9.0 FACILITY RADIATION SURVEYS

PURPOSE OF THIS SECTION

The purpose of this section is to describe radiation surveys to be performed in connection with Phase 1 of the WVDP decommissioning.

INFORMATION IN THIS SECTION

This section first refers to the cleanup criteria for surface soil, subsurface soil, and streambed sediment that will be used to ensure that the level of remediation achieved during Phase 1 will not limit options for Phase 2 of the decommissioning. It then identifies the types of radiological surveys to be performed and the purpose of each survey. Requirements for background surveys, characterization surveys, in-process surveys, and the Phase 1 final status surveys are described.

This section outlines the survey process for each waste management area and then for environmental media. It concludes with a summary of requirements for the Phase 1 Final Status Survey Report.

While this section addresses all applicable requirements for facility radiation surveys, it does so in general terms because two supplemental documents will provide additional details: a Characterization Sample and Analysis Plan and a Phase 1 Final Status Survey Plan.

RELATIONSHIP TO OTHER PLAN SECTIONS

To put into perspective the information in this section, one must consider:

- The information in Section 1 on the project background and those facilities and areas within the scope of the DP;
- The information in Section 2 on facilities to be removed before the Phase 1 decommissioning activities begin;
- The facility descriptions in Section 3;
- The information on the results of scoping and characterization surveys contained in Section 4 and Appendix B;
- The information in Section 5 on dose modeling and cleanup criteria; and
- The decommissioning activities and related characterization activities described in Section 7.

The characterization survey process described in this section applies to characterization surveys performed in connection with decommissioning activities described in Section 7.

The survey methodology specified in this section is consistent with the provisions of NUREG-1757, Volume 2 (NRC 2006) and with the guidance found in NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (NRC 2000). It is also consistent with DOE requirements of DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.

As used in this section, the term *surveys* includes both systematic scanning and static measurements performed with an appropriately-sensitive instrument calibrated to the radiation of interest, as well as the laboratory analysis of physical samples of potentially contaminated media.

9.1 Release Criteria

Release criteria are based on the dose modeling described in Section 5 and the planned end-states for facilities and areas within the scope of the plan as discussed in Sections 1 and 7. The appearance of the Phase 1 end-state for the project premises will be similar to that shown in Figure 1-5. As explained in Section 5, derived concentration guideline levels (DCGLs) were developed for surface soil, subsurface soil and streambed sediment.

Note that DCGLs for the WVDP Phase 1 decommissioning end state are expressed on the basis of 25 mrem total effective dose equivalent annually to the average member of the critical group. This annual dose is used as the basis for the cleanup criteria because the resulting DCGLs provide a conservative end state that ensures that all decommissioning options for the remainder of the project premises and the Center remain available in Phase 2.

DCGLs and Cleanup Goals

Because of the complexity of the site and the necessity to ensure that the Phase 1 cleanup activities will support a range of approaches that might be used for Phase 2 of the decommissioning, cleanup goals lower than the DCGLs will be used as indicated in Section 7. These goals are identified in Table 5-14 of Section 5. The cleanup goals are referred to in this section simply as the DCGLs for consistency in terminology.

The $DCGL_W$ is the release criterion based on average concentration of radioactivity distributed over a large area. Area factors are used to adjust the $DCGL_W$ values to estimate the $DCGL_{EMC}$, the criterion for small areas of contamination elevated above the release criterion and to estimate the minimum detectable concentration for scanning surveys.

The $DCGL_W$ and $DCGL_{EMC}$ values (i.e., the cleanup goals) for 18 radionuclides of interest are expressed in Table 5-14 in Section 5. Tables 9-1, 9-2, and 9-3 provide ranges of area factors. The DCGLs apply to the following areas:

- The surface soil DCGLs apply to surface soil throughout the project premises where there is no subsurface contamination below one meter and to the sides of the WMA 1 and WMA 2 large excavations from the ground surface to one meter below the ground surface,
- The subsurface soil DCGLs apply only to the bottoms of the WMA 1 and WMA 2 large excavations and to the sides of these excavations from the bottoms up to one meter below the ground surface, and
- The streambed sediment DCGLs apply only to the streambeds and banks of the portions of Erdman Brook and Franks Creek shown in Figure 5-12.

Table 9-1 Surface Soil Cleanup Goal Area Factors[1]

Nuclide	$DCGL_W$ 10,000 m^2 (pCi/g)	Area Factors ($DCGL_{EMC}/DCGL_W$)	
		100 m^2	1 m^2
Am-241	2.6E+01	1.5E+01	1.5E+02
C-14	1.5E+01	2.8E+02	1.1E+05
Cm-243	3.1E+01	3.0E+00	2.4E+01
Cm-244	5.8E+01	1.8E+01	2.1E+02
Cs-137	1.4E+01	2.8E+00	2.2E+01
I-129	2.9E-01	3.8E+01	2.1E+03
Np-237	2.3E-01	6.0E+00	3.2E+02
Pu-238	3.6E+01	1.7E+01	2.1E+02
Pu-239	2.3E+01	2.5E+01	3.0E+02
Pu-240	2.4E+01	2.4E+01	2.9E+02
Pu-241	1.0E+03	1.3E+01	1.3E+02
Sr-90	3.7E+00	2.6E+01	2.1E+03
Tc-99	1.9E+01	2.2E+01	1.4E+03
U-232	1.4E+00	5.4E+00	4.4E+01
U-233	7.5E+00	3.7E+01	1.1E+03
U-234	7.6E+00	4.1E+01	2.1E+03
U-235	3.1E+00	2.6E+01	1.9E+02
U-238	8.9E+00	2.9E+01	3.3E+02

NOTE: (1) The values in the second column are the cleanup goals (CG_W) from Table 5-14 and are based on the probabilistic peak-of-the-mean $DCGL_W$ values for combined soil-streambed sediment exposure assuming 22.5 mrem/y from surface soil. The area factors are based on the limiting case among the probabilistic analysis resident farmer analysis, the deterministic resident farmer analysis, and the deterministic residential gardener analysis.

Table 9-2. Subsurface Soil Cleanup Goal Area Factors[1]

Nuclide	$DCGL_W$ 2,000 m^2 (pCi/g)	Area Factors ($DCGL_{EMC}/DCGL_W$)	
		92 m^2[2]	1 m^2
Am-241	2.8E+03	1.1E+00	4.3E+00
C-14	4.5E+02	1.2E+01	1.8E+02
Cm-243	5.0E+02	3.2E+00	8.0E+00
Cm-244	9.9E+03	1.5E+00	4.5E+00
Cs-137	1.4E+02	9.3E+00	1.2E+01
I-129	3.4E+00	4.7E+00	9.9E+01
Np-237	4.5E-01	4.2E+00	9.6E+01
Pu-238	5.9E+03	1.0E+00	4.8E+00
Pu-239	1.4E+03	1.6E+00	1.9E+01
Pu-240	1.5E+03	1.5E+00	1.7E+01

Table 9-2. Subsurface Soil Cleanup Goal Area Factors(1)

Nuclide	$DCGL_W$ 2,000 m^2 (pCi/g)	Area Factors ($DCGL_{EMC}/DCGL_W$)	
		92 m^2(2)	1 m^2
Pu-241	1.1E+05	2.3E+00	6.2E+00
Sr-90	1.3E+02	2.6E+00	5.6E+01
Tc-99	2.7E+02	8.1E+00	5.7E+01
U-232	3.3E+01	2.1E+00	1.3E+01
U-233	8.6E+01	3.6E+00	1.1E+02
U-234	9.0E+01	3.6E+00	1.0E+02
U-235	9.5E+01	3.5E+00	3.5E+01
U-238	9.5E+01	3.6E+00	1.0E+02

NOTE: (1) The values in the second column are the cleanup goals (CG_W) from Table 5-14. The area factors are based on the multi-source analysis or the resident farmer analysis.

(2) The 92 m^2 area results from the grid spacing of the STOMP model, which is described in Section 5.

Table 9-3. Streambed Sediment Cleanup Goal Area Factors(1)

Nuclide	$DCGL_W$ 1,000 m^2 (pCi/g)	Area Factors ($DCGL_{EMC}/DCGL_W$)	
		100 m^2	1 m^2
Am-241	1.0E+03	2.9E+00	2.1E+01
C-14	1.8E+02	2.0E+01	3.3E+03
Cm-243	3.1E+02	1.2E+00	9.0E+00
Cm-244	3.8E+03	8.7E+00	9.4E+01
Cs-137	1.0E+02	1.2E+00	9.4E+00
I-129	7.9E+01	8.6E+00	2.5E+02
Np-237	3.2E+01	3.4E+00	3.3E+01
Pu-238	1.2E+03	9.1E+00	1.4E+02
Pu-239	1.2E+03	9.1E+00	1.4E+02
Pu-240	1.2E+03	9.1E+00	1.4E+02
Pu-241	3.4E+04	2.9E+00	2.2E+01
Sr-90	4.7E+02	7.2E+00	1.5E+02
Tc-99	6.6E+04	5.1E+00	6.3E+01
U-232	2.2E+01	1.2E+00	9.5E+00
U-233	2.2E+03	2.7E+00	2.0E+01
U-234	2.2E+03	8.5E+00	9.7E+01
U-235	2.3E+02	1.2E+00	8.6E+00
U-238	8.2E+02	1.4E+00	1.0E+01

NOTE: (1) The values in the second column are the cleanup goals (CG_W) from Table 5-14 and are based on the probabilistic peak-of-the-mean $DCGL_W$ values for combined soil-streambed sediment exposure assuming 2.5 mrem/y from streambed sediment. The area factors are based on the deterministic evaluation of the recreationist scenario.

A *surrogate radionuclide* is a radionuclide in a mixture of radionuclides whose concentration is more easily measured and can be used to infer the concentrations of the other radionuclides in the mixture. If actual radioactive contamination levels are below the specified concentrations of the surrogate radionuclide, then the sum of doses from all radionuclides in the mixture will fall below the dose limit of 25 mrem/y. Tables in Section 5 do not presently show $DCGL_W$ values for a surrogate radionuclide because available data on radionuclide distributions in soil and sediment are not sufficient to support this, but Section 5 may be revised after additional characterization data become available to provide such information.

As characterization and in-process surveys are performed, additional data will become available that could necessitate re-evaluation of the DCGLs, if, for example, assumptions used in development of the DCGLs were found to be incorrect based on the additional data. If such a situation develops, revised DCGLs will be calculated and this plan changed to incorporate the revised DCGLs and any related changes.

