 1.2. The remedial actions presented in this section were for discussion purposes. The RI/FS process will be used to determine the alternative actions and is subject to public review and comment.

1.6 OPERATING HISTORY

The U Pond system (216-U-10 Pond and 216-U-14 Ditch) was constructed in 1944 to receive low-level liquid effluent from the 200 West Area processing facilities. Discharges to the system were primarily cooling water, with additional wastewater from steam condensate, laundry wastewater, and chemical sewers. The 216-U-14 Ditch received discharges from several facilities, including the following:

- 284-W Powerhouse (and associated buildings) cooling water, steam condensate, and chemical sewer wastewater
- 2723-W Mask Cleaning Station and 2724-W Laundry Facility steam condensate and contaminated laundry wash and rinse water
- 221-U (U Plant) cooling water, steam condensate, and chemical sewer wastewater
- 224-U (Uranium Trioxide [UO_3] Plant) cooling water
- 241-U-110 condenser tank condenser water

- 271-U cooling water, steam condensate, and chemical sewer wastewater
- 242-S Evaporator steam condensate.

In 1986, a spill accident led to the release of reprocessed nitric acid containing uranium to the 216-U-14 Ditch. This release was diluted by cooling water from the UO_3 Plant.

During the useful life of the ditch, the ditch was periodically dredged to increase percolation capacity and to clear localized damming caused by plants. Contaminated soils that were dredged out were placed on a berm on the banks until these soils were later buried in a low-level waste burial ground.

The 216-U-10 Pond received all effluents that were discharged through the 216-U-14 Ditch. The U Pond was deactivated and interim stabilized in 1985. The northern section of the 216-U-14 Ditch from the head end to the 207-U Retention Basin was also stabilized at that time. The southern or western-most section of the ditch was surface stabilized in 1992 with gravel and cobbles and continued to receive seal water effluent from an air-sampling pump at the 242-S Evaporator until 1995. This section was backfilled and stabilized in 1997.

The 216-Z-11 Ditch operated from 1959 until 1971. The ditch received process cooling water and steam condensate from the 234-5Z Building, vacuum pump seal water and cooling water from the 291-Z Building, and laboratory waste and steam condensate from the 231-Z Building. The 216-Z-11 Ditch was deactivated and stabilized in 1971 when it was replaced by the 216-Z-19 Ditch.

Figure 1-4 shows a graphical representation of the waste streams that discharged to the 216-Z-11 Ditch, 216-U-14 Ditch, and ultimately the 216-U-10 Pond.

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 key decision makers, respectively. The scoping team developed the checklist and binder prior to the internal seven-step process. The DQO workshop team members participated in the seven-step process. The key decision makers provided external review of the results of the seven-step process.

Figure 1-4. Graphical Representation of the 200-CW-5 Waste Streams and Discharge Paths.

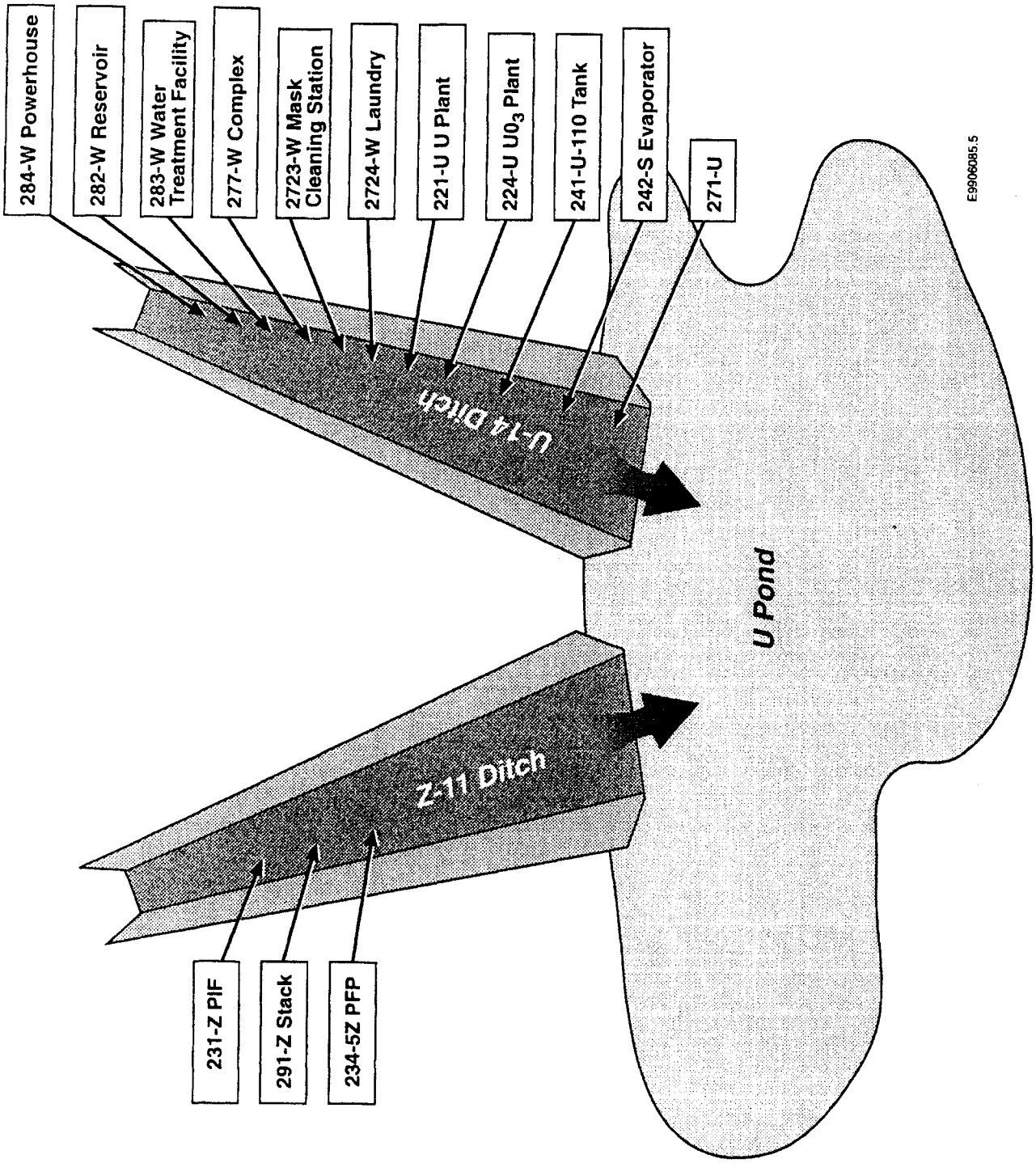


Table 1-1. DQO Scoping Team Members.

Name	Organization	Area of Expertise (Role)	Phone Number
Roy Bauer	CHI Environmental Engineering	DQO Workbook/Facilitator	372-9622
Janet Badden	CHI Regulatory Support/ Environmental Science	Regulatory	372-9303
Karl Fecht	BHI Engineering Technologies	Geological	372-9356
Russ Fabre	BHI Craft Supervisor	Field Support	531-0730
Michael Galgoul	CHI Sample/Data Management	Sampling Data Management/Site Sampling History	372-9617
Marie Kile	CHI Environmental Engineering	Scoping Document Lead	372-9680
Bruce Ford	BHI Site Assessments	BHI Project Manager	372-9176
Jim Sharpe	CHI Regulatory Support/ Environmental Science	Cultural/Biological Issues	372-9369
Wendy Thompson	BHI Engineering Technologies	Sampling/Data Management	376-8031
Rich Weiss	CHI Sample/Data Management	Radiochemical and Analytical	373-5673
Steve Weiss	CHI Regulatory Support/ Environmental Science	Task Lead	372-9531
Jon Wiles	TMA Radiological Engineering	Radiological Engineering	521-2098
Curt Wittreich	CHI Environmental Engineering	Project Management	372-9586

Table 1-2. DQO Workshop Team Members. (2 pages)

Name	Organization	Area of Expertise (Role)	Phone Number
Roy Bauer	CHI Environmental Engineering	DQO Workbook/Facilitator	372-9622
Bruce Ford	BHI Site Assessments	BHI Project Manager	372-9176
Michael Galgoul	CHI Sample/Data Management	Sampling Data Management/ Site Sampling History	372-9617
Marie Kile	CHI Environmental Engineering	Scoping Document Lead	372-9680
Mary Todd	CHI Environmental Engineering	Environmental Engineering	372-9030

Table 1-2. DQO Workshop Team Members. (2 pages)

Name	Organization	Area of Expertise (Role)	Phone Number
Christine Webb	BHI Waste Information Data System	Historical and Site Data	375-9690
Steve Weiss	CHI Regulatory Support/ Environmental Science	Task Lead	372-9531
Curt Wittreich	CHI Environmental Engineering	Project Management	372-9586

Table 1-3. DQO Key Decision Makers.

Name	Organization	Area of Expertise (Role)	Phone Number
Jack Donnelly	Washington State Department of Ecology	Ecology representative	--
Bryan Foley	U.S. Department of Energy	DOE representative	376-7087
Doug Sherwood	U.S. Environmental Protection Agency[a]	EPA representative	376-6623

[a] Regulatory lead.

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

Table 1-4. Existing Documents and Data Sources. (3 pages)

Reference	Summary
200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program, DOE/RL-98-28 (DOE-RL 1999a)	Geology of the 200 West Area.
200 Areas Waste Sites Handbook, Vol. III, RHO-CD-673 (RHO 1979)	Waste site descriptions, releases, waste discharge information, and management reports.
216-U-10 Pond and 216-Z-19 Ditch Characterization Studies, WHC-EP-0707 (WHC 1994)	Summary of historical data and characterization information on 216-U-10 Pond and 216-U-19 Ditch. Atmospheric, biological, geological, and hydrological studies of contamination.
242-S Evaporator Steam Condensate Stream-Specific Report, WHC-EP-0342, Add. 29 (WHC 1990a)	Process information on 242-S Evaporator facilities, chemicals used or stored, and process effluent sampling data from 1990. Results of a waste stream designation for the UO_3 Plant and U Plant systems, which concluded that the wastewater stream was not dangerous.
2724-W Laundry Wastewater Stream-Specific Report, WHC-EP-0342, Add. 11 (WHC 1990c)	Process info on 2724-W Laundry Facilities, chemicals used or stored, and process effluent sampling data from 1990. Results of a waste stream designation for the UO_3 Plant and U Plant systems, which concluded that the wastewater stream was not dangerous.

Table 1-4. Existing Documents and Data Sources. (3 pages)

Reference	Summary
284-W Powerplant Wastewater Stream-Specific Report, WHC-EP-0342, Add. 27 (WHC 1990b)	Process info on 284-W Facilities, chemicals used or stored, and process effluent sampling data from 1990. Results of a waste stream designation for the UO_3 Plant and U Plant systems, which concluded that the wastewater stream was not dangerous.
Borehole Summary Report for the 200-UP-2 Operable Unit, BHI-00034 (Kelty et al. 1995)	Characterization data from the 216-U-10 Pond borehole sampling and analysis.
Focused Feasibility Study for the 200-UP-2 Operable Unit, DOE/RL-95-106 (DOE-RL 1996)	Waste site historical and stabilization information, borehole, test pit, and cone penetrometer results, surface radiological survey results, and surface soil and vegetation sampling results, and a list of COPCs.
Hanford Site Atlas, BHI-01119 (BHI 1998)	Site maps.
Limited Field Investigation for the 200-UP-2 Operable Unit, DOE/RL-95-13 (DOE-RL 1995)	Surface radiological survey results, surface soil and vegetation sampling results, and cone penetrometer and test pit results.
Plutonium Finishing Plant Wastewater Stream-Specific Report, WHC-EP-0342, Add. 8 (WHC 1990d)	Process info on Z Plant source facilities, chemicals used or stored, and process effluent sampling data from 1990.
Radionuclide Distributions in Soils of the U-Pond Disposal System, RHO-CD-1117 (RHO 1980c)	Radiological data from soils in 216-U-10 Pond.
S Plant Source Aggregate Area Management Study Report, DOE/RL-91-60 (DOE-RL 1992a)	Process information on S Plant facilities, chemicals and radionuclides used and discharged, known and suspected contaminants, and a list of COPCs.
U Plant Source Aggregate Area Management Study Report, DOE/RL-91-52 (DOE-RL 1992b)	Waste unit descriptions; maps with locations of waste units; preliminary conceptual site exposure model; summary of waste producing processes in U Plant; known and suspected contaminants; affected media; results of soil, vadose zone, water, and biota sampling; plant buildings and waste discharge units (e.g., tanks, wells, vaults, ponds, ditches, trenches, septic systems, transfer lines and associated equipment, retention basins, and liquid effluent retention facilities); and site hazard rankings. Process history of U Plant aggregate area, waste management operations history, chemical waste inventory estimates, and history of unplanned releases.
U Plant Aggregate Area Management Study Technical Baseline Report, BHI-00174 (Carpenter and Deford 1995)	Descriptions of waste units, site locations, and waste type summaries. Conclusions from previous studies, general model of contaminant distributions for ditches, trenches, and ponds, and sampling.
UO_3/U Plant Wastewater Stream-Specific Report, WHC-EP-0342, Add. 7 (WHC 1990e)	Process information on U Plant source facilities, chemicals used or stored, and process effluent sampling data from 1990. Results of a waste stream designation for the UO_3 Plant and U Plant systems, which concluded that the wastewater stream was not dangerous.

Table 1-4. Existing Documents and Data Sources. (3 pages)

Reference	Summary
Waste Site Grouping for 200 Areas Soil Investigations, DOE/RL-96-81 (DOE-RL 1997)	Summarizes site name, location, 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 1997), 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.
WIDS reports: 207-U, 216-U-9, 216-U-10, 216-U-11, 216-U-14, 216-Z-1D, 216-Z-11, 216-Z-14, 216-Z-20, UPR-200-W-104, UPR-200-W-105, UPR-200-W-106, UPR-200-W-107, UPR-200-W-111, UPR-200-W-112, and UPR-200-W-139	Summarizes site name, location, type, 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, and description).
Z Plant Source Aggregate Area Management Study Report, DOE/RL-91-58 (DOE-RL 1992c)	Process information on Z Plant facilities, chemicals and radionuclides used and discharged, known and suspected contaminants, and a list of COPCs.

WIDS = Waste Information Data System (database)

The information in Table 1-5 represents the complete unconstrained set of COPCs that were, or could have been, discharged to the Z Ditches (Tables 2-8, 2-9, and 2-10 of the Z Plant AAMS report [DOE-RL 1992c]) and the *Plutonium Finishing Plant Wastewater Stream-Specific Report* (WHC 1990d). The master COPC list is then 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 exclusion are listed in Table 1-6. The exclusion rationale is discussed below.

The process streams that contaminated these sites were cooling water and steam condensate discharges from the U Plant, UO_3 Plant, Z Plant, 242-S Evaporator, 2723-W Mask Cleaning Station, 2724-W Laundry Facility, 284-W Powerhouse, and several other small-volume generators.

Based on a review of the potential waste constituent lists in the *U Plant Source Aggregate Area Management Study Report* (DOE-RL 1992b), the chemical behavior of the constituents was evaluated. Process knowledge indicates that the aqueous discharges to the U Pond/Z Ditches cooling water waste sites were predominantly uncontaminated cooling water releases. Leaks in cooling coils and operator errors resulted in unplanned contamination releases to the pond/ditches complex. Some of the releases from the Z Plant discharged large inventories of plutonium. In general, the majority of the water released to the pond and ditches was noncontaminated, with waste constituents being greatly diluted and dispersed by the large volumes of water. The chemical reactions expected in this environment include acid neutralization, stabilization of highly reactive compounds, and volatilization of the lighter fraction organic compounds.

Table 1-5. Sources of Contamination, COPCs, and Affected Media for the 216-Z-11 Ditch. (2 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	Affected Media
Cooling water discharges from Z Plant.	Mixed fission products, activation products, transuranics, and process solvents.	Shallow soils, deep zone soils associated with the 216-Z-11 Ditch and potentially the groundwater beneath the ditch.

