

# Data Quality Objectives Workbook for Waste Management Area S-SX

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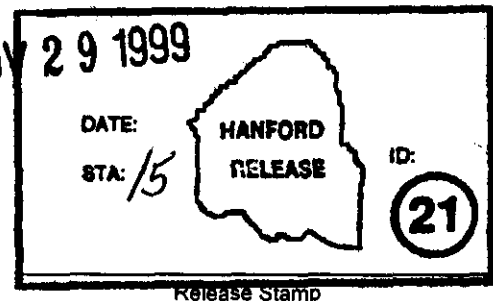
**Key Words:** Vadose Zone, RFI/CMS Work Plan, WMA S-SX, Characterization DQO, Data Quality Objectives

**Abstract:** This Data Quality Objectives Workbook documents the vadose zone characterization planning for WMA S-SX. The purpose of the characterization effort is to identify and collect the necessary and sufficient vadose zone data to support decisions on Interim Corrective Measures. The DQO workbook identifies the decisions, existing information and new information that needs to be collected to support decision making.

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# **Data Quality Objectives Report for Waste Management Area S-SX**

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## ACRONYMS

bgs	below ground surface
CMS	corrective measures study
COC	contaminant of concern
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DQO	data quality objective
DS	decision statement
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
FIR	Field Investigation Report
GWVZ	groundwater/vadose zone
HEIS	Hanford Environmental Information System
ICM	interim corrective measure
MTCA	<i>Model Toxic Control Act</i>
ORP	Office of River Protection
PSQ	principal study question
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCAP	RCRA Corrective Action Program
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
REDOX	reduction oxidation
RFI	RCRA facility investigation
RL	U.S. Department of Energy, Richland Operations Office
RPP	River Protection Project
RQL	Required Quantitation Limits
SST	single-shell tank
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i>
TWRS	Tank Waste Remediation System
WMA	waste management area

## METRIC CONVERSION CHART

The following conversion chart is provided to aid the reader in conversion.

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

## 1.0 STEP 1 – STATE THE PROBLEM

The purpose of this data quality objectives (DQO) process is to support decision-making activities as they pertain to the *Resource Conservation and Recovery Act of 1976* (RCRA) Corrective Action Program (RCAP) task addressing the site-specific single-shell tank (SST) Phase 1 RCRA facility investigation/corrective measures study (RFI/CMS) Work Plan Addendum for waste management area (WMA) S-SX. These activities include characterization, interim corrective measure (ICM) selection, tank waste retrieval decisions, and closure decisions. The objective of DQO Step 1 is to use the information gathered from the DQO scoping process, along with other relevant information, to clearly and concisely state the problem to be resolved. The free-form text sections included in this step are intended to define the project objectives and assumptions, present the project issues, summarize the facility background information, and provide a concise statement of the problem. The tables provided in this section are designed to document the personnel involved in the DQO process, identify the contaminants of concern, and summarize the key information needed to support the writing of the problem statement.

### 1.1 PROJECT OBJECTIVES



The objective of the site-specific SST Phase 1 RFI/CMS Work Plan Addendum for WMA S-SX is to develop adequate information to support ICMs, tank waste retrieval, and tank closure decisions. This objective can be achieved, in part, through the evaluation of existing data, currently planned characterization activities (41-09-39 borehole decommissioning sampling, tank SX-115 borehole, and new RCRA monitoring well sampling), the WMA S-SX Field Investigation Report (FIR), the Phase 1 RFI Report, and coordination of information needs with retrieval and closure. The primary goal of this DQO will be to identify surface soil (<4.6 meters; [<15 feet]) and vadose zone information needs that will be addressed by implementing a WMA S-SX Site Specific Work Plan Addendum. Secondary DQO goals include identifying integration/sampling opportunities and ensuring that identification of contaminants of concern (COCs) and quality assurance (QA)/quality control (QC) requirements are consistent with the Hanford Groundwater and 200 Area Environmental Restoration (ER) Programs.

### 1.2 PROJECT ASSUMPTIONS



This section identifies project-specific assumptions that have been made during DQO Team discussions and interviews with the regulators. The assumptions applicable to WMA S-SX Phase 1 RFI/CMS DQO planning efforts are:

1. The DQO process described in the Phase 1 RFI/CMS Work Plan (DOE/RL-99-36) will be followed.
2. The DQO planning effort will focus on surface and subsurface soil contamination within the WMA S-SX boundary (see Figure 1-1 attached at the end of Step 1). Groundwater information needs will not be a primary focus of this DQO, although future groundwater data needs to support ICM retrieval, and closure decisions will be addressed.
3. The Phase 1 RFI/CMS Work Plan (DOE/RL-99-36) overall guidance and framework for WMA-specific investigations will be followed. The Work Plan includes the following overall guidance:
  - a. Programmatic framework
  - b. Regulatory framework
  - c. Tank farm impacts and potential actions
  - d. Technical framework
  - e. Management and administrative issues
4. The overarching questions identified for RCRA interim corrective action, retrieval, and closure in the Phase 1 RFI/CMS Work Plan (DOE/RL-99-36) will be addressed through the DQO.
5. Single-shell tank (SST) decisions relying in part on subsurface information include:
  - a. Interim corrective measures (ICMs)
  - b. Tank waste retrieval
  - c. Tank farm closure
6. The DQO will primarily address data needs to support interim corrective measures, retrieval and closure decisions. The process will also opportunistically address data needs that might support other activities (e.g., the Hanford Site Groundwater/Vadose Zone (GWVZ) Integration Project).
7. The "Subsurface Condition for the WMA S-SX Waste Management Area," HNF-4936, Rev. 0, will be used as the principal source of information regarding what is currently known about the subsurface at the WMA S-SX.
8. The DQO results will be used to prepare a WMA S-SX Site-Specific Work Plan Addendum that will include a sampling and analysis plan. The Addendum for WMA S-SX has a Tri-Party Agreement milestone of 10/29/99.
9. The RFI will be conducted in a phased approach as defined in the Tri-Party Agreement change package (M-45-98-03). A FIR will be prepared for each WMA (i.e., S-SX, T-TX-TY, and B-BX-BY) followed by a cumulative evaluation for all WMAs conducted in the Phase 1 RFI Report. Therefore, information in each FIR and the Phase 1 RFI report can be used to refine data needs to support future decisions.
10. There is enough known about contamination in the tank farm based on historical records and drywell monitoring to target specific regions for characterization.

11. This DQO planning effort will identify characterization options. The DQO Team will work with DOE and Ecology to prioritize and optimize the field activities.
12. New data from the WMA S-SX Phase 1 characterization effort will be combined with existing data to support risk evaluations (including computer-modeling efforts) and the need for ICMs as part of the FIR.
13. Information needs for WMA S-SX will be reassessed after the Phase 1 characterization effort is complete, to determine if further characterization is required.

If necessary, ICMs will be evaluated by refining the conceptual model of past tank leaks and surface spills and developing a contaminant transport model to evaluate a base case (existing tank farm conditions) and engineered alternatives for ICMs. Sufficient characterization needs to be conducted to develop a defensible conceptual model for the concentration, distribution, and mobility of the contaminants of potential concern. This model must be defensible for present and anticipated future conditions. A conceptual model along with a contaminant transport model will be used to evaluate and compare potential impacts among ICM options.

The Tank Farm Vadose Zone Project technical team plans to use existing information and the characterization data collected during the Phase 1 characterization to develop a best basis or best estimate of the concentration and distribution of COCs in WMA S-SX. This will involve integrating and synthesizing historical data, process knowledge, and in-tank inventory models, as well as the characterization data collected during Phase 1. Integrating and synthesizing these data will require extrapolation, due to the limitations of collecting samples within the tank farms. This will result in a conceptualization of COC concentrations and distributions that would be used to evaluate human health and environmental risk.

### **1.3 PROJECT ISSUES**

#### **1.3.1 Global Issues**



No global or policy issues were identified that require resolution prior to proceeding with the WMA S-SX DQO. For this reason, a global issue meeting was not held.

The global issues identified that will require resolution prior to WMA S-SX retrieval and closure include regulatory compliance point locations, performance standards or media-specific cleanup standards for contaminants of potential concern (COPCs), and the compliance time frame.

### 1.3.2 Project-Specific Technical Issues and Resolutions

Identify technical issues identified during the DQO process and discuss how the issues were resolved

The project-specific technical issues and resolutions or assumptions made to allow the characterization planning effort to proceed include:

**Corrective Measure Performance Standards** - Preliminary corrective measure performance standards are identified in the RFI/CMS Work Plan (DOE/RL-99-36) and are sufficient for use in this characterization planning effort. However, because of the uncertainties regarding compliance points, the DQO process will consider the WMA boundary, the 200 Area exclusive use area boundary, the 200 Area buffer zone boundary, and the Columbia River as hypothetical compliance points where corrective measure performance standards would be applied (see Figure 1-2 attached at the end of Step 1).

**Media Cleanup Standards** - Exposure scenarios and point-of-compliance locations that would support the calculation of media cleanup standards have not been established. For this DQO, analytical detection limit requirements will be set at laboratory Required Quantitation Limits (RQLs) for the analytical methods selected. RQLs are typically in the range of non-radiological cleanup standards identified in the *Model Toxic Control Act* (MTCA-B and MTCA-C criteria) and individual isotope concentrations that are equivalent to a 15 mrem/year dose (EPA, 1997a).

**Study Boundary** - The primary area of interest is the WMA S-SX. It is recognized that contamination outside the WMA is of interest and will be considered in the identification and evaluation of characterization options. The principal study questions (PSQs) for the WMA boundary will be addressed in terms of "the vicinity of the WMA boundary." For this DQO effort, investigation of waste transfer pipelines leading to/from WMA S-SX will be limited to pipelines in the vicinity of the WMA S-SX boundary (generally regarded to be the fenceline). It is acknowledged that TSD unit remediation will include pipelines associated with the TSD units, regardless of the WMA boundary.

**Groundwater** - The WMA S-SX characterization effort could include vadose zone soil sampling to the water table but groundwater sampling is not planned. The current RCRA groundwater monitoring program and new RCRA monitoring wells planned by DOE-RL are believed to be adequate for current/future WMA S-SX information requirements. Supplemental data needs that could be collected through the RCRA groundwater program will be addressed in this DQO effort.

### 1.4 EXISTING REFERENCES

Section 8.0 presents a list of the references that were reviewed as part of the scoping process along with a summary of the pertinent information contained within each

reference. These references were the primary source for the background information presented in Section 1.5.

## 1.5 FACILITY BACKGROUND INFORMATION



### 1.5.1 Facility Description

WMA S-SX consists of the 241-S and 241-SX Tank Farms, waste transfer lines, leak detection systems, and other miscellaneous equipment. There are 12 SSTs in the 241-S Tank Farm and 15 SSTs in 241-SX Tank Farm (Figure 1-1). Of the 27 SSTs, 11 are known to have leaked or are suspected to have leaked. The tanks are not known to be currently leaking. The WMA S-SX also includes 8 ancillary facilities, four valve pits, three diversion boxes and one catch tank. Releases from the WMA S-SX, including spills, transfer line leaks, and other ancillary facility waste, have contributed to soil and groundwater contamination. In addition, waste sites outside the WMA boundaries have been used during S and SX Tank Farm operations. These include numerous cribs, located to the east, south, and west of the WMA S-SX, the 242-S Evaporator facility (located just north of the S Tank Farm) the SY Tank Farm, and the U-10 pond, located approximately 300 meters (984 feet) west of the WMA S-SX.

The following paragraphs address the status of the raw water system in the S and SX Tank Farms. This information is from the *Draft Waterline Assessment; Interim Remedial Action for Single Shell Tank Farms* (FDNW, 1999) document.

The 12 S-Farm storage tanks are supplied raw water through a 0.15-meter (6-inch) pipe along the east side of the farm. Along the north boundary of the farm area are active 0.61-meter (24-inch) and 0.35-meter (14-inch) raw water lines and a 0.1-meter (4-inch) process water line serving the 242-S Evaporator Building in the northwest corner of the tank farm. There are also numerous active raw water lines to the northeast, in and around the SY Tank Farm. In total there are about 1,280 meters (4,200 linear feet) of active and inactive water lines in the S Tank Farm, ranging from 0.61 to 0.01 meter (24 to 0.5 inch) in diameter. Eight of the twelve tanks that have not been interim stabilized are scheduled to start pumping in FY 1999, with completion by FY 2003. Raw water will be required over this time period for placing the saltwater screen system and jet pumping. Raw water will also be required for retrieval operations.

The 15 storage tanks in the SX-Farm are supplied with raw water through a 0.15-meter (6-inch) pipe from the north and west sides of the farm. Within the SX-Farm area, there are over 1,432 meters (4,700 linear feet) of inactive raw water pipes ranging from 0.2 to

0.01 meter (8 to 0.5 inch) in diameter. Six of the fifteen tanks that have not been interim stabilized are scheduled to start pumping in FY 1999, with completion by FY 2003. Raw water will be required over this time period for placing the saltwater screen system and jet pumping. Raw water will also be required for retrieval operations.

The 27 SSTs in WMA S-SX were designed very similarly in both tank farms; each is a vertical cylinder with a domed top, constructed with a carbon steel liner and surrounded by reinforced concrete. The bases of the tanks were placed about 17 to 18 meters (56 to 59 ft) below ground surface during construction and were covered with 1.8 to 2.4 meters (6 to 8 feet) of earth over the dome. The 241-S and 241-SX tanks are 23 meters (75 feet) diameter, about 13.5 meters (44.4 feet) tall, and have a capacity of 2,869,030 liters (757,000 gallons) and 3,785,000 liters (1,000,000 gallons), respectively. The 12 tanks in the 241-S Tank Farms are numbered 241-S-101 through 241-S-112, and the 15 tanks in the 241-SX Tank Farms are numbered 241-SX-101 through 241-SX-115.

Each tank in the S and SX Tank Farms has shallow ~22.8 to 45.7 meters (~75 to 150 feet) radiation monitoring wells (drywells) installed around it as a secondary leak detection system. With the exception of two wells drilled in 1996 and 1997 (41-09-39 and 41-12-01), all 170 drywells were installed from 1954 to 1978. In addition, the boiling waste tanks in the SX Farm have laterals installed approximately 3 meters (10 feet) below the tank bottom for gamma logging. Gamma logging data from the drywells and laterals were used to ascertain the integrity of the tank.

### **1.5.2 Process History**

The S Tank Farm was built in 1950-1951 and consists of twelve 22.8 meter (75-foot) diameter tanks with nominal 2,869,030-liter (757,000-gallon) storage capacity. In 1951, the S Tank Farm tanks began receiving reduction oxidation (REDOX) wastes. In the summer of 1952, some tanks unexpectedly began to boil because of the radioactive decay heat load in the REDOX high-level wastes. A surface condenser was added to remove excess liquid from these tanks, and the collected liquids were piped to nearby cribs. After the REDOX plant was deactivated, the S Farm tanks received solids from the 242-S Evaporator. Only one tank in the S Farm (S-104) is assumed to have leaked. The S tanks were removed from service in the late 1970s and early 1980s.

The SX Tank Farm is made up of 15 single-shell tanks, each with a nominal 3,785,412 liters (1,000,000 gallon) storage capacity. The SX Tank Farm was constructed in 1953 and 1954, and the first six SX tanks began receiving waste from the REDOX plant in 1954. In 1955, the remaining nine tanks began to receive waste. Tanks SX-105 and SX-107 through SX-115 were designed to handle REDOX high-level boiling wastes. Heat loads within the tanks were reduced by allowing supernates to evaporate and, as required, return as condensates to maintain desired liquid levels. According to Hanlon (1999), all nine of the SX tanks that operated as boiling waste tanks are confirmed or assumed leakers. Tanks 241-SX-101 through 241-SX-106 are at least half-filled with solids (mostly saltcake and some sludge).

There are a number of cribs around the WMA S-SX that received large volumes of slightly contaminated water and other waste streams (see Figure 1-1 attached at the end of Step 1). Historical records indicate that tank wastes were not cascaded directly from the tanks into cribs. Rather, the cribs received excess condensate from the boiling waste tanks and cooling water from the condensers. Other additions to these cribs included discharges from the first "cold" REDOX startup run to the 216-S-8 trench and from the U-crib "pump and treat" groundwater operations in the mid-1980s to the 216-S-25 crib.