9.2 Types of Surveys and Their Purposes

Seven types of radiological surveys are associated with the WVDP Phase 1 decommissioning project: (1) background surveys, (2) scoping surveys, (3) end-of-task surveys taken at the conclusion of deactivation activities, (4) characterization surveys, (5) in-process or remedial action support surveys, (6) Phase 1 final status surveys, and (7) confirmatory surveys. The nature of these surveys and, in some cases, the basic requirements are summarized here; more detail is provided further below on background surveys (9.3), characterization surveys (9.4), in-process surveys (9.5), and Phase 1 final status surveys (9.6).

9.2.1 Background Surveys

Background surveys are performed in non-impacted areas around the facility and in non-impacted buildings of construction similar to those impacted buildings of interest. Background surveys establish the baseline levels of radiation and radioactivity from radionuclides occurring in the environment or incorporated into the structural materials. Requirements for background surveys are summarized in Section 9.3 below.

9.2.2 Scoping Surveys

Scoping surveys are conducted (1) to provide preliminary data to supplement historical site assessment information needed to guide planning of characterization surveys, (2) to identify radionuclide contaminants, (3) to identify relative radionuclide ratios, and (4) to identify the general levels and extent of contaminants. As noted in Section 4, much of the existing radiological data associated with the WVDP decommissioning project falls into the category of scoping survey data, although these data were generally not acquired as scoping survey data but were acquired for other operational needs. Additional scoping surveys are not planned for Phase 1 of the WVDP decommissioning.

9.2.3 End-of-Task Surveys

As explained in Section 1, additional deactivation work will be completed in certain areas of the Process Building during work to be accomplished before the Phase 1 decommissioning activities begin, and numerous ancillary project facilities will be removed during this period. After each area is deactivated and after each facility is removed, end-of-task or "final radiological characterization" surveys will usually be performed to define the resulting radiological conditions.

Such surveys are not within the scope of this plan since they will be completed before decommissioning activities begin. However, their results will be considered in connection with defining characterization surveys and Phase 1 final status surveys to be performed during the decommissioning.

9.2.4 Characterization Surveys

Characterization surveys include facility and site sampling, monitoring, and analysis activities to determine the extent and nature of residual contamination. They provide the basis for planning decommissioning actions, and provide technical information to develop, evaluate, and select appropriate remediation techniques. They also provide information for radiation protection purposes and for characterizing waste.

Four WVDP characterization survey programs have been completed: (1) the characterization program for the underground waste tanks, (2) the Facility Characterization Project, (3) a series of Resource Conservation and Recovery Act (RCRA) facility investigations performed in the 1990s, and (4) investigations of the north plateau groundwater plume using a Geoprobe®.[1] Additionally, routine groundwater and other environmental media sampling and analysis are performed as required by DOE Orders for annual monitoring programs. The results of these programs are summarized in Section 4. The approaches used are outlined in Section 9.7 below.

As indicated in Section 4 and Section 7, additional characterization will be performed. The requirements for this characterization are addressed in Section 9.4.

9.2.5 In-Process Surveys

In-process surveys, also referred to as remedial action support surveys, include facility and site sampling, monitoring, and analysis activities performed in support of decontamination work. They provide information necessary for radiation protection, for

[1] As indicated in Section 4, additional characterization of subsurface soil in the area of the north plateau groundwater plume was accomplished in 2008. The results of this program are summarized in Section 4. Also, a sample and analysis plan for additional characterization of the Waste Tank Farm was developed in 2008 and 2009 (Michalczak and Hadden-Carter 2009). This plan is expected to be implemented for additional characterization of Tank 8D-4 and possibly Tanks 8D-1 and 8D-2 as well.

guiding cleanup work, for determining when field decontamination goals have been attained, and to indicate when areas are ready for Phase 1 final status surveys. Requirements for in-process surveys are discussed in Section 9.5 below.

9.2.6 Final Status Surveys

A final status survey using MARSSIM guidance is performed to demonstrate completion of any necessary decontamination in preparation for release of the site or facility. To reflect the phased nature of the decommissioning, this plan uses the terminology "Phase 1 final status" and "radiological status" rather than "final status".

Because the decision to release or a final decision on status of the Phase 1 decommissioned areas will not be made until during Phase 2 decision making, using the terminology "final status" alone could be misinterpreted. The Phase 1 final status surveys consist of measurements and sampling to describe the radiological conditions at the close of Phase 1 decommissioning activities. The intent is that Phase 1 final status surveys will be designed with quality, quantity and statistical objectives such that the data could be used in a MARSSIM-based "final status" evaluation in the future without a need to re-survey the areas, unless subsequent site activities influence their status. Requirements for the Phase 1 final status surveys are addressed in Section 9.6 below.

Note that surveys of shallow excavations to remove infrastructure such as floor slabs, foundations, and hardstands are being performed in accordance with the Characterization Sample and Analysis Plan, rather than the Phase 1 Final Status Survey Plan. These surveys – which are similar to the Phase 1 final status surveys – are simply called "radiological status" surveys in recognition of the difference in the requirements document.

9.2.7 Confirmatory Surveys

Confirmatory surveys include limited, independent third-party measurements, sampling, and analysis to verify the results of the licensee's final status survey. Typically, confirmatory surveys conducted by NRC or its contractor consist of two components: (1) a review of the licensee's final status survey plan and report to identify any deficiencies in the planning, execution, or documentation, and (2) measurements taken at a small percentage of locations, previously surveyed by the licensee, to determine whether the licensee's results are valid and reproducible. (Note that while DOE is performing the Phase 1 final status surveys as part of its responsibilities under the WVDP Act, DOE is not the licensee for any part of the Center.).

DOE anticipates that NRC will arrange for independent in-process surveys to be performed after Phase 1 decommissioning work in an area is completed. DOE also anticipates that confirmatory surveys will be performed on an area basis after the Phase 1 final status survey has been completed for that area, a strategy that experience shows to be more efficient that a single confirmatory survey at the conclusion of the project. An *area* in this context may be a group of related survey units or an entire waste management area (WMA).

To facilitate NRC in-process and confirmatory surveys, DOE will:

- Keep NRC informed of the schedule and status of decommissioning activities and the Phase 1 final status survey,
- Notify NRC when particular areas are to be ready for confirmatory surveys, and

- Prepare the portion of the Phase 1 Final Status Survey Report that addresses survey results section-by-section and provide to NRC in draft form sections that describe DOE survey results for those areas in which NRC is to perform confirmatory surveys. Experience has shown that this practice promotes efficiency.[2]

9.3 Background Surveys

Some information on background radiation and radioactivity in non-impacted areas is available, such as that contained in annual site environmental reports (WVES and URS 2009) and that described in Section 4. Table 4-11 shows background concentrations in various environmental media for most radionuclides of interest.

Additional background measurements will be taken in connection with characterization surveys outlined in Section 9.4. The characterization surveys for environmental media will be described in a separate Characterization Sample and Analysis Plan to be developed and submitted for NRC review. The additional measurements will include exposure rates and samples from non-impacted soil in suitable non-impacted (background) reference areas. These additional samples will be subjected to appropriate radionuclide–specific analyses to address all 18 radionuclides of interest.

Applicable guidance for background surveys in the MARSSIM (NRC 2000) and in NUREG-1505 (Gogolak, et al. 1997) will be incorporated. Guidance provided in NUREG-1757, Vol. 2, (NRC, 2006) will be considered to ensure that quality objectives and survey execution, controls, and results are consistent with those of the characterization and Phase 1 final status surveys.

The surveys and sampling in non-impacted offsite areas to establish a basis for background radioactivity levels will be described in detail in the Characterization Sample and Analysis Plan. The application of the background data during assessment and use of the data obtained in the characterization and Phase 1 final status surveys will be based on guidance in Chapter 8 of the MARSSIM (NRC 2000) and will be described in each of the respective plans.

Since all surface soil in areas of interest on the project premises will be treated as impacted for Phase 1 final status surveys purposes, it is anticipated that the Sign test will be used in the Phase 1 final status surveys to show $DCGL_W$ compliance and application of a background reference area will not be necessary. (If the DCGLs were to be revised in a manner that results in lower values for naturally occurring radionuclides, the Wilcoxon Rank Sum test would be required instead, and a background reference area would become necessary.)

9.4 Characterization Surveys

As noted above, four formal characterization survey programs have been completed for portions of the project premises, additional characterization for the Waste Tank Farm is

[2] As explained in Section 9.8, DOE and the decommissioning contractor may choose to prepare multiple Phase 1 final status survey reports because of the site complexity. In this case, complete draft reports could be provided to NRC in support of the confirmatory surveys.

planned, and routine sampling and analysis of environmental media are performed in connection with the WVDP environmental monitoring program.

The Characterization Sample and Analysis Plan, the contents of which are described below, will provide for additional characterization of soil, sediment, and groundwater on the project premises. This plan is expected to be issued before the start of Phase 1 decommissioning activities. The characterization performed will be consistent with the following objectives and guidance.

9.4.1 Characterization Sample and Analysis Plan Content

This plan will provide details of characterization surveys to be performed to more precisely determine the extent and the amount of residual radioactivity in environmental media as Phase 1 decommissioning activities begin.

Scope of the Plan

The plan will focus primarily on radioactivity in soils, sediment, and groundwater on the project premises. It will also address the following matters:

- Identifying the presence of buried infrastructure,
- Collecting geotechnical data to support hydraulic barrier wall design,
- Determining the radiological status of soil around representative Process Building foundation pilings when they become accessible during demolition of the Process Building,
- Determining the radiological status of the HLW transfer trench after piping and equipment in the trench is removed,
- Determining the radiological status of soil in the bottom of shallow excavations after removal of infrastructure such as concrete slabs and foundations, and
- Collecting data to guide soil removal and to verify that remediation goals for a particular location have been achieved.

The plan will not address characterization of structures or characterization of materials (equipment, demolition debris, or excavated soil) for waste management purposes. Section 9.4.5 describes additional characterization surveys to support facility removal that will be performed in connection with Phase 1 decommissioning activities.

For characterizing materials for waste management purposes, the decommissioning contractor will provide a procedure and obtain DOE approval of this procedure. This procedure will be consistent with applicable DOE requirements and guidance, as well as any applicable State-specified waste acceptance criteria for radioactivity in the offsite landfill(s) where uncontaminated material may be disposed of. It will apply to, among other materials, surface and subsurface soil not known to have been impacted by radioactivity. (As an alternative, these matters may be addressed in the Waste Management Plan.)

Requirements and Guidance to be Followed

This plan will follow provisions in NUREG-1757, Volume 2 (NRC 2006) and applicable guidance of the MARSSIM (NRC 2000).

