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Rev. 0

200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report

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

Submitted by: Bechtel Hanford, Inc.

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200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Remedial Investigation DQO Summary Report

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Date Published

January 1999

EXECUTIVE SUMMARY

This data quality objectives (DQO) summary report supports remedial action decision-making activities for two representative sites and two treatment, storage, and disposal (TSD) units in the 200-CW-1 Gable Mountain Pond/B-Pond and Ditch Cooling Water Waste Group, and to confirm the preliminary site conceptual model. This waste group consists of twenty-eight waste sites that received mostly cooling water from a variety of 200 Area process facilities.

The sampling locations were selected with the goal of intersecting the highest area of contamination and also to determine the vertical and lateral extent of contamination at the historical boundaries of the waste sites. The type, concentration, and vertical and lateral extent of radiological and chemical contaminants are the major data needs. Twenty-nine sampling locations were selected in the representative sites. Samples will be collected from two boreholes and twenty-seven test pits (or auger boreholes) at these sites. Boreholes will be used to sample the vadose zone to groundwater, and the test pits will sample from the surface to 4.6 meters below the local grade elevation.

Data quality was addressed during the DQO session by identifying potential contaminants of concern and establishing associated analytical performance criteria. Analytical performance criteria were based on preliminary applicable, or relevant and appropriate requirements (ARARs) and preliminary remediation goals (PRGs) selected in the absence of ARARs and PRGs specified in a ROD. These preliminary action levels provide the basis for identifying analytical performance levels (i.e., laboratory detection limit requirements). Detection limit requirements and standards for precision and accuracy are used to define data quality.

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ACRONYMS

ARAR	applicable or relevant and appropriate requirements
CERCLA	*Comprehensive Environmental Response, Compensation and Liability Act of 1980*
CMP	corrugated metal pipe
COC	contaminants of concern
COPC	contaminant of potential concern
DQO	data quality objectives
PRG	preliminary remediation goals
PUREX	Plutonium Uranium Reduction Extraction Facility
RCRA	*Resource Conservation and Recovery Act of 1976*
RI	remedial investigation
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

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	millimeters
inches	2.54	centimeters
feet	0.305	meters
yards	0.914	meters
miles	1.609	kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	metric ton
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius
Radioactivity		
picocuries	37	millibecquerel

Out of Metric Units

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

1.0 STEP 1 - STATE THE PROBLEM

1.1 INTRODUCTION

This data quality objective (DQO) process is to support remedial action planning and decision-making for 200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group sites in the Hanford 200 East Area. The DQO process used for this project is a U.S. Environmental Protection Agency (EPA) approach to planning/coordinating data acquisition requirements and decision-making.

To accomplish the goals of the DQO, four representative sites in the 200-CW-1 Operable Unit will be investigated to determine the nature and extent of contamination in the vadose zone. 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 workbook identifies characterization requirements that will support the development of a sampling and analysis plan (SAP).

1.2 PROJECT OBJECTIVES

The primary objective of the data quality objectives (DQO) process for the 200-CW-1 Gable Mountain Pond/B-Pond and Ditch Cooling Water Waste Group is to determine the environmental measurements necessary to support remedial decision making (i.e., remedial investigation) and to confirm the preliminary site conceptual model. Possible remedial alternatives under consideration include:

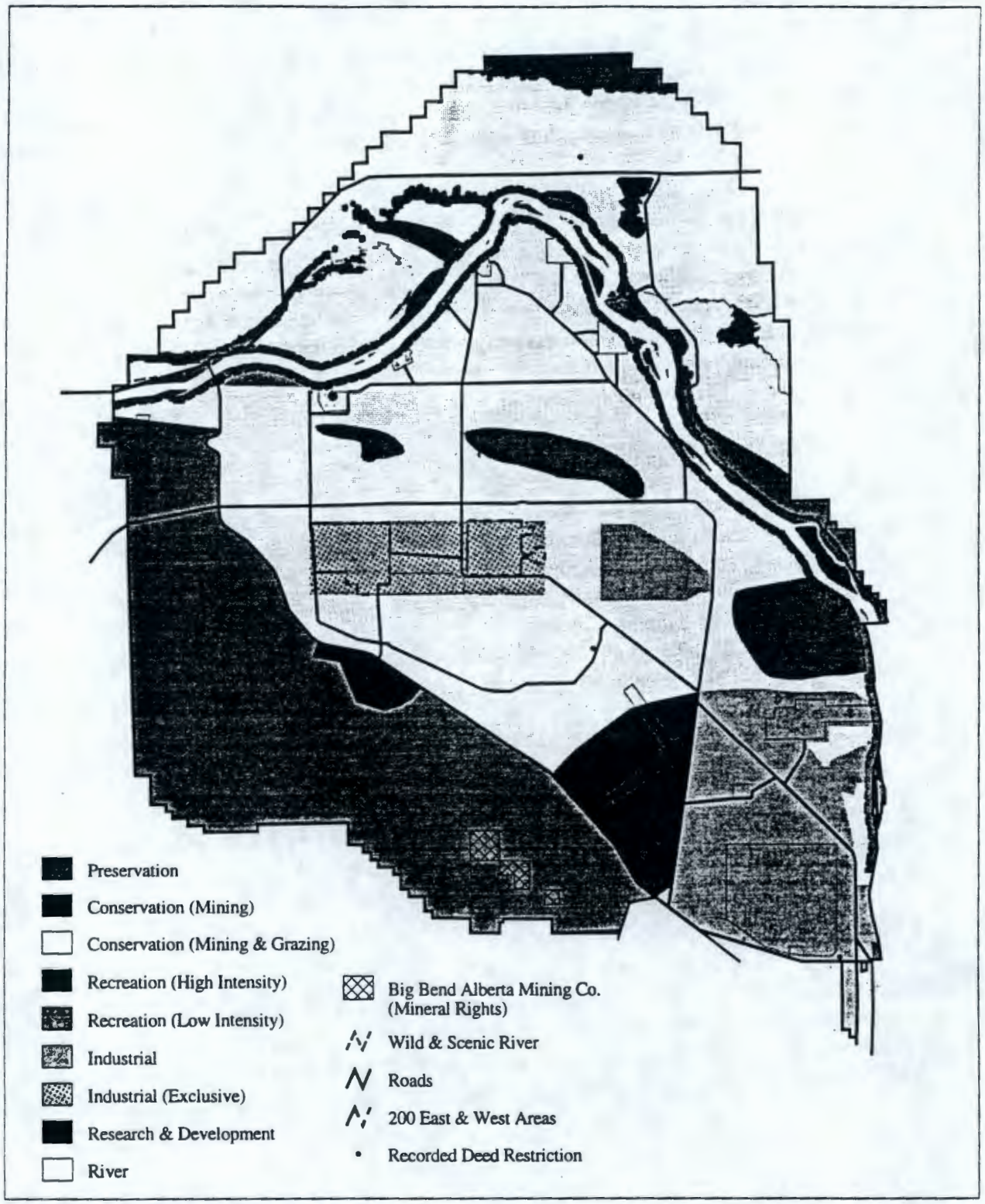
- No-Action Alternative (no institutional controls)
- Capping
- Excavate and Dispose of Waste
- Monitored Natural Attenuation (with institutional controls)

A secondary objective of the Gable Mountain Pond/B-Pond DQO Process is to develop generic aspects of the 200-CW-1 DQOs for application in other 200 Area waste groups or sites.

1.3 BACKGROUND

This DQO uses boundaries and land use alternatives that are a "snapshot in time" from the Hanford Remedial Action Environmental Impact Statement (HRA-EIS) 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.

Figure 1-1. Preferred Alternative Plan from the Hanford Remedial Action Environmental Impact Statement.



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The sites within the scope of this DQO Process are being remediated in an integrated *Resource Conservation and Recovery Act of 1976* (RCRA)/*Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) approach. There are 28 waste sites within the 200-CW-1 group. Of these, the 216-B-2-2 Ditch and Gable Mountain Pond (216-A-25) were selected as representative (typical and worst case) sites in the 200 Areas Waste Site Grouping Report (DOE/RL-96-81). The characterization performed in the representative sites will apply to other sites within the group. The 216-B-3, B-3A, B-3B, and B-3C ponds and the 216-B-3-3 Ditch are RCRA TSD units because the received effluent from the 216-A-29 Ditch which in turn received discharges from the Plutonium Uranium Reduction Extraction Facility (PUREX) chemical sewer. The 216-B-3-3 Ditch and 216-B-3 Pond TSD units are the RCRA representative sites that will also be characterized in this effort. The 216-B-3A, B-3B, and B-3C Expansion Lobes to B-Pond will not be characterized, as they were clean closed in 1994. However, radiological contamination will still need to be addressed in the 216-B-3A, B-3B, and B-3C Expansion Lobes during remediation of the 200-CW-1 waste group.

The Gable Mountain Pond, B-Pond, and associated ditches shared similar cooling and waste waters from the various operating facilities (see Section 1.4). When both Gable Mountain Pond and B Pond were operational, generally 25% of the flow was diverted to the B-3 Pond system, while the remaining 75% was directed to the Gable Mountain Pond.

Figures 1-2 through 1-4 depict the layout of the 200 East Area waste sites and source facilities addressed by this DQO report. Figure 1-2 is a vicinity map that shows the 200 East Area relative to Washington State and the Hanford Site. Figures 1-3 and 1-4 show the relationships between the source facilities and the waste sites.

Ditches and pipelines conveyed water to the Gable Mountain and B Ponds. A 42-inch diameter corrugated metal pipe (CMP) approximately 2.5 km long was used to convey wastewater from 200 East Area facilities to the Gable Mountain Pond. At the end of the 216-B-2 Ditches (B Plant wastewater) wastewater could be channeled either to the Gable Mountain Pond (via a 0.4 km-long, 24-inch-diameter CMP to the main 42-inch pipeline) or 216-B-3 Ditches (with a 0.4 km-long, 24-inch diameter vitrified clay pipeline). Other wastewater sources (other than B Plant) were conveyed to the ponds via a common 30 to 36-inch CMP that connected to the 42-inch pipeline to Gable Mountain Pond in the vicinity of the headend of the 216-B-3 Ditches. At this connection wastewater could be diverted to 216-B-3 Ditches or to the 42-inch pipeline to Gable Mountain Pond.

1.4 OPERATING HISTORY

The B-Pond system (207-B Retention Basin, 216-B-2-1 and 216-B-3-1 ditches, and 216-B-3 Pond) became operational in 1945 with the startup of the $BiPO_4$ process at B-Plant. Discharges to the system were principally cooling water (raw Columbia River water) with additions from steam condensate and chemical sewers. There is no process knowledge that breaks down the percentage contribution from the various process waste streams. The $BiPO_4$ process ceased in late 1952. However, raw water discharges continued from the plant. 284-E Powerhouse and water treatment system discharges were routed to the B-3-1 ditch when the PUREX complex was completed.

Figure 1-2. 200 East Area Vicinity Map.

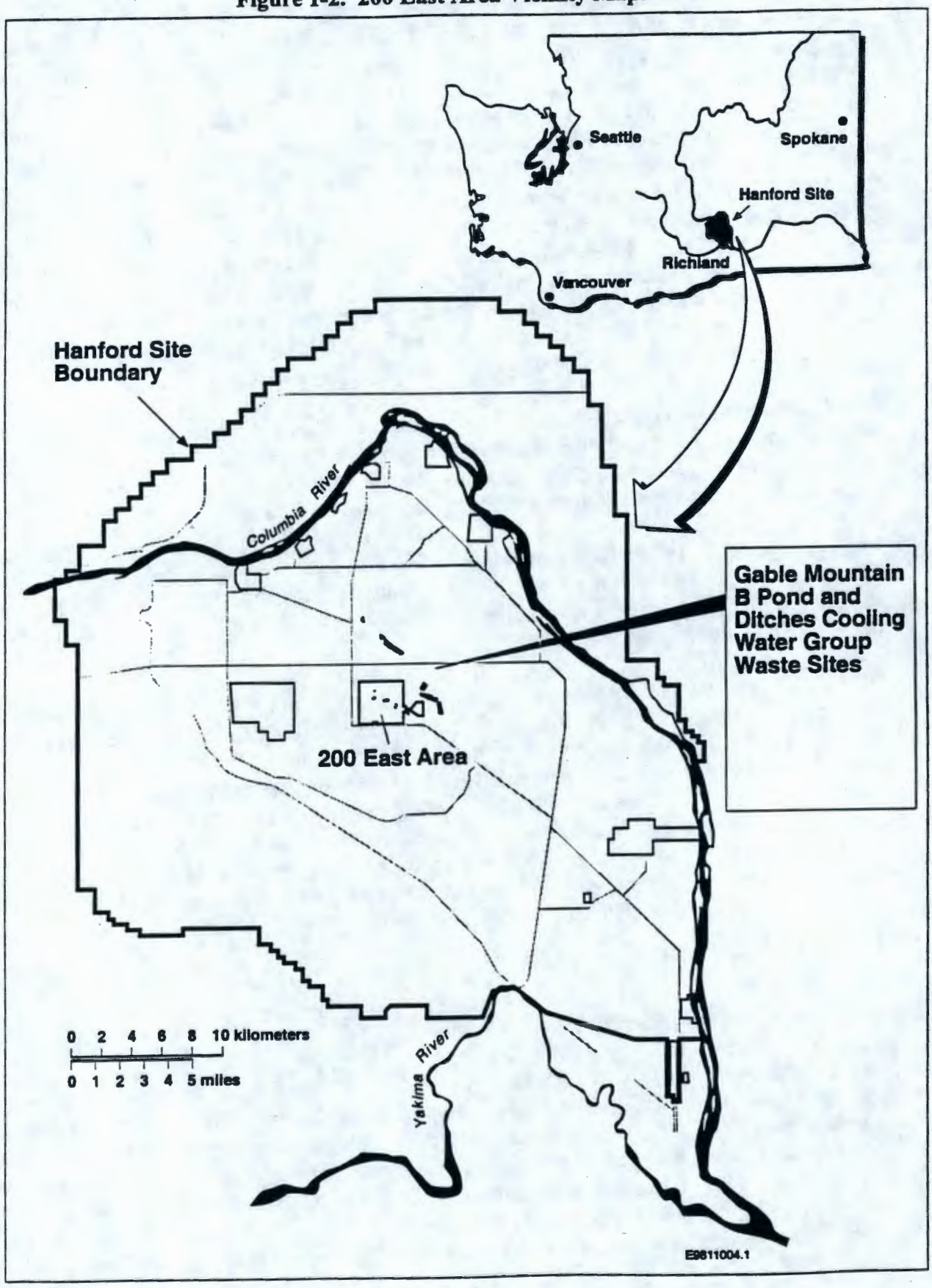
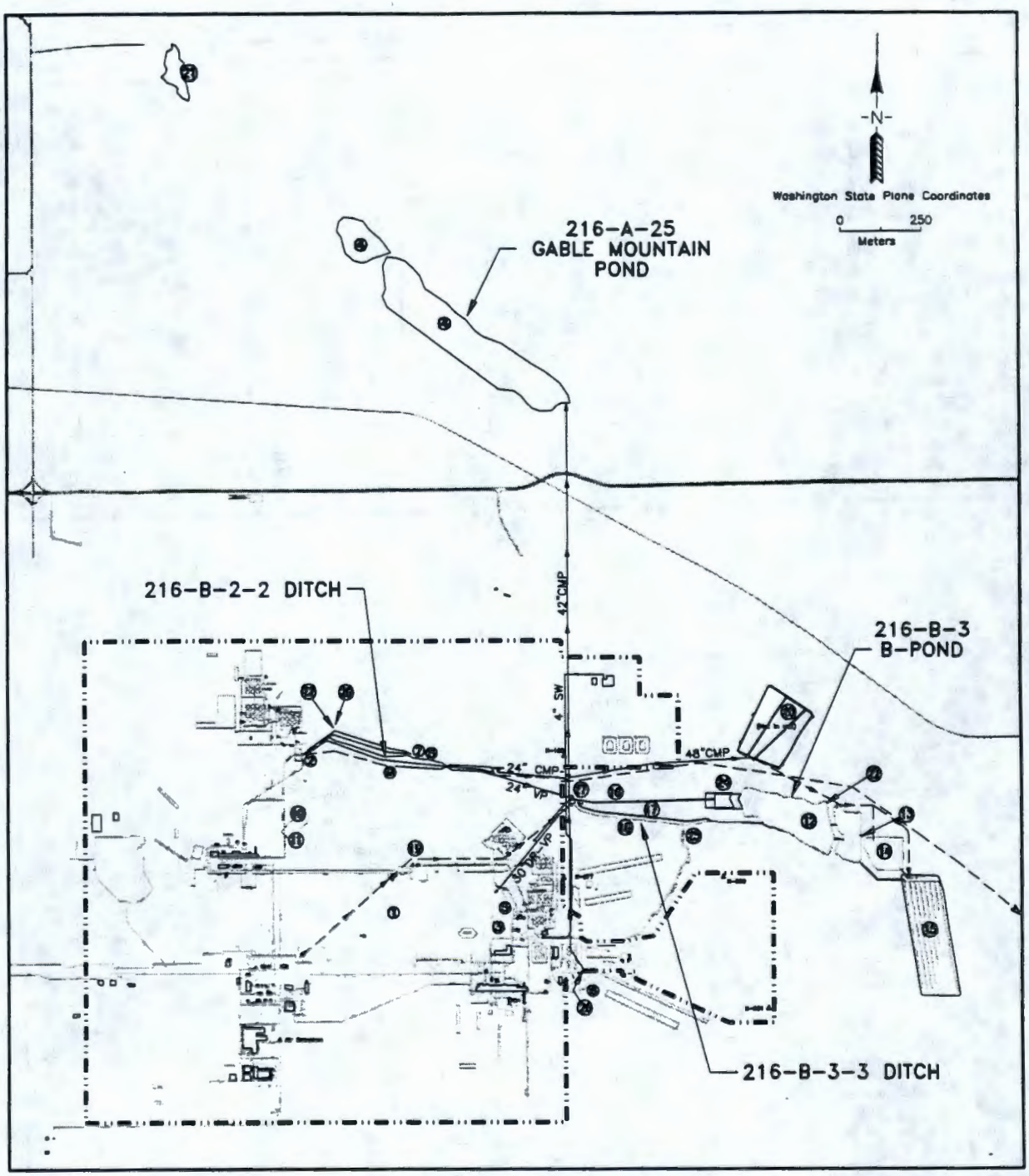


Figure 1-3. 200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Waste Sites Location Map.



LEGEND

CMP = CORRUGATED METAL PIPE
DR-VP = DRAIN-VITRIFIED PIPE
SW = SANITARY WATER

200 EAST BOUNDARY

1 = 200-E PD	9 = 216-B-2-3	20 = 216-E-28
2 = 207-B	10 = 216-B-59	21 = 216-N-8
3 = 216-A-9	11 = 216-B-59B	22 = UPR-200-E-14
4 = 216-A-25	12 = 216-B-3	23 = UPR-200-E-32
5 = 216-A-40	13 = 216-B-3A RAD	24 = UPR-200-E-34
6 = 216-A-42	14 = 216-B-3B RAD	25 = UPR-200-E-51
7 = 216-B-2-1	15 = 216-B-3C RAD	26 = UPR-200-E-66
8 = 216-B-2-2	16 = 216-B-3-1	27 = UPR-200-E-94
		28 = UPR-200-E-138

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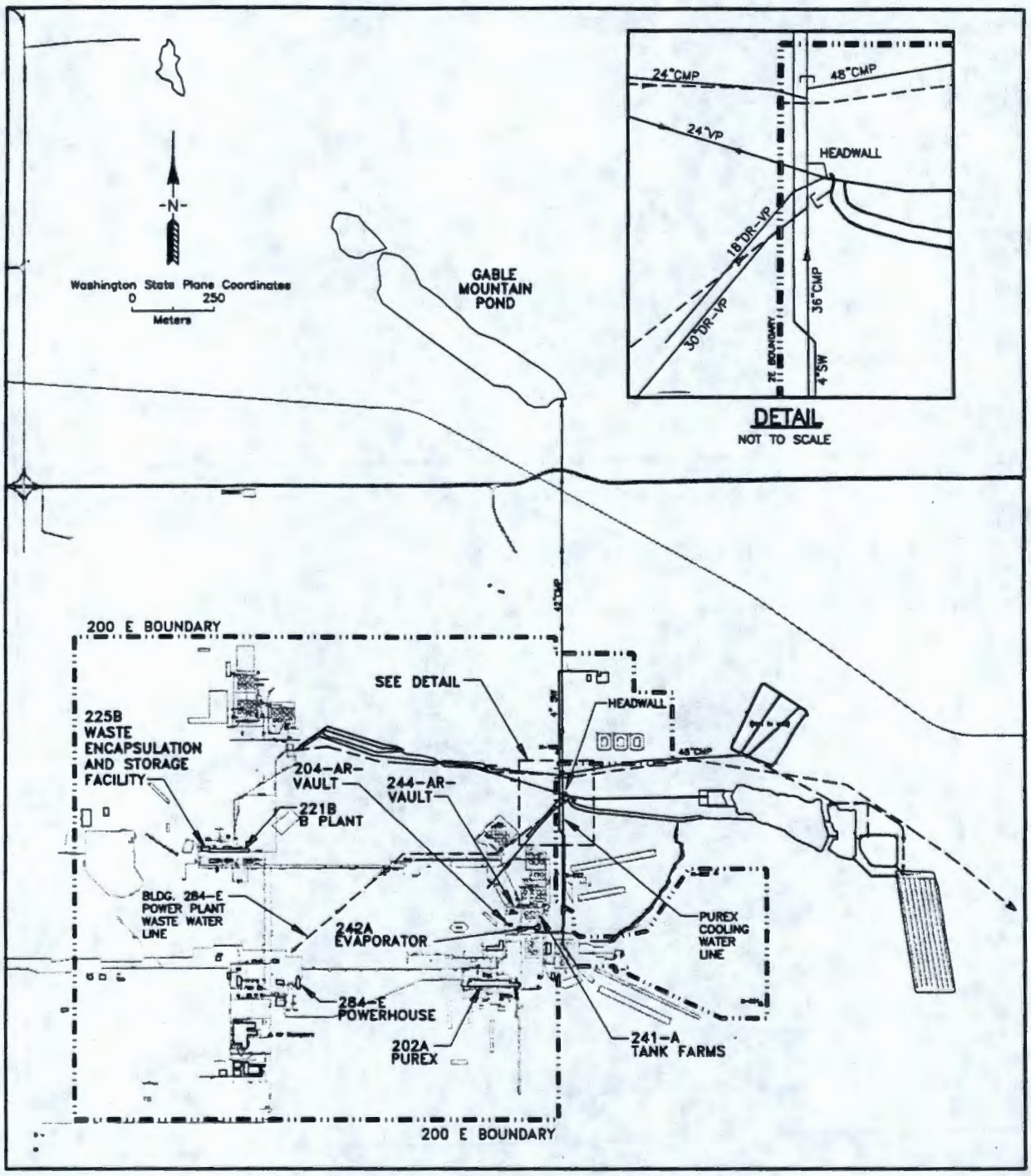
Figure 1-4. 200-CW-1 Gable/B-Pond and Ditches Cooling Water Waste Group Source Facility Location Map.



LEGEND

CMP = CORRUGATED METAL PIPE
DR-VP = DRAIN-VITRIFIED PIPE
SW = SANITARY WATER

200 EAST BOUNDARY

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The PUREX process came online in 1956, initially discharging to the B-Pond system. However, additional capacity was soon required. Consequently, Gable Mountain Pond (216-A-25) was put online in 1957. Cooling water from PUREX was discharged to Gable Mountain and B-Pond in a nominal 3:1 ratio from 1957 to 1983 when Gable Mountain Pond started shutting down. From 1963-1984, Waste Fractionization, and Waste Encapsulation and Storage Facility (WESF) operations increased discharges to B-Pond. Cooling water from first the 244-AR Vault (1963) and later, the 242-A Evaporator (1978) added to the liquid discharge volumes to Gable Mountain and B-Ponds systems.

Significant wastewater changes to the B-Pond B-2 and B-3 Ditch systems occurred as a result of in-plant vessel and equipment failures. The 207-B Retention Basin and B-2-1 ditch were grossly contaminated in 1963 following a coil leak. The ditch was subsequently replaced by the B-2-2 Ditch. A coil leak in PUREX contaminated the B-3-1 ditch, B-Pond and Gable Mountain Pond. The B-3-2 ditch replaced the B-3-1 ditch until 1970, when a coil leak in B-Plant grossly contaminated the B-2-2 and B-3-2 ditches as well as B-Pond. The B-2-3 and B-3-3 ditches were then excavated and placed in service. A pipeline was constructed in 1986 to replace the B-2-3 ditch.

The B-Pond was expanded by the addition of new Expansion Lobes (216-B-3A in 1983 and B-3B in 1984), and in 1985, the 216-B-3C lobe was added to replace the Gable Mountain Pond. Gable Mountain Pond was phased out between 1983 and 1988 when the surface soils were stabilized with clean soil and gravels. Discharges to B-Pond were halted in 1994 when the old main lobe was shut down, following construction of by-pass pipelines to 216-B-3A, B-3B, and B-3C lobes. Lobe 3B was closed in 1985. With the opening of the Treated Effluent Disposal Facility (TEDF) and 200 Area Effluent Treatment Facility, discharges to Lobe 3A were halted in 1994, and in 1997 for Lobe 3C.

The volume of water discharged to these sites exceeded 140 billion gallons of water. 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 in a saturated, or near saturated condition for some time. Although the groundwater mounds are declining, recharge from some of these facilities to the groundwater may still be occurring.

1.5 WORKSHEETS FOR STEP 1 - STATE THE PROBLEM

1) The following three tables identify the DQO Scoping Team members, DQO Workshop Team members, and Key Decision Makers. The Scoping Team develops the checklist and binder prior to the internal seven-step process. The DQO Workshop Team Members participate in the seven-step process. The Key Decision Makers provide the external review of the results of the seven-step process.

Table 1-1. DQO Scoping Team Members.

Name	Organization	Area of Expertise (Role)	Phone Number
Roy Bauer	CHI-Environmental Sci	DQO Workbook	372-9622
Bruce Bennett	BHI Cost Estimating	Cost Estimating	372-9040
Ella Coenenberg	CHI-Environmental Sci	Regulatory	372-9303
Steve DeMers	TMA-Rad Engineering	Radiological Engineering	531-0729
Dave Erb	CHI-Environmental Eng	Project Technical Lead	372-9680
Karl Fecht	BHI-Eng Technologies	Geological	372-9356
Larry Hulstrom	CHI-Environmental Eng	Project Engineer	372-9319
Greg Mitchem	BHI-E&T Task Leads	BHI Project Manager	372-9632
Roger Ovink	CHI-Environmental Sci	DQO Facilitator	372-9631
Brad Schilperoort	BHI-Field Engineering	ERDF Waste Management	373-3310
Jim Sharpe	CHI-Environmental Sci	Cultural/Biological Issues	372-9369
R.C. Smith	CHI-Environmental Sci	Regulatory Quantitative Limits	372-9592
Ray Swenson	BHI-Legal/Risk Mgt	Legal	372-9205
Wendy Thompson	BHI-Eng Technologies	Sampling/Data Management	376-8031
Rich Weiss	CHI-Sample/Data Mgt	RadioChem and Analytical	373-5673
Steve Weiss	CHI-Environmental Sci	Scoping Document Lead	372-9576
Curt Wittreich	CHI-Environmental Eng	Project Management	372-9586

Table 1-2. DQO Workshop Team Members.

Name	Organization	Area of Expertise (Role)	Phone Number
Roy Bauer	CHI-Environmental Eng	DQO Workbook	372-9622
Dave Erb[a]	CHI-Environmental Eng	Project Technical Lead	372-9680
Greg Mitchem	BHI-E&T Task Leads	BHI Project Manager	372-9632
Roger Ovink	CHI-Environmental Sci	DQO Facilitator	372-9631
Curt Wittreich	CHI-Environmental Eng	Project Management	372-9586

a Part-time support

Table 1-3. DQO Key Decision Makers.

Name	Organization	Area of Expertise (Role)	Phone Number
Bryan Foley	U.S. DOE	DOE representative	376-7087
Tom Post	U.S. EPA	EPA representative	376-6623
Ted Wooley	Washington State Department of Ecology[a]	Ecology representative	736-3012

[a]Regulatory lead

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

Table 1-4. Existing Documents and Data Sources. (2 Pages)

Reference	Summary
Waste Site Grouping for 200 Areas Soil Investigations (DOE/RL-96-81)	Summarizes site name, location, type status, site and process descriptions, known and suspected contamination, Preliminary conceptual model of the contaminant distribution (Section 4.13 and Figure 4-15), Site conditions that may affect contaminant of concern (COC) fate and transport, COC mobility in Hanford soils, COC distribution and transport to groundwater, Hazards associated with COCs
WIDS reports: 216-B-3 (B-Pond), 216-B-2-1 216-B-2-2, 216-B-2-3 216-B-3-1, 216-B-3-2 261-B-3-3, 216-B-3A 216-B-3B, 216-B-3C 216-B-59, 216-A-9 216-A-40, 216-A-42 216-E-28, 200-E-PD 216-C-9, 207-B 216-A-25 (Gable Mt Pond) 216-N-8 (West Lake) UPR-200-E-14 UPR-200-E-32 UPR-200-E-34 UPR-200-E-51 UPR-200-E-59 UPR-200-E-138	Summarizes site name, location, type, status, site and process descriptions, associated structures, cleanup activities, environmental monitoring description, access req.'s, references, regulatory information, waste information (type, category, physical state and description).
200 Areas Waste Sites Handbook Vol. III (RHO-CD-673)	Waste site descriptions, releases, waste discharge information, and management reports
B Plant Source Aggregate Area Management Study (AAMS) Report (DOE/RL-92-05)	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 (tanks, wells, vaults, ponds, ditches, trenches, septics, transfer lines and associated equipment, retention basins, liquid effluent retention facilities), and site hazard rankings. Process history of B Plant Aggregate area, waste management operations history, chemical waste inventory estimates, history of unplanned releases.
B Plant Aggregate Area Management Study Technical Baseline Report (BHI-00179 Rev 00)	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
Description of Work for a Vadose Zone Characterization Borehole at the 216-B-2-2 Ditch (BHI-01052 Rev 0)	Characterization activities in the borehole, DQOs, location and geology, maps, sample collection intervals, target analytes, analytical methods, sample preservation, container types and volumes, holding times. Comparison of contaminant PQLs, Hanford Site Background, and MTCA-C values
Borehole Summary Report for the 216-B-2-2 Ditch (BHI-01177) issued 6/17/98	Characterization data from the 216-B-2-2 Ditch borehole sampling and analysis.
PUREX Plant Aggregate Area Management Study Technical Baseline Report (BHI-00178 Rev 00)	Descriptions of waste units, site locations
SemiWorks Aggregate Area Management Study Technical Baseline Report (WHC-SD-EN-ES-019 Rev 0)	Descriptions of waste units, site locations
Aquatic Studies of Gable Mtn Pond, Cushing and Watson, 1974 (BNWL-1884)	Reports of radionuclide concentrations in fish, duck and sediments from Gable Mtn Pond.

Table 1-4. Existing Documents and Data Sources. (2 Pages)

Reference	Summary
Cesium-137 in Coots on Hanford Waste Ponds, Cadwell, et al, 1979 (PNL-SA-7167)	Table of radionuclide values from Coots collected at Gable Mtn Pond.
An Evaluation of the Chemical, Radiological, and Ecological Conditions of West Lake on the Hanford Site, 3/91 (PNL-7662/UC-602)	Well sampling data, well locations, water table elevation fluctuations over time, Concentrations of radionuclides in West Lake Water and sediment, animal radionuclide concentrations, metals concentrations,
Hanford Site Atlas, (BHI-01119, Rev 0)	Site maps
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, (DOE/RL-93-74, Draft B, 1995)	COC Determinations for 200-BP-11
Compsite Analysis for Low Level Waste Disposal in the 200 Area Plateau of the Hanford Site (PNNL 11800, 1998)	Identification of 200 Area land use alternatives
Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan (HRA-EIS) (DOE/EIS-0222D 1996)	Identification of 200 Area land use alternatives and the Preferred Alternative Plan map of the Hanford Site

3) Develop/Refine the Preliminary Conceptual Site Model

A) Develop a contaminant of potential concern (COPC) list

1) COPC development. Develop a table that lists the known or suspected sources of contamination, type of contamination, list of COPCs, and affected environmental media.

The information in Table 1-5 represents the complete unconstrained set of COPCs that were, or could have been, discharged to the Gable Mountain/B-Pond ditches/Ponds (DOE/RL-92-05). It is the master COPC list. The master list is then evaluated against a set of exclusion rationale to screen down to a final list of project 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 process streams that contaminated these sites were cooling water discharges from the B-Plant, PUREX, 241-A Ventilation System complex, 242-A Evaporator, 244-AR Vault, 283 E Water Treatment Plant and the 284-E Powerhouse, and several other small volume generators.

Table 1-5. Sources of Contamination, COPCs and Affected Media. (6 Pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination From each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
Cooling water discharges from B-Plant, PUREX, 242-A Evaporator, 244-AR Vault, 283 E Water Treatment Plant, 284-E Powerhouse	Mixed fission products, activation products, transuranics, process solvents,	**RADIOACTIVE CONSTITUENTS** Actinium-225 Actinium-227 Americium-241 Americium-242 Americium-242m Americium-243 Antimony-126 Antimony-126m Astitine-217 Barium-135m Barium-137m Barium-140 Beryllium-7 Bismuth-210 Bismuth-211 Bismuth-213 Bismuth-214 Carbon-14 Cerium-141 Cerium-144 Cesium-134 Cesium-135 Cesium-137 Cobalt-57 Cobalt-58 Cobalt-60 Curium-242 Curium-244 Curium-245 Europium-152 Europium-154 Europium-155 Francium-221 Francium-223 Iodine-129 Iron-59 Lanthanum-140 Lead-209 Lead-210 Lead-211 Lead-212 Lead-214 Manganese-54 Neptunium-237 Neptunium-239 Nickel-59 Nickel-63 Niobium-93m Niobium-95 Palladium-107 Plutonium-238 Plutonium-239/240 Plutonium-241 Potassium-40	Shallow soils, deep zone soils associated with the ditches and ponds, and potentially the groundwater beneath these sites.

Table 1-5. Sources of Contamination, COPCs and Affected Media. (6 Pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination From each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		RADIOACTIVE CONSTITUENTS (Cont'd) Praeseodymium-144 Promethium-147 Protactinium-231 Protactinium-233 Protactinium-234m Radium-223 Radium-225 Radium-226 Rhodium-103 Rhodium-106 Ruthenium-103 Ruthenium-106Samarium-151 Selenium-79 Silver-110m Sodium-22 Strontium-85 Strontium-89 Strontium-90 Technetium-99 Tellurium-129 Thallium-207 Thorium-227 Thorium-229 Thorium-230 Thorium-231 Thorium 232 Thorium-233 Thorium-234 Tin-126 Tritium Uranium-233/234 Uranium-235/236 Uranium-238 Yttrium-90 Yttrium-91 Zinc-65 Zirconium-93 Zirconium-95	
		INORGANIC CHEMICALS Acetic Acid Alkaline liquids Aluminum Aluminum nitrate Ammonia (anhydrous) Ammonium carbonate Ammonium fluoride Ammonium hydroxide Ammonium ion Ammonium nitrate Ammonium oxalate Ammonium silicofluoride Ammonium sulfate Antifreeze Arsenic Barium	

Table 1-5. Sources of Contamination, COPCs and Affected Media. (6 Pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination From each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		INORGANIC CHEMICALS (Cont'd)	
		Barium nitrate	
		Beryllium	
		Bismuth	
		Bismuth nitrate	
		Bismuth phosphate	
		Boric acid	
		Boron	
		Cadmium	
		Cadmium nitrate Calcium	
		Calcium carbonate	
		Calcium chloride	
		Carbon dioxide	
		Carbonate	
		Ceric fluoride	
		Ceric iodate	
		Ceric nitrate	
		Ceric sulfate	
		Cerium	
		Cesium carbonate	
		Cesium chloride	
		Chloride	
		Chromium	
		Chromium nitrate	
		Chromous sulfate	
		Copper	
		Cyanide	
		DOW Anti-Foam B	
		Duolite ARC-359 (IX Resin)	
		Ferric cyanide	
		Ferric nitrate	
		Ferrous sulfamate	
		Ferrous sulfate	
		Fluoride	
		Hydrazine	
		Hydrobromic acid	
		Hydrochloric acid	
		Hydrofluoric acid	
		Hydrogen	
		Hydrogen fluoride	
		Hydrogen peroxide	
		Hydroiodic acid	
		Hydroxide	
		Hydroxyacetic acid	
		Hydroxylamine hydrochloride	
		Iron	
		Lanthanum fluoride	
		Lanthanum hydroxide	
		Lanthanum nitrate	
		Lanthanum-neodymium nitrate	
		Lead	
		Lead nitrate	
		Lithium	
		Magnesium	
		Magnesium carbonate	

Table 1-5. Sources of Contamination, COPCs and Affected Media. (6 Pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination From each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		INORGANIC CHEMICALS (Cont'd)	
		Magnesium nitrate	
		Manganese	
		Mercuric nitrate	
		Mercury	
		Misc. Toxic Process Chemicals	
		Nickel	
		Nickel nitrate	
		Niobium	
		Nitrate	
		Nitric acid	
		Nitrite	
		Oxalic acid	
		Periodic acid	
		Phosphate Phosphoric acid	
		Phosphorous pentoxide	
		Phosphotungstic acid	
		Plutonium fluoride	
		Plutonium nitrate	
		Plutonium peroxide	
		Potassium	
		Potassium carbonate	
		Potassium ferrocyanide	
		Potassium fluoride	
		Potassium hydroxide	
		Potassium oxalate	
		Potassium permanganate	
		Pu-Lanthanum fluoride	
		Pu-Lanthanum oxide	
		Rubidium	
		Selenium	
		Silica	
		Silicon	
		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 nitrate	
		Sodium nitrite	
		Sodium persulfate	
		Sodium phosphate	
		Sodium sulfate	
		Sodium sulfite	
		Sodium thiosulfate	

Table 1-5. Sources of Contamination, COPCs and Affected Media. (6 Pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination From each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		INORGANIC CHEMICALS (Cont'd) Strontium carbonate Strontium fluoride Strontium sulfate Sugar Sulfamic acid Sulfate Sulfuric acid Tartaric acid Thorium Tin Titanium Uranium Uranium oxide Uranyl nitrate hexahydrate Vanadium Various acids Yttrium Zeolon Zinc Zirconium Zirconyl nitrate	
		ORGANIC CHEMICALS Acetone 1-Butanol (Butyl alcohol) 2-Butanone Butanoic acid Butylated hydroxy toluene Carbon tetrachloride Chloroform (Trichloromethane) Citric acid Chloroplatinic acid Decane Di2-Ethyl hexyl phosphoric acid Dibutyl butyl phosphonate Dibutyl phosphate Dichloromethane (Methylene Chloride) Diesel fuel DOWEX 21 K/Amberlite XE-270 Ethanol Ethylene diamine tetra acetic acid Ethyl ether Flammable solvents Formaldehyde (solution) Halogenated hydrocarbons Hydroxy acetic acid-Trisodium hydroxy ethylene-Diamine-triacetic acid (THEDTA) Hydroxylamine nitrate Kerosene Molybdate-citrate reagent Monobutyl phosphate Normal paraffin hydrocarbon Paraffin hydrocarbons PCBs Propanol (Isopropyl alcohol)	

Table 1-5. Sources of Contamination, COPCs and Affected Media. (6 Pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination From each Source (General Contamination)	COPCs (Specific Contamination)	Affected Media
		ORGANIC CHEMICALS (Cont'd) Shell E-2342 (napthalene and paraffin) Sodium acetate Soltrol-170 ($C_{10}H_{22}$ to $C_{16}H_{34}$) purified kerosene Tartaric acid Tetrasodium ethylene diamine tetra-acetate (EDTA) Thenoyltrifluoroacetone Toluene Tri-n-dodecylamine Tributyl phosphate 1,1,1-Trichloroethane 1,1,2-Trichloroethane Trisodium hydroxyethyl Ethylene-diamine triacetate (HEDTA) Waste Paint and Thinners Zeolite AW-500 (IX Resin)	

2) Exclusion/Inclusion Rationale

(a) List the COPCs which can be excluded from the investigation, with the rationale for the exclusion.

The master COPC list in Table 1-5 was evaluated against a set of exclusion rationale to enable the development of 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. The exclusion rationale follows:

Based on a review of the potential waste constituent lists in the B Plant Report Aggregate Area Management Study Report and the 200-BP-11 Work/Closure Plan, the chemical behavior of the constituents was evaluated. Process knowledge indicates that the aqueous discharges to the Gable Mountain Pond/B-Pond waste sites were predominantly uncontaminated cooling water releases. Leaks in cooling coils resulted in unplanned contamination releases to the Pond complex. The majority of the water released to the Ponds was noncontaminated, with waste constituents being greatly diluted and dispersed by the large volumes of water. The chemical reactions expected in this environment include acid neutralization, stabilization of highly reactive compounds, and volatilization of the lighter fraction organic compounds.

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 have low toxicity in the process stream were excluded from further consideration because they could not pose a health or environmental risk. For example, several rare earth compounds were employed. These are very costly and were never used in large quantities. They would not be expected to significantly affect human health or the environment in the quantities used.

Inorganic salts represent a large group of constituents in the waste sites being evaluated. Because laboratory analyses are generally not compound-specific, the inorganic salts were excluded from further consideration. Instead, the readily detected anions (fluorides, nitrates, phosphates, etc) associated with the inorganic salts serve as the target constituents for those compounds. This recognizes that small volumes of wastes were released into large volume aqueous discharges, where the salts dissolved into large bodies of water.

Generally the analytical approach employed for this project is focused on the significant risk drivers that are representative of the waste constituents present. By focusing on the significant risk constituents, other constituents with lower risk factors are also covered by the techniques used. General "suite type" analytical techniques have been chosen, which yield results on many metals and organic compounds, providing a cost-effective approach for detecting the known waste constituents. A summary of the rationale is provided. 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 non-detection.
- Naturally occurring isotopes that were not created as a result of Hanford operations.
- Constituents with atomic mass numbers greater than 242 that represent less than 1% of the actinide activities.
- Progeny (P) radionuclides that build insignificant activities within 50 years, and/or for which parent/progeny relationships exist that permit progeny estimation.
- Chemicals that have no known carcinogenic or toxic effects (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 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.

Table 1-6. COPC Exclusions and Justifications. (6 Pages)

COPC	Rationale for Exclusion
Radioactive Constituents - Activation Products	
Nickel-59	Less than 5E-5 times Cs-137 activity
Sodium-22	Short half-life (SHL)
Radioactive Constituents - Fission/Activation Products	
Antimony-126	SHL,. Progeny (P)
Antimony-126m	SHL, P
Barium-135m	SHL
Barium-137m	SHL (Daughter of Cs-137, which is a final COPC), P
Barium-140	SHL
Beryllium-7	SHL
Carbon-14	Highly mobile. Not expected in meaningful quantities in soils
Cerium-141	SHL
Cerium-144	SHL
Cesium-134	SHL
Cesium-135	Less than 5E-4 times Cs-137 activity
Cobalt-57	SHL
Cobalt-58	SHL
Iodine-129	Less than 5E-5 times Cs-137 activity
Iron-59	SHL
Lanthanum-140	SHL
Manganese-54	SHL
Niobium-93m	P
Niobium-95	SHL, P
Palladium-107	Less than 5E-5 times Cs-137 activity
Praeseodymium-144	SHL, P
Promethium-147	SHL
Rhodium-103	SHL, P
Rhodium-106	SHL, P
Ruthenium-103	SHL
Ruthenium-106	SHL
Samarium-151	Less than 1% of Cs-137 activity. Insignificant contribution to dose per RESRAD. No analytical detection methodology available
Selenium-79	Less than 5E-4 times Cs-137 activity
Silver-110m	SHL
Strontium-85	SHL
Strontium-89	SHL
Tellurium-129	SHL
Thorium-233	SHL
Tin-126	Less than 5E-4 times Cs-137 activity
Yttrium-90	SHL (Daughter of Sr-90, which is a final COPC), P
Yttrium-91	SHL
Zinc-65	SHL
Zirconium-93	Less than 5E-4 times Cs-137 activity
Zirconium-95	SHL

Table 1-6. COPC Exclusions and Justifications. (6 Pages)

COPC	Rationale for Exclusion
Radioactive Constituents - Uranium/Thorium Daughter Products	
Actinium-225	These daughter products are excluded due to very low ingrowth relative to the parent isotopes, and because the concentrations may be calculated from the uranium isotopes from which they originate.
Actinium-227	
Actinium-228	
Astitine-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	
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	SHL
Plutonium-241	Not detected by normal Pu analysis, can infer from Am/Pu results
Plutonium-242	High mass number. Very low product inventory

Table 1-6. COPC Exclusions and Justifications. (6 Pages)

COPC	Rationale for Exclusion
Radioactive Constituents - Other	
Potassium-40	Naturally occurring isotope not created in Hanford reactor operations
Inorganic Chemicals	
Acetic Acid	These inorganic substances are excluded because they qualify in one or more of the following categories: • 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. The analytical strategy will be to use the analytical techniques that focus on the major constituents, such as the metals, anions, etc via the following methods: 6010, GFAA, 7470/7471, IC 300.
Alkaline liquids	
Aluminum	
Aluminum nitrate	
Ammonia (anhydrous)	
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	
Carbonate	
Ceric fluoride	
Ceric iodate	
Ceric nitrate	
Ceric sulfate	
Cerium	
Cesium carbonate	
Cesium chloride	
Chromium nitrate	
Chromous sulfate	
DOW Anti-Foam B	
Duolite ARC-359 (IX Resin)	
Ferric cyanide	
Ferric nitrate	
Ferrous sulfamate	
Ferrous sulfate	

Table 1-6. COPC Exclusions and Justifications. (6 Pages)

COPC	Rationale for Exclusion
Inorganic Chemicals (Cont'd)	
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 Gable Mountain Pond/B-Pond systems.
Hydrobromic acid	These inorganic substances are excluded because they qualify in one or more of the following categories: • 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. The analytical strategy will be to use the analytical techniques that focus on the major constituents, such as the metals, anions, etc via the following methods: 6010, GFAA, 7470/7471, IC 300.
Hydrochloric acid	
Hydrofluoric acid	
Hydrogen	
Hydrogen fluoride	
Hydrogen peroxide	
Hydroiodic acid	
Hydroxide	
Hydroxyacetic acid	
Hydroxylamine hydrochloride	
Iron	
Lanthanum fluoride	
Lanthanum hydroxide	
Lanthanum nitrate	
Lanthanum-neodymium nitrate	
Lead nitrate	
Lithium	
Magnesium	
Magnesium carbonate	
Magnesium nitrate	
Manganese	
Mercuric nitrate	
Misc Toxic Process Chemicals	
Nickel nitrate	
Niobium	
Nitric acid	
Oxalic acid	
Periodic acid	
Phosphoric acid	
Phosphorous pentoxide	
Phosphotungstic acid	
Plutonium fluoride	
Plutonium nitrate	
Plutonium peroxide	
Potassium	
Potassium carbonate	
Potassium ferrocyanide	
Potassium fluoride	
Potassium hydroxide	
Potassium oxalate	
Potassium permanganate	
Pu-Lanthanum fluoride	Covered by radiological COPCs. Fluoride is a COPC

Table 1-6. COPC Exclusions and Justifications. (6 Pages)

COPC	Rationale for Exclusion
Inorganic Chemicals (Cont'd)	
Pu-Lanthanum oxide	Covered by radiological COPCs.
Rubidium	These inorganic substances are excluded because they qualify in one or more of the following categories: • 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. The analytical strategy will be to use the analytical techniques that focus on the major constituents, such as the metals, anions, etc via the following methods: 6010, GFAA, 7470/7471, IC 300.
Silica	
Silicon	
Silver nitrate	
Sodium	
Sodium aluminate	
Sodium bismuthate	
Sodium bisulfate	
Sodium bromate	
Sodium carbonate	
Sodium chloride	
Sodium citrate	
Sodium ferrocyanide	
Sodium fluoride	
Sodium gluconate	
Sodium hydroxide	
Sodium nitrate	
Sodium nitrite	
Sodium persulfate	
Sodium phosphate	
Sodium sulfate	
Sodium sulfite	
Sodium thiosulfate	
Strontium carbonate	
Strontium fluoride	
Strontium sulfate	
Sugar	
Sulfamic acid	
Sulfuric acid	
Tartaric acid	
Thorium	
Tin	
Titanium	
Uranium	
Uranium oxide	
Uranyl nitrate hexahydrate	
Various acids	
Yttrium	
Zeolon	
Zirconium	
Zirconyl nitrate	

Table 1-6. COPC Exclusions and Justifications. (6 Pages)

COPC	Rationale for Exclusion
Organic Chemicals	
Butanoic acid	See general note for organic chemicals
Citric acid	Note 1.
Chloroplatinic acid	
Di2-Ethyl hexyl phosphoric acid	Degrades to HCL and Platinum (NT) See general note
Dibutyl butyl phosphonate	Note 1
Dibutyl phosphate	
DOWEX 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	Note 1
Flammable solvents	See general note for organic chemicals
Formaldehyde (solution)	Detected in Kerosene TPHs
Hydroxyacetic acid-Trisodium hydroxyethylene-Diamine-triacetic acid (THEDTA)	See general note for organic chemicals
Hydroxylamine nitrate	**General Note**: These organic substances are excluded because they qualify in one or more of the following categories: • 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 during cooling water discharges. • Chemicals that are not persistent in the environment.
Molybdate-citrate reagent	
Monobutyl phosphate	
Sodium acetate	
Tartaric acid	
Tri-n-dodecylamine	
	The analytical strategy will be to use the analytical techniques that focus on the major constituents, and may be detected by VOA and Semi-VOA suite analyses. Methods 8240/8260, 8270 will be used:
Tetrasodium ethylene diamine tetra-acetate (EDTA)	Note 1
Thenoyltrifluoroacetone	
Trisodium hydroxyethyl Ethylene-diamine triacetate (HEDTA)	Note 1. Lab compound that has degraded.
Waste Paint and Thinners	Note 1
Zeolite AW-500 (IX Resin)	Detected in Cr, Pb, and VOA suite analyses

Note 1 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.
SHL = Short Half-Life
P = Progeny

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

Table 1-7. Final COC List. (2 Pages)

Final COCs	Rationale for Inclusion
Radioactive Constituents	
Americium-241	Included in GEA and isotopic Am/Pu
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
Neptunium-237	Np-237 may have been concentrated in the PUREX process. This analysis will only be performed for central pond axis samples, where contamination levels are expected to be highest.
Nickel-63*	Present in 100 Area remedial sites in deep zone.
Plutonium-238	Alpha exposure dose contributor
Plutonium-239/240	Alpha exposure dose contributor
Strontium-90	Abundant fission product. Strong beta emitter
Technetium-99*	Mobile, potential groundwater concern
Tritium*	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	TC metal
Barium	TC metal
Beryllium	Potentially toxic/hazardous
Cadmium	TC metal
Chromium	TC metal
Hexavalent Chromium	Mobile metal associated with operations
Copper	Potentially toxic/hazardous
Lead	TC metal
Mercury	TC metal
Nickel	Potentially toxic/hazardous
Selenium	TC metal
Silver	TC metal
Vanadium	Potentially toxic/hazardous
Zinc	Potentially toxic/hazardous
Chemical Constituents - Other Inorganics	
Ammonia	Constituent in several waste compounds
Chloride	
Cyanide	
Fluoride	
Nitrate/Nitrite	
Phosphate	
Sulfate	
Sulfide	

Table 1-7. Final COC List. (2 Pages)

Final COCs	Rationale for Inclusion
Chemical Constituents - Other Inorganics (Cont'd)	
pH	Indicator test
Chemical Constituents - Volatile Organics	
Acetone	VOA
1-Butanol (Butyl alcohol)	VOA
2-Butanone (MEK)	VOA
Butylated hydroxy toluene	VOA TIC
Carbon Tetrachloride	VOA
Chloroform (Trichloromethane)	VOA
Decane	VOA
Dichloromethane (Methylene Chloride)	VOA
Ethanol	VOA TIC
Halogenated hydrocarbons	VOA
Propanol (Isopropyl alcohol)	VOA TIC
Toluene	VOA
1,1,1 Trichloroethane	VOA
1,1,2 Trichloroethane	VOA
Semi-Volatile Organics	
Diesel fuel**	Semi-VOA
Kerosene**	Semi-VOA
Normal paraffin hydrocarbon**	Semi-VOA
Paraffin hydrocarbons**	Semi-VOA
Polychlorinated biphenyls (PCBs)	Semi-VOA
Shell E-2342 (napthalene and paraffin)**	Semi-VOA
Soltrol-170 ($C_{10}H_{22}$ to $C_{16}H_{34}$) purified kerosene**	Semi-VOA
Tributyl phosphate	Semi-VOA

* These COCs are deep zone sensitive only. No analyses are required for these in the shallow zone soils, as they are soft beta emitters in low abundance, that have insignificant dose impact in the shallow zone.
** Analyzed as kerosene total petroleum hydrocarbons
TIC = Tentatively identified compound
VOA = Volatile organic compound
Semi-VOA = Semi Volatile organic compound
TC Metal = Toxic Characteristic metal, required for designation of waste for disposal

B) Identify Conceptual Exposure Model

Figure 1-5 provides the Preliminary Conceptual Exposure Model.

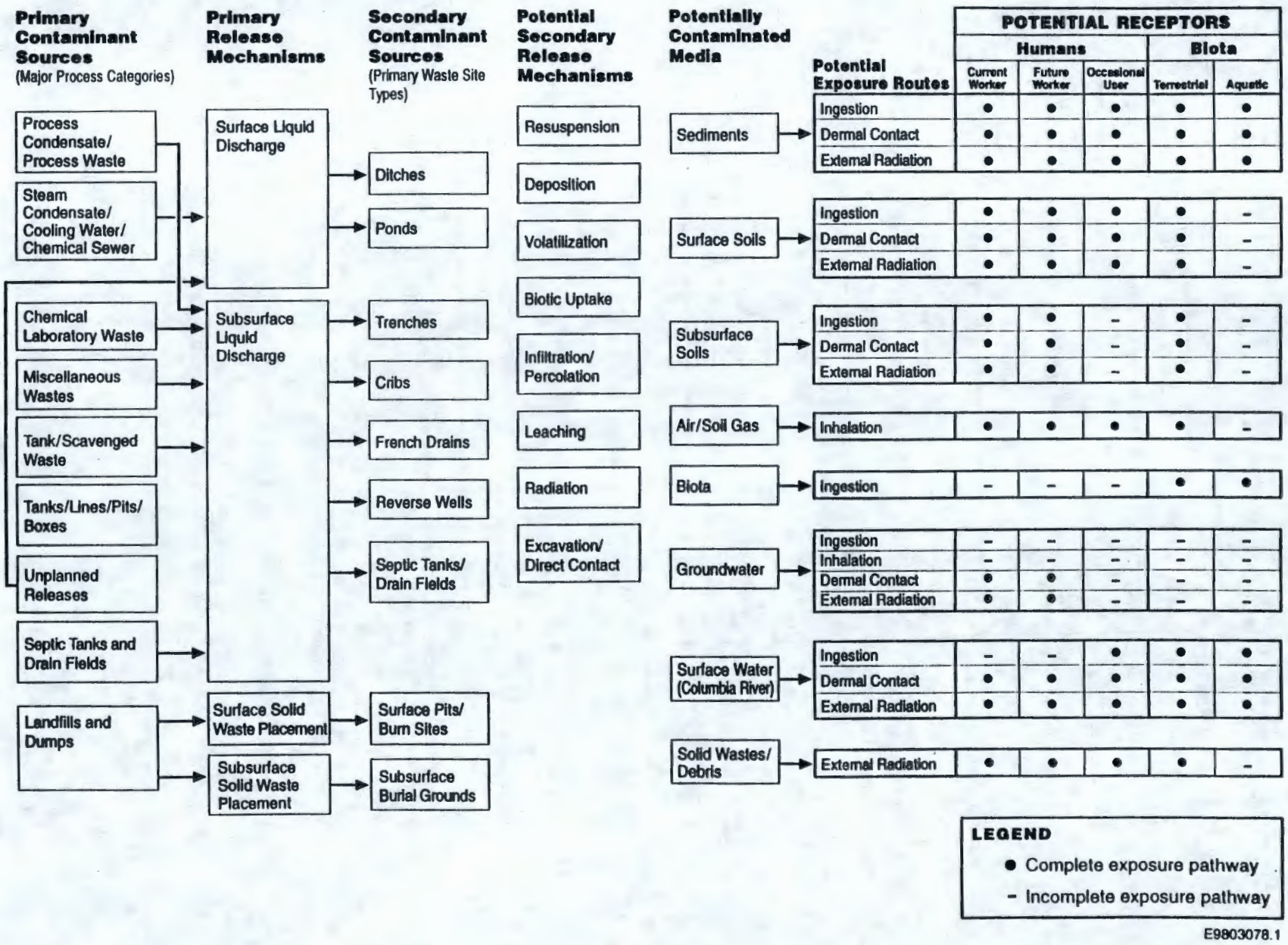


Figure 1-5. Preliminary Conceptual Exposure Model.

C) Table 1-8 identifies current and potential future land uses for the Gable/B-Pond Cooling Water Waste Group area.

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]
	EPA/Ecology: Industrial
Outside the 200 Area Land Use Boundary	
Hanford site; controlled access	Conservation
	Unrestricted Use for Clean Closure[b]

[a] This propsed future land use is unique to DOE. It is defined in the HRA-EIS (DOE/EIS-0222D).
[b] This proposed future land use is not defined in the HRA-EIS, but is a RCRA TSD Clean Closure scenario.

D) Table 1-9 defines applicable or relevant and appropriate requirements (ARARs) and preliminary remediation goals (PRGs) for each of the contaminants of concern (COC) for this work plan.

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

COC	Preliminary ARARs	PRG
Radionuclides Inside the 200 Area Land Use Boundary		
Shallow zone (0-15' below grade)[a]	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.	Contaminant-specific; RESRAD modeling[b]
Deep zone (>15' below grade)	4 mrem/yr above background to groundwater; or no additional degradation groundwater.	MCLs, State and Federal Ambient Water Quality Control Criteria
Chemicals Inside the 200 Area Land Use Boundary		
Shallow zone (0-15' below grade)[a]	MTCA-C and 100xGW per MTCA	Chemical-specific
Deep zone (>15' below grade)	100xGW per MTCA	Alternatively, site-specific RESRAD modeling
Radionuclides Outside the 200 Area Land Use Boundary		
Shallow zone (0-15' below grade)[a]	15 mrem/yr above background and 4 mrem/yr above background to groundwater, or no additional groundwater degradation.	Contaminant-specific; RESRAD modeling[b] for future land use of conservation
Deep zone (>15' below grade)	4 mrem/yr above background to groundwater, or No additional degradation of groundwater.	MCLs, State and Federal Ambient Water Quality Control Criteria
Chemicals Outside the 200 Area Land Use Boundary		
Shallow zone (0-15' below grade)[a]	MTCA-C and 100xGW per MTCA	Chemical-specific
Deep zone (>15' below grade)	100xGW per MTCA	Alternatively, Site-Specific Modeling

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

Clean Closure Scenario - Radionuclides		
Shallow zone (0-15' below grade)[a]	15 mrem/yr above background via Residential use scenario, and 4 mrem/yr above background to groundwater, or no additional groundwater degradation.	Contaminant-specific; RESRAD modeling[b]
Deep zone (>15' below grade)	4 mrem/yr above background to groundwater, or no additional groundwater degradation.	MCLs, State and Federal Ambient Water Quality Control Criteria
RCRA Clean Closure Scenario - Chemicals		
Shallow zone (0-15' below grade)[a]	MTCA-B, 100xGW per MTCA	Chemical-specific
Deep zone (>15' below grade)	100xGW per MTCA	Alternatively, Site-Specific Modeling

a The shallow zone definition (0-15-ft. below-grade) is consistent with that used in MTCA.
b RESRAD modeling has been historically used for similar waste sites. RESRAD will thus be utilized at this time. If more complex models are developed, they will be evaluated for use during RI/FS activities.

E) Table 1-10 provides the general exposure scenarios for the Gable/B-Pond Cooling Water Waste Group area.

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

Scenario No.	General Exposure Scenario Description
1.	**Industrial Land Use Scenario** (inside the 200 Area land use boundary) The source of contamination is the liquid effluents disposed in the B-Pond/Gable Mountain Pond systems from primarily B-Plant and PUREX plant operations. The release mechanism is direct radiation exposure to occupational workers in the vicinity of the ditches and pond areas (although shielded by stabilizing cover), volatilization of certain organic gases into the local air environs. Downward migration of mobile constituents into the groundwater would not affect occupational workers, as their drinking water source would not be the underlying aquifers. The exposure time is divided into time spent inside and outside an industrial facility: Building Occupancy: 8 hours/day x 0.6 (building occupancy factor), 5 days/week, 50 weeks/yr, for 20 years (of a 75 year lifetime). Outdoor Exposure: 8 hours/day x 0.4 (outdoor exposure factor), 5 days/week, 50 weeks/yr, for 20 years (of a 75 year lifetime). In addition, the building occupancy exposure includes a factor of 0.4 to reduce the ingested dust component due to building ventilation system filtration.

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

Scenario No.	General Exposure Scenario Description
2.	**Occasional User, based on the Conservation Land Use Scenario** (The details of this exposure scenario are yet to be defined) The source of contamination is the liquid wastes disposed in the B-Pond/Gable Mountain Pond systems. The release mechanisms are direct radiation exposure to the hypothetical occasional users in the vicinity of the pond areas (although shielded by stabilizing cover), and evaporation of volatile organic gases into the local air environs. Downward migration of mobile constituents 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 their use as drinking water. No water will be used for irrigation. Ingestion of soil is not considered to contribute any significant dose due to the presence of stabilizing soil cover over all of the affected sites.
3.	**Clean Closure Scenario** The clean closure scenario is based on a residential exposure scenario as defined by Washington State (Guidance for Clean Closure of Dangerous Waste Facilities, Publication No. 94-111). In this scenario, final closure means that dangerous waste activities regulated under the Washington Administrative Code are no longer conducted at this facility. As with the other scenarios, the source of contamination is the liquid effluents disposed in the B-Pond/Gable Mountain Pond systems from primarily B-Plant and PUREX 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 environs. Downward migration of mobile constituents into the groundwater could affect the resident who obtains drinking water from underlying aquifers. The exposure time would be 24 hours per day, 365 days/year, for 70 years for the maximum exposed resident.

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

Table 1-11. Regulatory Milestones.

Milestone	Due Date	Regulatory Driver
Submit 200 Gable Mountain/B Pond and Ditch Cooling Water Group Work Plan	4/30/99	TPA milestone M-13-20

Table 1-12. Project Milestones.

Milestone	Due Date	Driver
DQO Workbook Steps 1-2	3/16/98	Part I of DQO Workshop
DQO Workbook Steps 1-7	5/13/98	Part II of DQO Workshop
Completed DQO Workbook	5/30/98	Support 200 Area Implementation Plan
	12/30/98	Support 200-CW-1 Workplan
Work Plan - SAP - Field Implementation - Lab Analyses - Data Quality Assessment	4/30/99	TPA Milestone M-13-20 The subject matter listed are to be included in the Work Plan.

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

Table 1-13. Conceptual Model Discussion and Concise Statement of the Problem.

Preliminary Conceptual Site Contaminant Distribution Model[a]

The combined cooling water, steam condensate, and chemical sewer waste streams discharged to the Gable Mountain and B Pond(s) originated primarily from the PUREX and B Plant facilities. The streams were intended to be uncontaminated but often contained limited quantities of radionuclides and chemicals. Immobile contaminants accumulated in the sediments over time and mobile contaminants may have reached groundwater. Additionally, vegetation and algae within the ponds and ditches tended to collect and concentrate radionuclides. Six unplanned releases resulted in radionuclides contaminating the waste stream and entering the ditch/pond system. The contaminated ditches were sampled, backfilled, and covered to contain the contamination. New ditches were constructed to replace the contaminated ones. Plutonium, americium, and some cesium were fixed in the ditches near the ditch/pond junctions; uranium, strontium, ruthenium, and cesium proceeded to the pond. Most of the less mobile radionuclides are expected to be found within the top 5 to 10 m of sediment beneath the pond. 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 to the broad areas of these waste sites tend to minimize contaminant concentrations in the soil column.

Volatile organics 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. Groundwater monitoring has indicated VOA contamination present under Gable Mountain Pond. With the exception of the B-Pond and associated expansion lobes, limited chemical data are available for the waste group and is considered a broad data gap.

Limited lateral spreading of contaminants in the vadose zone has resulted from high-volume discharges to the ponds that exceeded the soil column pore volume capacity and formed an increased wetted area in the vadose zone. Mounding of groundwater is known under B Pond. Lateral spreading may have been enhanced due to the occurrence of local finer grained sediments and remnant subcrops of Ringold Formation that act as perching or spreading horizons for percolating waters/solutions. These two factors may contribute to lateral spreading of contaminants in the vadose zone.

Figure 1-6 presents a graphical rendition of the conceptual contaminant distribution model showing a cutaway view of a waste site.

DQO Approach

The DQO for the Gable Mountain/B-Pond and Ditch system is being performed to determine if the representative sites and RCRA TSD sites have been contaminated to levels that require remedial action. Two of the CERCLA waste sites in the B-Pond/Gable Mountain Pond system are considered as "Representative Sites". In addition, there are five RCRA TSD sites. Of these, the expansion Lobes A, B, and C to the B-Pond were clean closed in 1994 and need not be characterized. The other two RCRA sites, 216-B-3-3 and the main B Pond, are representative sites that will be characterized.

The outcome of the characterization being developed in this DQO for the representative sites will be applied to the other analogous sites. A sampling and analysis plan will be developed after completion of the DQO process, which specifies the sampling and analyses to be performed for characterization of the four representative 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 East area land use boundary line will be evaluated on the basis of future industrial uses. Sites located outside of the 200 East Area fence will be evaluated on the basis of a future Conservation land use.

The piping in the Gable Mountain Pond/B-Pond system is within the scope of this DQO. The piping associated with each waste site will be considered a 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 but on a smaller scale. The environmental data obtained for each waste site is considered analogous for the associated piping systems.

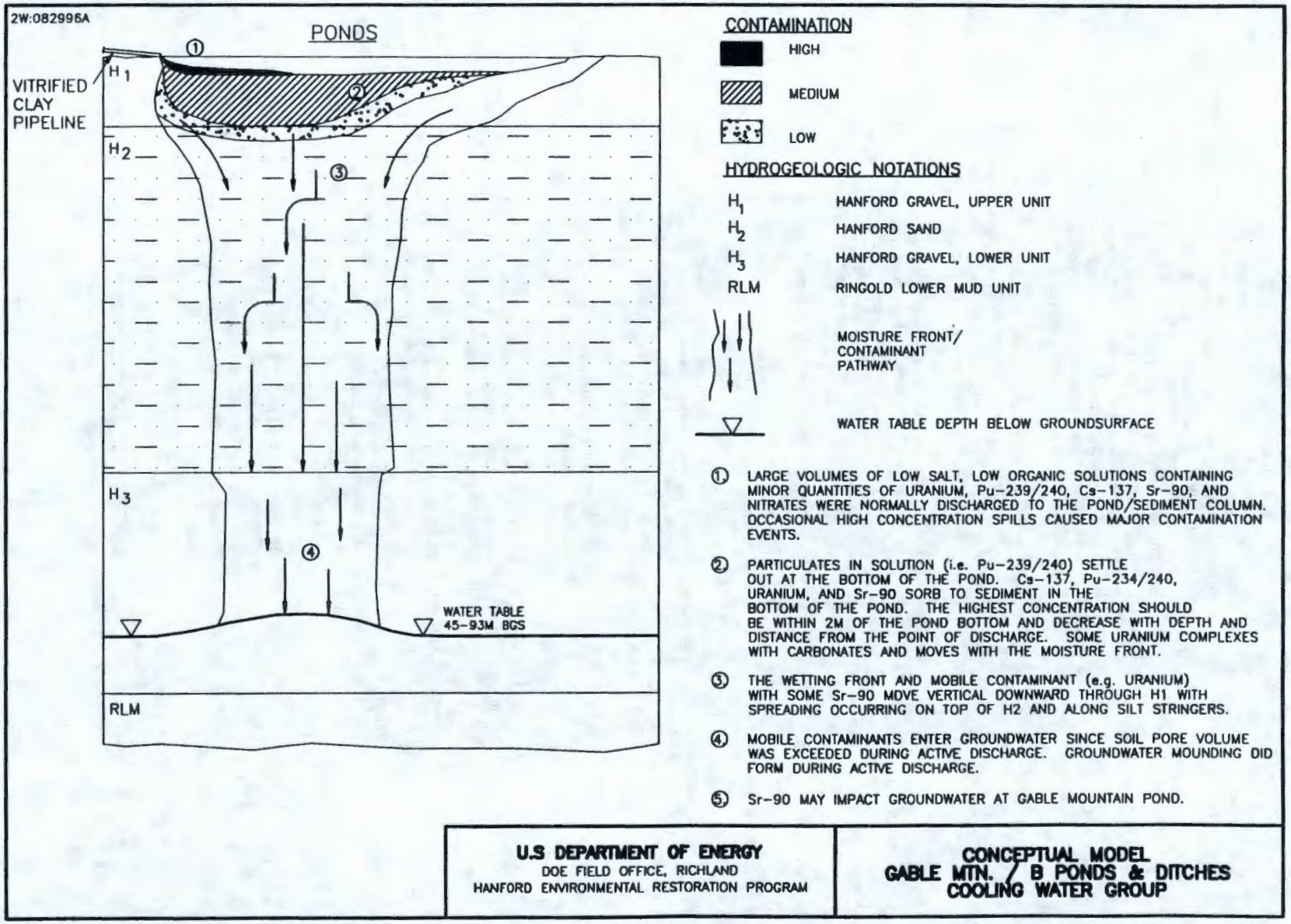
Goal Statement

Given the goal of selecting a remedial/closure alternative for the Gable Mountain Pond/B-Pond and Ditch systems, the problem is to verify the site preliminary group-specific conceptual contaminant distribution model and determine the sampling requirements (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 (No-Action, Capping, Excavate and Dispose, and Natural Attenuation).

The sites being considered for characterization include the 216-B-2-2 Ditch, Gable Mountain Pond (216-A-25), the 216-B-3-3 Ditch and B-Pond (216-B-3).

a The Preliminary Conceptual Contamination Model will become the Conceptual Contamination Model after acceptance of this DQO Workbook. The Conceptual Contamination Model will then be applied to the project Workplan.

Figure 1-6. Graphical Description of the Conceptual Site Model (from DOE/RL-96-81).



2.0 STEP 2 – IDENTIFY THE DECISION

2.1 WORKSHEETS FOR STEP 2 - IDENTIFY THE DECISION

Table 2-1 identifies the principal study question(s) that will require environmental measurements (e.g. physical, chemical, or radiological data) to resolve, alternative actions that could be taken once the principal study question(s) is resolved, the potential consequences of taking each action, and decision statements in a summary table format.

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

Principal Study Question #1 - Do the Gable Mountain Pond/ B-Pond system radionuclide concentrations in the soils meet the annual radiological exposure limits for human health protection? [a]			
PSQ-AA No.	**Alternative Action**	**Consequences of Erroneous Actions**	**Severity of Consequences**
1-1	Evaluate streamlined approach to site closure (e.g., add to an existing ROD)	In parallel with or after the ROD is issued, a confirmation step and/or verification sampling will be performed in analogous sites that will collect additional information to confirm the remedial alternative decisions. If the remedial decisions turn out to be inappropriate, the new environmental measurement data will be used to establish the proper remedial alternative. The consequences of wrong alternative actions are therefore considered to be insignificant	Not Severe
1-2	Evaluate remedial alternatives for implementation (e.g., via Feasibility Study)		
Decision Statement No. 1 - Determine whether or not the Gable Mountain Pond/B-Pond system soils exceed the radionuclide exposure limits for human health protection and require remedial action.			
Principal Study Question #2 - Do the Gable Mountain Pond/ B-Pond system metal and organic concentrations in the soils meet the chemical exposure limits for human health protection? [a]			
PSQ-AA No.	**Alternative Action**	**Consequences of Erroneous Actions**	**Severity of Consequences**
2-1	Evaluate streamlined approach to site closure (e.g., add to an existing ROD)	In parallel with or after the ROD is issued, a confirmation step and/or verification sampling will be performed in analogous sites that will collect additional information to confirm the remedial alternative decisions. If the remedial decisions turn out to be inappropriate, the new environmental measurement data will be used to establish the proper remedial alternative. The consequences of wrong alternative actions are therefore considered to be insignificant	Not Severe
2-2	Evaluate remedial alternatives for implementation (e.g., via Feasibility Study)		
Decision Statement No. 2 - Determine whether or not the Gable Mountain Pond/B-Pond system surface soils exceed the chemical constituent exposure limits for human health protection and require remedial action.			

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

Principal Study Question #3 - Does the Gable Mountain Pond/ B-Pond system Preliminary Contaminant Distribution Model properly reflect the distribution of contaminants in the waste sites?			
PSQ-AA No.	**Alternative Action**	**Consequences of Erroneous Actions**	**Severity of Consequences**
3-1	Apply preliminary contaminant distribution model for remedial alternative selection and remedial action planning	In parallel with or after the ROD is issued, a confirmation step and/or verification sampling will be performed in analogous sites that will collect additional information to confirm the remedial alternative decisions. If the remedial decisions turn out to be inappropriate, the new environmental measurement data will be used to establish the proper remedial alternative. The consequences of wrong alternative actions are therefore considered to be insignificant	Not Severe
3-2	Refine the contaminant distribution model for remedial alternative selection and remedial action planning		
Decision Statement No. 3 - Determine whether or not the preliminary conceptual contaminant distribution model represents the contaminant distribution conditions, and requires revision.			
Principal Study Question #4 - Do the Gable Mountain Pond/ B-Pond system waste plume concentrations in soil from 0-25-ft below-grade, over the wetted area for each site result in the need for 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)	In parallel with or after the ROD is issued, a confirmation step and/or verification sampling will be performed in analogous sites that will collect additional information to confirm the remedial alternative decisions. If the remedial decisions turn out to be inappropriate, the new environmental measurement data will be used to establish the proper remedial alternative. The consequences of wrong alternative actions are therefore considered to be insignificant	Not Severe
4-2	Evaluate remedial alternatives for implementation (e.g., via Feasibility Study)		
Decision Statement No. 4 - Determine whether or not the Gable Mountain Pond/ B-Pond system waste plume concentrations in soil from 0-25-ft depth, over the wetted area for each site requires remediation and support selection of a remedial action alternative.			

a Refer to Table 1-9 for scenario-specific alignment of action levels.

3.0 STEP 3 - IDENTIFY THE INPUTS TO THE DECISION

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

1) Tables 3-1 and 3-2 identify the information needed to resolve the decision statements presented in Table 2-1.

   A) Determine what environmental variables or other information is needed to resolve the decision statements.

   B) Identify the type of data needed to resolve the decision statements (e.g. physical, chemical, radiological, geotechnical).

   C) Determine whether sampling or computational methods (i.e. modeling) or a combination will be used to acquire the information to resolve the decision statements. Define any conceptual models selected for use, and the rationale for their use.

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

DS No.	Environmental Variable Informational Need	Type of Data Required	Computational Methods that Support the Informational Need	Survey/Sampling Methods that Satisfy the Informational Need
1, 3, 4	Radiological	Alpha, beta and gamma isotopic concentrations in soils for evaluation against action levels. Location data	RESRAD-Soil analytical modeling	Soil sampling followed by lab analysis of the radionuclide COCs
2, 3, 4	Chemical	Metal and organic concentrations in soils for evaluation against action levels. Location data	--	Soil sampling followed by lab analysis of the chemical COCs

Table 3-2. List of Potential Computational Methods.

PSQ No.	Computational Method	Source/ Author	Application to Study (Rationale for Use)	Satisfy Input Req't?
1,3, 4	RESRAD	Argonne National Laboratory	Estimation of direct radiation exposures for occupants and migration of contaminants to groundwater for indirect exposure estimating. RESRAD uses a one dimensional groundwater model that accounts for Kd values, recharge and vadose zone thickness and stratigraphic layers. It can track contamination migration and accounts for radioactive decay with time. A 1-D model is considered to be appropriate for 200-CW-1 because 1) the unsaturated flow direction is primarily vertical to groundwater in 200 East Area, 2) relatively low-levels of a small number of contaminants expected to be present, 3) the behavior of the primary contaminants are reasonably well understood and 4) no known complexing conditions are present that would require more sophisticated analysis. Since the model is simple, conservative input parameters are used, resulting in conservative output that is considered appropriate to support remedial action decisions. Also, RESRAD has been used for exposure dose modeling by Hanford 100 and 300 Area remedial action projects based on agreement between DOE and regulators.	Yes
	Summers Model	EPA	One dimensional, steady state model. Driven by Kd values and recharge. This model takes no account of vadose zone thickness or stratigraphic layers. Its usefulness depends on the uniformity of the soil column. It was originally developed the eastern United States with high annual rainfall and shallow water tables. It does not account for radioactive decay, as it is time independent.	No
	MTCA*Stat*	Washington State Department of Ecology	Performs statistical calculations required in the "Statistical Guidance for Ecology Site Managers"	No

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

Table 3-3. Required Information for Quantitative Assessment.

AA No.	Required Information to Assess Impact		
	Cost	Risk	
		Human Health	Environmental
The alternative actions for this project are assessments, not remedial actions from which cost estimates may be developed for decision-making. Alternative actions that involve remediation are required to support development of this table.			

2) Table 3-4 is used to determine the source(s) for each of the information needs identified in Tables 3-1, 3-2, and 3-3.

A) Identify and list the sources for the information needed to resolve the principal study questions (e.g. previous data collection efforts, historical records, regulatory guidance, professional judgement, scientific literature, new data collections, engineering standards, etc).

B) Qualitatively evaluate whether any existing data are appropriate for the study or additional data are required.

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

PSQ No.	Required Information Category	Does Data Exist? (Y/ N)	Source Reference	Sufficient Quality to Validate Prelim Concept Model? (Y/N)	Add'l Data Req'd? (Y/N)
1, 3, 4	Vadose zone radiological sample data	Y	- WHC, 1992, Vadose Zone Investigation of 216-B-3A, 216-B-3B and 216-B-3C Ponds, WHC-SD-EN-AP-104, Rev. 0, WHC, Richland, WA (aka, Appendix E, DOE/RL-89-28, Rev 2, 1994). Report provides radiological data from boreholes drilled in support of clean-closing B-Pond lobes. - 216-B-2-2 Ditch Borehole analytical data (BHI 01177, 6/17/98), which shows most contamination in the interval 8-15 ft below ground surface, i.e. 0-8 ft below the bottom of the ditch. - Goodwin, S.M., 1990, Borehole Completion Data Package for the 216-B-63 Trench, WHC-MR-0207, presents radiological data on contaminant concentrations in boreholes 299-E27-16 and 299-E33-37, near head end of the B-2 ditches	Y	Y
2, 3, 4	Vadose zone chemical sample data	Y	- WHC, 1992, Vadose Zone Investigation of 216-B-3A, 216-B-3B and 216-B-3C Ponds, WHC-SD-EN-AP-104, Rev. 0, WHC, Richland, WA (aka, Appendix E, DOE/RL-89-28, Rev 2, 1994). - Also, 216-B-2-2 Ditch Borehole analytical data (6/17/98), which shows most contamination in the interval 8-15 ft below ground surface, i.e. just below the bottom of the ditch. - Goodwin, S.M., 1990, Borehole Completion Data Package for the 216-B-63 Trench, WHC-MR-0207, presents chemical data on contaminant concentrations in boreholes 299-E27-16 and 299-E33-37, near head end of the B-2 ditches	Y	Y

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

PSQ No.	Required Information Category	Does Data Exist? (Y/ N)	Source Reference	Sufficient Quality to Validate Prelim Concept Model? (Y/N)	Add'l Data Req'd? (Y/N)
1, 3	Radiological pond/ditch bottom sample data.	Y	Environmental Surveillance Annual Reports, **1975**, ARH-LD-125; **1976**-ARH-LD-154; **1977**-RHO-LD-78-75; **1978**-RHO-LD-79-75; **1979**-RHO-LD-132; **1980**-RHO-LD-163; **1981**-RHO-HS-SR-82-13P; **1982**-RHO-HS-SR-83-13P; **1983**-RHO-HS-SR-84-13P; **1984**-RHO-HS-SR-85-13P; **1985**-RHO-HS-SR-86-13P; **1986**-WHC-EP-0145; **1987**-WHC-EP-0141; **1988**-WHC-EP-0145-1; **1989**-WHC-EP-0145-2, **1990**-WHC-EP-0145-4; **1991**-WHC-EP-0573; **1992**-WHC-EP-0573-1; **1993**-WHC-EP-0573-2; **1994**-WHC-EP-0573-3; **1995**-WHC-EP-0573-4, **1996**-HNF-EP-0573-5. Each report notes 2-5 sediment samples each for B-3 Pond, A-25 Pond, the active B-2 and/or B-3 ditch, 216-N-8, plus other surface waste sites active at the time. Radiological analysis for ^{90}Sr, ^{137}Cs. ^{239,240}Pu, Uranium were routine for most years. Analyses for ^{40}K, ^{54}Mn, ^{60}Co, ^{154}Eu, ^{155}Eu, ^{241}Am and others were performed as well. - Garland, T. R. to Cushing, C. E. 1974, PNL Letter Report, 'Evaluation and Recommendations Concerning the Isotopes Obtained by Gamma Spectrometry in Gable Mountain Pond Samples'. A review and summary of rad. data from a 1970 letter. - Gould, J.I. to L.E. Kusler, 1/12/84, Internal Letter, RHO-65452-84-005, Further Analyses of Core Samples from Overflow Region of Gable Mountain Pond. Cs-137, Sr-90 and K-40 data from 2 ft thick cores taken about pond. - Mitchell, R.M., 1997, Soil/Sediment Characterization for the 216-A-29 Ditch, HNF-SD-TWR-TI-005, Rev. 0, Summary of radionuclide concentrations in the first 3 ft of soil in samples taken along the A-29 ditch.	N	Y

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

PSQ No.	Required Information Category	Does Data Exist? (Y/ N)	Source Reference	Sufficient Quality to Validate Prelim Concept Model? (Y/N)	Add'l Data Req'd? (Y/N)
2, 3	Chemical pond/ditch bottom sample data.	Y	- DOE/RL-89-28, 1994, 216-B-3 Pond System Closure/Postclosure Plan, Appendix D, Soil and Sediment Sampling of A, B, and C Lobes. WHC, 1991, Phase I Characterization of the 216-B-3 Pond System, WHC-SD-EN-AP-042, (aka, Appendix C, DOE/RL-89-28, 1994). Presents chemical contaminant data from pond bottom samples taken at B-Pond, Main, A, B, & C lobes. - Mitchell, R.M., 1997, Soil/Sediment Characterization for the 216-A-29 Ditch, HNF-SD-TWR-TI-005, Rev. 0, Summary of chemical concentrations in the first 3 ft of soil in samples taken along the A-29 ditch.	Y	N
--	Groundwater Data	Y	- Environmental Surveillance Annual **1983**-RHO-HS-SR-84-13P; **1984**-RHO-HS-SR-85-13P; **1985**-RHO-HS-SR-86-13P; **1986**-WHC-EP-0145; **1987**-WHC-EP-0141. Annual reports note the rising concentrations of Sr in groundwater at the 216-A-25 Pond, likely attributable to increased discharges resulting from PUREX restart. - Gephardt, R.E., et al., 1976, ARH-CD-775, Geohydrologic Study of the West Lake Basin. Radiological and chemical data summary of contaminants in groundwater at West Lake. - Graham, M. J., G. V. Last & K.R. Fecht, 1984, An Assessment of Aquifer Intercommunication in the B-Pond-Gable Mountain Pond Area of the Hanford Site, RHO-RE-ST-12P. Provides general groundwater chemistry discussion of groundwater beneath ponds relative to contamination in confined aquifers. - Fuchs, M.R., Pachernegg, S.M., Routson, R.C., 1984, Strontium-90 Concentration in the Unconfined Aquifer Near the Gable Mountain Pond, WHC-SD-WM-TI-154, Rev. 0. Presents Sr-90 concentrations in boreholes around Gable Mountain Pond. - DOE/RL-92-19, 1992, 200 East Groundwater Aggregate Area Management Study Report. Provides data on both radioisotope and chemical plumes in the 200-East Area. - UOR-84-27, 1984, Unusual Occurrence Report, Anomalous Samples form	N;	Y, Monitor-ing data could support model develop-ment. But link to soil conc's is hypo-thetical.

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

PSQ No.	Required Information Category	Does Data Exist? (Y/ N)	Source Reference	Sufficient Quality to Validate Prelim Concept Model? (Y/N)	Add'l Data Req'd? (Y/N)
			Monitoring Wells at Gable Mountain Pond. Notes the exceedance of Rockwell control limits for Sr-90 at Gable Mountain Pond. - Carpenter, G. D to R.J. Baumhardt, 8/8/89, Compliance Plan (CP) 84-006, "Gable Mountain Pond Groundwater Contamination", 80300-89-127. Present graph data of Sr-90 at several wells around Gable Mountain Pond. - Dresel, P.E., et al, 1995, Hanford Site Ground-Water Monitoring for 1994, PNNL-10698 Report noted the continued high concentrations of Sr-90 in groundwater during the 1994 monitoring activities. - Dirkes and Hanf, 1997, Hanford Site Environmental Report for CY-1996, PNNL-11472, Section 4, Groundwater. Summary of groundwater contamination in the 200 East and surrounding 600 Areas.		
--	Pond Surface Water Quality Data	Y	- Gephardt, R.E., et al., 1976, ARH-CD-775, Geohydrologic Study of the West Lake Basin. Radiological and chemical data summary of contaminants in groundwater at West Lake. - Garland, T. R. to Cushing, C. E. 1974, PNL Letter Report, 'Evaluation and Recommendations Concerning the Isotopes Obtained by Gamma Spectrometry in Gable Mountain Pond Samples'. A review and summary of rad. data from a 1970 letter. - Conklin, A.W. to D.L. Uhl, 2/13/83, Investigation of Death of Fish at Gable Mountain Pond, Letter Report. Notes death of goldfish living in Gable Mountain Pond due to discharge of fire retardant foam from PUREX. - DOE/RL-92-05, 1993, B-Plant Aggregate Area Management Study Report. Reports surface water analyses of Gable Mountain Pond water. -Backman, G. E. and L.W. Roddy, 1965, Radiation Control of Accidentally Contaminated Seepage Ponds, RL-SA-15. General Electric Company. Detailed discussion of contaminants released in 6/11/64 release from PUREX. Document included in Maxfield, H.L., 1979, Handbook-200 Area Waste Sites, RHO-CD-673.	N;. Data could support model development. But link to soil conc's is hypothetical	N, No ponds to sample

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

PSQ No.	Required Information Category	Does Data Exist? (Y/ N)	Source Reference	Sufficient Quality to Validate Prelim Concept Model? (Y/N)	Add'l Data Req'd? (Y/N)
1, 3	Surface Radiological Contamination	Y	- EGG, 1990, An Aerial Radiological Survey of the Hanford Site and Surrounding Areas, Richland, WA, 1988 Survey. EGG-10617-1062. Photo overlay showing iso-radiation contours of man-made gross count gamma radiation, including B-Pond and Gable Mountain Pond areas. Minor contamination @ NW corner of inactive Gable Mountain Pond. - EGG, 1980, An Aerial Radiological Survey of the Hanford Site and Surrounding Areas, Richland, WA, 1978 Survey, 1980, No EGG document number. . Photo overlay showing iso-radiation contours of man-made gross count gamma radiation, including B-Pond and Gable Mountain Pond areas. Moderate contamination at active Gable Mountain Pond. - Subrahmanyan, V. B. to W. F. Heine, 9/1/83, Survey and Characterization of Radiation Zone Around Gable Mountain Pond, 654552-83-101, Letter report describing contamination around Gable Mountain Pond. - Hayward, W. M., 1989, Gable Mountain Pond Interim Stabilization Final Report, WHC-SD-DD-TI-036, Rev 0. Description of stabilization activities at Gable Mountain Pond between 1984 and 1988. Stabilization was primarily in response to elevating Sr-90 concentrations in Gable Mountain Pond groundwater. - Hayward, W. M., 1997, 216-A-25 Pond Overflow Extension (WIDS Site 600-118) Interim Stabilization Final Report., BHI-01133, Rev 0. Reports on interim stabilization measures taken at the contamination zone noted in previous fly-overs (EGG, 1990 above).	N	N
--	RCRA/ CERCLA Integration Information	Y	- DOE/RL-98-28, Draft, 200 Areas Remedial Investigation/Feasibility Study Implementation Plan–Environmental Restoration Program, Chapter 2, RCRA/CERCLA Integration.	--	--
1, 3	Waste Site Inventory Data	Y	- WIDS, Radionuclide Inventory Data. For selected sites within this group, a listing of radionuclides with quantities decayed through 4/8/98. No inorganic/organic constituents.	Y	N

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

PSQ No.	Required Information Category	Does Data Exist? (Y/ N)	Source Reference	Sufficient Quality to Validate Prelim Concept Model? (Y/N)	Add'l Data Req'd? (Y/N)
1, 3	RESRAD Input data; soil density, erosion rate, porosity, hydraulic conductivity, B parameter, hydraulic gradient.	Y/N	- Moisture content, particle size distribution, and lithology needed for determining soil density, hydraulic conductivity, and porosity. Other input parameters can be determined from existing data.	N	Y

3) Identify the information needed to establish the action level(s).

An action level is a threshold value, which provides the criterion for choosing between alternative actions. Action levels may be based on regulatory thresholds or standards, or they may be derived from problem-specific considerations such as risk analysis. Because ARARs and PRGs for this project have not been established via a ROD, the preliminary ARARs and PRGs shown in Table 1-9 provide the basis for the radiological and chemical action levels shown in Tables 3-7a and 3-7b. It should be noted that the action levels in Tables 3-7a and 3-7b are used for setting the analytical detection limits, not as final cleanup limits.

4) Table 3-5 lists the information needed to perform the Step 6 quantitative assessment of the alternative actions identified in Step 2 with severe decision error consequences. This information should evaluate the impact to cost, risk to human health and the environment, and schedule.

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

AA No.	Consequences of Decision Error			
	Cost	Human Health Risk	Environmental Risk	Schedule
The alternative actions for this project are assessments, not remedial actions from which cost estimates may be developed for decision-making. Alternative actions that involve remediation are required to support development of this table.				

5) 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 No.	Media	Environ' Variable	Potentially Appropriate Measurement Method	Possible Limitations or Reservations
This project will rely on standard fixed laboratories for sample analyses. Field screening data (XRF, Hach kit, etc) may be used in conjunction with the laboratory data, but will not be used to refine the preliminary conceptual contamination model, or for remdial action decision-making. The analytical techniques are provided in Tables 3-7a and 3-7b.				

B) Define the method detection limit, action level, limit of quantitation, precision, and accuracy requirements for each potential method.

Tables 3-7a and 3-7b list the analytes (COCs) from Table 1-7 and the analytical methods to be used, so that the laboratory detection limits/practical quantitation limits may be compared with the required action levels. This enables the DQO participants to verify that the detection capabilities for the selected analytical techniques meet the analytical requirements determined by the action levels. Table 3-7a addresses shallow zone soils, and Table 3-7b deals with the deep zone soils. It should be noted that the action levels for the deep zone are in many cases more conservative than those used in the shallow zone.

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

Data Type	Analytical Method	Analyte	Prelim Action Level[a]			Detection Limit Requirements[a]		Accuracy Req't	Precision Req't
			Ind	Cons	Cl/Close	MDL	PQL		
Rad	GeLi/HPGe AmAEA[b]	Americium-241	*	*	*	0.1 0.1	1 1	80-120 70-130	±30 ±30
Rad	GeLi/HPGe	Cesium-137	*	*	*	0.05	0.1	80-120	±30
Rad	GeLi/HPGe	Cobalt-60	*	*	*	0.05	0.1	80-120	±30
Rad	GeLi//HPGe	Europium-152	*	*	*	0.1	0.2	80-120	±30
Rad	GeLi/HPGe	Europium-154	*	*	*	0.1	0.2	80-120	±30
Rad	GeLi/HPGe	Europium-155	*	*	*	0.05	0.1	80-120	±30
Rad	NpAEA[b]	Neptunium-237	*	*	*	0.1	1	70-130	±30
Rad	PuAEA[b]	Plutonium-238	*	*	*	0.1	1	70-130	±30
Rad	PuAEA [b]	Plutonium-239/240	*	*	*	0.1	1	70-130	±30
Rad	RADSr	Strontium-90	*	*	*	0.2	1	70-130	±30
Rad	ThAEA[b]	Thorium-232	*	*	*	0.1	1	70-130	±30
Rad	UAEA[b]	Uranium-233/234	*	*	*	0.1	1	70-130	±30
Rad		Uranium-235/236	*	*	*	0.1	1	70-130	±30
Rad		Uranium-238	*	*	*	0.1	1	70-130	±30

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

Data Type	Analytical Method	Analyte	Prelim Action Level[a]		Detection Limit Requirements[a]		Accuracy Req't	Precision Req't
			MethC[c]	MethB	MDL	PQL		
Chem	EPA 6010	Arsenic	6.5[d]	6.5[d]	2.5/0.2[e]	10/1[e]	70-130	±30
Chem	EPA 6010	Barium	245[f]	132[d,f]	0.1	1	70-130	±30
Chem	EPA 6010	Beryllium	1.51[d]	1.51[d]	0.03	0.2	70-130	±30
Chem	EPA 6010	Cadmium	3.6[f]	1.6[f]	0.3	0.8	70-130	±30
Chem	EPA 6010	Chromium (III)	36[f]	36[f]	0.4	1	70-130	±30
Chem	EPA 7196	Hexavalent Chromium	17.5[g]	8.0[g]	0.1	0.7	70-130	±30
Chem	EPA 6010	Copper	130[f]	59.2[f]	0.5	2	70-130	±30
Chem	EPA 6010	Lead	353[f,h]	353[f,h]	3	20	70-130	±30
Chem	EPA 7471	Mercury	0.33[d,f]	0.33[d,f]	0.005	0.05	70-130	±30
Chem	EPA 6010	Nickel	70[f]	32[f]	1	4	70-130	±30
Chem	EPA 6010	Selenium	5[f]	5[f]	5	20	70-130	±30
Chem	EPA 6010	Silver	10[f]	8[f]	0.7	2	70-130	±30
Chem	EPA 6010	Vanadium	24.5[f]	11.2[f]	0.5	3	70-130	±30
Chem	EPA 6010	Zinc	500[f]	480[f]	0.5	2	70-130	±30
Chem	EPA 305.1	Ammonia	59,500[i]	27,200[i]	0.2	0.5	70-130	±30
Chem	EPA 9010	Cyanide	2.6	2.6	0.25	1	70-130	±30
Chem	EPA 300.0	Fluoride	210	96	0.2	1	70-130	±30
Chem	EPA 300.0	Nitrate	4,400	4,400	0.02	0.2	70-130	±30
Chem	EPA 300.0	Nitrite	330	330	0.2	1	70-130	±30
Chem	EPA 300.0	Sulfate	25,000	25,000	2	10	70-130	±30
Chem	EPA 300.0	Phosphate	N/A[f]	N/A[f]	0.6	6	70-130	±30
Chem	EPA 300.0	Chloride	25,000	25,000	0.2	2	70-130	±30
Chem	EPA 9030	Sulfide	N/A	N/A	4	20	70-130	±30
Chem	EPA 9045	pH	N/A	N/A	N/A	N/A	70-130	±30
Chem	EPA 8260	Acetone	175	80	0.05	0.01	70-130	±30
Chem	EPA 8260	1-Butanol (Butyl alcohol)	350	160	0.4	1	70-130	±30
Chem	EPA 8260	2-Butanone (MEK)	105	48	0.005	0.01	70-130	±30
Chem	EPA 8270 as TIC	Butylated hydroxy toluene			N/A	N/A	N/A	N/A
Chem	EPA 8260	Carbon Tetrachloride	0.337	0.0337	0.001	0.005	70-130	±30
Chem	EPA 8260	Chloroform (Trichloromethane)	7.17	0.717	0.001	0.005	70-130	±30
Chem	EPA 8260 as TIC	Decane			N/A	N/A	N/A	N/A
Chem	EPA 8260	Dichloromethane (Methylene Chloride)	0.5	0.5	0.002	0.005	70-130	±30
Chem	EPA 8260 as TIC	Ethanol			N/A	N/A	N/A	N/A
Chem	EPA 8260	Halogenated hydrocarbons			0.002	0.005	70-130	±30
Chem	EPA 8260 as TIC	Propanol (Isopropyl alcohol)			N/A	N/A	N/A	N/A
Chem	EPA 8260	Toluene	100	100	0.001	0.005	70-130	±30
Chem	EPA 8270	Tributyl phosphate			0.4	4	70-130	±30
Chem	EPA 8260	1,1,1-Trichloroethane	20	20	0.001	0.005	70-130	±30
Chem	EPA 8260	1,1,2-Trichloroethane	0.3	0.0768	0.001	0.005	70-130	±30

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

Data Type	Analytical Method	Analyte	Prelim Action Level[a]		Detection Limit Requirements[a]		Accuracy Req't	Precision Req't
			MethC	MethB	MDL	PQL		
Chem	EPA 8082	Polychlorinated biphenyls (PCBs)	66[f]	0.5[f]	0.01	0.1	70-130	±30
Chem	NWTPH-Dx Modified for Kerosene range	Kerosene Normal paraffin hydrocarbon Paraffin hydrocarbons Shell E-2342 (napthalene and paraffin) Soltrol-170 ($C_{10}H_{22}$ to $C_{16}H_{34}$) purified kerosene Diesel Fuel			0.5	5	70-130	±30

Note: Detection limits in this table are based on optimal conditions. Interferences and different matrices may significantly degrade the values shov
[a] Units pCi/g or mg/kg.
[b] AmAEA, PuAEA, UAEA, NpAEA, ThAEA - chemical separation, electro/microprecipitation deposition, alpha energy analysis via Si barrier det
[c] Method C values are based on MTCA Industrial Standards.
[d] Based on Hanford Site Background values.
[e] First value shown is via routine ICP, second value via "Trace" ICP or graphite furnace atomic absorption.
[f] The RESRAD model for the 100 Area RD/RA or 100-N Area CMS predicts that this constituent will not reach groundwater in 1000 years. It is anticipated that the same will be true in the 200 Areas.
[g] MTCA 100 times groundwater value.
[h] The lead value is based on the IEUBK model from EPA.
[i] Ammonia dissolves in the environment and is assumed to not reach groundwater.
* There are no values for these scenarios at this time. They will be developed in the RI/FS process.
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. (3 Pages)

Data Type	Analytical Method	Analyte	Prelim Action Level[a]	Detection Limit Requirements[a]		Accuracy Req't	Precision Req't
				MDL	PQL		
Rad	GeLi/HPGe AmAEA[b]	Americium-241		0.1 0.1	1 1	80-120 70-130	±30 ±30
Rad	GeLi/HPGe	Cesium-137		0.05	0.1	80-120	±30
Rad	GeLi/HPGe	Cobalt-60		0.05	0.1	80-120	±30
Rad	GeLi//HPGe	Europium-152		0.1	0.2	80-120	±30
Rad	GeLi/HPGe	Europium-154		0.1	0.2	80-120	±30
Rad	GeLi/HPGe	Europium-155		0.05	0.1	80-120	±30
Rad	NpAEA[b]	Neptunium-237		0.1	1	70-130	±30
Rad	Chem Separation Liq Scintillation	Nickel-63		5	30	70-130	±30
Rad	PuAEA[b]	Plutonium-238		0.1	1	70-130	±30
Rad	PuAEA [b]	Plutonium-239/240		0.1	1	70-130	±30
Rad	RADSr	Strontium-90		0.2	1	70-130	±30
Rad	Chem Separation Liq Scintillation	Technetium-99		5	15	70-130	±30
Rad	Distillation Liq Separation	Tritium		5	400	70-130	±30

Table 3-7b. Analytical Performance Requirements – Deep Zone Soils. (3 Pages)

Data Type	Analytical Method	Analyte	Prelim Action Level[a]		Detection Limit Requirements[a]		Accuracy Req't	Precision Req't
					MDL	PQL		
Rad	ThAEA[b]	Thorium-232			0.1	1	70-130	±30
Rad	UAEA[b]	Uranium-233/234			0.1	1	70-130	±30
Rad		Uranium-235/236			0.1	1	70-130	±30
Rad		Uranium-238			0.1	1	70-130	±30
Data Type	**Analytical Method**	**Analyte**	**Prelim Action Level[a]**		**Detection Limit Requirements[a]**		**Accuracy Req't**	**Precision Req't**
			MethC[c]	**MethB**	**MDL**	**PQL**		
Chem	EPA 6010	Arsenic	6.5[d, e]	6.5[d, e]	2.5/0.2[f]	10/1[f]	70-130	±30
Chem	EPA 6010	Barium	245[e]	132[d,e]	0.1	1	70-130	±30
Chem	EPA 6010	Beryllium	1.51[d]	1.51[d]	0.03	0.2	70-130	±30
Chem	EPA 6010	Cadmium	0.17[e,g]	0.17[e,g]	0.3	0.8	70-130	±30
Chem	EPA 6010	Chromium (III)	36[e]	36[e]	0.4	1	70-130	±30
Chem	EPA 7196	Hexavalent Chromium	17.5[g]	8.0[g]	0.1	0.7	70-130	±30
Chem	EPA 6010	Copper	130[e]	59.2[e]	0.5	2	70-130	±30
Chem	EPA 6010	Lead	353[e,h]	353[e,h]	3	20	70-130	± 30
Chem	EPA 7471	Mercury	0.33[d,e]	0.33[d,e]	0.005	0.05	70-130	±30
Chem	EPA 6010	Nickel	70[e]	32[e]	1	4	70-130	±30
Chem	EPA 6010	Selenium	5[e]	5[e]	5	20	70-130	±30
Chem	EPA 6010	Silver	10[e]	8[e]	0.7	2	70-130	±30
Chem	EPA 6010	Vanadium	24.5[e]	11.2[e]	0.5	3	70-130	±30
Chem	EPA 6010	Zinc	500[e]	480[e]	0.5	2	70-130	±30
Chem	EPA 305.1	Ammonia	59,500[i]	27200[i]	0.2	0.5	70-130	±30
Chem	EPA 9010	Cyanide	2.6[g]	2.6[g]	0.25	1	70-130	±30
Chem	EPA 300.0	Fluoride	200	96	0.2	1	70-130	±30
Chem	EPA 300.0	Nitrate	4,400	4,400	0.02	0.2	70-130	±30
Chem	EPA 300.0	Nitrite	330	330	0.2	1	70-130	±30
Chem	EPA 300.0	Sulfate	25,000	25,000	2	10		
Chem	EPA 300.0	Phosphate	N/A[e]	N/A[e]	0.6	6		
Chem	EPA 300.0	Chloride	25,000	25,000	0.2	2		
Chem	EPA 9030	Sulfide	N/A	N/A	4	20	70-130	±30
Chem	EPA 9045	pH	N/A	N/A	N/A	N/A	70-130	±30
Chem	EPA 8260	Acetone	175	80	0.05	0.01	70-130	±30
Chem	EPA 8260	1-Butanol (Butyl alcohol)	350	160	0.4	1	70-130	±30
Chem	EPA 8260	2-Butanone (MEK)	105	48	0.005	0.01	70-130	±30
Chem	EPA 8270 As TIC	Butylated hydroxy toluene			N/A	N/A	N/A	N/A
Chem	EPA 8260	Carbon Tetrachloride	0.337	0.0337	0.001	0.005	70-130	±30
Chem	EPA 8260	Chloroform (Trichloromethane)	7.17	0.717	0.001	0.005	70-130	±30
Chem	EPA 8260 As TIC	Decane			N/A	N/A	N/A	N/A
Chem	EPA 8260	Dichloromethane (Methylene Chloride)	0.5	0.5	0.002	0.005	70-130	±30
Chem	EPA 8260 as TIC	Ethanol			N/A	N/A	N/A	N/A
Chem	EPA 8260	Halogenated hydrocarbons			0.002	0.005	70-130	±30
Chem	EPA 8260 as TIC	Propanol (Isopropyl alcohol)			N/A	N/A	N/A	N/A
Chem	EPA 8260	Toluene	100	100	0.001	0.005	70-130	±30
Chem	EPA 8270	Tributyl phosphate			0.4	4	70-130	±30
Chem	EPA 8260	1,1,1-Trichloroethane	20	20	0.001	0.005	70-130	±30

Table 3-7b. Analytical Performance Requirements – Deep Zone Soils. (3 Pages)

Data Type	Analytical Method	Analyte	Prelim Action Level[a]		Detection Limit Requirements[a]		Accuracy Req't	Precision Req't
			MethC[c]	MethB	MDL	PQL		
Chem	EPA 8260	1,1,2-Trichloroethane	0.3	0.0768	0.001	0.005	70-130	±30
Chem	EPA 8082	Polychlorinated biphenyls (PCBs)	66[e]	0.5[e]	0.01	0.1	70-130	±30
Chem	NWTPH-Dx Modified for Kerosene range	Kerosene Normal paraffin hydrocarbon Paraffin hydrocarbons Shell E-2342 (napthalene and paraffin) Soltrol-170 ($C_{10}H_{22}$ to $C_{16}H_{34}$) purified kerosene Diesel Fuel			0.5	5	70-130	±30

Note: Detection limits in this table are based on optimal conditions. Interferences and different matrices may significantly degrade the values shown.
[a] Units pCi/g or mg/kg.
[b] AmAEA, PuAEA, UAEA, NpAEA, ThAEA - chemical separation, electro/microprecipitation deposition , alpha energy analysis via Si barrier detector.
[c] Method C values are basedon MTCA Industrial Standards.
[d] Based on Hanford Site Background values.
[e] 100 Area RESRAD model results show that this constituent will not reach groundwater in 1000 years.
[f] First value shown is via routine ICP, second value via "Trace" ICP or graphite furnace atomic absorption.
[g] .MTCA 100 times groundwater value.
[h] The lead value is based on the IEUBK model from EPA.
[i] Ammonia dissolves in the environment and is assumed to not reach groundwater.
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

4.1 WORKSHEETS FOR STEP 4 - DEFINE THE BOUNDARIES OF THE STUDY

Define the Boundaries of the Study - Define the spatial and temporal boundaries of the study in order to clarify what the samples are intended to represent.

1) Table 4-1 specifies the characteristics that define the population of interest.

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

DS No.	Population of Interest	Characteristics	Unit Measurement Size	Total Number of Potential Measurement Units Within the Population[a]
All	Gable Mountain Pond/B-Pond system high contaminant concentration soils	Soil radionuclide and chemical concentrations that contribute to the annual exposures	4,000 g soil sample	3.15 E8 possible soil samples in high concentration soils
	Gable Mountain Pond/B-Pond system moderate contaminant concentration soils			9.95 E8 possible soil samples in moderate concentration soils
	Gable Mountain Pond/B-Pond system low contaminant concentration soils			1.05 E10 possible soil samples in low concentration soils

[a] This column is intended to show how many 4000-gram samples could be collected from the three concentration zones in the preliminary conceptual model. It is a simple volumetric calculation for each zone, showing how many 4000-gram units exist for all of the waste sites combined. It provides a means to compare the final sampling design with the number of samples that could possibly be collected.

2) Define the Spatial Boundaries of the Decision.

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

Table 4-2. Geographic Areas of Investigation.

DS No.	Geographic Areas of Investigation
All	Two representative CERCLA waste sites (Gable Mountain Pond (216-A-25) and 216-B-2-2 Ditch) and two representative RCRA TSD units (B-Pond (216-B-3-3) and 216-B-3-3 Ditch).

Table 4-3 is used to divide the population into strata that have relatively homogeneous characteristics. The Waste Site Grouping Report evaluated process knowledge, historical data and plant configurations on a waste group-specific basis. The DQO Team refined that information for the representative sites by site-specific evaluation of process knowledge and historical data to present evidence of a logic that supports alignment of the population into strata with homogeneous characteristics.

Table 4-3. Strata with Homogeneous Characteristics.

DS No.	Population of Interest	Strata	Homogeneous Characteristic Logic
1, 2, 3, 4	Gable Mountain Pond/ B-Pond system surface soils	Stabilizing fill over each waste site	Soils placed as past stabilization cover to prevent migration of surface contaminants.
		Pond sediment layer at the bottom of the ponds and ditches (the topmost 6-ft of pond/ditch bottoms below stabilizing fill).	This is a zone in the preliminary contaminant distribution model that is expected to contain the highest concentrations of contaminants. This is due to the build-up of sediments (or pond sediment layer) on the bottom of the ponds and ditches that sorb or filter contaminants.
3, 4		Soils below the pond sediment layer down to approximately 25-ft depth below grade.	This is a zone in the preliminary contaminant distribution model that is expected to contain moderate concentrations of contaminants because immobile contaminants would have concentrated in the pond sediment layer.
1, 2, 3, 4	Gable Mountain Pond/ B-Pond system deep vadose zone soils	Soils deeper than 25-ft. below grade	This is a zone in the preliminary conceptual contaminant distribution model that is expected to contain low concentrations of mobile contaminants, and those concentrations are expected to continually decrease with depth. This is because the majority of the contaminants would have been filtered and/or sorbed in the upper soil strata, leaving the dissolved mobile contaminants in the moisture front.

Table 4-4 defines the spatial scale of decision making for the Gable/B-Pond Cooling Water 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.

The spatial scale of decision making for the Gable Mountain Pond/B-Pond system is defined as follows:

- Remedial Action Decision-Making Depths
  - Pond Sediment Layer at the Bottom of Ponds/Ditches
  - Soils from 6-25-ft Below-Grade (nominal values)
- Deep Vadose Zone Soils
- Pipeline and cover soils

Remedial Action Decision-Making Depths

Remedial action decision-making focuses on the contamination profile in the 0-25-ft. depth interval, based on MCACES cost models. The models show that modified RCRA 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 decision-making for the Gable Mountain Pond/B-Pond system sites requires analytical data to at least 25-ft.below the local grade elevation. There are two depth intervals that are subsets of the 0-25-ft depth. They are the Pond Sediment Layer and the Soils from 6-25-ft. Below-Grade.

Pond Sediment Layer

The pond sediment layer at the bottom of the ponds/ditches is expected to contain the highest contamination levels in each waste site. This zone therefore has the greatest likelihood of exceeding action levels, and is the primary area of importance for shallow zone decision making. If the contamination levels in this worst case layer are below the action levels, the shallow zone soils are not expected to require remedial action.

This zone is expected to be detectable by radiological field screening measurements for gamma activity.

Soils from 6-25-ft Below-Grade

The soils below the pond sediment layer are expected to contain moderate contamination concentrations. If the contaminant concentrations in the pond sediment layer exceed the regulatory action levels, the contamination levels in the soils below the pond sediment layer then become the most critical zone for waste site regulatory action level evaluation, remedial action decision-making, and preliminary contaminant distribution model verification. However, if the contamination levels in the worst case pond sediment layer are below the action levels, analysis of the shallow zone soils below the pond sediment layer will be primarily be used to verify the preliminary contaminant distribution model.

Deep Vadose Zone Soils

The deep vadose zone soils (>25-ft below grade) are represented in the preliminary contaminant distribution model as having decreasing contamination levels with depth. This is an area of importance to verify the model (Figure 1-6).

Pipeline and Cover Soils

The pipelines and cover soils represent a unique aspect of this project, which are considered as analogous to the waste sites as discussed in Table 1-13. Therefore, the decision rules established for the ponds/ditches apply to the pipelines and cover soils.

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

Table 4-5. Sampling Timeframe and Sampling Design Rigor Requirements.

The sampling design rigor for the remedial investigation (RI) must be adequate to support remedial decision-making for the waste group. Waste group sites will be accessible for additional sampling after the RI is completed. In addition, confirmatory and remedial design sampling will be performed after the RI at the sites within the waste group, providing additional sampling opportunities. Consequently, a rigorous statistical sample design is not considered to be required for the RI at this time. A judgmental sample design is considered adequate for the initial RI phase of 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			
Radiological	Beta/gamma measurements	Extreme weather conditions may limit field screening operations	Non-winter months due to impacts on worker efficiencies
Chemical	Metals in soils		
Laboratory Samples			
Radiological	Alpha, beta and gamma isotopic concentrations in the soils	Extreme weather conditions may shut down field operations	Non-winter months due to impacts on worker efficiencies and sample integrity
Chemical	Metal and organic concentrations in soils		
Physical	Soil properties		

Table 4-7. Temporal Scale of Decision-Making.

No temporal scale of decision making is identified for this DQO.

4) Table 4-8 identifies the practical constraints on data collection for the Gable/B-Pond and Ditches Cooling Water Waste Group sites.

Table 4-8. Practical Constraints on Data Collection.

Sampling in the pond sediment layer will require careful observation to ensure that the pond sediment layer has been encountered (stabilization layer has been removed) before collecting pond sediment samples. Samplers will need to carefully remove the stabilizing gravel layer, observing the change in grain size and color at the onset of the pond sediment layer and by field screening detection (beta/gamma detector levels). The soil media below the pond sediment is typical of Hanford soils and should not pose unusual sampling problems. No ALARA or other constraints are expected at this time.

5.0 STEP 5 - DEVELOP A DECISION RULE

5.1 WORKSHEETS FOR STEP 5 - DEVELOP A DECISION RULE

1) Table 5-1 is used to specify the statistical parameters of interest that characterizes the population.

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

DS No.	Decision Statement Summary	Parameter of Interest
All	Refer to Table 2-1 for Decision Statements	Maximum detected values

2) Table 5-2 specifies the scale of the decision-making.

Table 5-2. Scale of Decision-Making.

Refer to Table 4-4.

3) Table 5-3 specifies the action level or preliminary action level for the decision.

Table 5-3. Action Level for the Decision.

DS No.	COC	Action Level
1	Radiological COCs	Shallow Zone Action Levels in Table 3-7a
2	Chemical COCs	
1	Radiological COCs	Deep Zone Action Levels in Table 3-7b
2	Chemical COCs	

4) Table 5-4 specifies the alternative actions to be taken.

Table 5-4. Alternative Actions.

PSQ No.	AA No.	Alternative Actions
1, 2, 4	1	Evaluate streamlined approach to site closure
	2	Evaluate remedial alternatives for implementation
3	1	Apply preliminary contaminant distribution model for remedial alternative selection and remedial action planning
	2	Revise the contaminant distribution model for remedial alternative selection and remedial action planning

5) Decision rules are presented in Table 5-5.

The output of Step 5 is combined with the previous DQO steps into an "if … then ..." decision rule that incorporates the parameter of interest, the scale of decision making, and the action level, and the actions that would result from resolution of the decision.

Table 5-5. Decision Rules.

DR No.	Decision Rule
1	If the RESRAD analysis for the maximum detected concentrations of the radiological COCs in the pond sediment layer result in annual exposures above the human health protection limits for the appropriate scenario, then the remedial action alternatives[a] will be evaluated for the pond sediment layer.
2	If the RESRAD analysis for the maximum detected concentrations of the radiological COCs in the soils from 6-25-ft below-grade (below the pond sediment layer) result in annual exposures above the human health protection limits for the appropriate scenario, then the remedial action alternatives[a] will be evaluated for the soils from 6-25-ft below-grade.
3	If the maximum detected values of the chemical COCs in the pond sediment layer exceed the Table 3-7 action levels (for the appropriate scenario), then the remedial action alternatives[a] will be evaluated for the pond sediment layer.
4	If the maximum detected values of the chemical COCs in the soils from 6-25-ft below-grade (below the pond sediment layer) exceed the Table 3-7 action levels (for the appropriate scenario), then the remedial action alternatives[a] will be evaluated for the soils from 6-25-ft below-grade.
5	If the contamination distribution in the 0-25-ft. elevation, and in the deep vadose zones differ significantly from the preliminary contaminant distribution model, then the preliminary model requires revision prior to use for remedial decision-making or remedial action planning.

a The use of the term "remedial action" is used collectively to refer to one of the alternatives described in the project objectives discussion. The selection of the appropriate alternative action is beyond the scope of this DQO.

6.0 STEP 6 - SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

6.1 PURPOSE

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

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

Make a preliminary determination of the need for a statistically based sample design by evaluating the severity of the consequences in Steps 2 and 4 in the Figure 6-1 logic diagram. If a statistically based sample design is to be used, proceed to Activity No. 2 in Step 6. If a professional judgement sampling approach is to be applied, skip the rest of Step 6 and proceed directly to Step 7.

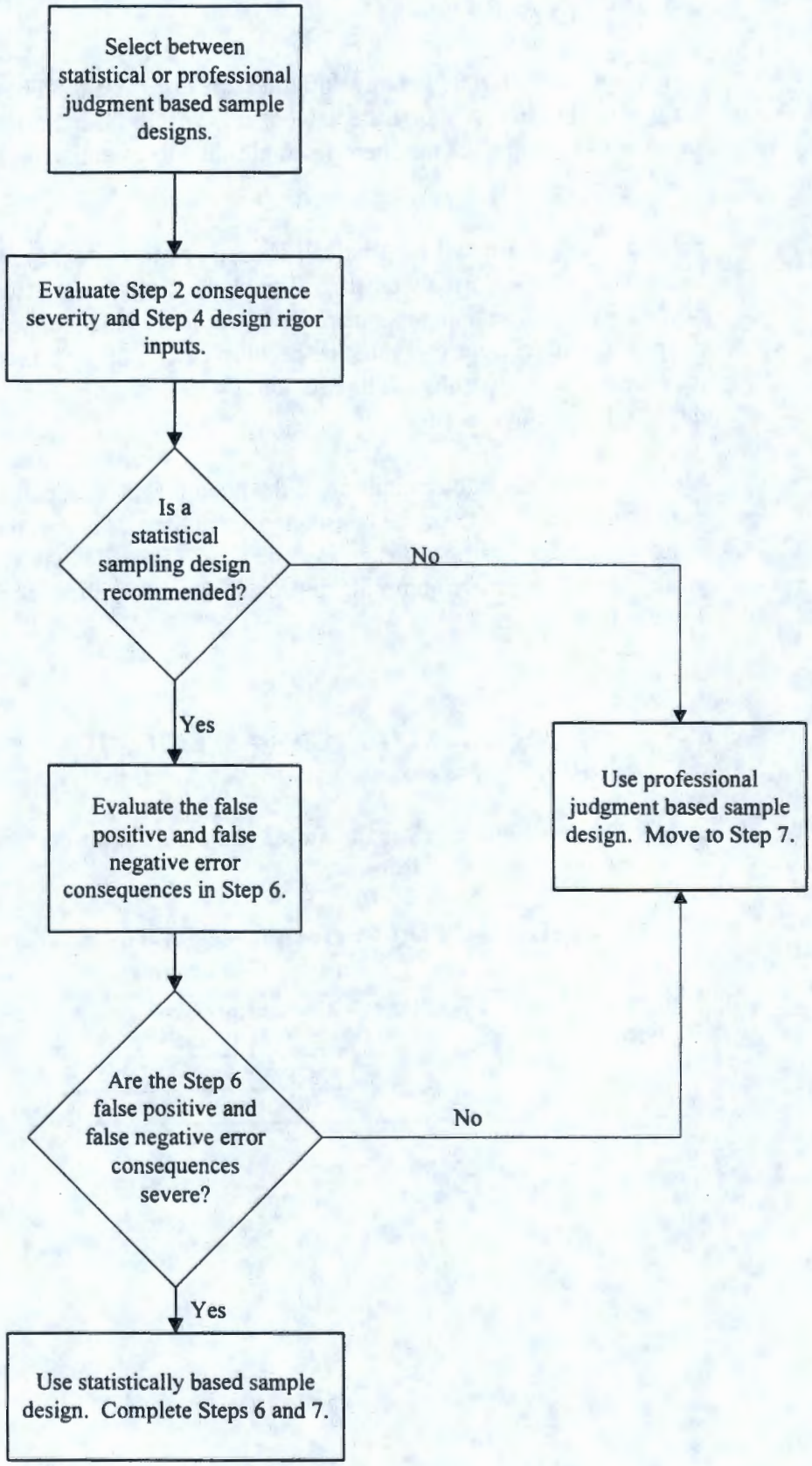
6.2 WORKSHEETS FOR STEP 6 - SPECIFY TOLERABLE LIMITS ON DECISION ERROR

1) Table 6-1 summarizes the Step 2 sample design inputs and and Step 4 consequence severity in tabular form.

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

DQO Step	PSQ No.	AA No.	Consequence Severity/Sampling Design Rigor	Preliminary Step 6 Sample Design Basis
Step 2	1-4	1-2	Not severe as stated in Table 2-1	Non-statistical sampling design
Step 4	1-4	1-2	Judgmental 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 identify the most resource-effective design for generating data to support decisions while maintaining the desired degree of precision and accuracy. When determining an optimal design, the following activities should be performed:

- Review the DQO outputs from the previous DQO steps along with existing environmental data.
- Develop general data collection design alternatives.
- Formulate the mathematical expressions needed to solve the design problem for each alternative design.
- Select the optimal sample size that satisfies the project goals for each alternative design.
- Select the most resource-effective data collection design that satisfies all of the project goals.
- Document the operational details and theoretical assumptions of the selected design.

7.2 WORKSHEETS FOR STEP 7 - OPTIMIZE THE DESIGN

1) Review the DQO outputs and existing environmental data.

Table 7-1 is used to determine from DQO Step 6 what type of data collection design is appropriate for each decision (statistical/non-statistical) and state the rationale for the selection.

Table 7-1. Determine Data Collection Design.

Decision	Statistical	Non-statistical	Rationale
All	N/A	Non-statistical sampling design	Consequences of erroneous decisions are not severe. Characterization sampling results will be verified by confirmatory sampling of analogous sites during the remedial design phase.

2) Develop general data collection design alternatives.

Because the data collection design for all decisions will be non-statistical, Table 7-2 determines what type of non-statistical design is appropriate (haphazard or judgmental).

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

Decision Rule No.	Haphazard	Judgmental
All	N/A	Professional Judgement sampling design

3) Table 7-3 identifies and describes the data collection design alternatives for this project.

Table 7-3. Methods for Collection of Soil Samples at Depth.

Method	Description
Trenching	Excavation with backhoe or excavator. This technique allows grab samples to be taken directly from the excavator bucket; samples may be taken at any time.
Cone Penetrometer	The cone penetrometer pushes a closed-end rod into the soil to the desired depth, where a removable tip is displaced and a small volume of formation is retrieved.
Auger Drilling	Samples collected from auger drilling may be grab samples retrieved directly from the auger fitting during the drilling process, or they may be split tube samples. Hollow stem auger flights are utilized to allow split tube samples to be taken during auger drilling. The samples are retrieved using a sample tube down the hollow center of the flight.
Cable Tool Drilling	Cable tool is a slow drilling method particularly useful in highly contaminated areas because contamination is better controlled. Either grab samples from the drive barrel or split spoon samples may be taken with cable tool drills. DOE-owned controlled cable tool rigs are available onsite.
Sonic Drilling	Sonic drill rigs are capable of advancing either a well casing or a sample tube. The samples retrieved via sonic drilling are comparable to split spoon samples from a cable tool operation. This technique is much faster than cable tool, but generates a significant amount of heat, which alters the sample and the surrounding formation.
Air Rotary Drilling	Air rotary drilling is much faster than other types of drilling. Both 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.

4) Select the Most Resource-Effective Data Collection Design that Satisfies the DQOs.

Table 7-4 evaluates the design options based on cost and ability to meet the DQO constraints resulting in the selection of a design that most efficiently meets all of the DQO constraints. The key features of the selected design are documented.

Table 7-4a. Key Features of Sampling Design for Gable Mountain Pond (216-A-25).

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Borehole sampling to groundwater	1 borehole location at the influent end of the pond where contamination is expected to be highest (Figure 7-1, sample point B-1). Collect soil samples at 2.5 ft intervals to 10 ft (2.5, 5, 7.5, 10 ft) starting at the pond sediment layer, then at 5 ft intervals to 25 ft bgs, then at 10 ft intervals to groundwater, as a general sampling scheme. Critical sample intervals are at the pond sediment layer, at 15-ft bgs and at 25-ft bgs. RLS logging of the borehole should be performed Deep zone (>15'deep) samples will be analyzed for all COCs in Table 1-7. Shallow zone samples (0-15' deep) will be analyzed for the Table 1-7 COCs, except for H-3, Ni-63, and Tc-99. Analytical requirements for physical soil properties identified in Tables 3-4 and 4-6 will be determined in the SAP.	A borehole is required to verify the contamination profile beneath the upper strata of the waste site. It will extend to groundwater to show the COC concentrations through the vadose zone, validating the preliminary conceptual vertical contaminant distribution model. The decision to use a single borehole was driven by the preliminary conceptual contamination distribution model and cost.
Trench/auger drill sampling/ analysis in the 0-25-ft elevation below-grade	15 trench locations: 3 along the central axis of the main pond where sediment radionuclide contamination was found to be highest historically (Figure 7-1, sample points T-1, T-2 and T-3); 12 locations outside of the original water line to verify horizontal extent (Figure 7-1, sample points T-4 through T-15). Collect soil samples at 2.5 ft intervals to 10 ft (2.5, 5, 7.5, 10 ft) starting at the pond sediment layer or the first indication of radiological contamination, then at 5 ft intervals to 25 ft bgs as a general sampling scheme. Maximum sample depth is 25-ft bgs. Critical sample intervals are at the pond sediment layer, at 15-ft bgs and at 25-ft bgs. Field screening instruments should be used to optimize the general intervals identified above Sample locations T-1, T-6, T-7, T-11, and T-12 will be analyzed for the gamma emitting radionuclide and metals COCs. The other sample locations will be analyzed for the COCs in Table 1-7, except for H-3, Ni-63, Np-237, and Tc-99. However, Np-237 will be analyzed for in sample locations T-2 and T-3. Analytical requirements for physical soil properties identified in Tables 3-4 and 4-6 will be determined in the SAP. Gamma-ray logging of existing boreholes sufficiently close to the pond may be used instead of an outside (of the original water line) sample location or as supplemental sampling locations provided that the borehole completion design is compatible (no seal, single casing in contact with soil).	A cost-effective method of collecting samples is required for collection of multiple samples in the upper soil strata to determine COC concentrations against action levels, support selection of remedial design alternatives, and to verify the preliminary conceptual contamination distribution model. Trenching meets these sampling needs, because it is relatively inexpensive for collection of multiple samples. In addition, sampling may be performed to a depth of approximately 25-ft below grade, which supports remedial design decisions. By focusing the trench sampling in areas of historically elevated contamination levels, waste sites may be evaluated against action levels. Sampling frequency in the most highly contaminated zone (central axis) is adequate to confirm the expected high waste concentrations indicated by historical sampling and analysis. Fringe area sampling determines the lateral and vertical extent of contamination in the expected transition zone. The number of trenches provides scattering for areal coverage.

Table 7-4b. Key Features of Sampling Design for B-Pond (216-B-3).

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Borehole sampling to groundwater	1 borehole location at the influent end of the pond where contamination is expected to be highest (Figure 7-2, sample point B-1). Collect soil samples at 2.5 ft intervals to 10 ft (2.5, 5, 7.5, 10 ft) starting at the pond sediment layer, then at 5 ft intervals to 25 ft bgs then at 50 ft, 100 ft, 150 ft bgs and above water table, as a general sampling scheme. Critical sample intervals are at the pond sediment layer, 15-ft bgs, and 25-ft bgs and at major lithologic changes particularly those that would tend to concentrate contaminants (e.g., fine-grained sediments). RLS logging of the borehole should be performed. Deep zone (>15'deep) samples will be analyzed for all COCs in Table 1-7. Shallow zone samples (0-15' deep) will be analyzed for the Table 1-7 COCs, except for H-3, Ni-63, and Tc-99. Analytical requirements for physical soil properties identified in Tables 3-4 and 4-6 will be determined in the SAP.	A borehole is required to verify the contamination profile beneath the upper strata of the waste site. It will extend to groundwater to show the COC concentrations through the vadose zone, validating the preliminary conceptual vertical contaminant distribution model. The decision to use a single borehole was driven by the preliminary conceptual contamination distribution model and cost.
Trench/auger drill sampling/ analysis in the 0-25-ft elevation below-grade	5 trench locations: 2 along the axis of the main pond where sediment radionuclide contamination was found to be highest historically (Figure 7-2 sample points T-1 and T-2); 3 locations where water depth was historically shallow and contamination levels low (close to background) to assess horizontal extent (Figure 7-2 sample points T-3, T-4 and T-5). 4 existing boreholes outside the pond to be gamma-ray logged, if compatible Collect soil samples at 2.5 ft intervals to 10 ft (2.5, 5, 7.5, 10 ft) starting at the pond sediment layer, then at 5 ft intervals down to 25 ft bgs as a general sampling scheme. Maximum sample depth is 25-ft bgs. Critical sample intervals are at the pond sediment layer, at 15-ft bgs and at 25-ft bgs. Field screening instruments should be used to optimize the depth intervals. Samples will be analyzed for the COCs in Table 1-7, except for H-3, Ni-63, Np-237, and Tc-99. However, Np-237 will be analyzed for in sample locations T-1 and T-2. Analytical requirements for physical soil properties identified in Tables 3-4 and 4-6 will be determined in the SAP. Gamma ray logging of 4 existing boreholes close to the pond from 0-25 ft may be used as supplemental sampling locations provided that the borehole completion design is compatible (no seal, single casing in contact with soil).	A cost-effective method of collecting samples is required for collection of multiple samples in the upper soil strata to determine COC concentrations against action levels, support selection of remedial design alternatives, and to verify the preliminary conceptual contamination distribution model. Trenching meets these sampling needs, because it is relatively inexpensive for collection of multiple samples. In addition, sampling may be performed to a depth of approximately 25-ft below grade, which supports remedial design decisions. By focusing the trench sampling in areas of historically elevated contamination levels, waste sites may be evaluated against action levels. Sampling frequency in the most highly contaminated zone (central axis) is adequate to confirm the expected high waste concentrations indicated by historical sampling and analysis. Fringe area sampling determines the lateral and vertical extent of contamination in the expected transition zone. The number of trenches provides scattering for areal coverage.

Table 7-4c. Key Features of Sampling Design for 216-B-2-2 Ditch.

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Borehole sampling to groundwater	None.	A borehole that extends to groundwater has been installed at the influent end of the ditch (as discussed in the 216B-2-2 Borehole Summary Report (BHI-01177)). The resulting data is considered to be representative of the ditch. Therefore, no need exists for another borehole in the B-2-2 ditch. This approach avoids costly sampling with little or no added benefit to the decision-making process.
Trench/auger drill sampling/ analysis in the 0-25-ft elevation below-grade	3 trench locations: 1 approximately midway between the completed characterization borehole at the head end of the ditch and the intersection with the 216-B-2-1 Ditch (Figure 7-3, sample point T-1), 1 at the intersection with the 216-B-2-1 Ditch (Figure 7-3, sample point T-2), and 1 where the 216-B-3-3 Ditch overlapped the ditch (Figure 7-3, sample point T-3). Collect soil samples at 2.5 ft intervals to 10 ft (2.5, 5, 7.5, 10 ft) starting at the sediment layer at the bottom of the ditch, then at 5 ft intervals down to 25 ft bgs, as a general sampling scheme. Maximum sample depth is 25-ft bgs. Critical sample intervals are at the pond sediment layer, at 15-ft bgs and at 25-ft bgs. Field screening instruments should be used to optimize the general intervals identified above. Samples will be analyzed for the COCs in Table 1-7, except for H-3, Ni-63, Np-237, and Tc-99. Analytical requirements for physical soil properties identified in Tables 3-4 and 4-6 will be determined in the SAP.	A cost-effective method of collecting samples is required for collection of multiple samples in the upper soil strata to determine COC concentrations against action levels, support selection of remedial design alternatives, and to verify the preliminary conceptual contamination distribution model. Trenching meets these sampling needs, because it is relatively inexpensive for collection of multiple samples. In addition, sampling may be performed to a depth of approximately 25-ft below grade, which supports remedial design decisions. By focusing the trench sampling in areas of historically elevated contamination levels, waste sites may be evaluated against action levels. One trench provides information at the junction with B-3-3 ditch. Another provides data at junction with B-2-1 ditch. Sampling at the junctions with these ditches takes account of the additive contaminant contribution from those sites.

Table 7-4d. Key Features of Sampling Design for 216-B-3-3 Ditch.

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Borehole sampling to groundwater	None.	No borehole data was deemed necessary, as the B-2-2 borehole data is considered to be representative of the soil profile in the B-3-3 ditch. It should also be noted that a single borehole to groundwater is placed at the influent end of the 216-B-3 Pond, which is also considered to be representative of the effluent end of the 216-B-3-3 Ditch.
Trench/auger drill sampling/ analysis in the 0-25-ft elevation below-grade	4 trench locations: 1 sample at the head end (Figure 7-2, sample point T-7); 1 ~1250 ft downstream of the influent end (Figure 7-2, sample point T-8); 1 sample at the intersection with the 216-A-29 Ditch (Figure 7-2, sample point T-9), and 1 sample between sample location T-9 and B-Pond (Figure 7-2, sample point T-10). Collect soil samples at 2.5 ft intervals to 10 ft (2.5, 5, 7.5, 10 ft) starting at the sediment layer in the bottom of the ditch, then at 5 ft intervals down to 25 ft bgs, as a general sampling scheme. Maximum sample depth is 25-ft bgs. Critical sample intervals are at the pond sediment layer, at 15-ft bgs and at 25-ft bgs. Field screening instruments should be used to optimize the general intervals identified above. Samples will be analyzed for the COCs in Table 1-7, except for H-3, Ni-63, Np-237, and Tc-99. Analytical requirements for physical soil properties identified in Tables 3-4 and 4-6 will be determined in the SAP.	A cost-effective method of collecting samples is required for collection of multiple samples in the upper soil strata to determine COC concentrations against action levels, support selection of remedial design alternatives, and to verify the preliminary conceptual contamination distribution model. Trenching meets these sampling needs, because it is relatively inexpensive for collection of multiple samples. In addition, sampling may be performed to a depth of approximately 25-ft below grade, which supports remedial design decisions. By focusing the trench sampling in areas of historically elevated contamination levels, waste sites may be evaluated against action levels. One trench is placed at the head end to capture the expected high contamination levels. Another is placed at a mid-position to determine the changes in concentration profile with distance. The third is located at the junction of the A-29 ditch to account for the cumulative contaminant loading.

5) Table 7-5 outlines and compares the alternative sampling strategies.

Table 7-5. Comparison of Alternative Sampling Strategies.

Decision Rule No.	Alternative	Potential Disadvantages	Discussion
All	1. Use additional boreholes in lieu of trenching or auger drilling	Cost, schedule	Borehole technique is expensive in comparison with the trenching method for the data obtained. However, boreholes do allow for geophysical logging. The preliminary conceptual contaminant distribution model shows that there should be little variability in the vadose zone below the moderately contaminated area. Little or no advantage may be gained by installing a second borehole for sample collection. The cost of a second borehole would be significant.
	2. Cone Penetrometer	Limited sample volume and grain size. Limited penetration in coarse-grained media. Depth limited in 200 area soils to <50-ft.	Cone penetrometer can be used to sample a number of locations relatively quickly and without removing contaminated soil (e.g., no drill cuttings). Specialized equipment does allow for collecting samples at depth but sample volumes are limiting, and would not allow for the full range of COC analyses required for this DQO. In addition, a separate push is required for each sample. Geophysical logging can be performed although quality may not be comparable to borehole geophysical techniques. Gamma ray logging of cone penetrometer holes may be used as an indicator of contamination, however, resolution is generally poor, due to the small detector size.
	3. Use more trenches or auger drill locations	Increased cost; incremental decision-making benefit	The use of multiple trenches or auger drill locations will be evaluated on a case basis. The trench sampling strategy focuses in the areas where historical sample data shows the highest contamination levels, as these are most likely to exceed the action levels, and it focuses on the areas most critical for remedial alternative evaluation (0-25-ft depth zone). Sampling will be performed in each of the representative sites, providing a basis for remedial decision making.
	4. Sonic Drilling instead of Cable Tool Drilling	Impact to organic constituents in soil	Sonic drilling causes heating of sampled media and surrounding formations. Likely destruction of organic constituents, degrading sample results.
	5. Air Rotary Drilling instead of Cable Tool Drilling	Impact to organic constituents in soil	Introduction of air to sample media affects analytical results for volatile organics

6) 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			
Gable Mountain Pond (216-A-25)	Drill temporary borehole for collection of samples from top of each waste site sampled to groundwater. Locate borehole where the highest contaminant concentrations are expected. Sample periodically	1	Figure 7-1
B-Pond (216-B-3)		1	Figure 7-2
216-B-2-2 Ditch		1[a]	Head end of the ditch (Figure 7-3)
216-B-3-3 Ditch		0	--
Trench/Auger drilling			
Gable Mountain Pond (216-A-25)	Trench or auger drill to 25-ft. depth below grade in each site sampled. Sample periodically	15	Figure 7-1
B-Pond (216-B-3)		5	Figure 7-2
216-B-2-2 Ditch		3	Figure 7-3
216-B-3-3 Ditch		4	Figure 7-2

a Completed in FY98

Figure 7-1. Gable Pond Approximate Sampling Locations.

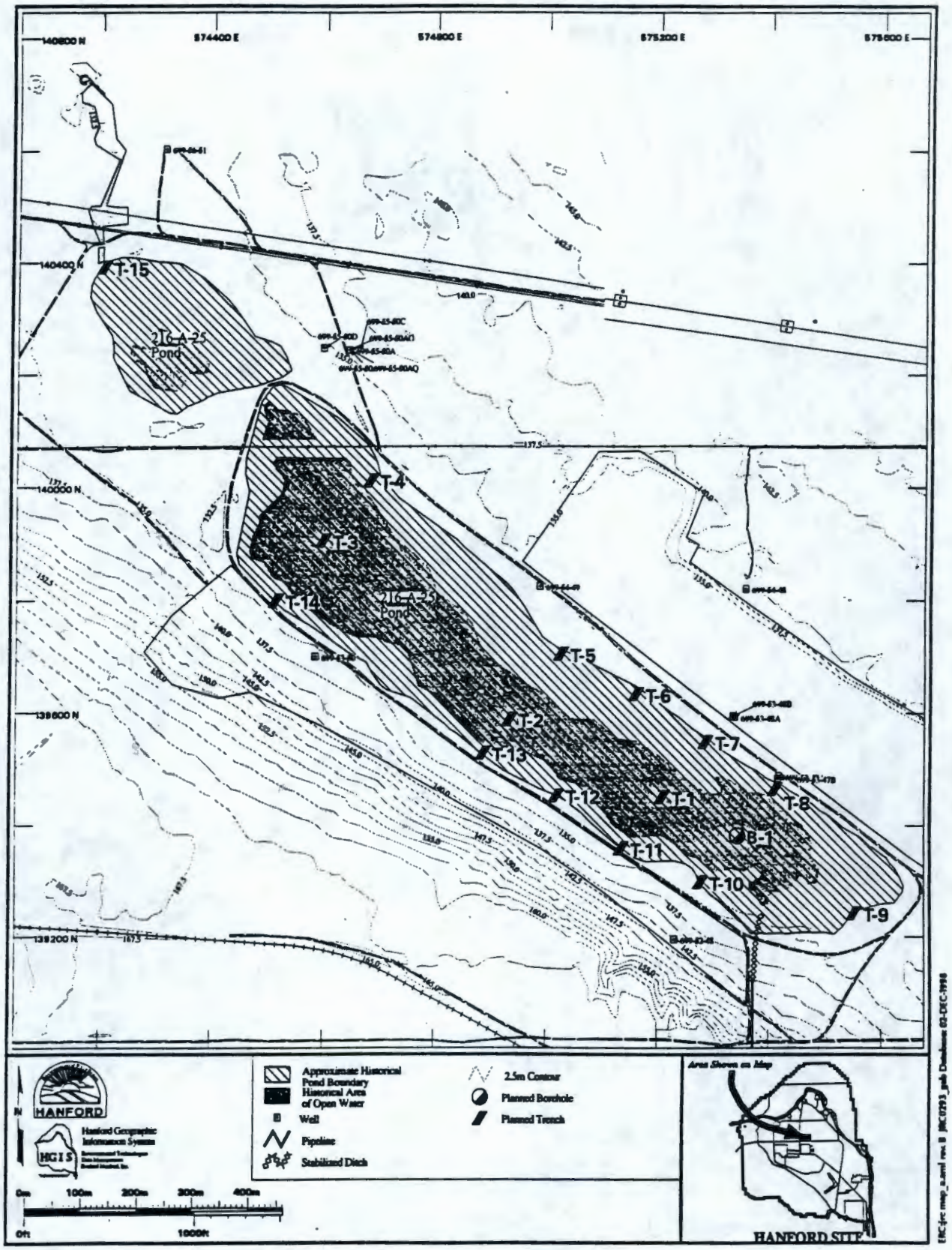
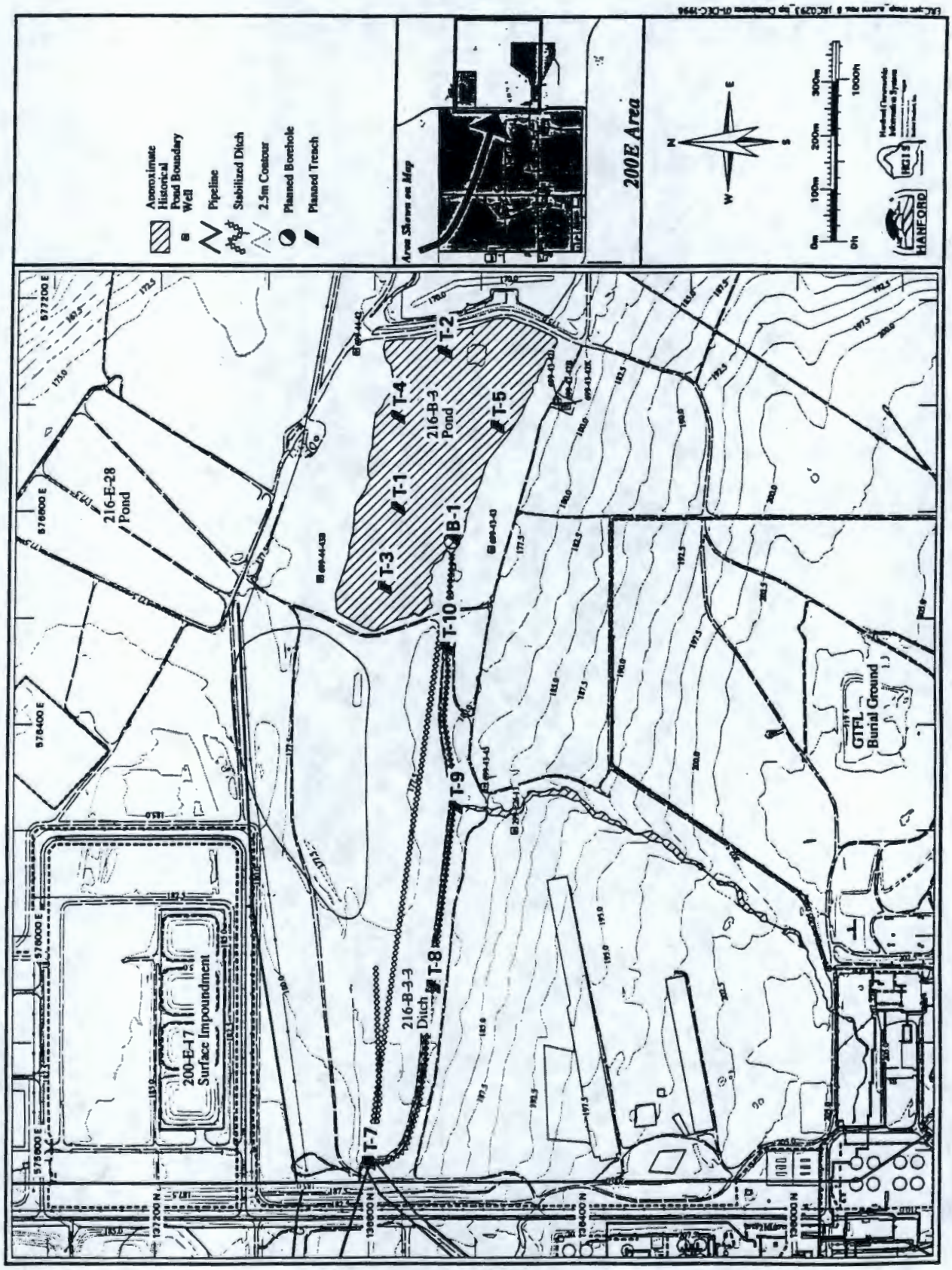


Figure 7-2. B Pond and 216-B-3-3 Ditch Approximate Sampling Locations.



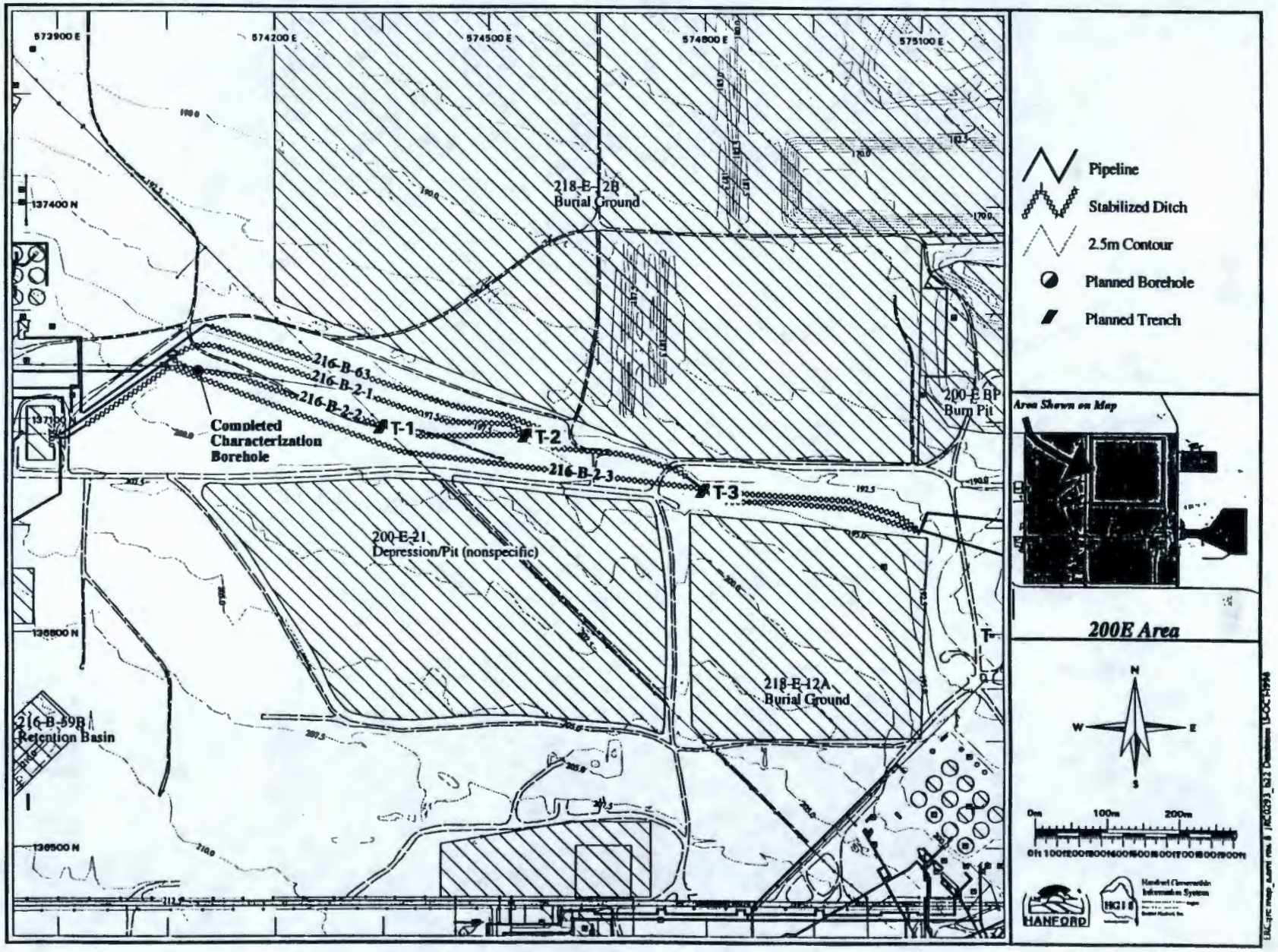


Figure 7-3. 216-B-2-2 Ditch Approximate Sampling Locations.

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