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SITE-SPECIFIC SST PHASE 1 RFI/CMS WORK PLAN ADDENDUM FOR WMA S-SX

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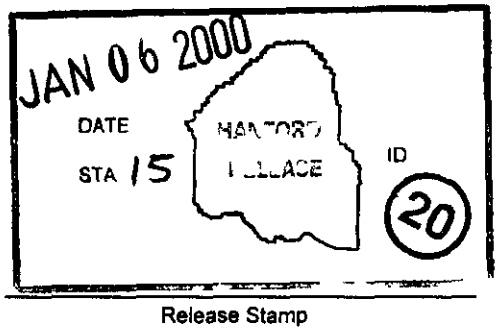
Richland WA 99352
U S Department of Energy Contract DE AC06 99RL14047

EDT/ECN ~~627984~~ 657725 UC 2010
Cost Center 73500 Charge Code 106497AJ60 ja HMLMO351
B&R Code EW3130010 Total Pages 127

Key Words Vadose Zone RFI/CMS Work Plan, WMA S-SX Characterization

Abstract This Site-Secific Waste Management Area S-SX RFI/CMS Work Plan Addendum addresses vadose zone characterization plans for collecting and analyzing soil samples from WMA S-SX



James Aardal 1-6-00
Release Approval Date

Release Stamp

Approved For Public Release

RECORD OF REVISION

(1) Document Number: HNF-5085

Page OA

(2) Title: SITE-SPECIFIC SST PHASE 1 RFI/CMS WORK PLAN ADDENDUM FOR WMA S-SX

Change Control Record

(3) Revision	(4) Description of Change Replace Add and Delete Pages	Authorized for Release		
		(5) Cog Engr	(6) Cog Mgr	Date
0	(7) Initially released ~~4/26~~ 10/20/99 on EDT 627984	JCH	A J Knepp	
0A RS	Incorporated per ECN-657725	JC Henderson	AJ Knepp	1 5 00

A 7320 005 (10/97)

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December 1999

Prepared for
U S Department of Energy
Office of River Protection

Prepared by
Lockheed Martin Hanford Corporation

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LIST OF TERMS

bgs	below ground surface
CMS	corrective measures study
CoCs	contaminants of concern
DOE	U S Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
HWMA	Hazardous Waste Management Act
ICM	interim corrective measures
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	reduction-oxidation
RFI	RCRA Facility Investigation
SAP	sampling and analysis plan
SST	single shell tank
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and/or disposal
WMA	waste management area

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1 0 INTRODUCTION

This Site-Specific Single-Shell Tank (SST) Phase 1 *Resource Conservation and Recovery Act of 1976* (RCRA) Facility Investigation/Corrective Measures Study (RFI/CMS) Work Plan Addendum for Waste Management Area (WMA) S-SX has been prepared to collect field characterization data in and near WMA S-SX to support RFI/CMS decision making This WMA S-SX addendum is necessary to identify and plan characterization efforts as part of an RFI The initial field characterization efforts implemented in fiscal year 1999 (HNF-4380) included the collection of vadose zone and groundwater data from the following

- Installation of a new borehole southwest of tank SX-115 (well number B8809)
- Decommissioning of borehole 41-09-39
- The installation of three proposed RCRA groundwater monitoring wells

Documented in this WMA S-SX addendum are the agreements made through a data quality objectives (DQO) process These agreements include the tasks, project responsibilities, and schedule for the next characterization effort to fulfill proposed Milestone M-45-52 (Ecology et al 1999) The field characterization efforts include the collection of vadose zone data from the following

- Installation of a slant borehole under tank SX-108
- Shallow vadose zone soil investigations in the north end of the S tank farm

1 1 BACKGROUND

The Hanford Federal Facility Agreement and Consent Order (Ecology et al 1998), commonly referred to as the Tri-Party Agreement, that is signed by the Washington State Department of Ecology (Ecology), the U S Environmental Protection Agency, and the U S Department of Energy (DOE), addresses cleanup at more than 2,000 waste disposal and unplanned release sites on the Hanford Site Some of these sites are treatment storage, and/or disposal (TSD) units that have been grouped into WMAs for the purpose of groundwater monitoring Included in the WMAs are 149 SSTs that are TSD units regulated under Washington's Hazardous Waste Management Act (HWMA) (Chapter 70 105 Revised Code of Washington) and its implementing requirements (Washington's Dangerous Waste Regulations in WAC 173-303)

The SSTs currently are operating under interim status pending closure The tank farms will be closed under the HWMA and Major Milestone series M-45-00 of the Tri-Party Agreement (Ecology et al 1998) The 149 SSTs are grouped into 12 SST farms, which are in turn grouped into 7 WMAs for purposes of HWMA groundwater assessment and monitoring To date, tank leaks and past practice releases of tank waste including dangerous waste and dangerous waste constituents have resulted in groundwater contamination documented at four of the seven SST WMAs (i e , WMA S-SX B-BX-BY, T, and TX-TY) The DOE has initiated a corrective action program to address the impacts of past and potential future tank waste releases to the environment A Phase 1 RFI/CMS work plan (DOE/RL-99-36) has been issued that establishes

the overall framework and requirements for the program This addendum presents details specific to WMA S-SX

The investigation activities outlined in this WMA S-SX addendum will be managed by the Tank Farm Vadose Zone Project as an integrated function of the Hanford Site Groundwater/Vadose Zone Integration Project This WMA S-SX addendum is a Tri-Party Agreement primary document submitted to Ecology for review and approval pursuant to proposed Milestone M-45-52 (Ecology et al 1999)

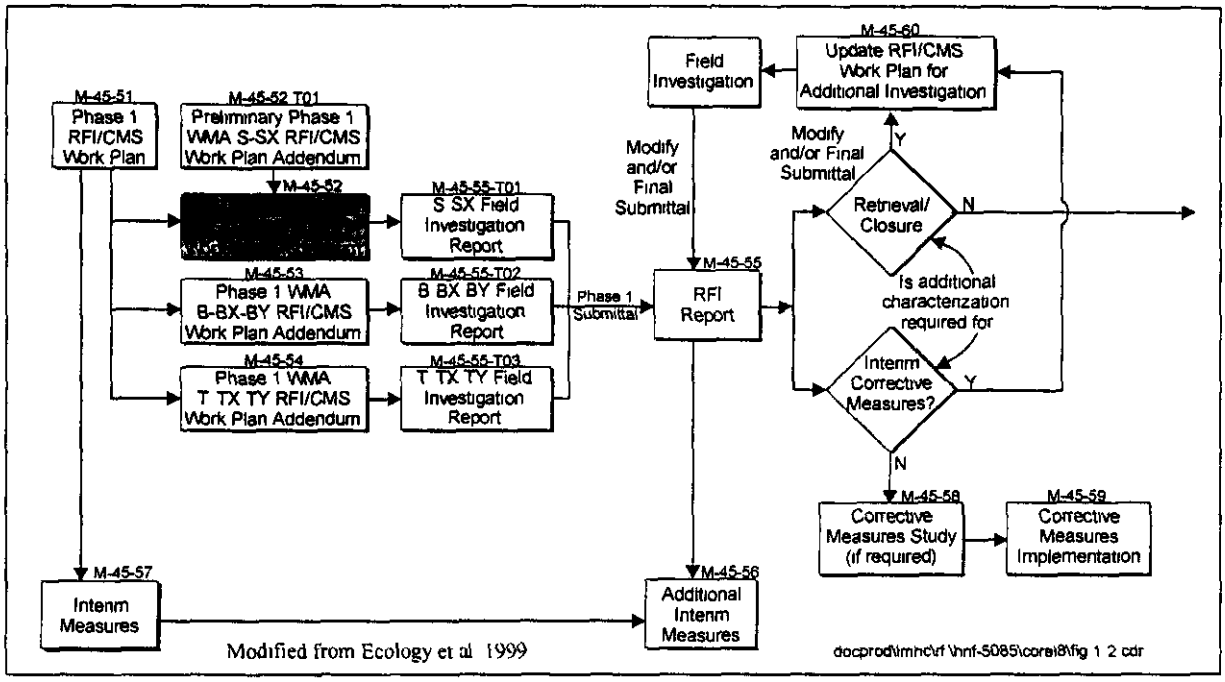
The WMA S and SX tank farms are regulated under HWMA interim status regulations (WAC 173-303-400) (Figure 1 1) The S and SX tank farms comprise WMA S-SX, which was placed in assessment groundwater monitoring in August 1996 because of elevated specific conductance and technetium-99 in downgradient monitoring wells (WHC-SD-EN-AP-191) Technetium-99 and nitrate are the only constituents to have exceeded drinking water standards The drinking water exceedances in the RCRA-compliant monitoring wells are currently limited to two wells (299-W22-45 and 299-W22-46) located along the southeast side of the SX tank farm (see Section 3 1 3)

In fiscal year 1995 spectral gamma logging (i e collection of baseline gamma-specific radioisotope information in the upper vadose zone) was completed at the SX tank farm Spectral gamma logging was completed at the S tank farm in fiscal year 1996 The spectral gamma logging program builds on a previous program in which gross gamma data were collected as a means of leak detection from the SSTs Both programs used the network of drywells installed around each tank in each SST farm In July 1996, the final report on spectral gamma logging at the SX tank farm (GJPO-HAN-4) indicated contaminant cesium-137 at a maximum depth of 43 m (140 ft) below ground surface (bgs) near tank SX-102 and contaminants at depths of 39 6 m (130 ft) bgs near tanks SX-108 and SX-109 In February 1998, the final report on spectral gamma logging at the S tank farm (GJO-HAN-11) indicated contaminants cesium-137 cobalt-60, and europium-154 at a maximum depth of 18 3 m (60 ft) bgs near tank S-102 and cesium-137 at depths of 29 m (95 ft) bgs near tank S-104 The network of drywells installed around each tank was intended for leak detection and was generally installed between depths of 22 8 m and 45 7 m (75 to 150 ft) bgs, thus the maximum detection depth is limited by the drywell depth

In 1996 a panel was formed to evaluate issues associated with vadose zone contamination in the tank farms Following a review of available data, the panel recommended a series of measures to improve characterization of the vadose zone and recommended installation of new boreholes in the SX tank farm to address issues associated with contaminant migration through preferential pathways (e g boreholes) and through the formation (DOE/RL-97-49, DOE/RL-98-G7) Two new drywells were installed (drywells 41-12-01 and 41-09-39), and in 1997 drywell 41-09-39 was extended from 39 6 m (130 ft) to below the water table at a depth of 69 m (225 ft) bgs (HNF-2855) Spectral gamma surveying determined that drag down of contaminants in the initial drywell (41-12-01) was occurring during drilling and that the drag down could be reduced by modifying the drilling techniques Improved drilling techniques were adopted for drywell 41-09-39 which minimized drag down The extension of drywell 41-09-39 indicated that from 40 to 41 m (131 to 134 ft), the concentration of cesium-137 decreases by over four orders

The initial sequence of investigations includes initiation of preliminary characterization efforts in fiscal year 1999 in WMA S-SX based on the preliminary addendum (HNF-4380) and characterization of the remainder of WMA S-SX (this addendum) (Figure 1 2) followed by characterization of WMAs B-BX-BY, T, and TX-TY All of these efforts will be based on the Phase 1 RFI/CMS work plan (DOE/RL-99-36) and site-specific SST Phase 1 RFI/CMS work plan addenda for WMAs (proposed Milestones M-45-52 M-45-53, and M-45-54)

Figure 1 2 Proposed Tri-Party Agreement Milestones for Corrective Actions



Negotiations between DOE and Ecology resulted in a plan in which preliminary characterization data were collected in fiscal year 1999 from WMA S-SX In April 1999, Lockheed Martin Hanford Corporation submitted the preliminary work plan addendum to "enable initial field work and borehole installation to commence in Fiscal Year 1999 ' (HNF-4380)

- DOE and Ecology decided to proceed with characterization efforts in WMA S-SX first because, of the four WMAs, more information is available for WMA S-SX based on recent investigations and existing DOE plans including decommissioning of borehole 41-09-39 during fiscal year 1999 (HNF-SD TRW PD-001) Within WMA S-SX the most information is available regarding past releases within the SX tank farm (GJPO-HAN-11, HNF-2855, HNF-2603, LA-UR 96-3537 and PNNL-11810) In addition much more work has been done in the SX tank farm in evaluating historical data compared to any other tank farm

1 2 SCOPE OF ACTIVITIES

The follow-on characterization effort at WMA S-SX for this addendum will address the following

- Slant borehole beginning from the northwest and directed under tank SX-108 to the southeast
- Installation of direct pushes in the northern portion of S tank farm for near-surface characterization

This scope of activities supports the following objectives (1) ongoing characterization activities in the SX tank farm (2) development of a best-estimate of the concentration and distribution of contaminants of concern (CoCs) in WMA S-SX, (3) refinement of a conceptual model for concentration, distribution, and mobility of contaminants in WMA S-SX, (4) quantifying the risks posed by migration of past tank releases to the groundwater if no interim corrective measures (ICMs) are implemented, and (5) determination whether interim measures or ICMs would effectively contribute to the mitigation of contaminant migration to groundwater to levels that would not pose unacceptable risk to human health and the environment before tank farm closure Risk assessments conducted in support of retrieval and closure decisions will be performed in the future and will include the potential contribution or reduction in risk as a result of ICMs

1 3 PURPOSE AND OBJECTIVE

The Phase 1 RFI/CMS work plan (DOE/RL-99-36) established the objectives of the characterization effort for the four WMAs that are a part of the RCRA corrective action process The objectives of this WMA S-SX work plan addendum are as follows

- Support the Phase 1 RFI/CMS work plan objectives
- Provide WMA-specific information on contamination
- Provide WMA-specific characterization programs to address information gaps identified through a DQO process

The DQO process was completed from August through September 1999 (HNF-5272) The DQO process included participation by Ecology and DOE (the decision makers), the Hanford Site Vadose Zone/Groundwater Integration Project, and Hanford contractors Meetings held as part of the DQO process involved varying levels of involvement by all participants Meetings were held between the decision makers with input from Site contractors and DQO process participants

The DQO process (HNF-5272) resulted in identification of activities to collect vadose zone data to support the objectives outlined in Section 1 2 and in this section The process included meetings to complete a review of existing data, define the problem, identify and prioritize decisions, identify the input required to make decisions, and boundaries for the decisions The meetings also addressed decision rules and uncertainty and sampling and analysis alternatives The focus of the DQO process for the WMA S-SX addendum was on sampling and analysis alternatives These alternatives and the decisions made by Ecology and DOE based on the alternatives are documented in Chapter 4 0 and HNF 5272

The overall objectives of the investigation efforts identified in this addendum are as follows

- Collect data to support an improved understanding of the nature and extent of contaminants in the vadose zone from surface to approximately 39 6 m (130 ft) bgs or maximum depth of contamination, whichever is deeper