### **1.5.3 Spills and Releases**

There are a number of release events that have resulted in contaminant releases to the vadose zone in and around WMA S-SX. Four types of fluid discharges have occurred in and around the WMA S-SX. These include: (1) collection and routing of cooling water and tank condensate to cribs, (2) mechanical failure of tanks and leakage into the underlying soil column, (3) failure of ancillary equipment used to transfer liquids between tanks, and (4) inadvertent overfilling of the tanks. The history of spills and releases that have occurred in the S and SX Tank Farms is presented in Sections 3.1, 3.3, and 3.4 of the Subsurface Conditions Report (HNF-4936, Rev. 0). The report also includes summaries of documented releases within and adjacent to the WMA S-SX.

There is a high degree of uncertainty in many of the volume estimates for tank leaks and surface spills. Leaks from ancillary equipment were observed and recorded when sufficient fluid reached the surface from the buried, but near surface, sources. Tank-leak volume estimates were based on liquid level measurements or other estimating methods that have resulted in one to two orders of magnitude difference in leakage estimates for some tanks. No basis can be found for the estimated leak volumes that are reported for some tanks.

### **1.5.4 Major Areas of Contamination**

Limited data are available to evaluate contamination in the subsurface beneath the WMA S-SX Tank Farm. A subsurface investigation was performed in the SX Tank Farm in 1965 to evaluate the nature and extent of contamination in the vadose zone near tanks SX-108 and SX-115 (Raymond and Shdo, 1966). Conclusions of the investigation indicate that Cs-137 was the predominant long-lived isotope in the subsurface. Three separate leak zones were identified associated with tanks SX-108 and SX-115. Virtually all the long-lived isotopes were detected within several feet of the bottom of the tanks.

In 1996, borehole 41-09-39 was driven to a depth of 40.0 meters (131.5 feet) in response to the determination that Cs-137 might reside in the soil column at depths greater than 30 meters (100 feet). The borehole was constructed to ascertain whether the contamination was an artifact of an adjacent unsealed borehole or had migrated as a plume within the formation. Geophysical logging of borehole 41-09-39 confirmed that

migration as a plume within the formation was probable and that contamination was present at a depth of 40 meters (131.5 feet), possibly due to "drag-down."

Concern was raised that if relatively immobile Cs-137 were present at depth, more mobile, long-lived tank waste constituents (e.g., Tc-99) might be at or near the water table (~64.3 meters [211 feet]). Borehole 41-09-39 was extended to groundwater, and samples of both sediments and groundwater were collected for laboratory analyses of tank waste components (Myers et al., 1998). Analyses of seven composite samples from the borehole show that tank waste constituents are predominantly held by the sediments within or above the Plio-Pleistocene Unit. Non-radiological constituents (i.e., sodium, calcium, and nitrate) suggest the leading edge of the tank waste COPCs is at about 47 meters (135 feet) depth.

Spectral gamma logging data from dry wells are available to evaluate contamination in the WMA S-SX (DOE-GJPO, 1996; DOE, 1998). These data are used to identify major areas of contamination (i.e., >10 pCi/g) in the WMA and to focus characterization planning efforts for the DQO. By considering all the S Tank Farm information, a gross understanding of the three-dimensional nature of high gamma locations in the S Tank Farm can be achieved. The data show limited contamination in the S Tank Farm, particularly below 11 meters (35 feet). The depth is consistent with the historical record, which identifies a large surface leak from a junction box close to tank S-102 and a suspected leak from S-104.

Contamination in the SX Tank Farm is far more widespread. In general, the location and intensity of gamma readings in the northern part of the farm (tanks SX-101 through SX-106) are above 11 meters (35 feet) and more often between 10 and 100 pCi/g. These characteristics are likely associated with surface leaks. Conversely, in the southern part of the farm, gamma readings are above 100 pCi/g and below 11 meters (35 feet). These characteristics are consistent with tank leaks. The highest levels of contamination are substantially greater than 100 pCi/g around tanks SX-108, -109, -111, and -112.

The results of groundwater quality assessment activities at the Tank Farms suggest that practices at WMA S-SX Tank Farm have resulted in groundwater contamination. Observations of the groundwater contamination lead to the following conclusions:

- Distribution patterns for Tc-99 and RCRA dangerous waste constituents (i.e., nitrate and chromate) indicate that the WMA S-SX Tank Farm has contributed to groundwater contamination observed in downgradient monitoring wells.
- Multiple sources (e.g., tank leaks or spills) are needed to explain historical as well as recent groundwater contamination. At least two WMA source areas are needed to explain the Tc-99 concentration in groundwater.

- The drinking water standard for technetium has been exceeded but is limited to wells 299-W22-45, 299-W22-46, 299-W23-6, and 299-W23-1. Technetium-99, the constituent with the highest concentration relative to the standard, is currently four to five times the EPA interim drinking water standard of 900 pCi/L in well 299-W22-46. The drinking water standard for nitrate has been exceeded and is currently limited to one well, 299-W22-46, with concentration at or slightly above the 45,000 µg/L standard. The Tc-99, nitrate, and chromium concentrations in downgradient well 299-W22-46 (the well with the highest current concentrations) appear to be declining after reaching maximum concentrations in May 1997. Wells 299-W23-6 and 299-W22-46 are located downgradient from the largest known soil contamination near tanks SX-108, SX-109, and SX-115.
- Cesium-137 and strontium-90 were not detected in any of the RCRA-compliant monitoring wells. This supports the expected retention or retardation of these radionuclides in vadose zone sediments and/or aquifer sediments.
- Circumstantial evidence suggests that short-term contaminant transients in multiple wells occurring at different times between 1985 and the present may have been caused by leaking water lines, rupture events, ponded snowmelt water, or a combination thereof, adjacent to and within the WMA. Data obtained from this preliminary investigation and subsequent investigations may provide an answer to whether contaminant migration that impacted groundwater was enhanced by water-line leaks. Continuing efforts are underway to identify and eliminate potential sources within and around the tanks.
- Confirmed detections of Sr-90 and Cs-137 have been limited primarily to one older well, 299-W23-7. Whether this occurrence represents a breakthrough from a vadose zone source to the groundwater or is a result of faulty well construction has not been completely evaluated.
- Results for groundwater samples collected from borehole 41-09-39 (January 1998) suggest that little, if any, tank waste reached the water table at this location. Gross alpha and beta concentrations are within the range of Hanford Site natural background, and hexavalent chromium was not detected (<10 µg/L).

All groundwater data, both historical (pre-Tri-Party Agreement) monitoring data, as well as the more recent RCRA data, are stored in the Hanford Environmental Information System (HEIS). The database is electronically available to the public but requires installation of specialized software for the most efficient access and use of the data. The RCRA data were collected in accordance with SW-846 procedures (EPA, 1997b). The associated quality assurance and related quality control documentation are described in Hartman and Dresel (1999). Gaps in data collection occur in the pre-Tri-Party Agreement period, especially prior to 1980.

Groundwater monitoring well locations in relation to the tank farms, associated facilities, and major spill or leak sites are presented in the subsurface investigation report.

Contaminant occurrences (based on the HEIS database records) for these monitoring wells, covering a time period of 1955 to the present, are summarized in the Subsurface Conditions Report (HNF-4936, Rev. 0).

### 1.6 DQO TEAM MEMBERS AND KEY DECISION-MAKERS

The members of the DQO Team were selected through the development of the DQO Scoping Checklist and discussions with the project task leads, based on their technical background, to provide expertise in the technical areas needed to meet WMA S-SX project objectives. The key decision-makers included representatives from the ORP and Washington State Department of Ecology (Ecology). Tables 1-1 and 1-2 identify the DQO Team members and the key decision-makers, respectively.

**Table 1-1. DQO Team Members.**

Name	Organization	Area of Participation
F. M. Mann	Fluor Daniel NW	Senior reviewer
ORP M. I. Wood	WMH	Background and process history
A. J. Knepp	Lockheed Martin Hanford Corporation	LMHC project manager
ORP R. E. Day	CH2M HILL	CH2M HILL project manager
J. C. Henderson	Jacobs Engineering Group, Incorporated	LMHC task lead
ORP T. E. Jones	MACTEC	Process history
D. A. Myers	IT Group	Subsurface investigations
L. M. Johnson	CH2M HILL	Regulatory issues
J. D. Crumpler	Jacobs Engineering Group, Incorporated	WMA S-SX work plan addendum
B. H. Ford	Bechtel Hanford, Inc.	Vadose zone/groundwater integration project
ORP R. Khaleel	Fluor Daniel NW	Subsurface modeling
K. Singleton	CH2M HILL	Background and process history
R. W. Ovink	CHI	DQO facilitator
D. J. Minter	LATA	Tank Farm Operations
R. L. Weiss	CHI	Sampling and Analysis
R. J. Serne	PNNL	Sampling and Analysis
D. J. Faust	Lockheed Martin Hanford Corporation	Tank Farm Radiation Control

**Table 1-2. DQO Key Decision-Makers.**

<b>Name</b>	<b>Organization</b>	<b>Area of Expertise</b>
R. M. Yasek	DOE-ORP	Project Manager
P. R. Staats	Ecology	Ecology point-of-contact
S. Leja	Ecology	Ecology point-of-contact

## **1.7 CONTAMINANTS OF CONCERN**

A list of the contaminants of concern (COCs) for WMA S-SX was generated by initially listing all of the COPCs based on historical process operations for all tank farms. A number of these COPCs are identified for exclusion from the WMA S-SX characterization effort because they have short half-lives, are not regulated, pose no human or ecological risk, are non-toxic, or from pertinent information are known not to be present in WMA S-SX.

### **1.7.1 WMA S-SX COPCs and COPC Exclusion Rationale**

A list of the contaminants of concern (COCs) for WMA S-SX was generated by initially listing all of the COPCs based on historical process operations for all tank farms. Table 1-3 (attached at end of Step 1) identifies all of the COPCs based on the RFI/CMS Work Plan (DOE/RL-99-36) and the rationale for excluding certain COPCs from the WMA characterization effort.

### **1.7.2 Final List of COCs**

Table 1-4 (attached at end of Step 1) presents the final list of WMA S-SX COCs. In addition to the COCs, the following parameters would also be assessed: pH, soil moisture, and hydraulic conductivity (on waste-altered sediments only). New information from the 41-09-39 and SX-115 boreholes will be used as appropriate to exclude additional COPCs and further refine the COC list.

Table 1-4 also defines the laboratory precision and accuracy for each COC RQL. The information developed will be used to assess human health and ecological risk under MTCA B and C exposure scenarios at four hypothetical compliance points: (1) WMA boundary, (2) 200 Area exclusive boundary, (3) 200 Area buffer zone boundary, and (4) the Columbia River. The characterization results, vadose zone and groundwater transport modeling efforts, and the risk evaluations will support ICM selections, waste retrieval decisions, and WMA S-SX closure requirements.

## 1.8 CURRENT AND POTENTIAL FUTURE LAND USE

The current and potential future land uses in the immediate vicinity of the WMA S-SX facility are "industrial" (Ecology) or "exclusive industrial" (DOE, 1999). However, as indicated in the RFI/CMS Work Plan (DOE/RL-99-36), both residential (MTCA Method B) and industrial (MTCA Method C) exposure scenarios will be evaluated for the WMA S-SX field investigation report (FIR).

## 1.9 PRELIMINARY MEDIA CLEANUP STANDARDS

Exposure scenarios and point-of-compliance locations that would support the calculation of media cleanup standards have not been established. For this DQO, analytical detection limit requirements will be set at laboratory Required Quantitation Limits (RQLs) for the analytical methods selected. RQLs are typically in the range of non-radiological cleanup standards (MTCA-B and MTCA-C criteria) and individual isotope concentrations that are equivalent to a 15-mrem/year dose.

## 1.10 CONCEPTUAL EXPOSURE PATHWAY MODEL

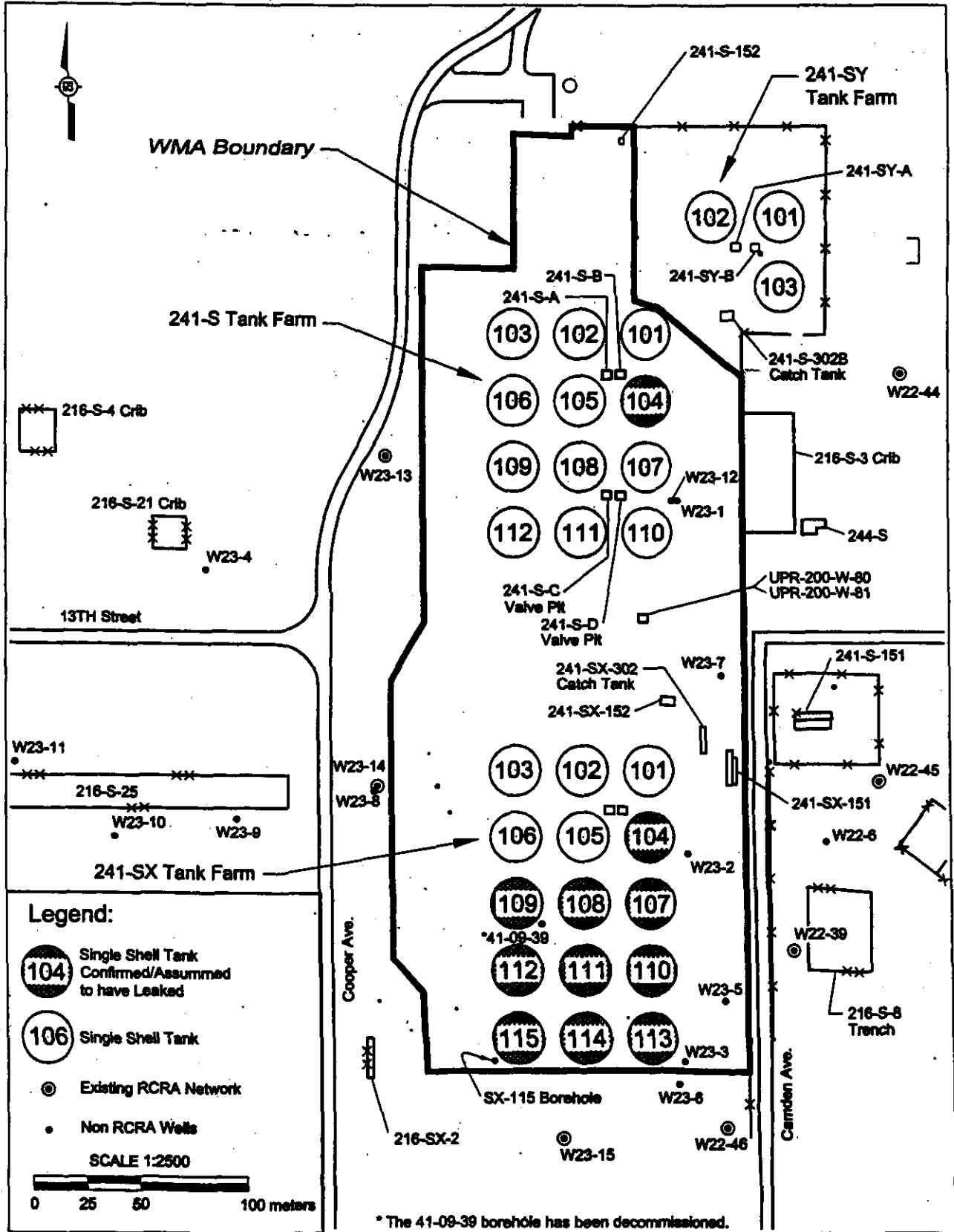
Figure 1-3 is the conceptual exposure model for WMA S-SX (from DOE/RL-99-36). It identifies the release mechanisms, migration pathways, and potential receptors for each of the COCs.

## 1.11 STATEMENT OF THE PROBLEM

Combine the relevant background information into a concise statement of the problem to be resolved.