Radioactive COPCs			
Aluminum-28	Curium-245	Niobium-94	Sulfur-35
Americium-241	Einsteinium-254	Niobium-95	Tantalum-182
Americium-243	Europium-152	Plutonium-238	Technetium-99
Antimony-122	Europium-154	Plutonium-239/240	Tellurium-121
Antimony-124	Europium-155	Polonium-210	Tellurium-125m
Antimony-125	Gadolinium-153	Potassium-40	Tellurium-127
Antimony-126	Germanium-68	Phosphorous -32	Tellurium-129m
Barium-133	Gold-195	Promethium-147	Thallium-204
Beryllium-7	Iodine-123	Protactinium-231	Thorium-232
Beryllium-10	Iodine-125	Radium-226	Thorium-234
Cadmium-109	Iodine-129	Radium-228	Thullium-170
Calcium-45	Iodine-131	Rhenium-187	Tin-113
Carbon-14	Iron-55	Rhodium-103	Tin-123m
Cerium-141	Iron-59	Rhodium-106	Tritium
Cerium-144	Krypton-85	Rubidium-86	Uranium-234
Cesium-134	Lead-212	Samarium-151	Uranium-235
Cesium-137	Lead-214	Scandium-46	Uranium-236
Chlorine-36	Manganese-54	Selenium-75	Uranium-238
Chromium-51	Molybdenum-93	Selenium-79	Vanadium-49
Cobalt-57	Neptunium-237	Silver-108	Yttrium-87
Cobalt-58	Nickel-59	Silver-110	Yttrium-88
Cobalt-60	Nickel-63	Sodium-22	Yttrium-90
Curium-243	Niobium-91	Strontium-82	Zinc-65
Curium-244	Niobium-93m	Strontium-90	Zirconium-95
Inorganic COPCs			
Aluminum	Ammonium sulfate	Chromium	Hydrofluoric acid
Aluminum fluoride	Arsenic	Copper	Hydrogen peroxide
Aluminum nitrate	Asbestos	Copper sulfate	Hydroiodic acid
Aluminum nitrate nonahydrate	Barium	Ferric ammonium sulfate	Hydroxylamine hydrochloride
Aluminum nitrate (mono basic)	Beryllium	Ferric nitrate	Hydroxylamine nitrate
Aluminum sulfate	Boric acid	Ferrous ammonium sulfate	Iron
Ammonia	Boron	Ferrous sulfamate	Lead
Ammonium chloride	Cadmium	Fluoride	Magnesium
Ammonium hydroxide	Calcium	Hydrazine	Magnesium nitrate
Ammonium oxalate	Calcium nitrate	Hydrobromic acid	Manganese
	Ceric ammonium nitrate	Hydrochloric acid	Mercury
	Chloride		Mercury - amalgamated
			Nickel

Table 1-5. Sources of Contamination, COPCs, and Affected Media for the 216-Z-11 Ditch. (2 pages)

Inorganic Chemical COPCs			
Nitrate	Potassium iodate	Sodium bisulfate	Sulfamic acid
Nitric acid	Potassium nitrate	Sodium carbonate	Sulfonic acid
Phosphoric acid	Potassium permanganate	Sodium chloride	Sulfate
Plutonium fluoride	Selenium	Sodium diuranate	Sulfuric acid
Plutonium oxide	Silicon	Sodium fluoride	Sulfide
Plutonium nitrate	Silver	Sodium hydroxide	Uranium
Potassium	Silver oxide	Sodium nitrate	Uranium hexafluoride
Potassium chloride	Slaked lime	Sodium oxalate	Vanadium
Potassium dichromate	Sodium	Strontium	Zinc
			Zirconium
Organic Chemical COPCs			
Acetic acid	Cyclohexanone	Hexanol	Pseudo cumene
Acetone	DDCP	Isopropanol	Sodium tartrate
Alizarin yellow	Decane	Kerosene	Tar
Acetonitrile	Dibutyl butyl phosphonate	Methanol	Tetrahydrofuran
Bromocresol purple	Dibutyl phosphate	Mineral oil	Thenoyltrifluoroacetone
1-Butanol	Dichloromethane	Monobutyl phosphate	Thymolphthalein
2-Butanone	Ethanol	Napthylamine	Toluene
Butyl acetate	Ethanolamine	Napthylamine tritium	Tributyl phosphate
Carbon tetrachloride	Ethylene glycol	Normal paraffins	Trichloroethene
Caffeine	Ethylene glycol monbutyl ether	Oxalic acid	Tri-iso-octylamine
Charcoal	Freon II	Paint thinner	Trioctyl phosphine
Chloro benzene	Glycerine	Polychlorinated biphenyls	Tris (hydroxylmethyl) amino methane
Chloroform (trichloromethane)	Graphite	Perchloroethylene	Vinyl chloride
Creosote	Hexane	Polyurethane	Xylene
Cyclohexane		Potassium acetate	

Table 1-6. 216-Z-11 Ditch COPC Exclusions and Justifications. (5 pages)

COPCs	Rationale for Exclusion
Radioactive Constituents – Activation Products	
Nickel-59	Less than 5E-5 times Cs-137 activity.
Sodium-22	SHL
Radioactive Constituents – Fission/Activation Products	
Aluminum-28	SHL
Antimony-122	SHL
Antimony-124	SHL
Antimony-125	SHL, P
Antimony-126	SHL, P
Barium-133	No known mechanism for production.
Beryllium-7	SHL
Beryllium-10	Not expected in detectable concentrations.
Cadmium-109	SHL
Calcium-45	SHL
Carbon-14	Extreme mobility; not expected in meaningful quantities in soils.
Cerium-141	SHL
Cerium-144	SHL
Cesium-134	SHL
Chlorine-36	Not expected in detectable concentrations.
Chromium-51	SHL
Cobalt-57	SHL
Cobalt-58	SHL

Table 1-6. 216-Z-11 Ditch COPC Exclusions and Justifications. (5 pages)

COPCs	Rationale for Exclusion
Gadolinium-153	SHL
Germanium-68	SHL
Gold-195	SHL
Iodine-123	SHL
Iodine-125	SHL
Iodine-129	Less than 5E-5 times Cs-137 activity.
Iodine-131	SHL
Iron-55	SHL
Iron-59	SHL
Krypton-85	Noble gas, not present in soils.
Manganese-54	SHL
Molybdenum-93	Not expected in detectable concentrations.
Niobium-91	No known mechanism for creating this isotope in Hanford Site processes; less than 5E-5 times Cs-137 activity.
Niobium-93m	P
Niobium-95	SHL, P
Phosphorous-32	SHL
Promethium-147	SHL
Rhodium-103	SHL, P
Rhodium-106	SHL, P
Rubidium-86	SHL
Samarium-151	Less than 1% of Cs-137 activity. Insignificant contribution to dose per RESRAD.
Scandium-46	SHL
Selenium-75	SHL
Selenium-79	Less than 5E-4 times Cs-137 activity.
Silver-108	SHL
Silver-110	SHL
Strontium-82	SHL
Sulfur-35	SHL
Tantalum-182	SHL
Telluriium-121	SHL
Telluriium-125m	SHL
Telluriium-127	SHL
Telluriium-129m	SHL
Thallium-204	Not expected in detectable concentrations.
Thullium-170	SHL
Tin-113	SHL
Tin-123m	SHL
Vanadium-49	SHL
Yttrium-87	SHL
Yttrium-88	SHL
Yttrium-90	SHL (daughter of Sr-90, which is a final COC), P
Zinc-65	SHL
Zirconium-95	SHL
Radioactive Constituents – Uranium/Thorium Daughter Products	
Lead-212	These daughter products are excluded due to very low in-growth relative to the parent isotopes and because the concentrations may be calculated from the uranium/thorium isotopes from which they originate.
Lead-214	
Polonium-210	
Protactinium-231	
Thorium-234	

Table 1-6. 216-Z-11 Ditch COPC Exclusions and Justifications. (5 pages)

COPCs	Rationale for Exclusion
Radioactive Constituents – Transuranics	
Americium-243	High mass number, very low product inventory.
Curium-244	High mass number, very low product inventory.
Curium-245	High mass number, very low product inventory.
Einsteinium-254	SHL, high mass number; very low product inventory.
Radioactive Constituents – Other	
Potassium-40	Naturally occurring isotopes not created in Hanford Site reactor operations.
Rhenium-187	
Inorganic Chemicals	
Aluminum	These inorganic substances are excluded because they qualify in one or more of the following categories: • Constituents that have been diluted, neutralized, and/or decomposed by the facility processes (e.g., mixture with large water volumes, or the mixture of acids/bases) • Solid materials that could not have leaked past process tubes for release to the environment • Chemicals in the gaseous state that cannot accumulate in soil media. • Chemicals that are unlikely to be present in toxic or high concentrations due to the significant dilution during cooling water discharges • Chemicals that are not persistent in the environment. The analytical strategy will be to use the analytical techniques that focus on the major constituents, such as the metals, anions, etc., via the following methods: 6010, GFAA, 7470/7471, and IC 300.
Aluminum fluoride	
Aluminum nitrate	
Aluminum nitrate nonahydrate	
Aluminum nitrate (monobasic)	
Aluminum sulfate	
Ammonia	
Ammonium chloride	
Ammonium hydroxide	
Ammonium oxalate	
Ammonium sulfate	The constituent parts will be analyzed (as shown in Table 1-7).
Asbestos	Asbestos was present on facility components and structures but is not expected in cooling water discharges.
Boric acid	These inorganic substances are excluded because they qualify in one or more of the following categories: • Constituents that have been diluted, neutralized, and/or decomposed by the facility processes (e.g., mixture with large water volumes, or the mixture of acids/bases) • Solid materials that could not have leaked past process tubes for release to the environment • Chemicals in the gaseous state that cannot accumulate in soil media. • Chemicals that are unlikely to be present in toxic or high concentrations due to the significant dilution during cooling water discharges • Chemicals that are not persistent in the environment. The analytical strategy will be to use the analytical techniques that focus on the major constituents, such as the metals, anions, etc., via the following methods: 6010, GFAA, 7470/7471, and IC 300.
Boron	
Calcium	
Calcium nitrate	
Ceric ammonium nitrate	
Copper sulfate	
Ferric ammonium sulfate	
Ferric nitrate	
Ferrous ammonium sulfate	
Ferrous sulfamate	
Hydrazine	Hydrazine is extremely reactive and volatile, and is no longer present in any media associated with the 216-Z-11 Ditch.

Table 1-6. 216-Z-11 Ditch COPC Exclusions and Justifications. (5 pages)

COPCs	Rationale for Exclusion
Hydrobromic acid	These inorganic substances are excluded because they qualify in one or more of the following categories: • Constituents that have been diluted, neutralized, and/or decomposed by the facility processes (e.g., mixture with large water volumes, or the mixture of acids/bases) • Solid materials that could not have leaked past process tubes for release to the environment • Chemicals in the gaseous state that cannot accumulate in soil media. • Chemicals that are unlikely to be present in toxic or high concentrations due to the significant dilution during cooling water discharges • Chemicals that are not persistent in the environment. The analytical strategy will be to use the analytical techniques that focus on the major constituents, such as the metals, anions, etc., via the following methods: 6010, GFAA, 7470/7471, and IC 300. Note: Plutonium, strontium, and uranium will be detected by radiological laboratory methods.
Hydrochloric acid	
Hydrofluoric acid	
Hydrogen peroxide	
Hydroiodic acid	
Hydroxylamine hydrochloride	
Hydroxylamine nitrate	
Iron	
Magnesium	
Magnesium nitrate	
Manganese	
Mercury - amalgamated	
Nitric acid	
Phosphoric acid	
Plutonium fluoride	
Plutonium oxide	
Plutonium nitrate	
Potassium	
Potassium chloride	
Potassium iodate	
Potassium permanganate	
Silicon	
Silver oxide	
Slaked lime	
Sodium	
Sodium bisulfate	
Sodium carbonate	
Sodium chloride	
Sodium diuranate	
Sodium fluoride	
Sodium hydroxide	
Sodium nitrate	
Sodium nitrite	
Sodium oxalate	
Strontium	
Sulfamic acid	
Sulfonic acid	
Sulfuric acid	
Uranium	
Uranium hexafluoride	
Vanadium	
Zirconium	

Table 1-6. 216-Z-11 Ditch COPC Exclusions and Justifications. (5 pages)

COPCs	Rationale for Exclusion
Organic Chemicals	
Acetic acid	See footnote a.
Alizarin yellow	Indicator chemical used in laboratory in minute quantities.
Bromocresol purple	
1-Butanol	Water soluble. Diluted upon entry into aqueous discharge.
Butyl acetate	No analytical methods available to detect this chemical.
Caffeine	Laboratory chemical.
Charcoal	Non-toxic in concentrations used.
DDCP	See footnote a.
Dibutyl butyl phosphonate	See footnote a.
Dibutyl phosphate	This compound is a degradation product of tributyl phosphate and is unlikely to be present in toxic or high concentrations due to the significant dilution during cooling water discharges. See footnote a.
Ethanol	Water soluble, diluted with entry into liquid discharge, not detectable.
Ethanolamine	
Ethylene glycol	Extremely water soluble liquid, diluted with entry into liquid discharge, not detectable in affected soils after discharge.
Ethylene glycol monobutyl ether	Extremely water soluble, diluted with entry into liquid discharge, not detectable in affected soils after discharge.
Freon II	Extremely volatile, has evaporated and is no longer present.
Glycerine	Laboratory chemical used in minute quantities.
Graphite	Non-toxic in concentrations used.
Hexanol	Water soluble, diluted with entry into liquid discharge; not detectable.
Isopropanol	
Methanol	
Mineral oil	Laboratory chemical not likely to be present in detectable concentrations.
Monobutyl phosphate	This compound is a degradation product of tributyl phosphate and is unlikely to be present in toxic or high concentrations due to the significant dilution during cooling water discharges. See footnote a.
Naphthylamine tritium	Not detectable as compound. Naphthylamine is detectable as a semi-volatile organic analyte.
Oxalic acid	Has dissolved to a complexant. See footnote a.
Polyurethane	Not water soluble solid media.
Potassium acetate	Dissociates in water. For acetate, refer to footnote a.
Sodium tartrate	Dissociates in water. For tartrate, refer to footnote a.
Thenoyltrifluoroacetone	Very reactive, small concentrations used. No longer present in liquid matrix.
Thymophthalein	Laboratory indicator chemical used in minute quantities.
Tri-iso-octylamine	Very reactive, small concentrations used. No longer present in liquid matrix.
Tri-octyl phosphine	
Tris (hydroxylmethyl) amino methane	Laboratory chemical used in minute quantities

[a] Complexing agent that could have affected the mobility of certain COPCs. The presence of these agents indicates that all non-excluded COPCs will need to be analyzed in the deep zone below the site.

SHL = short half-life
P = progeny
RESRAD = RESidual RADioactivity dose model

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

released into large volume aqueous discharges, where the salts dissolved into a large body of water.

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 a half-life less 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% of the actinide activities
- Progeny (P) radionuclides that build insignificant activities within 50 years, and/or for which parent/progeny relationships exist that permit progeny estimation
- Constituents that would be diluted, neutralized, and/or decomposed by the facility processes (e.g., mixtures with very large water volumes or mixtures of acids/bases)
- Solid materials that could not have leaked past process tubes for release to the environment
- Chemicals in the gaseous state that cannot accumulate in soil media
- Chemicals used in minor quantities relative to the bulk production chemicals consumed in the normal processes; these chemicals are not likely to be present in toxic or high concentrations due to the significant dilution during cooling water discharges
- Chemicals that are not persistent in the environment due to biological degradation or a natural mitigating feature.

Table 1-7 includes the final list of COCs with the rationale for their inclusion.

Table 1-7. 216-Z-11 Ditch Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Radioactive Constituents	
Americium-241	Process knowledge indicates potential presence. No basis for exclusion.
Cesium-137	
Cobalt-60	
Curium-243	
Europium-152	
Europium-154	
Europium-155	

Table 1-7. 216-Z-11 Ditch Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Neptunium-237	Detected in Z Crib down-well logging results
Nickel-63[a]	Present in 100 Area decontamination and decommissioning and remediation sites. Evaluated in 200-CW-5 as precautionary measure
Niobium-94	Process knowledge indicates potential presence. No basis for exclusion.
Plutonium-238	
Plutonium-239/240	
Radium-226	
Radium-228	
Strontium-90	
Technetium-99[a]	
Thorium-232	
Tritium[a]	
Uranium-234	
Uranium-235	
Uranium-236	
Uranium-238	
Chemical Constituents – Metals	
Arsenic	Process knowledge indicates potential presence. No basis for exclusion.
Barium	
Beryllium	
Cadmium	
Chromium	
Copper	
Hexavalent chromium	Present in potassium dichromate, which are potentially present based on process knowledge. No basis for exclusion.
Lead	Process knowledge indicates potential presence. No basis for exclusion.
Mercury	
Nickel	
Selenium	
Silver	
Zinc	
Chemical Constituents – Other Inorganics	
Chloride	Constituent in several waste compounds that were identified by process knowledge. No basis for exclusion.
Fluoride	
Nitrate	
Sulfate	
Sulfide	
Chemical Constituents – Volatile Organics	
Acetone	Potential presence based on process knowledge. No basis for exclusion.
Acetonitrile	
2-Butanone (MEK)	
Carbon tetrachloride	
Chlorobenzene	
Chloroform (trichloromethane)	
Cyclohexane	
Decane	
Dichloromethane	

Table 1-7. 216-Z-11 Ditch Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Hexane	Potential presence based on process knowledge. No basis for exclusion.
Perchloroethylene	
Pseudo cumene (1,2,4 trimethyl benzene)	
Tetrahydrofuran	
Toluene	
Trichloroethene	
Vinyl chloride	
Xylenes	
Semi-Volatile Organics	
Creosote	Potential presence based on process knowledge. No basis for exclusion.
Cyclohexanone	
Kerosene[b]	
Naphthylamine	
Normal paraffins[b]	
Paint thinner[b]	
Polychlorinated biphenyls	
Tar	
Tributyl phosphate	

[a] These COCs are deep zone sensitive only. No analyses are required for these in the shallow zone soils, as they are soft beta emitters in low abundance that have insignificant dose impact in the shallow zone.
[b] Analyzed as kerosene total petroleum hydrocarbons.

The preliminary contaminant distribution conceptual model at the 216-U-10 Pond after cessation of discharge is shown in Figure 1-5. Table 1-8 identifies the current and future land uses. Figure 1-6 shows graphically that all of the 200-CW-5 OU waste sites are located within the 200 Area land-use boundary.

Table 1-8. Current and Proposed Future Site Land Use.[a]

Current Land Use	Future Land Use[b]
Inside the 200 Area Land-Use Boundary	
Hanford Site; controlled access	DOE; Industrial-Exclusive (waste management)[c, d]

[a] The land-use designations made in this table support the ARARs and preliminary remediation goal assumptions developed in Table 1-9.
[b] Final HCP-EIS (DOE/EIS-0222F) (DOE 1999a).
[c] All of the waste sites in the 200-CW-5 OU are within the 200 Area land-use boundary.
[d] This future land use is unique to DOE.

Figure 1-5. Preliminary Conceptual Exposure Model for 200-CW-5 Operable Unit.