- Collect data to support an improved understanding of vadose zone parameters affecting contaminant fate and transport required to perform risk assessments

1 4 SELECTION OF FIELD ACTIVITIES

Based on input from Ecology and DOE, and input from the DQO participants, the characterization activities in support of the objectives and data needs identified for the WMA S-SX addendum are illustrated in Figure 1 3 The following summarize the decisions reached by Ecology and DOE based on the DQO process

- **Shallow vadose zone soil investigation** – This investigation will collect sediment samples via direct push technology in the northern portion of the S tank farm The shallow investigation will consist of collecting sediment samples at approximately nine areal locations between the ground surface and approximately 16 7 m (55 ft) bgs The main emphasis will be on characterizing unplanned releases within these areas of concern Further evaluation of historical data will be used to identify specific sampling target locations

- **Installation of a slant exploratory borehole underneath tank SX-108** – The DQO process resulted in the identification of several potential locations for the proposed new borehole, however, until the analysis of the sediment from borehole 41-09-39 and the new borehole at tank SX-115 are completed, the options that would provide the most new information would be those that involve collecting samples from beneath a tank Because of the large past leak associated with tank SX-108 and the high radiation content, this tank was identified as the best location during the DQO planning process This borehole would be installed to the top of the Plio-Pleistocene unit (39 6 m [130 ft]) or maximum depth of contamination, whichever is deeper

The rational and approach to these decisions are addressed in Section 4 0 of this work plan and in HNF-5272

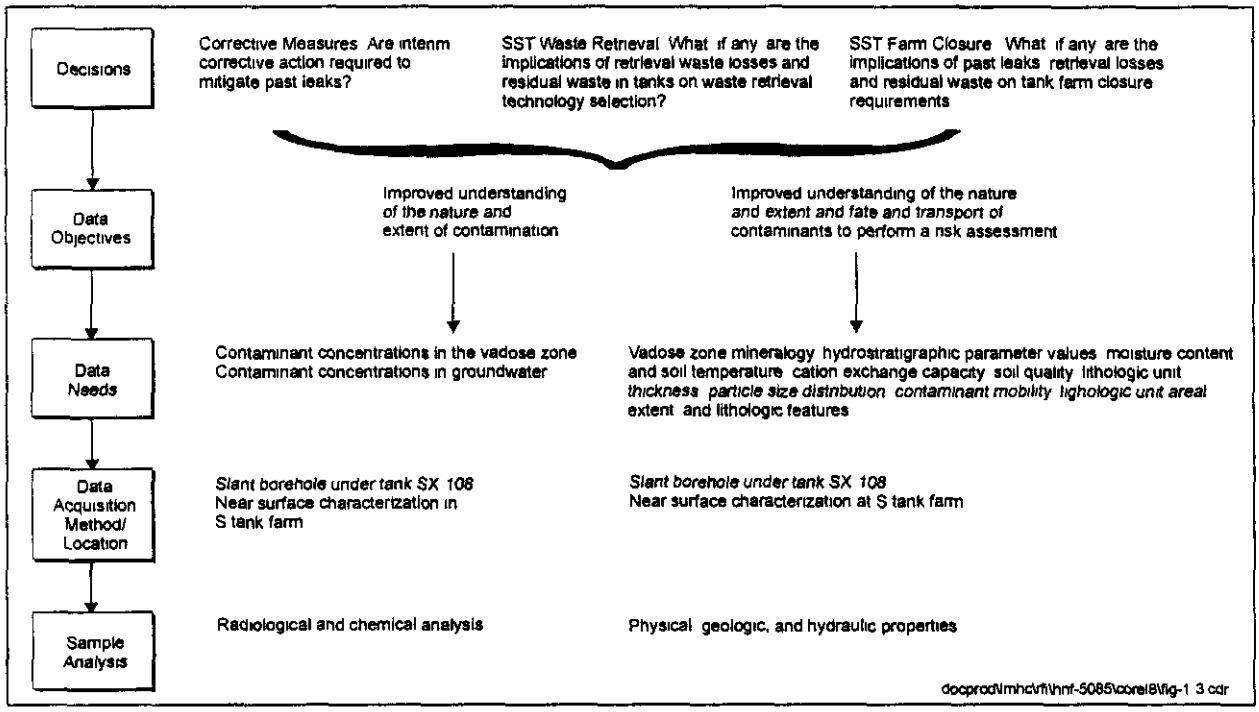
1 5 ORGANIZATION OF THE WMA S-SX ADDENDUM

Nine chapters and one appendix are included in this WMA S-SX addendum The addendum is structured to provide information necessary to continue the field investigations at WMA S-SX in fiscal year 2000 The chapters and appendix include the following

- **Chapter 1 0** – Introduction to the WMA S-SX addendum that provides an overview of the issues and technical approach detailed in the remainder of the addendum

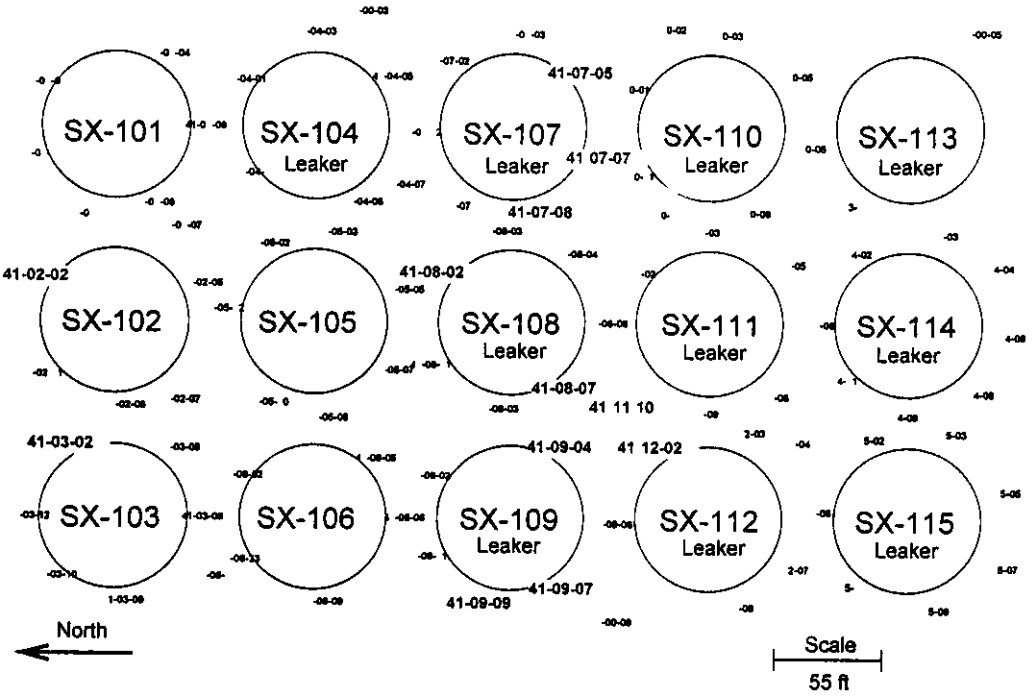
- **Chapter 2 0** – Overview of the physical and environmental setting of WMA S-SX

Figure 1 3 DQO Objectives and Data Needs

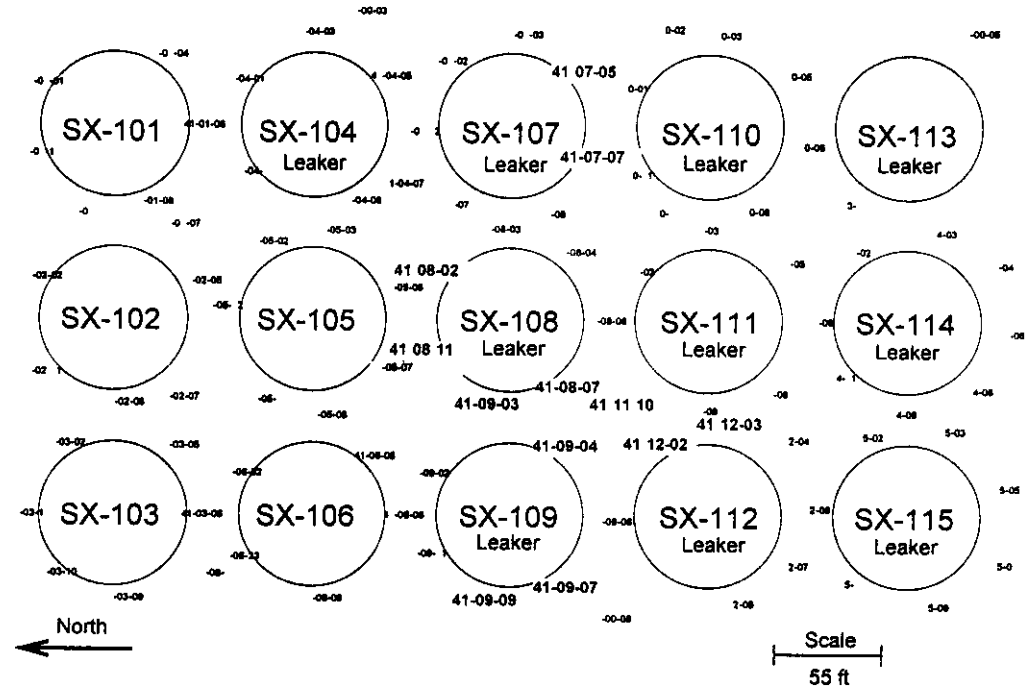


- **Chapter 3 0** – Summary of the available data on potential contaminant exposure pathways that will be used to develop a conceptual exposure pathway model for WMA S-SX needed to assess compliance with Federal and state environmental standards, requirements criteria, or limitations that may be considered potential corrective action requirements, and potential impacts to human health and the environment
- **Chapter 4 0** – Presentation of the rationale and approach for the field investigations
- **Chapter 5 0** – Presentation of the tasks and activities necessary to conduct field investigations
- **Chapter 6 0** – The schedule for the site-specific investigations focused on vadose zone-related aspects of WMA S-SX in accordance with the tasks and activities discussed in Chapter 5 0
- **Chapter 7 0** – Description of the project management tasks necessary to implement the field investigation activities, including responsibilities, organizational structure and project tracking and reporting procedures
- **Chapter 8 0** – References used to develop the WMA S-SX addendum
- **Chapter 9 0** – Glossary of terms that are used in this addendum
- **Appendix A** – Sampling and Analysis Plan

Figure 3 4 Location of Boreholes With Gamma Intensity Readings Between 10 pCi/g and 100 pCi/g and Below 10 7 m (35 ft) in SX Tank Farm



Gamma Contamination > 10 pCi/g and < 100 pCi/g below 35 ft
Bold font represents contamination identified



Gamma Contamination ≥ 100 pCi/g below 35 ft
Bold font represents contamination identified

The spectral gamma logging of borehole 41-09-39 was correlated with borehole 41-09-04 (GJPO-HAN-9) The purpose was to determine if the contamination previously detected in borehole 41-09-04 was in the formation or was simply local to the borehole (i e , borehole contamination) The spectral gamma data confirmed the formation More discussion of the findings is provided in HNF-4380

Borehole 41-09-39 Extension

In 1997, borehole 41-09-39 was extended to the groundwater using the cable tool-drilling method The findings of the extension are discussed in HNF-2855 which is summarized in the following discussion

Cesium-137 was present only above the carbonate-rich zone in the Plio-Pleistocene unit Concentrations of cesium-137 decreased rapidly with increasing depth and, other than material attributed to drag-down or slough from the interior of the casing, cesium was not found at depths below the carbonate-rich zone Determining distribution coefficients by desorption confirmed that Hanford Site sediments play a dominant role in restricting cesium-137 movement

Technetium-99 was not found to be distributed throughout the vadose zone The samples collected and analyzed associated with the extension of borehole 41-09-39 did not confirm the conceptual model of technetium-99 movement through the vadose zone or groundwater as identified by elevated spikes in technetium-99 concentrations over time (PNNL-11810) This radionuclide was believed to follow the moisture front and to essentially move through with any percolating water The maximum concentration of technetium-99 was 350 pCi/g (40 6 m [133 2 ft]) in the sediments (less than would be anticipated based on downgradient groundwater concentrations) Below the carbonate-rich zone, technetium-99 was undetected, with one exception at 56 3 m (184 6 ft), which correlates to the historic high groundwater level Technetium-99 detected in nearby monitoring wells (PNNL-11810) either resulted from a different source area or followed an indirect pathway to reach the groundwater Technetium-99 distribution coefficient test results were highly uncertain but did indicate a greater-than-zero value (typically distribution coefficients in numerical modeling use zero for a value) (HNF-2855)

Sodium, calcium, and nitrate were analyzed to determine their distributions and concentrations Sodium-to-calcium ratios determined from sample analyses indicate that the front of these contaminants resides higher in the vadose zone Correlating the sodium-to-calcium ratios with the nitrate analyses suggests that the leading edge of identifiable tank waste constituents is at about 47 m (135 ft) The maximum sodium concentrations occurred at a depth of 48 1 m (157 7 ft) immediately above the carbonate-rich zone A zone of enhanced calcium and magnesium concentrations was noted at a depth of 47 7 m (156 4 ft), which indicates that cation-exchange processes are operating and have not been overpowered by leak events Nitrate concentrations showed a dramatic (approximately 50%) decrease in concentration below 41 4 m (135 9 ft), the highest technetium concentration occurred from a sample at 40 6 m (132 2 ft) Based on the technetium-to-nitrate migration for SST T-106 maximum migration occurs at approximately the same depth (BHI-00061) The upper portion of borehole 41-09-39 has been sampled The analytical results are not available as of September 1999 The borehole has been

The tanks declared leakers in the SX tank farm (Chapter 2 0) were unique The tanks declared leakers in the SX tank farm apparently failed because of accelerated corrosion and/or physical stress induced by buckling beneath the center regions of the tank bottoms The buckling caused the floor to pull away from the wall at the welded seam The buckling was attributed to decay heat that generated intense pressures between the concrete base and the carbon steel floor This condition may have also contributed to expulsion of superheated steam and liquid waste into the surrounding sediment (DOE/RL-97-49)

The vadose zone conceptual model for this addendum focuses on those contamination sources in the vicinity of SSTs 241-SX-108 and -109 between the S and SX tank farms, the northern portion of both S and SX tank farms, where surface contamination exists, and the vicinity of SST S-104 As discussed in Section 3 1 and HNF-4936, one hypothesis for the observed contaminants in the RCRA groundwater monitoring is that contaminants from tank leaks have migrated downward through the vadose zone and then traveled in a southeasterly direction consistent with the local groundwater flow direction Releases from these tanks could represent a significant present contamination source in the vadose zone It is certain that the leaks from tanks S-104, SX-108, and SX-109 contained several radioisotopes and chemicals commonly found in tank waste (e g , cesium-137, technetium-99, sodium, and nitrate) Thus, contaminants (i e , technetium-99 and nitrate) that are remnants of these past leaks may be still present in the vadose zone, especially southwest within the Plio-Pleistocene unit Section 4 0 of HNF-4936 provides a discussion of the contaminated areas in WMA S-SX

3 3 1 2 Geologic Conceptual Model

The geology of the S and SX tank farms was documented after the drywell boreholes were completed in the early 1970s (ARH-LD-133 and ARH-LD-134) The major stratigraphic units of the suprabasalt sediments present beneath the SX tank farm are the Ringold Lower Mud Ringold Unit E, Plio-Pleistocene, and the Hanford formation (in ascending order) (see Chapter 2 0) The sources of data used in evaluating valid conceptual model(s) for the S and SX tank farms geology include ARH-LD-133, ARH-LD-134, BHI-00184, HNF-2603 HNF-4936 WHC-SD-EN-TI-008, PNNL-11463, PNNL-12114 and WHC-SD-EN-TI-019 Potential structural control or influence on contaminant migration in the vadose zone is of particular interest Elevation maps of the various stratigraphic units are presented in Figure 2 7 and HNF-4936 and will be used as a source for this information

Clastic dikes illustrated conceptually in Figure 3 6 and in HNF-4936 are lenses or tabular bodies relatively narrow at 18 to 38 cm (7 to 15 in) (BHI-00230 and BHI-01103), with textural characteristics typically comprising clay and sand Their localized effect on contaminant movement over the scale of a few meters is an unknown and could account for some observations of relatively immobile contaminants (e g cesium-137) deeper in the vadose zone than would be expected under nonpreferential flow conditions The geologic cross-sections provided in HNF-4936 represents the preliminary working geologic conceptual model for this work plan

3 3 1 3 Hydrologic Properties

Preliminary values will be provided in the site-specific Phase 1 RFI/CMS field investigation report for WMA S-SX that will be prepared pursuant to proposed Tri-Party Agreement Milestone M-45-55 (Ecology et al 1999)

3 3 1 4 Receptors

Receptors are organisms that have the potential for exposure to the released contaminants and include both biota and humans

A likely point of exposure for terrestrial biota is in the plant root zone where flora could absorb buried contaminants Terrestrial animals (especially burrowing animals) may be exposed by direct contact, inhalation, and ingestion of contaminated sediment, water, plants, and animals

For the receptors, the site-specific Phase 1 RFI/CMS field investigation report for WMA S-SX will use the Model Toxics Control Act Methods B and C exposure scenarios at the WMA boundary to evaluate human health risks

3 4 PRELIMINARY CORRECTIVE ACTION OBJECTIVES AND CORRECTIVE ACTION ALTERNATIVES

Interim and final corrective action objectives, general response actions, corrective technologies and process options and a range of preliminary corrective action alternatives are provided in the Phase 1 RFI/CMS work plan (DOE/RL-99-36) These objectives and alternatives are based on available site data, use of the qualitative risk assessment, and the conceptual exposure pathway model General interim actions are identified and represent broad classes of corrective actions that may be appropriate to achieve the corrective action objectives in Section 5 0 of the Phase 1 RFI/CMS work plan (DOE/RL-99-36) Corrective action objectives may change or be refined as additional site data are gathered and evaluated during the field investigation and implementation of interim measures or ICMs

Table 4 1 The 28 S-SX Characterization Options (Cont'd)

Notes

The scale is from 0 to 5 with 0 being no information and 5 having a high probability of obtaining data to evaluate the question/hypothesis

[b] The valuation of these characterization options is not time independent and represents the technical teams judgement on prioritizing the next characterization activities in the WMA S-SX recognizing that ongoing data collection and analysis from 41 09 39 decommissioning and the new borehole near tank SX 115 is underway and is not yet available to support the current characterization planning effort

The slant well at tank SX 115 is assumed to go from the NE toward the SW

[d] The direct push deployment is assumed to include multiple pushes (approximately 6 locations that reach approximately 35 feet)

[e] Boreholes go to groundwater except as noted

[f] The caisson approach uses the direct push technology with rods to collect samples and are pushed with a slight downward angle to reach a vertical depth approximately 20 ft below the base of the tanks The feasibility of using the caisson will be evaluated in FY00

[g] Slant holes at tanks SX 111 and SX 112 were considered but not evaluated in the chart because existing laterals data does not warrant consideration of a slant hole at these tanks

[h] The planning basis for installing a slant borehole beneath a tank includes a demonstration outside the tank farms

The vertical borehole at tank S 104 is assumed to be at the SE quadrant

[j] The location of the borehole in the S 25 crib has not been identified

[k] Sidewall sampling from existing boreholes is based on cutting out a section of the casing (i e a window) and collect a sidewall sample using a technique similar to that used for the 41-09 39 borehole

CoPCs = contaminants of potential concern
Plio = Plio Pleistocene unit

The slant borehole to groundwater was not selected because (1) going to groundwater would not provide any additional information than was obtained from borehole 41-09-39 and (2) a potential increased risk of creating a pathway with high contamination to the groundwater

The option to install a vertical borehole southeast of tank S-104 was not selected because the type of tank leak appears to be confined to the uppermost portion of the vadose zone according to gamma contamination in drywell 40-04-05 The planned near-surface characterization should provide the information required for this area related to the tank leak

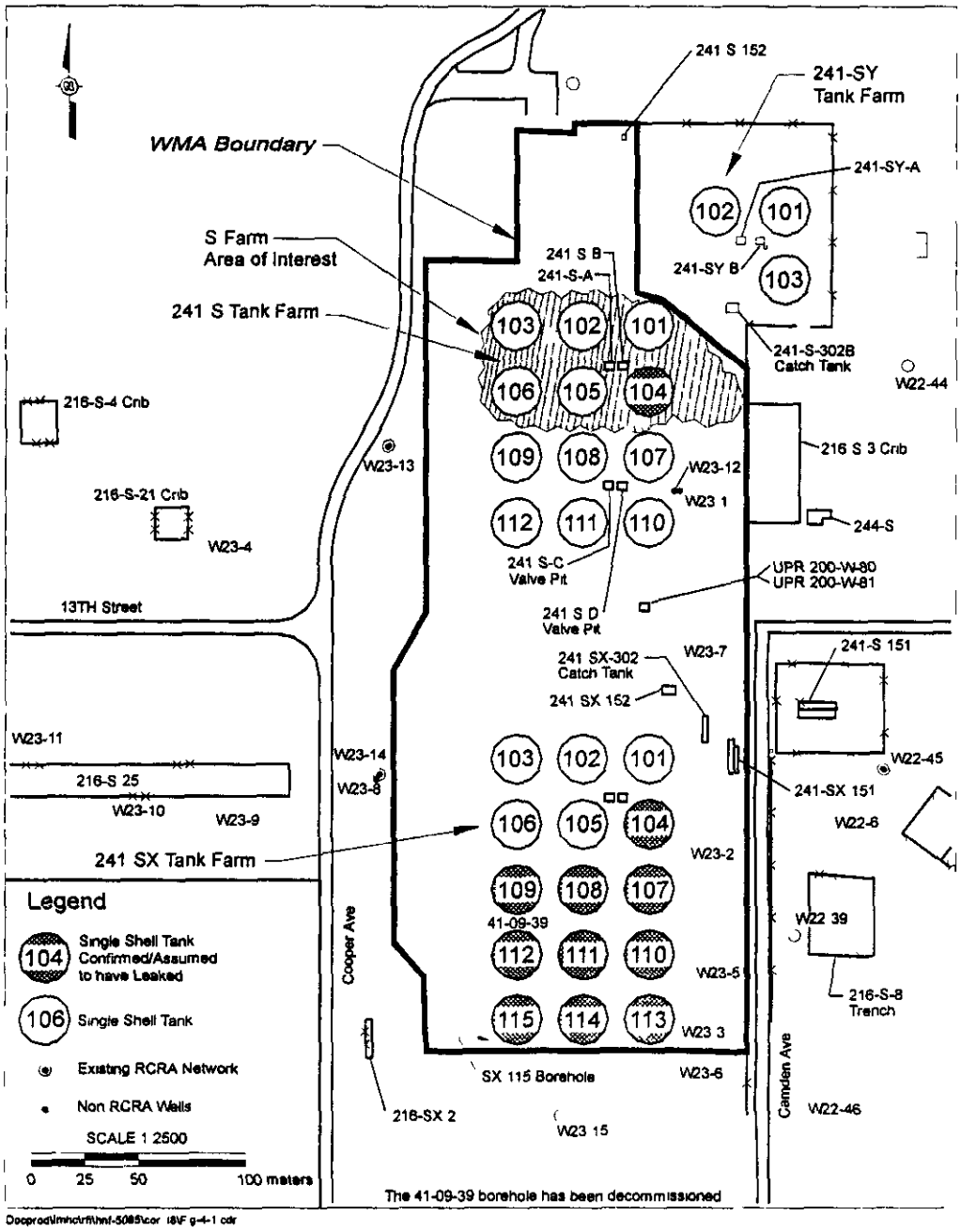
Following selection of the slant borehole under tank SX-108 for deep vadose zone characterization, the other slant and vertical borehole options identified in Table 4 1 would be on hold until the results of ongoing and proposed characterization activities were evaluated and a determination on the need for additional data made Although a number of characterization options were identified, the two selected for implementation in fiscal year 2000 provide a balance between filling the largest data gaps and available characterization resources

4 3 1 Near-Surface Characterization

One of the characterization options considered and selected during the DQO process was the collection of sediment samples from the upper portion of the vadose zone using direct push technology Direct push technology is the preferred method for defining the lateral extent of contamination in the upper part of the vadose zone The near-surface characterization would be implemented in areas of known leaks or spills indicated by gamma contamination at the S tank farm (Figure 4 1) A two-phased approach will be used for near-surface characterization Shallow soil characterization will be carried out using a truck-mounted cone penetrometer based system At specific sites cleared for access (underground piping and electrical services identified) and for which an excavation permit has been approved, the first phase will be to interrogate with a gross-gamma/spectral gamma cone penetrometer probe The depth of investigation will be determined by the depth to which the probe can be advanced using a standard deployment truck The probe will be deployed using the gross gamma mode with the tool advanced at approximately 2 cm/sec (0 8 in /sec) If, in the upper 5 m (15 ft) the downhole instrument indicates a potential cesium-137 concentration of 3 7 pCi/g or greater logging will be shifted to the spectral mode to determine the presence and level of concentration of cesium-137 below 5 m (15 ft) the threshold limit for spectral gamma determinations will be 20 pCi/g In zones where cesium-137 is present at concentrations greater than 20 pCi/g spectral gamma readings will be taken at 0 5 m (1 5 ft) intervals In all cases, gross gamma measurements are to be taken while the probe is advanced

The second phase will use the graphical log developed using the gross and spectral gamma measurements to select intervals to be sampled The sampling push is to be made in a location that is no more than 0 7 m (2 ft) from the site of the gamma push A single point sampler will be used to collect the required samples Sampling intervals will be selected from those horizons with a cesium-137 concentration of 20 pCi/g or greater In the event that horizons are penetrated that would yield samples having a greater that 50 mrem/hr dose rate at 30 cm (12 in) (based on calculations using sampler size and cesium-137 concentration) a sample will be collected from the first interval below the high rate zone having a dose rate of less than 50 mrem/hr The

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



sediment samples collected using direct push technology may require multiple pushes if sufficient material for analysis of CoCs was not collected from the initial push Direct push technology has been successfully deployed south of the SX tank farm to depths deeper than is proposed for this investigation Deployment of the direct push technology at these locations would be expected to begin to address a number of questions related to the concentration and distribution of contaminants, including the following

- What contaminants are present that are routinely identified as CoCs from a groundwater impact standpoint (e g technetium-99, nitrates)?
- What are the concentration/inventory correlations between the CoCs and cesium-137 in soil samples and with the tank contents?
- What is the vertical extent of the CoCs in the backfill material?
- What is the horizontal extent of the CoCs across the areas of interest?
- What are the potential drivers (e g , sediment moisture profile) in the upper portion of the vadose zone that could control the migration of contaminants?

The benefits and uncertainties associated with direct push technology were identified during the DQO meetings (HNF-5272) Direct push technology has not been previously deployed in the tank farms Direct push technologies are limited to approximately 16 7 m (55 ft) bgs in geology similar to the tank farms However, the authorization basis for using one type of direct push technology the cone penetrometer has been completed (HNF-SD-WM-HIE-012)

The benefits and uncertainties associated with auger drilling were also identified during the DQO meetings as a contingency to direct push technology The maneuverability of the auger rig and support vehicles has not been determined for dome loading The amount of contaminated material that would potentially be brought to the surface would require engineering controls The authorization basis for using the auger drilling method within WMA S-SX would need to be evaluated before this technique could be used Auger drilling would be maintained as a back-up to the direct push technology for collecting near-surface samples

The uncertainties associated with near-surface characterization are believed to be manageable and would support deployment within fiscal year 2000 The uncertainties are mainly associated with not having deployed these technologies in the tank farm and are not expected to constrain future deployment of these characterization efforts

4 3 2 Installation of a Slant Borehole

In addition to data collection from near-surface characterization several options were considered for collection of deeper vadose zone data The preferred option included installation of a slant borehole in WMA S-SX as identified in Table 4 1 sampling of the vadose zone from beneath a tank associated with past leaks, and sampling near-vertical features from a non-vertical approach to improve the opportunity to intercept these near-vertical features This option was selected

because a slant borehole would provide source characterization along with distribution of contaminants underneath tank SX-108 Source characterization would

- Provide a basis for estimating contaminant inventories and processes that would control the migration of contaminants
- Support evaluation of the correlations between concentrations of CoCs and existing gamma data, and potentially evaluating relationship between the CoCs in the soil and the concentrations of CoCs present in the tanks at the time the leak was believed to occur
- Support assessing contaminant mobility, potential drivers (e g moisture content), and the effects of tank leaks on soil properties to support predictive modeling efforts necessary to evaluate potential future groundwater impacts
- Provide information on the second largest source via the tank leak in the SX tank farm from tank SX-108

Source characterization efforts also would involve identifying what contaminants are present and subsequently the potential CoCs for corrective action retrieval and closure decisions If correlations between the CoCs and available gamma data can be established, there is a potential that the wealth of existing gross gamma and spectral gamma data can be used to better understand the location and distribution of CoCs in the vadose zone

Borehole Location

Potential locations for a new borehole were identified based on historical knowledge of WMA S-SX such as leak history previous vadose zone characterization efforts, historical gross gamma logging data recent spectral gamma logging data, and RCRA groundwater assessment findings Two primary areas considered for the characterization effort were the area near tank SX-108 and the area near tank S-104 Based on the information provided in Chapter 3 0 the area under tank SX-108 and between tanks SX-108, -109 -111 and -112 is of interest because it is impacted by one of the largest leaks (in terms of inventory and potentially volume based on leak volume uncertainty) in WMA S-SX (from 132,000 to 678 000 L [35,000 to 203 000 gal] from SX-108) The area surrounding tank S-104 is of interest because of the large 90 840 L (24,000 gal) leak that occurred from the tank and the observed groundwater contamination in the RCRA groundwater monitoring wells located on the eastern end of the S tank farm

Options considered in the DQO process are presented in HNF-5272 and Table 4 1 Each of these options was evaluated as a candidate for the characterization effort Each of the options was identified because samples from these locations would potentially provide data to address source characterization (i e nature of contamination), location and distribution (i e extent of contamination) and transport pathways and processes (i e contaminant fate and transport)

Additional considerations in evaluating the options included potential programmatic risk (i e , risk to the program if the characterization effort were unsuccessful) associated with a fiscal year 2000 deployment

Each of these options would potentially provide data to address a number of different questions and data gaps In terms of source characterization, the potential value of information provided by characterizing the source at tank SX-108, and in particular the slant borehole under tank SX-108 (Figure 4 2) is a primary characterization target

The current planning basis is to pursue installation of the slant borehole under tank SX-108 as the next characterization effort in WMA S-SX Given that the slant borehole beneath tank SX-108 is a potential primary target for the characterization effort the DQO participants decided that additional vertical boreholes in the SX tank farm should be deferred until the data from the the preliminary characterization efforts could be evaluated and the need for additional source characterization data from a vertical borehole in the SX tank farm was established

A new vertical borehole near borehole 41-11-10 potentially would provide data near the leading edge of the postulated gamma contamination plume resulting from the leak at tank SX-108 Because of the other tank leaks in the area (tanks SX-108, -109, -111, and -112), it is likely that some level of commingling of leaks from different tanks has occurred Much of the information that would be gained from placing a new borehole in this area would be similar to the information that will be gained from the extension and decommissioning of borehole 41-09-39 Both of these locations are in the path of the postulated gamma plume from tank SX-108 in the same general direction (southwest) from the tank The horizontal distance between the borehole 41-11-10 and borehole 41-09-39 is approximately 11 m (35 ft) Based on this information, a decision to install a new borehole near borehole 41-11-10 will be deferred until the data from decommissioning of borehole 41-09-39 are available and the need for additional characterization in this area is established

Based on the evaluation of borehole location options the characterization activity proposed in WMA S-SX is to install a slant borehole under tank SX-108 extended to the top of the Plio-Pleistocene unit This is consistent with recommendations for the location of a new borehole made by the SX Expert Panel (DOE/RL-97-49)

Borehole Construction and Sampling Methodology

Installation of a slant borehole under tank SX-108 targeted to intercept the tank leak plume would encounter highly contaminated sediments Based on historical logging data the slant borehole would likely encounter regions with cesium-137 concentrations as high as 10^6 to 10^8 pCi/g These concentrations raise significant worker safety and air emissions concerns for any drilling or sampling method that brings material to the surface Because of the anticipated contaminant concentrations the slant borehole would be constructed by driving a closed-end casing The advantage of this borehole construction method is that no cuttings would be brought to the surface during well construction Additionally at the anticipated contaminant concentration levels a closed end driven well would be the only construction method allowable in the current Notice of Construction (DOE/RL 99-34)

Two options have been identified for collecting sediment samples from a closed end driven borehole The two options include collecting a driven split-spoon sample ahead of the borehole casing or collecting a sidewall sample during borehole decommissioning Due to the anticipated radiation levels standard split spoon sampling equipment cannot be used for the proposed slant

borehole The split-spoon sampler would be specially designed to limit sample volume and provide radiation shielding Collection of split-spoon samples ahead of the borehole casing would be conducted by removing the drive tip at locations of interest, collecting the split-spoon sample and reinstalling the drive tip to advance the borehole to the next sampling location There are a number of advantages and disadvantages to both sampling options The major advantages of collecting split-spoon samples ahead of the casing include the ability to collect a representative sample of sufficient size to allow all anticipated laboratory analyses to be conducted

The proposed sampling methodology to be used during construction of the tank SX-108 slant hole is to collect driven split-spoon samples ahead of the casing There are a number of uncertainties associated with application of this sampling methodology at the tank SX-108 location The primary uncertainty is associated with the potential worker doses resulting from handling hot samples Additional uncertainties include sample handling in the laboratory and interfaces between the field and the lab Limitations associated with collecting split-spoon samples from the slant borehole include having to sample without the benefit of gamma ray logging to identify radiation levels Because of this limitation the details of the sampling plan will be developed assuming that each sample has the potential to be highly contaminated

The proposed sampling methodology will be demonstrated outside the tank farm to verify the approach prior to deployment in the tank farm Backup sampling techniques will be evaluated in the event that the split-spoon sampling technique will not work in the high radiation environment in the tank farm The sidewall sampling technique will be maintained as a back up or secondary sample collection technique

4 3 3 Other Activities

In addition to the slant borehole and near-surface characterization activities engineering studies and demonstrations are being pursued to reduce the technical uncertainties and to provide a basis for future characterization deployments in the tank farms A feasibility evaluation for utilizing the caissons will be conducted in fiscal year 2000 If using the caissons proves feasible collecting sediment samples under tanks in the SX tank farm could be accomplished using the caissons instead of installing a slant borehole A slant borehole demonstration is also being planned outside of the tank farms that would be similar in terms of features and approach to sediment sampling as the borehole planned at tank SX 108 prior to implementation in the SX tank farm

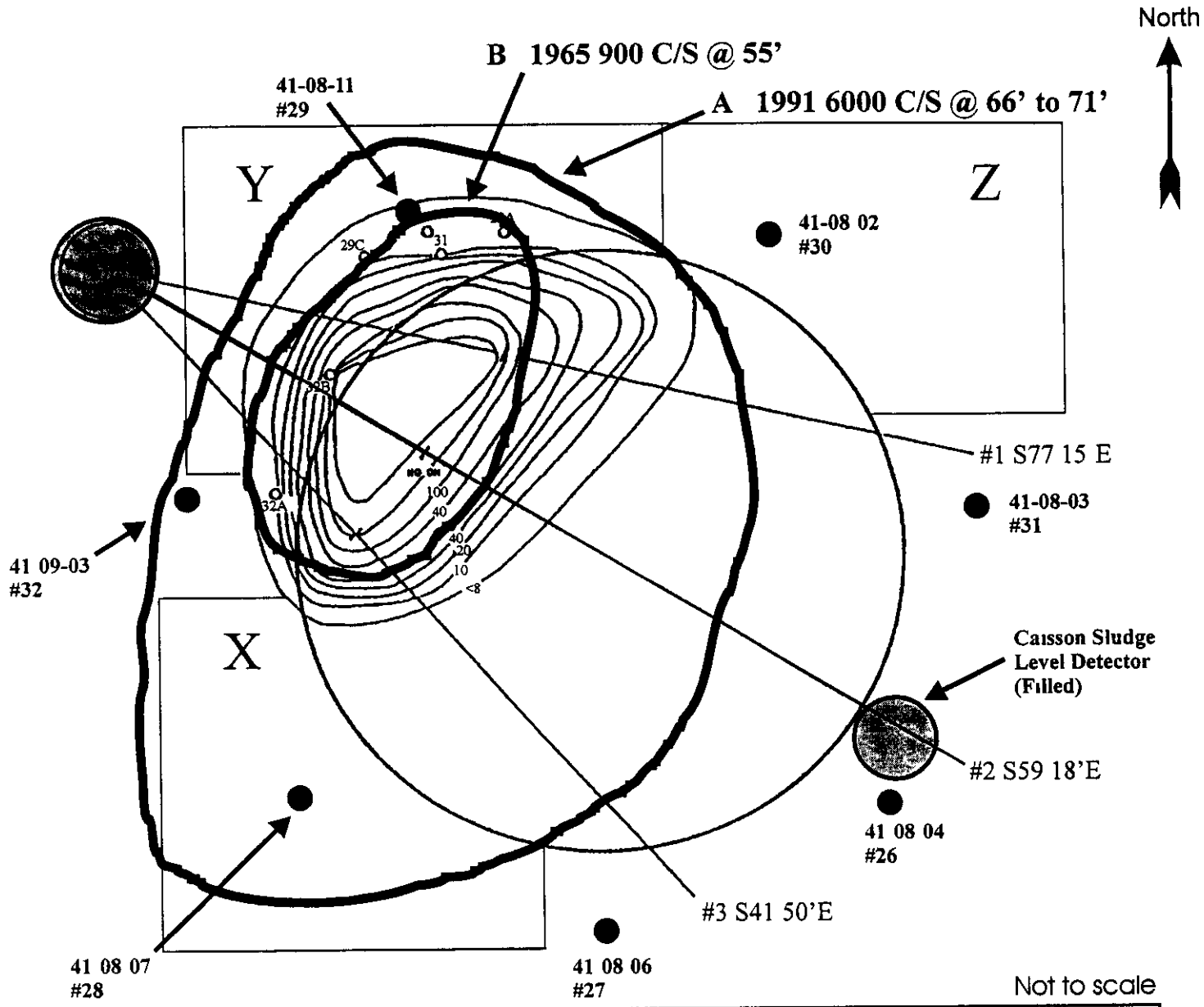
4 4 PROPOSED SPECIFIC TANK SX-108 BOREHOLE LOCATION

The specific location of the proposed slant borehole under tank SX-108 is based on tank leak history information Based on this information criteria have been developed for the selection of the specific location from among three potential sites near the tank

4 4 1 Leak History

The leak history for tank SX-108, which contains REDOX high-level waste is documented (WHC-MR-0300, BNWL-CC-701) Estimated releases from tank SX-108 vary from 9,084 L (2,400 gal) to 132,475 L (35 000 gal) of supernate between 1962 and 1964 based on

Figure 4 2 Tank 241-SX-108 Borehole Location Options



LEGEND

●	Drywell
41 08-06	Drywell number
#27	Number used in BNWL-CC-701 characterization study
▬	Counts per second Inside bold line represents 1965 data at 900 counts per second at 17 m (55 ft) Outside bold line represents 1991 data at 6000 counts per second at 20 1 to 21 6 m (66 to 71 ft)
—	Contour lines represent constant Cs-137 concentrations in µCi/g in mid-1965

Source WHC-MR-0300

Docprod\lmhc\rf\hnf-5085\corel8\fig-4-2 cdr

WHC-MR-0300 to 768,355 L (203,000 gal) based on LA-UR-96-3537 Tank SX-108 was suspected of leaking in December 1962, however, it was thought to have self-sealed and the tank was kept in service Tank SX 108 was observed to have leaked again in August 1964 By late 1965 the leak was thought to have self-sealed but, in March 1967, the tank was confirmed to be leaking and was taken out of service Based on a leak volume ranging from 9,084 L (2,400 gal) to 132,475 L (35,000 gal), the 1965 supernate analysis, and decay calculations (January 1991), the radionuclides in contaminated sediment under the tank are estimated to be between 10 000 and 140,000 Ci of cesium-137 (WHC-MR-0300)

4 4 2 Borehole Location Options Near Tank SX-108

The specific location of the borehole in relation to tank SX-108 has not yet been established The opportunities for gathering information and the trade-offs between the specific locations have been evaluated to optimize the data and information provided by the borehole

Three regions around tank SX-108 have been identified as potential targets for locating a new characterization borehole as identified in Figure 4 2 These locations are southwest of tank SX-108 (Area X), northwest of tank SX-108 (Area Y), and northeast of tank SX-108 (Area Z) An evaluation of the questions and the hypothesis that could be evaluated with data obtained from the three locations are discussed in greater detail in the following paragraphs Based on this evaluation (HNF-5272) Area Y has been selected as a preferred location for the slant borehole Based on gamma activity as shown in Figure 4 2, the slant borehole would be drilled from the northwest corner to the southeast and go underneath the tank

The current planning basis for the slant borehole beneath tank SX-108 includes the following

- The borehole enters the ground at approximately the 11 o clock position 12 2 m (40 ft) from the edge of the tank nominally 30° off vertical, heading directly underneath the center of the tank (toward the 5 o'clock position) 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 unit or to the maximum depth of contamination whichever is greater

- Driven samples would be collected ahead of the casing The samples would be transported to the laboratory and analyzed for the CoCs identified in Appendix A Nominally 10 horizons would be sampled based on nearby borehole geophysical logs or this borehole geophysical logs or the need to provide depth coverage as identified in Appendix A

As a contingency should a 30° off vertical slant borehole inside the tank farm not be attainable, a near vertical to vertical borehole closer to the tank will be implemented This would still provide data in regards to the contaminant plume without jeopardizing the schedule or requiring reevaluation of the authorization basis for a new borehole

This location northwest of tank SX-108 provides the opportunity to test a variety of hypotheses on the movement of contaminants and moisture and the role of the geologic system in controlling that movement

A slant borehole started northwest of tank SX-108 would enhance understanding of the fate and transport of contaminants needed to support risk assessment The advantage to northwest over northeast is a higher probability of collecting vadose zone samples that contain contaminants from the tank leak One issue that will affect final siting of the borehole is the potential interference from existing tank farm infrastructure Based on the sampling methodology employed the following information may be developed and the hypotheses tested by a borehole located northwest of tank SX-108

- A hypothesis has been offered that mobile contaminants (e g , tritium, nitrate, and technetium) will move vertically until a hydraulic barrier causes them to move laterally (HNF-2603) This lateral movement would likely be preferential along the sloping Plio-Pleistocene unit-Hanford formation contact The Plio-Pleistocene unit is finer grained than the Hanford formation and also contains carbonate-rich zones both of which may be important factors in this hypothesis Vertical movement would likely be enhanced if the sediments became saturated due to either the waste itself or through the addition of moisture from other sources

- This location allows for the contamination immediately below the tank to be sampled This provides conditions for sediments affected by tank waste directly under the tank (i e depth of 18 3 to 21 3 m [60 to 70 ft] bgs) to be evaluated

- The slant borehole will enable access to both between (contaminated) tank conditions and under tank conditions Contaminated sediment from these two conditions could be examined for fate and transport considerations

- Vertical distribution and concentrations of ^{99}Tc, nitrate and chromium, particularly in the most concentrated gamma zone

- Identification and distribution of other contaminants and their concentrations

- Comparison of cesium 137 distribution versus other contaminants

- In-situ moisture content

- Contaminant leachability in the highest concentrated gamma zone

- Mineralogical, chemical reactivity, density and porosity changes in soil from interactions with tank fluid in the highest gamma concentration zone

- Chemistry of extracted pore water (pH inorganic and organic concentrations)

- Cation exchange capacity of soils

A slant borehole located northeast of tank SX-108 would provide most of the same information as would a slant borehole located northwest of the tank except penetrating the contaminant plume has a lesser chance of occurring

- The slant borehole will enable access to both between (contaminated) tank conditions and under tank conditions Contaminated sediment from these two conditions could be examined for fate and transport considerations

- Starting point allows traverse through uncontaminated area before reaching edge of tank This would reduce the concern for worker safety at the beginning of the drilling operations

A borehole located southwest of tank SX-108 would provide most of the same information as would a slant borehole located northwest of the tank, however based on Figure 4 2, the tank leak appears to have occurred in the northwest quadrant Therefore, a slant borehole northwest of tank SX-108 has a higher probability of success

4 5 INVESTIGATIVE SAMPLING AND ANALYSIS AND DATA VALIDATION

Samples and data will be collected during the slant borehole investigation while driving the casing and by conducting geophysical surveying as described in Appendix A Sediment samples will be collected ahead of the driven casing using split-spoon sampling techniques modified with shielding to accommodate the high radiation levels in the borehole All samples will be field screened for radiation, sealed, refrigerated and shipped for analysis Laboratory analyses will be performed on the sediment samples for radiological and geochemical constituents as described in the SAP presented in Appendix A Limited analysis for physical parameters (e g , moisture retention and hydraulic conductivity) may also be performed on sediments that show visible evidence of being altered by the tank leak chemistry (e g cementation discoloration)

For the near-surface characterization, sediment samples from discrete zones will be collected from the upper vadose zone using direct push technology All samples will be field screened for radiation containerized, and retained for possible analysis Geophysical logging will be used in conjunction with the direct push technology to monitor for evidence of gamma contamination and target sample locations prior to sediment sample collection Samples will be selected for analysis based on the geophysical logs from the initial push or completed borehole and as needed to fill in gaps consistent with the overall objective of identifying the distribution of radiological and chemical species with depth Laboratory analyses will be performed on the sediment samples for radiological and geochemical constituents and parameters as described in the SAP (Appendix A) Additionally, physical and hydrological analyses will be performed on selected samples if there is visible or geochemical evidence that the waste has altered the sediments

Data from the slant borehole and near-surface characterization determined by project management to be relevant for the purpose of validation will be made available by the primary laboratory on request Validation will be performed in accordance with the quality assurance project plan in the Phase 1 RFI/CMS work plan (DOE/RL-99-36)

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5 0 RCRA FACILITY INVESTIGATION/CORRECTIVE MEASURES STUDY TASKS AND PROCESS

The primary purpose of Chapter 5 0 of this addendum is to provide a summary of the tasks that will be performed for the investigation A detailed description of these tasks is provided in the SAP (Appendix A) Section 5 1 outlines the tasks to be conducted during the field investigation for the RFI Tasks are designed to provide information needed to meet the DQOs identified in Chapter 4 0 A SAP is provided in Appendix A for the field investigation for the RFI Environmental monitoring requirements for protecting the health and safety of onsite investigators are described in the Phase 1 RFI/CMS work plan (DOE/RL-99-36)

Following approval, this work plan will not be modified without approval from Ecology and DOE Any changes to the scope of work that may be needed will be documented through change requests in accordance with the procedures identified in Appendix A of the Phase 1 RFI/CMS work plan (DOE/RL-99-36)

To satisfy the data needs and DQOs specified in Chapter 4 0, the following tasks will be performed during the RFI

- Task 1 Project Management
- Task 2 Geological and Vadose Zone Investigation
- Task 3 Data Evaluation

No groundwater investigation is planned for the proposed investigation in this work plan A separate plan (PNNL-12114) covers groundwater investigations at WMA S-SX This plan has been released (September 1999) and references back to the Phase 1 RFI/CMS work plan The tasks and their component subtasks and activities are outlined in the following sections Information is provided on each task to allow estimation of the project schedule (Chapter 6 0) and costs

5 1 TASK 1 – PROJECT MANAGEMENT

The project management objectives throughout the course of the WMA S-SX RFI/CMS are to direct and document project activities so the data and evaluations generated meet the goals and objectives of the work plan and to ensure that the project is kept within budget and on schedule General project management is addressed in Section 7 0 of the Phase 1 RFI/CMS work plan (DOE/RL-99-36) The project management activity will be to assign individuals to the roles established in Chapter 7 0 Specific subtasks that will occur throughout the RFI and RFI/CMS are addressed in Section 7 0 of the Phase1 RFI/CMS work plan (DOE/RL-99-36)

5 2 TASK 2 – GEOLOGIC AND VADOSE ZONE INVESTIGATION

The geologic and vadose zone investigation will further characterize the geology of WMA S-SX and provide additional information on the nature and extent of contamination and the potential migration paths

The geologic and vadose zone information will be evaluated to determine their influence on the following

- WMA conceptual vadose zone model
- Release and movement of contaminants
- Development of ICM alternatives
- Initiate data collection for support of retrieval and closure activities

The geologic and vadose zone investigation for WMA S-SX will consist of compiling pertinent existing data and collecting data from drilling activities in the vadose zone The types of data needed from the surface and vadose zone include the following

- Thickness and areal extent of geologic units
- Lithology bedding types, facies geometry, particle size, and sorting
- Presence, concentration and nature of contaminants in sediments

The following two subtasks have been established to gather geologic and vadose zone data

- Subtask 2a Field Activities (logging and sampling of a slant borehole, and sediment sampling of the backfill materials in the S tank farm
- Subtask 2b Laboratory Analysis

5 2 1 Subtask 2a – Field Activities

Field activities will include geologic and geophysical logging associated with the slant borehole and direct pushes or auger drilling in the S tank farm and between the S and SX tank farms for near-surface characterization The tentative locations of the planned slant borehole and direct push are provided in Figures 5 1 and 5 2

The requirements for geologic and geophysical surveying and sediment sampling for physical and laboratory analytical parameters in the vadose zone borings are provided in Appendix A Information and data will be collected from the surface downward to the top of the Plio-Pleistocene unit or the depth to which contamination is present Geologic logging will be performed

5 2 1 1 Slant Borehole

The following activities are planned for the slant borehole

- Conduct borehole geophysical surveying and analysis (moisture neutron gross gamma spectral gamma and neutron-enhanced spectral gamma analysis)

- Obtain sediment samples to analyze for the presence and concentration of contaminants and to evaluate alterations of the sediments from waste chemistry effects

- Obtain sediment samples to support preparation of the borehole geologic logs and stratigraphic and lithologic contact correlation with other boreholes/wells in the WMA S-SX vicinity

Figure 5 1 Waste Management S-SX Vadose Zone Soil Sampling Locations

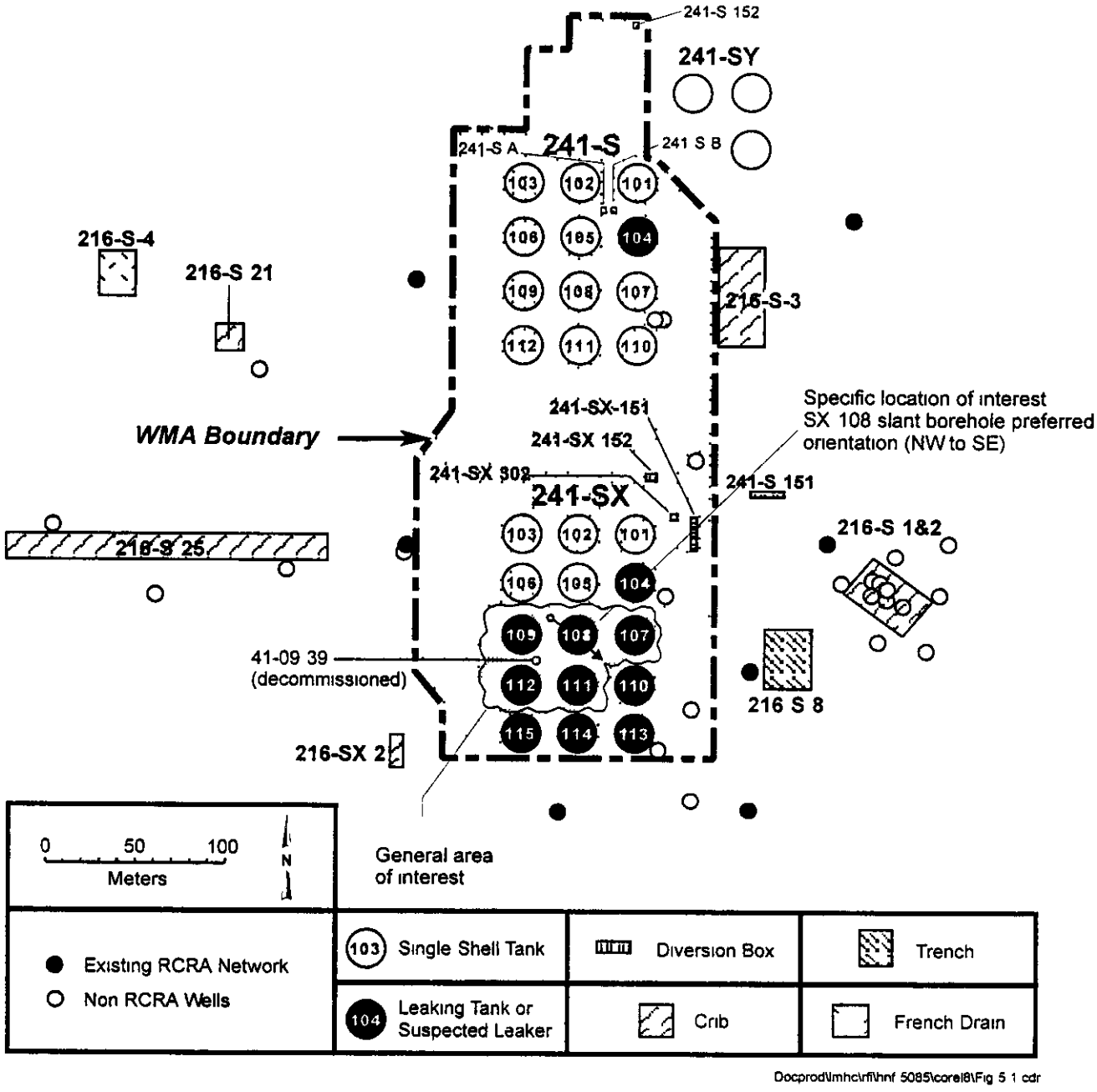
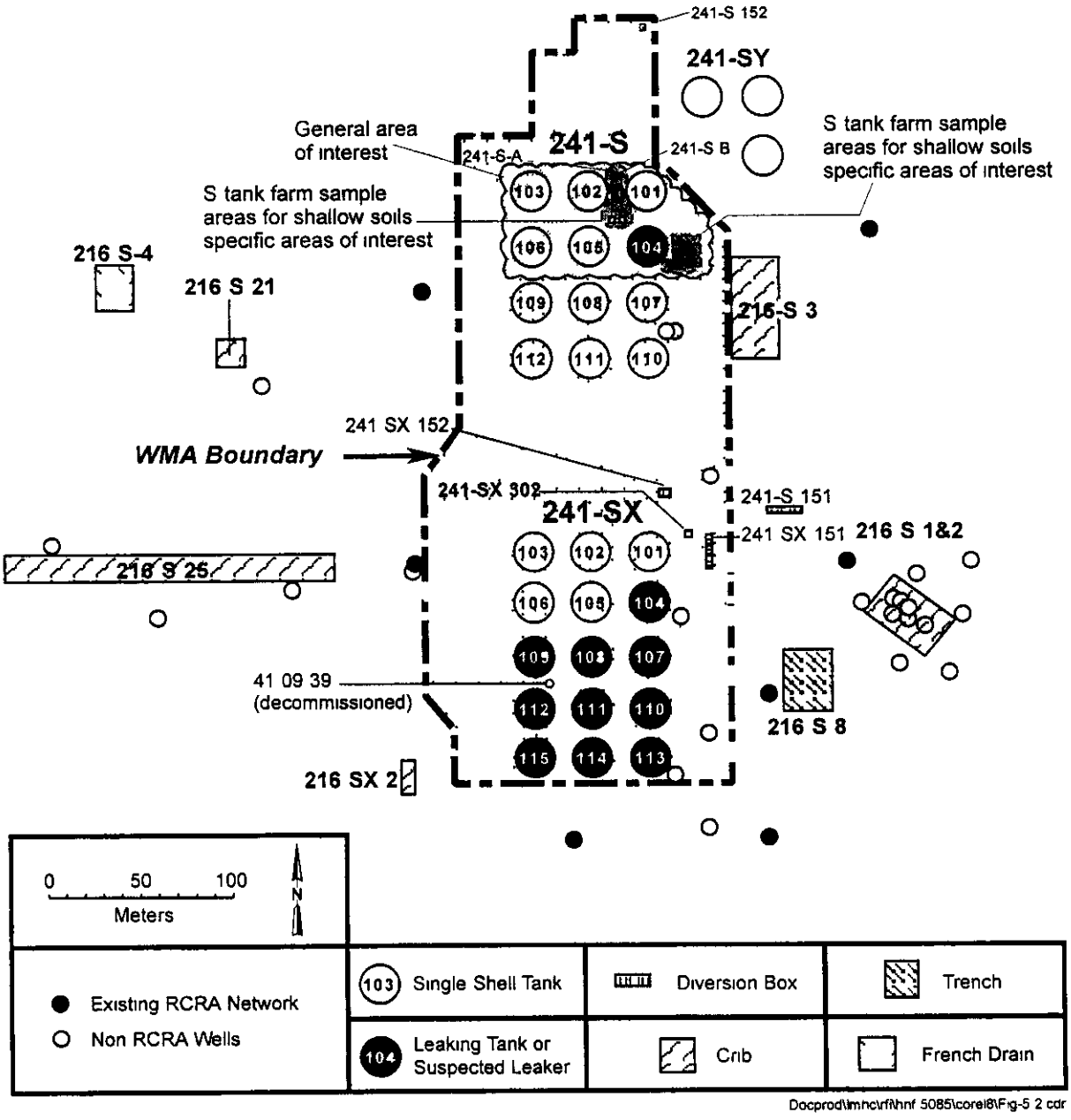


Figure 5 2 Waste Management S-SX Shallow Soil Sampling Locations



The final design for the slant borehole under tank SX-108 has not been completed One of the primary constraints on sample collection from the "hot" zone under tank SX-108 is the potential radiation level (>500 mrem/hr) which will limit the sample volumes that can be brought to the surface To reduce the uncertainties associated with placing a slant borehole under tank 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 tank SX-108 includes the following

- The borehole enters the ground at approximately the 11 o clock position 40 feet from the edge of the tank nominally 30° off vertical, heading directly underneath the center of the tank (toward the 5 o'clock position) 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 unit or to the maximum depth of contamination, whichever is greater

- Driven samples would be collected ahead of the casing The samples would be transported to the laboratory and analyzed for the CoCs identified in Appendix A Nominally, 10 horizons would be sampled based on the geophysical surveys or the need to provide depth coverage as identified in Appendix A

Subsurface conditions are variable and the process of installing the slant borehole must be flexible A planned demonstration will determine the methodology for conducting the drilling activity Some or all of the work described in Appendix A may require modification This addendum is intended to serve as a guideline and is designed to allow for changes depending on conditions encountered in the field and borehole Any change will be recorded on the appropriated field documentation, memoranda, or letters A complete documented record of activities will be maintained for preparation of a final summary report

Appropriate permits and compliance with the Notice of Construction (NOC) permit (DOE/RL-99-34) will be maintained during the drilling operations for inside the tank farm The selected drilling method will comply with the requirements of the Washington State Department of Health for the notice of construction permit and other pertinent requirements and appropriate engineering systems to prevent the possible contaminated air from being released to the environment

5 2 1 2 Shallow Vadose Soil Investigation

Two areas have been identified as regions of interest for the Phase 1 characterization of the shallow vadose zone soil These areas are within the north end of the S tank farm The S tank farm areas of interest include

- Unplanned release near diversion box 241-S-B

- East of tank S-104 near the fence (in the drainage path of the unplanned release that occurred in the SY tank farm and flowed into the S tank farm)

For the purpose of the DQO, the shallow investigation of these areas would consist of collecting samples between the tank farm surface and approximately 16 7 m (55 ft) bgs using direct push technology at nine locations within either or both of these two areas

Shallow soil characterization will be carried out using a truck mounted cone penetrometer-based system Specific sites cleared for access (underground piping and electrical services identified) and with an approved excavation permit will be interrogated with a gross-gamma/spectral gamma cone penetrometer probe The depth of investigation will be determined by the depth to which the probe can be advanced using a standard deployment truck The probe will be deployed using the gross gamma mode with the tool advanced at approximately 2 cm/sec (0 8 in /sec) If, in the upper 5 m (15 ft) the downhole instrument indicates a potential cesium-137 concentration of 3 7 pCi/g or greater logging will be shifted to the spectral mode to determine the presence and level of concentration of cesium-137, below 5 m (15 ft) the threshold limit for spectral gamma determinations will be 20 pCi/g In zones where cesium-137 is present at concentrations greater than 20 pCi/g, spectral gamma readings will be taken at 0 5 m (1 5 ft) intervals In all cases, gross gamma measurements are to be taken while the probe is advanced

The graphical log developed using the gross and spectral gamma measurements will be used to select intervals to be sampled The sampling push is to be made in a location that is no more than 0 7 m (2 ft) from the site of the gamma push A single point sampler will be used to collect the required samples Sampling intervals will be selected from those horizons with a cesium-137 concentration of 20 pCi/g or greater In the event that horizons are penetrated that would yield samples having a greater that 50 mrem/hr dose rate at 30 cm (12 in) (based on calculations using sampler size and cesium-137 concentration) a sample will be collected from the first interval below the high rate zone having a dose rate of less than 50 mrem/hr

Two separate areas are to be characterized The areas consist of the vicinity of tank S-102 and the vicinity of tank S-104 These two sites exhibit separate instances of cesium-137 in vadose zone dry wells that may be indicative of near-surface sources In addition, the region to the east of tank S-104 has potentially been impacted by a tank overfill event in the 241-SY double shell tank farm A total of nine push sites have been identified An average of four samples per site will be collected

5 2 1 3 241-S-104 Site

The highest recorded levels of cesium-137 contamination associated with this site are in borehole 40-04-05 in the southeast quadrant of the tank Contamination is estimated at about 10^6 pCi/g at a depth of about 14 m (48 ft) bgs Up to five sets of gamma probe and sampling pushes may be made to investigate this site The pushes include the following

- Adjacent to the 40-04-05 drywell between the drywell and the tank This location will be to ascertain if there is a vertical gradient between the push location and the identified elevation of contamination in 40-04-05 and to collect a sample from below the

contaminated zone to determine if mobile contaminants are moving ahead of the cesium-137 hot spot

- Adjacent to tank S-104 at the 5 o'clock position This location is to be as close to the tank as the push-truck can be positioned within dome-load restrictions The S tank farm tanks are constructed with a spare inlet port at this point Experience in other farms has shown that these spare inlet ports are subject to failure if a tank is overfilled This push will test the hypothesis that the contamination adjacent to the tank is due to an overfill event

- Adjacent to the normal fill line at the 3 o'clock position This location is to be within 3 to 4 5 m (10 to15 ft) of the tank and as close to the fill line as safety considerations allow This location will be used to determine the horizontal and vertical extent of the contamination found in the 40-04-05 borehole

- Adjacent to the S tank farm fence line This location will be used to determine the impact to shallow soils due to the surface release and subsequent ponding that occurred in the SY tank farm

- Midway between the previous two pushes This location would only be interrogated if positive determinations of contamination were found in one of the two previous pushes

5 2 1 4 241-S-102 Site

The highest recorded levels of cesium-137 contamination associated with this site are in borehole 40-02-03 in the northeast quadrant of the tank Contamination is estimated at about 10^6 pCi/g at a depth of about 6 m (20 ft) bgs Four sets of gamma probe and sampling pushes are planned to investigate this site The pushes include the following

- Adjacent to tank S-102, northwest of drywell 40-02 03 Because no contamination is detected in drywell 40-02-01, this push will be used to determine the extent of contamination in a northwesterly direction from borehole 40-02-03 The push will be situated about midway between the boreholes and as near the tank as safety considerations allow

- Along the line projected between 40-02-01 and 40-02-03 north of the cascade line between tanks S-101 and S-102 This location will provide information on the extent on contamination known to exist at 40-02-03 and assess the depth of movement of that contamination

- Along the line projected between 40-02 01 and 40-02-03 south of the cascade line between tanks S-101 and S-102, and near the 241-S-A diversion box This location will provide information as to the extent and general direction of movement of contaminants for this site In addition the accumulation pit associated with the 241-S-A will be assessed as a possible contributor to the contamination

- Adjacent to the 241-S-B diversion box The potential for contamination in this region to be related to operation of the 241-S-B accumulation pit will be assessed

5 2 1 5 Additional Pushes

Additional pushes may be made based on the information developed during the initial campaign or decisions of the River Protection Project Vadose Zone Project management These additional pushes will be determined based on the determined extent of contamination and (1) the availability of both the cone penetrometer truck and crew and (2) availability of budget and support personnel

The samples would be transported to the laboratory and analyzed for the CoCs identified in Appendix A

Following approval of the general plan outlined in this 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 completed The physical and operational constraints will require evaluation prior to identifying specific target locations

5 2 2 Subtask 2b – Laboratory Analysis

Laboratory analyses for the geologic and vadose zone investigation are described in Appendix A These analyses include radiological and chemical analysis of selected sediment samples Also, physical and hydrologic analysis of selected sediment samples will be performed

5 3 TASK 3 – DATA EVALUATION

Data generated during the field investigation will be integrated and evaluated, coordinated with RFI activities and presented in an ongoing manner to allow decisions to be made regarding any necessary rescoping during the course of the project The results of these evaluations will be made available to project management personnel to keep project staff informed of progress being made The interpretations developed under this task will be used in refining the conceptual model and determining whether interim measures or ICMs are warranted for this WMA

APPENDIX A

SAMPLING AND ANALYSIS PLAN

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FIGURES

TABLES

LIST OF TERMS

bgs	below ground surface
CMS	corrective measures study
Ecology	Washington State Department of Ecology
HASQARD	Hanford analytical services quality assurance requirements document
LMHC	Lockheed Martin Hanford Corporation
RFI	*Resource Conservation and Recovery Act of 1976* Facility Investigation
SAP	sampling and analysis plan
UPR	unplanned release
WMA	waste management area

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A 1 0 INTRODUCTION

The focus of this Sampling and Analysis Plan (SAP) is vadose zone investigation of the Waste Management Area (WMA) S-SX, which contains the S and SX tank farms Sampling and analysis of vadose zone sediments will occur in the vicinity of the S and SX tank farms to meet the objectives of this investigation

A 1 1 PURPOSE AND OBJECTIVE

This plan details the field and laboratory activities to be performed in support of the investigation of vadose zone contamination in WMA S-SX and is designed to be used in conjunction with the work plan and referenced procedures The field investigations at WMA S-SX addressed in this SAP are as follows

- Installation of a slant exploratory borehole, under tank SX-108 starting northwest of tank SX-108 and extending underneath the tank Sediment samples will be attempted from about 16 m (50 ft) below ground surface (bgs) to the top of the Plio-Pleistocene unit or maximum depth of contamination, whichever is greater Selected portions of the sediment samples will be analyzed for their chemical radiological, and physical characteristics A suite of geophysical surveys will be performed depending on the degree of contamination on the inside of casing following sampling This borehole will require decommissioning Following completion of the field investigation the borehole will be decommissioned per Washington Administrative Code requirements

- Deployment of direct push technology for the near-surface characterization in the north portion of S tank farm Two areas have been identified for the Phase 1 characterization These areas include the north end of the S tank farm in the vicinity of tanks S-102 and S-104 The S tank farm areas of interest include southeast of the S-104 tank the unplanned release (UPR) near diversion box 241 S-B and the area east of tank 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) Sediment samples would be collected between the tank farm surface and approximately 16 7 m (55 ft) bgs using direct push technology Although near-surface characterization is focused typically on the upper 4 6 m (15 ft) the sampling method has the capability to sample deeper and provide additional data for the characterization activities

This SAP describes two distinct field scope elements thus it is divided into two parts

Part I – Installation of a slant exploratory borehole

Part II – Near-surface characterization between the tank farms and S tank farm

Technical procedures or specifications that apply to this work include Waste Management Federal Services sampling and geophysical surveying procedures (SML-EP-001), sample and mobile laboratories procedures (SML-EP-001), and vadose zone characterization at the Hanford tank farms high-resolution passive spectral gamma-ray logging procedures (P-GJPO-1783) All field and laboratory work prescribed by this SAP shall also be in conformance with Hanford

analytical services quality assurance requirements document (HASQARD) (DOE/RL-96-68) Field and laboratory personnel should be familiar with these documents, as appropriate and maintain a copy for guidance during work activities

The field activities related to this investigation consist of vadose zone sampling and sample analysis This SAP addresses the requirements of the vadose zone sampling and analysis

The quality assurance project plan, Appendix A of the Phase 1 *Resource Conservation and Recovery Act of 1976* Facility Investigation/corrective measures study (RFI/CMS) work plan (DOE/RL-99-36), is an integral part of the SAP and they must be used jointly HNF-5272, data quality objectives workbook of WMA S-SX, references the sampling analytical quality assurance and quality control requirements that must be used to obtain representative field samples and measurements Knowledge of the health and safety plan Appendix B of DOE/RL-99-36, is required by those involved in the field sampling, because it specifies procedures for the occupational health and safety protection of project field personnel The data management plan, Appendix C of DOE/RL-99-36, denotes the requirements for field and laboratory data storage The waste management plan, Appendix D of DOE/RL 99-36, denotes the requirements for the management of investigative derived waste and the appropriate collection characterization and designation of waste produced by the characterization activities

The proposed technique for collecting sediment samples will be a removable tip in conjunction with a split-spoon sampler to allow driven samples to be collected ahead of the casing The removable tip concept would likely lead to contamination problems on the inside of the borehole casing and would require the tip to be replaced with a new one each time it was removed and limit the ability to geophysical log the borehole The split-spoon sampler that would be used would be approximately 2-in diameter by 2 ft-long with a 4-in -diameter shielded lead casing around the sampler The hole would result in being 4-in in diameter after the sample was collected, but only a 2-in sample would be collected and brought to the surface The 2-ft sample would allow for the depth of penetration to be beyond potential disturbed sediments below the end of the hole and would bring sediments unable to be handled to the surface This approach is still in the developmental stages and would be one that would be demonstrated outside the tank farms prior to implementation inside the tank farms This method would collect enough sediment sample to be analyzed, and provide the least amount of disturbance therefore providing a sample that is as close as possible to representative sample

There are backup approaches that could be taken to collect sediment samples during casing extraction if collecting a split-spoon sample is found to be impractical These options include using a sidewall sampling tool and scraping or under-reaming the hole and collecting the material with a split spoon sampler

In case the sidewall sampling technique will be maintained in the event that split-spoon sampling cannot be implemented or additional sampling horizons are identified The prototype spring sampler initially proposed for sample collection during decommissioning of borehole 41-09-39 had little success and a number of design modifications were made during the course of the decommissioning It became apparent during this process that development of sampling tools while working in the tank farm is cost prohibitive and that unexpected field conditions warrant having alternative sampling techniques available A drop-arm sampler was fabricated as a backup to the spring sampler and after being effectively deployed became the main sampling tool throughout the 41-09-39 decommissioning effort Samples were recovered from every sampling horizon attempted Drawbacks with all of the sidewall sampling techniques are sample volume and the depth of penetration into the formation Because sample volume is limited multiple sampling attempts at each horizon of interest are necessary The depth of penetration is an issue relative to the dragdown argument with the idea being if a representative sample of sufficient penetration can be collected then a gamma energy analysis conducted along the length of the sample could be used to assess near-borehole contamination versus contamination in the formation The drop arm sampler penetrates approximately 4 in into the formation whereas the spring sampler is designed to penetrate approximately 6 in into the formation

Contaminant dragdown during drilling and sampling activities is unavoidable and has been observed in recent sampling activities Different drilling/sampling techniques will impact dragdown to varying degrees Because the objective of the characterization activities identified in the data quality objectives is to safely sample in and below the "hot" zone in a region of known leakage and not to tag the leading edge of a contaminant plume, the dragdown issue is a secondary concern

To reduce the uncertainties associated with placing a slant borehole under tank SX-108, a demonstration is planned outside of the tank farms to evaluate the techniques for installing the borehole implementing all sampling method techniques and collecting samples This demonstration will help refine the borehole angle and the sample collection methods The sampling method that provides the best results through implementation and scheduling issues (i e time management) will be deployed The current planning basis for the slant borehole beneath tank SX-108 includes the following

- The borehole enters the ground at approximately the 11 o clock position 12 2 m (40 ft) from the edge of the tank nominally 30° off vertical, heading directly underneath the center of the tank (toward the 5 o'clock position) at nominally 30° off vertical 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 unit or to the maximum depth of contamination, whichever is deeper

- Sediment samples would be collected using a split-spoon sampler ahead of the borehole casing The samples would be transported to the laboratory and analyzed for the contaminants of concern identified in Tables A 1 and A 2 Nominally, 10 horizons would be sampled based on existing logging and the need to provide depth coverage

An optional method for collecting samples from the area of interest under tank SX-108 involves a direct push (or some other alternative sample collection method) out horizontally from an existing caisson This option has the potential to collect the necessary samples within and below the hot zone however, there are a number of issues associated with the caissons that require further evaluation A task has been identified in the fiscal year 2000 plan to evaluate the feasibility of using the caissons for sample collection under tank SX-108

Procedures for decontamination of sampling equipment are contained in WP 2 2, "Field Cleaning and/or Decontamination of Equipment (ES-WSPM-001)

The depth of the vadose zone boring will be to the maximum depth of contamination or the top of the Plio-Pleistocene unit whichever is deeper unless perched water is encountered If the U S Department of Energy desires to continue the borehole through a perched water zone then a waiver from the Washington State Department of Ecology (Ecology) would be required If the U S Department of Energy does not seek a waiver or if it is sought but denied by Ecology then, drilling will be terminated and the borehole decommissioned with approved material In this case decommissioning will commence immediately following final geophysical logging of the borehole

The use of field screening instruments will be used for evaluating alpha- beta-, and gamma-emitting radionuclides Radiological screening is expected to be effective in determining the initial extent of contamination

Table A 2 Constituents and Methods for Organic Analysis of Borehole Sediment Samples

Analysis/Constituent	Preparation Method	Preparation Procedure Number	Analytical Method	Analytical Procedure Number
VOA	Bulk Sediment	Note 1	GC/MS	SW846 8260
SVOAs with TICs	Bulk Sediment	Note 1	GC/MS	SW846 8270
PCBs (Note 2)	Bulk Sediment	Note 1	GC	GW846 8082

Note 1 Preparation/extraction procedures for VOA and SVOA analysis will depend on the types of organic compounds present in the sediment
Note 2 Analyzed on selected samples collected from the near surface characterization effort

GC = gas chromatography
MS = mass spectrometry
PCBs = polychlorinated biphenyls
SVOA = semi volatile organic analysis
VOA = volatile organic analysis

In addition to the borehole geologic logging, radiation measurements will be made using hand-held instruments on each segment of sample recovered during sampling General observation will be noted as to drilling progress and problems All of this information will be included in each borehole geologic log Borehole geologic logs and well summary sheets will be prepared in accordance with approved or standard methods procedures

A geologist will prepare a geological log for the slant borehole, based on the sediment samples Borehole geologic logs will be prepared in accordance with approved procedures The geologic log will include lithologic descriptions sampling intervals, health physics technician hand-held instrument readings, screening results, evidence of any alteration of sediments, and general information and observations deemed relevant by the geologist to the characterization of subsurface conditions Sediment samples will be screened with hand-held instruments for radiation as appropriate using techniques and procedures defined in the work package Screening results and general observations as to drilling progress and problems will be included in each borehole log

Waste containing unknown, low-level mixed radioactive waste and/or hazardous waste will be contained stored, and disposed of according with Appendix D of DOE/RL 99-36 and specified in the quality assurance project plan (Appendix A of DOE/RL-99-36) and will be documented in the field activity reports Investigative-derived waste will be disposed of in accordance with Appendix D of DOE/RL-99-36 and the Mixed Waste Burial Grounds All important information will be recorded on a field activity report forms per approved procedures Field activity report form includes borehole number, site location drawings, drawing of the downhole tool strings site personnel sampling types and intervals zones noted by the health physics technician as elevated in radiological contaminants instrument readings will be noted and the depth represented by those readings and specific information concerning borehole completion

The slant borehole will be abandoned following completion of the geophysical surveying All steel casing will be removed and transferred to an appropriate disposal facility or controlled decontamination facility and the borehole will be pressure-grouted from the bottom up, using a Portland cement/bentonite slurry or other appropriate material in accordance with WAC 173-160 Specific procedures for borehole abandonment will be documented in the field work package These procedures will comply with U S Environmental Protection Agency requirements and WAC 173-160

A 3 1 2 Geophysical Surveying Activities

Based on sampling and construction methods, downhole spectral-gamma or gross gamma geophysical logging will be conducted to ascertain the gamma-emitting radionuclide concentrations The spectral gamma or gross gamma logging frequency will be directed by Lockheed Martin Hanford Corporation (LMHC)

A full suite of geophysical logs will be run any time the casing size is changed and at the completion of the borehole Because the proposed sampling method involves pulling split-spoon samples up through the borehole there is a high probability that the inner bore of the casing will become contaminated Following completion of the sampling the contamination levels will be evaluated and a determination will be made on the utility of geophysically logging the borehole

The following logging techniques could be used for the slant borehole

- Gross-gamma logging to support correlation of confining layers and stratigraphy
- Spectral-gamma logging for measuring the distribution of selected radionuclides
- Neutron log for measuring the relative moisture content
- Neutron enhanced spectral gamma logging for correlation of high salt tank waste and moisture content with spectral gamma and neutron probes, respectively

The existing equipment and procedures for gross-gamma and spectral-gamma logging in use at the Hanford Site provide acceptable data (P-GJPO-1783)

A 3 1 3 Sediment Sampling Activities

Borehole sampling will be performed to define the nature of contamination Data from the borehole samples and analyses may provide evidence concerning how radionuclides and other contaminants migrate in the vadose zone and will support refinement of the general lithology and hydrostratigraphy of the sediments lying below the site It also will provide sediment samples for determination of sediment chemistry and vadose zone properties This SAP is specific to this borehole sampling event, and is not applicable to future borehole sampling events

For the slant borehole sediment sampling will be conducted beginning at 16 7 m (55 ft) bgs and will continue at discreet intervals of approximately 1 5 m (5 ft) until maximum depth of contamination or the Plio Pleistocene unit is reached Figures A 2 and A 3 show the proposed sampling strategy for the slant borehole

SP 4-1, "Soil and Sediment Sampling" (ES-SSPM-001) and in accordance with the quality assurance project plan (Appendix A of DOE/RL-99-36) All samples for laboratory analysis will be transported under chain of custody in accordance with the quality assurance project plan (Appendix A of DOE/RL-99-36)

Sediment cuttings containing low-level and mixed radioactive waste will be contained stored and disposed of according to procedures defined in Appendix D of the Phase 1 RFI/CMS work plan (DOE/RL-99-36) Sediment cuttings containing hazardous waste and those containing unknown waste will be contained and disposed of in accordance with Appendix D of the Phase 1 RFI/CMS work plan (DOE-RL-99-36) at the Mixed Waste Burial Grounds Storage of archive samples will be done until approval to dispose of the samples is provided by the LMHC technical representative

A 3 2 1 Sediment Sample Analysis

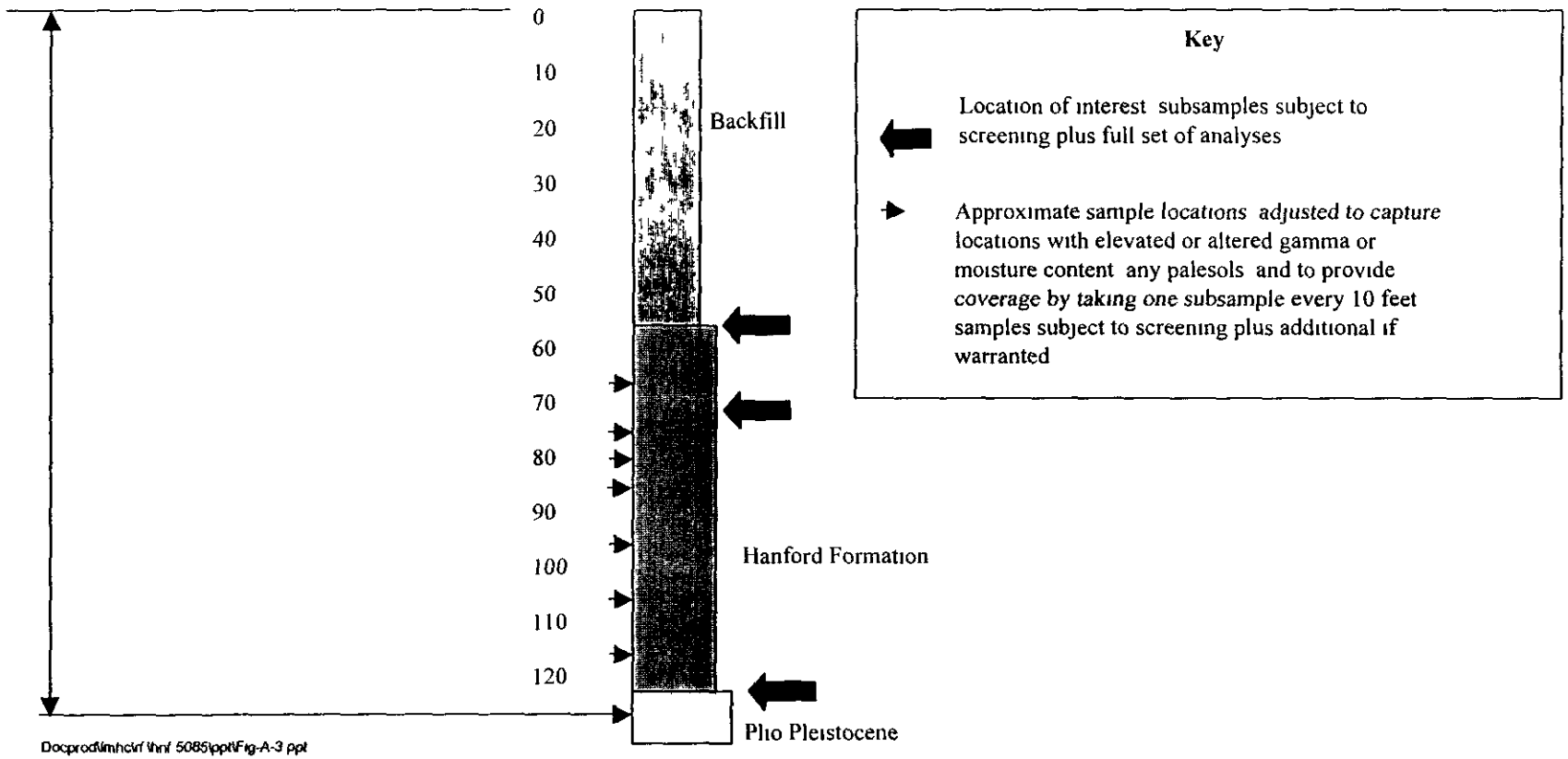
Geologic logging for this borehole will be conducted as it was for the borehole 41-09-39 extension Specifically once sample material from the slant borehole is received at the laboratory it will be geologically logged by an assigned geologist in general conformance with standard procedures The assigned geologist will photograph the samples and describe the geologic structure, texture, and lithology of the recovered samples Special attention is to be paid to the presence of contaminant alteration If such a phenomenon is noted, that sample will be noted, preserved for more detailed physical, chemical, and mineralogic analyses, and recorded in the laboratory notebook

Sediment samples for laboratory analysis will be defined by location in the sample after the field screening and geologic logging have been completed and indication of contamination locations have been identified Approximately 10 sediment samples from the borehole will be chosen for screening analysis Screening analyses consist of nitrate, electrical conductivity, total organic/carbon/total carbon, and pH The following criteria will be used to identify samples for laboratory analysis based on concurrence with Ecology

- One subsample will be taken at approximately 17 m (55 ft) bgs, at or near the base of the tank
- Subsamples will be taken at the major lithology changes in the Hanford formation
- One subsample will be taken at the Plio-Pleistocene unit and Hanford formation contact
- Subsamples will be taken in locations where elevated or altered gamma surveying was measured during the geological and geophysical borehole logging process based on nearby geophysical drywell logging
- At least one subsample will be taken every 3 m (10 ft) if samples have not already been taken based on the above criteria to ensure continuous distribution and lithologic completeness

Worker safety considerations may limit the collection of samples at certain intervals Figure A 3 shows the subsamples identified for laboratory analyses A 1 1 water extract of all subsamples shall undergo screening analyses which consist of nitrate analysis by the colorimetric method

Figure A 3 SX-108 Borehole Subsample Analyses Strategy



pH measurement, electrical conductance measurement In addition each subsample will be directly measured for gamma emitters by gamma energy analysis These analyses along with the gamma surveying and moisture content measurements performed during the field geophysical surveys and the geologic logging, will be used to determine the extent of further subsample analysis Table A 1 identifies the full complement of analyses and their respective laboratory preparation and analytical methods This paragraph and the remainder of Appendix A identifies which analysis will be conducted on which sample If more than one preparation or analytical method is listed, the expertise of the laboratory geochemistry staff will be used to determine which methods will produce the best results and will provide the best understanding of the chemistry involved For those methods that produce multiple constituents (i e , inductively coupled plasma), all constituents identified will be reported Every effort is to be made to meet regulatory holding times where appropriate

Because the purpose of the slant borehole analysis is to gain an understanding of the nature and extent of contamination, the fate and transport of the contaminants in the vadose zone, and to produce RCRA-compliant data, the analysis of these subsamples consists of two levels The baseline level involves analysis of inorganic and radiochemical constituents in full conformance with HASQARD and with no modifications to methods (as defined by HASQARD) without concurrence from the LMHC technical representative and from Ecology Substitutions and deviations to methods as defined by HASQARD will not require concurrence from Ecology The second level involves a research-type approach to the analyses In this level, procedures may be modified or developed to gain a more comprehensive understanding of the dynamics involved Although specific quality control criteria do not apply to this level, compliance with an approved quality assurance plan provided by the primary laboratory will be performed and research analysis will be initiated following notification and approval of the activities by the LMHC technical representative

The backfill – Hanford formation contact sample peak gamma concentration sample and the sample obtained at the Hanford formation and Plio-Pleistocene unit contact will be analyzed for the constituents and properties identified in Table A 1 It is recognized that conditions may occur when all of the an ilyses identified in Table A 1 are not warranted (e g , limited potential for data) and these occurrences will be evaluated on a case-by case basis

One sample from at or near the base of the tank will be analyzed for volatile organics identified in Table A 2

The remaining samples will be analyzed for specific constituents listed in Table A 1 depending on the results of the nitrate electrical conductivity, total organic carbon/total carbon, and pH screening analyses A review of the screening analyses results with technical representatives along with Ecology will be conducted prior to performing additional analyses Screening analysis may be used to determine whether alternative analytical techniques with lower detection limits should be used for specific radionuclides of concern The screening criteria and associated analytical requirements are identified as follows

- Gamma-emitting radioisotopes by gamma energy analysis
- Metals and radioisotopes by inductively coupled plasma-mass spectrometry

- Tritium and strontium 90 by the liquid scintillation method
- Particle size distribution
- Carbon 14

A minimum of two samples collected within the Hanford formation will be analyzed for metals as identified in Table A 1

The data obtained from the above analyses will be used to evaluate the location of contamination plumes in the sediment column The results of the above analyses will also be used to determine if additional analyses are warranted Additional analyses would be performed based on the judgement and expertise of the responsible Pacific Northwest National Laboratory geochemist, with concurrence from the LMHC technical representative and Ecology The following analyses would be performed as additional analyses

- Cation exchange capacity
- Mineralogy
- Matric potential
- K_d (distribution coefficient)
- Bulk density
- Moisture retention
- Saturated hydraulic conductivity

Tables A 1 and A 2 identify the analyses and laboratory methods to be used for the sample analyses For the chemical and radiological constituents the preferred methods are those listed in SW-846 (EPA 1986) or the American Society for Testing Materials standards (ASTM 1998) The requested constituents may be analyzed by laboratory-specific procedures, provided that the procedures are validated and conform to HASQARD Both the EPA SW-846 methods and the Pacific Northwest National Laboratory methods listed in Tables A 1 and A 2 are based on techniques from ' Methods of Soil Analysis " Therefore these procedures should be comparable The detection limit, precision and accuracy guidelines for the parameters of interest are listed in the data quality objectives workbook for WMA S-SX (HNF-5272)

PART II

NEAR-SURFACE CHARACTERIZATION

The following is a discussion of the field tasks and associated subtasks required for the sampling and sample analysis associated with the near-surface characterization in the northern portion of S tank farm The tasks are generally parallel to those addressed for the slant borehole

A 4 0 PROJECT MANAGEMENT (TASK 1 OF CHAPTER 5 0)

Project management will be followed as described in the Phase 1 RFI/CMS work plan (DOE/RL-99-36)

A 5 0 GEOLOGIC AND VADOSE ZONE INVESTIGATION (TASK 2 OF CHAPTER 5 0)

As with installation of the slant borehole, the geologic and vadose zone investigation task for the near-surface characterization has two subtasks Subtask 2a-Field Activities and Subtask 2b-Laboratory Analysis The following subsections describe each of the subtasks with a field activity component

A 5 1 FIELD ACTIVITIES (SUBTASK 2A OF CHAPTER 5 0)

The field activities addressed in this subtask that are required to support the geologic and vadose zone investigation are geophysical surveying, sediment sampling, and reporting

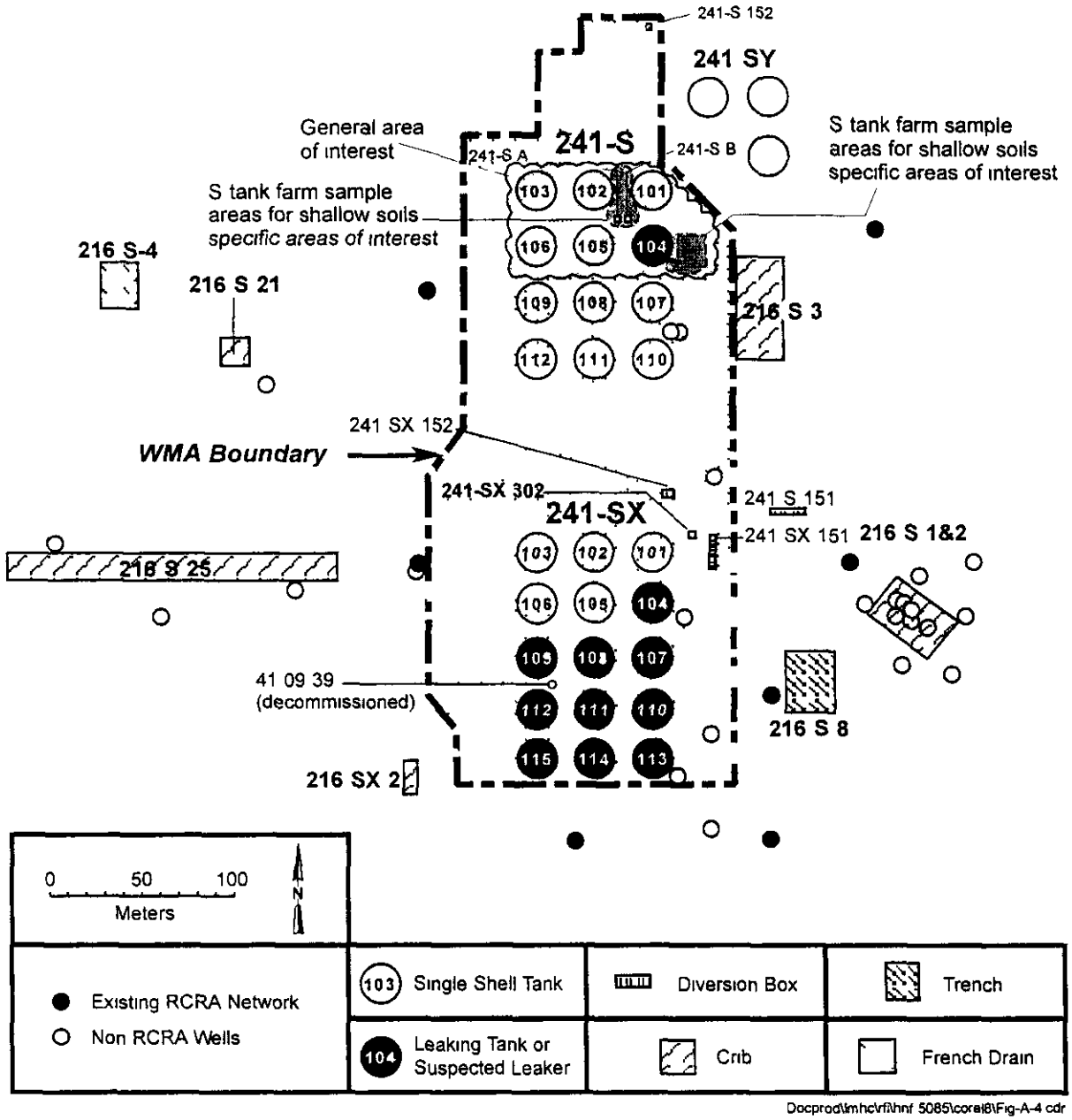
A 5 1 1 Exploratory Activity

Two areas have been identified for the Phase 1 shallow vadose zone soil characterization These areas are within the north end of the S tank farm The S tank farm areas of interest include southeast of tank S-104, the UPR near diversion box 241-S-B, and the area east of tank 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) For the purpose of the data quality objectives, the shallow investigation of these areas would consist of collecting samples at approximately nine locations The general sampling locations are identified on Figure A 4 Sediment samples would be attempted from the tank farm surface to approximately 16 7 m (55 ft) bgs using direct push technology Although near-surface characterization is focused typically on the upper 4 6 m (15 ft) both sampling methods have the capability to sample deeper and provide additional data for the characterization effort

Direct push deployment at the shallow zone characterization locations would include the following

- Shallow soil characterization will be carried out using a truck mounted cone penetrometer-based system

Figure A 4 Waste Management S-SX Shallow Soil Sampling Locations



- Deployment and interrogation with a gross-gamma/spectral gamma cone penetrometer probe The depth of investigation will be determined by the depth to which the probe can be advanced using a standard deployment truck The probe will be deployed using the gross gamma mode with the tool advanced at approximately 2 cm/sec (0 8 in /sec) If, in the upper 5 m (15 ft) the downhole instrument indicates a potential cesium-137 concentration of 3 7 pCi/g or greater, logging will be shifted to the spectral mode to determine the presence and level of concentration of cesium-137 below 5 m (15 ft) the threshold limit for spectral gamma determinations will be 20 pCi/g In zones where cesium-137 is present at concentrations greater than 20 pCi/g, spectral gamma readings will be taken at 0 5 m (1 5 ft) intervals In all cases gross gamma measurements are to be taken while the probe is advanced

- The graphical log developed using the gross and spectral gamma measurements will be used to select intervals to be sampled

- The sampling push is to be made in a location that is no more than 0 7 m (2 ft) from the site of the gamma push

- A single point sampler will be used to collect the required samples Sampling intervals will be selected from those horizons with a cesium-137 concentration of 20 pCi/g or greater In the event that horizons are penetrated that would yield samples having a greater that 50 mrem/hr dose rate at 30 cm (12 in) (based on calculations using sampler size and cesium-137 concentration) a sample will be collected from the first interval below the high rate zone having a dose rate of less than 50 mrem/hr

- The samples would be transported to the laboratory and analyzed for the contaminants of concern identified in Table A 1

As a contingency if direct push technology was not feasible a hollow-stem auger deployment at the shallow zone characterization locations would be implemented

The samples selected for analysis would be subject to screening analyses, which consist of nitrate analysis by colormetric method pH, electric conductance, and gamma energy analysis Based on the results of the screening, the samples would be analyzed for the remaining contaminants of concern identified in Table A 1

Two separate areas are to be characterized The areas consist of the vicinity of tank S-102 and the vicinity of tank S-104 These two sites exhibit separate instances of cesium-137 in vadose zone dry wells that may be indicative of near-surface sources In addition, the region to the east of tank S-104 has potentially been impacted by a tank overfill event in the SY double-shell tank farm A total of nine push sites have been identified An average of four samples per site will be collected

A 5 1 1 1 241-S-104 Site

The highest recorded levels of cesium-137 contamination associated with this site are in borehole 40-04-05 in the southeast quadrant of the tank Contamination is estimated at about 10^6 pCi/g at

a depth of about 14 m (48 ft) bgs Up to five sets of gamma probe and sampling pushes may be made to investigate this site The pushes include the following

- Adjacent to the 40-04-05 drywell, between the drywell and the tank This location will be to ascertain if there is a vertical gradient between the push location and the identified elevation of contamination in 40-04-05 and to collect a sample from below the contaminated zone to determine if mobile contaminants are moving ahead of the cesium-137 hot spot

- Adjacent to tank S-104 at the 5 o'clock position This location is to be as close to the tank as the push-truck can be positioned within dome-load restrictions The S tank farm tanks are constructed with a spare inlet port at this point Experience in other farms has shown that these spare inlet ports are subject to failure if a tank is overfilled This push will test the hypothesis that the contamination adjacent to the tank is due to an overfill event

- Adjacent to the normal fill line at the 3 o clock position This location is to be within 3 to 4 5 m (10 to 15 ft) of the tank and as close to the fill line as safety considerations allow This location will be used to determine the horizontal and vertical extent of the contamination found in the 40-04-05 borehole

- Adjacent to the S tank farm fence line This location will be used to determine the impact to shallow soils due to the surface release and subsequent ponding that occurred in the SY tank farm

- Midway between the previous two pushes This location would only be interrogated if positive determinations of contamination were found in one of the two previous pushes

A 5 1 1 2 241-S-102 Site

The highest recorded levels of cesium-137 contamination associated with this site are in borehole 40-02-03 in the northeast quadrant of the tank Contamination is estimated at about 10^6 pCi/g at a depth of about 6 m (20 ft) bgs Four sets of gamma probe and sampling pushes are planned to investigate this site The pushes include the following

- Adjacent to tank S-102 northwest of drywell 40 02-03 Because no contamination is detected in drywell 40-02-01 this push will be used to determine the extent of contamination in a northwesterly direction from borehole 40-02 03 The push will be situated about midway between the boreholes and as near the tank as safety considerations allow

- Along the line projected between 40-02-01 and 40-02 03, north of the cascade line between tanks S-101 and S-102 This location will provide information on the extent on contamination known to exist at 40-02 03 and assess the depth of movement of that contamination

- Along the line projected between 40-02-01 and 40-02 03, south of the cascade line between tanks S-101 and S-102 and near the 241 S-A diversion box This location will

provide information as to the extent and general direction of movement of contaminants for this site In addition the accumulation pit associated with the 241-S-A will be assessed as a possible contributor to the contamination

- Adjacent to the 241-S-B diversion box The potential for contamination in this region to be related to operation of the 241-S-B accumulation pit will be assessed

A 5 1 1 3 Additional Pushes (Optional)

Additional pushes may be made based on the information developed during the initial campaign or decisions of River Protection Project Vadose Zone Project management These additional pushes will be determined based on the determined extent of contamination and (1) the availability of both the cone penetrometer truck and crew and (2) availability of budget and support personnel

A 5 1 2 Field Quality Control

After the samples are screened, these samples will be transported to the Pacific Northwest National Laboratory (Applied Geology and Geochemistry group) for analysis All material removed from the push holes will be sent to the laboratory for possible future analysis Samples will be contained in airtight sample containers after their initial screening by the health physics technician and are to be kept under refrigeration This process is used to retain sediment moisture in as close to field condition as possible and prevent chemical and physical changes from occurring All samples will be transported to the laboratory under refrigeration to further limit alteration of sediment moisture

Field quality control samples also will be submitted for the full spectrum of chemical and radionuclide analyses These quality control samples will consist of the following

- Field duplicate samples A minimum of 5% of the total collected samples shall be duplicated or one duplicate for every 20 samples, whichever is greater

- Equipment rinseate blanks One equipment rinseate blank per direct push or if multiple types of samplers are used, once per type of sampler

A 5 1 3 Geophysical Surveying Activities

Prior to sediment sampling using the direct push downhole gross gamma and spectral gamma geophysical surveying will be conducted to ascertain the gamma-emitting radionuclide concentration in the surrounding sediments After each push with the direct push or each borehole with the hollow-stem auger decommissioning will occur

A 5 1 4 Field Reporting Activities

Field logs will be maintained to record all observations and activities conducted A site representative will record the activities on a field activity report Items for entry will include the following

- Direct push or borehole number
- Site location drawings including distances from known locations
- Drawings of the downhole tool strings for direct push or auger drilling
- Site personnel present
- Sampling types and intervals
- Zones noted by the health physics technician as elevated in radiological contaminants
- Instrument readings and the depth represented by those readings
- Specific information concerning borehole completion

All completed field records will be maintained and processed in accordance with approved LMHC procedures

A 5 2 LABORATORY ANALYSIS (SUBTASK 2C OF CHAPTER 5 0)

The following sections describe the laboratory analyses required for the samples collected from the near surface characterization

A 5 2 1 Near-Surface Characterization Sediment Sample Analysis Requirements

A total of approximately nine site locations have been identified for the near-surface characterization effort Once received at the laboratory these samples shall undergo analysis using the analytical methods listed in Table A 1 This analysis may be sample-limited Therefore hold points have been inserted into the process to allow the laboratory and LMHC technical staff to collaborate and review data before each new round of analyses Analyses may be reprioritized based on the results of other measurements

Based on the results of the screening analyses that was identified in the slant borehole and spectral gamma surveys performed during the field geophysical surveys, and the geologic logging and field notes geological technical experts, LMHC technical staff the laboratory technical staff and decision-makers (Ecology and the U S Department of Energy) will convene to determine what if any, additional analyses should be conducted Some of the determining criteria will be the amount and integrity of the remaining sample, screening analytical results and regulatory requirements Based on these decisions additional analyses will be performed

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