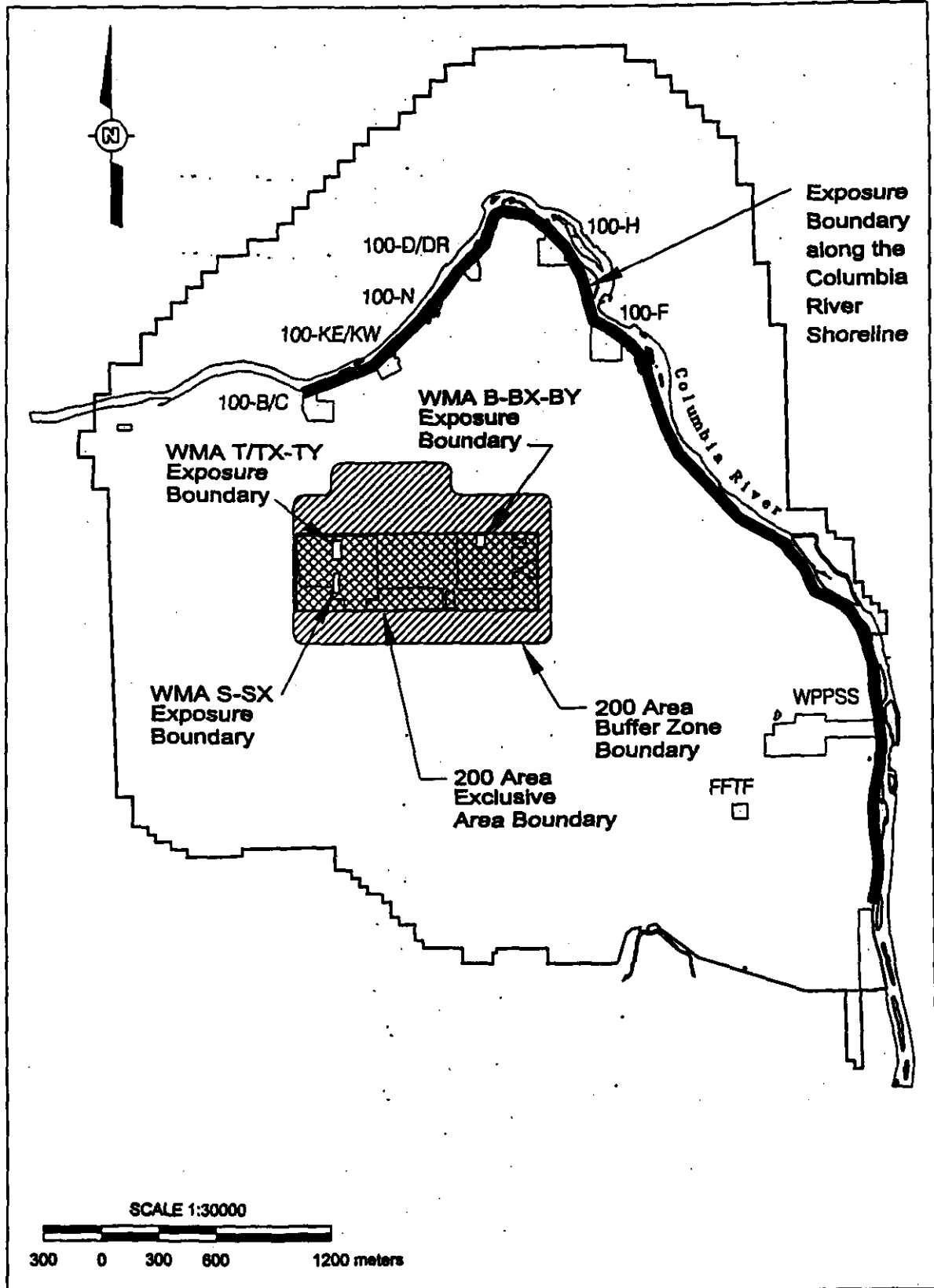
Releases from several WMA S-SX waste tanks and ancillary facilities plus surface spills have occurred. Tank waste retrieval activities in the future may cause additional releases of tank wastes. The magnitude, nature, and extent of vadose zone contamination in WMA S-SX, and the contaminant driving forces and pathways to groundwater are inadequately understood to support ICM, retrieval, and closure decisions.

Figure 1-1. Waste Management Area S-SX.

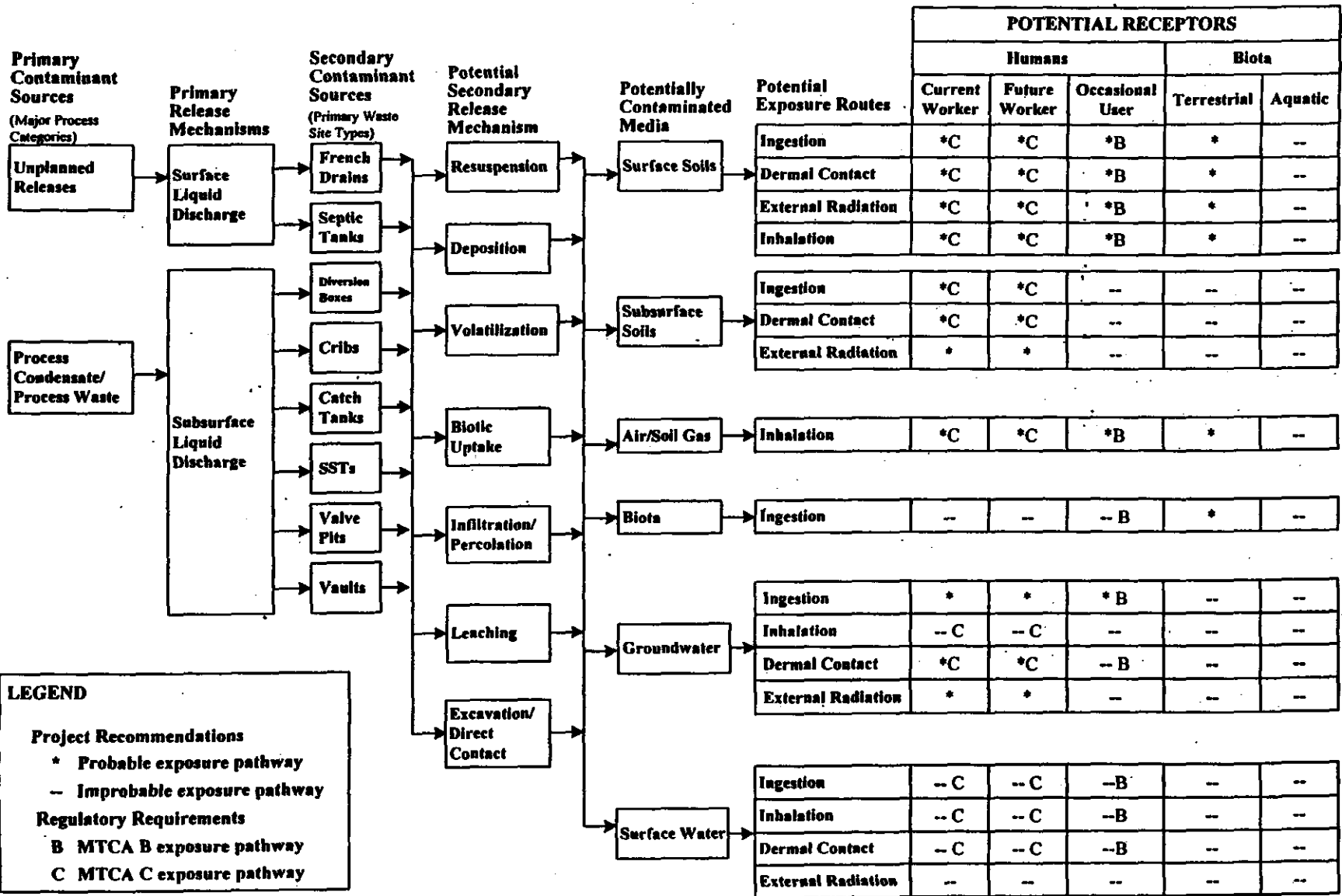


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Figure 1-2. Hypothetical Receptor Locations for Risk Evaluation.



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Source: Adapted from DOE/RI-98-28

Figure 1-3. Conceptual Exposure Model for the Waste Management Areas.

Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

COPC	CAS #	Rationale for Exclusion
<b>Radionuclides</b>		
Actinium-225	14265-85-1	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Actinium-227	14952-40-0	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Aluminum-28		Short-lived radionuclide (half-life <3 years)
Americium-241	14596-10-2	
Americium-242	13981-54-9	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Americium-242m	13981-54-9	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Americium-243	14993-75-0	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Antimony-122	14374-79-9	Short-lived radionuclide (half-life <3 years)
Antimony-124	14683-10-4	Short-lived radionuclide (half-life <3 years)
Antimony-125	14234-35-6	Short-lived radionuclide (half-life <3 years)
Antimony-126	15756-32-8	Short-lived radionuclide (half-life <3 years)
Antimony-126m	15756-32-8	Short-lived radionuclide (half-life <3 years)
Astatine-217		Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Barium-133	13981-41-4	No apparent source in the 200 Areas (GEA will report if detected)
Barium-135m	14698-58-9	Short-lived radionuclide (half-life <3 years)
Barium-137m		Short-lived daughter of Cs-137 (which is a final COPC)
Beryllium-7	13966-02-4	Short-lived radionuclide (half-life <3 years)
Beryllium-10		No apparent source in the 200 Areas (no standard analytical procedure available)
Bismuth-210	14331-79-4	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Bismuth-211		Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Bismuth-212	14913-49-6	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Bismuth-213	15776-20-2	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Bismuth-214	14733-03-0	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Cadmium-109	14109-32-1	Short-lived radionuclide (half-life <3 years)
Carbon-14	14762-75-5	
Cerium-141	13967-74-3	Short-lived radionuclide (half-life <3 years)
Cerium-144	14762-78-8	Short-lived radionuclide (half-life <3 years)
Cesium-134	13967-70-9	Short-lived radionuclide (half-life <3 years)
Cesium-135	15726-30-4	Constituent generated at less than 5E-5 times Cs-137 activity (no standard analytical procedure available)
Cesium-137	10045-97-3	

Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

COPC	CAS #	Rationale for Exclusion
Chlorine-36	13981-43-6	No apparent source in the 200 Areas (no standard analytical procedure available)
Chromium-51	14392-02-0	Short-lived radionuclide (half-life <3 years)
Cobalt-57	13981-50-5	Short-lived radionuclide (half-life <3 years)
Cobalt-58	13981-38-9	Short-lived radionuclide (half-life <3 years)
Cobalt-60	10198-40-0	
Curium-242	15510-73-3	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Curium-243	15757-87-6	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Curium-244	13981-15-2	Constituent with atomic mass number greater than or equal to 242 that represents less than 1% of the actinide activity. May be reported via Americium Isotopic analysis.
Curium-245	15621-76-8	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Einsteinium-254	15840-03-6	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Europium-152	14683-23-9	
Europium-154	15585-10-1	
Europium-155	14391-16-3	
Francium-221		Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Francium-223	15756-98-6	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Gadolinium-152	14867-5400	Naturally occurring isotope not created in Hanford reactor operations.
Gadolinium-153	14276-65-4	Short-lived radionuclide (half-life <3 years)
Germanium-68	15756-77-1	Short-lived radionuclide (half-life <3 years)
Gold-195	14320-93-5	Short-lived radionuclide (half-life <3 years)
Iodine-123	15715-08-9	Short-lived radionuclide (half-life <3 years)
Iodine-125	14158-31-7	Short-lived radionuclide (half-life <3 years)
Iodine-129	15046-84-1	Constituent generated at less than 5E-5 times Cs-137 activity, historical tank sampling indicates nondetection
Iodine-131	10043-86-0	Short-lived radionuclide (half-life <3 years)
Iron-55	14681-59-5	Short-lived radionuclide (half-life <3 years)
Iron-59	14596-12-4	Short-lived radionuclide (half-life <3 years)
Krypton-85	13983-27-2	Gas
Lead-209	14119-30-3	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Lead-210	14255-04-0	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Lead-211	15816-77-0	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Lead-212	15092-94-1	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Lead-214	15067-28-4	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.

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Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

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COPC	CAS #	Rationale for Exclusion
Manganese-54	13966-31-9	Short-lived radionuclide (half-life <3 years)
Molybdenum-93	14119-13-2	No apparent source in the 200 Areas (no standard analytical procedure available)
Neptunium-237	13994-20-2	
Neptunium-239	13968-59-7	Short-lived radionuclide (half-life <3 years)
Nickel-59	14336-70-0	Activity will be < 5% of Ni-63 activity and may be estimated from that isotope
Nickel-63	13981-37-8	
Niobium-91		No apparent source in the 200 Areas (no standard analytical procedure available)
Niobium-93m		Constituent generated at less than 5E-5 times Cs-137 activity (no standard analytical procedure available)
Niobium-95	13967-76-5	Short-lived radionuclide (half-life <3 years)
Niobium-94	14681-63-1	No apparent source in the 200 Areas (GEA will report if detected)
Palladium-107	17637-99-9	Constituent generated at less than 5E-5 times Cs-137 activity (no standard analytical procedure available)
Phosphorus-32	14596-37-3	Short-lived radionuclide (half-life <3 years)
Plutonium-238	13981-16-3	
Plutonium-239	15117-48-3	Measurement cannot resolve Pu-239 + Pu-240 isotopes, reported as Pu-234/240
Plutonium-240	14119-33-6	Measurement cannot resolve Pu-239 + Pu-240 isotopes, reported as Pu-234/240
Pu-239/240	PU-239/240	
Plutonium-241	14119-32-5	Not detected by normal Pu analysis, can infer from Am/Pu results.
Plutonium-242	13982-10-0	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Polonium-210	13981-22-7	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Polonium-211		Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Polonium-212		Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Polonium-213		Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Polonium-214	15735-67-8	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Polonium-215		Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Polonium-216		Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Polonium-218	15422-74-9	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Potassium-40	13966-00-2	Naturally occurring isotope not created in Hanford reactor operations.
Praseodymium-144	14119-05-2	Short-lived radionuclide (half-life <3 years)
Promethium-143	14834-72-1	Short-lived radionuclide (half-life <3 years)
Promethium-147	14380-75-7	Short-lived radionuclide (half-life <3 years)
Protactinium-231	14331-85-2	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.

Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

COPC	CAS #	Rationale for Exclusion
Protactinium-233	13981-14-1	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Protactinium-234	15100-28-4	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Radium-223	15623-45-7	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Radium-225	13981-53-8	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Radium-226	13982-63-3	Daughter product which may be calculated from the isotope from which it originates. (GEA will report Ra-226 and Ra-228.)
Radium-228	15262-20-1	Daughter product which may be calculated from the isotope from which it originates. (GEA will report Ra-226 and Ra-228.)
Radon-219		Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Radon-220	22461-48-7	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Radon-222	14859-67-7	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Rhenium-187	14391-29-8	Naturally occurring isotope not created in Hanford reactor operations.
Rhodium-106	14234-34-5	Short-lived radionuclide (half-life <3 years)
Ruthenium-103	13968-53-1	Short-lived radionuclide (half-life <3 years)
Ruthenium-106	13967-48-1	Short-lived radionuclide (half-life <3 years)
Samarium-147	14392-33-7	Naturally occurring isotope not created in Hanford reactor operations greater than 5E-5 times Cs-137 activity.
Samarium-151	15715-94-3	Less than 1% of Cs-137 activity. Insignificant contribution to dose; no standard analytical detection methodology available.
Scandium-46	13967-63-0	Short-lived radionuclide (half-life <3 years)
Selenium-75	14265-71-5	Short-lived radionuclide (half-life <3 years)
Selenium-79	15758-45-9	Constituent generated at less than 5E-5 times Cs-137 activity, historical tank sampling indicates nondetection
Silver-108	14391-65-2	Short-lived radionuclide (half-life <3 years)
Silver-110m	14391-76-5	Short-lived radionuclide (half-life <3 years)
Sodium-22	13966-32-0	Short-lived radionuclide (half-life <3 years)
Strontium-85	13967-73-2	Short-lived radionuclide (half-life <3 years)
Strontium-90	10098-97-2	Routinely analyzes as Total Radioactive Strontium
Sulfur-35	15117-53-0	Short-lived radionuclide (half-life <3 years)
Tantalum-182	13982-00-8	Short-lived radionuclide (half-life <3 years)
Technetium-99	14133-76-7	
Tellurium-121	14304-79-1	Short-lived radionuclide (half-life <3 years)
Tellurium-125m	14390-73-9	Short-lived radionuclide (half-life <3 years)
Tellurium-127	13981-49-2	Short-lived radionuclide (half-life <3 years)
Tellurium-129m	14269-71-7	Short-lived radionuclide (half-life <3 years)
Thallium-204	13968-51-9	No apparent source in the 200 Areas (no standard analytical procedure available)
Thallium-207		Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Thallium-209		Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.

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Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

COPC	CAS #	Rationale for Exclusion
Thallium-208	14913-50-9	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Thorium-227	15623-47-9	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Thorium-228	14274-82-9	Daughter product which may be calculated from the isotopes from which it originates. (Thorium Isotopic - AEA will report this isotope)
Thorium-229	15594-54-4	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Thorium-230	14269-63-7	Daughter product which may be calculated from the isotopes from which it originates. (Thorium Isotopic - AEA will report this isotope)
Thorium-231	14932-40-2	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Thorium-232	TH-232	
Thorium-233		Short-lived radionuclide (half-life <3 years)
Thorium-234	15065-10-8	Daughter product with very low ingrowth relative to the parent, or the concentration may be calculated from the isotope from which it originates.
Thulium-170	13981-30-1	Short-lived radionuclide (half-life <3 years)
Tin-113	13966-06-8	Short-lived radionuclide (half-life <3 years)
Tin-123m	14683-07-9	Short-lived radionuclide (half-life <3 years)
Tin-126	15832-50-5	Constituent generated at less than 5E-5 times Cs-137 activity (GEA will report if detected)
Uranium-233	13968-55-3	Measurement cannot resolve U-233 + U-234 isotopes, reported as U-234 or U-233/234
Uranium-234	13966-29-5	
Uranium-235	15117-96-1	
Uranium-236	13982-70-2	Measurement cannot resolve U-235 + U-236 isotopes, reported as U-235
Uranium-237	14269-75-1	Short-lived radionuclide (half-life <3 years)
Uranium-238	U-238	
Uranium	7440-61-1	
Vanadium-49	14392-01-9	Short-lived radionuclide (half-life <3 years)
Yttrium-88	13982-36-0	Short-lived radionuclide (half-life <3 years)
Yttrium-90	1-98-91-6	Short-lived daughter of Sr-90 (which is a final COPC)
Zinc-65	13982-39-3	Short-lived radionuclide (half-life <3 years)
Zirconium-93	15751-77-6	Constituent generated at less than 5E-5 times Cs-137 activity (no standard analytical procedure available)
Zirconium-95	13967-71-0	Short-lived radionuclide (half-life <3 years)
<b>Organics</b>		
Benzo(a)pyrene	50-32-8	
Dibenz[a,h]anthracene	53-70-3	
Carbon tetrachloride	56-23-5	
1,1-dimethylhydrazine	57-14-7	No direct standard analytical technique available. Used in minimal quantities at Hanford. Reactive material with minimal lifetime in Hanford environment.
gamma-BHC (Lindane)	58-89-9	
Methylhydrazine	60-34-4	No direct standard analytical technique available. Used in minimal quantities at Hanford. Reactive material with minimal lifetime in Hanford environment.

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Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

COPC	CAS #	Rationale for Exclusion
Dieldrin	60-57-1	
N-nitroso-N,N-dimethylamine	62-75-9	
Ethyl alcohol	64-17-5	
Formic acid	64-18-6	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents. Used in minimal quantities at Hanford.
Acetic acid	64-19-7	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Methyl alcohol (methanol)	67-56-1	
2-propyl alcohol (isopropanol; propan-2-01)	67-63-0	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
2-Propanone (Acetone)	67-64-1	
Chloroform	67-66-3	
n-Propyl alcohol (1-propanol)	71-23-8	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
n-Butyl alcohol	71-36-3	
Benzene	71-43-2	
1,1,1-trichloroethane	71-55-6	
Endrin	72-20-8	
Bromomethane	74-83-9	
Chloromethane	74-87-3	
2-methyl-2-propanol	75-65-0	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Trichlorofluoromethane	75-69-4	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
Dichlorodifluoromethane	75-71-8	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
Chloroethane	75-00-3	
1-chloroethene	75-01-4	
Acetonitrile	75-05-8	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
Dichloromethane (methylene chloride)	75-09-2	
Carbon disulfide	75-15-0	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.

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Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

COPC	CAS #	Rationale for Exclusion
Oxirane (ethylene oxide)	75-21-8	Gas
1,1-dichloroethane	75-34-3	
1,1-dichloroethene	75-35-4	
Dichlorofluoromethane (Freon 21)	75-43-4	Gas
Chlorodifluoromethane (Freon 22)	75-45-6	Gas
1,2,2-trichloro-1,1,2-trifluoroethane	76-13-1	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
1,2-dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	76-14-2	Gas
Heptachlor	76-44-8	
1,2-dichloropropane	78-87-5	
1-methylpropyl alcohol (2 butanol)	78-92-2	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
2-butanone	78-93-3	
1,1,2-trichloroethane	79-00-5	
1,1,2-trichloroethylene	79-01-6	
2-propenoic acid	79-10-7	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
1,1,1,2-tetrachloroethane	79-34-5	
Pentachloronitrobenzene (PCNB)	82-68-8	Minimal use at Hanford. Semmovolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during semivolatile analysis, quantitation possible if requested.
Hexachlorobutadiene	87-68-3	
Pentachlorophenol	87-86-5	
2-sec-butyl-4,6-dinitrophenol (dinoseb)	88-85-7	Minimal use at Hanford. Semmovolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during semivolatile analysis, quantitation possible if requested.
Picric acid	88-89-1	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
1,1-biphenyl	92-52-4	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
o-Xylene	95-47-6	Measured as total Xylene
1,2-dichlorobenzene	95-50-1	

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Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

COPC	CAS #	Rationale for Exclusion
3-pentanone	96-22-0	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Acetophenone	98-86-2	Minimal use at Hanford. Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during semivolatile analysis, quantitation possible if requested.
Nitrobenzene	98-95-3	
p-Nitrochlorobenzene	100-00-5	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
1,4-dinitrobenzene	100-25-4	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Ethyl benzene	100-41-4	
Styrene	100-42-5	
3-heptanone	106-35-4	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
p-Xylene	106-42-3	Measured as total Xylene
1,4-dichlorobenzene	106-46-7	
Ethylene dibromide	106-93-4	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
Butane	106-97-8	Gas
1,3-butadiene	106-99-0	Gas
Acrolein	107-02-8	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
3-chloropropene	107-05-1	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
1,2-dichloroethane	107-06-2	
Propionitrile	107-12-0	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
Acrylonitrile	107-13-1	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
2-pentanone	107-87-9	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
4-methyl-2-pentanone	108-10-1	
m-Xylene	108-38-3	Measured as total Xylene

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Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

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COPC	CAS #	Rationale for Exclusion
Methylcyclohexane	108-87-2	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Toluene	108-88-3	
Chlorobenzene	108-90-7	
Cyclohexanone	108-94-1	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Phenol	108-95-2	Minimal use at Hanford. Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during semivolatile analysis, quantitation possible if requested.
n-Pentane	109-66-0	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Tetrahydrofuran	109-99-9	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
5-methyl-2-hexanone	110-12-3	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
2-heptanone	110-43-0	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
n-Hexane	110-54-3	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Cyclohexane	110-82-7	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Cyclohexene	110-83-8	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Pyridine	110-86-1	
n-Octane	111-65-9	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
n-Nonane	111-84-2	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Hexachlorobenzene	118-74-1	
1,2,4-trichlorobenzene	120-82-1	
Triethylamine	121-44-8	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.

Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

COPC	CAS #	Rationale for Exclusion
N,N-diphenylamine	122-39-4	Minimal use at Hanford. Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during semivolatile analysis, quantitation possible if requested.
4-heptanone	123-19-3	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
n-Propionaldehyde	123-38-6	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Acetic acid n-butyl-ester	123-86-4	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
1,4-dioxane	123-91-1	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
Tributyl phosphate	126-73-8	
2-methyl-2-propenenitrile	126-98-7	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
1,1,2,2-tetrachloroethene	127-18-4	
2,6-bis(tert-butyl)-4-methylphenol	128-37-0	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Acetic acid ethyl ester	141-78-6	Minimal use at Hanford. Volatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during volatile analysis, quantitation is possible if requested.
n-Heptane	142-82-5	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Oxalic acid	144-62-7	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Cyclopentane	287-92-3	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Aldrin	309-00-2	
Alpha-BHC	319-84-6	
Beta-BHC	319-85-7	
Isodrin	465-73-6	Minimal use at Hanford. Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for these compounds or compounds of similar structure. If identified as a TIC during semivolatile analysis, quantitation possible if requested.
1,3-dichlorobenzene	541-73-1	
3-methyl-2-butanone	563-80-4	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.

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Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

COPC	CAS #	Rationale for Exclusion
2-hexanone	591-78-6	
Methyl isocyanate	624-83-9	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Nitric acid, Propyl ester	627-13-4	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Hexafluoroacetone	684-16-2	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Pentachloronaphthalene	1321-64-8	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Hexachloronaphthalene	1335-87-1	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Tetrachloronaphthalene	1335-88-2	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Polychlorinated biphenyls (PCBs)	1336-36-3	
Octachloronaphthalene	2234-13-1	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Ammonium perfluorooctanoate	3825-26-1	No direct standard analytical technique available. Used in minimal quantities at Hanford.
2-butenaldehyde (2-butenal)	4170-30-3	Minimal use at Hanford. No routine analytical methodology available. Volatile/Semivolatile analysis (via GCMS technology) of potentially contaminated soils from high organic inventory tank farm areas reported non-detection for compounds of similar structure.
Toxaphene	8001-35-2	
cis-1,3-dichloropropene	10061-01-5	
Trans-1,3-dichloropropene	10061-02-6	
<b>Inorganics</b>		
Cyanide	57-12-5	
Carbon	1333-86-4	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubilities.
Aluminum	7429-90-5	This inorganic substance is unlikely to be present in toxic concentrations.
Iron	7439-89-6	This inorganic substance is unlikely to be present in toxic concentrations.
Lead	7439-92-1	
Lithium	7439-93-2	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubilities.
Magnesium	7439-95-4	This inorganic substance is unlikely to be present in toxic concentrations.
Manganese	7439-96-5	This inorganic substance is unlikely to be present in toxic concentrations.

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Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

COPC	CAS #	Rationale for Exclusion
Mercury	7439-97-6	
Molybdenum	7439-98-7	This inorganic substance is unlikely to be present in toxic concentrations.
Nickel	7440-02-0	
Osmium		This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Platinum		This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Potassium	7440-09-7	This inorganic substance is unlikely to be present in toxic concentrations.
Rhodium	7440-16-6	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Silicon	7440-21-3	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Silver	7440-22-4	
Sodium	7440-23-5	This inorganic substance is unlikely to be present in toxic concentrations.
Tantalum	7440-25-7	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Thallium	7440-28-0	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford.
Tin	7440-31-5	This inorganic substance is unlikely to be present in toxic concentrations.
Titanium	7440-32-6	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Tungsten	7440-33-7	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Antimony	7440-36-0	
Antimony	7440-36-0	
Arsenic	7440-38-2	
Arsenic	7440-38-2	
Barium	7440-39-3	
Barium	7440-39-3	
Beryllium	7440-41-7	
Boron	7440-42-8	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford.
Cadmium	7440-43-9	
Cesium	7440-46-2	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford.
Chromium (total)	7440-47-3	
Cr VI	18540-29-9	
Cobalt	7440-48-4	This inorganic substance is unlikely to be present in toxic concentrations.
Copper	7440-50-8	
Germanium	7440-56-4	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Hafnium	7440-58-6	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Vanadium	7440-62-2	This inorganic substance is unlikely to be present in toxic concentrations.

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Table 1-3. Tank Farm S-SX COPC List and Exclusion Rationale. (13 pages)

COPC	CAS #	Rationale for Exclusion
Yttrium	7440-65-5	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Zinc	7440-66-6	This inorganic substance is unlikely to be present in toxic concentrations.
Zirconium	7440-67-7	This inorganic substance is unlikely to be present in toxic concentrations.
Bismuth	7440-69-9	This inorganic substance is unlikely to be present in toxic concentrations.
Calcium	7440-70-2	This inorganic substance is unlikely to be present in toxic concentrations.
Indium	7440-74-6	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Selenium	7782-49-2	
Tellurium	13494-80-9	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Phosphorus	7723-14-0	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use at Hanford or very low solubalities.
Iodine	7553-56-2	Used in minimal quantities at Hanford. Minimal lifetime in Hanford environment.
Ammonia/ammonium	7664-41-7	
Nitrogen	7727-37-9	Gas
Phosphate	14265-44-2	
Nitrate	14797-55-8	
Nitrite	14797-65-0	
Sulfate	14808-79-8	
Chloride	16887-00-6	
Fluoride	16984-48-8	
Sulfides	18496-25-8	
Bromide	24959-67-9	
Carbonate(axb)	3812-32-6	This inorganic substance is unlikely to be present in toxic concentrations.
Sulfite	14265-45-3	Used in minimal quantities at Hanford. Reactive material with minimal lifetime in Hanford environment.
Hydroxide	14280-30-9	Assessed via pH determination.

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Table 1-4. WMA S-SX COCs, Action Levels, and Target RQLs. (2 pages)

COC	CAS #	ACTION LEVELS		NAME/ANALYTICAL TECHNOLOGY <sup>2</sup>	TARGET REQUIRED QUANTITATION LIMITS				PRECISION WATER	ACCURACY WATER	PRECISION SOIL	ACCURACY SOIL
					WATER <sup>1</sup> low level	WATER <sup>1</sup> high level	SOIL-OTHER low level	SOIL-OTHER high level				
		RR <sup>3</sup>	CR <sup>4</sup>		pC/L	pC/L	pC/g	pC/g				
<b>RADIONUCLIDE</b>		pC/g	pC/g									
Americium-241	14598-10-2	31	210	Americium Isotopic - Alpha Energy Analysis (AEA)	1	400	1	4000	+20%	70-130%	+35%	70-130%
Carbon-14	14762-75-5	5.2	33100	Carbon-14 - Liquid Scintillation	200		50	NA	+20%	70-130%	+35%	70-130%
Cesium-137	10045-97-3	6.2	25	Gamma Energy Analysis	15	200	0.1	2000	+20%	70-130%	+35%	70-130%
Cobalt-60	10198-40-0	1.4	5.2	Gamma Energy Analysis	25	200	0.05	2000	+20%	70-130%	+35%	70-130%
Europium-152	14883-23-9	3.3	12	Gamma Energy Analysis	50	200	0.1	2000	+20%	70-130%	+35%	70-130%
Europium-154	15585-10-1	3	11	Gamma Energy Analysis	50	200	0.1	2000	+20%	70-130%	+35%	70-130%
Europium-155	14391-16-3	125	449	Gamma Energy Analysis	50	200	0.1	2000	+20%	70-130%	+35%	70-130%
Neptunium-237	13994-20-2	2.5	62.2	Neptunium-237 - AEA	1		1	8000	+20%	70-130%	+35%	70-130%
Nickel-63	13981-37-8	4026	3008000	Nickel-63 - Liquid Scintillation	15	NA	30	NA	+20%	70-130%	+35%	70-130%
Plutonium-238	13981-16-3	37.4	47.3	Plutonium Isotopic - AEA	1	130	1	1300	+20%	70-130%	+35%	70-130%
Pu-239/240	PU-239/240	33.9	437	Plutonium Isotopic - AEA	1	130	1	1300	+20%	70-130%	+35%	70-130%
Total radioactive Strontium or Sr-90	SR-RAD or 10088-97-2	4.5	2500	Total Radioactive Strontium or Strontium Isotopic - Gas Proportional Counting (GPC)	2	80	1	800	+20%	70-130%	+35%	70-130%
Technetium-99	14133-78-7	5.7 pC/g 0.33 ug/Kg	41000 pC/g 24000 ug/Kg	Technetium-99 - Liquid Scintillation (pCi) ICPMS (ug)	15	400 pC/L 2 ug/L	15	4000 pC/L 20 ug/Kg	+20%	70-130%	+35%	70-130%
Tritium (H-3)	10028-17-9			Tritium - Liquid Scintillation	400		400		+20%	70-130%	135%	70-130%
Thorium-232	TH-232	1 uC/g 9100 ug/Kg	5.1 pC/g 47000 ug/Kg	Thorium Isotopic - AEA (pCi) ICPMS (ug)	1	2 ug/L	1	20 ug/Kg	+20%	70-130%	+35%	70-130%
Uranium-234	13986-29-5	180 pC/g 28 ug/Kg	1200 pC/g 190 ug/Kg	Uranium Isotopic - AEA (pCi) ICPMS (ug)	1	2 ug/L	1	20 ug/Kg		70-130%	+35%	70-130%
Uranium-235	15117-96-1	26 uC/g 12000 ug/Kg	100 uC/g 48000 ug/Kg	Uranium Isotopic - AEA (pCi) ICPMS (ug)	1	2 ug/L	1	20 ug/Kg	+20%	70-130%	+35%	70-130%
Uranium-238	U-238	85 uC/g 250000 ug/Kg	420 pC/g 1250000 ug/Kg	Uranium Isotopic - AEA (pCi) ICPMS (ug)	1	2 ug/L	1	20 ug/Kg	+20%	70-130%	+35%	70-130%
<b>CHEMICAL</b>		Meth B ug/Kg	Meth C ug/Kg		ug/L	ug/L	ug/Kg	ug/Kg				
Cyanide	57-12-5	20000	20000	Total Cyanide - 8010 - Colorimetric	5	5	500	500	f	f	f	f
Lead	7439-92-1	353000	353000	Metals - 8010 - ICP	100	200	10000	20000	f	f	f	f
Lead	7439-92-1	353000	353000	Metals - 8010 - ICP (TRACE)	10	NA	1000	NA	f	f	f	f
Lead	7439-92-1	353000	353000	Metals - 8020 - ICPMS <sup>5</sup>	0.02	2	2	20	f	f	f	f
Mercury	7439-97-8	N/A	N/A	Mercury - 7470 - CVAA	0.5	5	N/A	N/A	f	f	f	f
Mercury	7439-97-8	330	330	Mercury - 7471 - CVAA	N/A	N/A	200	200	f	f	f	f
Nickel	7440-02-0	32000	70000	Metals - 8010 - ICP	40	40	4000	4000	f	f	f	f
Nickel	7440-02-0	32000	70000	Metals - 8020 - ICPMS	0.02	2	2	20	f	f	f	f
Silver	7440-22-4	8000	10000	Metals - 8010 - ICP	20	20	2000	2000	f	f	f	f
Silver	7440-22-4	8000	10000	Metals - 8010 - ICP (TRACE)	5	NA	500	NA	f	f	f	f
Silver	7440-22-4	8000	10000	Metals - 8020 - ICPMS	0.02	2	2	20	f	f	f	f
Antimony	7440-36-0	32000	1400000	Metals - 8010 - ICP	80	120	8000	12000	f	f	f	f
Antimony	7440-36-0	32000	1400000	Metals - 8010 - ICP (TRACE)	10	NA	1000	NA	f	f	f	f
Antimony	7440-36-0	32000	1400000	Metals - 8020 - ICPMS	0.02	2	2	20	f	f	f	f
Arsenic	7440-38-2	6500	6500	Metals - 8010 - ICP	100	200	10000	20000	f	f	f	f
Arsenic	7440-38-2	6500	6500	Metals - 8010 - ICP (TRACE)	10	NA	1000	NA	f	f	f	f
Arsenic	7440-38-2	6500	6500	Metals - 8020 - ICPMS	0.02	2	2	20	f	f	f	f
Barium	7440-38-3	132000	245000	Metals - 8010 - ICP	200	200	20000	20000	f	f	f	f

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COC	CAS #	ACTION LEVELS		NAME/ANALYTICAL TECHNOLOGY <sup>6</sup>	TARGET REQUIRED QUANTITATION LIMITS				PRECISION WATER	ACCURACY WATER	PRECISION SOIL	ACCURACY SOIL
					WATER <sup>4</sup> low level	WATER <sup>4</sup> high level	SOIL-OTHER low level	SOIL-OTHER high level				
Barium	7440-39-3	132000	245000	Metals - 6010 - ICP(TRACE)	5	NA	500	NA	f	f	f	f
Barium	7440-39-3	132000	245000	Metals - 6020 - ICPMS	0.02	2	2	20	f	f	f	f
Beryllium	7440-41-7	1510	1510	Metals - 6010 - ICP	5	10	500	1000	f	f	f	f
Beryllium	7440-41-7	1510	1510	Metals - 6020 - ICPMS	0.02	2	2	20	f	f	f	f
Cadmium	7440-43-9	500	500	Metals - 6010 - ICP	5	10	500	1000	f	f	f	f
Cadmium	7440-43-9	500	500	Metals - 6010 - ICP(TRACE)	5	NA	500	NA	f	f	f	f
Cadmium	7440-43-9	500	500	Metals - 6020 - ICPMS	0.02	2	2	20	f	f	f	f
Chromium (total)	7440-47-3	1600000	3500000	Metals - 6010 - ICP	10	10	1000	2000	f	f	f	f
Chromium (total)	7440-47-3	1600000	3500000	Metals - 6010 - ICP(TRACE)	10	NA	1000	NA	f	f	f	f
Chromium (total)	7440-47-3	1600000	3500000	Metals - 6020 - ICPMS	0.02	2	2	20	f	f	f	f
Cr VI	18540-29-9	8000	17500	Chromium (hex) - 7196 - Colorimetric	10	4000	500	200000	f	f	f	f
Copper	7440-50-8	59200	130000	Metals - 6010 - ICP	25	25	2500	2500	f	f	f	f
Copper	7440-50-8	59200	130000	Metals - 6020 - ICPMS	0.02	2	2	20	f	f	f	f
Selenium	7782-49-2	5000	5000	Metals - 6010 - ICP	100	200	10000	20000	f	f	f	f
Selenium	7782-49-2	5000	5000	Metals - 6010 - ICP(TRACE)	10	NA	1000	NA	f	f	f	f
Uranium (total)	7440-61-1	240000	10500000	Uranium Total - Kinetic Phosphorescence Analysis	0.1	20	1000	200	f	f	f	f
Ammonia-ammonium	7884-41-7	27200000	59500000	Ammonia - 350.N <sup>6</sup>	50	800000	500	8000000	f	f	f	f
Phosphate	14285-44-2	N/A	N/A	Anions - 9056 - IC	500	15000	5000	40000	f	f	f	f
Nitrate	14797-55-8	4400000	4400000	Anions - 9056 - IC	250	10000	2500	40000	f	f	f	f
Nitrite	14797-85-0	330000	330000	Anions - 9056 - IC	250	15000	2500	20000	f	f	f	f
Nitrate/nitrite as N	NO3+NO2-N	330000	330000	Nitrate/Nitrite - 353.N <sup>6</sup>	75	NA	750	NA	f	f	f	f
Sulfate	14808-79-8	25000000	25000000	Anions - 9056 - IC	500	15000	5000	40000	f	f	f	f
Chloride	18887-00-8	25000000	25000000	Anions - 9056 - IC	200	5000	2000	5000	f	f	f	f
Fluoride	16984-48-8	96000	200000	Anions - 9056 - IC	500	5000	5000	5000	f	f	f	f
Sulfides	18496-25-8	N/A	N/A	Sulfide - 9030 - Colorimetric	500	NA	5000	NA	f	f	f	f
Bromide	24959-87-9	N/A	N/A	Anions - 9056 - IC	250	NA	2500	NA	f	f	f	f
pH		N/A	N/A	pH - 9045 - Electrode	N/A	N/A	N/A	N/A	f	f	f	f

Table 1-4. WMA S-SX COCs, Action Levels, and Target RQLs. (2 pages)

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<sup>6</sup>Based on Contract No. 615, Quanta Environmental Services, and Contract No. 630, Thermo Analytical Services, Statement of Work, Revision No. 6 Price List.

<sup>4</sup>RR - Rural Residential CA - Commercial Industrial Values from WDOH "Hanford Guidance for Radiological Cleanup", WDOH/320-015.

Italicized values are calculated using the same parameters as the WDOH guidance. Mass based concentrations calculated from activity limit using specific activity of specified isotope. Activity basis will govern decision making.

<sup>3</sup>Water values for sampling QC (e.g. equipment blanks/tnses) or drainable liquid (if recovered)

<sup>4</sup>All 4 digit numbers refer to "Test Methods for Evaluating Solid Waste" (EPA SW-846)

<sup>5</sup>"Methods of Analysis of Water andWaste" (EPA-800/4-79-020)

<sup>6</sup>Precision and Accuracy Requirements as Identified and defined in the referenced EPA procedures.

<sup>7</sup>ICPMS technology not routinely available from low level commercial laboratories

N/A - not applicable NA - not available

**2.0 STEP 2 -- IDENTIFY THE DECISION**

In Step 2, the PSQs that need to be resolved to address the problem identified in DQO Step 1 are documented. In addition, the alternative actions that would result from resolving the PSQs are identified. The PSQs and alternative actions are then combined into decision statements (DSs) that express a choice among alternative actions.

Performance standards for preliminary corrective measures are identified in the RFI/CMS Work Plan (DOE/RL-99-36) and are sufficient for use in this characterization planning effort. However, because of the uncertainties regarding compliance points, the DQO process will consider the WMA boundary, the 200 Area exclusive use area boundary, the 200 Area buffer zone boundary, and the Columbia River as hypothetical compliance points where corrective measure performance standards would be applied.

**Table 2-1. Summary of DQO Step 2 Information. (3 pages)**

<b>Principal Study Question #1 – Do current shallow (&lt;4.6 meters [<math>&lt;15</math> feet]) soil radionuclide and chemical concentrations resulting from releases within the WMA achieve preliminary corrective measure performance standards for direct exposure in the vicinity of the WMA boundary.</b>	
<b>PS</b>	<b>Alternative Action</b>
<b>AA</b>	
<b>1-1</b>	Do not evaluate soil ICMs at WMA S-SX; proceed with retrieval and closure activities.
<b>1-2</b>	Evaluate soil ICMs at WMA S-SX.
<b>Decision Statement #1 – Determine if current shallow (&lt;4.6 meters [<math>&lt;15</math> feet]) soil radionuclide and chemical concentrations resulting from releases within the WMA achieve preliminary corrective measure performance standards for direct exposure in the vicinity of the WMA boundary.</b>	
<b>Principal Study Question #2 – Do current vadose zone (surface to water table) soil radionuclide and chemical concentrations resulting from releases within the WMA achieve preliminary corrective measure performance standards for groundwater protection in the vicinity of the WMA boundary, 200 Areas exclusive area boundary, 200 Area buffer zone boundary, and Columbia River boundary.</b>	
<b>PS</b>	<b>Alternative Action</b>
<b>AA</b>	
<b>2-1</b>	Do not evaluate soil ICMs at WMA S-SX; proceed with retrieval and closure activities.
<b>2-2</b>	Evaluate soil (surface to water table) ICMs at WMA S-SX.
<b>Decision Statement #2 - Determine if current vadose zone (surface to water table) soil radionuclide and chemical concentrations resulting from releases within the WMA achieve preliminary corrective measure performance standards for groundwater protection in the vicinity of the WMA boundary, 200 Areas exclusive area boundary, 200 Area buffer zone boundary, and Columbia River boundary.</b>	
<b>Principal Study Question #3 – Do current groundwater radionuclide and chemical concentrations resulting from releases within the WMA achieve preliminary corrective measure performance standards for the protection of the Columbia River?</b>	
<b>PS</b>	<b>Alternative Action</b>
<b>AA</b>	

**Table 2-1. Summary of DQO Step 2 Information. (3 pages)**

3-1	Do not evaluate groundwater ICMs at WMA S-SX; proceed with retrieval and closure.
3-2	Hanford ER Program evaluates groundwater ICMs for WMA S-SX.
<p><b>Decision Statement #3 – Determine if current groundwater radionuclide and chemical concentrations resulting from releases within the WMA achieve preliminary corrective measure performance standards for the protection of the Columbia River in the vicinity of the WMA boundary.</b></p> <p><b>Principal Study Question 3:</b> Will shallow soil (&lt;4.6 meters; [&lt; 15 feet]), vadose zone soil (surface to water table), or groundwater radionuclide and chemical concentrations resulting from releases and potential retrieval leak losses will achieve preliminary corrective measure performance standards in the vicinity of the WMA boundary?</p> <p>PSC AA</p>	
4-1	Collect pertinent soil/groundwater ICM-related information during WMA S-SX characterization.
4-2	Do not collect soil/groundwater ICM-related information during WMA S-SX characterization.
<p><b>Decision Statement #4 – Determine if there is shallow soil, deep soil, or groundwater information (e.g., impact at the compliance point, dominant parameters, safety concerns, effects on operations) pertinent to soil/GW ICM technology evaluations that can be developed concurrent with WMA S-SX characterization activities.</b></p> <p><b>Principal Study Question 4:</b> Will shallow soil (&lt;4.6 meters; [&lt; 15 feet]), vadose zone soil (surface to water table), or groundwater radionuclide and chemical concentrations resulting from releases and potential retrieval leak losses will achieve preliminary corrective measure performance standards in the vicinity of the WMA boundary?</p> <p>PSC AA</p>	
5-1	Collect pertinent soil/groundwater retrieval-related information during WMA S-SX characterization.
5.2	Do not collect soil/groundwater retrieval-related information during WMA S-SX characterization.
<p><b>Decision Statement #5 - Determine if shallow soil (&lt;4.6 meters; [&lt; 15 feet]), vadose zone soil (surface to water table), or groundwater radionuclide and chemical concentrations resulting from releases and potential retrieval leak losses will achieve preliminary corrective measure performance standards in the vicinity of the WMA boundary.</b></p> <p><b>Principal Study Question 5:</b> Will shallow soil (&lt;4.6 meters; [&lt; 15 feet]), vadose zone soil (surface to water table), or groundwater radionuclide and chemical concentrations resulting from releases and potential retrieval leak losses will achieve preliminary corrective measure performance standards in the vicinity of the WMA boundary?</p> <p>PSC AA</p>	
6-1	Collect pertinent soil/groundwater closure-related information during WMA S-SX characterization.
6-2	Do not collect soil/groundwater closure-related information during WMA S-SX characterization.

**Table 2-1. Summary of DQO Step 2 Information. (3 pages)**

**Decision Statement #6** - Determine if shallow soil (<4.6 meters [<15 feet]), vadose zone soil (surface to water table), or groundwater radionuclide and chemical concentrations resulting from releases, potential retrieval leak losses, residual waste, and remaining structures will achieve closure performance standards in the vicinity of the WMA boundary, 200 Areas exclusive area boundary, 200 Area buffer zone boundary, and the Columbia River.

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

In Step 3, the information needed to resolve the DSs is documented. If it is determined that the information needed does not already exist, new information is required.

### 3.1 SOURCE REFERENCE INFORMATION

Table 3-1 documents whether new information to resolve the WMA S-SX decision statements is needed.

**Table 3-1. Required Information and Reference Sources.**

DS	Zone of Interest	Required Data	Data Exist (Y/N)	Information Description	Sufficient Data (Y/N)	New Data Required (Y/N)
1	Surface soil (0-15 ft)	Concentrations of waste in soil	Yes	Gamma data from dry wells; tank leak/surface spill info; UPR locations/information	No	Yes
2, 5, 6	Vadose zone (surface to water table)	Concentrations of waste in soil	Yes	Cs-137 tank leak, tank waste, and 41-09-39 information	No	Yes
		<u>Hydrology</u> (e.g., moisture conditions and transport properties for vadose zone model; hydraulic conductivity)	Yes	Outside WMA data applicable inside farm except for waste-impacted soils	No	Yes
		<u>Geochemistry</u> (e.g., $K_d$ , fate and transport information, decay rates)	Yes	Natural transport is well understood; unknown transport influence from waste/soil interactions	No	Yes
		<u>Geology</u> (e.g., stratigraphy, soil conditions)	Yes	Outside WMA S-SX info is sufficient for inside	Yes	No
		<u>Recharge</u> (e.g., natural and artificial infiltration)	Yes	Outside WMA lysimeter data are surrogates for tank farm conditions	Yes	No

**Table 3-1. Required Information and Reference Sources.**

DS#	Zone of Interest	Required Data	Data Exist (Y/N)	Information Description	Sufficient (Y/N)	New Data Required? (Y/N)
3	Ground-water	Inventory; future nature/extent of COCs	Yes	RCRA well information outside WMA boundary; not all COCs evaluated	No	Yes
4	ICMs	Inventory and Extent of COC	Yes	Some COCs evaluated	No	Yes

### 3.2 COMPUTATIONAL AND SURVEY/ANALYTICAL METHODS

Table 3-2 documents the computation methods (including computer models) and the surveying/sampling methods that could be used to obtain the information to resolve the DSs. This table also documents the application of the new information to the study and possible data/information limitations.

### 3.3 ANALYTICAL PERFORMANCE REQUIREMENTS

Analytical performance requirements have not been established for the WMA S-SX characterization effort. Table 1-3 (attached at the end of Step 1) includes target RQLs from current Hanford Site analytical contracts. For this DQO, analytical detection limit requirements will be set at laboratory Required Quantitation Limits (RQLs) for the analytical methods selected. RQLs are typically in the range of non-radiological cleanup standards (MTCA-B and MTCA-C criteria) and individual isotope concentrations that are equivalent to a 15-mrem/year dose.

**Table 3-2. Information Required to Resolve the Decision Statements.**

				Survey/Analytical Methods	Application of Study	Possible Limitation
1	Surface soils (0-15 feet)	COC concentrations; MTCA-B and C criteria for comparison; vadose-GW transport model inputs; Radiation dose information	Human health and ecological risk evaluations (radiation dose models and chemical toxicity calculations)  Vadose zone -GW flow transport model	Analytical analyses for COCs and transport model inputs  Gamma spectrometry and soil moisture field screening	Evaluate direct exposure in vicinity of WMA boundary for MTCA B and C hypothetical risk exposure scenarios; risk evaluation results would support closure decisions	Access to sampling locations; sample size (grams); high rad interference with std methods;
2, 4, 5, and 6	Vadose zone (surface to water table)	COC concentrations and total quantities; vadose-GW flow transport model inputs	Vadose zone -GW flow transport model	Analytical analyses for COCs and transport model inputs  Gamma spectrometry and soil moisture field screening	Evaluate vadose contamination transport to GW pathway with computer model; data and model results would support retrieval (leak allowance) and closure decisions  Establish current COC concentrations and extent of contamination inside WMA to assess possible ICM applications	Same as DS #1 limitations

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Table 3-2. Information Required to Resolve the Decision Statements.

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

In Step 4, the DQO Team identifies the spatial and temporal boundaries of the WMA, as well as practical constraints for the sampling design.

#### 4.1 AREAS OF INTEREST

Define the attributes of the "areas of interest" that apply for each DS. The attributes could relate to media (e.g., soil or groundwater) or waste.

**Table 4-1. Areas of Interest.**

DS #	Population of Interest
1, 4, 5, 6	Soils <4.6 meters (<15 feet) deep within the WMA S-SX boundary (see Figure 4-1) <ul style="list-style-type: none"> <li>• Northeast quadrant of the S Farm (tanks S-101 through S-106; the area east of tanks S-101 and S-104)</li> <li>• the area between the S and SX Tank Farms</li> <li>• the northern two rows of tanks (SX-101 through SX-106) in the SX Farm</li> </ul>
2, 4, 5, 6	Vadose zone soils (surface to water table) within the WMA S-SX boundary (see Figure 4-2) <ul style="list-style-type: none"> <li>• the southeast quadrant of tank S-104</li> <li>• under tank SX-108, SX-109, and SX-107 (in order of information importance)</li> </ul>
3	Groundwater within the WMA S-SX boundary (SE quadrant of tank S-104; see Figure 4-3). Groundwater outside the WMA S-SX boundary associated with other waste sites that may influence WMA S-SX groundwater quality (e.g., 216-S-25 see Figure 4-3).

#### 4.2 ZONES WITH HOMOGENEOUS CHARACTERISTICS

Table 4-2 documents the zones within the WMA that have relatively homogeneous characteristics. These zones were identified by using existing information to segregate the elements of the areas of interest into subsets that have relatively homogeneous characteristics, such as types of contaminants.

**Table 4-2. Zones With Homogeneous Characteristics.**

DS	Area of Interest	Zone of Interest	Homogeneous Characteristic Logic
1, 4, 5, 6	Surface soil Soils <4.6 meters (<15 feet) deep within the WMA S-SX boundary	Northeast quadrant of S Farm (tanks S-101 through S-106 plus the area east of S-101 and S-104)	Similar waste source within the zone of interest
		Area between the S & SX Farms	Similar waste source within the zone of interest
		Northern two rows of tanks (SX-101 through SX-106) in the SX Farm	Similar waste source within the zone of interest
2, 4, 5, 6	Vadose zone soil Vadose zone soils (surface to water table) within the WMA S-SX boundary	Southeast quadrant of S-104	Tank S-104 release plume
		Near SX-107, SX-108, SX-109, SX-111, and SX-112	Similar waste source within the zone of interest
3	Ground-water Groundwater within the WMA S-SX boundary Groundwater outside the WMA S-SX boundary	SE quadrant of tank S-104	S-104 release plume
		Near 216-S-25	Liquid discharge at 216-S-25

### 4.3 SPATIAL AND TEMPORAL BOUNDARIES

Table 4-3 documents the spatial (areas or volumes for which remediation/regulatory compliance decisions apply) and temporal boundaries (e.g., days, months, or years) that apply to each DS.

**Table 4-3. Spatial Scale and Temporal Boundaries for Decision Making.**

DS	Spatial Scale	Temporal Bound
1, 2, 4	Within the WMA S-SX boundary	1,000 years for risk evaluations
3, 5, 6	Within the WMA S-SX, the 200 Area exclusive, the 200 Area buffer zone, and the Columbia River boundaries	1,000 years for risk evaluations

#### 4.4 PRACTICAL CHARACTERIZATION CONSTRAINTS

Table 4-4 documents constraints that may affect data collection (e.g., worker safety issues, equipment limitations, or existing infrastructure interference).

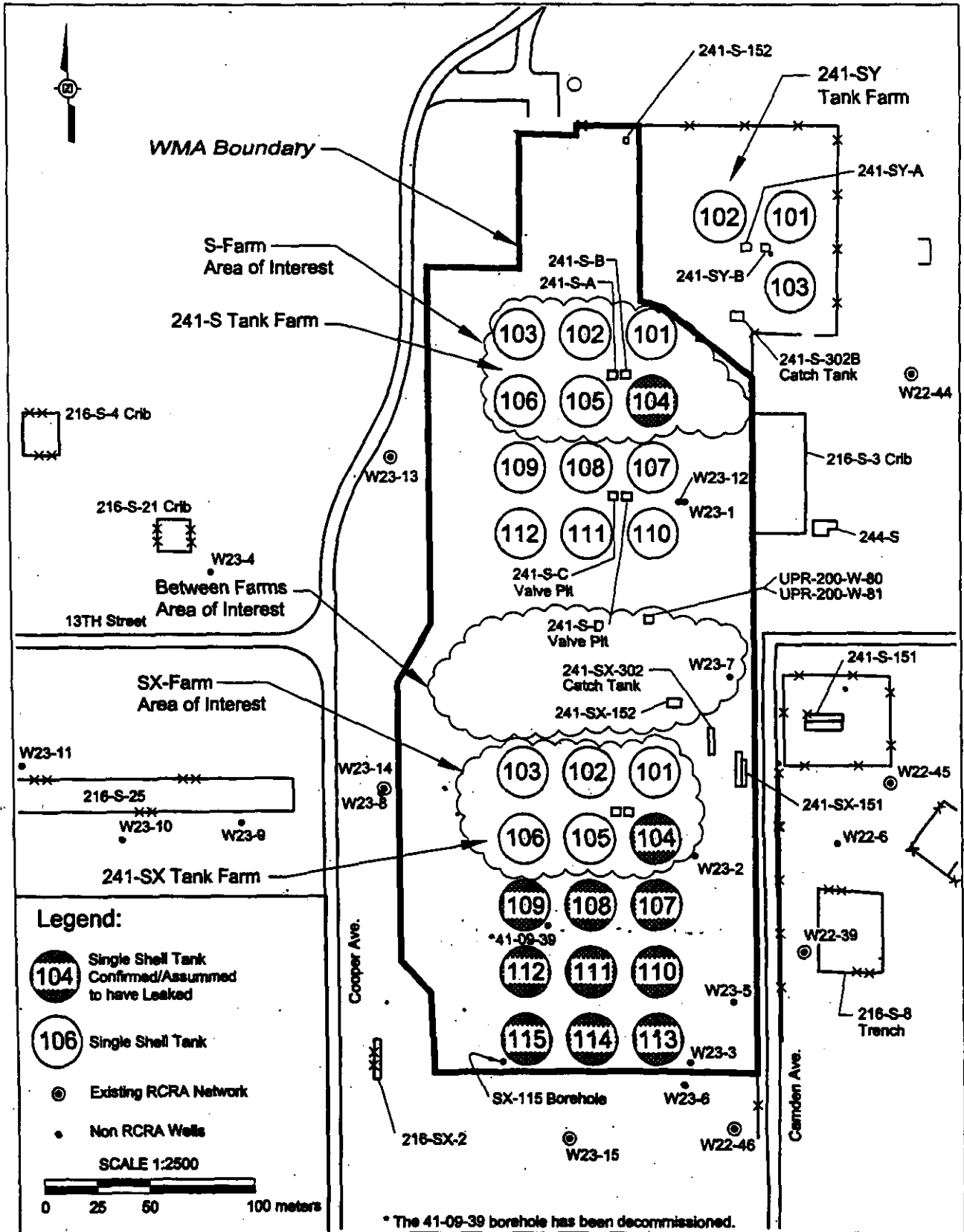
**Table 4-4 - Practical Constraints on Data Collection.**

Constraint	Details
Physical Access	<p>Drilling near a tank not located at the perimeter of the grouping or not accessible from directly outside the perimeter fencing will pose additional access challenges due to:</p> <ul style="list-style-type: none"> <li>• Dome loads imposed on multiple surrounding tanks</li> <li>• More potential tank system equipment interactions</li> <li>• Limited access routes to drilling location</li> <li>• Limited equipment staging areas</li> <li>• More complicated/difficult to "down post" radiation status (if desired)</li> </ul>
Tank Dome Loads	<p>Tank dome loads will need to be maintained within the allowable load limits for the affected tank(s). An assessment will be performed to consider all loads from:</p> <ul style="list-style-type: none"> <li>• Equipment and material weights</li> <li>• Drilling and casing pulling operations</li> </ul> <p>A detailed engineering evaluation may be required to complete the assessment depending on the proposed equipment and methods used near the affected tank(s) and the complexity of the loads.</p>
Drilling and Decommissioning Method	<p>The methods used to drill and decommission each borehole will influence:</p> <ul style="list-style-type: none"> <li>• Operational controls required (e.g., industrial safety, Authorization Basis)</li> <li>• Number of support personnel required (e.g., operators, HP technicians)</li> </ul> <p>Accident and consequence potential (amend Authorization Basis?)</p>
Radiological Control	<p>Radiological issues that could impact the ability to perform the work involve:</p> <ul style="list-style-type: none"> <li>• Handling of contaminated sediment samples (high radiation)</li> <li>• Handling of drill cuttings (depending on drilling method used)</li> <li>• Equipment contamination potential</li> <li>• Use of restrictive personal protective equipment</li> </ul> <p>Ability to "down post" radiological area status</p>
Authorization Basis	<p>Depending on the drilling location and method, Authorization Basis accident frequency and/or consequences may be affected (determined by an Unreviewed Safety Question review). If so, additional analyses may need to be performed. An Authorization Basis amendment may be needed, which will require DOE approval.</p>
Notice of Construction	<ol style="list-style-type: none"> <li>1. The NOC covers activities associated with vadose zone characterization within the SST Farms (200-East &amp; West Areas). NOC characterization activities include drilling and sampling subsurface soil to the depth of groundwater (no mention of non-drilling or groundwater sampling).</li> <li>2. The NOC appears to bound characterization activities by a hypothetical maximally exposed individual receiving a dose of 7.03E-02 mrem per year. This dose is based on an assumed maximum of 10 equivalent boreholes per year (within a consecutive 12-month time frame).</li> <li>3. Assumptions describing the process, emission control, monitoring systems, and release rates are presented as the basis for the NOC (see Sections 6-10).</li> </ol>

**Table 4-4 - Practical Constraints on Data Collection.**

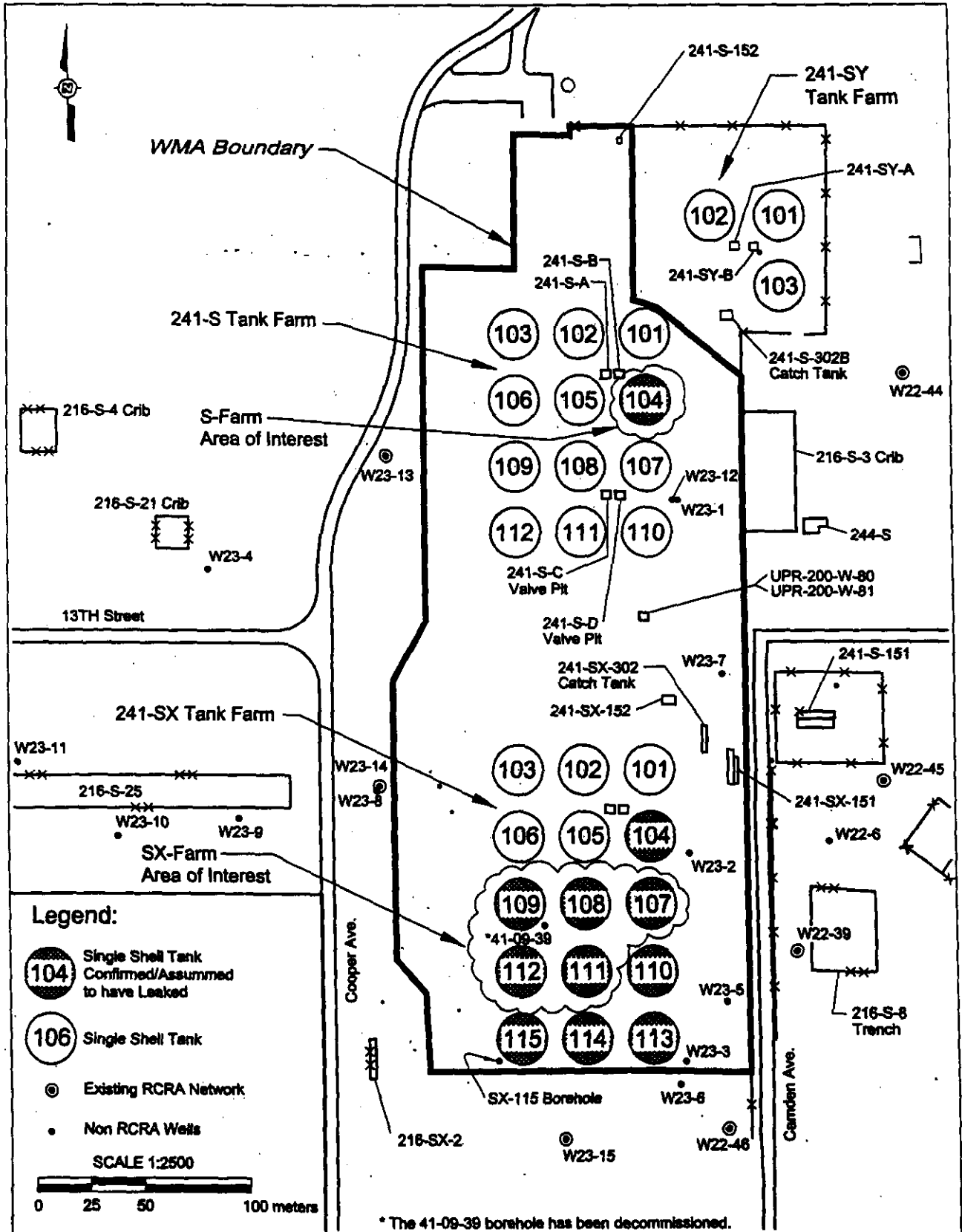
<b>Constraint</b>	<b>Details</b>
Waste Management Requirements	The management of characteristic wastes (e.g., drill cuttings). All waste generated in the WMA is assumed to be "listed" and is stored at the CWC for later disposal. CWC has waste characterization, packaging, and transport requirements that must be addressed.

Figure 4-1. Waste Management Area S-SX (Shallow Soil Areas of Interest).



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Figure 4-2. Waste Management Area S-SX. (Vadose Soil Areas of Interest)



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## 5.0 STEP 5 -- DEVELOP DECISION RULES

In Step 5, selected information from Steps 1 through 4 is typically combined with statistical parameters of interest and the preliminary corrective measure performance standards to describe actions that may be taken based on the information collected. However, for the WMA S-SX characterization, there are no statistical parameters of interest. New data plus process knowledge and historical information will be used to develop data inputs to support risk evaluations. Therefore, the decision rules have been developed using the geographical and temporal boundaries, the S and SX Farm zones of interest, and the preliminary corrective measure performance standards.

### 5.1 SCALE FOR DECISION-MAKING

Table 5-1 combines the spatial scale and temporal boundaries.

**Table 5-1. Scale for Decision-Making.**

DS	Scale of Decision Making
1, 2, 4	Within the WMA S-SX boundary for 1,000 years for risk evaluations
3, 5, 6	Within the WMA S-SX boundary, within the 200 Area exclusive boundary, within the 200 Area buffer zone boundary, and within the Columbia River boundary for 1,000 years for risk evaluations

### 5.2 DECISION RULES

Table 5-2 combines the scale for decision-making, preliminary corrective measure performance standards, and alternative ICMs into IF...THEN... statements or "decision rules" (DRs). DSs can have one or more DRs.

**Table 5-2. Decision Rules.**

DS#	DR#	Decision Rule
1, 4	DR-1	IF the top 4.6 meters (15 feet) of soils from the three areas of interest within WMA S-SX do not achieve preliminary corrective measure performance standards for the next 1,000 years, THEN an RFI/CMS should be conducted to identify, evaluate, and (as appropriate) implement appropriate ICMs.
2, 4	DR-2	IF vadose zone soils (surface to water table) from the two areas of interest within WMA S-SX do not achieve preliminary corrective measure performance standards for the next 1,000 years, THEN an RFI/CMS should be conducted to identify, evaluate, and (as appropriate) implement appropriate ICMs.
3	DR-3	There are no decision rules associated with DS #3. Information developed during the WMA S-SX characterization that would be useful in addressing tank farm closure, GW/VZ Project, and other RPP issues would be provided to the appropriate project teams to support their decision-making efforts through RCAP-specific interfaces.
5	DR-4	There are no decision rules for DS # 5. Information developed during the WMA S-SX characterization that would be useful in addressing tank farm retrieval, GW/VZ Project, and other RPP issues would be provided to the appropriate project teams to support their decision-making efforts through RCAP-specific interfaces.
6	DR-5	There are no decision rules associated with DS # 6. Information developed during the WMA S-SX characterization that would be useful in addressing tank farm closure, GW/VZ Project, and other RPP issues would be provided to the appropriate project teams to support their decision-making efforts through RCAP-specific interfaces.

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

Analytical information provides only an estimate of true WMA conditions, so decisions based on analytical information can be in error, this is known as "decision error." For this reason, Step 6 is typically used to define tolerable limits on the probability of making decision errors. However, the data developed in the Phase 1 WMA S-SX characterization will not be used by itself to make decisions with substantial consequences. Instead, the WMA S-SX characterization data will be used to fill key data gaps and will be combined with existing information to support decisions regarding ICM applications, retrieval limitations, and closure requirements. Therefore, the portions of Step 6 that are applicable to this DQO effort have been used. The reasons specific sections were not applicable are also presented.

### **6.1 CONCENTRATION RANGES**

Table 1-4 (attached at the end of Step 1) defines the laboratory precision and accuracy for each COC. The soil and groundwater data developed through the WMA S-SX characterization will not be compared to media cleanup standards (e.g., MTCA B soil criteria) to establish whether ICMs are required at WMA S-SX or the WMA S-SX can be closed. Rather, the information developed will be used to assess human health and ecological risk under MTCA B and C exposure scenarios at four hypothetical compliance points (WMA, 200 Area exclusive, 200 Area buffer zone, and Columbia River boundaries). The characterization results, vadose zone and groundwater transport modeling efforts, and the risk evaluations will support ICM selections, waste retrieval decisions, and WMA S-SX closure requirements.

### **6.2 HYPOTHESIS TESTING**

Hypotheses regarding conceptual site waste distribution models will be tested through the WMA S-SX Phase 1 characterization.

### **6.3 SAMPLING DESIGN**

Statistical or nonstatistical sampling designs for each DS are documented in Table 6-1.

**Table 6-1. Selected Sampling Design.**

DS#	Severity of Decision Error	Sampling Phase	Sampling Design (Statistical or Non-Statistical)	Justification
1, 2, 3, 4, 5, 6	Low	Phase 1	Non-statistical	The ICM decisions, retrieval decisions, closure decisions, and the vadose-GW flow transport codes the WMA S-SX characterization information will support do not require a statistical sampling approach.

#### 6.4 TOLERABLE DECISION ERROR

A statistical sampling design is not proposed for the WMA S-SX characterization, so a tolerable decision error was not developed.

## 7.0 STEP 7 -- OPTIMIZE THE DESIGN

In Step 7, alternative characterization designs are documented that meet the needs specified in DQO Steps 1 through 6. The most resource-effective design that satisfies the data quality requirements can then be selected.

### 7.1 NON-STATISTICAL SAMPLING

Tables 7-1, 7-2, and 7-3 are for DSs that can be resolved without a statistical approach. These tables identify alternative sampling approaches, select the preferred sampling approach, and present the final sampling design.

#### 7.1.1 Field Screening Methods

The following table summarizes field screening data collection techniques (e.g., with hand-held field instruments) for the WMA S-SX characterization effort.

**Table 7-1. Summary of Field Screening Method Alternatives.**

DS#	Media	Screening Technology	Implementation Design	Comments	Relative Cost
1, 2, 4, 5, 6	Shallow and vadose zone soils	Gamma spectrometry	In situ probes in new or current boreholes inside the WMA	Gross gamma; current sampling data already exists inside the WMA	Low
		Soil moisture (neutron probe)	In situ probes in new or existing boreholes inside the WMA	Limited sampling data exists inside the WMA	Low
1, 2, 4, 6	Shallow and vadose zone soils	Gamma spectrometry	In situ probes in new or current boreholes outside the WMA	Gross gamma; may provide Cs-137 extent information	Low
		Soil moisture (neutron probe)	In situ probes in new or existing boreholes outside the WMA	No sampling data exists outside the WMA	Low
3, 4, 5, 6	Ground-water	N/A	N/A	No field screening techniques would be suitable for groundwater samples	N/A

## 7.1.2 Sampling Method Alternatives

Table 7-2. Summary of Sampling Method Alternatives.

DS#	Media	Sampling Method	Implementation Basis	Limitations/Advantages	Relative Cost
1, 4, 5, 6	Shallow Soil	Cone penetrometer (CP)	Collect samples for lab analysis when gamma >10 pCi/g; analyze for COCs, gross alpha-beta, and model inputs	Sample size (200 grams) may be inadequate for all analyses; CP cumbersome to move from site to site due to "sled" size/weight; currently authorized for use at WMA S-SX; down-hole gamma would allow sample location ID; sample depth to 50+ feet	Medium
		Hollow-stem auger	Collect samples for lab analysis when gamma >10 pCi/g; analyze for COCs, gross alpha-beta, and model inputs	Authorization Basis amendment needed; more mobile than cone pen; larger sample size than CP possible (>200 g); no down-hole gamma (sample at predetermined depths or continuous sampling); sample depth to 50+ feet	Medium
		GeoProbe	Collect samples for lab analysis when gamma >10 pCi/g; analyze for COCs, gross alpha-beta, and model inputs	Authorization Basis amendment needed; sample depth to 50+ feet; sample size (~80 g) may be inadequate for all analyses; possible Authorization Basis amendment needed; more mobile than CP; no down-hole gamma (sample at predetermined depths)	Medium
		Test pit	Collect samples for lab analysis when gamma >10 pCi/g; analyze for COCs, gross alpha-beta, and model inputs	Depth of excavation limited to 25 feet; unlimited sample size; more mobile than cone penetrometer; operations clearance and Rad Con H&S issues	Medium

**Table 7-2. Summary of Sampling Method Alternatives.**

DS	Media	Sampling Method	Implementation Design	Limitations/Advantages	Relative Cost
2, 4, 5, 6	Vadose zone soil	Vertical borehole at tank S-104	Collect samples when gamma >10 pCi/g; lab analysis for COCs, gross alpha-beta, and model inputs; use sampling/analysis approach developed for the new SX-115 borehole (see Note #3 and Figure 7-3 following Table 7-3).	Placement in SE quadrant of tank is critical to hit plume; H&S issues with sample size due to high radiation; suspected shallow plume (sample with CP, auger, or GeoProbe first—then decide if borehole is needed); Authorization Basis issues	High
2, 4, 5, 6	Vadose zone soil	Slant borehole under tank S-104	Collect samples when gamma >10 pCi/g; lab analysis for COCs, gross alpha-beta, and model inputs; use sampling/analysis approach developed for 41-09-39 borehole decommissioning sampling (see Note #3 following Table 7-3).	No evidence of plume under S-104; H&S issues with sample size due to high rad; suspected shallow plume (sample with CP, auger, or GeoProbe first—then decide if borehole is needed); Authorization Basis issues	High
2, 4, 5, 6	Vadose zone soil	Vertical borehole at tank SX-107, SX-108, SX-109, SX-111, or SX-112	Collect samples when gamma >10 pCi/g; lab analysis for COCs, gross alpha-beta, and model inputs; use sampling/analysis approach developed for the new SX-115 borehole (see Note #3 and Figure 7-3 following Table 7-3).	Existing vertical borehole data available for this area from 09-39 extension and anticipated for SX-115 borehole; H&S issues with sample size due to high rad; Authorization Basis issues	High
2, 4, 5, 6	Vadose zone soil	Slant borehole under tank SX-107, SX-108, or SX-109 (to groundwater)	Collect samples when gamma >10 pCi/g; lab analysis for COCs, gross alpha-beta, and model inputs; use sampling/analysis approach developed for 41-09-39 borehole decommissioning sampling (see Note #3 following Table 7-3).	Placement critical to access plume (best chance is under 108); H&S issues with sample size due to high rad; sidewall sampling issues; little added value in new GW data from this area; 41-09-39 borehole to GW in this area raises vadose-GW transport issues; Authorization Basis issues	High

**Table 7-2. Summary of Sampling Method Alternatives.**

DS#	Media	Sampling Method	Implementation Design	Limitations/Advantages	Reliability
2, 4, 5, 6	Vadose zone soil	Slant borehole under tank SX-107, SX-108, or SX-109 (not to groundwater)	Collect samples when gamma >10 pCi/g; lab analysis for COCs, gross alpha-beta, and model inputs; use sampling/analysis approach developed for 41-09-39 borehole decommissioning sampling (see Note #3 following Table 7-3).	Placement critical to access plume (best chance is under 108); H&S issues with sample size due to high rad; sidewall sampling issues; less expensive than slant borehole to groundwater (shorter hole); Authorization Basis issues.	High
2, 4, 5, 6	Vadose zone soil	Existing caisson access under tank SX-107, SX-108, or SX-109	Horizontal GeoProbe, CP, or auger deployment from inside existing caissons.  Collect samples when gamma >10 pCi/g; lab analysis for COCs, gross alpha-beta, and model inputs.	Existing caissons provide access to all 3 tanks; H&S issues with caisson temperature, confined space, and potential dose; technical issues with horizontal sampling; Authorization Basis issues; structural integrity of caisson may not support sampling.	High
2, 4, 5, 6	Vadose zone soil	Extend existing drywell at tank SX-108 (41-08-07)	Collect samples when gamma >10 pCi/g; lab analysis for COCs, gross alpha-beta, and model inputs; use sampling/analysis approach developed for decommissioning sampling at 41-09-39 (see Note #3 after Table 7-3).	Existing vertical borehole data available for SX area from 41-09-39 extension and anticipated for SX-115 borehole; H&S issues with sample size for high rad; Authorization Basis issues.	High
4, 6	Shallow and vadose zone soil	Characterize S-25 crib	TBD by Hanford ER Program with WMA S-SX RFI/CMS Team input.	Could provide key shallow and vadose zone soil information regarding contaminant sources near WMA S-SX and potential local groundwater impacts from other sources.	Medium

**Table 7-2. Summary of Sampling Method Alternatives.**

DS	Media	Sampling Method	Implementation Design	Limitations/Advantages	Relative Cost
3, 4, 5, 6	Ground-water	Grab sample from borehole S-104	Collect groundwater from S-104 borehole, by extending it to groundwater, once soil sampling is complete.	"Snapshot" of current S Farm groundwater conditions; access to key groundwater area in S Farm.	High
		Grab sample from ERC characterization borehole at 216-S-25	Get groundwater data from ERC 200 Area characterization project (if they extend a borehole to groundwater).	Groundwater data from an area that could influence groundwater within the WMA S-SX boundary.	Low

### 7.1.3 Implementation Design

Table 7-3 presents the selected field screening and sampling methods for resolving each DS, a summary of how the selected methods will be integrated into the final design, and the rationale for the selected methods and design.

**Table 7-3. Selected Implementation Design.**

DS	Screening Technology	Sampling Method	Implementation Design	Rationale
1, 4, 5, 6 Shallow soils	Gamma spectrometry and soil moisture	Hollow stem auger or cone penetrometer	See Note #1 (below)  The general sampling locations are identified on the attached map (Figure 7-1).	Flexible application for shallow soils sample collection; sample in S Farm and between the S and SX Farms during Phase 1. These two areas would fill more key data gaps than the north SX Farm area.

**Table 7-3. Selected Implementation Design.**

DS#	Screening Technology	Sampling Method	Implementation Detail	Rationale
2, 4, 5, & 6 Vadose zone soils	Gamma spec; gross alpha/beta; soil moisture	Slant borehole under tank SX-108 (not to groundwater)	<p>See Note #2 (below)</p> <p>The attached map (Figure 7-2) indicates the preferred orientation of the tank SX-108 slant borehole.</p> <p>Use sampling/analysis approach developed for 41-09-39 borehole decommission sampling. About 10 soil sampling horizons would be selected using the criteria in Note #3 (below).</p> <p>All samples would be conditionally analyzed for the COCs (see Table 1-4) and model inputs based on a screening approach similar to the one developed for the new SX-115 borehole (see Figure 7-3).</p>	<p>A slant borehole under tank SX-108 fills a more critical data gap than a vertical borehole at tank S-104 (plus shallow soil sampling at tank S-104 may adequately define that plume).</p> <p>This slant borehole would access the primary WMA S-SX contaminant plume and is key to ICM, retrieval, and closure decisions.</p> <p>SX-108 slant hole may provide "bed dip" contaminant transport information.</p>
3, 4, 5, 6 Groundwater	N/A	No groundwater sample collection is proposed at this time.	N/A	<p>The most cost effective groundwater samples would be associated with a vadoze soil borehole to groundwater. No such boreholes are proposed and the local groundwater data gaps are not sufficient to merit groundwater wells in addition to those currently monitored or planned by DOE in the WMA S-SX area.</p>

**Note #1:** Of the three areas of interest for shallow vadose zone soil investigation, two areas have been identified for the Phase 1 characterization. These areas include the north end of the S Tank Farm and the area between the S and SX Tank Farms. The S Tank Farm areas of interest include: southeast of the S-104 tank, the UPR near diversion box 241-S-B, and the area east of S-104 near the fence (in the drainage path of the UPR that occurred in the SY Tank Farm and flowed into the S Tank Farm). A major cleanup of the UPR near 241-S-B was conducted and will be reviewed prior to

selecting specific S-Farm sampling locations in the zones of interest identified in Figure 7-1. The area of particular interest between the S and SX Tank Farms is near the location of UPR-200-W-80 and -81. The shallow investigation of these areas would consist of collecting samples at up to six (6) locations. This characterization effort would be conducted from the tank farm surface to about 4.6 meters (15 feet) below ground surface (bgs) using either a cone penetrometer or a hollow-stem auger. Although DS #1 is focused on the upper 4.6 meters (15 feet), both sampling methods have the capability to sample deeper and would be used to collect samples from deeper than 4.6 meters (15 feet) to provide additional data for the remaining DSs.

Sampling and analysis quality assurance/quality control (QA/QC) for the WMA S-SX characterization effort will generally follow the guidelines developed for the new SX-115 borehole and for sampling during the decommissioning of the 41-09-39 borehole (HNF-4380, Rev. 1A; Appendix C). Modifications to this QAPjP may be required to address specific WMA S-SX characterization activities and will be evaluated with the decision-makers.

Cone penetrometer deployment at the shallow zone characterization locations would include the following procedures:

- 1) Up to four pushes per location would be attempted using the existing Cone Penetrometer Platform;
- 2) The spectral gamma tool would be pushed to refusal to target sampling zones (depths) of interest;
- 3) A soil sampling probe would be used for the remaining pushes (up to three) to collect soil samples at depths of interest (soil samples would be collected in regions where gamma contamination was found in excess of 10 pCi/g);
- 4) The samples would be conditionally analyzed for the COCs identified in Table 1-4 plus the modeling inputs identified in Section 1.7.2. Laboratory analysis of all COCs and model parameters could be restricted by sample volume limitations (inability to collect enough soil or sample volume limitations due to high radiation). A screening approach, similar to the one developed for the new SX-115 borehole (see Figure 7-3), would be used to establish sample analysis requirements.

A hollow-stem auger deployment at the shallow zone characterization locations would include the following procedures:

- 1) A single penetration would be made at the location of interest to a target depth of 11 meters (35 feet) or deeper depending on contamination levels;
- 2) Near-continuous samples would be collected;

- 3) The samples would be screened at the surface using gamma spectrometry to identify samples for further analysis. The samples selected for further analysis would be conditionally analyzed for the COCs identified in Table 1-4 plus the modeling inputs identified in Section 1.7.2. Laboratory analysis of all COCs and model parameters could be restricted by sample volume limitations (inability to collect enough soil or sample volume limitations due to high radiation). A screening approach, similar to the one developed for the new SX-115 borehole (see Figure 7-3), would be used to establish sample analysis requirements.

Following approval of the general plan outlined in this DQO report and the Site-Specific Work Plan Addendum, a detailed field work plan would be prepared to identify the number and location of samples to be collected. The detail necessary for this plan has not yet been developed. The detailed planning effort will include a tradeoff between the cone penetrometer and the hollow-stem auger sampling techniques to maximize the number of sampling locations and samples. This plan would be reviewed with the decision-makers prior to implementation. Additionally, the physical and operational constraints will require evaluation prior to identifying specific target locations.

**Note #2:** The final design for the slant borehole under SX-108 has not been completed. One of the primary constraints on sample collection from the "hot" zone under SX-108 is the potential radiation concentration ( $\sim 10^8$  pCi/g), which will limit the sample volumes that can be brought to the surface. To reduce the uncertainties in placing a slant borehole under SX-108, a demonstration is planned outside of the tank farms to evaluate the techniques for installing the borehole and collecting samples. This demonstration will help refine the borehole angle and the sample collection methods. The current planning basis for the slant borehole beneath SX-108 (see Figure 7-2) includes the following:

- The borehole enters the ground at ~11 o'clock position (north-northwest) 40 feet from the edge of the tank nominally 30 degrees from vertical, heading directly across the center of the tank (toward the 5 o'clock position [south-southwest]). A preliminary investigation of surface and subsurface interference has identified this as a potentially viable location. The borehole depth would be limited to the Plio-Pleistocene or to the maximum depth of contamination, whichever is greater.
- Driven samples (shielded split-spoon) or sidewall samples (similar to 41-09-39) would be collected. The samples would be transported to the laboratory and analyzed for the COCs identified in Table 1-4. Nominally, 10 locations/horizons would be sampled based on the geophysical logs or the need to provide depth coverage.

An optional method for collecting samples from the area of interest under tank SX-108 involves pushing a cone penetrometer (or some other sample collection method) out horizontally from an existing caisson. This option has the potential to collect the necessary samples; however, there are a number of issues associated with the

caissons that require further evaluation. A task has been identified in the FY00 plan to evaluate the feasibility of using the caissons for sample collection under tank SX-108.

Sampling and analysis quality assurance/quality control (QA/QC) for the WMA S-SX characterization effort will generally follow the guidelines developed for the new SX-115 borehole and for sampling during the decommissioning of the 41-09-39 borehole (HNF-4380, Rev. 1A; Appendix C). Modifications to this QAPjP may be required to address specific WMA S-SX characterization activities and will be evaluated by the decision-makers.

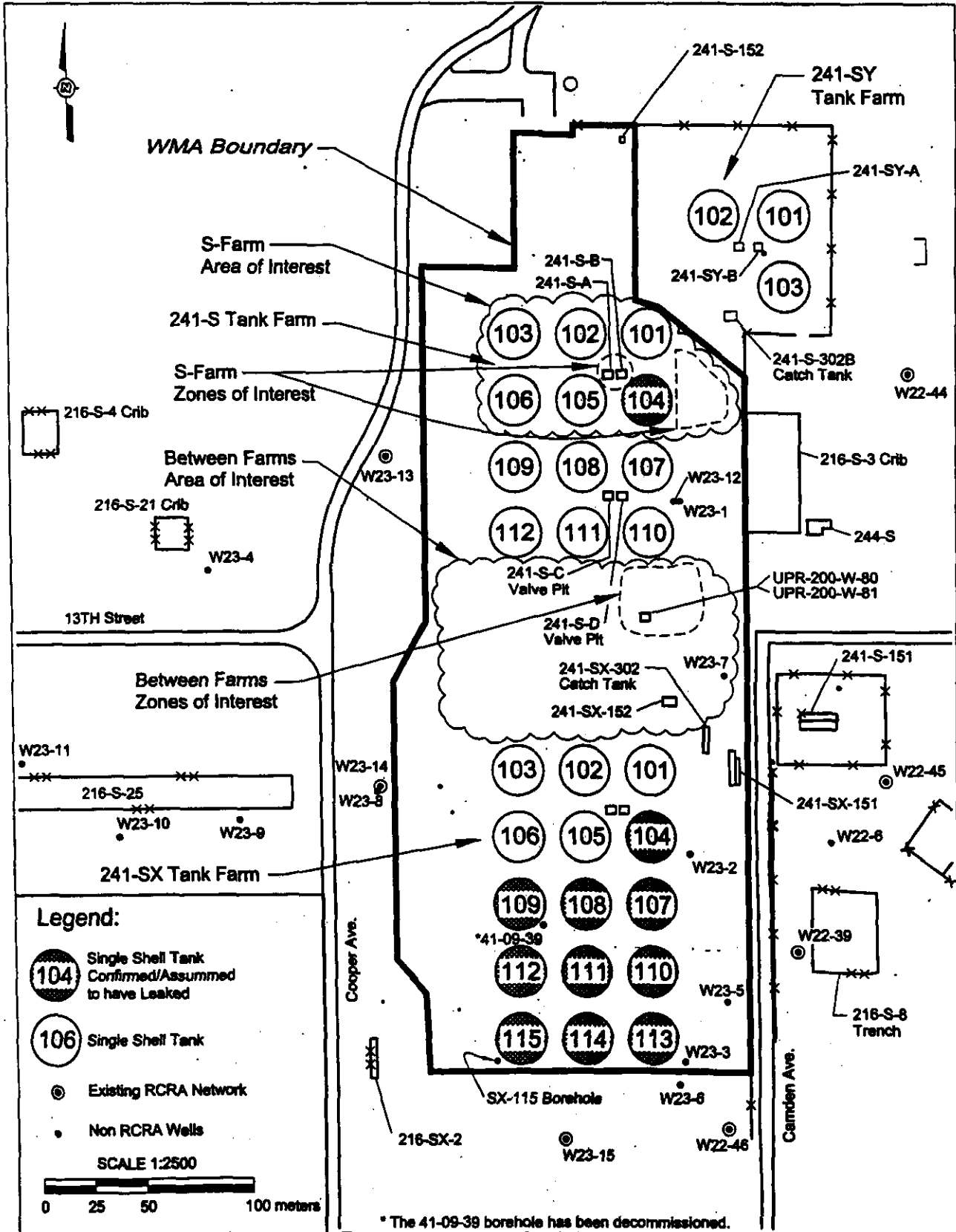
**Note #3:** The following criteria will be used to identify tank SX-108 slant borehole sampling horizons for laboratory analysis:

- One background sample will be taken at 9 meters (30 feet) bgs.
- One sample will be taken at 17 meters (55 feet) bgs, at the level of the tank bottom.
- Two samples will be collected at major lithology changes in the Hanford formation.
- Samples will be taken of any paleosols seen on the drive samples.
- Samples will be taken in locations where elevated or altered gamma surveying or moisture content is measured during the geological/geophysical logging process.
- At least one sample will be taken every 3 meters (10 feet) if samples have not already been taken (based on the above criteria) to ensure continuous distribution and lithologic completeness.

## **7.2 STATISTICAL SAMPLING**

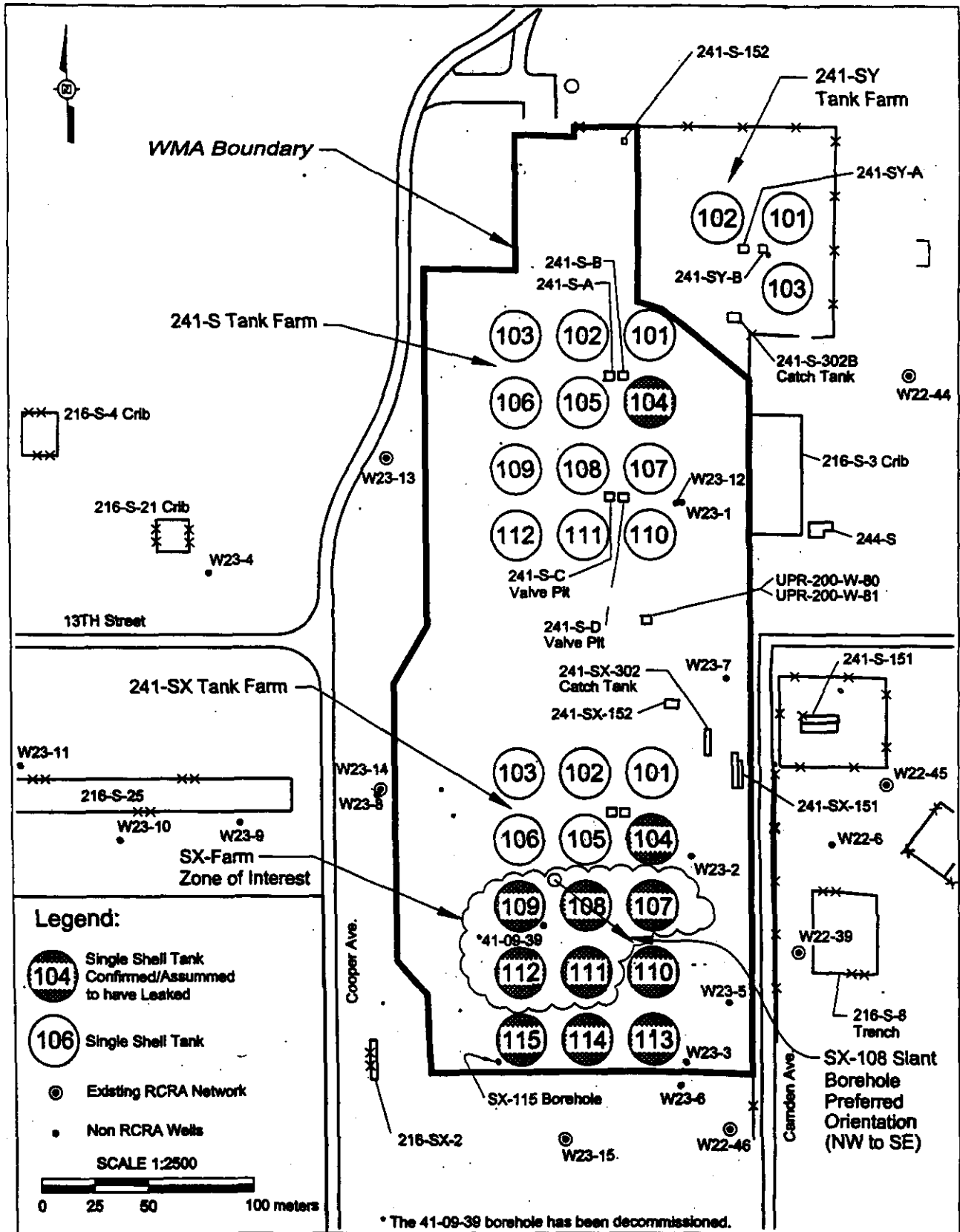
A statistical sampling approach is not proposed for the WMA S-SX characterization.

Figure 7-1. Waste Management Area S-SX. (Shallow Soil Sampling Design)



\* The 41-09-39 borehole has been decommissioned.

Figure 7-2. Waste Management Area S-SX. (Vadose Zone Soil Sampling Design)



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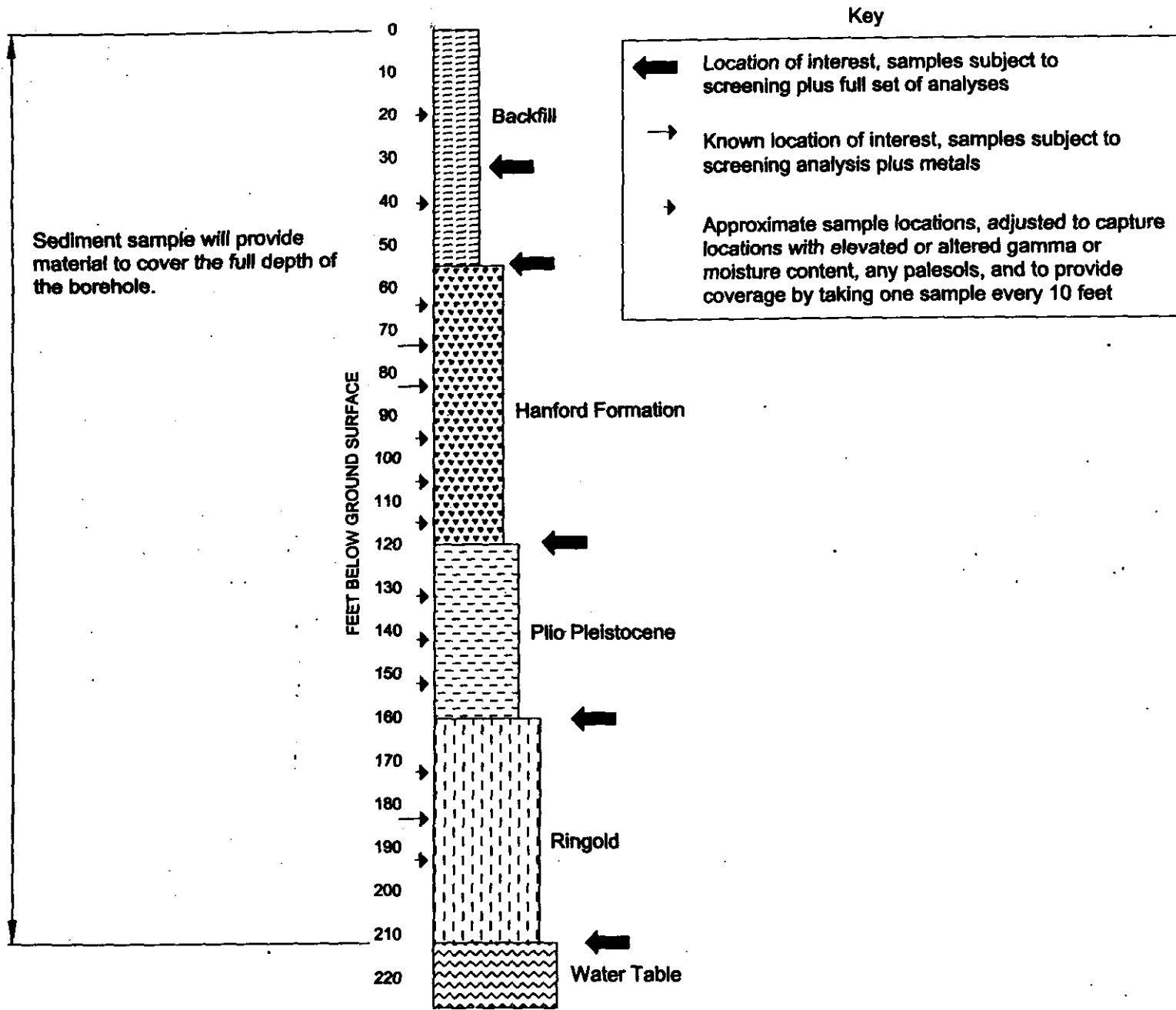


Figure 7-3. SX-108 Slant Borehole Subsample Analyses Strategy.

## 8.0 ANNOTATED REFERENCES

**Table 8-1. Annotated References.**

Reference	Summary
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**Table 8-1. Annotated References.**

Reference	Summary
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**Table 8-1. Annotated References.**

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Table 8-1. Annotated References.

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**Table 8-1. Annotated References.**

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