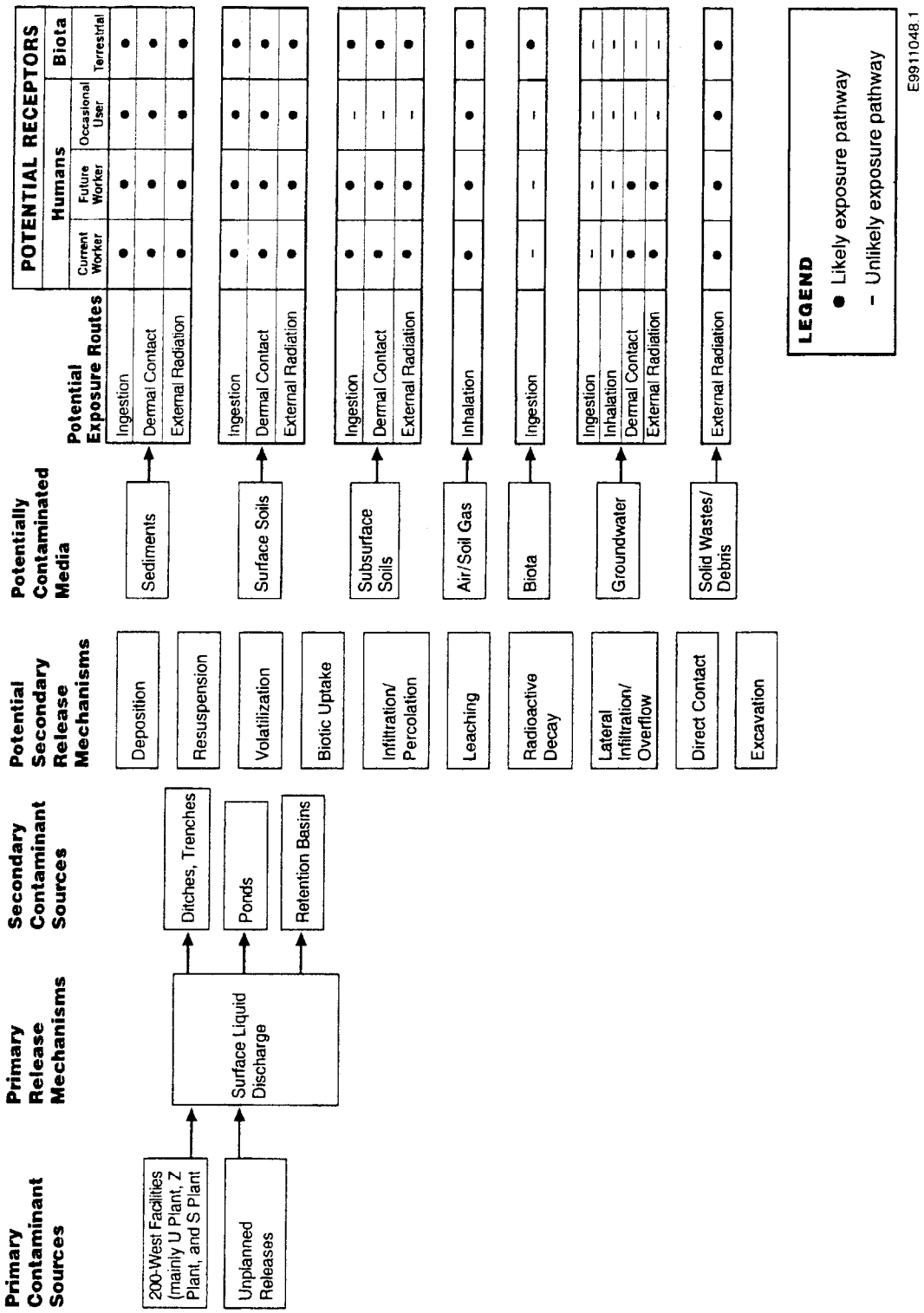
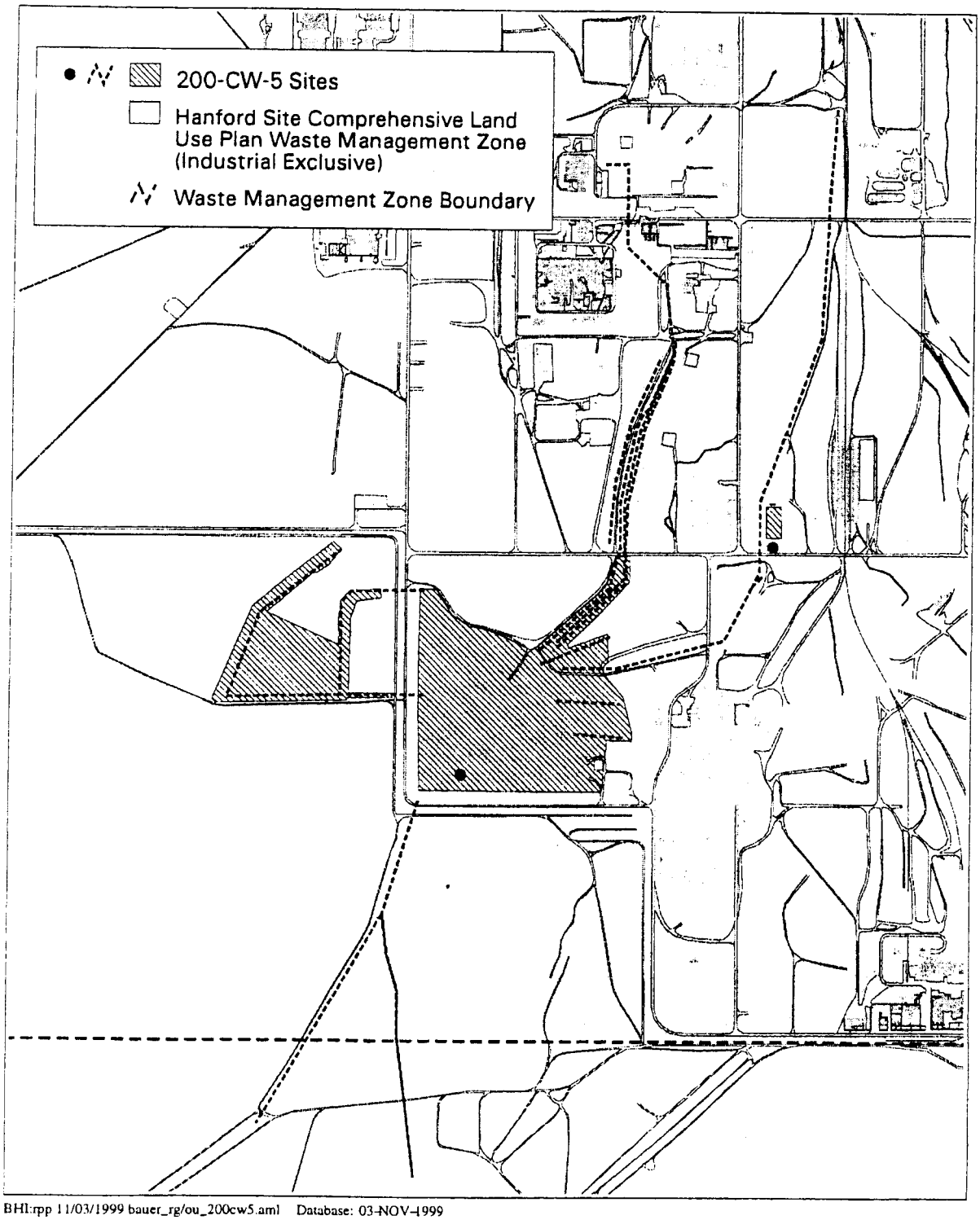


Figure 1-6. 200-CW-5 Operable Unit Sites Relative to the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999a) Waste Management Boundary.



BHI:rpp 11/03/1999 bauer_rg/ou_200cw5.aml Database: 03-NOV-1999

Table 1-9 defines the ARARs and preliminary remediation goals (PRGs) for each of the COCs.

Table 1-9. List of Preliminary ARARs and PRGs.

COCs	Preliminary ARARs	PRGs
Radionuclides Inside the 200 Area Land-Use Boundary		
Shallow zone (0 to 4.6 m [0 to 15 ft] bgs)	100 mrem/yr above background via industrial 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.[b]	Contaminant-specific; RESRAD modeling.[b]
Deep zone (>4.6 m [>15 ft] bgs)	4 mrem/yr above background to groundwater, or no additional groundwater degradation.[b]	MCLs, state and Federal ambient water quality control criteria. Alternatively, site-specific RESRAD modeling.
Chemicals Inside the 200 Area Land-Use Boundary		
Shallow zone (0 to 4.6 m [0 to 15 ft] bgs)	MTCA Method C	Chemical-specific.
Deep zone (>4.6 m [>15 ft] bgs)	100 x groundwater (per MTCA)	Alternatively, site-specific RESRAD modeling.
TRU Definition		
Any depth zone	Wastes containing transuranic radionuclides with half-lives greater than 20 years in concentrations greater than 100 nCi/g[d]	Contaminant-specific

[a] RESRAD modeling 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.
[b] Radionuclide standards are not final, and will be agreed upon in the Record of Decision. A radionuclide standard of 25 mrem/yr above background has been proposed by the Washington State Department of Health.
[c] MTCA Method B = residential land use.
[d] Working definition of TRU waste developed by DOE in 1984. No formal definition exists (DOE 1999b).
bgs = below ground surface
MCL = maximum contamination level
RCRA = *Resource Conservation and Recovery Act of 1976*

Table 1-10 lists the general exposure scenarios.

Table 1-10. General Exposure Scenarios.

Scenario No.	General Exposure Scenario Description
1	Industrial land-use scenario (inside the 200 Areas land-use boundary): The source of contamination is the liquid effluent disposed in the U Pond/Z Ditch systems from primarily U Plant and Z Plant operations. The release mechanism is direct radiation exposure to occupational workers in the vicinity of the ditches and pond areas (although shielded by stabilizing cover) and volatilization of certain organic gases into the local air environment. Ingestion 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 anticipated during excavation activities in an industrial setting. Downward migration of mobile constituents into the groundwater would not affect occupational workers, as their drinking water source would not be the underlying aquifers.
	The exposure time is divided into time spent inside and outside an industrial facility: • 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). • 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). In addition, the building occupancy exposure includes a factor of 0.4 to reduce the ingested dust component due to building ventilation system filtration.

Table 1-11 provides the regulatory milestones and regulatory drivers associated with this project.

Table 1-11. Regulatory Milestones.

Milestone	Due Date	Regulatory Driver
M-13-22	December 31, 1999	Submit U Pond/Z Ditches cooling water group work plan.

The project milestones and their drivers are listed in Table 1-12.

Table 1-12. Project Milestones.

Milestone	Due Date	Driver
Internal DQO workshop	August 4, 1999	DQO schedule
External DQO workshop	TBD	
Issue DQO summary report	TBD	DQO process documentation
Work plan and field sampling plan	December 30, 1999	Tri-Party Agreement milestone

TBD = to be determined
Tri-Party Agreement = *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990)

Table 1-13 combines the relevant background information into a concise statement of the problem to be resolved.

Table 1-13. Preliminary Contaminant Distribution Conceptual Model Discussion and Concise Statement of the Problem. (2 pages)

Preliminary Contaminant Distribution Conceptual Model:[a]

The combined cooling water, steam condensate, and chemical sewer waste streams discharged to the 200-CW-5 OU originated primarily from the U Plant and Z Plant facilities. The streams were designed to be uncontaminated but periodically contained radionuclides and process chemicals. Immobile contaminants accumulated in the sediments over time, and the mobile contaminants may have reached the groundwater. In addition, vegetation and algae within the ponds and ditches tended to collect and concentrate radionuclides. Most of the contaminated ditches were routinely sampled and were eventually backfilled and surface stabilized to contain the contamination. Plutonium, americium, and some cesium were fixed in the bottom of the ditches near the ditch/pond junctions; americium, uranium, strontium, some plutonium, and some cesium proceeded to the pond. Most of the less mobile radionuclides are expected to be found within the top 2 m (7 ft) of sediment beneath the pond/ditches. More mobile contaminants were distributed through the soil column but are expected to be present only in trace concentrations.

Volatile organics are assumed to have traveled with the liquid discharge into the groundwater, leaving only trace quantities (if any) in the vadose zone. Groundwater monitoring has indicated chemical contamination under the U Pond, 216-Z-11 Ditch, and 216-U-14 Ditch (carbon tetrachloride and chloroform). With the exception of the U Pond and the 216-U-14 Ditch, limited chemical data are available for the waste group, resulting in a broad data gap.

Lateral spreading of contaminants in the vadose zone (in the lower unit of the Hanford formation and the top of the Plio Pleistocene unit) has resulted from high-volume discharges to the ponds that exceeded the soil column's pore-volume capacity and forced an increased wetted area in the vadose zone. Mounding of groundwater is known to have occurred under the 216-U-14 Ditch. Lateral spreading may have been enhanced due to the occurrence of local fine-grained sediments and may contribute to the spreading of contaminants in the vadose zone.

Figure 1-7 presents a graphical representation of the conceptual contaminant distribution model of the 216-Z-11 Ditch, showing a cut-away view of the 216-Z-11 Ditch after cessation of liquid discharges.

DQO Approach:

The focus of the DQO process for the 216-Z-11 Ditch is to locate the TRU hot spots, determine the TRU concentrations, and support remediation decision making.

A SAP will be developed after completion of the DQO process that specifies the sampling and analyses to be performed. The outcome of the characterization for the representative sites will be applied to the other analogous sites (i.e., in this case, the Z Ditches).

All of the 200-CW-5 OU waste sites are within the 200 West Area land-use boundary and will be evaluated on the basis of future industrial uses.

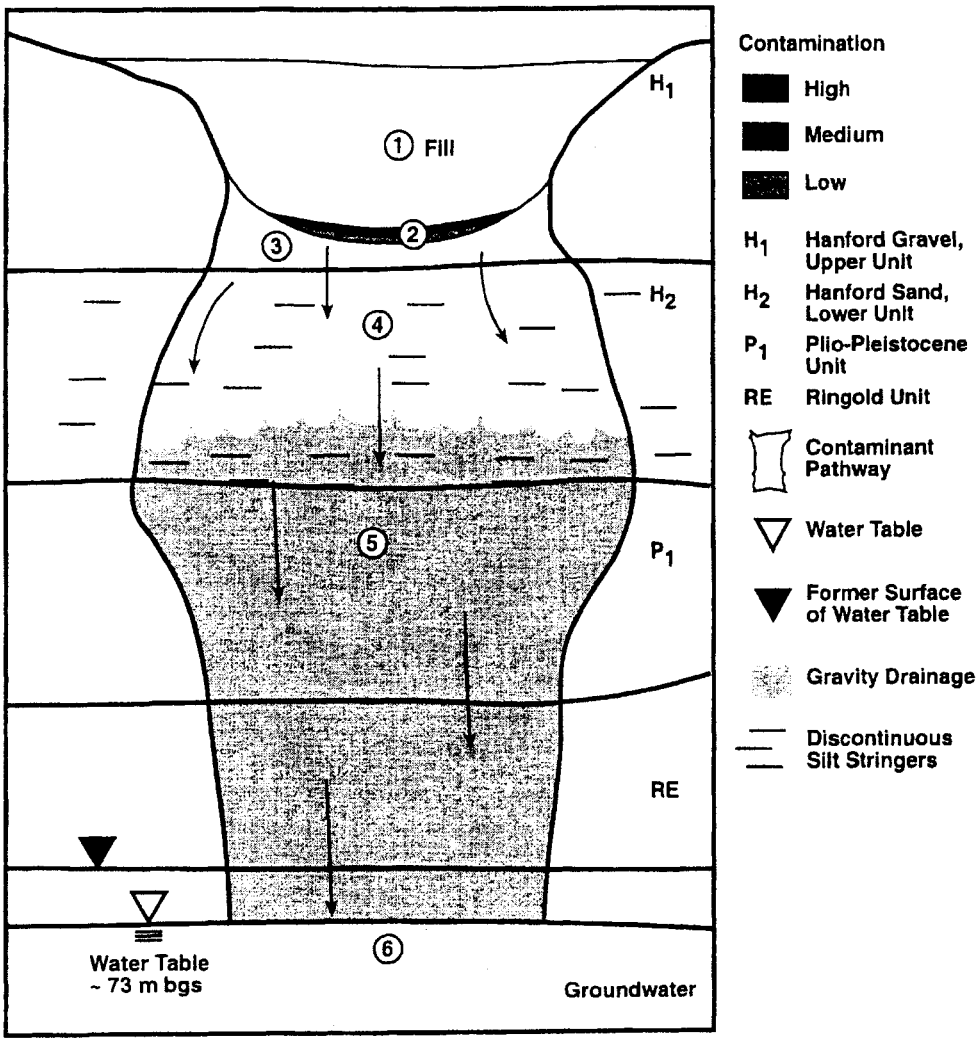
The piping in the U Pond/Z Ditch system is within the scope of this DQO process. The piping associated with each waste site will be considered a part of that waste site to within 1 m (3 ft) of the source facility. Therefore, the decisions reached for the waste sites will also apply to their respective piping systems. The potential for pipeline leakage will be considered. Pipeline leaks are expected to have the same conceptual contaminant distribution model as a pond/ditch but on a smaller scale. The environmental data obtained for each waste site is considered analogous for the associated piping systems.

Table 1-13. Preliminary Contaminant Distribution Conceptual Model Discussion and Concise Statement of the Problem. (2 pages)

Goal Statement:
Given the goal of selecting a remedial/closure alternative for the U Pond/Z Ditch systems, the problem is to verify the preliminary group- or site-specific contaminant distribution conceptual model and to determine the sampling requirements (type and frequency) that may be used to support the decision-making process. The sampling design that results will need to address the unique aspects of the remedial action alternatives (i.e., no action alternative, capping, excavate and dispose, in situ vitrification, in situ grouting and stabilization, and natural attenuation). Of the three representative sites within the 200-CW-5 OU, only the 216-Z-11 Ditch (including its delta region near the 216-U-10 Pond) is being considered for characterization.

[a] The preliminary contamination distribution conceptual model will become the contamination distribution conceptual model after acceptance of this DQO summary report, and will then be applied to the project work plan.

Figure 1-7. Preliminary Contaminant Distribution Conceptual Model at the 216-Z-11 Ditch After Cessation of Discharge (not to scale).



① Site has been backfilled/stabilized with approximately 2 m of clean soil. Upward migration of contaminants has been noted in the clean fill on the Hanford site.

② Some particulates in the effluent (e.g., Pu-239/240, Am-241) settled out in the bottom of ditch. Most of the dissolved contaminants in solution sorbed to sediments within 2 m of the ditch bottom; concentrations decrease rapidly with depth.

③ Contaminant concentrations are very low compared to the bottom of the ditch.

④ Lateral spreading within the lower unit of the Hanford formation and at the top of the Plio-Pleistocene unit.

⑤ High moisture zone. Moisture flux in this zone is decreasing over time. Wetting front moves vertically down into Ringold Unit E with gravity drainage. Residual concentrations of the more mobile contaminants may remain in the vadose zone after gravity drainage.

⑥ No contaminants have been attributed to the groundwater from the 216-Z-11 ditch.

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2.0 STEP 2 -- IDENTIFY THE DECISION

2.1 WORKSHEETS FOR STEP 2 -- IDENTIFY THE DECISION

Table 2-1 contains a summary of the information for DQO Step 2.

Table 2-1. Summary of DQO Step 2 Information. (2 pages)

PSQ-AA #	Principal Study Question #1 -- Do the U Pond/Z Ditch system contaminant concentrations in the sediment layer soils exceed the TRU definition of 100 nCi/g?		
	Alternative Action	**Consequences of Erroneous Actions**	**Severity of Consequences**
1-1	Evaluate application of special remedial alternatives for TRU-contaminated media in a FS.	Waste site data may not represent actual conditions. During ROD development or after the ROD is issued, confirmation and/or verification samples will be collected. Confirmation data will be used to validate the remedial alternative selection. If data indicate that the remedial actions selected are inappropriate, the confirmation data will be used to select appropriate remedial actions. Therefore, the consequences of selecting incorrect remedial actions are considered to be not severe.	Not severe
1-2	Evaluate the need for conventional remedial action alternatives in a FS.		
DS #	**Decision Statement #1** -- Determine if the U Pond/Z Ditch system contaminant concentrations in the sediment layer soils exceed the TRU definition of 100 nCi/g and require special remedial action.		
PSS-AA #	Principal Study Question #2 -- Do the U Pond/Z Ditch system radionuclide concentrations in the surface soils exceed the annual radiological exposure limits for human health protection?		
	Alternative Action	**Consequences of Erroneous Actions**	**Severity of Consequences**
2-1	Evaluate a streamlined approach to site closure (e.g., add to an existing ROD).	Representative waste site data may not represent actual conditions at 200-CW-5 analogous waste sites. During ROD development or after the ROD is issued, confirmation and/or verification samples will be collected from analogous 200-CW-5 sites. Confirmation data will be used to validate 200-CW-5 remedial alternative selections. If the data indicate that the remedial actions selected are inappropriate, the confirmation data will be used to select appropriate remedial actions. Therefore, the consequences of selecting incorrect remedial actions for analogous 200-CW-5 sites based on representative site data are considered to be not severe.	Not severe
2-2	Evaluate the need for remedial action alternatives in a FS.		
DS #	**Decision Statement #2** -- Determine if the U Pond/Z Ditch system surface soils exceed the radionuclide exposure limits for human health protection and require remedial action.		

Table 2-1. Summary of DQO Step 2 Information. (2 pages)

PSQ -AA #	**Principal Study Question #3** -- Do the U Pond/Z Ditch system metal and organic concentrations in the surface soils exceed the chemical exposure limits for human health protection?[a]		
	Alternative Action	**Consequences of Erroneous Actions**	**Severity of Consequences**
3-1	Evaluate a streamlined approach to site closure (e.g., add to an existing ROD).	Representative waste site data may not represent actual conditions at the 200-CW-5 analogous waste sites. During ROD development or after the ROD is issued, confirmation and/or verification samples will be collected from the analogous sites. Confirmation data will be used to validate the remedial alternative selections. If the data indicate that the remedial actions selected are inappropriate, the confirmation data will be used to select appropriate remedial actions. Therefore, the consequences of selecting incorrect remedial actions are considered to be not severe.	Not severe
3-2	Evaluate the need for remedial action alternative in a FS.		
DS #	**Decision Statement #3** -- Determine if the U Pond/Z Ditch system surface soils exceed the chemical constituent exposure limits for human health protection and require remedial action.		
PSQ -AA#	**Principal Study Question #4** -- Does the U Pond/Z Ditch system preliminary contaminant distribution conceptual model properly reflect the distribution of contaminants in the waste sites?		
	Alternative Action	**Consequences of Erroneous Actions**	**Severity of Consequences**
4-1	Apply preliminary contaminant distribution conceptual model for remedial alternative selection and remedial action planning.	Representative waste site data may not represent actual conditions at the 200-CW-5 analogous waste sites. During ROD development or after the ROD is issued, confirmation and/or verification samples will be collected from the analogous 200-CW-5 sites. The confirmation data will be used to validate the remedial alternative selection. If the data indicate that the remedial actions selected are inappropriate, the confirmation data will be used to select appropriate remedial actions. Therefore, the consequences of selecting incorrect remedial actions are considered to be not severe.	Not severe
4-2	Revise the preliminary contaminant distribution conceptual model for remedial alternative selection and remedial action planning.		
DS #	**Decision Statement #4** -- Determine if the U Pond/Z Ditch system preliminary contaminant distribution conceptual model represents the contaminant distribution conditions in each waste site or if the model needs to be refined.		

[a] Refer to Table 1-9 for scenario-specific ARARs and PRGs.
PSQ = principal study question
ROD = Record of Decision

3.0 STEP 3 -- IDENTIFY THE INPUTS TO THE DECISION

3.1 PURPOSE

The purpose of DQO Step 3 is to identify the information that will be required to resolve the principal study questions (PSQs) and determine which inputs require environmental measurements and/or sampling.

3.2 WORKSHEETS FOR STEP 3 -- IDENTIFY THE INPUTS TO THE DECISION

Table 3-1 identifies the information needed to resolve the PSQs and includes the following information:

- Determines what environmental variables or other information is needed to resolve the PSQs
- Identifies the type of data needed to resolve the PSQs (e.g. physical, chemical, radiological, or geotechnical)
- Determines if sampling or computational methods (i.e., modeling) or a combination will be used to acquire the information to resolve the PSQs
- Defines any conceptual models selected for use and the rationale for their use.

Table 3-1. Informational Needs, Data Requirements, and Data Acquisition Methods.

DS #	Environmental Variable Informational Need	Type of Data Required	Computational Methods that Support the Informational Need	Survey/Sampling Methods that Satisfy the Informational Need
1, 2, and 4	Radiological	Alpha, beta, and gamma COC (from Table 1-7) concentrations in soils for evaluation against ARARs and PRGs. Location data (depth and lateral extent of COCs within waste site boundaries).	Analytical modeling method for human health direct dose by RESRAD. Analytical modeling through groundwater TBD.	Soil sampling and laboratory analysis.

SGL = spectral gamma logging
TBD = to be determined

Table 3-2 provides a list of potential computational methods.

Table 3-2. List of Potential Computational Methods.

PSQ #	Computational Method	Source/ Author	Application to Study (Rationale for Use)	Satisfy Input Req't?
1 and 2	RESRAD	Argonne National Laboratory	RESRAD will be used to estimate direct human radiation exposure. It accounts for radioactive decay.	Yes
	TBD[a]	TBD	Estimates direct human radiation exposures and the migration of all contaminants (chemical and radioactive) to groundwater for indirect exposure estimates. If mobile contaminants are present, then a groundwater model will be needed and typically requires site-specific geohydrologic soil properties, such as hydraulic conductivity, moisture, etc.	TBD

[a] TBD = to be determined in a groundwater model co-selection process.

Table 3-3 identifies the type of information needed to perform a quantitative assessment for the alternative actions identified in DQO Step 2 as having severe decision error consequences.

Table 3-3. Required Information for Quantitative Assessment.

AA #	Required Information to Assess Impact		
	Cost	Risk	
		Human Health	Environmental
This table is not used in this DQO process because sampling decisions will be based on inputs needed to support the RI/FS process. Because the FS includes quantitative risk assessment, those considerations are deferred until the FS.			

Required information and reference sources for each of the information needs identified in Tables 3-1, 3-2, and 3-3 are listed in Table 3-4 based on the following observations:

- Identify and list the sources for the information needed to resolve the PSQs (e.g., previous data collection efforts, historical records, regulatory guidance, professional judgment, scientific literature, new data collections, and engineering standards).
- Qualitatively evaluate if existing data are appropriate for the study.

Table 3-4 is a significant decision-making tool for the DQO process because it is the means by which historical data are evaluated for their usefulness to the project. It is the focal point for deciding what environmental measurements, if any, are needed to satisfy the decision statements in DQO Step 2.

Table 3-4. Required Information and Reference Sources. (6 pages)

PSQ #	Required Information Category	Do Data Exist ? (Y/N)	Source Reference	Sufficient Quality to Validate Preliminary Concept Model? (Y/N)			Add'l Data Req'd? (Y/N)		
				U-14	U-10	Z-11	U-14	U-10	Z-11
1, 3, and 4	Soil and/or sediment radiological sample data	Y	*216-U-10 Pond and 21--Z-19 Ditch Characterization Studies*, WHC-EP-0707 (WHC 1994). Reports estimated total Pu inventory for 216-Z-11 Ditch and detected levels of Pu and Am. Data for Cs, Am, Pu, U, and Sr in 216-U-10 Pond.	N/A	Y	N	N/A	N	Y
			Environmental Characterization of 216-U-14 Ditch, RHO-HS-EV-4 (RHO 1980b). Reports Cs, Co, total U contamination in sediment 5 to 30 cm (2 to 12 in.) from head end of 216-U-14 Ditch, to outflow, to pond.	Y	N/A	N/A	N	N/A	N/A
			Groundwater Impact Assessment Report for the 216-U-14 Ditch, WHC-EP-0698 (Lindsey and Singleton 1994). Reports Cs, Pu, Sr, U, Am, Co, gross alpha, gross beta, Mn, and Tc detected in soils and sediments. Subsurface contaminants attributed to the 216-U-14 Ditch: Am, arsenic, polychlorinated biphenyls, bis-(-2-ethyloxyl)phthalate, Cs, Co, gross alpha, gross beta, Mn, Pu, Sr, Tc, and U.	Y	N/A	N/A	N	N/A	N/A
			Input and Decayed Values of Radioactive Liquid Wastes to the Ground in the 200 Areas through 1971, ARH-2761 (ARH 1973). Reports summation of U, Pu, Sr, and Cs discharged to the 216-U-10 Pond from 1944 through 1971.	N/A	N/A	N/A	N/A	N/A	N/A
			Limited Field Investigation for the 200-UP-2 Operable Unit, DOE/RL-95-13 (DOE-RL 1995). Summarizes most significant results from historic and limited field investigations – data on Cs, Pu, Sr, U, Am from pond sediments, test pits, cone penetrometer tests, vegetation samples, and boreholes.	N/A	Y	N/A	N/A	N	N/A

Table 3-4. Required Information and Reference Sources. (6 pages)

PSQ #	Required Information Category	Do Data Exist? (Y/N)	Source Reference	Sufficient Quality to Validate Preliminary Concept Model? (Y/N)			Add'l Data Req'd? (Y/N)		
				U-14	U-10	Z-11	U-14	U-10	Z-11
			Radionuclide Distributions in Soils of the U-Pond Disposal System, RHO-CD-1117 (RHO 1980c), and *216-U-10 Pond and 216-Z-19 Ditch Characterization Studies*, RHO-CD-1119 (RHO 1980a). Present data on Co, Cs, Eu, Pu, and Sr contamination in the 216-U-14 Ditch.	Y	Y	Y[a]	N	N	Y
			U Plant Source Aggregate Area Management Study Report (DOE-RL 1992b). Summary of historic data on 216-U-10 Pond for Pu, Am, U, Sr, and Cs; highest contamination levels detected; contaminant distribution is also reported.	N/A	Y	N/A	N/A	N	N/A
			Z Plant Source Aggregate Area Management Study Report, DOE/RL-91-58 (DOE-RL 1992c). Reports the 216-Z-11 Ditch Pu contamination burden and the Z Plant COPC list.	N/A	N/A	N	N/A	N/A	Y
2, 3, and 4	Soil and sediment chemical sample data	Y	*Groundwater Impact Assessment Report for the 216-U-14 Ditch*, WHC-EP-0698 (Lindsey and Singleton 1994). Reports that the arsenic, bis-(2-ethyloxyl) phthalate, polychlorinated biphenyls detected are attributed to the 216-U-14 Ditch.	Y	Y	N/A	N	N	N/A
			A Research Report for Rockwell Hanford Operations, Inventory and Chemical Analysis of Sediments from U Pond and S-19 Pond (RHO 1986 [no document number]). Examines the levels of polychlorinated biphenyls in U Pond.	N/A	Y	N/A	N/A	N	N/A

Table 3-4. Required Information and Reference Sources. (6 pages)

PSQ #	Required Information Category	Do Data Exist ? (Y/N)	Source Reference	Sufficient Quality to Validate Preliminary Concept Model? (Y/N)			Add'l Data Req'd? (Y/N)		
				U-14	U-10	Z-11	U-14	U-10	Z-11
3	Groundwater data	Y	*Groundwater Impact Assessment Report for the 216-U-14 Ditch*, WHC-EP-0698 (Lindsey and Singleton 1994). Reports carbon tetrachloride detected in groundwater under the 216-U-10 and 216-U-14 Ditches. Strontium, Co, gross alpha, gross beta, Mn, and U detected in perched water under 216-U-14. Only arsenic, carbon tetrachloride, Mn, and U detected in groundwater under 216-U-14.	N – Groundwater data cannot be used to validate a vadose zone conceptual model.			N		
			Hanford Site Groundwater Monitoring for Fiscal Year 1998, PNNL-12086 (Barnett et al. 1999). Contaminant plume maps for carbon tetrachloride, chloroform, and U under the 216-U-10 Pond.	N – Groundwater data cannot be used to validate a vadose zone conceptual model.			N		
			U Plant Area Source Aggregate Management Study Report, DOE/RL-91-52 (DOE-RL 1992b). Notes uranium in groundwater below the 216-U-14 Ditch. Documents perched water under the 216-U-14 Ditch south of 207-U Retention Basin.	N – Groundwater data cannot be used to validate a vadose zone conceptual model.			N		
			Westinghouse Hanford Company Operational Environmental Monitoring Annual Report, CY 1995, WHC-EP-0573-4 (WHC 1996). Reports 216-U-14 Ditch concentrations declined below drinking water standards. Documents that area of perched water under 216-U-14 were gone after discharge stopped; Sr and arsenic detected. Reports U levels under 216-U-10 Pond in groundwater.	N – Groundwater data cannot be used to validate a vadose zone conceptual model.			N		
			U Plant Area Source Aggregate Management Study Report, DOE/RL-91-52 (DOE-RL 1992b). Reports on contamination detected in former perched water under the 216-U-14 Ditch.	N – Groundwater data cannot be used to validate a vadose zone conceptual model.			N		

Table 3-4. Required Information and Reference Sources. (6 pages)

PSQ #	Required Information Category	Do Data Exist ? (Y/N)	Source Reference	Sufficient Quality to Validate Preliminary Concept Model? (Y/N)			Add'l Data Req'd? (Y/N)		
				U-14	U-10	Z-11	U-14	U-10	Z-11
3	Groundwater data	Y	*216-U-10 Pond and 216-Z-19 Ditch Characterization Studies*, WHC-EP-0707 (WHC 1994). Reports total alpha, beta, tritium, and nitrate contamination in groundwater under Z Ditches. Uranium, total alpha, total beta, Cs, and Co were detected in the 216-U-10 Pond groundwater.	N – Groundwater data cannot be used to validate a vadose zone conceptual model.			N		
3	Pond/ditch surface water quality data	Y	*216-U-10 Pond and 216-Z-19 Ditch Characterization Studies*, WHC-EP-0707 (WHC 1994). Summaries of historical data: surface water data from all three sites in 1979 (from RHO-LD-132 [RHO 1980d]), radionuclide concentration data in water of the 216-Z-19 Ditch (from PNL-2499 [Emery and McShane 1978]), comparison of gross alpha counts discharged to the 216-Z-19 Ditch to measured levels in U Pond (from BNWL-1879 [Emery and Garland 1974]).	N – Groundwater data cannot be used to validate a vadose zone conceptual model.			N		
			U Plant Source Aggregate Area Management Study Report, DOE/RL-91-52 (DOE-RL 1992b), reports surface water analyses of 284-W Powerhouse pond located over head end of the 216-U-14 Ditch.	N – Groundwater data cannot be used to validate a vadose zone conceptual model.			N		
1 and 3	Surface radiological contamina-tion	Y	*An Aerial Radiological Survey of the Hanford Site and Surrounding Area*, EGG-10617-1062 (EG&G 1990). Survey of 200 West Area performed in June 1988; includes waste sites in 200-CW-5 OU.	N – Aerial radiological and surface radiological survey data cannot validate a vadose zone conceptual model.			N		

Table 3-4. Required Information and Reference Sources. (6 pages)

PSQ #	Required Information Category	Do Data Exist ? (Y/N)	Source Reference	Sufficient Quality to Validate Preliminary Concept Model? (Y/N)			Add'l Data Req'd? (Y/N)		
				U-14	U-10	Z-11	U-14	U-10	Z-11
			Focused Feasibility Study for the 200-UP-2 Operable Unit, DOE/RL-95-106 (DOE-RL 1996). Greatest degree of surface contamination is in proximity of the 207-U retention basins from the *Surface Radiation Survey Report for the 200-UP-2 Operable Unit*.						
			Limited Field Investigation for the 200-UP-2 Operable Unit, DOE/RL-95-13 (DOE-RL 1995). The 216-U-10, 216-U-14, and 216-Z-11 units were surveyed using MSCM-II tractor. Notes areas of surface radiological contamination around perimeter of former U Pond, and delta regions of the 216-U-14 and 216-Z-11 Ditches.						
			Photo aerial radiological survey of U Pond performed June 2, 1973. Data for Cs, Am, and total gamma (by the U.S. Atomic Energy Commission).						
1 and 3	Surface radiological contamina-tion	Y	*216-U-10 Pond and 216-Z-19 Ditch Characterization Studies*, WHC-EP-0707 (WHC 1994). Summarizes historical surface radiological contamination data (aerial radiological measurement systems data from 1972 through 1973). Also reports new data (1980) obtained from Dev Van IA in situ measurements for U, Pu, Cs, Am, and Sr.	N – Aerial radiological and surface radiological survey data cannot validate a vadose zone conceptual model.			N		

Table 3-4. Required Information and Reference Sources. (6 pages)

PSQ #	Required Information Category	Do Data Exist ? (Y/N)	Source Reference	Sufficient Quality to Validate Preliminary Concept Model? (Y/N)			Add'l Data Req'd? (Y/N)		
				U-14	U-10	Z-11	U-14	U-10	Z-11
1, 3, and 4	RESRAD input data	Y/N	*Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0*, RESRAD v5.82, ANL-EAD-LD-2 (ANL 1993). Inputs are moisture content, particle size distribution, and lithology needed for determining soil density, hydraulic conductivity, and porosity. Erosion rate[b], B parameter[b], and hydraulic gradient can be determined from existing data.	Y	Y	N	N	N	Y

[a] These data are useful analogous information but do not resolve the site data collection requirements.
[b] Erosion rate and B parameter are RESRAD default settings provided in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 1998).