Radionuclides of Interest and Radionuclide Ratios

This plan will identify the radionuclides of interest. It will also address the variability of radionuclide ratios across the site and identify areas where the ratios need to be confirmed for use in the Phase 1 final status survey analysis. An additional 12 radionuclides have been identified as possibly (but unlikely to be) present at the site. In addition, the presence of progeny not in equilibrium with the 18 radionuclides of interest has also been identified as a possible concern. Both issues have the potential for requiring changes to the radionuclides of interest list. Data collected in implementation of the Characterization Sample and Analysis Plan will determine whether this is necessary.

Data Quality Objectives

This plan will identify data quality objectives (DQOs) for the characterization surveys, as discussed in Section 9.4.2.

Use of Characterization Data for Final Status Survey Purposes

A key objective of this plan will be to produce data for the Phase 1 final status survey of sufficient quality and quantity to serve final status survey purposes when practicable, and this matter will be addressed in the Characterization Sample and Analysis Plan.

Background Radiation and Radioactivity

The Characterization Sample and Analysis Plan will specify appropriate measurements in reference areas for materials and structures to establish background levels, taking into account available data on background radioactivity provided in Section 4, in Appendix B, and that compiled in connection with the WVDP environmental monitoring program.

Characterization Methods for Radioactivity

This plan will specify the methods to be used to collect the necessary characterization data. Among the methods considered will be:

- Exposure rate measurements
- Surface contamination scans
- Surface contamination direct measurements
- Smear surveys for removable contamination
- Soil samples
- Groundwater samples
- Sediment samples

Note that surface contamination scans, surface contamination direct measurements, and smear surveys for removable contamination apply only to surveys of the empty HLW transfer trench.

Other, more technically sophisticated characterization methods may be used as well, such as *in-situ* gamma spectroscopy and advanced characterization technologies that DOE has helped develop. Any new technology or instrumentation to be used will be shown to perform with sensitivities that allow detection of residual radioactivity at an appropriate fraction of the DCGLs and corresponding investigative levels.

Radiological Instrumentation

The Characterization Sample and Analysis Plan will specify the field and laboratory instruments to be used and the sensitivity of these instruments and methods. Table 9-4 shows typical field instruments to be addressed in the plan.

Table 9-4. Radiological Field Instruments

Survey Type	Instrument (or equivalent)	Characteristics	Approximate Sensitivity(2)	Remarks
Exposure rate	Eberline RO-7(1)	Ion chamber	> 1 R/h	For high-range readings.(3)
Exposure rate	Eberline RO-2(1)	Ion Chamber	0.1 mrem/h	For low-range readings. (3)
Exposure rate	Ludlum 44-10(1)	2-inch NaI scintillator	900 cpm/μR/h	For scanning soil, low potential areas.
Exposure rate	FIDLER	5-inch diameter NaI scintillator	500 cpm per uCi/m^2	For scanning soil for low energy gamma.
Alpha	Ludlum 43-89(1)	ZnS (Ag) scintillator, 100 cm^2 probe	100 dpm/100 cm^2 85 dpm/100 cm^2	Scans 100 dpm, direct measurements 85 dpm. (3)
Beta	Ludlum 43-89(1)	ZnS (Ag) scintillator, 100 cm^2 probe	2,500 dpm/100 cm^2 800 dpm/100 cm^2	Scans 2,500 dpm, direct measurements 800 dpm. (3)
Beta-gamma	Ludlum 44-40(1)	Geiger-Mueller (G-M) shielded pancake probe	3,300 cpm/mrem/h	For scanning in tight areas. (3)
Beta-gamma	Ludlum 44-9(1)	G-M unshielded pancake probe	3,300 cpm/mrem/h	For scanning in tight areas(3)
Beta-gamma	Ludlum 44-6(1)	G-M sidewall detector	1,200 cpm/mrem/h	For use as a pipe probe.(4)

NOTES: (1) To be used with an appropriate scaler-ratemeter.

(2) These are approximate values based primarily on manufacturer's ratings. The sensitivities depend on background, count time, and other factors. Calculated, more precise information will be specified in the Characterization Sample and Analysis Plan.

(3) Suitable for surveys of empty HLW transfer trench but not of soil areas.

(4) For use in surveys of underground lines on the edges of excavations as specified in Section 9.7.

Samples may be analyzed onsite or shipped to an offsite contract laboratory for analysis. Laboratory methods, instruments and sensitivities will be in accordance with New York State protocols for environmental analysis. Any laboratory used for environmental sample analysis

will have appropriate New York State Department of Health Environmental Laboratory Approval Program certification, or equivalent.

Table 9-5 indicates the target minimum detectable concentrations for radionuclides in laboratory analyses of soil samples. Minimum detectable concentration requirements are set to whichever is lower: (1) approximately 10 percent of the most restrictive radionuclide-specific cleanup goal identified in Table 5-14, (2) 25 percent of nominal background for naturally occurring radionuclides, or (3) standard laboratory minimum detectable concentrations.

Table 9-5. Radionuclide Target Sensitivity for Laboratory Sample Analysis

Nuclide	Instrument/Method	Target Sensitivity pCi/g(1)
Am-241	Alpha and/or gamma spectrometry	1(4)
C-14	Sample oxidizer and liquid scintillation	2(4)
Cm-243/244(5)	Alpha and/or gamma spectrometry	1(4)
Cs-137	Gamma spectrometry	0.1(4)
I-129	Gamma spectrometry and/or gas flow proportional counting	0.06(2)
Np-237	Alpha and/or gamma spec	0.01(2)
Pu-238	Alpha spectrometry	1(3)
Pu-239/240(5)	Alpha spectrometry	1(3)
Pu-241	Liquid scintillation	15(3)
Sr-90	Liquid scintillation	0.9(2)
Tc-99	Gas flow proportional counting	3(2)
U-232	Alpha spectrometry	0.5(2)
U-233/234(5)	Alpha spectrometry	0.2(3)
U-235 (-236)(5)	Alpha spectrometry	0.1(3)
U-238	Alpha spectrometry	0.2(3)

NOTES: (1) Dependent on sample size, counting time, etc.
(2) Approximately 10 percent of the most restrictive radionuclide-specific cleanup goal identified in Table 5-14.
(3) 25 percent of background for naturally occurring radionuclides.
(4) Standard laboratory minimum detectable concentrations.
(5) When analytical results cannot be identified to a single isotope, the results will be applied to the isotope with the more restrictive DCGL.

Survey Locations

This plan will specify how to locate and identify sampling and measurement locations, such as how to lay out and mark appropriate size survey grids. Grid control points and positions of samples and survey readings within the grid will be located using global position system devices or conventional surveying. Class 1, Class 2, and Class 3 survey units are discussed in Section 9.6.1.

Surveys and Sampling of Individual Facilities and Areas

This plan will specify the type and extent of characterization measurements in different facilities and areas.

Handling Waste Generated During Characterization

The Characterization Sample and Analysis Plan will specify how to minimize and manage investigative derived waste.

Health and Safety

This plan will identify health and safety requirements associated with characterization activities; it may reference the project Health and Safety Plan for this purpose.

Quality Assurance

The Characterization Sample and Analysis Plan will address quality control and quality assurance requirements for characterization, addressing matters identified in Section 9.4.3 and referring to the Quality Assurance Project Plan as appropriate.

Supporting Procedures

This plan will specify necessary supporting procedures, such as those for obtaining, handling, preserving, and packaging samples, as well as chain of custody procedures.

Documentation

This plan will detail the requirements for formally documenting characterization data in a written report.

9.4.2 Characterization Data Quality Objectives

The Data Quality Objectives for the characterization will be detailed in the Characterization Sample and Analysis Plan; they may be briefly stated as follows:

The Problem

Available characterization data in many areas are insufficient to support decommissioning activities and waste characterization and, in some cases, planning for radiation protection.

The Decision

The principal study question is what additional radiological data are needed for decommissioning activities, waste management, and radiation protection. The decision statement may be expressed as follows: if collection of additional data is warranted, collect data of sufficient quality and quantity to support decommissioning activities, waste characterization and/or planning for radiation protection.

Inputs to the Decision

Inputs to the decision include: (1) available data on radiological conditions; (2) professional judgment concerning data necessary to support the decommissioning activities, waste management, and radiation protection; and (3) available characterization measurement methods to collect necessary additional data, such as using field instruments to determine exposure rates and contamination levels and obtaining samples of materials and having them analyzed in a laboratory.

Study Boundaries

The study boundaries include:

- The characteristics of the contaminants of interest: Various radionuclides known to be present at the site from reprocessing of spent nuclear fuel and the hazardous and toxic materials that may be present based on facility history and process history, along with the physical parameters of the facilities and areas involved, such as size, geometry, and material composition.
- The spatial boundary of the decision statement: The facilities and areas within the scope of the DP, including soil from the surface to depths of six inches (15 cm) and 3.3 feet (one meter) from the surface and, when contamination is present, down to a depth indicating the bound of sub-surface impacts.
- The temporal boundary of the problem: The data can be acquired any time before the beginning of decommissioning activities in the facility or areas involved, so long as sufficient time is allowed to make preparations based on the data. Measurements and sampling in outside areas are dependent on the weather.
- Scale of decision-making: Areas of interest will generally conform to particular areas to undergo decommissioning, i.e., decisions will be made on specific areas or survey units, rather than the project premises as a whole.
- Practical constraints on data collection: These include limited access to certain areas, radiation exposure to those collecting data, availability of personnel and equipment, laboratory capabilities and capacity, and costs. Another constraint is the risk of releasing contamination to the environment and introducing new environmental contamination transport mechanisms.

Decision Rule

The decision rule on whether or not to collect data in particular areas and how much data to collect will be addressed in the Characterization Sample and Analysis Plan. It will involve the use of project experience and professional judgment to determine the adequacy of available data and the type and extent of any additional data needed.

Limits on Decision Errors

The conclusion that a facility or area has been adequately characterized is subject to the possibility of a decision error. Decisions are based on data subject to different variabilities due to choices on sample number, location, collection, and analysis. The acceptable

probability of making a decision error on the adequacy of the characterization (false positive and false negative) will be addressed.

Optimizing the Design

The content of the Characterization Sample and Analysis Plan will reflect an optimum design based on the various factors considered in its preparation, including the matters discussed above.

9.4.3 Characterization Quality Requirements

The quality requirements of Section 8 will apply to characterization. The following matters will also be addressed in the Characterization Sample and Analysis Plan.

Quality Objectives for Measurements

Objectives for precision, bias, completeness, representativeness, reproducibility, comparability and statistical confidence (control charts) will be addressed.

Field Instruments

Field instruments will be calibrated in accordance with written procedures using standards traceable to the National Institute of Standards and Technology. They will be calibrated every six months and following any substantial repair. Battery status, check source response, and background measurements will be performed prior to use each day, at the completion of use each day, and any time that instrument operation is in question. Control charts with specified limits of acceptability will be used to document and trend source response and background measurements.

Laboratory Instruments

Laboratory instruments such as alpha spectrometers, gamma spectrometers, low-background alpha-beta counters, and liquid scintillation counters will also be calibrated in accordance with written procedures using standards traceable to the National Institute of Standards and Technology. Appropriate operational checks such as background counts and reproducibility checks will be performed before use. Control charts with specified limits of acceptability will be used to document and trend source and background checks.

Offsite analytical laboratories will be required to meet all applicable quality requirements; the laboratory Quality Assurance Plan will be reviewed to ensure that applicable requirements are included. Offsite laboratories will be audited to assure quality performance.

Sample Chain of Custody

Sample chain of custody procedures will be established and followed to ensure that sample accountability and integrity are maintained. This process will include appropriate documentation utilized from the point of collection to the point where the sample is consumed in analysis, transferred to another organization, or properly disposed of.

Analytical Quality Control

Quality controls utilized for analytical chemical processes will include:

- Maintaining the quality of standards,
- Maintaining controls over sample flow,
- Controlling batch quality using method blanks,
- Using laboratory control standards traceable to the National Institute of Standards and Technology or using other industry-accepted standards or reference materials,
- Formally evaluating unacceptable results, and
- Utilizing process control charts as appropriate.

Data Quality Control

Data will be recorded in a legible manner and reviewed for matters such as accuracy of recording and transcription, procedure compliance, completeness, and consistency. Data recorded on the location of field measurements and samples in excavations will include the depth of the measurement point with respect to the nearby ground surface or the elevation above mean sea level. Calculations will be checked and conclusions will be peer reviewed. Problems identified will be resolved before the data are utilized. Data reports and documents will be archived and maintained to comply with the Project Quality Assurance Program described in Section 8.

9.4.4 Applying DQOs for Characterization Surveys

The following example illustrates how DQOs will be applied to characterize a particular area of interest in a manner supportive of final status survey information needs.

The example is the footprint of the old hardstand, which was located on the west side of the Lag Storage Additions 3 and 4. The old hardstand footprint has the potential for radioactive contamination below the surface due to the major spill described in Table 2-17. The footprint of the old hardstand will undergo characterization as part of the planned Characterization Sample and Analysis Plan activities.

The Characterization Sample and Analysis Plan includes a set of characterization objectives that form the basis for DQO planning process. Of this set, the following are pertinent to the old hardstand area:

- Evaluate appropriateness of the current list of radionuclides of interest,
- Verify absence of additional radionuclides of interest,
- Identify the presence/absence of buried contamination,
- Determine extent of surface contamination,
- Identify soil waste stream characteristics, and
- Obtain data to support Phase 2 planning.

Data collection requirements specific to the old hardstand for each of these objectives will be developed as part of the DQO evaluation contained in the Characterization Sample and Analysis Plan. Characterization Sample and Analysis Plan decision-making (and

consequently, Characterization Sample and Analysis Plan data collection activities) will be sequential with respect to these objectives. For example, data collection to verify the absence of additional radionuclides of interest may result in changes to the list of analytes for the balance of sampling work conducted for the old hardstand. As another example, if sampling identifies contamination likely to require remediation (either as a discretionary Phase 1 activity or during Phase 2), analyses would be conducted to determine waste stream characteristics.

Characterization Sample and Analysis Plan data collection will support final status survey requirements in a number of ways. The first two Characterization Sample and Analysis Plan objectives listed above will determine the list of radionuclides that final status survey activities will need to address. If contamination is encountered deeper than one meter (third objective), then the old hardstand area will not be a candidate for Phase 1 final status survey data collection, and instead data collection will focus on identifying the nature and extent of surface and subsurface contamination that is present. Alternatively, if contamination is present above Phase 1 DCGL requirements but not at depths greater than one meter, DOE may defer remediation until Phase 2.

If initial Characterization Sample and Analysis Plan data collection indicates the old hardstand area is a candidate for Phase 1 final status surveys (i.e., there is no evidence of contamination exceeding DCGL requirements in surface soils and no evidence of contamination deeper than one meter), then the balance of soil sampling from the former hardstand area would be conducted in a manner consistent with final status survey DQO requirements. Final status survey sampling requirements are described in detail in the Phase 1 Final Status Survey Plan. In general, these would include biased surface soil samples (representative of a 0 to 15 cm depth and representative of a 0 to 1 m depth) that targeted specific locations of concern (e.g., historical locations where contamination was present, gamma walkover survey anomalies, etc.) to determine $DCGL_{EMC}$ compliance, and systematic surface soil sampling (representative of a 0 to 15 cm depth and representative of a 0 to 1 m depth) to determine $DCGL_W$ compliance.

9.4.5 Characterization Surveys of Structures

Because the structures within the scope of Phase 1 decommissioning activities will be entirely removed, the additional characterization of these structures will focus on data necessary to support worker protection, waste management, and minimizing airborne radioactivity releases during demolition, this last factor being especially important for the Process Building. This characterization will take into account available radiological data.

> NOTE
>
> Because the additional characterization of structures within the scope of Phase 1 of the decommissioning is being performed for the purposes of health and safety, environmental control, and radioactive waste management – activities which are based on DOE procedures as explained in the Section 1 and will have no bearing on conditions at the conclusion of Phase 1 decommissioning activities – the additional characterization is briefly summarized below, rather than being described in more detail.

Available Radiological Data

Available characterization data on structures to be removed during Phase 1 of the decommissioning are summarized in Section 4.1.5. A large body of data is available on different areas of the Process Building and the Vitrification Building from the Facility Characterization Project undertaken during the 2002 to 2005 period. The Facility Characterization Project produced a total of 33 radioisotope inventory reports with bounding estimates of residual radioactivity in different building areas. Characterization data on structures other than the Process Building and Vitrification Facility are more limited.

A substantial amount of data on radionuclide distributions in different parts of the Process Building was developed during the Facility Characterization Project. These data have been used for waste management purposes during deactivation work and the characteristics of many of the waste streams associated with Process Building equipment have been well defined.

Due to the continuing deactivation work, radiological conditions in parts of the Process Building and some other areas will have changed by the time the interim end state is reached. Updated characterization data may be available for some areas before Phase 1 decommissioning activities begin.

Given this situation, the initial step in additional characterization of the structures of interest will entail review of available data to determine the additional data that will be needed.

Review of Available Radiological Data

Radiological conditions within the structures can vary widely. In the Process Building, some areas have never been entered since plant operations began due to high radiation levels while others have virtually no contamination.

Available radiological data for the facility or area of interest will be reviewed, considering activities that may have taken place since those data were collected. Such data will include data collected in the Facility Characterization Project and in end of task surveys discussed in Section 9.2.3. Conditions in the facility or area of interest will be taken into account in evaluating these data, such as cases where concrete grout has been poured over contamination on a floor or a fixative applied to a contaminated wall.

Because radiological conditions in different areas vary widely, the scope of additional characterization will be tailored to the potential hazards involved.

Exposure Rate Measurements

A clear understanding of the general area dose rates and any significant hot spots is necessary for all controlled areas where people will be working.

Before work begins in such an area, exposure rate measurements will be taken to identify the general area dose rates and the hot spots in those areas with hot spot potential, unless such data reflecting current conditions are already available. Table 9-6 identifies field instruments suitable for a wide range of exposure rate measurements inside structures.

Table 9-6. Radiological Field Instruments for Facility Characterization

Survey Type	Instrument (or equivalent)	Characteristics	Approximate Sensitivity(2)	Remarks
Exposure rate	Eberline RO-7(1)	Ion chamber	> 1 R/h	For high-range readings.
Exposure rate	Eberline RO-2(1)	Ion Chamber	0.1 mrem/h	For low-range readings
Exposure rate	Bicron Micro Rem	Organic scintillator	Several µrem/h	For scanning low potential areas.
Exposure rate	Ludlum 44-10(1)	2-inch NaI scintillator	900 cpm/µR/h	For scanning low potential areas.
Alpha	Ludlum 43-89(1)	ZnS (Ag) scintillator, 100 cm^2 probe	100 dpm/100 cm^2 85 dpm/100 cm^2	Scans 100 dpm, direct measurements 85 dpm.
Beta	Ludlum 43-89(1)	ZnS (Ag) scintillator, 100 cm^2 probe	2,500 dpm/100 cm^2 800 dpm/100 cm^2	Scans 2,500 dpm, direct measurements 800 dpm.
Beta-gamma	Ludlum 44-40(1)	Geiger-Mueller (G-M) shielded pancake probe	3,300 cpm/mrem/h	For scanning in tight areas
Beta-gamma	Ludlum 44-9(1)	G-M unshielded pancake probe	3,300 cpm/mrem/h	For scanning in tight areas

Contamination Measurements

A general understanding of accessible removable contamination is necessary for all controlled areas where people will be working. Before work begins in such an area, smears will be taken on representative surfaces and counted for removable beta and alpha radioactivity unless sufficient data on removable contamination are already available. Airborne radioactivity measurements will be made as necessary to support radiation protection planning. Surface scans for total alpha and/or beta contamination will be performed only in cases where the resulting data would be useful for planning purposes.

Because the facilities of interest in Phase 1 of the decommissioning will be entirely removed, surveys of inaccessible areas are not expected to be necessary.

Characterization Data for Waste Management Purposes

Where necessary for waste stream characterization, exposure rate measurements will be made and smears or other physical samples of materials will be analyzed to determine radionuclide distributions.

Documentation of Additional Characterization Surveys

These characterization data will be formally documented and reviewed. Information recorded for exposure rate and contamination measurements will include the date, location, type of measurement, instrument type, instrument serial number, and mode of operation.

Samples will be controlled and laboratory analyses performed and documented using the processes for environmental media samples described above.

Quality Assurance and Quality Control

All facility characterization measurements will be accomplished and documented in accordance with the provisions of Section 8 of this plan and the Quality Assurance Project Plan.

9.5 In-Process Surveys

In-process or remedial action support surveys will be performed while remediation is in progress. The primary purposes of these surveys are to guide decontamination and determine when remediation to the cleanup goals specified in Section 5 has been attained. In-process surveys also support radiation protection.

9.5.1 Measurement Methods and Instrumentation

Measurement methods and instruments used will be identical to those utilized during the characterization surveys described in Section 9.4 and the Phase 1 final status surveys. Survey quality objectives during in-process survey activities for soil and sediment will be aligned with the quality objectives of the Phase 1 final status surveys, to ensure that decisions and interpretations of data have the same confidence as those based on the Phase 1 final status survey results. Data quality objectives and quality control parameters will be consistent with those identified for the Characterization Sample and Analysis Plan, in Section 9.4, above. Media-specific and instrument/method-specific background levels developed by measurements and sampling in the Characterization Sample and Analysis Plan will be applied during the remediation, usually through subtraction from onsite analysis of samples.

The Characterization Sample and Analysis Plan will specify the sampling, instruments and data objectives for surveys in the area around the Process Building foundation pilings, an area that will not be readily accessible until late in the excavation in WMA 1 when overlaying structures are removed. In-process surveys in this area will be used to guide remediation and to identify locations for biased sampling.

Because surveys performed in the deep excavations are expected to be dominated by Sr-90, nuclide-specific measurements by onsite sample analysis will be used to guide the excavation. Where practicable, correlations between gamma exposure rates and soil radioactivity concentrations will be used to help determine when removal of target soil has been completed and to demonstrate that the instrument scan and direct measurement sensitivities are sufficient for the purpose of the in-process survey.

9.5.2 Scan Surveys and Direct Measurements

Investigation levels for scanning surveys to identify areas of elevated activity will be determined in the implementation of the Characterization and Sampling Plan. Scanning surveys will be performed to locate radiation anomalies indicating residual gross activity that may require further investigation or action. Areas of elevated activity typically represent a small portion of the site or survey unit. Thus, random or systematic direct measurements or

sampling on a grid spacing may have a low probability of identifying these areas, so that scanning surveys are typically performed before direct measurements or sampling. Because of the inability to detect certain radionuclides of interest in scanning surveys as discussed below, collection and analysis of soil samples will be necessary using protocols specified in the Characterization Sample and Analysis Plan and the Phase 1 Final Status Survey Plan.

Scan Minimum Detectable Concentrations

Procedures are provided in the MARSSIM for calculating scan minimum detectable concentrations (MDCs) for particular survey instruments. More detail on signal detection theory and instrument response is provided in NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC 2007). These procedures will be followed to obtain appropriate scan MDCs for the specific instruments to be used at the site. These calculations will take into account site-specific factors such as soil properties, the expected distribution of radionuclides in soil, and the scanning speed. This information will be developed as part of future planning activities for the project and will be available for NRC review.

To assist with current planning activities, estimated scanning MDCs in soil for the radionuclides of interest were obtained for field survey instruments by reviewing available information, and these values are shown in Table 9-7. Information is only provided for 14 of the 18 radionuclides, as four have no or minimal photon (gamma ray and X-ray) emissions making them impractical to detect with field scanning instruments. Field survey instruments for soil contamination are generally limited to those that can detect photons, given the uneven terrain and conditions encountered in the field. This is in contrast to survey instruments that can be used for buildings, many of which allow for the detection of alpha and beta contamination as well as gamma emissions.

Table 9-7. Estimated Scanning Minimum Detectable Concentrations (MDCs) of Radionuclides in Soil

Radionuclide	Type of detector	Scan MDC (pCi/g)
Am-241	FIDLER	30
C-14	NA[(1)]	-
Cm-243	2” by 2” NaI	50
Cm-244	FIDLER	300
Cs-137	2” by 2” NaI	7[(2)]
I-129	FIDLER	60
Np-237	FIDLER	30
Pu-238	FIDLER	100[(3)]
Pu-239	FIDLER	200[(3)]
Pu-240	FIDLER	100
Pu-241	NA[(1)]	-
Sr-90	NA[(1)]	-

Table 9-7. Estimated Scanning Minimum Detectable Concentrations (MDCs) of Radionuclides in Soil

Radionuclide	Type of detector	Scan MDC (pCi/g)
Tc-99	NA(1)	-
U-232	FIDLER	60
U-233	FIDLER	500
U-234	FIDLER	60
U-235	FIDLER	30
U-238	FIDLER	60

NOTES: (1) NA means not applicable; either there are no photons associated with the radionuclide or the photon yield is too low to allow for detection by field scanning instruments.

(2) A specific calculation of scanning minimum detectable count rate for Cs-137 in soil performed in connection with preparation of the Phase 1 Decommissioning Plan yielded a value equivalent to 7 pCi/g Cs-137. A comparable value of 6.4 pCi/g is given in Table 6.7 of the MARSSIM when units are given in pCi/g.

(3) While scan MDCs of 10 and 20 pCi/g are reported for Pu-238 and Pu-239, respectively, in Appendix H of MARSSIM, much larger values were reported elsewhere. The values given here are those expected to be reasonably achievable under field conditions.

The scanning MDCs given in Table 9-7 are representative of those that reasonably can be expected to be obtained with currently available instruments under conditions encountered in the field. These values were obtained from reported values and scanning experience at other radioactively contaminated sites.[3]

Experience for the Shallow Land Disposal Area site in Pennsylvania indicated that the calculated values were much lower than was actually obtainable under field conditions, which is reflected in the values given in Table 9-7. For some radionuclides (such as Pu-238 and Pu-239), a wide range of values was reported. In this case, a midpoint value is given in the table.

Information for scan MDCs was not available for about half of the radionuclides. In these cases, the energy spectrum and yields of the gamma rays and X-rays were reviewed along with the relative detector response (by photon energy). This allowed for an estimate to be made of the scan MDCs for those radionuclides without published information.

The scan MDCs for some radionuclides exceed surface and subsurface soil $DCGL_W$ values (cleanup goals) given in Table 5-14 of this plan. Also, the general approach used to calculate scan MDCs assumes flat terrain and does not account for situations where scans may be occurring on the sides of excavations. Experience has shown that it is difficult to obtain scan MDCs at the levels calculated using conditions that are more ideal than

[3] Calculations of scan MDCs are provided in a number of gamma walkover plans including the *Site Radiological Survey Plan* for the CWM Chemical Services site in Model City, New York (CWM 2006) and the *Final Gamma Walkover Survey Sampling and Analysis Plan* for the Shallow Land Disposal Area FUSRAP site in Pennsylvania (USACE 2003). Additional information reviewed included the article *Detection of Depleted Uranium in Soil Using Portable Hand-Held Instruments* (Coleman and Murray 1999) and *Ask an Expert Question and Answer Page on Survey Instruments (conventional)* (ORAU 2009). These sources provided a range of scan MDCs for several different detectors.

generally occur at the site. The values given in Table 9-7 account for expected field conditions.

Because there may be multiple radionuclides present at many locations, it will be necessary to achieve soil concentrations at some relatively small fraction of the DCGLs to arrive at definitive conclusions as to the need to conduct further remedial action. This typically cannot be done using scanning instruments. Rather, scanning techniques are generally used to indicate the presence of elevated radioactivity (above background) and the radionuclides that may have elevated concentrations. Definitive conclusions as to the presence or absence of contamination above radionuclide-specific DCGLs will be made by making direct static measurements or by collecting samples for analysis.

Direct Measurements

Direct measurements may be collected at random locations in the area of interest. Alternatively, direct measurements may be collected at systematic locations to supplement scanning surveys for the identification of small areas of elevated activity. Direct measurements may also be collected at locations identified by scanning surveys as part of an investigation to determine the source of the elevated instrument response. Professional judgment may also be used to identify locations for direct measurements to further define the areal extent of residual radioactivity and to determine maximum radiation levels within an area, although these types of direct measurements are usually associated with preliminary surveys (i.e., scoping, characterization, remedial action support). All direct measurement locations and results shall be documented.

For those radionuclides that cannot be effectively measured directly in the field, samples of the soil in the area under investigation will be collected and then analyzed with a laboratory-based procedure including gamma spectrometry, beta analysis using liquid scintillation counting, or alpha spectrometry following separation chemistry.

9.5.3 Documentation

Data collected during in-process survey field measurements and sampling will be formally controlled and documented as specified in Section 8. Data recorded on the location of field measurements and samples in excavations will include the depth of the measurement point with respect to the nearby ground surface or the elevation above mean sea level. Data reports and documents will be archived and maintained to comply with the Project Quality Assurance Program described in Section 8.

9.6 The Phase 1 Final Status Survey

As indicated previously, the Phase 1 final status survey will be accomplished in accordance with a Phase 1 Final Status Survey Plan(s). Because the decommissioning work spans a significant period of time and area of the site, the Phase 1 final status survey efforts may be more readily described and controlled in several area-specific or survey unit-specific plans rather than a single, more complex plan. The use of the DQO process in the project planning cycle will ensure consistency in the design, execution, and evaluation of Phase 1 Final Status Survey Plans if multiple plans are developed.

This Phase 1 Final Status Survey Plan(s) will have an integrated design incorporating:

- Analysis of media samples from systematic positions to determine the average concentration of activity distributions in relatively large areas, and
- Surface scanning meter surveys to identify localized areas of elevated activity.

Appendix G describes the conceptual framework for the Phase 1 Final Status Survey Plan.

9.6.1 Phase 1 Final Status Survey Plan Content

The Phase 1 Final Status Survey Plan(s) will provide details of the Phase 1 final status surveys to demonstrate that residual radiological conditions satisfy the cleanup criteria described in Section 9.1 or to document final radiological conditions as indicated below. (The plan elements described below will apply to all Phase 1 Final Status Survey Plans if multiple plans are prepared.)

Requirements and Guidance to be Followed

The Phase 1 Final Status Survey Plan will follow provisions in NUREG-1757 Volume 2 (NRC 2006) and guidance of the MARSSIM (NRC 2000).

Overview of Survey Design

This plan will provide a brief overview of the survey design. This design will follow NUREG-1757 Volume 2 (NRC 2006) and the MARSSIM (NRC 2000), utilizing statistical tests to determine adequate sample density.

Radionuclides of Interest

This plan will specify the radionuclides of interest identified in Section 9.1, considering that all radionuclides may not be of interest in certain areas.

Designating Residual Radioactivity Limits and Investigative Levels

This plan will identify the cleanup criteria specified in Section 5. It will also identify investigative levels and how they were established.

Use of Characterization Data for Phase 1 Final Status Survey Purposes

As indicated previously, DOE plans to produce characterization data of sufficient quality to serve Phase 1 final status survey purposes when practicable for areas that appear to meet the cleanup criteria without the need for remediation, and this matter and the data of interest will be addressed in the Phase 1 Final Status Survey Plan.

Additional Radioactivity Not Accounted For During Characterization

If any radioactivity from licensed or WVDP operations is not accounted for by characterization performed previously or in connection with decommissioning activities, this will be identified in the Phase 1 Final Status Survey Plan.

Classification of Areas

Different areas of the project premises facilities and areas of interest will be classified based on potential for radioactive contamination. Four classifications will be used:

·Class 1: impacted areas that, prior to remediation, are expected to have concentrations of residual radioactivity that exceed the $DCGL_W$;

Class 2: impacted areas that, prior to remediation, are not likely to have concentrations of residual radioactivity that exceed the $DCGL_W$;

Class 3: any impacted areas that have a low probability of containing residual radioactivity; and

Non-impacted: areas without reasonable potential for radioactive contamination from licensed or WVDP activities.

Impacted areas are identified in Section 4 based on information available in 2009. Preliminary classification will be confirmed or adjusted based on subsequent characterization and in-process survey data.

Survey Units

Survey units are geographical areas of specified size and shape for which a separate decision will be made as to whether or not that area exceeds the regulatory limit. Areas within a survey unit will have a similar usage history and contamination potential and be contiguous areas of the same area classification.

Survey units will be specified in the Phase 1 Final Status Survey Plan. They will be identified in tables or drawings or a combination of the two. Among areas considered in designating survey units will be:

- The bottoms and sides of the WMA 1 and WMA 2 excavations before they are back-filled;
- Laydown areas for excavated soil after the soil has been removed; and
- Areas where Phase 1 final status surveys are to be performed for surface soil.

In some survey units, data from characterization will be sufficient for Phase 1 final status survey purposes; this matter will be addressed in the Phase 1 Final Status Survey Plan.

Background Radiation and Radioactivity

Appropriate measurements will be taken in non-impacted background reference areas to establish background levels, taking into account available data on background summarized in Section 4, in Appendix B, that compiled in connection with the WVDP environmental monitoring program, and that collected during characterization. Media background will be subtracted from Phase 1 final status survey results.

Data Quality Objectives

Data Quality Objectives for the Phase 1 final status survey will be established as indicated in Section 9.6.2.

Survey Methods

The methods to be used to collect the necessary data in Phase 1 final status surveys will be similar to methods used in characterization surveys discussed previously. Among these are:

- Surface contamination scans,
- Direct measurements for contamination,
- Exposure rate measurements, and
- Soil and/or other media samples.

The Phase 1 Final Status Survey Plan will incorporate performance-based measurement systems, specifying the analytical sensitivity goal of each survey method. Individual methods (i.e., static surface counts) will then be translated to field procedures (instrument, detector, geometry, and count time) to assure attainment of the sensitivity required. Information necessary to perform the surveys and sampling, such as procedures for collecting and preparing samples, will be specified. Other survey methods may be used in support of the methods specified above, such as gamma scans to help identify locations of soil samples.

Radiological Instrumentation

This plan will specify the field and laboratory instruments to be used and the sensitivity of these instruments and methods. Table 9-8 shows typical field instruments to be addressed in the plan.

Table 9-8. Radiological Field Instruments for Phase 1 Final Status Survey

Survey Type	Instrument (or equivalent)	Characteristics	Approximate Sensitivity(1)	Remarks
Exposure rate	Bicron Micro Rem	Organic scintillator	Several µrem/h	For scanning soil.
Exposure rate	Ludlum 44-10	2-inch NaI scintillator	900 cpm/µR/h	For scanning soil.
Exposure Rate	FIDLER	5-inch diameter NaI scintillator	500 cpm per $\mu Ci/m^2$	For scanning soil for low energy gammas

NOTE: (1) These are approximate values based primarily on manufacturer's ratings. The sensitivities depend on background, count time, and other factors. Calculated, more precise information will be specified in the Phase 1 Final Status Survey Plan.

The Phase 1 Final Status Survey Plan will specify how the minimum detectable concentration (MDC) for media samples and the MDC for scanning surveys (MDC_{scan}) will be determined for each instrument and technique using methods specified in NUREG-1757, Volume 2 (NRC 2006). It will also demonstrate that the instrument scan and direct measurement sensitivities are consistent with MARSSIM (NRC 2000) guidance and sufficient for the goals of the Phase 1 final status survey.

The laboratory instruments and methods to be utilized will also be addressed in the Phase 1 Final Status Survey Plan, along with the minimum detectable concentrations of the methods used. Instruments and methods are expected to be similar to those shown in Table 9-5.

Scan Surveys

Scan surveys of survey units of the different classifications will be performed as indicated in Table 9-9 below. The purpose of such scan surveys is to identify small areas of elevated activity.

Table 9-9. Scan Surveys for Different Survey Area Classifications

Classification	Scanning Required	Scanning Investigative Levels
Class 1	100% coverage(1)	>$DCGL_{EMC}$
Class 2	10-100% coverage(2)	>$DCGL_W$ or >MDC_{scan} if MDC_{scan} is greater than $DCGL_W$.
Class 3	Judgmental	>$DCGL_W$ or >MDC_{scan} if MDC_{scan} is greater than $DCGL_W$.
Non-impacted	None	Not applicable.

NOTES: (1) Entire surface of accessible soil areas.
(2) Surveys will be both systematic and judgmental.

The derivation of scan and fixed MDCs will take into account instrument efficiencies (surface and detector), scan rates and distances over surfaces, surveyor efficiency, and minimum detectable count rate, using guidance in the MARSSIM (NRC 2000) and NUREG-1507 (Abelquist, et al. 1998).

Sample Collection and Handling

A brief description of how samples are to be collected, controlled, and handled will be provided, with reference to the detailed procedure(s) to be used for this purpose.

Survey Grids

Survey grids of appropriate size will be laid out and marked on excavations and land areas. Where practicable, grids established for characterization surveys will be re-established for use in the Phase 1 final status survey. Grid control points and positions of samples and survey readings within the grid will be located using global position system devices or conventional surveying.

Surrogate Radionuclides

Surrogate measurements focusing on Cs-137 may be used in areas where the radionuclide mix in a survey unit is consistent and Cs-137 is one of the dominant radionuclides. The Phase 1 Final Status Survey Plan will specify how this will be done in particular areas.

Surveys and Sampling of Individual Facilities and Areas

This plan will specify the process to determine the number of samples required in different areas following MARSSIM protocols. This process will include the following elements:

- Developing DQOs consistent with the requirements in Section 9.6.2,

- Utilizing as the null hypothesis (H_o) to be tested the assumption that the residual contamination exceeds the release criteria with the alternative hypothesis (H_A) being that the residual contamination meets the release criteria,
- Determining the relative shift – a ratio involving the difference between the $DCGL_W$ and the field remediation concentration goal divided by the variability in the concentration across the survey unit following remediation,
- Determining acceptable decision errors,
- Determining the number of samples needed for the Wilcoxon rank sum test (for radionuclides present in background),
- Determining the number of samples needed for the Sign test (for radionuclides not present in background), and
- Determining the number of additional samples needed if the MDC_{scan} is greater than the $DCGL_W$.

Evaluation of Results and Determination of Compliance

The measurement data will be first reviewed to confirm that the survey units were properly classified. In any cases where the results show that an area was misclassified with a less restrictive classification, the areas will be reclassified correctly, and a survey appropriate to the new classification will be performed.

Whether the measurement results demonstrate that the survey unit meets the release criteria will then be determined. The process for this and the statistical tests to be used will be specified in the Phase 1 Final Status Survey Plan, taking into account the multiple radionuclides present at the site and the different radionuclide distributions present in some areas.

If compliance is not demonstrated, then additional remediation followed by additional Phase 1 final status surveys will be performed until the release criteria are achieved.

One radionuclide (I-129) in surface soil will be treated as a special case because its cleanup goal is the same order of magnitude as the minimum detectable concentration in typical laboratory sample analyses.[4] Section 7 of the MARSSIM indicates that the analytical detection limits should be 10-50 percent of the DCGL, but that higher detection sensitivities may be acceptable when lower limits are impracticable (NRC 2000). Because this radionuclide should not appear in background soil samples, analysis at a detection limit near the DCGL will be sufficient to flag results should a sample indicate the presence of either radionuclide above its detection limit.

[4] In Revision 1 of this plan, both I-129 and Np-237 were identified as special cases because of low cleanup goals. The revised surface soil cleanup goal for Np-237 is higher than the Revision 1 value (0.23 vs. 0.096 pCi/g). Typical laboratory detection limits for Np-237 in soil samples are around 0.01 pCi/g as shown in the 2008 data in Table C-4. However, typical laboratory detection limits for I-129 are in the 0.1 to 0.3 pCi/g range as shown in Table C-4, so the laboratory detection limit may exceed 50 percent of the cleanup goal for this radionuclide. Although Table 9-5 specifies a target detection limit of 0.06 pCi/g for I-129, it is unlikely that this value can be consistently achieved in practice without special efforts.

The Phase 1 Final Status Survey Plan will provide an alternate method for evaluating analytical results for I-129 that do not exceed the minimum detectable concentration. This alternate method may involve use of an easy to detect surrogate radionuclide prevalent in surface soil, such as Cs-137 or Am-241, to infer the concentration of I-129. Scaling factors for spent fuel reprocessed specified in Table 4-1 will be suitable for this purpose. Another suitable alternate evaluation method could involve larger soil volumes and longer counting times for representative samples to reduce the minimum detectable concentration to a value well below the cleanup goal.

The amounts of I-129 that might be found in surface soil contamination, if any, will likely be small. This conclusion is based on comparisons between the estimated amounts of this radionuclide at the site at the conclusion of spent fuel reprocessing compared to the estimated amounts of predominant radionuclides such as Sr-90 and Cs-137. Table 2-5 in Section 2 shows estimates for the radionuclide content of the underground waste tanks at the completion of reprocessing. This table shows the estimated inventory of I-129 to be more than seven orders of magnitude less than the estimated Cs-137 present.

Health and Safety

This plan will identify health and safety requirements associated with survey activities; it may reference the project Health and Safety Plan for this purpose.

Quality Assurance

The Phase 1 Final Status Survey Plan will address quality control and quality assurance requirements for characterization, addressing matters identified in Section 9.6.3 and in Section 8, referring to the Project Quality Assurance Plan as appropriate.

Supporting Procedures

This plan will specify necessary supporting procedures, such as those for obtaining and managing samples.

Documentation

This plan will detail the requirements for formally documenting and archiving Phase 1 final status survey data, in accordance with the requirements of Section 9.8. Data recorded on the location of field measurements and all sample locations in excavations will include the depth of the measurement point with respect to the elevation above mean sea level.

9.6.2 Data Quality Objectives for the Phase 1 Final Status Survey

The DQOs will be detailed in the Phase 1 Final Status Survey Plan; they will involve considerations such as:

- Stating the problem: Provide adequate data of sufficient quality to determine the extent and magnitude of residual radioactive contamination.
- Identifying the decision: Will the data generated be adequate to support all survey objectives?
- Identifying inputs to the decision: Available data, including final characterization data obtained in connection with deactivation, information needed, measurement methods that will produce necessary data.

- Defining the study boundaries. Radionuclides of interest, areas of interest, necessity to obtain data to support the decommissioning schedule, appropriate-sized units, limited access to certain areas, availability of personnel and equipment, laboratory analysis throughput.
- Developing a decision rule. How to make the judgment as to whether or not additional data will need to be collected.
- Specifying limits on decision error. Consider the consequences of inadequate survey data and express what is acceptable in this regard.
- Optimizing the design. Data quality assessment will be used to determine the validity and performance of the data collection design and determine the adequacy of the data set to support the decision.

9.6.3 Phase 1 Final Status Survey Quality Requirements

The quality requirements of Section 8 will apply, along with the quality requirements for the characterization survey as identified in Section 9.4.3. These matters will be addressed in the Phase 1 Final Status Survey Plan.

9.7 The Survey Process By Waste Management Area

This section outlines surveys completed and surveys to be accomplished in each WMA (9.7.1 through 9.7.11) and, separately, surveys completed and planned for environmental media across the project premises (9.7.12). Note that other considerations such as decommissioning activities in adjacent areas and the impact of routes for transportation of radioactive materials on survey units and area classification will be addressed as appropriate in the Phase 1 Final Status Survey Plan(s).

9.7.1 WMA 1 Process Building and Vitrification Facility Area

Characterization surveys of the Process Building and Vitrification Facility have been performed in connection with the Facility Characterization Project. However, because radiological conditions in most building areas will change during deactivation work performed before the start of the decommissioning, additional surveys will be performed as decommissioning activities begin. Characterization of the contaminated soil in WMA 1 that is the source for the north plateau groundwater plume is addressed in Section 4.2; surveys related to its remediation are addressed in Section 9.7.12 below.

The Facility Characterization Project

As noted previously, the Facility Characterization Project focused on development of conservative source term estimates for various areas of the Process Building and Vitrification Facility. It followed the MARSSIM (NRC 2000) process and was carried out in accordance with the WVNSCO Characterization Management Plan (Michalczak 2004).

Description of Previous Survey Measurements. The primary process for determining the source term in a particular area involved using exposure rate measurements to quantify the amount of a surrogate gamma-emitting radionuclide such as Cs-137, and using scaling ratios to estimate the amounts of other radionuclides present. Scaling

ratios were based on sample analysis, process knowledge, or other bounding assumptions. In some cases, samples were collected and the analytical results were used in calculating a source term based on surface area or volumetric computations.

The process entailed four basic steps: (1) collection and evaluation of existing data and preparation of a draft technical approach, (2) review of these data and the approach by a Technical Review and Approval Panel, (3) collection of any needed data and modeling to estimate the source term, and (4) review and concurrence on the estimated source term by the Panel. Where additional data were needed, a biased sampling approach was used that typically involved field measurements such as radiation and contamination levels, along with samples of materials analyzed in a laboratory. Radiation level measurements were typically taken with a Geiger-Mueller detector (Ludlum Model 133-6) or ion chamber (Eberline RO-20) attached to a scaler/rate meter. Smears were counted with a Tennelec gas-flow proportional counter. Detection sensitivities for the exposure rate instruments were approximately 0.1 mrem/h for the RO-20 and higher for the Model 133-6, whose scales range from 1 mR/h to 1000 R/h.

Due to the high activity associated with most of the samples, samples taken in connection with the project were analyzed in the former onsite Analytical and Process Chemistry Laboratory. Table 9-10 shows laboratory instruments and methods, along with their sensitivities.

Table 9-10. Laboratory Methods

Nuclide	Instrument/Method	WVDP Procedure	Approximate Sensitivity(1)
Am-241	Alpha and/or gamma spectrometry	ACM-2707/3104	1.0 E-05 µCi/g
C-14	Sample oxidizer and liquid scintillation	ACM-4904	1.0 E-02 µCi/g
Cm-234/244	Alpha and/or gamma spectrometry	ACM-2707/3104	1.0 E-03 µCi/g
Cs-137	Gamma spectrometry	ACM-3103/3104	1.0 E-03 µCi/g
I-129	Gamma spectrometry	ACM-3104	1.0 E-03 µCi/g
Np-237	Alpha and/or gamma spec	ACM-2707/3104	1.0 E-03 µCi/g
Sr-90	Liquid scintillation	ACM-2707/3002	1.5 E-05 µCi/g (1g sample)
Tc-99	Gas flow proportional counting	ACM-4001	1.0 E-06 µCi/g (1g sample)
Pu-238	Alpha spectrometry	ACM-2704	1.0 E-05 µCi/g
Pu-239/240	Alpha spectrometry	ACM-2704	1.0 E-05 µCi/g
Pu-241	Liquid scintillation	ACM-2707/2708	1.0 E-05 µCi/g
U-232	Alpha spectrometry	ACM-2707	1.0 E-05 µCi/g
U-233/234	Alpha spectrometry	ACM-2707	1.0 E-05 µCi/g
U-235 (-236)	Alpha spectrometry	ACM-2707	1.0 E-05 µCi/g
U-238	Alpha spectrometry	ACM-2707	1.0 E-05 µCi/g

NOTES: (1) Dependent on sample size, counting time, etc.

Formal quality assurance requirements were implemented. Data quality objectives following the MARSSIM (NRC 2000) process were used. Data collected were compiled into individual reports for the area or facility. Each report included a discussion of available historical data, the approach used to gather additional data, and the conservatively bounding source term estimate, along with all the supporting information.

Justification for Previous Survey Measurements. The focus on conservative source terms supported one of the decommissioning alternatives envisioned by DOE when the Facility Characterization Project began. This alternative would have entailed leaving most of the Process Building and Vitrification Facility in place beneath a multi-layer cap.

The focus on source term estimates rather than general radiological conditions produced information important to the performance assessment under this alternative. The process for collection and evaluation of historical data was similar to that used for historical site assessments. Data acquired during the effort were obtained following MARSSIM quality protocols. However, these data are being treated as scoping survey data in some cases because of their limited extent.

Process Building and Vitrification Facility Characterization Surveys

In connection with decommissioning activities in each area, characterization measurements will be taken as specified in Section 9.4.5. The measurements will take into account data from deactivation end-of-task surveys and fill in data gaps for areas where these surveys were not performed. Characterization measurements will be performed on the WMA 1 facilities commensurate with plans for their disposition, which is removal in each case. As indicated in Section 7, there are no plans to release these facilities from radiological controls before dismantlement or demolition, which limits characterization data needs.

Description of Planned Survey Measurements. Measurements will typically include exposure rates, removable contamination, and total contamination. Samples will be analyzed for specific radionuclides to confirm radionuclide distributions where such information is not already available and to provide information for radiation protection and waste characterization. Areas inaccessible to surveys will be exposed so surveys can be made only in cases where this is essential for radiation protection purposes.

Justification for Planned Survey Measurements. These are the appropriate measurements necessary to facilitate radiation protection and support planning decommissioning activities and waste management.

Characterization of Other WMA 1 Facilities

The other facilities to remain within WMA 1 after 2009 that may have been impacted by radioactivity are: (1) the 01-14 Building, (2) the Plant Office Building, (3) the Utility Room, and (4) the Utility Room Expansion. Because these facilities will be entirely or partially within the bounds of the planned excavation, characterization measurements will be performed on these WMA 1 facilities commensurate with plans for their disposition, which is removal in each case. As indicated in Section 7, there are no plans to release these facilities from radiological controls before dismantlement or demolition, which limits characterization data needs.

Routine WVDP surveys taken through mid-2009 in these areas have typically not shown removable contamination above detection limits. However, contamination from the major acid spill during NFS operations that produced the north plateau groundwater plume is known to be present beneath the floor in the men's shower room of the Plant Office Building and some areas on the third and fourth floor in the 01-14 Building that contain ventilation system equipment, are not routinely surveyed.

Description of Planned Survey Measurements. Measurements will typically include exposure rates, removable contamination, and total contamination. Representative embedded piping in the 01-14 Building floor slab, except for sealed floor drains, will be characterized, with measurements such as (1) total beta using a suitable pipe probe (such as a Ludlum 44-6 sidewall detector) in the exposed ends of the pipe, (2) removable alpha and beta contamination in the ends of the pipe by smears, and (3) exposure rates on the accessible piping. (Note that some equipment will be removed from the 01-14 Building during deactivation.)

Characterization is not planned for the non-impacted facilities in WMA 1 – the Fire Pump House and water tank and the electrical substation.

Justification for Planned Survey Measurements. These are the appropriate measurements necessary to facilitate radiation protection and support planning decommissioning activities and waste management.

Characterization of Subsurface Piping in WMA 1

DOE has evaluated contaminated underground piping as described in Appendix F. This evaluation produced conservative source term estimates based on existing data, but it did not include characterization measurements. Subsurface piping within the bounds of the WMA 1 excavation will be removed, packaged and disposed of at offsite disposal facilities. There is no intent in Phase 1 of the decommissioning to trace or excavate underground piping outside the bounds of the excavation.

When these lines become exposed during the course of decommissioning work, measurements will be taken as necessary, for instance for waste characterization purposes for lines removed or to provide data to support Phase 2 decision-making for portions of lines remaining in place.

Description of Survey Measurements. The measurements will be taken after the interior surfaces of the lines are exposed during the course of decommissioning work. Three types of measurements will be taken as appropriate: (1) total beta using a suitable pipe probe (such as a Ludlum 44-6 sidewall detector) in the exposed ends of the pipe, (2) removable alpha and beta contamination in the ends of the pipe by smears, and (3) exposure rates on the accessible piping. Where sufficient data on radionuclide distributions are not available, smears or metal coupons will be obtained and analyzed to determine the radionuclide distributions.

Justification for Survey Measurements. These measurements will provide information on interior contamination levels that will support radiation protection, waste management, and

subsequent disposition determinations. The lines have a constant downward slope and ones that carried higher concentrations of radioactive liquid are made of stainless steel. This design makes contamination traps unlikely and contamination levels in areas where piping will be cut are expected to be representative of the entire length. Line 7P120 that carried THOREX waste from the Chemical Process Cell to Tank 8D-4 is expected to contain the most residual radioactivity.

In-Process Surveys in WMA 1 Facilities

In-process surveys will be performed in the Process Building and Vitrification Facility during remediation as specified in Section 9.5. In-process surveys in other WMA 1 facilities will also be performed during remediation as described in Section 9.5. However, the scope of such surveys will be minimal because of the relative low potential for contamination, except in some areas of the 01-14 Building which may contain significant contamination.

In-Process Surveys in the WMA 1 Excavation

In-process surveys will be performed in connection with removing soil during the large WMA 1 excavation as specified in Section 7 and Section 9.5. They will be coordinated with surveys performed around Process Building foundation pilings that are specified in the Characterization Sample and Analysis Plan.

When the excavation has reached the planned depth of at least one foot into the unweathered Lavery till, a systematic in-process survey will be performed as specified in the Characterization Sample and Analysis Plan. Survey grids will be laid out. A complete gamma scan of both the floor and the sides of the excavation will be performed to identify areas of elevated activity as evidenced by above-background measurements. Biased soil samples will be collected from areas of elevated activity and analyzed onsite for Sr-90 and Cs-137. Systematic soil samples will also be collected and analyzed onsite for Sr-90.

The survey results and sample analytical data will be used to determine if additional soil removal is necessary. If additional soil removal is necessary, an additional in-process survey will be performed in the area of interest after the soil is removed using the protocols described in the Characterization Sample and Analysis Plan.

In-Process Surveys Related to Subsurface Piping in WMA 1

In-process surveys will be performed during removal of piping as described in Section 9.5. Some characterization surveys will effectively be in-process surveys since they will be performed in conjunction with piping removal activities.

Phase 1 Final Status Surveys in the WMA 1 Excavation

As explained previously, the final end-state of the Process Building and Vitrification Facility will involve total removal including excavation of the subsurface portions, backfilling with soil, and installing a vertical hydraulic barrier wall on the down-gradient side of the excavation footprint. Phase 1 final status surveys will be performed for exposed subsurface areas before they are backfilled in accordance with the Phase 1 Final Status Survey Plan, which will provide details of the surveys required.

Separate Phase 1 final status surveys of the piping not encountered during excavation and subsequently abandoned in place are not planned; characterization survey data are intended to serve Phase 1 final status survey purposes.

Confirmatory Surveys in the WMA 1 Excavation

After Phase 1 final status surveys are completed, arrangements will be made to have any desired confirmatory surveys performed.

Radiological Status Surveys Outside of the Large Excavation

After all facilities within WMA 1 have been removed, radiological status surveys of the areas outside of the large excavation will be performed. These areas will consist of the shallow excavations for removal of infrastructure not within the large excavation footprint, that is, the footprints of the portions of the Utility Room, Utility Room Expansion, and the Laundry Room floor slabs and foundations and the floor slabs and foundations for the Fire Pumphouse and Water Storage Tank. These surveys will be performed in accordance with the Characterization Sample and Analysis Plan.

Confirmatory Surveys in Areas Outside of the Large Excavation

After these radiological status surveys are completed, arrangements will be made to have any desired confirmatory surveys of these areas performed before they are backfilled.

9.7.2 WMA 2 Low-Level Waste Treatment Facility Area

Of the facilities to remain within WMA 2 after 2009 that have been impacted by radioactivity, significant characterization data are available for only one: the Old Interceptor. Only limited data on radiological conditions are available for the others within the scope of the plan: (1) the LLW2 Building, (2) the Neutralization Pit, (3) the Solvent Dike, (4) the twin New Interceptors, and (5) the North Plateau Groundwater Pump and Treat Facility.

Note that the five lagoons in WMA 2 are addressed as environmental media in Section 9.7.12 below.

Existing Characterization Data for Old Interceptor

Description of Previous Survey Measurements on Old interceptor. Two radiation surveys taken in 2003 show levels up to 408 mrem/h (WVNSCO 2003a and WVNSCO 2003b)[5].

Justification for Previous Survey Measurements. While these surveys provided useful information, they did not completely characterize the facility, which is expected to contain contamination in depth and contamination covered by a layer of concrete added to the floor.

Characterization of WMA 2 Facilities

[5] Although no radioisotope inventory report was issued for the Old Interceptor, these radiation surveys were taken for characterization purposes for the Facility Characterization Project.

Characterization measurements will be performed on the WMA 2 facilities commensurate with plans for their disposition, which is removal in each case. As indicated in Section 7, there are no plans to release these facilities from radiological controls before dismantlement or demolition, which limits characterization data needs.

Description of Planned Survey Measurements. Measurements will typically include exposure rates, removable contamination, total contamination, and core samples of facility surfaces in cases where they will produce information of value. Smears or samples of building materials will be obtained and analyzed to provide information on radionuclide distributions.

Justification for Planned Survey Measurements. These are the appropriate measurements necessary to facilitate radiation protection and support decommissioning activities and waste management in cases where such information is not already available.

Characterization of Subsurface Piping in WMA 2

Underground piping within WMA 2 is comprised primarily of Duriron wastewater drain lines leading to the Interceptors and interconnecting with equipment in the treatment buildings, the interceptors, and the lagoons. Also within WMA 2 is a portion of the Leachate Transfer Line from the NRC-Licensed Disposal Area (NDA).

Subsurface piping within the bounds of the WMA 2 excavations will be removed, packaged and disposed of at offsite disposal facilities. There is no intent in Phase 1 of the decommissioning to trace or excavate underground piping outside the bounds of the excavations.

When these lines become exposed during excavation of the WMA 2 Facilities, during removal of the LLW2 Building floor slab and foundations, and during removal of Lagoons 4 and 5, measurements will be taken as necessary, for instance for waste characterization purposes for lines removed or to provide data to support Phase 2 decision-making for portions of lines remaining in place.

Description of Survey Measurements. Measurements will be taken after the interior surfaces of the lines are exposed when the lines are cut. Two types of measurements will be taken: (1) removable alpha and beta contamination in the end of the pipe measured by smears, and (2) exposure rates of the accessible piping.

Justification for Survey Measurements. These measurements will provide information to support waste characterization purposes and to support decision-making for Phase 2 of the decommissioning.

In-Process Surveys of WMA 2 Area

In-process surveys will be performed during remediation as described in Section 9.5. These surveys will include the surface of the soil in excavations made during removal of the interceptors, the Neutralization Pit, and the associated valve pits.

In-Process Surveys in the WMA 2 Excavation

In-process surveys of the completed large excavation will be performed in a manner similar to those for the WMA 1 large excavation described in Section 9.7.1, except that there are no foundation pilings involved. In-process surveys will be performed on all sides of the excavation. The different conditions in WMA 2 will be taken into account, especially the situation where Lagoon 2 and Lagoon 3 extend within the Lavery till and require only limited excavation to reach the point where all of the sediment and at least one foot of the underlying Lavery till has been removed, as specified in Section 7.

In-Process Surveys Related to Subsurface Piping in WMA 2

In-process surveys as subsurface piping is encountered during remediation will be performed as specified in Section 9.5.

Phase 1 Final Status Surveys in WMA 2 Areas

After decommissioning activities are completed in these areas, Phase 1 final status surveys will be performed in each survey unit in accordance with the Phase 1 Final Status Survey Plan. These surveys will focus on the exposed soil in the large excavation made to remove Lagoons 1-3, the interceptors, the Neutralization Pit, and Solvent Dike.

Radiological status surveys will be performed in other areas of interest in accordance with the Characterization Sample and Analysis Plan. These surveys will include the exposed soil surfaces from removal of remaining floor slabs and foundations of facilities removed prior to the start of decommissioning: the 02 Building, the Test and Storage Building, the Vitrification Test Facility, the Maintenance Shop, the Maintenance Storage Area, the Vehicle Maintenance Shop, and the Industrial Waste Storage Area. Similar surveys will also be performed in the excavation to remove the Maintenance Shop leach field equipment and in the areas where Lagoons 4 and 5 were removed.

Confirmatory Surveys in WMA 2 Areas

After the Phase 1 final status surveys are completed, arrangements will be made to have confirmatory surveys performed. NRC or its contractor will be afforded an opportunity to perform confirmatory surveys in excavations before they are filled in.

Phase 1 Final Status Surveys of Subsurface Piping in WMA 2

Separate Phase 1 final status surveys of the piping not encountered during excavation and subsequently abandoned in place are not planned; characterization survey data are intended to serve Phase 1 final status survey purposes.

Confirmatory Surveys of Subsurface Piping in WMA 2

Arrangements will be made for any confirmatory surveys NRC desires to be accomplished at the time when the piping ends are accessible, prior to the excavation being filled in.

9.7.3 WMA 3, Waste Tank Farm Area

Four facilities or groups of equipment within WMA 3 have been impacted by radioactivity and are within the scope of the plan: (1) the pumps in Tanks 8D-1, 8D-2, 8D-3, and 8D-4, (2) the piping and equipment in the HLW transfer trench, (3) the Equipment Shelter and Condensers, and (4) the Con-Ed Building. Limited data on radiological conditions are available for these facilities and this equipment as indicated in Section 4.

WMA 3 Facility Characterization Surveys

Characterization measurements will be performed in connection with decommissioning activities.

Description of Planned Survey Measurements. Measurements will typically include exposure rates, removable contamination, and total contamination in areas of interest.

Justification for Planned Survey Measurements. These are the appropriate measurements necessary to facilitate radiation protection and support decommissioning activities and waste management.

WMA 3 Facility In-Process Surveys

In-process surveys will be performed during remediation as specified in Section 9.5.

WMA 3 Facility Radiological Status Surveys

After decommissioning activities are completed in this area, radiological status surveys will be performed in accordance with the Characterization Sample and Analysis Plan. Procedures and detection levels for scan surveys may be modified due to the higher ambient radiation levels in the area from radioactivity in the HLW tanks.

WMA 3 Confirmatory Surveys

Arrangements will be made for any confirmatory surveys desired by NRC or its contractor.

WMA 4, Construction and Demolition Debris Landfill

This landfill, which was closed in 1986, is not within the scope of the Phase 1 decommissioning work.

9.7.4 WMA 5 Waste Storage Area

The primary facilities within WMA 5 impacted by radioactivity and within the scope of the plan are the Remote Handled Waste Facility and Lag Storage Addition 4 and its associated Shipping Depot. Other facilities in WMA 5 within the scope of the plan are concrete pads and foundations remaining from facilities removed prior to the start of decommissioning.

Characterization of the Remote Handled Waste Facility

Characterization measurements will be performed in this building commensurate with plans for its disposition, which is removal.

Description of Planned Survey Measurements. Measurements will typically include exposure rates, removable contamination, and total contamination. Representative smears will be analyzed for radionuclides of interest.

Justification for Planned Survey Measurements. These are the appropriate measurements necessary to facilitate radiation protection and support decommissioning activities and waste management.

Characterization of Lag Storage Addition 4/Shipping Depot

Characterization measurements will be performed in this building commensurate with plans for its disposition, which is removal.

Description of Planned Survey Measurements. