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Rev. 0

200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report



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

Submitted by: Bechtel Hanford, Inc.

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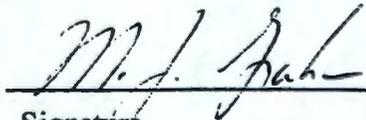
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200-CS-1 Chemical Sewer Operable Unit DQO Process Summary Report

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Date Published

August 1999

EXECUTIVE SUMMARY

This data quality objective (DQO) summary report supports initial site characterization decisions for remedial investigation (RI) and remedial action decisions for four treatment, storage, and disposal (TSD) units and three additional waste sites in the 200-CS-1 Chemical Sewer Operable Unit (OU). These seven sites are man-made ponds, ditches, or trenches created to receive chemical wastewater from the separation/concentration processes (e.g., Plutonium-Uranium Extraction Plant, Reduction-Oxidation Facility, and B Plant operations). The waste sites within this OU were designed as liquid effluent disposal units for nonradioactive operations; however, all of the waste sites in this OU were contaminated with low levels of radionuclides.

This DQO effort followed the concepts developed in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (hereinafter referred to as the 200 Area Implementation Plan) (DOE-RL 1998) for the use of analogous site contaminant data to reduce the amount of characterization required to support remedial action decisions. The 200 Area 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 similar chemical characteristics to the sites that are characterized. For the 200-CS-1 Chemical Sewer OU, two of the TSD units (216-A-29 ditch and the 216-S-10 ditch) are representative sites and will be characterized. Compliance with the

200 Area Implementation Plan also requires the characterization of the 216-B-63 trench and 216-S-10 pond TSD units. The goals of the RI are to provide the data needed to refine the preliminary conceptual contaminant distribution models for the OU and to support remediation decisions.

The proposed sampling locations were selected with the goal of intersecting the highest areas of contamination and determining the vertical and lateral extent of contamination at the waste site boundaries. The nature (e.g., contaminant type and concentration) and the vertical/lateral extent of the contamination are the major RI data needs.

Boreholes will be developed to sample the vadose zone to groundwater; however, no groundwater samples are proposed. Trenches, test pits, and/or auger holes will be developed to sample from the surface to about 7.6 m below the local ground surface elevation.

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 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

ARAR	applicable or relevant and appropriate requirement
CERCLA	<i>Comprehensive Environmental Response, Compensation and Liability Act of 1980</i>
CMP	corrugated metal pipe
COC	contaminant of concern.
COPC	contaminant of potential concern
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HRA-EIS	<i>Hanford Remedial Action Environmental Impact Statement</i>
OU	operable unit
PRG	preliminary remediation goal
PSQ	principal study question
PUREX	Plutonium-Uranium Extraction Plant
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
REDOX	Reduction-Oxidation Facility
RI	remedial investigation
ROD	Record of Decision
SAP	sampling and analysis plan
TSD	treatment, storage, and disposal

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METRIC CONVERSION CHART

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

Into Metric Units			Out of Metric Units		
<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>	<i>If You Know</i>	<i>Multiply By</i>	<i>To Get</i>
Length			Length		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			Area		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			Mass (weight)		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			Volume		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			Radioactivity		
picocuries	37	millibecquerel	millibecquerel	0.027	picocuries

1.0 STEP 1 -- STATE THE PROBLEM

1.1 INTRODUCTION

This data quality objective (DQO) process is to support remedial investigation (RI) initial characterization and remedial action decision making for the 200-CS-1 Chemical Sewer Operable Unit (OU) sites in the Hanford Site's 200 Areas. The DQO process used for this project is a U.S. Environmental Protection Agency (EPA) approach to planning and coordinating environmental data acquisition requirements and decision making.

To accomplish the goals of the DQO, the four treatment, storage, and disposal (TSD) sites in the 200-CS-1 OU will be investigated to determine the nature and extent of contamination in the vadose zone. Under the *Resource Conservation and Recovery Act of 1976* (RCRA), all TSD sites must be characterized. Two of the 200-CS-1 TSD sites (216-A-29 ditch [worst-case] and 216-S-10 ditch [typical case]) are representative of the chemical sewer OU. Specifically, determinations of the type, concentration, and vertical and lateral extent of radiological and chemical contaminants in the vadose zone are the major data needs. This DQO workbook identifies the initial characterization requirements that will support the development of a sampling and analysis plan (SAP).

1.2 PROJECT OBJECTIVES

The primary objective of the DQO process for the 200-CS-1 Chemical Sewer OU is to determine the environmental measurements necessary to support remedial decision making (i.e., remedial investigation) and to confirm the site conceptual contaminant distribution model. Possible remedial alternatives under consideration include the following:

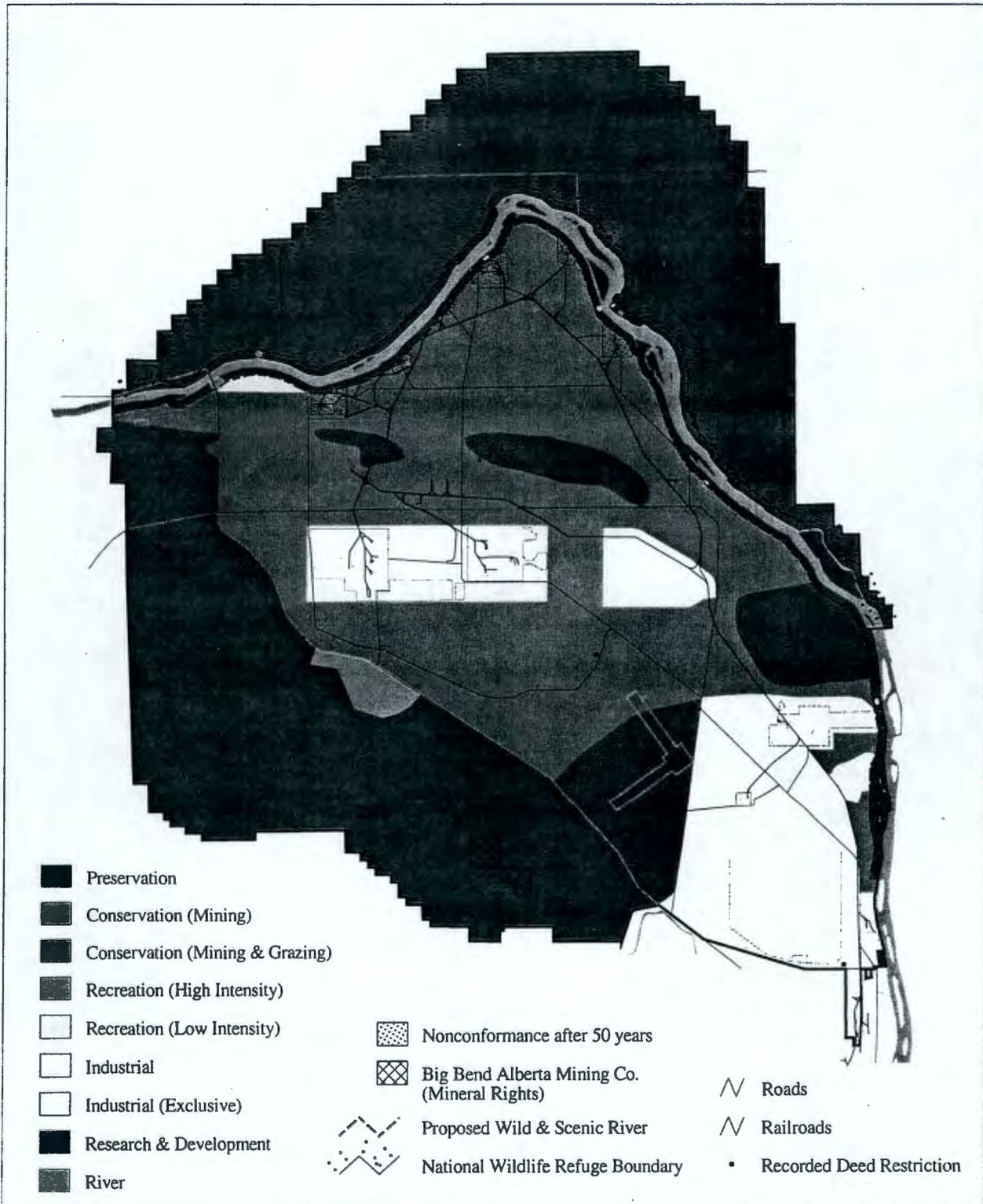
- No-action alternative (no institutional controls)
- Capping
- Excavate and dispose of waste
- In situ vitrification
- In situ grouting and stabilization
- Monitored natural attenuation (with institutional controls).

1.3 BACKGROUND

This DQO uses boundaries and land-use alternatives that are a "snapshot in time," taken from the *Revised Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan* (DOE 1999), as shown in Figure 1-1. Other land-use alternatives have been developed for the 200 Areas in a composite analysis (PNNL 1998). The land-use alternatives in the composite analysis were not used in this DQO workbook.

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**Figure 1-1. Preferred Alternative Plan from the Revised Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan.
 (adapted from DOE 1999)**



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The sites within the scope of this DQO process will be assessed and remediated in an integrated RCRA/*Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) approach. There are seven waste sites within the 200-CS-1 group. Of these sites, the 216-A-29 and 216-S-10D ditches were selected as representative (typical and worst-case) sites in the 200 Areas waste site grouping report (DOE-RL 1997). The characterization performed in the representative sites will apply to other sites within the group. The 216-S-10P pond and the 216-B-63 trench are also RCRA TSD units. The 216-S-10P, 216-S-11, and 216-W-LWC sites will not be characterized. Data collected from the representative sites (216-A-29 and 216-S10D) will be used for these three waste sites to establish their remediation needs.

Figures 1-2, 1-3, 1-4, 1-5, and 1-6 depict the layout of the 200 Areas waste sites and the source facilities addressed by this DQO workbook. Figure 1-2 is a vicinity map that shows the location of the wastes sites in the 200-CS-1 OU in respect to the general Hanford Site. Figures 1-3, 1-4, and 1-5 show the locations of the 216-A-29 ditch, the 216-B-63 trench, and the 216-S-10 ditch and pond, respectively.

Pipelines conveyed wastewater to the chemical sewer OU ponds and ditches from the Plutonium-Uranium Extraction Plant (PUREX), B Plant, and the Reduction-Oxidation Facility (REDOX). The wastewater streams for the TSD units and representative sites are discussed in Section 1.4.

1.4 OPERATING HISTORY

The 216-A-29 ditch became operational in 1945 with the startup of the 284-E Powerhouse and water treatment system. An open unlined ditch ran east across 200 East Area, then entered an underground pipeline and discharged to a land depression east of the 200 East Area boundary. In February 1955, the powerhouse wastewater was routed to the 216-B-3-1 ditch. From November 1955 to December 1957, the head end of 216-A-29 received PUREX chemical sewer and cooling water (raw Columbia River water) from separate pipelines. In December 1957, the cooling water was routed to Gable Mountain and B Ponds. There is no process knowledge that breaks down the percentage contribution from the various waste streams. The amount of wastewater discharged to the 216-A-29 ditch is difficult to estimate because the flows from the ditches leading to B Pond were not differentiated. The 216-A-29 ditch was backfilled and surface stabilized in 1991.

The 216-B-63 trench began receiving effluent from the B Plant chemical sewer in May 1970. The major source of waste contributions to the 216-B-63 trench were the 2902-B high tank (potable sanitary water), cooling water from B Plant and the Waste Encapsulation and Storage Facility air compressor aftercoolers, some of the 221-B steam condensate, and the demineralizer effluent. Minor contributions came from chemical makeup overflow systems (sodium hydroxide and sodium nitrite), air-conditioning units, and space heaters. In August 1970, the 216-B-63 trench was

Figure 1-2. Location of the Hanford Site and Waste Sites in the 200-CS-1 Operable Unit.

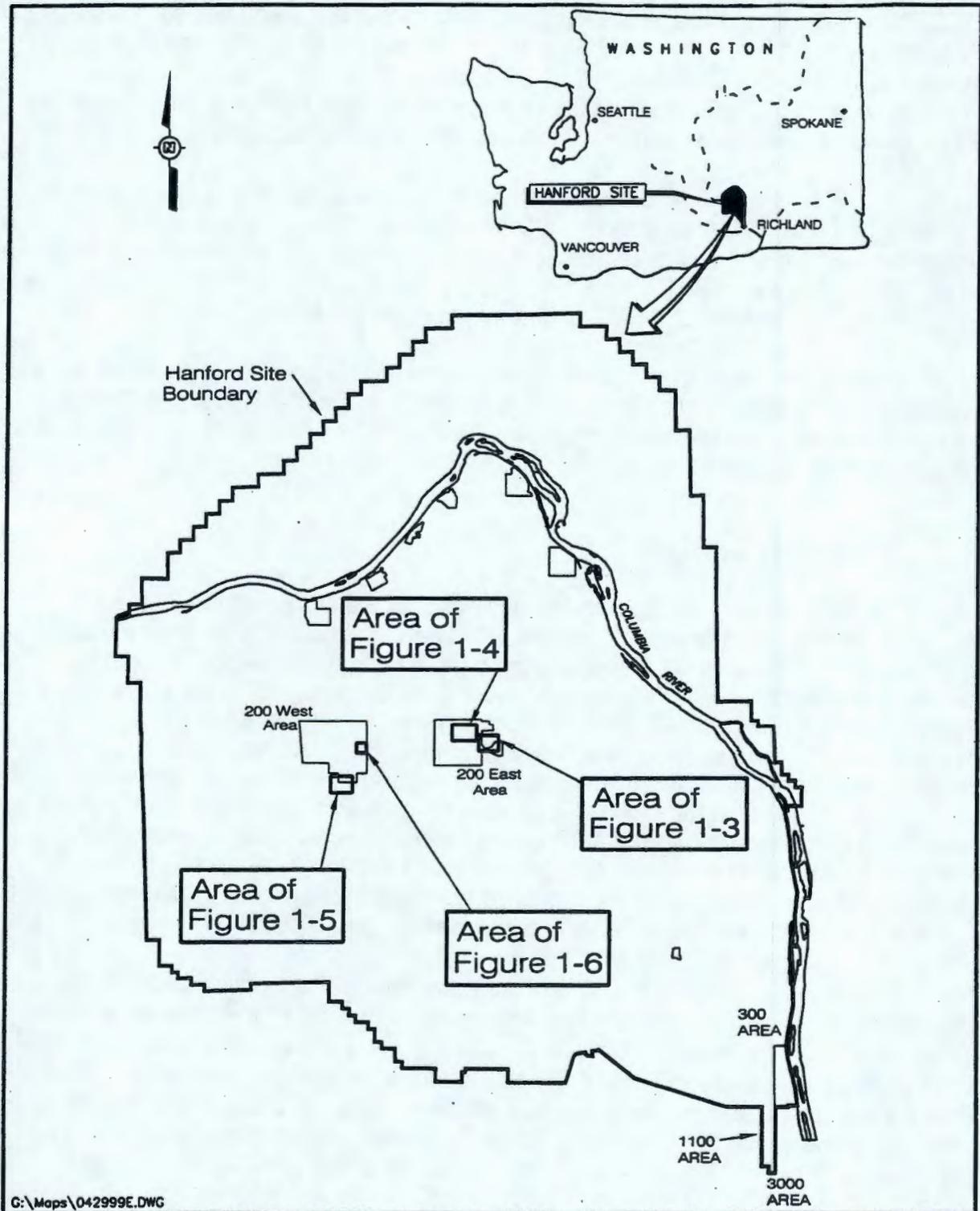


Figure 1-3. Location of the 216-A-29 Ditch.

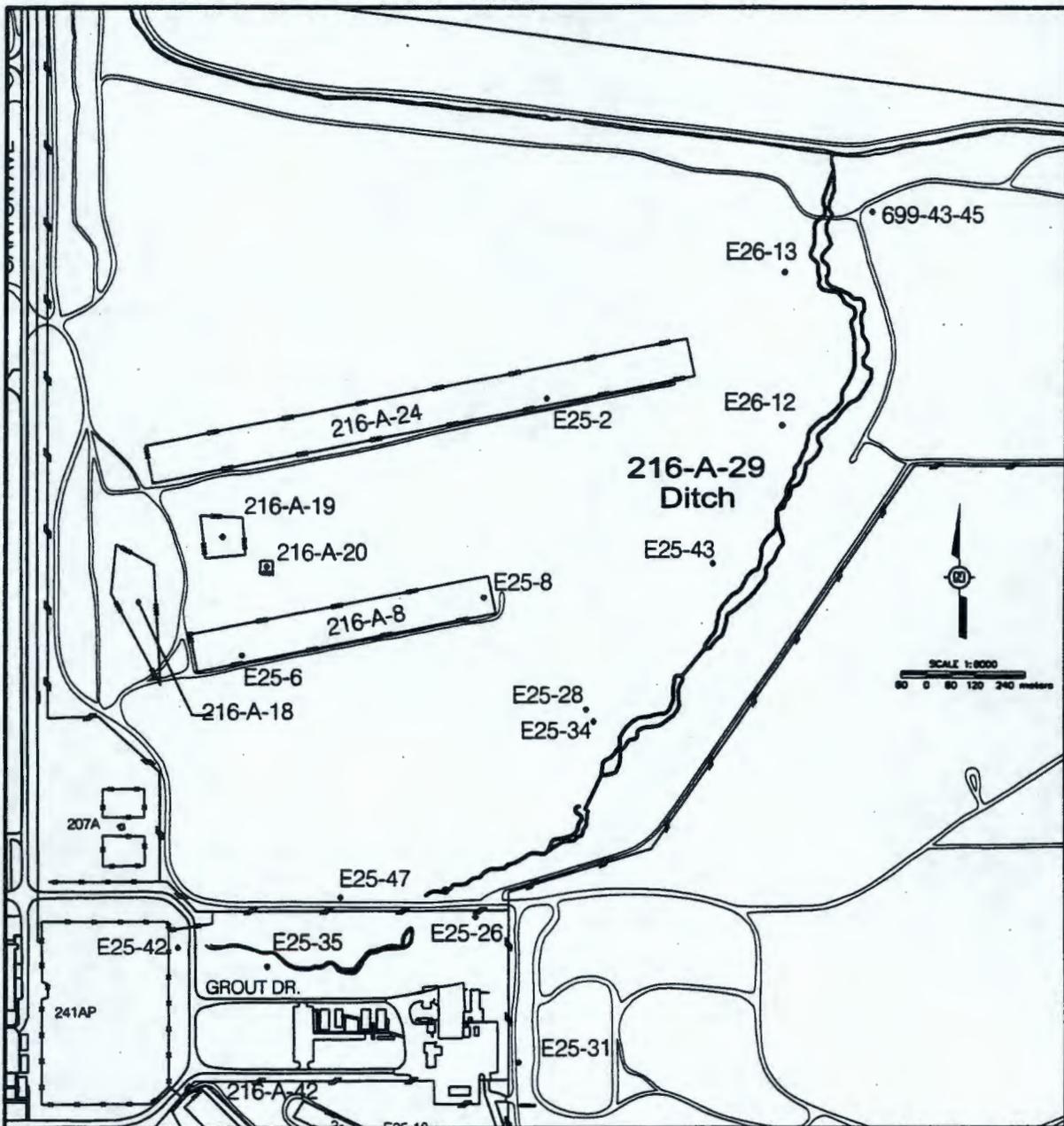
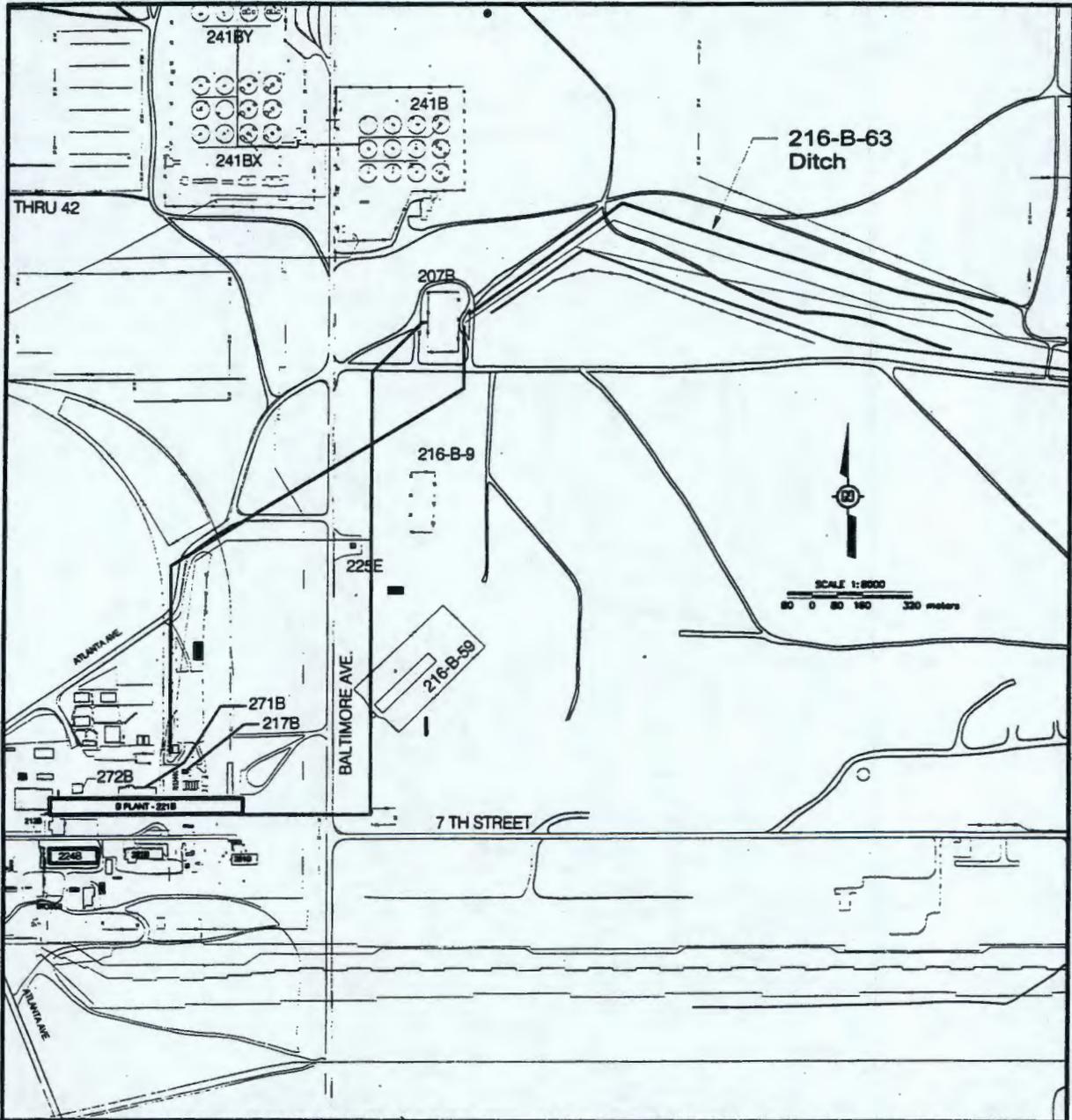
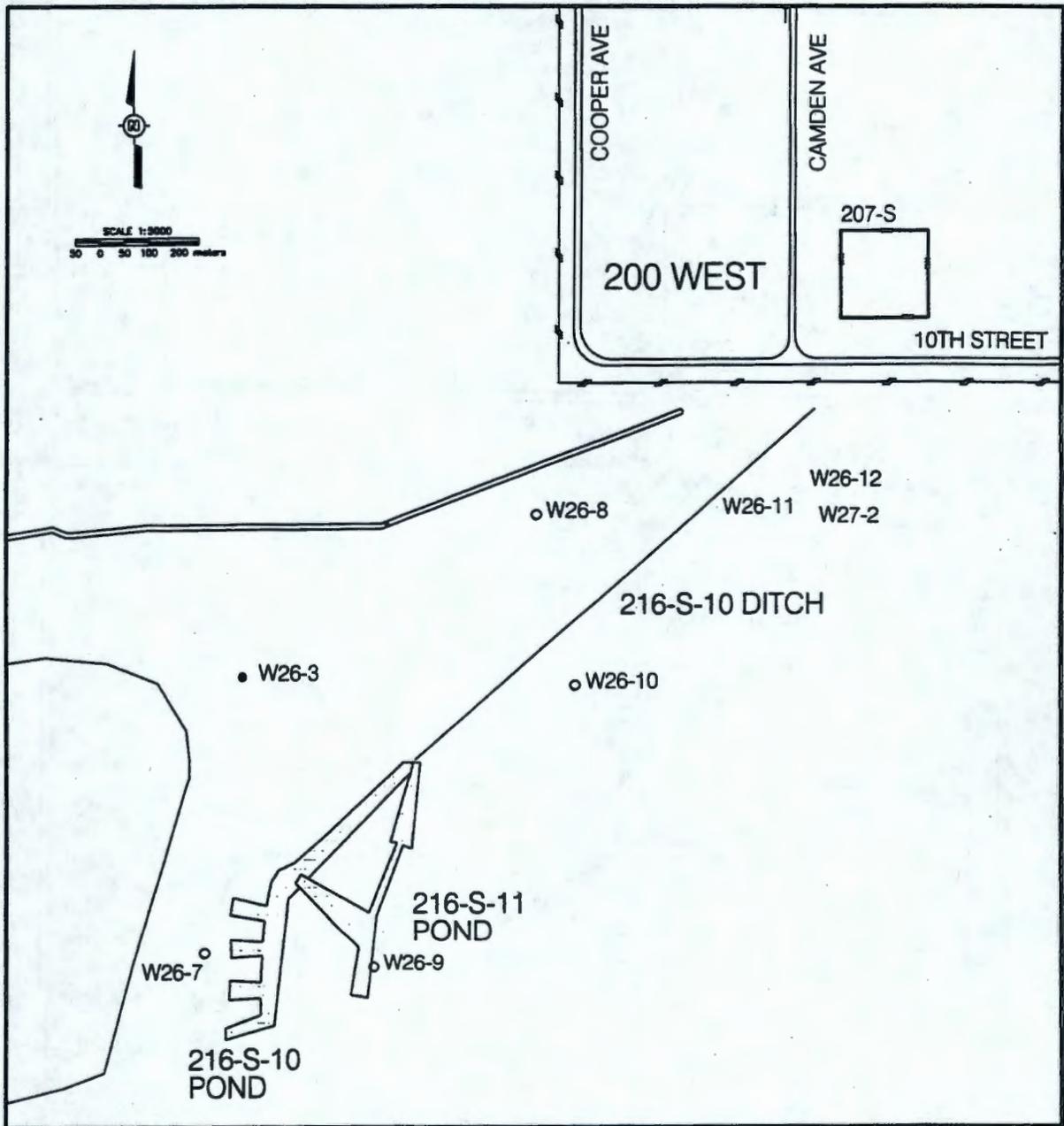


Figure 1-4. Location of the 216-B-63 Trench.



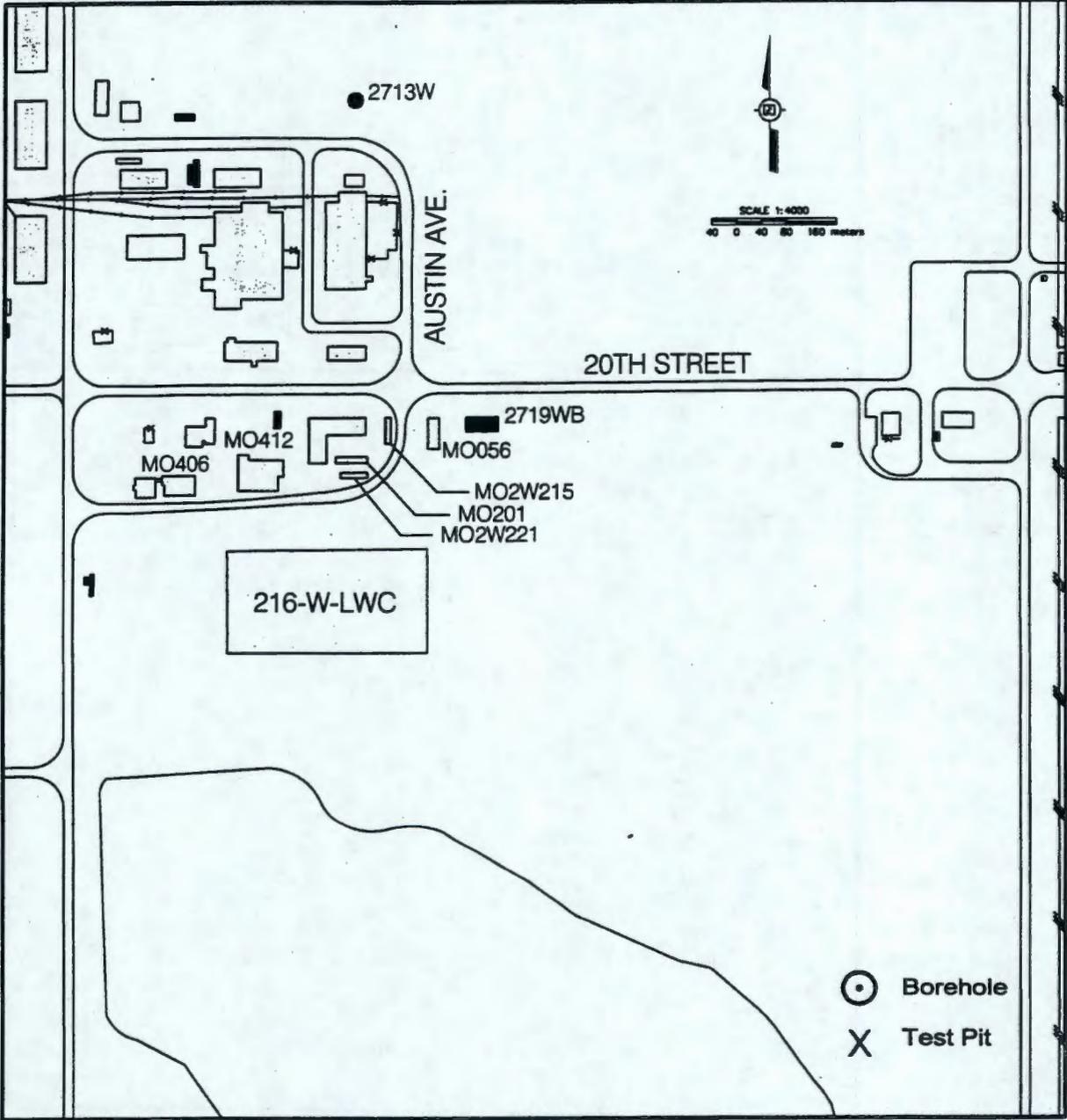
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Figure 1-5. Locations of 216-S-10 Ditch and Pond.



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Figure 1-6. Location of 216-W-LWC.



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dredged (after UPR-200-E-138). The dredgings (reading about 3,000 counts per minute beta/gamma activity) were buried in the 218-E-12B burial ground. The only documented hazardous effluent discharged in the past consisted of regeneration solutions from the B Plant demineralizers. These effluents were routine corrosive discharges (D002) of aqueous sulfuric acid and sodium hydroxide solutions. The corrosive discharges occurred from 1970 until October 1985. After 1985, the cation column effluent was treated with sodium carbonate, and the anion column effluent was treated with monosodium phosphate to maintain a combined pH between 4 and 10. As of 1987, the waste discharged to 216-B-63 trench was no longer considered to be dangerous waste. Radiological discharges to the trench were relatively low, with an estimated total beta discharge of 8.7 Ci and approximately 7.6 kg of uranium. The chemical sewer pipelines to the 216-B-63 trench were recognized as leaking (primarily within 200 ft of B Plant) from 1970 until a sewer upgrade was completed in 1985. No other influent pipelines associated with the chemical sewer OU were reported to leak as extensively as the 216-B-63 pipeline. A major portion of the vitrified clay pipeline on the north side of 221/271-B Building was relined with reinforced thermosetting resin pipe. In 1992, discharge to the trench ceased, and the trench was backfilled with clean fill by November 1994. A total of 7.2 billion liters of effluent were discharged to the 216-B-63 trench.

The 216-S-10D ditch received discharge from the REDOX complex. The site started operation in August 1951. This ditch was part of a system that includes the 216-S-10P pond and the 216-S-11 pond. In addition to these three sites, during May 1955 there was a 0.405-hectare (i.e., approximately one-acre) overflow from the ditch that released an estimated 215 kg of uranium from the ditch in the southeast dike of the 216-S-11 pond. This unplanned release is referenced as UPR-200-W-34. After the unplanned release, the ditch was dredged and the sludge was removed and placed in low spots on both sides of the ditch. The ditch was then covered with 2 ft of soil.

The 216-S-10 ditch and pond both routinely received large quantities of nondangerous, low-level radioactive liquid effluent from the 202-S REDOX Plant chemical sewer and the Chemical Engineering Laboratory. The waste stream was comprised of cooling water, steam condensate, water tower overflow, and drain effluent. The effluent to the chemical sewer was comprised of approximately 60% REDOX raw wastewater, 20% sanitary water, and 20% steam condensate. The 216-S-10 ditch and pond remained in use until 1984, when the south two-thirds of the ditch and the entire pond were backfilled and stabilized. The 216-S-10D ditch last received discharges during 1991 and was permanently isolated June 1994.

The volume of water discharged to the chemical sewer OU sites exceeded 20 billion liters. Consequently, the vadose zone under some of these waste sites became saturated during the years of operation. After the water discharges ceased and the surfaces of the waste sites were stabilized with clean soil and gravels, portions of the vadose zone remained at or near saturation for an extended period of time. Although the groundwater mounds are declining, recharge from some of these facilities to the groundwater may still be occurring.

1.5 WORKSHEETS FOR DQO STEP 1

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 develops the checklist and DQO binder prior to the internal seven-step process. The DQO workshop team members participate in the seven-step process, and the key decision makers provide the external review of the results from the seven-step process.

Table 1-1. DQO Scoping Team Members.

Name	Organization	Area of Expertise (Role)	Phone Number
Roy Bauer	CHI Environmental Science	200-CW-1 Lessons Learned	372-9622
Steve DeMers	TMA Radiological Engineering	Radiological Engineering	531-0729
Karl Fecht	BHI Engineering Technologies	Geological	372-9356
Janet Badden	CHI Regulatory Support	CHI Task Lead/Regulatory Support	372-9698
Tony Knepp	Groundwater and Vadose Zone Integration	BHI 200 Area Assessment Task Lead	372-9189
Bruce Ford	ERC Integration	BHI Environmental Lead	372-9176
Roger Ovink	CHI Environmental Science	DQO Facilitator/DQO Report	372-9631
Randy Jackson	BHI Field Engineering	ERDF Waste Management	373-5473
Jim Sharpe	CHI Environmental Science	Cultural/Historical Resources	372-9369
Steve Weiss	CHI Environmental Science	Biological Resources	372-9576
Steve Clark	CHI Environmental Science	Regulatory Quantitative Limits	372-9613
Ray Swenson	BHI Legal/Risk Management	Legal	372-9205
Wendy Thompson	BHI Engineering Technologies	Sampling and Data Management	376-8031
Michael Galgoul	CHI Sample and Data Management	Sampling and Data Management	372-9617
Rich Weiss	CHI Sample and Data Management	Radiochemical and Analytical	373-5673
Dave Weekes	CHI Environmental Sciences	Scoping Document Lead	375-3444
Curt Wittreich	CHI Environmental Engineering	CHI Project Management	372-9586

Table 1-2. DQO Workshop Team Members.

Name	Organization	Area of Expertise (Role)	Phone Number
Dave Weekes	CHI Geologist	Site Background	375-3444
Janet Badden	CHI Regulatory Support	CHI Task Lead	372-9698
Tony Knepp	Groundwater and Vadose Zone Integration	BHI 200 Area Assessment Task Lead	372-9189
Roger Ovink	CHI Environmental Science	DQO Facilitator/DQO Report	372-9631
Curt Wittreich	CHI Environmental Engineering	CHI Project Management	372-9586

Table 1-3. DQO Key Decision Makers.

Name	Organization	Area of Expertise (Role)	Phone Number
Bryan Foley	U.S. DOE	RL Representative	376-7087
Tom Post	U.S. EPA	EPA Representative	376-6623
Jack W. Donnelly	Washington State Department of Ecology ^a	Ecology Representative	736-3013

^a Regulatory lead.

All existing documents and data for the sites under investigation were used to support the development of the conceptual site model and to aid the decision-making process. The key sources of existing documents and data collected from previous investigations reviewed by the DQO Team are presented in Table 1-4.

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

Reference	Summary
<i>Waste Site Grouping for 200 Areas Soil Investigations</i> , DOE/RL-96-81 (DOE-RL 1997)	Summarizes the site name, location, type status, site and process descriptions, known and suspected contamination, preliminary conceptual contaminant distribution model (Section 4.13 and Figure 4-15), site conditions that may affect contaminant of concern (COC) fate and transport, COC mobility in Hanford Site soils, COC distribution and transport to groundwater, and hazards associated with COCs.
Waste Information Data System (WIDS) database reports: 216-A-29, 216-B-63, 216-S-10D, 216-S-10P, 216-S-11, 216-W-LWC, and UPR-200-W-34	Summarizes the 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).
<i>200 Areas Waste Sites Handbook</i> , Vol. III, RHO-CD-673 (RHO 1979a)	Waste site descriptions, releases, waste discharge information, and management reports.

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

Reference	Summary
<i>B Plant Source Aggregate Area Management Study Report</i> , DOE/RL-92-05 (DOE-RL 1993b)	Waste unit descriptions; maps with locations of waste units; preliminary conceptual site exposure model; summary of waste-producing processes in B 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, septs, transfer lines and associated equipment, retention basins, and liquid effluent retention facilities); and site hazard rankings. Process history of B Plant aggregate area, waste management operations history, chemical waste inventory estimates, and history of unplanned releases.
<i>B Plant Aggregate Area Management Study Technical Baseline Report</i> , BHI-00179, Rev. 00 (BHI 1995a)	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.
<i>PUREX Plant Aggregate Area Management Study Technical Baseline Report</i> , BHI-00178, Rev. 00 (BHI 1995b)	Descriptions of waste units and site locations.
<i>PUREX Source Aggregate Area Management Study Report</i> , DOE/RL-92-04 (DOE-RL 1993c)	Waste unit descriptions; maps with locations of waste units; preliminary conceptual site exposure model; summary of waste-producing processes in Plutonium-Uranium Extraction Plant (PUREX) 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, septs, transfer lines and associated equipment, retention basins, and liquid effluent retention facilities); and site hazard rankings. Process history of PUREX aggregate area, waste management operations history, chemical waste inventory estimates, and history of unplanned releases.
<i>S Plant Aggregate Area Management Study Report</i> , DOE/RL-91-60 (DOE-RL 1992b)	Waste unit descriptions; maps with locations of waste units; preliminary conceptual site exposure model; summary of waste-producing processes in S 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, septs, transfer lines and associated equipment, retention basins, and liquid effluent retention facilities); and site hazard rankings. Process history of S Plant aggregate area, waste management operations history, chemical waste inventory estimates, and history of unplanned releases.
<i>S Plant Aggregate Area Management Study Technical Baseline Report</i> , BHI-00176, Rev. 00 (BHI 1995c)	Descriptions of waste units and site locations.
<i>200 Areas Remedial Investigation/Feasibility Study Implementation Plan-Environmental Restoration Program</i> , DOE/RL-98-28, Rev. 0 (DOE-RL 1999)	Waste sites in the 200 Areas; outlines framework for implementing assessment activities and consolidates background information. Describes 23 process-based waste site operable units.
<i>Hanford Site Atlas</i> , BHI-01119, Rev. 1 (BHI 1998b)	Provides Hanford Site maps.
<i>200-BP-11 Operable Unit RFI/CMS and 216-B-3 Main Pond, 216-B-63 Trench, and 216-A-29 Ditch Work/Closure Plan</i> , DOE/RL-93-74, Draft B (DOE-RL 1995)	Contaminant of concern determinations for 200-BP-11.

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

Reference	Summary
<i>Composite Analysis for Low Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800 (PNNL 1998)</i>	Identification of 200 Areas land-use alternatives.
<i>Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan (HRA-EIS), DOE/EIS-0222D (DOE 1996)</i>	Identification of 200 Areas land-use alternatives and the Preferred Alternative plan map of the Hanford Site.

The information provided in Table 1-5 represents the complete unconstrained set of contaminants of potential concern (COPCs) that were, or could have been, discharged to the 200-CS-1 Chemical Sewer OU sites. This master COPC list is then evaluated against a set of exclusion rationale to develop a final list of project contaminants of concern (COCs). The COPC exclusion rationale and excluded analytes are presented in Table 1-6. The final COCs are shown in Table 1-7. The COPCs/COCs were categorized in these tables in the same manner as in the source documents. The waste streams that contaminated these sites were primarily inorganic chemical wastewaters from various 200 Areas processes. Wastewater from some of the sources also contained minor uranium and organic chemical components.

The master COPC list in Table 1-5 was evaluated against a set of exclusion rationale to develop a final list of COPCs. The COPC exclusion rationale is generally discussed in this text, with specific applications shown in Table 1-6. The COPCs excluded in Table 1-6 are eliminated from further consideration.

Based on a review of the potential waste constituent lists in PUREX and B Plant, the chemical behaviors of the constituents were evaluated. Process knowledge indicates that the aqueous discharges to the chemical sewer OU waste sites were predominantly inorganic chemical releases with a minor uranium and organic chemical component. The majority of the releases to the chemical sewer OU trench, pond, and ditches were greatly diluted and dispersed by large volumes of water. The chemical reactions expected in this environment include acid neutralization, stabilization of reactive compounds, and volatilization of organic compounds.

The first step in the evaluation process was to extract known toxic materials from the master list for placement on the final COPC list. Materials that are inert or that have low toxicity in the process stream were excluded from further consideration because they would not pose a health or environmental risk. For example, several rare earth compounds were employed. These compounds are very costly, were never used in large quantities, and would not be expected to significantly affect human health or the environment in the quantities that were used.

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (9 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
<p>Chemical sewer and cooling water discharges from B Plant, PUREX, S Plant, 242-A evaporator, 244-AR vault, 283-E Water Treatment Plant, and 284-E Powerhouse</p>	<p>Mixed fission products, activation products, transuranics, and process solvents</p>	<p>RADIOACTIVE CONSTITUENTS Actinium-225 Actinium-227 Aluminum-28 Americium-241 Americium-242 Americium-242m Americium-243 Antimony-122 Antimony-124 Antimony-125 Antimony-126 Antimony-126m Astatine-217 Barium-133 Barium-135m Barium-137 Barium-137m Barium-140 Beryllium-7 Beryllium-10 Bismuth-210 Bismuth-211 Bismuth-213 Bismuth-214 Cadmium-109 Calcium-45 Carbon-14 Cerium-141 Cerium-144 Cesium-134 Cesium-135 Cesium-137 Chlorine-36 Chromium-51 Cobalt-57 Cobalt-58 Cobalt-60 Curium-242 Curium-243 Curium-244 Curium-245 Einsteinium-254 Europium-152 Europium-154 Europium-155 Francium-221 Francium-223 Gadolinium-153 Germanium-68 Gross alpha</p>	<p>Shallow soils, deep zone soils associated with the ditches and ponds, and potentially the groundwater beneath these sites.</p>

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (9 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		Gross beta Iodine-123 Iodine-125 Iodine-129 Iron-55 Iron-59 Iodine-131 Krypton-85 Lanthanum-140 Lead-209 Lead-210 Lead-211 Lead-212 Lead-214 Manganese-54 Molybdenum-93 Neodymium Neptunium-237 Neptunium-239 Nickel-59 Nickel-63 Niobium-93m Niobium-94 Niobium-95 Palladium-107 Phosphorus-32 Plutonium Plutonium-238 Plutonium-239/240 Plutonium-241 Polonium-210 Polonium-213 Polonium-214 Polonium-215 Polonium-218 Potassium-40 Praseodymium Praseodymium-144 Promethium-147 Protactinium-231 Protactinium-233 Protactinium-234m Radium Radium-223 Radium-225 Radium-226 Radium-228 Rhenium-187 Rhodium-103 Rhodium-106 Rubidium-86	

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (9 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		Ruthenium-103 Ruthenium-106 Samarium-151 Scandium-46 Selenium-75 Selenium-79 Silver-108 Silver-110 Silver-110m Sodium-22 Strontium-82 Strontium-85 Strontium-89 Strontium-90 Sulfur-35 Tantalum-182 Technetium-99 Tellurium-121 Tellurium-125m Tellurium-127 Tellurium-129 Tellurium-129m Thallium-204 Thallium-207 Thallium-208 Thorium-227 Thorium-229 Thorium-230 Thorium-231 Thorium-233 Thorium-234 Thulium-170 Tin-113 Tin-121 Tin-123m Tin-126 Tritium Uranium Uranium-233 Uranium-234 Uranium-235 Uranium-236 Uranium-238 Vanadium-49 Yttrium-87 Yttrium-88 Yttrium-90 Yttrium-91	

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (9 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		<p>NONRADIOACTIVE CONSTITUENTS</p> <p>Acetic acid Alkaline liquids Aluminum Aluminum nitrate Aluminum nitrate (mono basic) Aluminum nitrate (nonahydrate) Aluminum oxide Ammonia Ammonia (anhydrous) Ammonium carbonate Ammonium fluoride Ammonium hydroxide Ammonium ion Ammonium nitrate Ammonium oxalate Ammonium silicofluoride Ammonium sulfate Arsenic Barium Barium nitrate Beryllium Bismuth Bismuth nitrate Bismuth phosphate Boric acid Boron Cadmium Cadmium nitrate Calcium Calcium carbonate Calcium chloride Carbon dioxide Carbonate Ceric ammonium nitrate Ceric fluoride Ceric iodate Ceric nitrate Ceric sulfate Cerium Cesium carbonate Cesium chloride Cesium phosphotungstic salts Chloride Chromium Chromium nitrate Chromous sulfate Copper Cyanide Dibasic aluminum nitrate</p>	

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (9 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		Ferrous ammonium sulfate Ferric cyanide Ferric nitrate Ferrous sulfamate Ferrous sulfate Fluoride Gold Hydrazine Hydrobromic acid Hydrochloric acid Hydrofluoric acid Hydrogen Hydrogen fluoride Hydrogen peroxide Hydroiodic acid Hydroxide Hydroxyacetic acid Hydroxylamine hydrochloride Hydroxylamine nitrate Iron Lanthanum Lanthanum fluoride Lanthanum hydroxide Lanthanum nitrate Lanthanum-neodymium nitrate Lead Lead nitrate Lithium Magnesium Magnesium carbonate Magnesium nitrate Manganese Manganese dioxide Mercuric nitrate Mercuric thiocyanate Mercury Miscellaneous toxic process chemicals Nickel Nickel nitrate Niobium Nitrate Nitric acid Nitric oxide Nitrite Nitrogen dioxide Periodic acid Phosphate Phosphoric acid Phosphorous pentoxide Phosphotungstic acid	

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (9 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		Plutonium fluoride Plutonium nitrate Plutonium peroxide Potassium Potassium carbonate Potassium dichromate Potassium ferrocyanide Potassium fluoride Potassium hydroxide Potassium oxalate Potassium permanganate Pu-Lanthanum fluoride Pu-Lanthanum oxide Rubidium Selenium Selenium tetroxide Silica Silicon Silicon dioxide Silicon trioxide Silver Silver nitrate Sodium Sodium aluminate Sodium bismuthate Sodium bisulfate Sodium bromate Sodium carbonate Sodium chloride Sodium citrate Sodium dichromate Sodium ferrocyanide Sodium fluoride Sodium gluconate Sodium hydroxide Sodium metasilicate Sodium nitrate Sodium nitrite Sodium persulfate Sodium phosphate Sodium sulfate Sodium sulfite Sodium thiosulfate Strontium Strontium carbonate Strontium fluoride Strontium sulfate Sulfamic acid Sulfate Sulfuric acid Tartaric acid Tetrabromoethane	

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (9 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		Thorium Tin Titanium Titanium chloride Tungsten tetroxide Uranium Uranium oxide Uranyl nitrate hexahydrate Vanadium Various acids Xenon Yttrium Zeolon Zinc Zirconium Zirconium oxide Zirconyl nitrate Dichloromethane (methylene chloride) Diesel fuel DOW Anti-Foam B DOW 21 K/Amberlite XE-270 Duolite ARC-359 (IX resin)(sulfonated phenolic) Ethanol Ethylene diamine tetra acetic acid (EDTA) Ethyl ether Flammable solvents Formaldehyde (solution) Glycolate Grease Halogenated hydrocarbons Hydroxyacetic acid Hydroxy acetic acid-trisodium hydroxy ethylene-diamine-triacetic acid (THEDTA)	

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (9 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		1-Butanol (butyl alcohol) 1-Butanone 2-Butanone Acetone Antifreeze Bromonaphthalene Butanoic acid Butyl alcohol Butylated hydroxy toluene Carbon tetrachloride Chloroform (trichloromethane) Citrate Citric acid Chloroplatinic acid Decane Di2-ethyl hexyl phosphoric acid Dibutyl butyl phosphonate Dibutyl phosphate Hydroxylamine nitrate Hydroxyquinoline Ionac A-580/Permutit SK Isopropyl alcohol Kerosene Methyl isobutyl ketone (MIBK) Methylene chloride Methyl isobutyl carbinal Methyl isopropyl diketone Mineral oil Molybdate-citrate reagent Monobutyl phosphate Normal paraffin hydrocarbon N-(2-hydroxyethyl) ethylenediaminetriacetate (HEDTA)O-phenanthroline Other degradation products Oxalate Oxalic Acid Paraffin hydrocarbons PCBs Propane Propanol (isopropyl alcohol) S-diphenyl carbizide Shell E-2342 (naphthalene and paraffin) Sodium acetate Soltrol-170 (C ₁₀ H ₂₂ to C ₁₆ H ₃₄) purified kerosene Sugar Tartaric acid Tetraphenyl boron Tetrasodium ethylene diamine tetra-acetate (EDTA)	

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (9 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		Thenoyltrifluoroacetone Toluene Tri-iso-octylamine Tri-n-dodecylamine Tri-n-octylamine Tributyl phosphate 1,1,1-trichloroethane 1,1,2-trichloroethane Trichloromethane Trisodium hydroxyethyl Ethylene-diamine triacetate (HEDTA) Waste paint and thinners Xylene Zeolite AW-500 (IX resin)	

Inorganic salts represent a large group of chemical constituents in the chemical sewer sites. Because laboratory analyses are generally not compound-specific, inorganic salts were excluded from further consideration. Instead, the anions (e.g., fluorides, nitrates, and phosphates) associated with the inorganic salts serve as their target constituents. This recognizes that small volumes of wastes were released into large-volume aqueous discharges, where the salts dissolved.

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
<i>Radioactive Constituents – Activation Products</i>	
Nickel-59	Less than 5E-5 times cesium-137 activity
Sodium-22	Short half-life
<i>Radioactive Constituents – Fission/Activation Products</i>	
Aluminum-28	Short half-life, activation only -low potential formation
Antimony-122	Short half-life
Antimony-125	Short half-life
Antimony-124	Short half-life
Antimony-126	Short half-life, progeny
Antimony-126m	Short half-life, progeny
Barium-133	Activation only – low potential formation
Barium-135m	Short half-life
Barium-137	Stable

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Barium-137m	Short half-life (daughter of cesium-137, which is a final COPC), progeny
Barium-140	Short half-life
Beryllium-7	Short half-life
Beryllium-10	Activation only – low potential formation
Cadmium-109	Short half-life, activation only – low potential formation
Calcium-45	Short half-life
Carbon-14	Highly mobile, not expected in meaningful quantities in soils
Cerium-141	Short half-life
Cerium-144	Short half-life
Cesium-134	Short half-life
Cesium-135	Less than 5E-4 times cesium-137 activity
Chlorine-36	Activation only – low potential formation
Chromium-51	Short half-life
Cobalt-57	Short half-life
Cobalt-58	Short half-life
Curium-243	High mass number, very low production; not expected in meaningful quantities
Einsteinium-254	Short half-life, high mass number, very low production
Gadolinium-153	Short half-life
Germanium-68	Short half-life
Iodine-123	Short half-life
Iodine-125	Short half-life
Iodine-129	Less than 5E-5 times cesium-137 activity; not expected in meaningful quantities
Iodine-131	Short half-life
Iron-55	Short half-life, activation only – low potential formation
Iron-59	Short half-life
Krypton-85	Gas
Lanthanum-140	Short half-life
Manganese-54	Short half-life
Molybdenum-93	Activation only – low potential formation
Neodymium	Short half-life
Niobium-93m	Progeny

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Niobium-94	Activation only -- low potential formation
Niobium-95	Short half-life, progeny
Palladium-107	Less than 5E-5 times cesium-137 activity
Phosphorus-32	Short half-life
Praseodymium	Short half-life
Praseodymium-144	Short half-life, progeny
Promethium-147	Short half-life
Radium	Isotope-specific
Rhodium-103	Short half-life, progeny
Rhodium-106	Short half-life, progeny
Rubidium-86	Short half-life
Ruthenium-103	Short half-life
Ruthenium-106	Short half-life
Samarium-151	Less than 1% of cesium-137 activity; insignificant contribution to dose per RESRAD; no analytical detection methodology available
Scandium-46	Short half-life, activation only -- low potential formation
Selenium-75	Short half-life, activation only -- low potential formation
Selenium-79	Less than 5E-4 times cesium-137 activity
Silver-108	Short half-life
Silver-110	Short half-life
Silver-110m	Short half-life
Strontium-82	Short half-life
Strontium-85	Short half-life
Strontium-89	Short half-life
Sulfur-35	Short half-life, activation only -- low potential formation
Tantalum-182	Short half-life, activation only -- low potential formation
Tellurium-121	Short half-life
Tellurium-125m	Short half-life
Tellurium-127	Short half-life
Tellurium-129	Short half-life
Tellurium-129m	Short half-life
Thallium-204	Activation only -- low potential formation; half-life less than 4 years
Thallium-208	Short half-life
Thullium-170	Short half-life

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Thorium-233	Short half-life
Tin-113	Short half-life
Tin-121	Activation only – low potential formation
Tin-123m	Short half-life
Tin-126	Less than 5E-4 times cesium-137 activity
Vanadium-49	Short half-life
Yttrium-87	Short half-life
Yttrium-88	Short half-life
Yttrium-90	Short half-life (daughter of strontium-90, which is a final COPC), progeny
Yttrium-91	Short half-life
Zinc-65	Short half-life
Zirconium-93	Less than 5E-4 times cesium-137 activity
Zirconium-95	Short half-life
Radioactive Constituents – Uranium/Thorium Daughter Products	
Actinium-225	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 isotopes from which they originate.
Actinium-227	
Actinium-228	
Astatine-217	
Bismuth-210	
Bismuth-211	
Bismuth-212	
Bismuth-213	
Bismuth-214	
Francium-221	
Francium-223	
Lead-209	
Lead-210	
Lead-211	
Lead-212	
Lead-214	
Polonium-210	

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Polonium-213	
Polonium-214	
Polonium-215	
Polonium-218	
Protactinium-231	
Protactinium-233	
Protactinium-234m	
Radium-223	
Radium-225	
Radium-226	
Radon-219	
Radon-222	
Thallium-207	
Thorium-227	
Thorium-229	
Thorium-230	
Thorium-231	
Thorium-234	
Radioactive Constituents — Transuranics	
Americium-242	High mass number – very low product inventory
Americium-242m	High mass number – very low product inventory
Americium-243	High mass number – very low product inventory
Curium-242	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
Neptunium-239	Short half-life
Plutonium-241	Not detected by normal plutonium analysis; can infer from americium/plutonium results
Plutonium-242	High mass number – very low product inventory
Radioactive Constituents — Other	
Rhenium-187	Natural – no identified source
Potassium-40	Naturally occurring isotope not created in Hanford Site reactor operations

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Inorganic Chemicals	
Acetic acid	<p>These inorganic substances are excluded because they qualify in one or more of the following categories:</p> <ul style="list-style-type: none"> • Chemicals that have no known carcinogenic or toxic effects (inert) • Constituents that have been diluted, neutralized, and/or decomposed by high volumes of water and/or the presence of acids and bases • 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. <p>The analytical strategy will be to use the analytical techniques that focus on the major constituents (e.g., the metals and anions) via the following methods: 6010, GFAA, 7470/7471, IC 300.</p> <p>Routine ICP multi-component analysis will report total metal cation concentrations. Routine anion IC multi-component analysis will report total anion constituents. Total ammonium concentration will be requested COC.</p>
Alkaline liquids	
Aluminum	
Aluminum nitrate	
Aluminum nitrate (mono basic)	
Aluminum nitrate (dibasic)	
Aluminum nitrate (nonahydrate)	
Aluminum oxide	
Ammonia (anhydrous)	
Ammonium bicarbonate	
Ammonium carbonate	
Ammonium fluoride	
Ammonium hydroxide	
Ammonium ion	
Ammonium nitrate	
Ammonium oxalate	
Ammonium silicofluoride	
Ammonium sulfate	
Antifreeze	
Barium nitrate	
Bismuth	
Bismuth nitrate	
Bismuth phosphate	
Boric acid	
Boron	
Cadmium nitrate	
Calcium	
Calcium carbonate	
Calcium chloride	
Carbon dioxide	

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Carbonate	
Ceric ammonium nitrate	
Ceric fluoride	
Ceric iodate	
Ceric nitrate	
Ceric sulfate	
Cerium	
Cesium carbonate	
Cesium chloride	
Cesium phosphotungstic salts	
Chromium nitrate	
Chromous sulfate	
DOW Anti-Foam B	
Duolite ARC-359 (IX resin)	
Ferric cyanide	
Ferric nitrate	
Ferrous ammonium sulfate	
Ferrous sulfamate	
Ferrous sulfate	
Gold	
Hydrazine	Hydrazine is a listed waste that was potentially discharged with the cooling waters. However, because hydrazine is extremely reactive and volatile, it is no longer present in any media associated with the 200-CS-1 OU.

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Hydrobromic acid	<p>These inorganic substances are excluded because they qualify in one or more of the following categories:</p> <ul style="list-style-type: none"> • Chemicals that have no known carcinogenic or toxic effects (inert) • Constituents that have been diluted, neutralized, and/or decomposed by high volumes of water and/or the presence of acids and bases. • 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.
Hydrochloric acid	
Hydrofluoric acid	
Hydrogen	
Hydrogen fluoride	
Hydrogen peroxide	
Hydroiodic acid	
Hydroxide	
Hydroxyacetic acid	
Hydroxylamine hydrochloride	
Iron	<p>Routine ICP multi-component analysis will report total metal cation concentrations. Routine Anion IC multi-component analysis will report total anion constituents. Total ammonium concentration will be the requested COC.</p>
Lanthanum	
Lanthanum fluoride	
Lanthanum hydroxide	
Lanthanum nitrate	
Lanthanum-neodymium nitrate	
Lead nitrate	
Lithium	
Magnesium	
Magnesium carbonate	
Magnesium nitrate	
Manganese	
Manganese dioxide	
Mercuric nitrate	
Mercuric thiocyanate	
Miscellaneous toxic process chemicals	
Nickel nitrate	
Niobium	
Nitric acid	
Oxalic acid	
Periodic acid	

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Phosphoric acid	
Phosphorous pentoxide	
Phosphotungstic acid	
Plutonium fluoride	
Plutonium nitrate	
Plutonium peroxide	
Potassium	
Potassium carbonate	
Potassium dichromate	
Potassium ferrocyanide	
Potassium fluoride	
Potassium hydroxide	
Potassium oxalate	
Potassium permanganate	
Selenium tetroxide	
Silicon trioxide	Does not exist
Titanium chloride	Degrades to TiO ₂ and HCl
Zirconium oxide	Refractory oxide
Nitric oxide	Gas
Nitrogen dioxide	
Xenon	
Tungsten tetroxide	Does not exist
Pu-Lanthanum fluoride	Covered by radiological COPCs, fluoride is a COPC
Pu-Lanthanum oxide	Covered by radiological COPC

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Rubidium	These organic substances are excluded because they qualify in one or more of the following categories:
Silica	
Silicon	
Silicon dioxide	<ul style="list-style-type: none"> • Chemicals that have no known carcinogenic or toxic effects (inert)
Silver nitrate	
Sodium	
Sodium aluminate	<ul style="list-style-type: none"> • Constituents that have been diluted, neutralized, and/or decomposed by high volumes of water and/or the presence of acids and bases.
Sodium bismuthate	
Sodium bisulfate	
Sodium bromate	<ul style="list-style-type: none"> • Chemicals that are unlikely to be present in toxic or high concentrations due to the significant dilution during cooling water discharges
Sodium carbonate	
Sodium chloride	
Sodium citrate	The analytical strategy will be to use the analytical techniques that focus on the major constituents (e.g., metals and anions) via the following methods: 6010, GFAA, 7470/7471, IC 300.
Sodium dichromate	Routine ICP multi-component analysis will report total metal cation concentrations. Routine Anion IC multi-component analysis will report total anion constituents. Total Ammonium concentration will be the requested COC.
Sodium ferrocyanide	
Sodium fluoride	
Sodium gluconate	
Sodium hexametaphosphate	
Sodium hydroxide	
Sodium metasilicate	
Sodium nitrate	
Sodium nitrite	
Sodium persulfate	
Sodium phosphate	
Sodium sulfate	
Sodium sulfite	
Sodium thiosulfate	
Strontium	
Strontium carbonate	
Strontium fluoride	
Strontium sulfate	
Sugar	
Sulfamic acid	

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Sulfuric acid	
Tartaric acid	
Thorium	
Tin	
Titanium	
Uranium	
Uranium oxide	
Uranyl nitrate hexahydrate	
Various acids	
Yttrium	
Zeolon	
Zirconium	
Zirconyl nitrate	
Organic Chemicals	
Methyl isopropyl diketone	Not a compound, routine VOA measures methyl isopropyl ketone
1-butanone	Not a compound, routine VOA measures 2-butanone
Butanoic acid	See general note for organic chemicals
Citric acid	See Note a
Chloroplatinic acid	
Di2-ethyl hexyl phosphoric acid	Degrades to HCl and platinum (NT) (see general note)
Dibutyl butyl phosphonate	See Note a
Dibutyl phosphate	
DOW 21 K/Amberlite XE-270	Degradation product of TBP (see general note)
Ethylene diamine tetra acetic acid	See general note for organic chemicals
Ethyl ether	See Note a
Flammable solvents	See general note for organic chemicals
Formaldehyde (solution)	Detected in kerosene pHs
Grease	See general note for organic chemicals
Hydroxyacetic acid-trisodium hydroxyethylene-diamine-triacetic acid (THEDTA)	See general note for organic chemicals

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Hydroxylamine nitrate	<p>General Note: These organic substances are excluded because they qualify in one or more of the following categories:</p> <ul style="list-style-type: none"> • Chemicals with no known carcinogenic or toxic effects (inert) • Diluted, neutralized, and/or decomposed by high volumes of water and/or the presence of acids and bases • Chemicals that are unlikely to be present in toxic or high concentrations due to the significant dilution • Chemicals that are not persistent in the environment.
Ionac A-580 Permutit SK	
Mineral oil	
Molybdate-citrate reagent	
Monobutyl phosphate	
Sodium acetate	
Tartaric acid	
Tri-n-dodecylamine	
Tetrasodium ethylene diamine tetra-acetate (EDTA)	See Note a
Thenoyltrifluoroacetone	
Trisodium hydroxyethyl Ethylene-diamine triacetate (HEDTA)	See Note a; laboratory compound that has degraded
Tetrabromoethane	<p>These compounds excluded due to low usage at the Hanford Site and/or no identified drivers to quantify. No analytical procedures have been identified for these specific compounds. If present, most may be identified as tentatively identify compounds as part of routine VOA and SVOA.</p>
Bromonapthalene	
Butylated hydroxytoluene	
Butyl cellosolve	
Hydroxyacetic acid	
Hydroxyquinoline	
Methyl isobutyl carbinal	
O-phenanthroline	
S-diphenyl carbazide	
Tetraphenyl boron	
Tri-iso-octylamine	
Tri-n-octylamine	

Table 1-6. COPC Exclusions and Justifications. (13 pages)

COPCs	Rationale for Exclusion
Propane	Gas
Citrate	Complexants having low toxic characteristics and/or expected to degrade in the environment. No routine analyses available. Presence of these materials may affect the mobility of some COCs. All identified COCs will need to be analyzed in the deep zones below the sites.
Glycolate	
Oxalate	
Waste paint and thinners	See Note a
Zeolite AW-500 (IX resin)	Detected in chromium, lead, and VOA suite analyses

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

Generally, the analytical approach employed for this project focuses on the significant risk drivers represented by the waste constituents present. Other constituents with lower risk factors (e.g., some metals and organic chemicals) are also covered by using general "suite-type" analytical techniques, which yield results on many lower-risk compounds and results for risk-driver compounds. This approach provides a cost-effective alternative for detecting suspected waste constituents. The COPCs in the following categories were excluded from further consideration:

- Short-lived radionuclides were excluded (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 an atomic mass greater than 242 that represent less than 1% of the actinide activities
- Progeny radionuclides that build insignificant activities within 50 years and/or for which parent/progeny relationships exist that permit progeny estimation
- Chemicals that have no known carcinogenic or toxic effect (inert)
- Constituents that have been diluted, neutralized, and/or decomposed by the high volumes of water discharged and/or the presence of acids and bases
- Chemicals that are not persistent in the environment.

Table 1-7 shows the final list of COCs with inclusion rationale.

Table 1-7. Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Radioactive Constituents	
Americium-241	Included in gamma energy analysis and isotopic americium/plutonium
Cesium-137	Most abundant fission product-direct exposure dose contributor
Cobalt-60	Common activation product, strong gamma emitter-direct exposure dose contributor
Europium-152	Direct exposure dose contributor
Europium-154	Direct exposure dose contributor
Europium-155	Direct exposure dose contributor
Gross alpha	Alpha exposure dose contributor
Gross beta	Direct exposure dose contributor
Neptunium-237	May have been concentrated in the PUREX process
Nickel-63 ^a	Present in 100 Areas remedial sites in deep zone
Plutonium	Isotopic specific will be performed
Plutonium-238	Alpha exposure dose contributor
Plutonium-239/240	Alpha exposure dose contributor
Radium-228	Included in gamma energy analysis
Strontium-90	Abundant fission product; strong beta emitter
Technetium-99 ^a	Mobile, potential groundwater concern
Tritium ^a	Mobile, potential groundwater concern
Thorium-232	Was processed in PUREX
Uranium-233/234	Mobile, potential groundwater concern
Uranium-235/236	Mobile, potential groundwater concern
Uranium-238	Mobile, potential groundwater concern
Chemical Constituents -- Metals	
Arsenic	Toxicity characteristic metal
Barium	Toxicity characteristic metal
Beryllium	Potentially toxic/hazardous
Cadmium	Toxicity characteristic metal
Chromium	Toxicity characteristic metal
Hexavalent chromium	Mobile metal associated with operations
Copper	Potentially toxic/hazardous
Lead	Toxicity characteristic metal
Mercury	Toxicity characteristic metal
Nickel	Potentially toxic/hazardous
Selenium	Toxicity characteristic metal
Silver	Toxicity characteristic metal
Vanadium	Potentially toxic/hazardous
Zinc	Potentially toxic/hazardous

Table 1-7. Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Chemical Constituents -- Other Inorganics	
Ammonia	Constituent in several waste compounds
Chloride	
Cyanide	
Fluoride	
Nitrate/nitrite	
Phosphate	
Sulfate	
Sulfide	
Thiocyanate	
pH	Indicator test
Chemical Constituents -- Volatile Organics	
Acetone	VOA
1-butanol (butyl alcohol)	VOA
2-butanone (MEK)	VOA
Carbon tetrachloride	VOA
Chloroform (trichloromethane)	VOA
Decane	VOA
Dichloromethane (methylene chloride)	VOA
Ethanol	VOA tentatively identified compound
Halogenated hydrocarbons	VOA
Isopropyl alcohol	VOA tentatively identified compound
Methylene chloride	VOA
Methyl isobutyl ketone (MIBK)	VOA
Propanol (isopropyl alcohol)	VOA tentatively identified compound
Toluene	VOA
Trichloromethane	VOA
Xylene	VOA
1,1,1 trichloroethane	VOA
1,1,2 trichloroethane	VOA
Semi-Volatile Organics	
Diesel fuel ^D	SVOA
Kerosene ^D	SVOA
Normal paraffin hydrocarbon ^D	SVOA
Paraffin hydrocarbons ^D	SVOA

Table 1-7. Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Polychlorinated biphenyls	SVOA
Shell E-2342 (naphthalene and paraffin) ^b	SVOA
Soltrol-170 (C ₁₀ H ₂₂ to C ₁₆ H ₃₄) purified kerosene ^b	SVOA
Tributyl phosphate	SVOA

^a These contaminants of concern 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.

PUREX = Plutonium-Uranium Extraction Plant

VOA = volatile organic compound

SVOA = semi-volatile organic compound

Table 1-8 identifies current and potential future land uses for the chemical sewer OU area as currently identified by DOE in the *Revised Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan* (DOE-EIS-02220 [DOE 1999]). The land-use designations indicated in Table 1-8 support the applicable or relevant and appropriate requirements (ARARs) and preliminary remediation goal (PRG) assumptions developed in Table 1-9.

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

Current Land Use	Proposed Future Land Use
Inside the 200 Area Land-Use Boundary	
Hanford Site; controlled access	DOE: Industrial-Exclusive (Waste Management) ^a The land use designations indicated in Table 1-8 support the ARAR and PRG assumptions developed in Table 1-9.
Outside the 200 Area Land-Use Boundary	
Hanford Site; controlled access	DOE: Conservation and Preservation

^a This proposed future land use is unique to DOE.

Table 1-9 defines the ARARs and PRGs for each of the COCs.

Table 1-9. List of Preliminary ARARs and PRGs. (2 pages)

COCs	Preliminary ARARs	PRGs
Radionuclides Inside the 200 Area Land-Use Boundary^a		
Shallow zone (0 to 15 ft below grade)	100 mrem/yr above background for 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 (>15 ft below grade)	4 mrem/yr above background to groundwater, or no additional degradation groundwater. ^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 15 ft below grade)	MTCA	Chemical-specific
Deep zone (>15 ft below grade)	MTCA	Alternatively, site-specific RESRAD modeling
Radionuclides Outside the 200 Area Land-Use Boundary^a		
Shallow zone (0 to 15 ft below grade)	15 mrem/yr above background and 4 mrem/yr above background to groundwater, or no additional groundwater degradation. ^b	Contaminant-specific; RESRAD modeling ^b for future land use of Conservation
Deep zone (>15 ft below grade)	4 mrem/yr above background to groundwater, or no additional degradation of groundwater. ^b	MCLs, state and Federal ambient water quality control criteria
Chemicals Outside the 200 Area Land-Use Boundary		
Shallow zone (0 to 15 ft below grade)	MTCA	Chemical-specific
Deep zone (>15 ft below grade)	MTCA	Alternatively, site-specific modeling

Table 1-9. List of Preliminary ARARs and PRGs. (2 pages)

Clean Closure Scenario – Radionuclides		
Shallow zone (0 to 15 ft below grade)	15 mrem/yr above background via Residential use scenario, and 4 mrem/yr above background to groundwater, or no additional groundwater degradation. ^b	Contaminant-specific; RESRAD modeling ^b
Deep zone (>15 ft below grade)	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
RCRA Clean Closure Scenario – Chemicals		
Shallow zone (0 to 15 ft below grade)	MTCA Method B, 100 x groundwater per MTCA	Chemical-specific
Deep zone (>15 ft below grade)	100 x groundwater per MTCA	Alternatively, site-specific modeling

^a RESRAD modeling has been used for similar waste sites; thus, RESRAD will be used at this time. If more appropriate models are developed, they will be evaluated for use.

^b Radionuclide standards are not final; final standards will be agreed to in the Record of Decision.

MCLs = maximum contamination levels

MTCA Method B = residential land use

MTCA = *Model Toxics Control Act*

RESRAD = RESidual RADioactivity dose model

Table 1-10 provides the general exposure scenarios discussed for the chemical sewer OU. As appropriate, additional exposure scenarios would be evaluated in the feasibility study and/or proposed plan phases of the project. It should be noted that exposure scenarios are associated with specific land uses.

Table 1-10. General Exposure Scenarios. (2 pages)

Scenario No.	General Exposure Scenario Description
1	<p>Industrial Land-Use Scenario (inside the 200 Area land-use boundary)</p> <p>The source of contamination is the liquid effluents disposed in the chemical sewer OU sites from various 200 Area plant operations. The primary 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 (i.e., organic, inorganic, or radioactive) into the groundwater would not affect occupational workers, as their drinking water source would not be the underlying aquifers.</p>
	<p>The exposure time is divided into time spent inside and outside an industrial facility:</p> <p><u>Building occupancy</u>: 8 hrs/day x 0.6 (building occupancy factor), 5 days/week, 50 weeks/yr, for 20 years (of a 75-year lifetime).</p> <p><u>Outdoor exposure</u>: 8 hrs/day x 0.4 (outdoor exposure factor), 5 days/week, 50 weeks/yr, for 20 years (of a 75-year lifetime).</p> <p>In addition, the building occupancy exposure includes a factor of 0.4 to reduce the ingested dust component due to building ventilation system filtration.</p>
2	<p>Occasional User, based on the Conservation Land-Use Scenario (the details of this exposure scenario are yet to be defined)</p> <p>The source of contamination is the liquid wastes disposed in the chemical sewer OU sites. The release mechanisms are direct radiation exposure to the hypothetical occasional users in the vicinity of the site areas (although shielded by stabilizing cover) and evaporation of volatile organic gases into the local air environment. Downward migration of mobile constituents (i.e., organic, inorganic, or radioactive) into the groundwater would not affect the occasional users, as their drinking water could not originate from the underlying aquifers because of the waste plumes they contain. Administrative restrictions will prohibit local groundwater use as drinking water. No water will be used for irrigation.</p> <p>Ingestion of surface soil is not considered to contribute any significant dose due to the presence of stabilizing soil cover over all of the affected sites.</p>

Table 1-10. General Exposure Scenarios. (2 pages)

Scenario No.	General Exposure Scenario Description
3	<p>Clean Closure Scenario</p> <p>The Clean Closure scenario is based on a residential exposure scenario as defined by Washington State (<i>Guidance for Clean Closure of Dangerous Waste Facilities</i> [Ecology 1994]). In this scenario, final closure means that dangerous waste activities regulated under the <i>Washington Administrative Code</i> are no longer conducted at this facility. As with the other scenarios, the source of contamination is the liquid effluents disposed in the chemical sewer waste sites from various 200 Area plant operations. The release mechanism is direct exposure to the maximum exposed resident in the vicinity of the ditches and pond areas. In addition, volatilization of certain organic gases would be present in the local air environment. Downward migration of mobile constituents into the groundwater could affect the resident who obtains drinking water from underlying aquifers.</p> <p>The exposure time would be 24 hrs/day, 365 days/year, for 70 years for the maximum exposed resident.</p>

Tables 1-11 and 1-12 specify the regulatory and project schedule constraints.

Table 1-11. Regulatory Milestones.

Milestone	Due Date	Regulatory Driver
Submit chemical sewer OU work plan	August 31, 1999	Tri-Party Agreement Milestone M-13-21
Submit 216-S-10 pond and ditch closure/post-closure plans to Ecology	February 28, 2003	Tri-Party Agreement Milestone M-20-39

Table 1-12. Project Milestones.

Milestone	Due Date	Driver
DQO workbook (strawman)	April 26, 1999	Internal DQO workbook review
Draft DQO report (RL/ERC review)	May 4, 1999	RL briefing and ERC senior review
Revised draft DQO summary report	May 18, 1999	Decision maker briefing and review
Final DQO summary report	July 1999	Support 200-CS-1 work plan development
Work plan	July 16, 1999	Decisional draft for RL review

Table 1-13 provides a summary of the conceptual contaminant distribution model, combining the relevant background information into a concise statement of the problem to be resolved.

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

Preliminary Conceptual Site Contaminant Distribution Model^a

The waste streams discharged to the chemical sewer OU sites originated from various 200 Area facilities. The streams primarily contained inorganic chemicals (strongly acidic and basic) but also contained limited quantities of radionuclides and organic chemicals. Immobile contaminants accumulated in the sediments over time and mobile contaminants may have reached the groundwater. The contaminated ditches were backfilled and covered to contain the contamination, and new ditches were constructed to replace the contaminated ones. Most of the less mobile contaminants are expected to be within the top 2 m of soil beneath the ditches, trench, and pond sediment layer (below approximately the 2-m stabilization layer at the current ground surface). More mobile contaminants traveled through the soil column and into the groundwater and are expected to be present only in trace concentrations. The very low concentrations of radionuclides in the large volumes of wastewater discharged should tend to minimize contaminant concentrations in the soil column.

Volatile organics were discharged in small quantities and are assumed to have either historically volatilized into the atmosphere or traveled with the liquid discharge into the groundwater, leaving only trace quantities (if any) in the vadose zone. Limited chemical data are available for the OU and are considered a broad data gap. However, the strong acids and bases discharged to the chemical sewer OU likely neutralized each other and were buffered in the soil column.

Limited lateral spreading of contaminants in the vadose zone is expected. Lateral spreading may have been locally enhanced due to the occurrence of finer grained sediments of the Hanford and Ringold formations that act as perching or spreading horizons for percolating wastewater. In the 200 West Area, the Plio-Pleistocene Unit acts as a perching or spreading horizon.

DQO Approach

The DQO for the 200-CS-1 Chemical Sewer OU is being performed to determine if the four TSD waste sites have been contaminated to levels that require remedial action. All four RCRA TSD sites will be characterized. Two of the four RCRA TSD waste sites are considered "representative sites," and data collected for these two sites will be used to establish remediation needs for the three non-TSD waste sites in the chemical sewer OU. Following the analogous approach to waste site characterization, these three sites need not be characterized.

A work plan will be developed after completion of the DQO process, which specifies the sampling and analyses to be performed for characterization of the four TSD sites.

A distinction is being applied to waste sites that fall within and outside the 200 Area land-use boundary line. Sites within the 200 Area land-use boundary line will be evaluated on the basis of future industrial uses. Sites located outside of the 200 Area fence will be evaluated on the basis of a future Conservation land use.

The piping in the chemical sewer OU is within the scope of this DQO. The piping associated with each waste site will be considered part of that waste site; 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/trench, but on a smaller scale. The environmental data obtained for each waste site are considered analogous for the associated piping systems.

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

Goal Statement

Given the goal of selecting a remedial/closure alternative for the 200-CS-1 Chemical Sewer OU, the problem is to verify the preliminary site-specific conceptual contaminant distribution models and to determine the sampling requirements (i.e., type and frequency) that may be used to support the decision-making process. The sampling design will need to address the unique aspects of the remedial action alternatives (i.e., no-action, capping, excavate and dispose, and natural attenuation).

The four TSD sites being characterized are the 216-A-29 ditch, the 216-B-63 trench, the 216-S-10D ditch, and the 216-S-10P pond. The three non-TSD sites that will not be characterized are 216-S-11, UPR-200-W-34, and 216-W-LWC.

^a The preliminary conceptual contamination distribution models will become the conceptual contamination distribution models after acceptance of this DQO summary report. The conceptual contamination distribution models will then be applied to the project work plan.

2.0 STEP 2 – IDENTIFY THE DECISION

Table 2-1 summarizes the principal study questions (PSQs) requiring environmental information (e.g., chemical or radiological data), the alternative actions associated with each PSQ, the potential consequences of taking each alternative action, and the severity of the consequences associated with potentially incorrect actions. Decision statements for each PSQ are also presented in Table 2-1.

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

Principal Study Question #1 - Do the chemical sewer radionuclide concentrations in the soils meet the annual radiological exposure limits for human health/environmental protection?			
PSQ-AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
1-1	Evaluate streamlined approach to site closure (e.g., add to an existing ROD).	Representative waste site data may not represent actual conditions at 200-CS-1 analogous waste sites. During ROD development or after the ROD is issued, confirmation and/or verification samples will be collected from analogous 200-CS-1 sites. These data will be used to confirm 200-CS-1 remedial alternative selections. If these data indicate that the remedial actions selected are inappropriate, the data will be used to select appropriate remedial actions. Therefore, the consequences of selecting incorrect remedial actions for analogous 200-CS-1 sites based on representative site data are considered to be inconsequential.	Not severe
1-2	Evaluate remedial alternatives for implementation (e.g., via feasibility study).		
Decision Statement #1 - Determine if the chemical sewer soils exceed the radionuclide exposure limits for human health/environmental protection and require remedial action.			
Principal Study Question #2 - Do the chemical sewer metal and organic concentrations in the soils meet the chemical exposure limits for human health/environmental protection?			
PSQ-AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
2-1	Evaluate streamlined approach to site closure (e.g., add to an existing ROD).	Representative waste site data may not represent actual conditions at 200-CS-1 analogous waste sites. During ROD development or after the ROD is issued, confirmation and/or verification samples will be collected from analogous 200-CS-1 sites. These data will be used to confirm 200-CS-1 remedial alternative selections. If these data indicate that the remedial actions selected are inappropriate, the data will be used to select appropriate remedial actions. Therefore, the consequences of selecting incorrect remedial actions for analogous 200-CS-1 sites based on representative site data are considered to be inconsequential.	Not severe
2-2	Evaluate remedial alternatives for implementation (e.g., via feasibility study).		

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

Decision Statement #2 - Determine if the chemical sewer surface soil chemical concentrations exceed the exposure limits for human health/environmental protection and require remedial action.			
Principal Study Question #3 - Do the chemical sewer conceptual contaminant distribution models reflect the actual distribution of contaminants in the waste sites?			
PSQ-AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
3-1	Apply conceptual contaminant distribution model for remedial alternative selection and remedial action planning.	Representative waste site data may not represent actual conditions at 200-CS-1 analogous waste sites. During ROD development or after the ROD is issued, confirmation and/or verification samples will be collected from analogous 200-CS-1 sites. These data will be used to confirm 200-CS-1 remedial alternative selections. If these data indicate that the remedial actions selected are inappropriate, the data will be used to select appropriate remedial actions. Therefore, the consequences of selecting incorrect remedial actions for analogous 200-CS-1 sites based on representative site data are considered to be inconsequential.	Not severe
3-2	Refine the conceptual contaminant distribution model for remedial alternative selection and remedial action planning.		
Decision Statement #3 - Determine if the conceptual contaminant distribution model represents the actual contaminant distribution in each waste site.			
Principal Study Question #4 - Do the chemical sewer contaminant concentrations in subsurface soils (0 to 25 ft below grade), over the historically wetted area for each site, require remediation?			
PSQ-AA No.	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
4-1	Evaluate streamlined approach to site closure (e.g., add to an existing ROD).	Representative waste site data may not represent actual conditions at 200-CS-1 analogous waste sites. During ROD development or after the ROD is issued, confirmation and/or verification samples will be collected from analogous 200-CS-1 sites. These data will be used to confirm 200-CS-1 remedial alternative selections. If these data indicate that the remedial actions selected are inappropriate, the data will be used to select appropriate remedial actions. Therefore, the consequences of selecting incorrect remedial actions for analogous 200-CS-1 sites based on representative site data are considered to be inconsequential.	Not severe
4-2	Evaluate remedial alternatives for implementation (e.g., via feasibility study).		
Decision Statement # 4 - Determine if the chemical sewer waste concentrations in soil from 0- to 25-ft depth over the historically wetted area for each site requires remedial action.			

^a Refer to Table 1-9 for scenario-specific ARARs and preliminary remediation goals.
ROD = Record of Decision

3.0 STEP 3 -- IDENTIFY THE INPUTS TO THE DECISION

Tables 3-1 and 3-2 identify the inputs needed to resolve the decision statements presented in DQO Step 2, Table 2-1. These two tables summarize the following information:

- Determine what environmental variables or other information is needed to resolve the decision statements.
- Identify the type of data needed to resolve the decision statements (e.g. physical, chemical, and radiological).
- Determine whether sampling, computational methods (i.e. modeling), or a combination of sampling and modeling will be used to acquire information to resolve the decision statements. Define any models selected and provide the rationale for their use in resolving the decision statements.

Table 3-1. Information/Data Required and Computational Method Summary.

DS #	Environmental Information Needed	Type of Data Required	Computational Methods that Support the Information Need	Survey/Sampling Methods that Satisfy the Information Need
1, 3, and 4	Radiological (soil)	Alpha, beta, and gamma COC concentrations in soils for evaluation against action levels (ARARs and PRGs). Location data (depth and lateral extent of COCs within waste site boundaries).	RESRAD-SOIL analytical modeling	Soil sampling followed by laboratory analysis of the radionuclide COCs. Initial field screening to help define appropriate sample locations and depths.
2, 3, and 4	Chemical (soil)	Soils metal/organic COC concentrations for evaluation against ARARs and PRGs. Location data (depth and lateral extent of COCs within waste site boundaries).	None identified	Soil sampling followed by laboratory analysis for the chemical COCs.

ARARs = applicable or relevant and appropriate requirements

PRGs = preliminary remediation goals

RESRAD-SOIL = RESidual RADioactivity dose model (computer code for soil)

Table 3-2. List of Potential Computation Methods.

PSQ #	Computation Method	Source/ Author	Application to Study (Rationale for Use)	Satisfy Input Required?
1, 3, and 4	RESRAD	Argonne National Laboratory	<p>RESRAD estimates direct human radiation exposures and the migration of all contaminants (chemical and radioactive) to groundwater for indirect exposure estimates. RESRAD uses a one-dimensional groundwater model that accounts for Kd values, recharge rate, vadose zone thickness, and lithologic layers. It can track contaminant migration and accounts for radioactive decay.</p> <p>For tracking contaminant migration to groundwater, RESRAD's one-dimensional model is considered appropriate for 200-CS-1. This is because the unsaturated flow direction is primarily vertical in the 200 Area, relatively low concentrations of a few contaminants are expected to be present, the behaviors of the primary contaminants are well understood, and no "complexing" conditions are present. Because the RESRAD migration model is relatively simple, conservative input parameters are used and conservative outputs are developed that are considered appropriate to support remedial action decisions.</p> <p>RESRAD is considered appropriate for modeling radiological exposure doses because it has been used by Hanford Site's 100 and 300 Area remedial action projects based on agreements between DOE, EPA, and Ecology.</p>	Yes
	Summers Model	EPA	A one-dimensional, steady-state model, driven by Kd values and groundwater recharge rates. The Summers model does not account for vadose zone thickness or lithologic layers. Its usefulness depends upon the uniformity of the soil column. It was originally developed for the eastern United States to assess high annual rainfall and shallow water tables. This model does not account for radioactive decay.	No
	MTCASat	Ecology	Performs statistical calculations required in the <i>Statistical Guidance for Ecology Site Managers</i> .	No

MTCASat = Model Toxics Control Act – Statistical Guidance for Ecology Site Managers (Ecology 1992).

RESRAD = RESidual RADioactivity dose model

Table 3-3 summarizes the information needed to perform quantitative assessments of the DQO Step 2 alternative actions having severe decision error consequences.

Table 3-3. Required Information for Quantitative Assessment.

AA #	Required Information to Assess Impact	
	Cost	Risk
		Human Health
<p>No alternative actions with potentially severe consequences were identified in DQO Step 2 for the chemical sewer waste group. The chemical sewer DQO results will support remedial field investigation decisions. The characterization data will be used to refine the site conceptual models, determine if remediation is needed, and support initial decisions regarding appropriate remedial alternatives. The remedial alternatives will then be evaluated in feasibility studies.</p>		

Table 3-4 is used to determine the sources for the information needs identified in Tables 3-1, 3-2, and 3-3.

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

PSQ #	Required Information Category	Does Data Exist? (Y/N)	Source Reference	Sufficient Quality to Validate Concept Model? (Y/N)	New Data Needed? (Y/N)
1, 3, and 4	Vadose zone radiological sample data	Y	<p><i>Borehole Completion Data Package for the 216-B-63 Trench, WHC-MR-0207 (WHC 1990b) – Radiological contaminant concentrations in boreholes 299-E27-16 and 299-E33-37, near head end of the B-2 ditches).</i></p> <p><i>Borehole Completion Data Package for the 216-B-63 Trench, CY 1992, WHC-SD-EN-DP-051, Rev. 0 (WHC 1993a) – Radiological contaminant concentrations in boreholes 299-E27-18 and 299-E27-19.</i></p> <p><i>Borehole Completion Package for the 216-S-10 Facility CY 1992, WHC-SD-EN-DP-052, Rev. 0 (WHC 1993b) – Radiological contaminant concentrations in borehole 299-W27-2.</i></p> <p><i>Borehole Completion Data Package for the 216-S-10 Ditch and Pond, WHC-MR-0206 (WHC 1990a) – Radiological contaminant concentrations in boreholes 299-W26-8, 299-W26-9, and 299-W26-11.</i></p> <p><i>Grout Treatment Facility Environmental Baseline and Site Characterization Report, WHC-EP-0150 (WHC 1988a) – Surface/subsurface soil radiological data near the 216-A-29 ditch.</i></p>	Y	Y

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

PSQ #	Required Information Category	Does Data Exist? (Y/N)	Source Reference	Sufficient Quality to Validate Concept Model? (Y/N)	New Data Needed? (Y/N)
			<i>Borehole Summary Report for the 216-B-2-2 Ditch</i> , BHI-01177, Rev. 0 (BHI 1998a) – Radiological contaminant concentrations at head end of 216-B-2-2 ditch.	Y	Y (216-B-63 trench-specific data needed)
			<i>Transmittal of Final Letter Report on Sampling and Analytical Activities at the 216-A-29 Ditch</i> , Work Order XE8028 (BHI 1998c) – Attachment, letter report, <i>Description and Results of Soil Analyses from the 216-A-29 Ditch</i> , report on soil samples from 216-A-29 ditch, constituent list very limited.	Y	Y (for the ends of 216-A-29 ditch)
2, 3, and 4	Vadose zone chemical sample data	Y	<i>Borehole Completion Data Package for the 216-B-63 Trench</i> , WHC-MR-0207 (WHC 1990b) – Chemical contaminant levels in boreholes 299-E27-16 and 299-E33-37 (head end of B-2 ditches). <i>Borehole Completion Data Package for the 216-S-10 Ditch and Pond</i> , WHC-MR-0206 (WHC 1990a) – Chemical contaminant concentrations in boreholes 299-W26-8, 299-W26-9, and 299-W26-11.	Y	Y
			<i>Transmittal of Final Letter Report on Sampling and Analytical Activities at the 216-A-29 Ditch</i> , Work Order XE8028 (BHI 1998c) – Attachment, letter report, <i>Description and Results of Soil Analyses from the 216-A-29 Ditch</i> , report on soil samples from 216-A-29 ditch	Y	Y (for the ends of 216-A-29 ditch)
			<i>Borehole Summary Report for the 216-B-2-2 Ditch</i> , BHI-01177 (BHI 1998a) – Chemical contaminant concentrations at head end of 216-B-2-2 ditch.	Y	Y (216-B-63 trench-specific data needed)
1 and 3	Radiological pond/ditch bottom sample data	Y	<i>Environmental Surveillance Annual Reports</i> , 1975 through 1997 (ARH 1976, 1977; RHO 1977, 1978, 1979c, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987; WHC 1988b, 1988c, 1989, 1990c, 1991, 1992, 1993c, 1994, 1995b, 1996; FDH 1997a, 1998) – Reports note two to five sediment samples for each active surface waste site. Analyses for Sr-90, Cs-137, Pu-239/240, and U were routine. Some data for K-40, Mn-54, Co-60, Eu-154, Eu-155, and Am-241.	N	Y

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

PSQ #	Required Information Category	Does Data Exist? (Y/N)	Source Reference	Sufficient Quality to Validate Concept Model? (Y/N)	New Data Needed? (Y/N)
			<p><i>Soil/Sediment Characterization for the 216-A-29 Ditch</i>, HNF-SD-TWR-TI-005 (FDH 1997b) – Summary of radionuclide concentrations in the first 3 ft of soil in samples along the 216-A-29 ditch (considered screening level).</p> <p><i>Current Status of 200 Area Ponds</i>, RHO-CD-798 (RHO 1979b) – Radionuclide sediment concentration summary for 216-B-63 trench and 216-A-29 ditch.</p>	N	Y
			<p><i>Transmittal of Final Letter Report on Sampling and Analytical Activities at the 216-A-29 Ditch</i>, Work Order XE8028 (BHI 1998c) – Attachment, letter report, <i>Description and Results of Soil Analyses from the 216-A-29 Ditch</i>, report on soil samples from A-29 ditch.</p>	Y	Y (for the ends of 216-A-29 ditch)
2 and 3	Chemical pond/ditch bottom sample data	Y	<p><i>Soil/Sediment Characterization for the 216-A-29 Ditch</i>, HNF-SD-TWR-TI-005 (FDH 1997b) – Summary of chemical concentrations in the first 3 ft of soil samples taken along the 216-A-29 ditch (considered screening level).</p> <p><i>Transmittal of Final Letter Report on Sampling and Analytical Activities at the 216-A-29 Ditch</i>, Work Order XE8028 (BHI 1998c) – Attachment, letter report, <i>Description and Results of Soil Analyses from the 216-A-29 Ditch</i>, report on soil samples from 216-A-29 ditch</p>	N	Y
	Groundwater data	Y	<p><i>200 East Groundwater Aggregate Area Management Study Report</i>, DOE/RL-92-19 (DOE-RL 1992a) – Radioisotope and chemical plumes data for the 200 East Area.</p> <p><i>200 West Groundwater Aggregate Area Management Study Report</i>, DOE/RL-92-16 (DOE-RL 1993a) – Radioisotope and chemical plume data for 200 West Area.</p> <p><i>Hanford Site Groundwater Monitoring for Fiscal Year 1998</i>, PNNL-12086 (PNNL 1999) – Includes all RCRA TSD sites.</p> <p><i>Hanford Site Groundwater Monitoring for Fiscal Year 1997</i>, PNNL-11793 (PNNL 1998b) – Includes all RCRA TSD sites.</p>	Y	Y Monitoring data could support model development. But link to soil conc's is hypothetical.

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

PSQ #	Required Information Category	Does Data Exist? (Y/N)	Source Reference	Sufficient Quality to Validate Concept Model? (Y/N)	New Data Needed? (Y/N)
			<p><i>Hanford Site Groundwater Monitoring for Fiscal Year 1996</i>, PNNL-11470 (PNNL 1997b) – Includes all RCRA TSD sites.</p> <p><i>Results of the Groundwater Quality Assessment Program at the 216-A-29 Ditch Facility</i>, WHC-SD-EN-EV-132 (WHC 1995a) – Results to support reinstating indicator-evaluation program; groundwater samples had exceeded critical means for specific conductance.</p> <p><i>Hanford Groundwater Monitoring for 1994</i>, PNNL-10698 (PNNL 1995) – Notes continued high concentrations of Sr-90 in groundwater during 1994 monitoring.</p> <p><i>Hanford Site Environmental Report for CY 1996</i>, PNNL-11472 (PNNL 1997b) – Summary of groundwater contamination in the 200 East Area and surrounding 600 Areas.</p>		
1 and 3	Surface radiological contamination	Y	<p><i>An Aerial Radiological Survey of the Hanford Site and Surrounding Areas, Richland, WA</i>, EG&G-10617-1062 (EG&G 1990) – Photo overlay shows iso-radiation contours of gross count gamma radiation.</p> <p><i>An Aerial Radiological Survey of the Hanford Site and Surrounding Areas, Richland, WA</i> (EG&G 1980) – 1980 survey; no EGG document number. Photo overlay shows iso-radiation contours of gross count gamma radiation.</p>	N	N/A (the surface has been stabilized with clean soils and is monitored by S/M&T)
3 and 4	RCRA/CERCLA integration information	Y	<i>200 Areas Remedial Investigation/Feasibility Study Implementation Plan—Environmental Restoration Program</i> , Chapter 2, DOE/RL-98-28 (DOE-RL 1999)	Y	N
1 and 3	Waste site inventory data	Y	Radionuclide inventory data obtained from WIDS database – For selected sites; lists radionuclides with quantities decayed through April 8, 1998; no inorganic/organic constituents.	Y	N
1 and 3	RESRAD input data	Y	<p>Moisture content, particle size distribution, and lithology needed for determining soil density, hydraulic conductivity, and porosity.</p> <p>Erosion rate^a, B parameter^a, and hydraulic gradient can be determined from existing data.</p>	N	Y

^a Erosion rate and B parameter are RESRAD default settings provided in the *100 Area Remedial Design Report/Remedial Action Work Plan for the 100 Areas* (DOE-RL 1998).
S/M&T = Surveillance/Maintenance and Transition organization

Table 3-5 lists the information needed to perform quantitative assessments (in DQO Step 6) of the alternative actions with severe decision error consequences that were identified in DQO Step 2. This information is used to evaluate cost/schedule impacts and human/environmental risks.

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 chemical sewer waste group. The chemical sewer DQO results will support remedial field investigation decisions. The characterization data will be used to refine the site conceptual models, determine if remediation is needed, and support initial decisions regarding appropriate remedial alternatives. The remedial alternatives will then be evaluated in feasibility studies.				

Table 3-6 confirms that appropriate measurement methods exist to provide the necessary data in a list of potentially appropriate measurement methods (Table 3-1 provides the required information).

Table 3-6. Appropriate Measurement Methods.

P/WS #	Media	Environmental Variable	Potentially Appropriate Measurement Method	Possible Limitations or Reservations
The 200-CS-1 project will rely on standard fixed laboratories for soil sample analyses. Field screening data (e.g., x-ray fluorescence and Hach kit) may be used in conjunction with the laboratory data but will not be used to refine the preliminary conceptual contamination model or for remedial action decisions. The analytical techniques needed for the 200-CS-1 project are provided in Tables 3-7a and 3-7b.				

Tables 3-7a and 3-7b list the analytes (i.e., COCs) from Table 1-7 and the analytical methods proposed so the laboratory detection limits/practical quantification limits may be compared with the required COC action levels. This enables the DQO participants to verify that the detection capabilities for the proposed analytical methods meet the analytical requirements determined by the action levels. Table 3-7a addresses shallow zone (<4.6 m) soils, while Table 3-7b deals with the deep zone (>4.6 m) soils. The soil depth zones are based on MTCA action levels at 4.6 m (15 ft). Above 4.6 m, both direct exposure and groundwater/river protection cleanup standards apply; below 4.6 m, only groundwater/river protection standards apply. Note that the action levels for the deep zone are often more conservative than the shallow zone action levels.

Action levels are threshold values that provide the criteria for choosing between alternative action options. Action levels may be based on regulatory standards (e.g., ARARs), or the action levels may be derived from site-specific conditions (e.g., human

health risk assessments and PRGs). Because the ARARs and PRGs for 200-CS-1 have not been established through a Record of Decision (ROD), the preliminary ARARs/PRGs in Table 1-9 provide the basis for the radiological and chemical action levels shown in Tables 3-7a and 3-7b. The action levels presented in Tables 3-7a and 3-7b are used for setting analytical detection limits, not site cleanup limits.

**Table 3-7a. Analytical Performance Requirements –
Shallow Zone Soils. (3 pages)**

Analytical Method	Analyte	Preliminary Action Level ^a			Detection Limit Requirements ^{a,b}		Accuracy Req't	Precision Req't
		Ind	Cons	Cl/Close	MDL	PQL		
GeLi/HPGe AmAEA ^d	Americium-241	c	c	c	0.1	1	80-120	±30
		c	c	c	0.1	1	70-130	±30
GeLi/HPGe	Cesium-137	c	c	c	0.05	0.1	80-120	±30
GeLi/HPGe	Cobalt-60	c	c	c	0.05	0.1	80-120	±30
GeLi/HPGe	Europium-152	c	c	c	0.1	0.2	80-120	±30
GeLi/HPGe	Europium-154	c	c	c	0.1	0.2	80-120	±30
GeLi/HPGe	Europium-155	c	c	c	0.05	0.1	80-120	±30
GeLi/HPGe	Radium-228	c	c	c	0.1	0.2	80-120	±30
Gross alpha	Gross alpha	c	c	c	5	10	70-130	±30
Gross beta	Gross beta	c	c	c	3	15	70-130	±30
NpAEA ^d	Neptunium-237	c	c	c	0.1	1	70-130	±30
PuAEA ^d	Plutonium-238	c	c	c	0.1	1	70-130	±30
PuAEA ^d	Plutonium-239/240	c	c	c	0.1	1	70-130	±30
RADSr	Strontium-90	c	c	c	0.2	1	70-130	±30
ThAEA ^d	Thorium-232	c	c	c	0.1	1	70-130	±30
UAEA ^d	Uranium-233/234	c	c	c	0.1	1	70-130	±30
	Uranium-235/236	c	c	c	0.1	1	70-130	±30
	Uranium-238	c	c	c	0.1	1	70-130	±30
Analytical Method	Analyte	Preliminary Action Level ^a		Detection Limit Requirements ^{a,b}		Accuracy Req't	Precision Req't	
		MethC ^c	MethB ^c	MDL	PQL			
EPA 6010	Arsenic	6.5 ⁱ	6.5 ⁱ	2.5/0.2 ^g	10/1 ^g	70-130	±30	
EPA 6010	Barium	245 ^h	132 ^{h,i}	0.1	1	70-130	±30	
EPA 6010	Beryllium	1.51 ^f	1.51 ^f	0.03	0.2	70-130	±30	
EPA 6010	Cadmium	0.5 ^h	0.5 ^h	0.3	0.8	70-130	±30	
EPA 6010	Chromium (III)	3,500 ^h	1,600 ^h	0.4	1	70-130	±30	
EPA 7196	Hexavalent chromium	17.5	8.0	0.1	0.7	70-130	±30	
EPA 6010	Copper	130 ^h	59.2 ^h	0.5	2	70-130	±30	
EPA 6010	Lead	353 ^{h,i}	353 ^{h,i}	3	20	70-130	±30	
EPA 7471	Mercury	0.33 ^{h,i}	0.33 ^{h,i}	0.005	0.05	70-130	±30	
EPA 6010	Nickel	70 ^{h,i}	32 ^{h,i}	1	4	70-130	±30	
EPA 6010	Selenium	5 ^h	5 ^h	5	20	70-130	±30	
EPA 6010	Silver	10 ^h	8 ^h	0.7	2	70-130	±30	
EPA 6010	Vanadium	24.5 ^h	11.2 ^h	0.5	3	70-130	±30	
EPA 6010	Zinc	500 ^h	480 ^h	0.5	2	70-130	±30	
EPA 305.1	Ammonia	59,500	27,200	0.2	0.5	70-130	±30	
EPA 9010	Cyanide	20	20	0.25	1	70-130	±30	

**Table 3-7a. Analytical Performance Requirements –
Shallow Zone Soils. (3 pages)**

Analytical Method	Analyte	Preliminary Action Level ^a		Detection Limit Requirements ^{a,b}		Accuracy Req't	Precision Req't
		MethC ^c	MethB ^c	MDL	PQL		
EPA 300.0	Fluoride	200	96	0.2	1	70-130	±30
EPA 300.0, 353.1	Nitrate/Nitrite	4,400/330	4,400/30	0.02/0.1	0.2/0.5	70-130	±30
EPA 300.0	Sulfate	25,000	25,000	2	10	70-130	±30
EPA 300.0	Phosphate	N/A ⁿ	N/A ⁿ	0.6	6	70-130	±30
EPA 300.0	Chloride	25,000	25,000	0.2	2	70-130	±30
EPA 9030	Sulfide	N/A	N/A	4	20	70-130	±30
EPA 9045 or field measurement	pH	N/A	N/A	N/A	N/A	70-130	±30
EPA 8260	Acetone	175	80	0.05	0.01	70-130	±30
Analytical Method	Analyte	Preliminary Action Level ^a		Detection Limit Requirements ^{a,b}		Accuracy Req't	Precision Req't
		MethC ^c	MethB ^c	MDL	PQL		
EPA 8260	1-butanol (butyl alcohol)	350	160	0.4	1	70-130	±30
EPA 8260	2-butanone (MEK)	1,050	480	0.005	0.01	70-130	±30
EPA 8260	Methyl isobutyl ketone (MIBK)	140	6.4	0.005	0.01	70-130	±30
EPA 8260	Carbon tetrachloride	0.337	0.0337	0.001	0.005	70-130	±30
EPA 8260	Chloroform (trichloromethane)	7.17	0.717	0.001	0.005	70-130	±30
EPA 8260	Decane (TIC)			N/A	N/A	N/A	N/A
EPA 8260	Dichloromethane (methylene chloride)	0.5	0.5	0.002	0.005	70-130	±30
EPA 8260	Ethanol (TIC)			N/A	N/A	N/A	N/A
EPA 8260	Halogenated hydrocarbons			0.002	0.005	70-130	±30
EPA 8260	Propanol (isopropyl alcohol) (TIC)			N/A	N/A	N/A	N/A
EPA 8260	Toluene	100	100	0.001	0.005	70-130	±30
EPA 8260	Xylene	1,000	1,000	0.001	0.005	70-130	±30
EPA 8260	1,1,1-trichloroethane	20	20	0.001	0.005	70-130	±30
EPA 8260	1,1,2-trichloroethane	0.3	0.0768	0.001	0.005	70-130	±30
EPA 8082	Polychlorinated biphenyls	65 ⁿ	0.5 ⁿ	0.01	0.1	70-130	±30

**Table 3-7a. Analytical Performance Requirements –
Shallow Zone Soils. (3 pages)**

Analytical Method	Analyte	Preliminary Action Level ^a		Detection Limit Requirements ^{a,b}		Accuracy Req't	Precision Req't
		Meth C ^c	Meth B ^e	MDL	PQL		
NWTPH-Dx modified for kerosene range	Kerosene Normal paraffin hydrocarbon Paraffin hydrocarbons Shell E-2342 (naphthalene and paraffin) Soltrol-170 (C ₁₀ H ₂₂ to C ₁₆ H ₃₄) purified kerosene Diesel fuel			0.5	5	70-130	±30
Soil Physical Properties							
D2216	Moisture content	N/A	N/A	wt %		N/A	N/A
D422	Particle size distribution	N/A	N/A	wt %		N/A	N/A
Field measurement	Soil density	N/A	N/A	g/cm ³		N/A	N/A
BHI-EE-01, Procedure 7.0	Lithology	N/A	N/A	Descriptive		N/A	N/A

- ^a Units pCi/g or mg/kg.
^b The detection limits shown are based on optimal conditions. Interference and matrix affects may significantly degrade the values shown.
^c There are no values for these scenarios at this time; they will be developed in the remedial investigation/feasibility study process.
^d AmAEA, PuAEA, UAEA, NpAEA, ThAEA – chemical separation, electro/microprecipitation deposition, alpha energy analysis via Si barrier detector.
^e Method C values are based on *Model Toxics Control Act* industrial standards; Method B values are based on residential standards.
^f Based on Hanford Site background values.
^g First values shown are routine ICP results, the second values are "race" inductively coupled plasma or graphite furnace atomic absorption results.
^h The RESRAD model for the 100 Area remedial design/remedial action and 100-N Area corrective measures study predicts that this constituent will not reach groundwater in 1,000 years. It is assumed that the same will be true in the 200 Areas.
ⁱ The lead value is based on the IEUBK model from the U.S. Environmental Protection Agency (EPA 1994b).
^j Nickel as a soluble salt.
 GeLi = lithium-drifted germanium detector
 HPGe = high-purity germanium
 N/A = not applicable
 TBD = to be determined

**Table 3-7b. Analytical Performance Requirements –
Deep Zone Soils. (4 pages)**

Analytical Method	Analyte	Preliminary Action Level ^b		Detection Limit Requirements ^{a,b}		Accuracy Req't	Precision Req't
		Meth C ^d	Meth B ^d	MDL	PQL		
GeLi/HPGe AmAEA ^b	Americium-241			0.1	1	80-120	±30
				0.1	1	70-130	±30
GeLi/HPGe	Cesium-137			0.05	0.1	80-120	±30
GeLi/HPGe	Cobalt-60			0.05	0.1	80-120	±30
GeLi/HPGe	Europium-152			0.1	0.2	80-120	±30

**Table 3-7b. Analytical Performance Requirements –
Deep Zone Soils. (4 pages)**

Analytical Method	Analyte	Preliminary Action Level ^b		Detection Limit Requirements ^{a,b}		Accuracy Req't	Precision Req't
		Meth C ^d	Meth B ^d	MDL	PQL		
GeLi/HPGe	Europium-154			0.1	0.2	80-120	±30
GeLi/HPGe	Europium-155			0.05	0.1	80-120	±30
GeLi/HPGe	Radium-228			0.1	0.2	80-120	±30
Gross alpha	Gross alpha			5	10	70-130	±30
Gross beta	Gross beta			3	15	70-130	±30
NpAEA ^o	Neptunium-237			0.1	1	70-130	±30
Chem Sep Liq Scintil	Nickel-63			5	30	70-130	±30
PuAEA ^o	Plutonium-238			0.1	1	70-130	±30
PuAEA ^o	Plutonium-239/240			0.1	1	70-130	±30
RADSr	Strontium-90			0.2	1	70-130	±30
Chem Sep, Liq Scintil	Technetium-99			5	15	70-130	±30
Distillation, Liquid Sep	Tritium			5	400	70-130	±30
ThAEA ^o	Thorium-232			0.1	1	70-130	±30
UAEA ^o	Uranium-233/234			0.1	1	70-130	±30
	Uranium-235/236			0.1	1	70-130	±30
	Uranium-238			0.1	1	70-130	±30
EPA 6010	Arsenic	6.5 ^{e,t}	6.5 ^{e,t}	2.5/ 0.2 ^o	10/1 ^o	70-130	±30
EPA 6010	Barium	245 ^t	132 ^{e,t}	0.1	1	70-130	±30
EPA 6010	Beryllium	1.51 ^e	1.51 ^e	0.03	0.2	70-130	±30
EPA 6010	Cadmium	0.5 ^t	0.5 ^t	0.3	0.8	70-130	±30
EPA 6010	Chromium (III)	3,500 ^t	1,600 ^t	0.4	1	70-130	±30
EPA 7196	Hexavalent chromium	17.5	8.0	0.1	0.7	70-130	±30
EPA 6010	Copper	130 ^t	59.2 ^t	0.5	2	70-130	±30
EPA 6010	Lead	353 ^{o,n}	353 ^{o,n}	3	20	70-130	±30
EPA 7471	Mercury	0.33 ^{e,t}	0.33 ^{e,t}	0.005	0.05	70-130	±30
EPA 6010	Nickel	70 ^{t,j}	32 ^{t,j}	1	4	70-130	±30
EPA 6010	Selenium	5 ^t	5 ^t	5	20	70-130	±30
EPA 6010	Silver	10 ^t	8 ^t	0.7	2	70-130	±30
EPA 6010	Vanadium	24.5 ^t	11.2 ^t	0.5	3	70-130	±30
EPA 6010	Zinc	500 ^t	480 ^t	0.5	2	70-130	±30
EPA 305.1	Ammonia	59,500	27200	0.2	0.5	70-130	±30
EPA 9010	Cyanide	20	20	0.25	1	70-130	±30
EPA 300.0	Fluoride	200	96	0.2	1	70-130	±30
EPA 300.0; 353.1	Nitrate/ Nitrite	4,400/ 330	4,400/ 330	0.02/ 0.1	0.2/0.5	70-130	±30
EPA 300.0	Sulfate	25,000	25,000	2	10		
EPA 300.0	Phosphate	N/A ^t	N/A ^t	0.6	6		
EPA 300.0	Chloride	25,000	25,000	0.2	2		
EPA 9030	Sulfide	N/A	N/A	4	20	70-130	±30
EPA 9045 or field measurement	pH	N/A	N/A	N/A	N/A	70-130	±30
EPA 8260	Acetone	175	80	0.05	0.01	70-130	±30

**Table 3-7b. Analytical Performance Requirements –
Deep Zone Soils. (4 pages)**

Analytical Method	Analyte	Preliminary Action Level ^b		Detection Limit Requirements ^{a,b}		Accuracy Req't	Precision Req't
		Meth C ^d	Meth B ^d	MDL	PQL		
EPA 8260	1-Butanol (butyl alcohol)	350	160	0.4	1	70-130	±30
EPA 8260	2-Butanone (MEK)	1,050	480	0.005	0.01	70-130	±30
EPA 8260	Methyl isobutyl ketone (MIBK)	140	6.4	0.005	0.01	70-130	±30
EPA 8260	Carbon tetrachloride	0.337	0.0337	0.001	0.005	70-130	±30
EPA 8260	Chloroform (trichloromethane)	7.17	0.717	0.001	0.005	70-130	±30
EPA 8260	Decane (TIC)			N/A	N/A	N/A	N/A
EPA 8260	Dichloromethane (methylene chloride)	0.5	0.5	0.002	0.005	70-130	±30
EPA 8260	Ethanol (TIC)			N/A	N/A	N/A	N/A
EPA 8260	Halogenated hydrocarbons			0.002	0.005	70-130	±30
EPA 8260	Propanol (isopropyl alcohol) (TIC)			N/A	N/A	N/A	N/A
EPA 8260	Toluene	100	100	0.001	0.005	70-130	±30
EPA 8260	Xylene	1,000	1,000	0.001	0.005	70-130	±30
EPA 8270	Tributyl phosphate			0.4	4	70-130	±30
EPA 8260	1,1,1-trichloroethane	20	20	0.001	0.005	70-130	±30
EPA 8260	1,1,2-trichloroethane	0.3	0.0768	0.001	0.005	70-130	±30
EPA 8082	Polychlorinated biphenyls	65 ^f	0.5 ^f	0.01	0.1	70-130	±30
NWTPH-Dx modified for kerosene range	Kerosene Normal paraffin hydrocarbon Paraffin hydrocarbons Shell E-2342 (naphthalene and paraffin) Soltrol-170 (C ₁₀ H ₂₂ to C ₁₆ H ₃₄) purified kerosene Diesel fuel			0.5	5	70-130	±30
Soil Physical Properties							
D2216	Moisture content	N/A	N/A	wt %		N/A	N/A
D422	Particle size distribution	N/A	N/A	wt %		N/A	N/A

**Table 3-7b. Analytical Performance Requirements –
Deep Zone Soils. (4 pages)**

Analytical Method	Analyte	Preliminary Action Level ^b		Detection Limit Requirements ^{a,b}		Accuracy Req't	Precision Req't
		Meth C ^d	Meth B ^d	MDL	PQL		
Field measurement	Soil density	N/A	N/A	g/cm ³		N/A	N/A
BHI-EE-01, Procedure 7.0	Lithology	N/A	N/A	Descriptive		N/A	N/A

^a The detection limits presented are based on optimal conditions. Interference and matrix effects may significantly degrade the values shown.

^b Units pCi/g or mg/kg.

^c AmAEA, PuAEA, UAEA, NpAEA, ThAEA - chemical separation, electro/microprecipitation deposition, alpha energy analysis via Si barrier detector.

^d Method C values are based on *Model Toxics Control Act* industrial standards; Method B values are based on residential standards.

^e Based on Hanford Site background values.

^f 100 Area RESRAD model results show that this constituent will not reach the groundwater in 1,000 years.

^g First values shown are routine ICP results, second values are "trace" inductively coupled plasma or graphite furnace atomic absorption results.

^h The lead value is based on the IEUBK model from the U.S. Environmental Protection Agency (EPA 1994b).

ⁱ Nickel as a soluble salt.

GeLi = lithium-drifted germanium detector

HPGe = high-purity germanium

N/A = not applicable

TBD = to be determined

4.0 STEP 4 -- DEFINE THE BOUNDARIES OF THE STUDY

Step 4 of the DQO process is used to define the spatial and temporal boundaries of the study to clarify what the samples are intended to represent. Table 4-1 specifies the characteristics that define the population of interest.

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

DS #	Population of Interest	Characteristics	Unit Measurement Size	Total Number of Potential Measurement Units Within the Population ^a
All	Chemical sewer high concentration soils	Soil radionuclide and chemical concentrations that contribute to potential annual exposures	4,000 g soil sample	11,066 possible soil samples in high concentration soils
	Chemical sewer moderate concentration soils			22,132 possible soil samples in moderate concentration soils
	Chemical sewer low concentration soils			22,132 possible soil samples in low concentration soils

^a This column shows how many 4,000 g samples could be collected from the three concentration zones predicted in the conceptual models for all four treatment, storage, and disposal sites being characterized. This calculation allows a comparison between the final sampling design and the number of samples that could potentially be collected.

Table 4-2 defines the domain, geographic area, or volume where all decisions must apply. Physical features (e.g., length, width, and/or depth) typically mark the decision domain.

Table 4-2. Geographic Areas of Investigation.

DS #	Geographic Areas of Investigation
All	Two representative RCRA TSD units (216-A-29 ditch and 216-S-10D ditch).
	Two additional RCRA TSD units (216-B-63 trench and 216-S-10P pond).

Table 4-3 is used to divide the sample population into strata that have relatively homogeneous characteristics. The waste site grouping report evaluated process knowledge, historical, and plant configurations on a waste group-specific basis. This information was refined for the two representative TSD sites and the two TSD characterization sites through a site-specific evaluation to align the sample population into strata with homogeneous characteristics.

Table 4-3. Strata with Homogeneous Characteristics.

DS #	Population of Interest	Strata	Homogeneous Characteristic Logic
1, 2, 3, and 4	Chemical sewer surface soils	Stabilizing fill over each waste site	Soils placed as past stabilization cover to prevent migration of surface contaminants.
		Sediment layers at the bottom of the ponds and ditches (about the first 6 ft of pond/ditch sediment/soils below stabilizing fill)	This is a zone in the conceptual model that is expected to contain the highest concentrations of contaminants due to the build-up of sediments (or pond sediment layer) on the bottom of the ponds and ditches that could have historically sorbed or filtered contaminants.
3 and 4	Chemical Sewer shallow vadose zone	Soils below the sediment layer to about 15 to 25 ft below ambient grade	This is a zone in the conceptual model that is expected to contain moderate concentrations of moderately mobile contaminants because immobile contaminants would have concentrated in the pond/ditch sediment layer while more mobile contaminants would be located in the deeper soils.
1, 2, and 3	Chemical sewer deep vadose zone soils	Soils deeper than 15 to 25 ft below grade	This is a zone in the conceptual model that is expected to contain low concentrations of mobile contaminants. Contaminant concentrations are expected to decrease with depth.

Table 4-4 defines the spatial scale of decision making for the chemical sewer waste group sites. This decision unit is the smallest area or volumetric unit for which each decision applies.

Table 4-4. Spatial Scale of Decision Making. (2 pages)

<p>The spatial scale of decision making for the chemical sewer waste group is defined below.</p> <p>Remedial action decision-making depths:</p> <ul style="list-style-type: none"> • Shallow vadose zone soils <ul style="list-style-type: none"> - Pond sediment layer at the bottom of ponds/ditches (approximately the first 6 ft below cover soil layer) - Soils from 6 ft below cover soil layer to about 15 ft below grade (216-A-29 and 216-S-10D) and 25 ft below-grade (216-B-63 and 216-S10P) • Deep vadose zone soils (>25 ft) • Pipeline and cover soils.
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Table 4-4. Spatial Scale of Decision Making. (2 pages)

Remedial Action Decision-Making Depths

Remedial action decision making focuses on the contamination profile in the 0- to 15- or 25-ft-depth interval based on MCACES cost models. For viable Containment sites (e.g., 216-B-63 and 216-S-10P), the models show that modified RCRA surface barriers become more cost effective than the excavate and dispose alternative in the 15- to 20-ft-depth range. Therefore, the data required to support remedial action decisions for the chemical sewer sites requires analytical data to at least 25 ft below the local grade elevation. For viable excavate and dispose sites (e.g., 216-A-29 and 216-S-10D), the decision-making depth is 15 ft, as directed by MTCA direct exposure requirements. The 15-ft depth is critical in determining the potential depth of excavation to comply with direct human exposure and groundwater/river protection standards. Two depth intervals are subsets of the 0- to 15- or 25-ft depths: (1) the ditch/pond sediment layer (up to 6 ft below the historical ditch/pond bottom), and (2) the soils below the sediment layer (starting at approximately 6 ft below the ditch/pond bottom but not extending deeper than 15 or 25 ft below ambient grade).

- Shallow vadose zone soils

Ditch/pond sediment layer

The sediment layer at the bottom of the ponds/ditches is expected to contain the highest contamination levels at each waste site. This zone has the greatest likelihood of exceeding action levels and is of primary importance for shallow zone remediation decisions. If contamination in this layer is less than action levels (ARARs or PRGs), the shallow zone soils are not expected to require remedial action.

The onset of this zone is expected to be detectable by radiological field screening measurements for beta/gamma activity, plus visual inspection of the soils (to detect the difference between the stabilizing soil and the ditch sediment particle size).

Soils from 1.8 to 4.6 or 7.6 m below the ditch/pond bottom

The soils below the ditch/pond sediment layer are expected to contain moderate contamination concentrations. If the contaminant concentrations in the sediment layer exceed regulatory action levels, the soils below the pond sediment layer then become the most critical zone for regulatory action level evaluation, remedial action decisions, and conceptual model verification. However, if the contamination levels in the ditch/pond sediment layer are less than action levels, analysis of the soils below the sediment layer will be primarily used to verify the conceptual model.

- Deep vadose zone soils

The deep vadose zone soils (greater than 4.6 or 7.6 m below grade) are represented in the conceptual model as having decreasing contamination levels with depth. This is an area of importance to verify the conceptual model and define the potential depth of excavation.

- Pipeline and cover soils

The pipelines and cover soils are considered analogous to the waste sites as discussed in Table 1-13. The decisions established for the ponds/ditches will also apply to the pipelines and cover soils.

Tables 4-5 through 4-7 define the temporal boundaries of the decision.

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 chemical sewer waste group. The consequences of actions taken due to the Phase I RFI are considered "not severe." The sites will be accessible for additional sampling after the Phase I RFI is completed, and confirmatory and remedial design sampling efforts are planned after the Phase I RFI is completed. Following the guidance in Table 4-5a, the sampling design rigor required for the chemical sewer waste group sites is "low." A judgmental sample design is considered adequate for Phase I RFI sampling.

Table 4-5a. 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 4-6. When to Collect Data.

Measurement	Measurement Objective	Influencing Conditions	Measurement/Condition Constraints (time units)
Field Screening/Soil Sample Collection			
Radiological	Beta/gamma 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.
Chemical	Metals in soils		
Laboratory Sample Analyses			
Radiological	Alpha, beta, and gamma isotopic concentrations in the soils	Extremely cold weather conditions may influence soil sample integrity.	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)		

Table 4-7. Temporal Scale of Decision Making.

No temporal scale of decision making was identified for the 200-CS-1 DQO.

Table 4-8 identifies the practical constraints on data collection for the chemical sewer waste group sites.

Table 4-8. Practical Constraints on Data Collection.

Sampling Constraints

Sampling the ditch/pond sediment layer will require careful visual observation to ensure that the sediment layer is exposed (i.e., stabilization soils/gravels have been removed) before collecting sediment layer samples. Samplers must carefully remove the stabilizing soil/gravel layers during backhoe sampling and observe expected changes in the media grain size, color, and perhaps beta/gamma activity (via field screening) at the onset of the sediment layer.

Backhoe collection of thin layers (6 ft 1 in.) may mix soil layers. Boreholes may not obtain sufficient volumes of sample media if the sampled zone is 2-ft thick or less. Borehole drive barrels 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 ditch/pond sediment layer are expected to be typical Hanford Site soils. These soils should be easily recognizable and should not pose unusual sampling problems.

Excavator access to the head-end of the 216-S-10D ditch may be limited due to steep side slopes.

Excavator sampling depths are typically limited to 25 ft or less. Test pit or trench depths beyond 25 ft may be attempted but cannot be assured.

Other Constraints

No as low as reasonably achievable issues or other sampling constraints are expected for the chemical sewer waste group sites.

No laboratory analysis or field screening constraints are expected for the ditch/pond sediment or soil contaminants of concern, except that extreme weather conditions may limit or shut down field screening operations.

5.0 STEP 5 – DEVELOP A DECISION RULE

Table 5-1 lists the key statistical parameters that characterize the population.

Table 5-1. Key Statistical Parameters.

DS #	Decision Statement Summary	Parameter of Interest
All	Refer to Table 2-1 for decision statements.	Maximum detected values

Table 5-2 specifies the scale of the decisions.

Table 5-2. Scale of the Decisions.

Refer to Table 4-4.

Table 5-3 specifies the action levels for the decision statements.

Table 5-3. Action Levels for the Decisions.

DS #	COCs	Action Level
1, 3, and 4	Radiological COCs	Shallow zone action levels in Table 3-7a
2, 3, and 4	Chemical COCs	
1 and 3	Radiological COCs	Deep zone action levels in Table 3-7b
2 and 3	Chemical COCs	

Table 5-4 lists the potential actions under consideration for the chemical sewer.

Table 5-4. Summary of Potential Alternative Actions.

PSQ #	AA #	Alternative Actions
1, 2, and 4	1	Evaluate streamlined approach to site closure.
	2	Evaluate remedial alternatives for implementation.
3	1	Apply conceptual contaminant distribution model for remedy selection and remedial action planning.
	2	Revise the conceptual contaminant distribution model for remedy selection and remedial action planning.

The previous DQO step information is combined in DQO Step 5 to develop "IF... THEN" statements (decision rules) that combine the parameters of interest, the decision scales, the COC action levels, and the potential actions that would result through the resolution of chemical sewer decisions. Table 5-5 identifies the decision rules.

Table 5-5. Decision Rules.

DR #	Decision Rules
1	If the RESRAD results for the maximum detected concentrations of the radiological COCs in the sediment layer exceed annual exposure limits for human health protection (under the appropriate exposure scenario), then remedial alternatives ^a will be evaluated for the sediment layer in a feasibility study.
2	If the RESRAD results for the maximum detected concentrations of the soil radiological COCs from the top of the sediment layer (about 6 ft bgs) to 15 or 25 ft below grade (below the sediment layer) exceed annual exposure limits for human health protection (under the appropriate scenario), then remedial alternatives ^a will be evaluated for these soils in a feasibility study.
3	If the maximum detected concentrations of chemical COCs in the sediment layer exceed the Table 3-7a action levels, then remedial alternatives ^a will be evaluated for the sediment layer in a feasibility study.
4	If the maximum detected concentrations of soil chemical COCs from the top of the sediment layer (about 6 ft bgs) to 15 or 25 ft (below the sediment layer) exceed the Table 3-7b action levels, then remedial alternatives ^a will be evaluated for these soils in a feasibility study.
5	If contaminant distribution in the 0- to 15- or 25-ft zone and deep vadose zone (>15 or 25 ft bgs) for all four TSD sites sampled differ significantly from the conceptual contaminant distribution model, then the conceptual contaminant distribution model requires revision prior to use in remedial decision or remedial action planning efforts for the three non-TSD sites.

^a As described in the chemical sewer project objectives. The actual selection of remedial alternatives is beyond the DQO scope.

RESRAD = RESidual RADioactivity dose model

TSD = treatment, storage, and disposal

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 the error occurs within these error limits. The established error limits are used to estimate the number of samples needed and to establish performance goals for the newly collected data.

Sampling designs may be based on statistical principles or professional judgment. Neither approach is absolutely correct. The choice between these two approaches depends upon project objectives, available data/information, alternative actions under consideration, and the consequences associated with the alternative actions. The primary objective in DQO Step 6 is to select a statistical or judgmental sample design.

Determining whether a statistical sample design is needed can be achieved by using the following logic diagram (Figure 6-1) to evaluate the severity of the consequences of erroneous actions identified in DQO Step 2 (Table 2-1) and the sampling rigor requirements identified in DQO Step 4 (Table 4-5). If a sample design based on professional judgment is indicated, proceed to DQO Step 7.

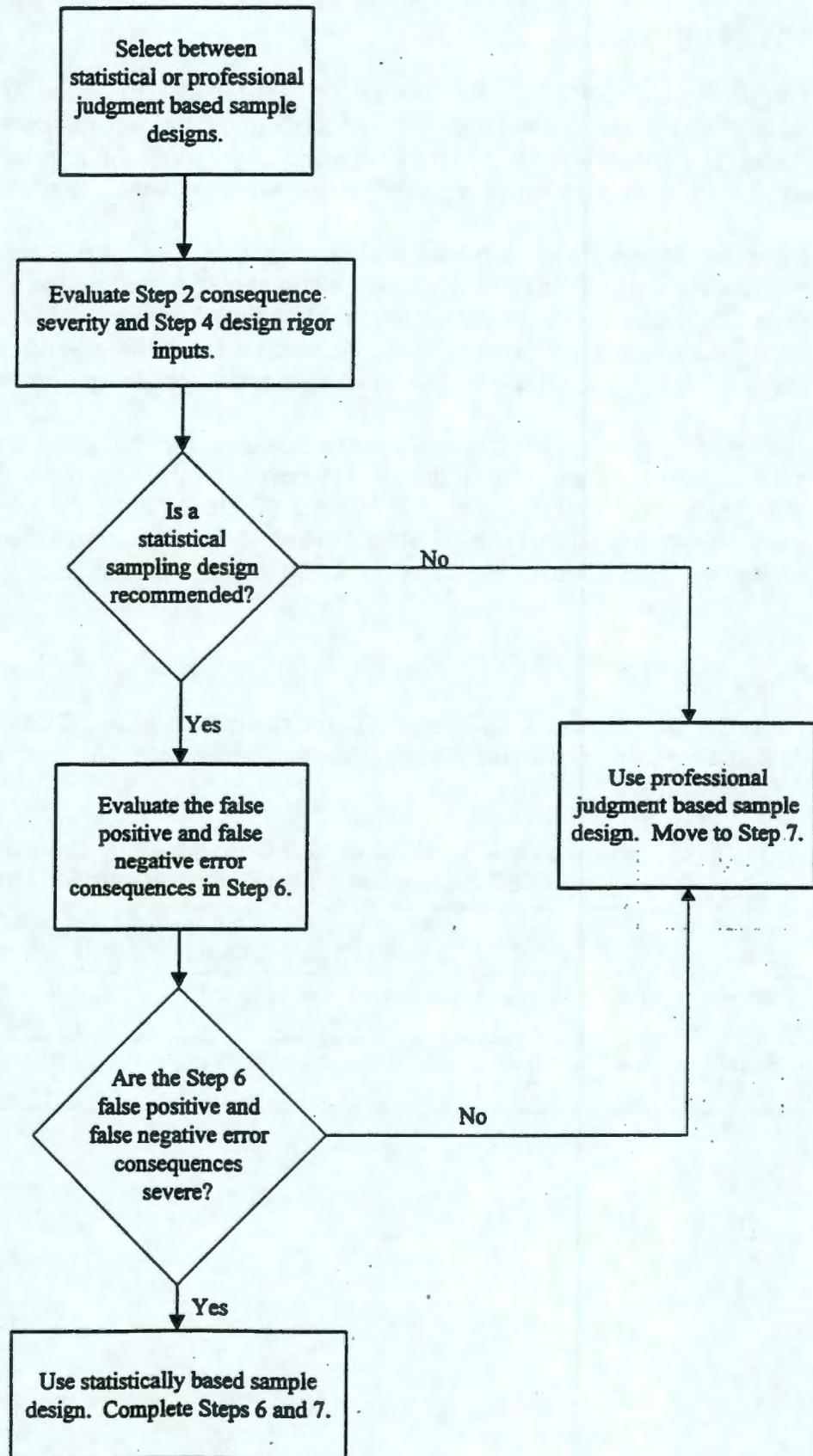
6.2 WORKSHEETS FOR DQO STEP 6

Table 6-1 summarizes DQO Step 2 (consequence severity), DQO Step 4 (sample design rigor), and preliminary sample design basis decisions.

Table 6-1. DQO Step 2 Consequence Severity and DQO Step 4 Sampling Design Rigor Summary.

DQO Step	PSQ #	AA #	Erroneous Action Consequence Severity/Sampling Design Rigor	Preliminary DQO Step 6 Sample Design Basis
Step 2	1-4	1 and 2	"Not severe" per Table 2-1	Non-statistical sampling design
Step 4	1-4	1 and 2	"Low" design rigor per Table 4-5	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 develop the most resource-effective design for new data collection to support project decisions while maintaining the desired degree data quality (e.g., precision and accuracy). In developing the optimal design, the following activities were performed:

- Review the outputs from DQO Steps 1 through 6 and any existing environmental data
- Develop general data collection design alternatives
- Select the optimal sample numbers/volumes that satisfy the project goals
- Select the sampling design that most resource-effectively satisfies the project goals
- Document the operational details and assumptions for the selected design.

7.2 WORKSHEETS FOR DQO STEP 7

Table 7-1 summarizes DQO Step 6 outputs regarding the appropriate sampling design (statistical/non-statistical) for each decision rule and the rationale for the sampling design selection.

Table 7-1. Determine Data Collection Design.

Decision Rules	Statistical	Non-Statistical	Rationale
All	None	All	The consequences of erroneous decisions are not severe. Judgmental design rigor is indicated. Characterization results will be verified by confirmatory sampling of analogous sites during the remedial design phase.

The data collection design for all decision rules will be non-statistical. Table 7-2 documents the type of non-statistical design selected (haphazard or judgmental).

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

Decision Rules	Haphazard	Judgmental
All	None	A judgmental sampling design is indicated.

Table 7-3 summarizes the sampling design alternatives for the chemical sewer TSDs.

Table 7-3. Methods for Collecting Soil Samples at Depth.

Method	Description
Trenching or test pits	Excavation with backhoe or excavator. This technique allows grab samples to be taken directly from the soil column (approximately 1-ft intervals) or from the excavator bucket.
Cone penetrometer	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 are often required to meet laboratory analysis needs.
Auger drilling	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, a 2-ft core sample is typically needed. Running a sample tube down the hollow center of the flight retrieves split tube samples.
Cable tool drilling	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, a 2-ft-long core sample is typically needed. The DOE-owned controlled cable tool rigs are available onsite.
Sonic drilling	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 2-ft-long core sample is typically needed. Sonic drilling is much faster than cable tool but the technique generates a significant amount of heat, which can alter samples and the surrounding formation.
Air rotary drilling	Air rotary 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 2-ft-long core sample is typically needed. This technique may introduce air into the soil, potentially altering the samples.

Tables 7-4a through 7-4d summarize the sample design options for each 200-CS-1 TSD site that will be characterized. The discussions presented focus on costs and the ability of the design options to comply with DQO constraints. The key features of the selected design are documented.

Table 7-4a. Key Features of Sampling Design for the 216-A-29 Ditch. (2 pages)

Sampling Methodology	Key Features of Design	Basis for Sampling Design
<p>Borehole sampling (to groundwater)</p>	<p>One borehole location at the influent end of the ditch where all previous influent paths converged (see Figure 7-1). A shallow trench perpendicular to the ditch (or some other technique [i.e., ground-penetrating radar]) may be used to locate the borehole in the deepest portion of the channel.</p> <p>Starting at the historical ditch sediment layer (about 2 to 8 ft bgs), collect shallow zone samples at 2.5-ft intervals to a depth of 10 ft below the onset of the ditch sediment layer. Also collect a sample at 15 ft bgs. Deep zone samples would be collected at 20 ft, 25 ft and 50 ft, then at about 50-ft intervals to groundwater (approximately 235 ft). One of these deep zone samples would be collected at the maximum elevation of the local groundwater "mound" during site operations (based on historical records). Critical sample depths are at the ditch sediment layer, at 15 ft, 20 ft, and 25 ft bgs. RLS borehole logging should be performed.</p>	<p>The decision to use a single borehole was driven by the conceptual vertical contamination distribution model and cost. There were several influent paths to the 216-A-29 ditch. The COC levels are expected to be highest where all previous influent paths converged.</p> <p>A borehole is needed to verify the vertical COC profile beneath the ditch. The borehole will extend to groundwater (but will not include a groundwater sample) to identify COC concentrations through the vadose zone, verifying the conceptual vertical contaminant distribution model. A 15-ft sample will not be collected if the 15-ft sampling depth falls within a 2.5-ft sampling interval to 10 ft below the onset of the ditch sediment layer. The sampling depths identified correspond to the top of the sample interval.</p>
	<p>Deep zone samples (>15 ft) would be analyzed for all COCs in Table 1-7. Shallow zone samples would be analyzed for the Table 1-7 COCs, except for H-3, Ni-63, and Tc-99</p> <p>Borehole soil samples would be analyzed for the RESRAD physical property inputs (e.g., moisture content, particle size distribution, and lithology).</p>	<p>H-3, Ni-63, and Tc-99 are not included in shallow zone analyses because they are highly mobile and are only expected to be present in the deep zone soils.</p> <p>Physical property data from the borehole samples are needed for RESRAD modeling.</p>
<p>Trench, test pit, or auger drill sampling and analysis in the 0 to 25-ft elevation bgs</p>	<p>Two sample locations are proposed, one at the upper end of the ditch in the most recent influent channel, and one at the lower end of the ditch above the B-3 ditch confluence (see Figure 7-1). Trenching may be used to locate ditch channel.</p> <p>Starting at the historical ditch sediment layer, collect soil samples at 2.5-ft intervals to 10 ft below the ditch sediment layer (approximately 12 to 18 ft bgs). Also collect a soil sample at 15 ft bgs. Field screening for beta/gamma activity and visual subsurface soil inspections would be used to optimize the sampling intervals identified. Critical sample depths are at the ditch sediment layer, 15 ft bgs.</p>	<p>Trenches, test pits, and auger holes are cost-effective methods of collecting multiple samples in the upper soil strata (to 25 ft bgs) to determine local COC distribution, compare COC levels against action levels, and support selection of remedial design alternatives. The sampling depths identified correspond to the top of the sample interval.</p> <p>Previous soil sampling in the middle section of the ditch (BHI 1998c) is expected to support 216-A-29 decisions in this area (see Figure 7-1 for previous sampling locations). A 15-ft sample will not be collected if the 15-ft sampling depth falls within a 2.5-ft sampling interval to 10 ft below the onset of the ditch sediment layer.</p>

Table 7-4a. Key Features of Sampling Design for the 216-A-29 Ditch. (2 pages)

Sampling Methodology	Key Features of Design	Basis for Sampling Design
	<p>Samples would be analyzed for the chemical COCs identified in Table 1-7, except for COCs not detected in a previous study (BHI 1998c). Samples would be analyzed for the radioactive COCs identified in Table 1-7.</p> <p>No samples from this effort will be analyzed for physical soil properties (e.g., moisture content, particle size distribution, and lithology).</p>	<p>No pipeline sample locations are proposed because the 216-A-29 influent pipeline was not reported to leak.</p> <p>Sampling in the primary channel should assess the shallow zone vertical extent of contamination and the highest contamination zone. Laboratory analysis would help confirm expected high waste concentrations in the main channel. Beta/gamma field screening and visual soil inspections could define the lateral extent of contamination perpendicular to the ditch edges.</p> <p>No additional physical property data are needed from the trench/auger/test pit effort. The physical property data developed for the borehole samples will be sufficient to satisfy project needs.</p>

Table 7-4b. Key Features of Sampling Design for the 216-B-63 Trench. (2 pages)

Sampling Methodology	Key Features of Design	Basis for Sampling Design
Borehole sampling (to 100-ft)	<p>One borehole location at the influent end of the trench (see Figure 7-2). A shallow excavation, perpendicular to the 216-B-63 trench (or some other technique [e.g., ground-penetrating radar] may be used to locate the borehole in the deepest portion of the trench.</p> <p>Starting at the historical trench sediment layer (about 2 to 8 ft bgs), collect shallow zone samples at 2.5-ft intervals to a depth of 10 ft below the onset of the trench sediment layer. Also collect samples at 15, 20, and 25 ft bgs. Deep zone samples would be collected at 25 ft, 50 ft, and 100 ft. Critical sample depths are at the trench sediment layer, 15 ft, and 25 ft bgs. RLS borehole logging should be performed.</p> <p>Deep zone samples (>15 ft) would be analyzed for all COCs in Table 1-7. Shallow zone samples would be analyzed for the Table 1-7 COCs, except for H-3, Ni-63, and Tc-99.</p> <p>Borehole soil samples would be analyzed for the RESRAD physical property inputs (e.g., moisture content, particle size distribution, and lithology).</p>	<p>The decision to use a single borehole was driven by the conceptual vertical contamination distribution model and cost. The COC levels are expected to be highest at the influent end of the trench. The sampling depths identified correspond to the top of the sample interval.</p> <p>A borehole is needed to verify the vertical COC profile beneath the trench. The borehole will extend to 100 ft to identify COC concentrations through the vadose zone, verifying the conceptual vertical contaminant distribution model. Existing data from the nearby B-2-2 borehole would provide COC information below 100 ft. A 20- or 25-ft sample will not be collected if the sampling depth falls within a 2.5-ft sampling interval to 10 ft below the onset of the trench sediment layer or within 2 ft of the last sampling interval.</p> <p>H-3, Ni-63, and Tc-99 are not included in shallow zone analyses because they are highly mobile and are only expected to be present in the deep zone soils.</p> <p>Physical property data from the borehole samples are needed for RESRAD modeling.</p>

**Table 7-4b. Key Features of Sampling Design
for the 216-B-63 Trench. (2 pages)**

Sampling Methodology	Key Features of Design	Basis for Sampling Design
<p>Trench, test pit, and auger drill sampling and analysis in the 0- to 25-ft elevation bgs</p>	<p>Two sample locations along the trench are proposed (see Figure 7-2).</p> <p>Starting at the historical trench sediment layer, collect soil samples at 2.5-ft intervals to 10 ft below the trench sediment layer (about 12 to 18 ft bgs). Also collect soil samples at 15 ft, 20 ft, and 25 ft bgs. Field screening for beta/gamma activity and visual subsurface soil inspections would be used to optimize the sampling intervals identified. Critical sample depths are at the trench sediment layer and at 15, 20, and 25 ft bgs.</p> <p>Samples would be analyzed for the chemical and radioactive COCs identified in Table 1-7.</p> <p>No samples will be analyzed for physical soil properties (e.g., moisture content, particle size distribution, or lithology).</p>	<p>Trenches, test pits, and auger drills are cost-effective methods to determine vertical COC distribution, to compare COC levels against action levels, and to support selection of remedial design alternatives. Pipeline leaks are expected to migrate primarily downward, lateral contaminant spread is not expected to be as extensive for the pipeline as it is for the trench.</p> <p>Sampling in the primary channel should assess the shallow zone vertical extent of contamination and the highest contamination zone. Laboratory analysis would help confirm expected high waste concentrations in the main channel. Beta/gamma field screening and visual soil inspections could define the lateral extent of contamination perpendicular to the trench edges.</p> <p>The sampling depths identified correspond to the top of the sample interval. A 20- or 25-ft sample will not be collected if the sampling depth falls within a 2.5-ft sampling interval to 10 ft below the onset of the trench sediment layer or within 2 ft of the last sampling interval.</p> <p>The 216-B-63 pipeline reportedly leaked extensively between the north wall of B Plant and the 217-B Building (within about 200 ft of B Plant). Due to the proximity of the leak area to the plants the fact that this area is outside the TSD unit boundary, potential conflicts with plant disposition plans, and possible problems with underground utilities near the plants, no pipeline sampling is proposed at this time in the leak area.</p> <p>No additional physical property data are needed from the trench/auger/test pit effort. The physical property data developed for the borehole samples will be sufficient to satisfy project needs.</p>

**Table 7-4c. Key Features of Sampling Design
for the 216-S-10D Ditch. (2 pages)**

Sampling Methodology	Key Features of Design	Basis for Sampling Design
<p>Borehole sampling (to groundwater)</p>	<p>One borehole location in the backfilled portion at the influent end of the ditch (see Figure 7-3). A shallow trench, perpendicular to the ditch (or some other technique [e.g., ground-penetrating radar]), may be used to locate the borehole in the deepest portion of the channel.</p> <p>Starting at the historical ditch sediment layer (about 2 to 8 ft bgs), collect shallow zone samples at 2.5-ft intervals to a depth of 10 ft below the onset of the ditch sediment layer. Also collect a sample at 15 ft bgs. Deep zone samples would be collected at 20 ft, 25 ft and 50 ft, then at about 50-ft intervals to groundwater (approximately 225 ft). One of these deep zone samples would be collected at the maximum elevation of the local groundwater "mound" during site operations (based as historical records). Critical sample depths are at the ditch sediment layer and at 15 ft bgs. RLS borehole logging should be performed.</p> <p>Deep zone samples (>15 ft) would be analyzed for all COCs in Table 1-7. Shallow zone samples would be analyzed for the Table 1-7 COCs, except for H-3, Ni-63, and Tc-99.</p> <p>Borehole soil samples would be analyzed for the RESRAD physical property inputs (moisture content, particle size distribution, and lithology).</p>	<p>The decision to use a single borehole was driven by the conceptual vertical contamination distribution model and cost. The COC levels are expected to be highest at the influent end of the ditch.</p> <p>A borehole is needed to verify the vertical COC profile beneath the ditch. The borehole will extend to groundwater (but will not include a groundwater sample) to identify COC concentrations through the vadose zone, verifying the conceptual vertical contaminant distribution model. The sampling depths identified correspond to the top of the sample interval. A 15-ft sample will not be collected if the 15-ft sampling depth falls within a 2.5-ft sampling interval to 10 ft below the onset of the sediment layer.</p> <p>H-3, Ni-63, and Tc-99 are not included in shallow zone analyses because they are highly mobile and are only expected to be present in the deep zone soils.</p> <p>Physical property data from the borehole samples are needed for RESRAD modeling.</p>

**Table 7-4c. Key Features of Sampling Design
for the 216-S-10D Ditch. (2 pages)**

Sampling Methodology	Key Features of Design	Basis for Sampling Design
<p>Trench, test pit, and auger drill sampling and analysis in the 0- to 25-ft elevation bgs</p>	<p>Two sample locations, at the upper and lower sections of the ditch, are proposed (see Figure 7-3). Trenching may be used to locate ditch channel.</p> <p>The upper ditch location has not been filled and is too steep for heavy equipment access. Therefore, surface soil samples (to about 3 ft) would be collected with hand tools. Samples would be collected from the current ditch surface and at about 3 ft bgs.</p>	<p>Trenches, test pits and auger drills are cost-effective methods to determine vertical COC distribution, to compare COC levels against action levels, and to support selection of remedial design alternatives. The sampling depths identified correspond to the top of the sample interval.</p> <p>Sampling in the primary channel should assess the shallow zone vertical extent of contamination and the highest contamination zone. Laboratory analysis would help confirm expected high waste concentrations in the main channel. Beta/gamma field screening and visual soil inspections could define the lateral extent of contamination perpendicular to the ditch edges.</p> <p>A 15-ft sample will not be collected if the 15-ft sampling depth falls within a 2.5 ft sampling interval to 10 ft below the onset of the ditch sediment layer.</p>
	<p>For the lower ditch location, starting at the historical ditch sediment layer, collect soil samples at 2.5-ft intervals to 10 ft below the ditch sediment layer (approximately 12 to 18 ft bgs). Also collect a soil sample at 15 ft bgs. Field screening for beta/gamma activity and visual subsurface soil inspections would be used to optimize the sampling intervals identified. Critical sample depths are at the ditch sediment layer and at 15 ft bgs.</p> <p>Samples would be analyzed for the chemical and radioactive COCs identified in Table 1-7.</p> <p>No samples will be analyzed for physical soil properties (e.g., moisture content, particle size distribution, or lithology).</p>	<p>No pipeline sample locations are proposed because the 216-S-10D ditch influent pipe was not reported to leak.</p> <p>No additional physical property data are needed from the trench/auger/test pit effort. The physical property data developed for the borehole samples will be sufficient to satisfy project needs.</p>

**Table 7-4d. Key Features of Sampling Design
for the 216-S-10P Pond. (2 pages)**

Sampling Methodology	Key Features of Design	Basis for Sampling Design
<p>Borehole sampling (to groundwater)</p>	<p>One borehole location at the influent end (north end) of the pond just outside the historic pond boundary (see Figure 7-3).</p> <p>Beginning at 50 ft bgs, deep zone samples would be collected at about 50-ft intervals to groundwater (approximately 200 ft). One of these deep zone samples would be collected at the maximum elevation of the local groundwater "mound" during site operations (based as historical records). RLS borehole logging should be performed.</p> <p>Deep zone samples would be analyzed for all COCs in Table 1-7.</p>	<p>The decision to use a single borehole was driven by the conceptual vertical contamination distribution model and cost. The COC levels are expected to be highest at the influent end of the pond. The sampling depths identified correspond to the top of the sample interval.</p> <p>A borehole is needed to verify the vertical COC profile beneath the pond. The borehole will extend to groundwater (but will not include a groundwater sample) to identify COC concentrations through the vadose zone, verifying the conceptual vertical contaminant distribution model. (NOTE: The RCRA monitoring well planned in the vicinity of the 216-S-10P pond (see Figure 7-3) will be logged and sampled to satisfy 200-CS-1 characterization needs and RCRA groundwater monitoring requirements.</p> <p>The planned RCRA well would be completed downgradient and outside the waste site boundary to meet regulatory requirements.</p> <p>For 216-S-10P Pond, the shallow zone samples will be collected from a test pit within the northern portion of the waste site, in the vicinity of the well. No shallow zone samples will be collected from the well.</p>
	<p>Borehole soil samples would be analyzed for the RESRAD physical property inputs (moisture content, particle size distribution, and lithology).</p>	<p>Physical property data from the borehole samples are needed for RESRAD modeling.</p>

**Table 7-4d. Key Features of Sampling Design
for the 216-S-10P Pond. (2 pages)**

Sampling Methodology	Key Features of Design	Basis for Sampling Design
<p>Trench, test pits, or auger drill sampling and analysis in the 0- to 25-ft elevation bgs</p>	<p>Four locations are proposed within the historical pond "footprint" along the north, west, south, and east edges (see Figure 7-3). The west side location would be along one of the middle lobes of the pond. The sample sites should be located near the pond edge.</p> <p>Starting at the historical pond sediment layer, collect soil samples at 2.5-ft intervals to 10 ft below the pond sediment layer (approximately 12 to 18 ft bgs). Also collect a soil sample at 15, 20, and 25 ft bgs. Field screening for beta/gamma activity and visual subsurface soil inspections would be used to optimize the sampling intervals identified. Critical sample depths are at the pond sediment layer, 15 ft and 25 ft bgs.</p> <p>Samples would be analyzed for the chemical and radioactive COCs identified in Table 1-7.</p> <p>No samples will be analyzed for physical soil properties (e.g., moisture content, particle size distribution, or lithology).</p>	<p>Trenches, test pits and auger holes are cost-effective methods of collecting multiple samples in the upper soil strata (to 25 ft bgs) to determine lateral COC distribution, to compare COC levels against action levels, and to support selection of remedial design alternatives. The sampling depths identified correspond to the top of the sample interval.</p> <p>Sampling along the pond edge should assess the shallow zone vertical extent of contamination and the highest contamination zone. Beta/gamma field screening and visual soil inspections could define the lateral extent of contamination perpendicular to the pond edges.</p> <p>A 15, 20, or 25 ft bgs sample will not be collected if the sampling depth falls within a 2.5-ft sampling interval to 10 ft below the onset of the pond sediment layer or within 2 ft of the last sampling interval.</p> <p>No pipeline sample locations are proposed because no pipelines are associated with the 216-S-10P pond.</p> <p>No additional physical property data are needed from the trench/auger/test pit effort. The physical property data developed for the borehole samples will be sufficient to satisfy project needs.</p>

Table 7-5 documents key considerations for alternative sampling strategies.

Table 7-5. Comparison of Alternative Sampling Strategies. (2 pages)

Decision Rules	Alternatives	Potential Disadvantages	Discussion
All	1. Additional borehole locations; use additional boreholes instead of trenching or auger drilling techniques.	Additional cost, extended schedule.	<p>Boreholes are an expensive and time-consuming alternative to trenches and auger holes, especially for shallow zone sample collection. However, boreholes allow for geophysical logging while auger holes/trenches do not.</p> <p>The conceptual contaminant distribution model suggests there is little variability in the deep vadose zone below the moderately contaminated area. Little or no advantage would be expected from additional deep zone samples. The cost of more deep zone samples would be significant.</p>
	2. Cone penetrometer	Limited sample volume and grain size. Limited penetration in coarse-grained media. Depth limited in 200 Area soils to <50 ft.	<p>This method can be used to quickly sample numerous locations and produces no drill cuttings to dispose. Specialized equipment allows for collecting samples at depth but the sample volumes would not allow for the full range of COC analyses required for this project. Also, a separate push is required for each sample. Geophysical logging can be performed although quality may not be comparable to borehole geophysical techniques. Gamma logging of cone penetrometer holes may be used as an indicator of contamination; however, resolution is generally poor, due to the small detector size.</p>
	3. Additional trench or auger drill locations	Increased cost; expanded schedule; no incremental decision-making benefit.	<p>The use of multiple trenches or auger drill locations will be evaluated on a case-by-case basis. The trench sampling strategy focuses on areas most likely to exceed the action levels, and areas most critical for remedial alternative evaluation (e.g., the 0- to 25-ft-depth zone).</p> <p>Sampling will be performed in each of the representative sites, providing a basis for remedial decision making.</p>

Table 7-5. Comparison of Alternative Sampling Strategies. (2 pages)

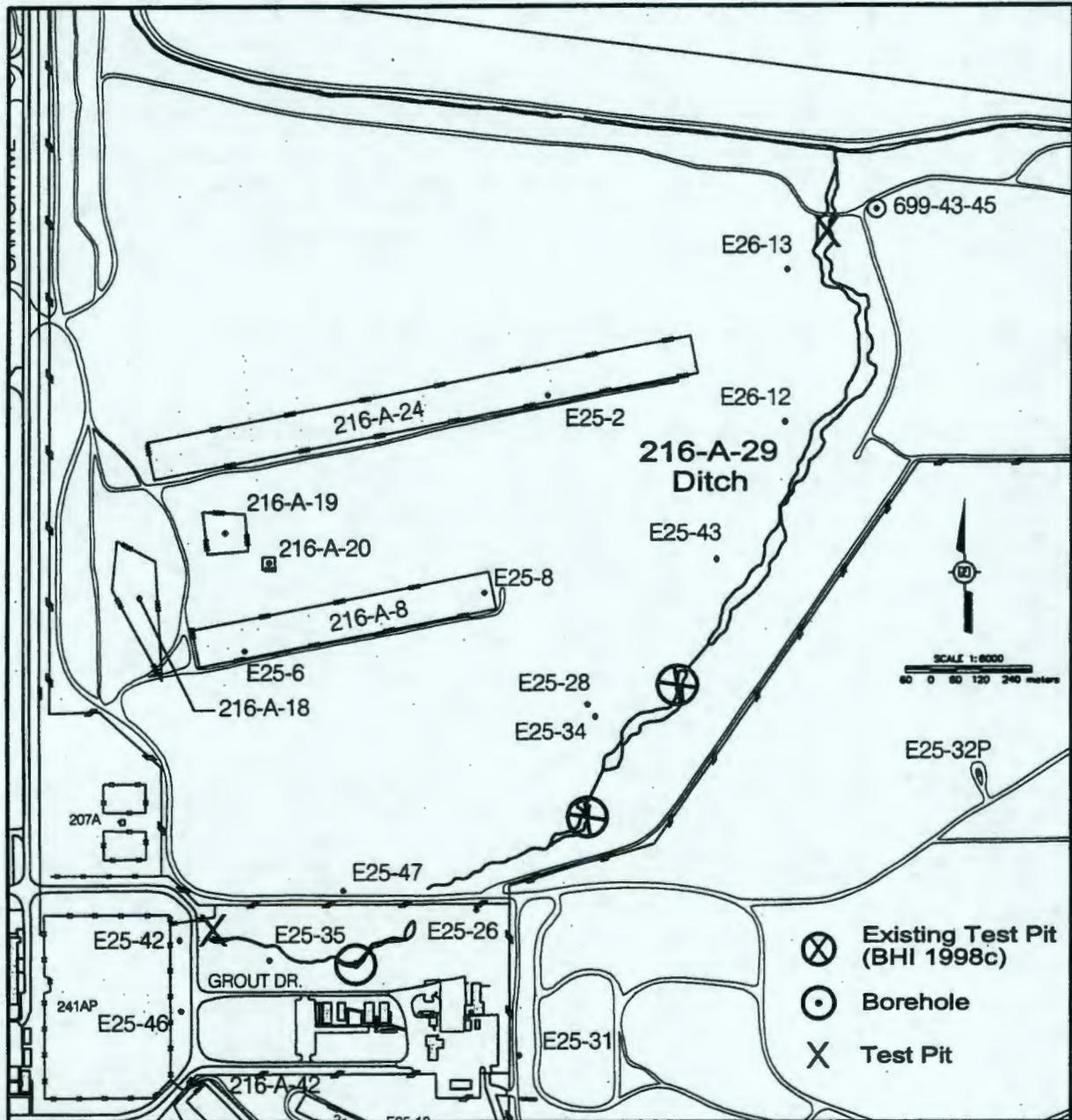
Decision Rules	Alternatives	Potential Disadvantages	Discussion
	4. Sonic drilling instead of cable tool drilling	Degraded sample quality; increased contaminant release potential.	Sonic drilling heats the sampled media and surrounding soils. Likely destruction of organic constituents, degrading sample results.
	5. Air rotary drilling instead of cable tool drilling	Degraded sample quality; increased contaminant release potential.	Introduction of air to sample media affects analytical results for volatile organics and it can be difficult to control the dust resulting from this drilling technique.

Table 7-6 summarizes the sampling frequencies and sampling locations.

Table 7-6. Summary of Sampling Frequencies and Locations.

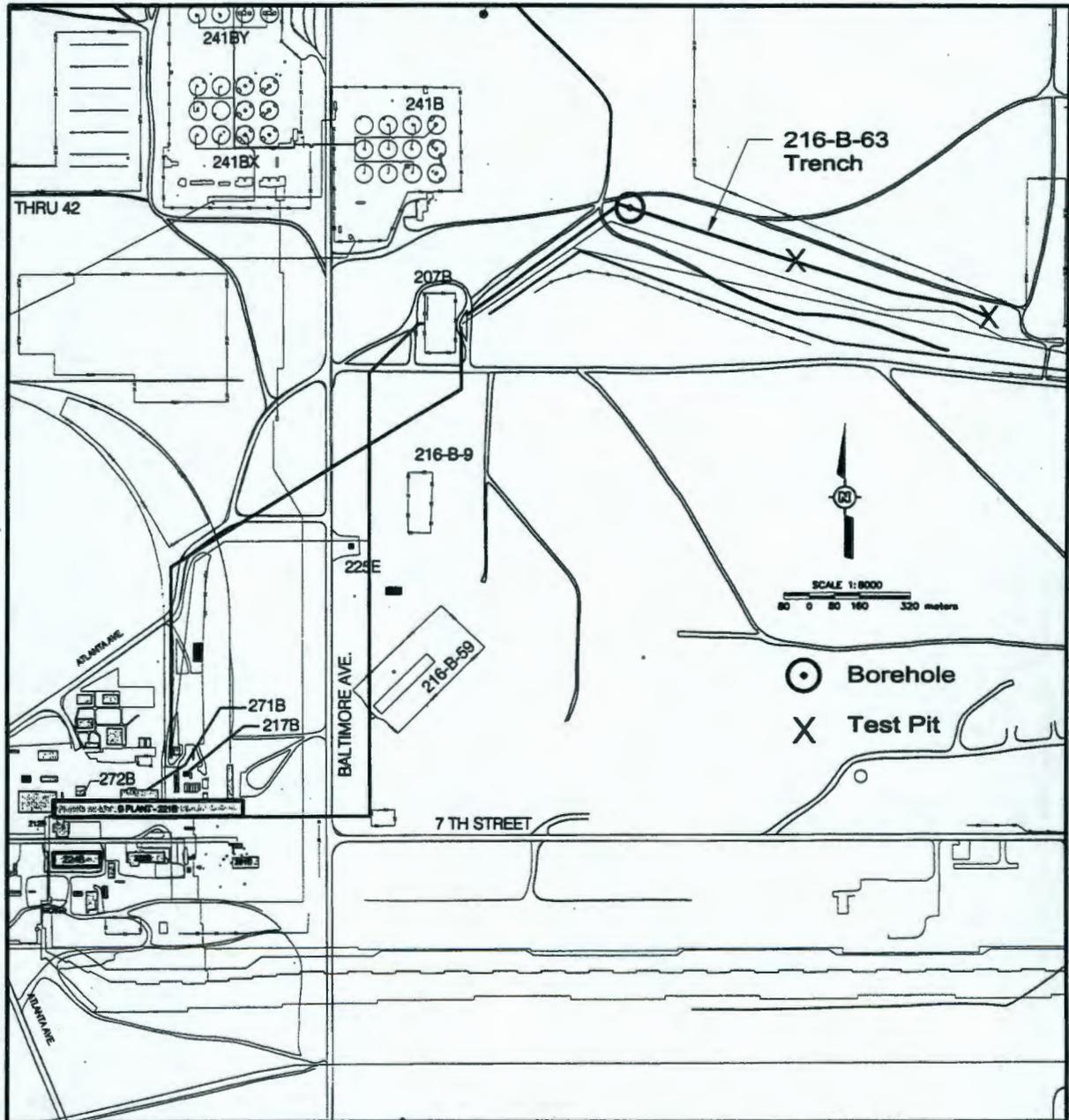
Waste Site	Sampling Methodology	No. of Sample Locations	Sampling Location
Borehole Drilling			
216-A-29 ditch	Generally locate borehole where the highest contaminant concentrations are expected. Sample periodically with depth (see Tables 7-4a to 7-4d). The 216-S-10P pond borehole samples will be provided by logging and sampling a nearby RCRA monitoring well during its construction.	1	See Figure 7-1
216-B-63 trench		1	See Figure 7-2
216-S-10D ditch		1	See Figure 7-3
216-S-10P pond		1	See Figure 7-3
Trench/Test Pit/Auger Drilling			
216-A-29 ditch	Trench, test pit, or auger to 25 ft below grade at each site sampled. Sample periodically with depth (see Tables 7-4a to 7-4d).	2	See Figure 7-1
216-B-63 trench		2	See Figure 7-2
216-S-10D ditch		2	See Figure 7-3
216-S-10P pond		4	See Figure 7-3

Figure 7-1. Sampling Locations for the 216-A-29 Ditch.



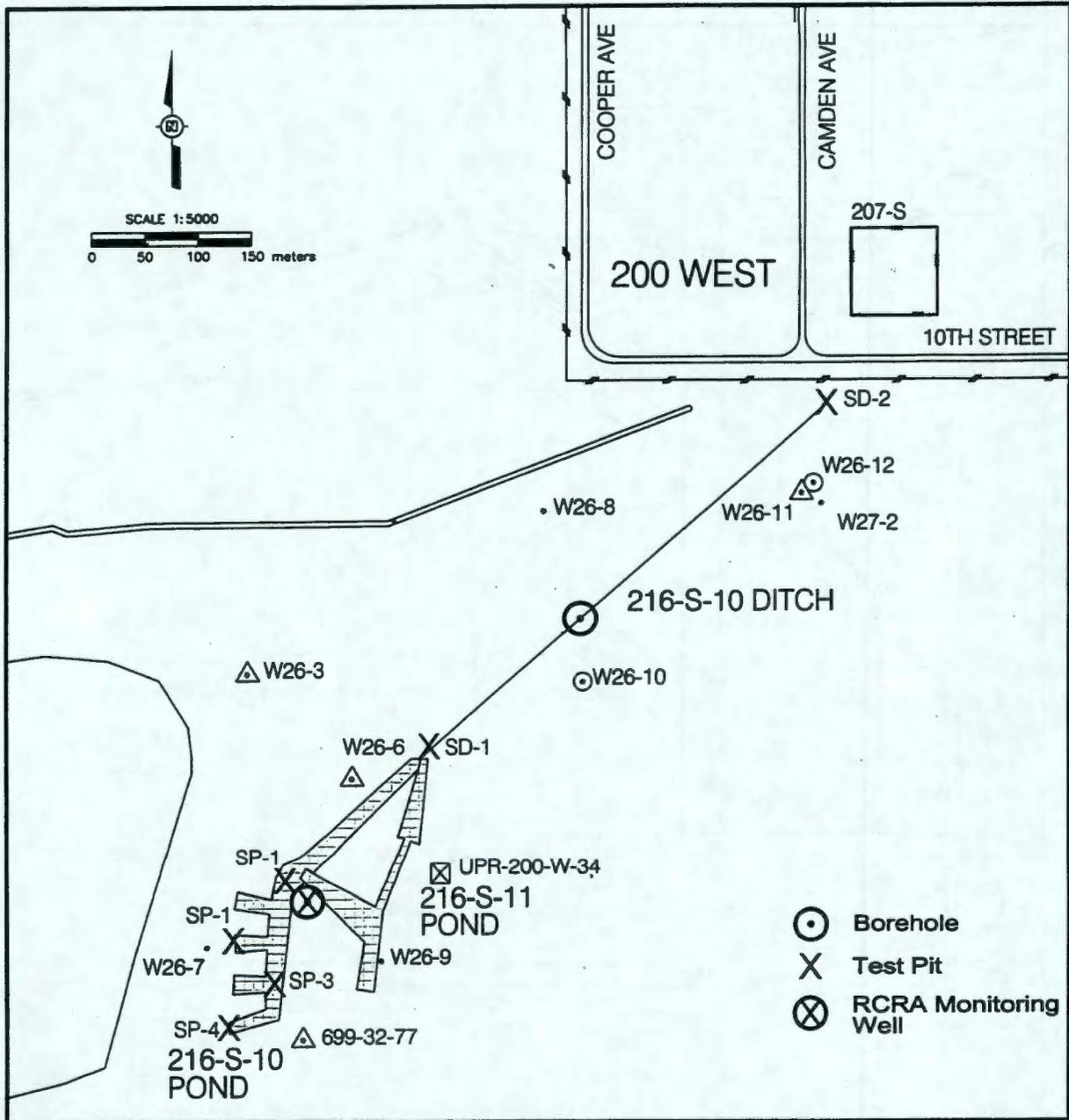
C:\Maps\051499A.DWG

Figure 7-2. Sampling Locations for the 216-B-63 Trench.



G:\Maps\051499B.DWG

Figure 7-3. Sampling Locations for the 216-S-10 Ditch and Pond.



G:\Maps\051299C.DWG

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