Table 3-5 provides a list of the information needed to perform the DQO Step 6 quantitative assessment of the alternative actions identified in DQO Step 2 with severe decision error consequences.

Table 3-5. Quantitative Assessment of Decision Error Consequences.

AA #	Consequences of Decision Error			
	Cost	Human Health Risk	Environmental Risk	Schedule
No alternative actions with potentially severe consequences were identified in DQO Step 2 for the U Pond/Z Ditch System OU waste group. The 216-Z-11 Ditch characterization data may be used to refine the preliminary contaminant distribution conceptual model, determine if remediation is needed, and support initial decisions regarding appropriate remedial alternatives. The remedial alternatives will then be evaluated in a FS.				

Table 3-6 is used to identify if appropriate measurement methods exist to provide the necessary data. It should be noted that the consequences of decision error (DQO Step 6) will determine the level of analysis required (e.g., field screening or fixed laboratory).

Table 3-6. Potentially Appropriate Measurement Methods. (2 pages)

Media	Environmental Variable	Potentially Appropriate Measurement Method	Possible Limitations or Reservations
Field Screening			
Ditch bottom	216-Z-11 Ditch location	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.
		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.
Ditch sediment layer	Gross gamma emissions	Cone penetrometer NaI detector logging	A closed-end rod is pushed into the soil to the desired depth, A small-diameter NaI (or other suitable detector) is used to log the gross gamma response with depth. Because of the very small-diameter detectors used with this technique, results are limited to gross gamma readings. The cone penetrometer is not effective in cobbly or rocky soils.
	Gamma emissions from Am-241, Pu-239, and Np-237	Borehole SGL with 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.

Table 3-6. Potentially Appropriate Measurement Methods. (2 pages)

Media	Environmental Variable	Potentially Appropriate Measurement Method	Possible Limitations or Reservations
	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 they have logistical problems associated with the handling of intense sources or generators.
Vadose zone soils	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.
Z Ditch discharge piping	All COCs	Remote video camera visual observation through manholes	Visual observation only. No indication of absolute or relative contamination levels.
		Remote spectral gamma assay through manholes	May be difficult to assign activity levels because of the geometric variables in the manhole. Corresponding analytical data from soil samples are needed to assess activities from the gamma detector.
Laboratory Samples			
Ditch sediment layer	All COCs	Laboratory analysis	Highly contaminated samples require use of onsite laboratories, with associated impacts (e.g., high costs, reduced analyte lists, matrix effects, degraded detection limits, and long turn-around times). Lower contamination levels allow use of offsite laboratories, avoiding these limitations.
Z Ditch discharge piping	All COCs	Laboratory analysis	Samples are likely to be the worst-case media associated with the Z Ditches; expensive to handle, analyze, and dispose.

EMI = electromagnetic induction
GPR = ground-penetrating radar
NaI = sodium iodide

Table 3-7 indicates the laboratory analytical performance requirements for the shallow and deep zone soils. Table 3-7a provides the analytical performance requirements for spectral gamma logging (SGL).

Table 3-7. Analytical Performance Requirements. (3 pages)

Data Type	Analytical Method	Analyte	Preliminary Action Level	Detection Limit Requirements[a]		Accuracy Required	Precision Required
				MDL	PQL		
Radiological Constituents (pCi/g)							
Rad, α	AmAEA[b]	Americium-241	c	0.1	1	70-130	±30
Rad, γ	HPGe	Cesium-137	c	0.05	0.1	80-120	±30
Rad, γ	HPGe	Cobalt-60	c	0.05	0.1	80-120	±30
Rad, α	AmAEA[b]	Curium-243	c	0.1	1	70-130	±30
Rad, γ	HPGe	Europium-152	c	0.1	0.2	80-120	±30
Rad, γ	HPGe	Europium-154	c	0.1	0.2	80-120	±30
Rad, γ	HPGe	Europium-155	c	0.1	0.2	80-120	±30
Rad, α	NpAEA[b]	Neptunium-237	c	0.1	1	70-130	±30
Rad, β	Liq Scintillation	Nickel-63	c	5	30	70-130	±30
Rad, γ	HPGe	Niobium-94	c	0.1	1	80-120	±30
Rad, α	PuAEA[b]	Plutonium-238	c	0.1	1	70-130	±30
Rad, α	PuAEA [b]	Plutonium-239/240	c	0.1	1	70-130	±30
Rad, γ	HPGe	Radium-226	c	0.1	0.2	80-120	±30
Rad, γ	HPGe	Radium-228	c	0.1	0.2	80-120	±30
Rad, β	RADSr	Radiogenic strontium	c	0.2	1	70-130	±30
Rad, β	Liq Scintillation	Technetium-99	c	5	15	70-130	±30
Rad, α	ThAEA[b]	Thorium-232	c	0.1	1	70-130	±30
Rad, β	Liq Separation	Tritium	c	5	400	70-130	±30
Rad	KPA[d]	Total uranium	N/A	0.2 mg/kg	1.0 mg/kg	70-130	±30
Rad, α	UAEA[b]	Uranium-234	c	0.1	1	70-130	±30
Rad, α		Uranium-235/236	c	0.1	1	70-130	±30
Rad, α		Uranium-238	c	0.1	1	70-130	±30
Data Type	**Analytical Method**	**Analyte**	**Preliminary Action Level**	**Detection Limit Requirements[a]**		**Accuracy Required**	**Precision Required**
			Meth C	**MDL**	**PQL**		
Inorganic Chemical Constituents[e] (mg/kg)							
Chem	EPA 6010	Arsenic	6.5[f]	2.5/0.2[g]	10/1[g]	70-130	±30
Chem	EPA 6010	Barium	245	0.1	1	70-130	±30
Chem	EPA 6010	Beryllium	1.51[f]	0.03	0.2	70-130	±30
Chem	EPA 6010	Cadmium	0.5[h]	0.3	0.8	70-130	±30
Chem	EPA 6010	Chromium (III)	3,500[h]	0.4	1	70-130	±30
Chem	EPA 6010	Copper	130[h]	0.5	2	70-130	±30
Chem	EPA 7196	Hexavalent chromium	8[i]	0.1	0.7	70-130	±30
Chem	EPA 6010	Lead	1,000[h,j]	5	20	70-130	±30

Table 3-7. Analytical Performance Requirements. (3 pages)

Data Type	Analytical Method	Analyte	Preliminary Action Level	Detection Limit Requirements[a]		Accuracy Required	Precision Required
			Meth C	MDL	PQL		
Chem	EPA 7471	Mercury	0.33[f,h]	0.005	0.05	70-130	±30
Chem	EPA 6010	Nickel	70[h]	1	4	70-130	±30
Chem	EPA 6010	Selenium	5[h]	5/.05	20/0.5	70-130	±30
Chem	EPA 6010	Silver	10[h]	0.7	2	70-130	±30
Chem	EPA 6010	Zinc	500[h]	0.5	2	70-130	±30
Chem	EPA 300.0	Chloride	25,000	0.2	2	70-130	±30
Chem	EPA 300.0	Fluoride	200	0.2	1	70-130	±30
Chem	IC 300 modified and 353.1[k]	Nitrate/nitrite	4,400	0.2	0.1	70-130	±30
Chem	EPA 300.0	Sulfate	25,000	2	10	70-130	±30
Chem	EPA 9030	Sulfide	N/A	4	20	70-130	±30
Organic Chemical Constituents (mg/kg)							
Chem	EPA 8260	Acetone	175	0.01	0.05	70-130	±30
Chem	EPA 8260	Acetonitrile	10.5	0.02	0.1	I	I
Chem	EPA 8260	2-Butanone (MEK)	1050	0.01	0.05	I	I
Chem	EPA 8260	Carbon tetrachloride	0.337	0.001	0.005	I	I
Chem	EPA 8260	Chlorobenzene	10.0	0.002	0.010	I	I
Chem	EPA 8260	Chloroform (trichloromethane)	7.17	0.001	0.005	I	I
Chem	EPA 8270	Creosote/tar	N/A	Var[m]	Var[m]	I	I
Chem	EPA 8260 as TIC	Cyclohexane	N/A	N/A	N/A	I	I
Chem	EPA 8270 as TIC	Cyclohexanone	17,500	N/A	N/A	I	I
Chem	EPA 8260 as TIC	Decane	N/A	N/A	N/A	I	I
Chem	EPA 8260	Dichloromethane	5.83	0.001	0.005	I	I
Chem	EPA 8260 as TIC	Hexane	105	N/A	N/A	I	I
Chem	EPA 8270	Naphthylamine	N/A	0.3	0.85	I	I
Chem	EPA 8260	Perchloroethylene	100	0.001	0.005	I	I
Chem	EPA 8080/ 8082	Polychlorinated biphenyls	0.5	0.01	0.1	I	I
Chem	EPA 8260 as TIC	Pseudo cumene (1,2,4 trimethyl benzene)	N/A	N/A	N/A	I	I
Chem	EPA 8260	Tetrahydro furan	N/A	0.01	0.05	I	I
Chem	EPA 8260	Toluene	100	0.001	0.005	I	I
Chem	EPA 8270	Tributyl phosphate	N/A	0.4	4	I	I

Table 3-7. Analytical Performance Requirements. (3 pages)

Data Type	Analytical Method	Analyte	Preliminary Action Level	Detection Limit Requirements[a]		Accuracy Required	Precision Required
			Meth C	MDL	PQL		
Chem	EPA 8260	Trichloroethene	100	0.001	0.005	I	I
Chem	EPA 8260	Vinyl chloride	0.023	0.001	0.005	I	I
Chem	EPA 8260	Xylenes	1,000	0.001	0.005	I	I
Chem	NWTPH-Dx modified for kerosene range	Kerosene, normal paraffins, paint thinner	N/A	0.5	5	I	I
Soil Physical Properties							
D2216		Moisture content	N/A	wt%		N/A	N/A
D422		Particle size distribution	N/A	wt%		N/A	N/A
BHI-EE-01, Procedure 7.0		Lithology	N/A	Descriptive		N/A	N/A

[a] Detection limits are based on optimal conditions in a standard fixed laboratory. Interferences and matrix effects may degrade the values shown. If soil samples are determined to contain radiological contaminants in high concentrations, they will need to be analyzed in an onsite laboratory because of offsite laboratory acceptance criteria limits. In this case, expected impacts include high analytical costs, degradation of detection limits, reduced analyte lists, and long turnaround times.

[b] AmAEA, PuAEA, UAEA, NpAEA, ThAEA – chemical separation, electro/microprecipitation deposition, alpha energy analysis via Si barrier detector.

[c] There are no preliminary action levels for radionuclides at this time. They will be developed in the RI/FS process.

[d] Uranium will be analyzed for total abundance in all samples; any samples with values significantly above background levels will be analyzed for the individual species.

[e] Waste disposition for this project will comply with the Phase IV RCRA implementation requirements per 40 CFR 261.24 and 40 CFR 268.40. This applies to the toxicity characteristic metals and require performance of TCLP analyses for sample results that exceed the land disposal restriction threshold values (determined by applying the 20 times totals values). If TCLP analyses are performed, the analyte list will be expanded to include antimony and thallium as potential underlying hazardous constituents.

[f] This value represents Hanford Site background.

[g] First value shown is via routine inductively coupled plasma (ICP), second value via "trace" ICP or graphite furnace atomic absorption.

[h] If reported value is given by the laboratory, the approximate detection limit will be identified.

[i] Based on Federal ambient water quality control criteria and assumed dilution-attenuation factor of 2.

[j] MTCA Method A, Table 3 (WAC 173-340-740).

[k] Nitrate/Nitrite analysis yields total nitrogen.

[l] As reported by SW-846 procedure (EPA 1986).

[m] Creosote is a mixture of, primarily, aromatic (e.g., benzene) and polynuclear aromatic (e.g., pyrene) constituents. Analysis by EPA 8260 and 8270 will report primary constituents at detection limits comparable to benzene and pyrene.

α = alpha analysis
γ = gamma analysis
HPGe = high-purity germanium
KPA = kinetic phosphorescence analysis
N/A = not applicable
TCLP = toxicity characteristic leachate procedure

Table 3-7a. Analytical Performance Requirements for Spectral Gamma Logging.

Data Type	Analytical Method	Analyte	Preliminary Action Level	Detection Limit Requirements[a]		Accuracy Required	Precision Required
				MDL	PQL		
Rad, γ	HPGe	Americium-241	100 nCi/g	~25 nCi/g	---	70-130	±30
Rad, γ	HPGe	Cesium-137	a	0.3 pCi/g	---	70-130	±30
Rad, γ	HPGe	Cobalt-60	a	0.2 pCi/g	---	70-130	±30
Rad, γ	HPGe	Europium-152	a	2 pCi/g	---	70-130	±30
Rad, γ	HPGe	Europium-154	a	2 pCi/g	---	70-130	±30
Rad, γ	HPGe	Europium-155	a	5 pCi/g	---	70-130	±30
Rad, γ	HPGe	Neptunium-237	a	~100 pCi/g	---	70-130	±30
Rad, γ	HPGe	Plutonium-239/240	100 nCi/g	~50 nCi/g	---	70-130	±30

[a] There are no preliminary action levels for radionuclides at this time. They will be developed in the RI/FS process.
γ = gamma analysis
HPGe = high-purity germanium

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) is to ensure 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 spatial and temporal boundaries of the study 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
All	Sediment layer soils	Soil radionuclide and chemical concentrations in pond/ditches and underlying soils
	Moderate contaminant concentration soils	
	Low contaminant concentration soils	

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 Areas of Investigation.

DS #	Geographic Areas of Investigation
All	The geographic area of investigation is the 216-Z-11 Ditch.

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. Strata with Homogeneous Characteristics.

DS #	Population of Interest	Strata	Homogeneous Characteristic Logic
1, 2, 3, and 4	Soils from 0 to 8 m (25 ft) bgs	Clean or very low concentration stabilizing fill over waste site.	Soils placed as past stabilization cover to prevent migration of surface contaminants.
		Sediment layer. (This layer contains high contaminant concentrations. It includes the 2-m (6-ft) - thick soil layer below the stabilizing fill.	This is the sediment layer at the bottom of the site. This is a zone in the preliminary contaminant distribution model that is expected to contain the highest concentrations of contaminants due to the build-up of sediments by absorption and/or filtration.
2, 3 and 4		Moderate contaminant concentration layer (from the bottom of the sediment layer to approximately 8 m [25 ft] bgs).	This zone in the preliminary contaminant distribution model is expected to contain moderate concentrations of contaminants because immobile contaminants were filtered and/or sorbed in the sediment layer.
1, 2, 3, and 4	Soils deeper than 8 m (25 ft) bgs	Low contaminant concentration layer (soils from the bottom of the moderate contaminant concentration layer, to the groundwater).	This zone in the preliminary conceptual contaminant distribution model is expected to contain low concentrations of mobile contaminants, and those concentrations are expected to continually decrease with depth. This is because the majority of the contaminants would have been filtered and/or sorbed in the upper soil strata, leaving primarily dissolved mobile contaminants in the moisture front.

Table 4-4 defines the spatial scale of decision making (i.e., defines each decision unit that is the smallest area or volumetric unit for which each decision applies). Decision units may be remediation units or risk units.

Table 4-4. Spatial Scale of Decision Making.

The spatial scale of decision making is defined as follows:

- Sediment layer at the bottom of the waste site
- Soils immediately beneath the sediment layer to a depth of 8 m (25 ft) bgs
- Soils from 8 m (25 ft) bgs to groundwater
- Remedial cost/benefit decision depths
- Pipeline and cover soils.

Sediment Layer at the Bottom of the Waste Site:

The sediment layer at the bottom of the waste site is expected to contain the highest contamination concentrations. This zone, therefore, has the greatest likelihood of exceeding action levels and is the primary area of importance for shallow zone decision making. This layer is expected to be approximately 2-m (6-ft) thick. Tight sampling intervals are required in this zone because the contaminant concentrations are expected to drop rapidly with increasing depth.

Soils Immediately Beneath the Sediment Layer to a Depth of 8 m (25 ft) bgs:

The soils below the sediment layer are expected to contain moderate contamination concentrations. The contamination levels in the soils below the sediment layer are also significant for remedial action decision making and preliminary contaminant distribution model verification. Tight sampling intervals are required in this zone because the contaminant concentrations are expected to drop rapidly with increasing depth.

Soils from 8 m (25 ft) bgs to Groundwater:

The soils from 8 m (25 ft) bgs elevation to groundwater are represented in the preliminary contaminant distribution model as having low contamination concentrations that diminish with depth. This area is important to verify the preliminary contaminant distribution model (see Figure 1-7). The sampling intervals in this region will be expanded because the contaminant concentrations are expected to show very gradual changes between 8 m (25 ft) and the groundwater table.

If a geological obstruction is encountered that stops the borehole drilling, the project team will evaluate the progress made and elect to either stop or move to another location.

Remedial Cost/Benefit Decision Depths:

Remedial action decisions will be affected primarily by the concentrations of contaminants and their lateral and vertical distribution throughout the shallow vadose zone. Based on professional judgment, contaminant distribution data are required to approximately 8 m (25 ft) bgs to support remedial action alternative decision making (i.e., excavation vs. barriers). Sample data are also required below 31 m (100 ft) because barriers may not be effective remedial alternatives for the 200-CW-5 OU sites. The sampling performed for the preliminary contaminant distribution model verification sampling will support this need.

The temporal boundaries of the decision are defined in Table 4-5.

Table 4-5. Sampling Time Frame and Sampling Design Rigor Requirements.

The sampling design rigor for the Phase I remedial field investigation (RFI) must be adequate to support remedial action decisions for the waste sites. The consequences of actions taken due to the Phase I RFI are considered "not severe." The time frame for which the decisions apply in this case is assumed to be 3 to 5 years. This is the time frame for which the sites will be accessible for additional sampling after the Phase I RFI is completed. Confirmatory and remedial design sampling efforts are also planned after the Phase I RFI is completed (to provide remedial design input). Following the guidance in Table 4-6, the sampling design rigor required for the 200-CW-5 OU waste sites is "low."

The consequences, resampling access, and sampling design rigor requirements are identified in Table 4-6.

Table 4-6. Consequences, Resampling Access, and Sampling Design Rigor Requirements.

Consequences of Actions	Resampling Access After Remedial Actions	Sampling Design Rigor Requirement
Severe	Inaccessible	Very robust
Severe	Accessible	Robust
Not severe	Inaccessible	Moderate
Not severe	Accessible	Low

Table 4-7 identifies measurement objectives, conditions, and constraints in relation to when data will be collected.

Table 4-7. When to Collect Data.

Measurement	Measurement Objective	Influencing Conditions	Measurement/ Condition Constraints (time units)
Field Screening			
GPR/EMI	Geophysical measurements	Extreme weather conditions (hot or cold) may limit or shut down field screening operations.	Avoid extreme hot/cold months due to impacts on worker efficiency.
Radiological	Spectral gamma measurements		
Laboratory Samples			
Radiological	Alpha, beta, and gamma isotopic concentrations in the soils	Extremely cold weather conditions may influence soil sample integrity and may limit or shut down soil sampling operations.	Avoid extreme cold months due to impacts on sample integrity.
Chemical	Metal and organic concentrations in soils		
Physical	Soil properties, moisture content, particle size distribution, and lithology)		

A temporal scale of decision making may be necessary for certain types of studies. For example, to regulate water quality, it would be useful to set a scale of decision making that limits the time between sampling events, which would minimize the potential adverse effects in case the water quality was degraded between sampling events. The temporal scale of decision making is defined in Table 4-8.

Table 4-8. Temporal Scale of Decision Making.

No temporal scale of decision making is identified for the 200-CW-5 DQO process.

The practical constraints on data collection are listed in Table 4-9.

Table 4-9. Practical Constraints on Data Collection.

Boreholes may not obtain sufficient volumes of sample media if the sampled zone is 0.6-m (2-ft) thick or less. Borehole drive casings and split-spoon samplers may smear contamination. Borehole sampling results may not be directly comparable with borehole logging results due to differences in the interrogation zones between the two techniques. The soils below the sediment layer are expected to be typical Hanford Site soils. These soils should be easily recognizable and should not pose unusual sampling problems. **Other Constraints:** Health and safety constraints will be imposed during characterization of the Z Ditches to ensure that as low as reasonably achievable issues are properly addressed when sampling potentially TRU-contaminated soils. 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.

5.0 STEP 5 -- DEVELOP A DECISION RULE

5.1 PURPOSE

The purpose of DQO Step 5 is to identify the parameter of interest (i.e., mean, upper 95th percent confidence interval), specify the action level, and integrate outputs from the previous DQO steps into a single statement that describes a logical basis for choosing among alternative actions.

5.2 WORKSHEETS FOR STEP 5 -- DEVELOP A DECISION RULE

The statistical parameters of interest that characterize the population are identified in Table 5-1.

Table 5-1. Statistical Parameter of Interest that Characterizes the Population.

DS #	Decision Statement Summary	Parameter of Interest
1	Contaminant concentrations in the sediment layer soils exceed the TRU definition of 100 nCi/g.	SGL results = 95% UCL of the mean, or average (as applicable) detected values
		Soil sampling = maximum detected value
2	Soil compliance with radionuclide exposure limits for human health protection.	SGL results = 95% UCL of the mean, or average (as applicable) detected values
		Soil sampling = maximum detected value
3	Soil compliance with chemical constituent exposure limits for human health protection.	Soil sampling = average detected value, or MTCA three-part statistical criteria:[a] • 95% UCL of mean concentration is less than the cleanup level • Maximum detected concentration is less than two times the cleanup level • Less than 10% of the data may exceed the cleanup level.
4	Preliminary conceptual contaminant distribution model representation.	SGL results = detected values
		Soil sampling = detected values

a The three-part MTCA criteria only applies in the 0- to 4.6-m (0- to 15-ft) depth bgs. The 95% upper confidence limit (UCL) of the mean concentration is the parameter of interest at depths greater than 4.6 m (15 ft) bgs. If the number of samples collected is not sufficient to perform the 95% UCL calculation, the average detected value will be used.

Table 5-2 specifies the scale of decision making.

Table 5-2. Scale of Decision Making.

Refer to Table 4-4.

The action levels or preliminary action levels for each of the decision statements are specified in Table 5-3.

Table 5-3. Action Level for the Decision.

DS #[a]	COCs	Action Level
1	Transuranic COCs	100 nCi/g
2	Radiological COCs	Shallow zone action levels in Table 3-7 (values TBD, pending scenario selection)
3	Chemical COCs	Action levels in Table 3-7
4	Radiological and chemical COCs	Judgmental assessment; action levels are not applicable

TBD = to be determined

The alternative actions are specified in Table 5-4.

Table 5-4. Alternative Actions.

PSQ #	AA #	Alternative Actions
1	1	Evaluate the need for special remedial alternatives for the TRU-contaminated media in a FS.
	2	Evaluate the need for conventional remedial action alternatives in a FS.
2 and 3	1	Evaluate a streamlined approach to site closure (e.g., add to an existing ROD).
	2	Evaluate the need for remedial action alternatives in a FS.
4	1	Apply preliminary contaminant distribution conceptual model for remedial alternative selection and remedial action planning.
	2	Revise the preliminary contaminant distribution conceptual model for remedial alternative selection and remedial action planning.

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 5-5.

Table 5-5. Decision Rules. (2 pages)

DR #	Decision Rule
1	If the 95% UCL of the mean or average (as applicable) detected SGL results and/or the maximum detected soil sampling results for the transuranic COCs in the 216-Z-11 Ditch sediment layer exceed the TRU definition of 100 nCi/g, then the chemical COCs will be evaluated in accordance with DR #4, and the need for special remedial alternatives will be evaluated in a FS. If the 95% UCL of the mean or average (as applicable) detected SGL results and/or the maximum detected soil sampling results for the transuranic COCs in the 216-Z-11 Ditch sediment layer do not exceed the TRU definition of 100 nCi/g, then the results will be evaluated by the RESRAD analytical model to determine if sediment layer exceeds the annual exposure limits for human health protection under the appropriate exposure scenario, the chemical COCs will be evaluated in accordance with DR #4, and the need for conventional remedial action alternatives will be evaluated for the sediment layer in a FS.
2	If the RESRAD analysis of the 95% UCL of the mean or average (as applicable) detected SGL results and/or the maximum detected soil sampling results for the radiological COCs in the 216-Z-11 Ditch from the bottom of the sediment layer (about 3.6 m [12 ft] bgs) to 4.6 m (15 ft) bgs exceed or do not exceed the annual exposure limits for human health protection (under the appropriate scenario), then the chemical COCs will be evaluated in accordance with DR #5, and a FS will be performed to evaluate the need for remedial action alternatives, or a streamlined approach to site closure will be applied administratively, via an existing ROD.
3	If the RESRAD analysis of the 95% UCL of the mean or average (as applicable) detected SGL results and/or the maximum detected soil sampling results for the radiological COCs in the 216-Z-11 Ditch from 4.6 m (15 ft) bgs to 8 m (25 ft) bgs exceed or do not exceed the annual exposure limits for human health protection (under the appropriate scenario), then the chemical COCs will be evaluated in accordance with DR #6, and a FS will be performed to evaluate the need for remedial action alternatives, or a streamlined approach to site closure will be applied administratively, via an existing ROD.
4	If the analytical results of the 216-Z-11 Ditch sediment layer samples indicate that the three-part MTCA criteria or average detected values (as applicable) have or have not been met for the respective chemical COCs preliminary action levels, then a FS will be performed to evaluate the need for remedial action alternatives, or a streamlined approach to site closure will be applied administratively, via an existing ROD.
5	If the analytical results of the 216-Z-11 Ditch from the bottom of the sediment layer (about 4 m [12 ft] bgs) to 4.6 m (15 ft) indicate that the three-part MTCA criteria or average detected values (as applicable) have or have not been met for the respective chemical COCs preliminary action levels, then a FS will be performed to evaluate the need for remedial action alternatives, or a streamlined approach to site closure will be applied administratively, via an existing ROD.
6	If the analytical results of the 216-Z-11 Ditch from 4.6 m (15 ft) bgs to 8 m (25 ft) indicate that the 95% UCL of the mean or average detected values (as applicable) have or have not been met for the respective chemical COCs preliminary action levels, then a FS will be performed to evaluate the need for remedial action alternatives, or a streamlined approach to site closure will be applied administratively, via an existing ROD.

Table 5-5. Decision Rules. (2 pages)

DR #	Decision Rule
7	If the detected values indicate that the contamination distribution in the 0- to 8-m (0- to 25-ft) elevation and from 8 m (25 ft) to groundwater for the 216-Z-11 Ditch does not differ significantly from the preliminary contaminant distribution model, then the preliminary model will not be revised prior to use for remedial decision making or remedial action planning. If the detected values indicate that the contamination distribution in the 0- to 8-m (0- to 25-ft) elevation and from –8 m (-25 ft) to groundwater for the 216-Z-11 Ditch differs significantly from the preliminary contaminant distribution model, then the preliminary model will be revised prior to use for remedial decision making or remedial action planning.

[a] 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.

6.0 STEP 6 -- SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

6.1 PURPOSE

The purpose of DQO Step 6 is to develop tolerable error limits. The probability of making an erroneous decision will be acceptable if it is within these limits. The established error limits will be used to estimate the number of samples and to establish performance goals for the newly collected data.

Sampling designs may be statistically based or based on professional judgment. Neither approach is deemed to be absolutely correct. The choice between the two depends on the project task objectives, existing data, actions to be taken, and consequences of taking such actions. One of the primary objectives that must be accomplished in DQO Step 6 is to choose between a statistical or judgmental sampling design. The user and DQO Team are assisted in this decision-making process through use of the logic diagrams and tables.

A preliminary determination of the need is made for a statistically based sample design by evaluating the severity of the consequences in DQO Steps 2 and 4 in the logic diagram in Figure 6-1.

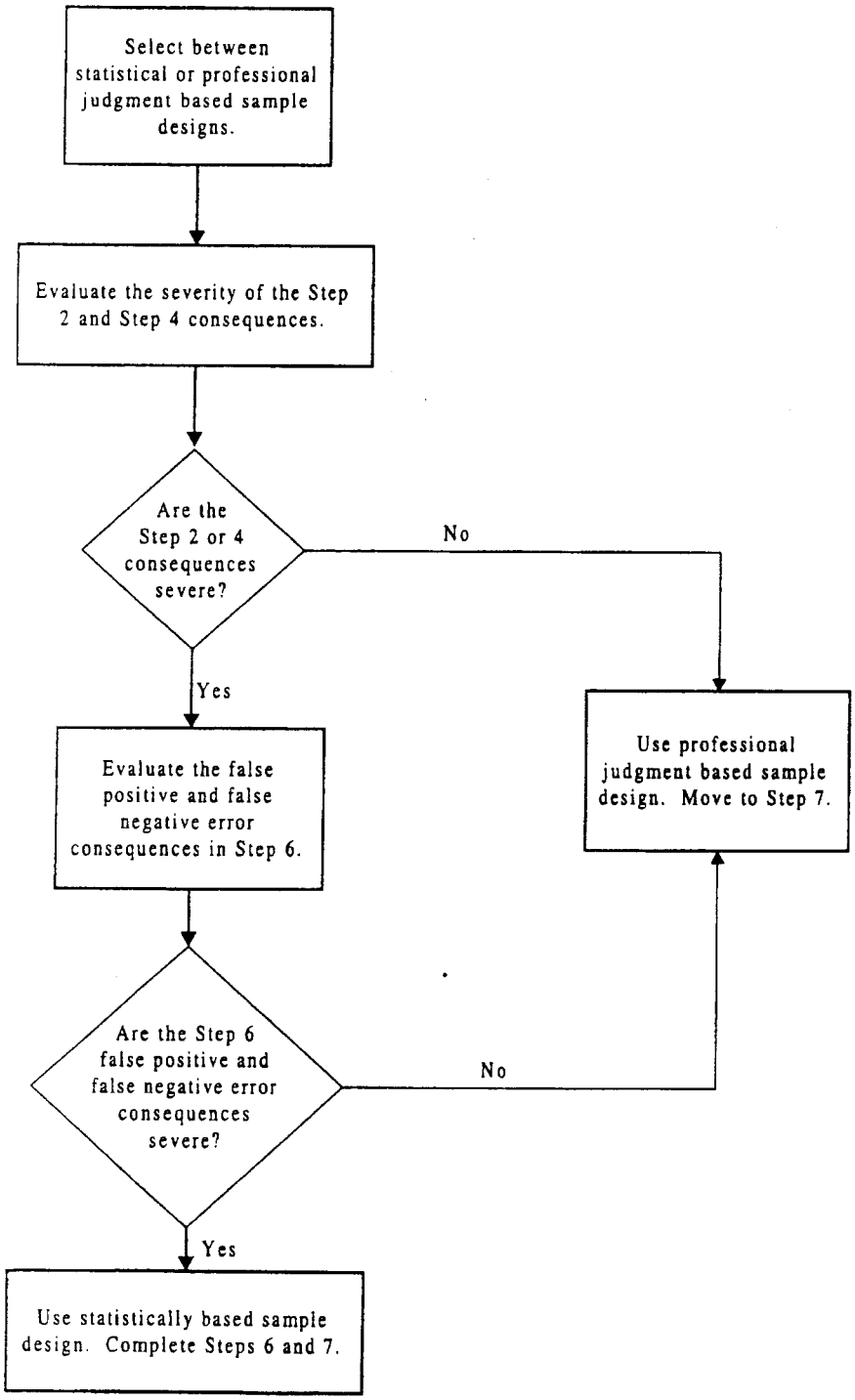
6.2 WORKSHEETS FOR STEP 6 -- SPECIFY TOLERABLE LIMITS ON DECISION ERROR

The consequences of severity for DQO Steps 2 and 4 are summarized in Table 6-1.

Table 6-1. DQO Steps 2 and 4 Consequences Severity Summary.

DQO Step	PSQ #	AA #	Consequence Severity	Preliminary DQO Step 6 Sample Design Basis
Step 2	1-4	1-2	Not severe, as stated in Table 2-1.	Non-statistical sampling design
Step 4	1-4	1-2	Low, as shown in Tables 4-5 and 4-6.	Non-statistical sampling design

Figure 6-1. Logic Diagram for Selection of Statistical or Professional Judgment-Based Sample Designs.



7.0 STEP 7 -- OPTIMIZE THE DESIGN

7.1 PURPOSE

The purpose of this step 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	Non-Statistical	Rationale
All	N/A	Non-statistical sampling design	Consequences of erroneous decisions are not severe. Judgmental design rigor is indicated. Characterization sampling results will be verified by confirmatory sampling of analogous sites during the 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 non-statistical, determine what type of non-statistical design is appropriate (haphazard or judgmental).

Table 7-2. Determine Non-Statistical Sampling Design.

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

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
Trenching or test pit sampling	Excavation with backhoe or excavator. This technique provides grab samples taken directly from the soil column (approximate 0.3-m [1-ft] intervals) or from the excavator bucket. Because this technique creates a trench, direct inspection of the exposed soil column is possible. This method is not well suited for soils contaminated with alpha-emitting radionuclides because of direct exposure to personnel, equipment, wind, and weather.
Cone penetrometer 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 is easily stopped by cobbles, rocks, or other features in the soil column.
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.) 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. Grab samples from the drive barrel or split-spoon samples may be taken with cable tool drills. To achieve laboratory analysis sample volume needs for large analytical lists, a 0.6-m (2-ft)-long core sample from a 13-cm (5-in.)-diameter sampler is typically needed. The DOE-owned controlled cable tool rigs are available onsite. 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.
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 laboratory analysis sample volume needs, 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, 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.

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

Method	Description
Air rotary drilling and sampling	Air rotary drilling is much faster than other drilling techniques. Grab samples and split-spoon samples may be taken with this method. In addition, most rotary drill rigs can be configured to collect core samples. To achieve laboratory analysis sample volume needs, 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 samples and formation moisture levels.
Direct sampling of Z Ditch discharge piping	Significant contamination controls required. Potential for contaminating equipment and personnel. The fine-grained nature of the sludge likely provides opportunities for release of airborne contamination. Retrieval of samples by remote methods through glove bags may be difficult to accomplish.
Remote visual and gamma detector use in Z Ditch discharge piping	Significant contamination controls required Potential for contaminating equipment and personnel.

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 initial step in the DQO effort concluded that the historical characterization data available for the 216-U-Pond and 216-U-14 Ditch met the data quality needs for remedial action decision making (Section 1.2 and Table 3-4). However, because of the data gaps for the 216-Z-11 Ditch, characterization sampling is required to support remedial decisions. The characterization objectives identified in Section 1.3 result in the following characterization goals:

- Determine the probable locations of TRU hot spots based on ditch hydraulics and physical features
- Determine the maximum concentrations of transuranic materials present in the identified hot spots
- Obtain characterization data for the chemical constituents in the 216-Z-11 Ditch
- Analyze soils for physical properties to support modeling and to validate the preliminary contaminant distribution conceptual model.

7.4 SAMPLING DESIGN

The characterization approach for the 216-Z-11 Ditch takes into account the physical constraints present at the site. The characterization techniques are expected to yield meaningful radiological and chemical characterization data. The sampling design includes three vadose zone characterization steps and one discharge pipe characterization activity, including the following:

- Surface geophysical surveys over the 216-Z-11 Ditch
- Spectral gamma logging (SGL) of shallow casings in selected locations over the 216-Z-11 Ditch
- Borehole soil sampling of the 216-Z-11 Ditch
- Characterization of the discharge piping sludge through manhole access ports in the Z Ditch discharge piping between the Z Plant and the 216-Z-11 Ditch.

The first three vadose zone characterization steps listed above will be performed in sequence to locate and sample the soils within the ditch. The pipeline characterization is independent of the ditch characterization activities. The characterization techniques are described further in the following subsections.

7.4.1 Surface Geophysical Surveys

One of the primary objectives of the soil sampling in the 216-Z-11 Ditch is to locate and sample the radiological hot spot areas for laboratory analysis. However, stabilizing fill placed on the site for contamination control purposes rendered the ditch unrecognizable from its surrounding features. This, combined with a lack of accurate photographs or site coordinates, focused the initial efforts on locating the site. Historical records indicate that the stabilizing fill is shallow (nominally 2-m [6-ft] thick) and the ditch bottom is covered with a fine-grained layer of sediment, a configuration that is expected to work well with surface geophysical survey techniques. This is because the depth of stabilizing fill material is within the range of the current surface scanning technologies, and the fine-grained sediment layer should act as a reflecting media for certain geophysical survey signals. Therefore, surface geophysical survey techniques were chosen as the first characterization activity.

Two geophysical survey techniques will be used to locate the 216-Z-11 Ditch, including ground penetrating radar (GPR) and electromagnetic induction (EMI). Historical sampling data from the

other Z Ditches indicate that fluid velocity changes likely caused sediments to deposit, creating radiological hot spots. Historical aerial photographs and site maps were studied in an effort to select locations where fluid velocity changes were likely. As a result, seven areas were identified over the presumed location of the 216-Z-11 Ditch for performance of surface geophysical surveys between the head-end of the discharge pipe and the 216-U-10 Pond. Figure 7-1 shows the planned locations for surface geophysical surveys.

7.4.1.1 Ground-Penetrating Radar. GPR is a non-invasive method of detecting, locating, and/or mapping shallow subsurface features. It uses a transducer to transmit frequency modulation electromagnetic energy into the ground. Interfaces in the ground, defined by contrasts in di-electric constants, magnetic susceptibility, and to some extent, electrical conductivity, reflect the transmitted energy. The GPR system then measures the travel time between transmitted pulses and the arrival of reflected energy. Geologic features (e.g., cross-bedding, lateral and vertical changes in soil properties, and rock interfaces) can cause reflections of a portion of the electromagnetic energy.

The reflected energy provides the means for mapping the subsurface features of interest, whether man-made or geologic. When numerous adjacent profiles are collected, often in two orthogonal directions, a plan view map showing the location and depth of features can be generated.

7.4.1.2 Electromagnetic Induction. EMI is a noninvasive method of detecting, locating, and/or mapping shallow subsurface features, and it works well as a complimentary tool with GPR because of the way it responds to subsurface anomalies and its ability to quickly obtain reconnaissance level information over large areas to help focus GPR efforts. The EMI techniques are used to determine the electrical conductivity of the subsurface soil. The method is based on a transmitting coil radiating an electromagnetic field that induces eddy currents in the earth. A resulting secondary electromagnetic field is measured at a receiving coil as a voltage that is linearly related to the subsurface conductivity.

7.4.2 SGL of Shallow Casings

Characterization data provided by Last et al. (1994) indicate that contamination concentrations varied significantly across the ditch bottom. This led to the conclusion that a screening technique was needed to optimize the selection of borehole locations based on indications of radiological activity. Because the ditch sediment layer is buried, the screening technique would need to be intrusive. Therefore, a spectral gamma logging technique in shallow drill casings was identified as the second characterization activity for the 216-Z-11 Ditch.

The 216-Z-11 Ditch will be logged with a high-resolution SGL system to determine the distribution and relative concentrations of amercium-241, plutonium-239, and neptunium-237 (via its gamma-emitting daughter product, protactinium-233) along the length of the ditch and also vertically. The results will be used to locate the TRU hot spots for subsequent borehole soil sampling and laboratory analysis.

7.4.2.1 Spectral Gamma Logging Target Radionuclides. Based on the previous study of the 216-Z-11 Ditch (Last et al. 1994) in which sediment samples were analyzed, several radionuclides are expected to be present and act as indicators of contamination deposition in the bottom of the ditch.

Several isotopes of plutonium are expected, including plutonium-238, plutonium-239, and plutonium-240. Of those isotopes, only plutonium-239 is detectable in the down-hole regime by the emission of gamma rays during decay.

Previous SGL experience at the Hanford Site (Brodeur et al. 1993) demonstrated that plutonium-239 can be identified and assayed from the emission of 414 keV and 375 keV photons. Unfortunately, these photons are only emitted 0.0015 % and 0.0016% for every decay event. This creates a much higher minimum detection level (MDL) than for other gamma-emitting radionuclides. In previous work using an 18% efficiency detector and a counting time of 100 seconds, the MDL was approximately 25 nCi/g whereas a strong gamma-emitting radionuclide such as cesium-137 will have an MDL of approximately 0.1 pCi/g. However, the previous sampling at the 216-Z-11 Ditch indicates that plutonium-239 will be present at concentrations greater than several hundred nCi/g, so plutonium-239 can be used as an indicator of the presence of contamination and the objective of characterizing the higher contaminant concentrations is satisfied.

Other isotopes of plutonium may also be detected depending on the presence of other gamma-emitting radionuclides. If no other radionuclides are present, some of the low-intensity gamma-ray photons may be detected at a level that is above the Compton continuum background in the spectra.

Americium-241 is also expected to be present in the 216-Z-11 Ditch. Americium-241 is detected with gamma-ray spectroscopy in two ways. First, it can be directly detected from the emission of a photon at 335 keV. However, as with plutonium-239, the rate of emission of that photon is very low (0.001%), and americium-241 must be present in concentrations at several tens of nCi/g for reliable detection. Americium-241 concentrations from previous samples collected (Last et al. 1994) indicate that it will also be present at concentrations exceeding several tens of nCi/g indicating that it will be above the MDL, and it will be detectable using SGL methods.

An alternative method of americium-241 detection is the first daughter product, neptunium-237. This radionuclide is detected and assayed from several high-intensity gamma-ray photons emitted by its first daughter, protactinium-233. The presence of protactinium-233 is an indicator of the presence of neptunium-237 because protactinium-233 has a very short half-life, so the concentration of protactinium-233 is a direct reflection of the concentration of neptunium-237.

The difficulty in using neptunium-237 to indicate the presence of americium-241 is that neptunium-237 has a very long half-life, and both neptunium-237 and americium-241 were likely released into the ditch. Thus, not all neptunium-237 originated from the decay of americium-241. Additionally, if appreciable amounts of neptunium-237 were released with americium-241, the gamma-ray lines from neptunium-237 can elevate the Compton continuum background and obscure the gamma rays that originate directly from americium-241.

However, the intended objective of the characterization is to use gamma-ray detection to identify the TRU hot spots; therefore, it does not matter if it is either americium-241 or neptunium-237 that is detected; if either one is present, they will be detected. If americium-241 is present in the nCi/g range, it can be assayed directly along with neptunium-237 as it was at the 216-Z-18 Crib (Brodeur et al. 1993). Either way, the objectives of the characterization would be satisfied.

There is no indication made by Last et al. (1994) that an assay of neptunium-237 was attempted in the samples recovered in that study. However, neptunium-237 is present in several cribs that received effluent from Z Plant, and there is a high probability that it is present in the ditch, making neptunium-237 a primary target radionuclide for this characterization effort.

Other radionuclides that may be detected include the usual list of fission and activation products that are strong gamma emitters. This includes radionuclides such as cesium-137, antimony-125, cobalt-60, europium-152, and several others. The sampling performed by Last et al. (1994) did not identify the presence of any of these radionuclides; however, the possibility of the presence of these radionuclides at low concentrations cannot be ruled out, and the logging data acquisition and analysis must be designed to detect and assay these nuclides.

7.4.2.2 Drill Casings. Drill casings will be installed vertically at least 8 m (25 ft) into the 216-Z-11 Ditch in a series of transects perpendicular to the ditch axis. At least three casings are expected to be installed and logged per transect. Up to five transects are expected to be logged along the ditch at locations indicated by the surface geophysical surveys. A spectral gamma detector (high-purity germanium [HPGe]) will be lowered the full depth of the casings, retrieved, and moved to the next location, until all of the casings have been surveyed. The starting point for logging will be recorded, usually the ground surface or the top of the casing. Multiple installation steps and logging may be required to assess the potential for "drag-down" as the casing is driven into the soil. Additional geophysical logging associated with the soil sampling boreholes is discussed in Section 7.4.3.1.

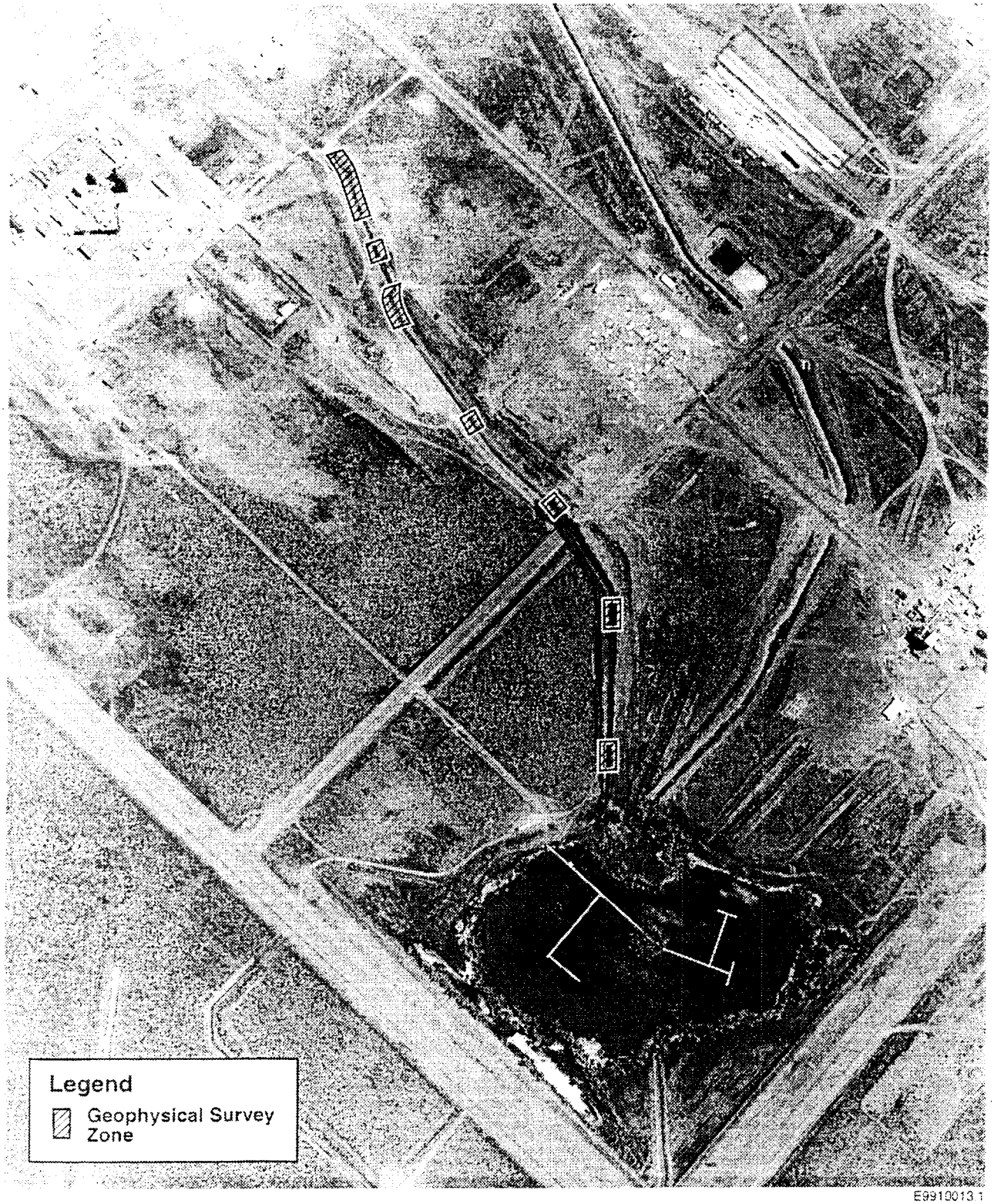
7.4.2.3 Logging at Depth. All casings will be initially installed to a depth of at least 8 m (25 ft) below the ditch bottom. After the results of the SGL have been evaluated, the casing with the highest and/or deepest concentrations of transuranic materials will be chosen for deeper SGL assays. The casing at that location will be installed to a depth of at least 15 m (50 ft) below the ditch bottom for additional gamma logging to determine if the mobility of neptunium-237 results in detectable concentrations at depth below the ditch. Geologic constraints (e.g., the presence of boulders) may limit the depth to which casing can be installed.

7.4.3 Borehole Sampling and Analysis

The third characterization step involves interpreting the spectral logging data, selecting the most highly contaminated locations, and installing boreholes for soil sampling. Soil samples will be collected via the use of a split-spoon-type sampler.

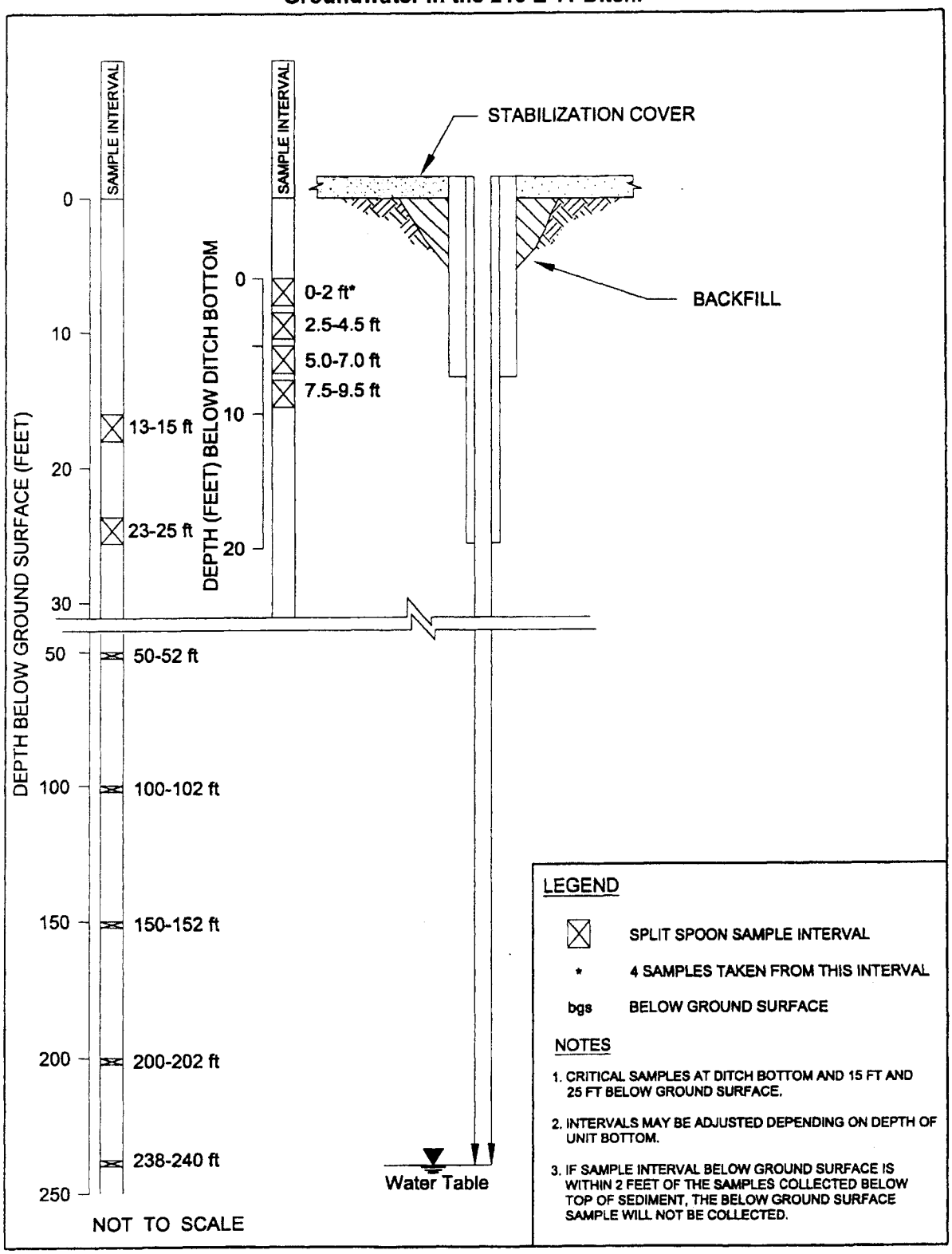
Up to four boreholes will be installed in the 216-Z-11 Ditch to collect soil samples for chemical, radiological, and physical properties analyses. The boreholes will be drilled at the locations that correspond to the TRU hot spots based on interpretation of the SGL data. Up to three shallow boreholes and one deep borehole will be used for soil sampling. The final sampling intervals may vary somewhat depending on the thickness of the strata observed in the split-spoon samples and field screening results. The intent of the sampling design is to begin sample collection at the ditch sediment layer. As the split-spoon samples are removed, the ditch sediment layer will be identified by use of field screening methods and geologic observations in the drill cuttings. Figure 7-2 illustrates the planned borehole sampling intervals.

Figure 7-1. Location of Planned Surface Geophysical Surveys at the 216-Z Ditches (216-Z-19 Ditch Shown as Open).



E9910013.1

Figure 7-2. Example Illustration of Borehole Sampling Intervals to Groundwater in the 216-Z-11 Ditch.



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Soil sampling will be initiated at the ditch sediment layer. It is a critical sample point because the highest transuranic material concentrations are expected at this horizon. Samples from 4.6 m (15 ft) below ground surface (bgs) and 8 m (25 ft) bgs are also considered critical sampling points for remedial alternative decision making. Sampling from depths greater than 8 m (25 ft) bgs will be used to verify the site conceptual model and to evaluate potential groundwater impacts. Drilling and sampling will stop when the water table is encountered.

Physical soil properties of interest are moisture content, grain-size distribution, and lithology. Samples will be analyzed in accordance with American Society for Testing and Materials methods, listed in Table A2-1 of the *1993 Annual Book of ASTM Standards* (ASTM 1993), if applicable. A minimum of three soil samples will be collected at the same time as the chemical and radiological split-spoon samples for analysis of physical properties.

7.4.3.1 Borehole Spectral Logging. As the four soil sampling boreholes are installed, they will be geophysically logged via the high-resolution SGL detector. The deep borehole will also be logged with a neutron moisture detector to obtain a vertical moisture profile. The SGL data will be used to expand the Z Ditches SGL database and may be evaluated for possible correlation with the soil analytical data. Multiple drilling and logging steps may be required to assess the potential for "drag-down" as the casing is driven into the soil.

The data obtained during from the borehole SGL monitoring may not be directly comparable with the shallow SGL assays because of potential differences in the casing diameter and thickness.

7.4.3.2 Logging in Existing Wells. Existing boreholes and groundwater wells sufficiently near the Z Ditches that are properly configured for SGL (i.e., single casing in contact with the formation) will also be logged with the spectral gamma detector to expand the Z Ditches SGL database. Table 7-4 identifies the existing wells that may be suitable for SGL.

7.4.4 Z Ditches Discharge Pipe Characterization

Particulates that may have settled in the bottom of the manhole access vaults could represent the worst-case contaminated media associated with the Z Ditches. Therefore, the manhole ports will be characterized to assess impacts on remedial decision making and for health and safety purposes.

The 216-Z-11 and 216-Z-19 Ditches received liquid effluents from the 231-Z Building via a vitrified clay discharge pipe. As shown in Figure 7-3, four manholes are located upstream of the 216-Z-11 Ditch along the length of this 45-cm (18-in.)-diameter discharge pipe. The 234-5Z and 291-Z Buildings' effluents were discharged to the 216-Z-11 Ditch via a 38-cm (15-in.)-diameter vitrified clay pipe. This pipeline has six manholes that are being considered for characterization. Figure 7-4 shows typical section views of the manholes in the Z Ditch pipelines.

The Z Ditches discharge piping will be visually inspection through the manhole access ports by remote video camera, followed by in situ spectral gamma measurements. Sodium iodide and/or HPGe detectors will be employed for this purpose.

Figure 7-3. Z Ditch Discharge Pipeline Area and Manhole Locations.

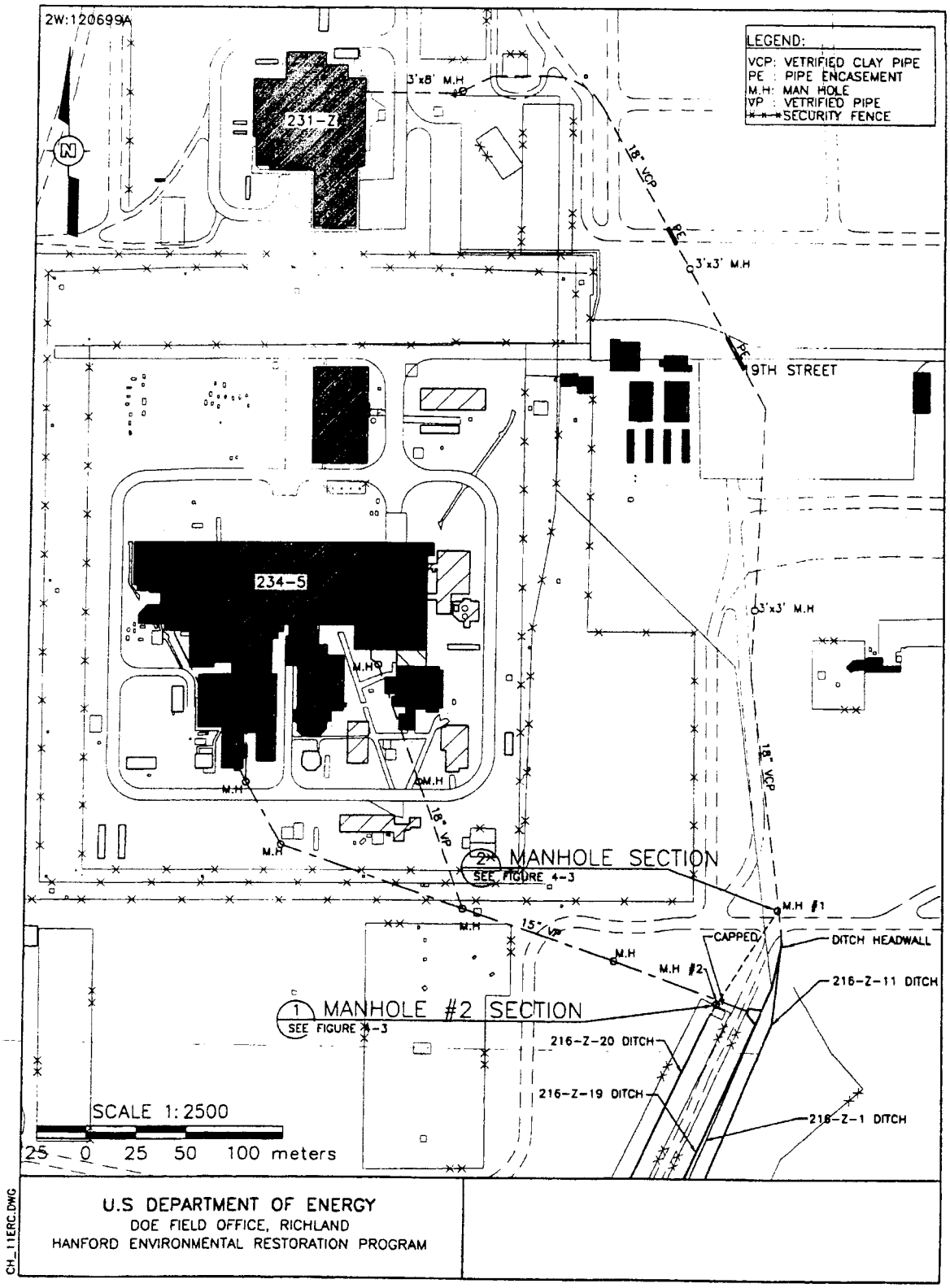
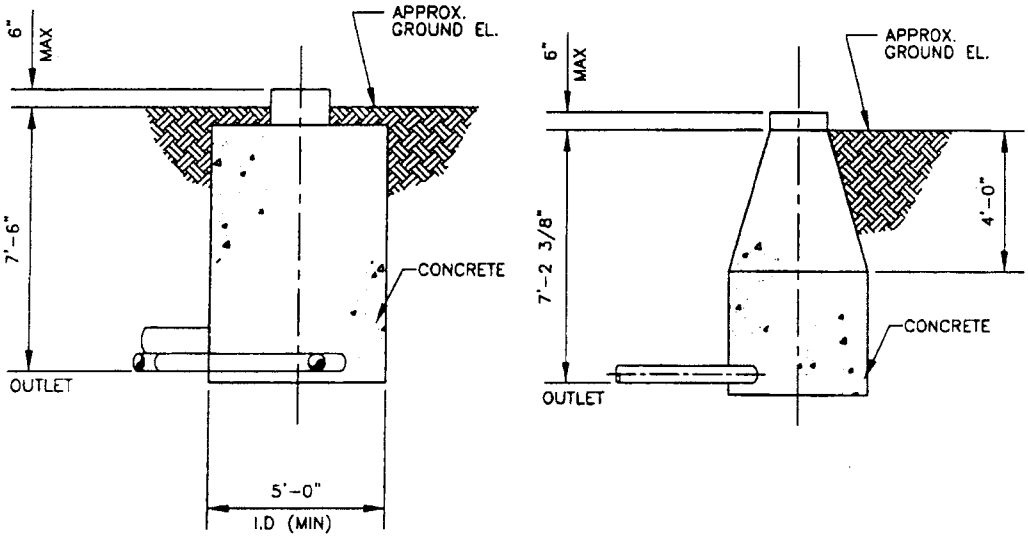


Figure 7-4. Typical Section Views of Manholes in Z Ditch Pipelines.

2W:120699B



1 MANHOLE#2 SECTION
FIGURE 4-2 SCALE NONE

2 TYPICAL MANHOLE
FIGURE 4-2 SCALE NONE

NOTES.

1. ALL DIMENSION SHOWN ARE REFERENCED IN FEET AND INCHES

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7.4.5 Summary of Sampling Activities

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

Table 7-4. Key Features of the Sampling Design for the 216-Z-11 Ditch. (3 pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Step 1 – Vadose Zone Characterization		
Surface geophysical surveys (GPR and EMI)	Perform GPR/EMI over the entire width of the Z Ditches as transects up to seven locations (as shown in Figure 7-1). If the geophysical surveys do not identify a continuous ditch, the shallow SGL casings will be installed where the surveys indicate the probable location of the 216-Z-11 Ditch bottom. If the geophysical surveys are nonconclusive, establish sampling locations based on best judgment using historical data, maps, and global positioning instruments.	Geophysics is expected to distinctly identify the 216-Z-11 Ditch relative to the other Z Ditches. It is the first step in a three-step vadose zone characterization, identifying the three parallel ditches in the "X-Y" plane and the depth below round surface. The results of the GPR will be evaluated to locate the shallow SGL casings.
Step 2 – Vadose Zone Characterization		
SGL of shallow casings	Install shallow casings to a depth of 8 m (25 ft) for the SGL detector. Nominally, three core barrels will be installed at each of five transects across the 216-Z-11 Ditch. Locations will be based upon interpretation of the geophysical results. The drill casings will initially be driven to a depth of 8 m (5 ft). At the location of the highest indicated contamination level, the casings will be driven to a depth of 15 m (50 ft) to determine if Pa-233 is present (it is more mobile than Am or Pu). The results of the SGL readings will be evaluated to identify the preferred locations and depths for physical sampling.	Spectral logging in shallow drill casings is expected to effectively locate the areas of high Am-241, Pu-239, and Pa-233 activity. Am and Pu are expected to coincide in the vertical strata due to similar chemical behavior and their decay-chain relationship. These are the target isotopes for gamma detection because of characteristic gamma emissions and the absence of interfering gamma isotopes.

Table 7-4. Key Features of the Sampling Design for the 216-Z-11 Ditch. (3 pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Step 3 Vadose Zone Characterization		
Borehole sampling	***Sampling from Surface to 8 m (25 ft) bgs***	
	Three shallow boreholes (8-m [25-ft] depth) bgs, and one deep borehole (to groundwater) will be installed based on the highest and/or deepest readings from the SGL data. Collect samples at 15-cm (6-in.) intervals within the first 0.6 m (2 ft) of the ditch sediment layer. Collect samples at 0.6-m (2-ft) intervals at 0.8-, 1.5-, and 2.3-m (2.5-, 5-, and 7.5-ft) depths below the ditch bottom, and then at the 4- to 4.6-m (13- to 15-ft) and 7- to 8-m (23- to 25-ft) depth bgs. Critical sampling depths are the first 0.6 m (2 ft) of the ditch, 4 to 4.6 m (13 to 15 ft) bgs and 7 to 8 m (23 to 25 ft) bgs.	Soil samples are required to determine the TRU concentrations in the ditch sediment layer and in the underlying soils. Sampling to 8 m (25 ft) bgs provides COC data at depths significant to remedial action decision making and to confirm the preliminary conceptual vertical contaminant distribution model. Soil physical properties (moisture content, grain size distribution and lithology) will also be evaluated to support modeling.
	Sampling from 8 m (25 ft) bgs to Groundwater	
	One deep borehole will be installed to groundwater. At a depth of 8 m (25 ft) bgs, the core barrel size will be reduced to prevent drag-down of contaminants into the deeper vadose zone. Collect samples at 15-m (50-ft) intervals from 15 m (50 ft) bgs to groundwater (8 m , 31 m, 46 m, 61 m, and 73 m [50 ft, 100 ft, 150 ft, 200 ft, and 238 ft] bgs).	Soil samples are required in the deeper vadose zone (to groundwater) to confirm the preliminary conceptual vertical contaminant distribution model. Soil physical properties (moisture content, grain size distribution and lithology) will also be evaluated to support modeling.
	Borehole Spectral Logging	
	Perform borehole spectral logging in up to four boreholes installed for soil sampling. Perform neutron moisture monitoring in only the deep borehole.	SGL logging will be performed in boreholes to expand the SGL database and to compare the SGL data with the sample analytical results.
	Perform borehole spectral logging and neutron moisture detection in accessible boreholes and groundwater wells near the Z Ditches. Bechtel Hanford, Inc. well status records indicate that the following wells are accessible: • 299-W18-15 • 299-W18-17.	This data will be collected to expand the Z Ditches SGL database.

Table 7-4. Key Features of the Sampling Design for the 216-Z-11 Ditch. (3 pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Discharge Pipeline Characterization		
Z Ditch discharge pipe characterization	Open the manhole access in the 46-cm (18-in.)-diameter clay vitrified Z Ditch discharge pipe from the 231-Z Plant (Hanford drawing H-2-10011) for remote video inspection and spectral gamma assay using NaI and/or HPGe detectors.	The manhole ports will be characterized to assess impacts on remedial decision-making and for health and safety purposes.
	Open up to three manhole access ports in the 38-cm (15-in.)-diameter clay vitrified Z Ditch discharge pipe from the 234-5Z/291-Z Plants (Hanford drawing H-2-32528) for remote video inspection and spectral gamma assay using NaI and/or HPGe detectors.	

bgs = below ground surface
COC = contaminant of concern
EMI = electromagnetic induction
GPR = ground penetrating radar
HPGe = high purity germanium detector
NaI = sodium iodide detector
SGL = spectral gamma logging

7.5 POTENTIAL SAMPLE DESIGN LIMITATIONS

The sample design developed in this DQO process has several potential limitations that may affect the sampling results. Some of the factors that have the potential to affect the outcome of this sampling effort are identified in the following bullets:

- The geophysical survey locations were based on the assumption that the transuranic COCs would preferentially be deposited where the wastewater velocities decreased. It is possible that transuranic deposition was influenced by other factors. The historical data for the 216-Z Ditches show significant spatial variability in both axial and longitudinal orientations in the ditch bottoms, with measured concentrations varying by several orders of magnitude over minor distances. Last et al. (1994) reported that the transuranics may have preferentially collected on mats of decayed organic plant matter, which would be impossible to locate under a blanket of stabilizing fill.

- The effectiveness of the geophysical survey techniques in identifying the 216-Z-11 Ditch bottom under the stabilizing fill soil has not been determined. Certain factors could degrade the survey results sufficiently to preclude positive identification of the subsurface ditch profile.

- The use of the shallow drill casings for logging with spectral gamma detectors is a proven technology, but the weak gamma emissions from the target isotopes may not yield the expected results if the drill casings are not placed in close proximity to the contaminated ditch sediment layer.

- The sampling design is based on the use of multiple interdependent technologies to locate and characterize the 216-Z-11 Ditch. The overall success of this sampling effort depends on effective utilization of the individual technologies.

- Drilling impediments (e.g., boulders) may be encountered and/or insufficient sample volumes may be retrieved from the split-spoon samplers.

- The sample design is based on a limited number of samples that could limit the ability to identify TRU hot spot locations.

- The discharge pipeline manholes may not be accessible for in situ measurements, or safety/radiological concerns may prohibit access.

- Because the soil samples retrieved from the ditch sediment layer are expected to contain significant concentrations of radiological COCs, it is likely that the samples will be analyzed in an onsite laboratory. In this case, expected impacts include high analytical costs, degradation of detection limits, reduced analyte lists, and long turnaround times.

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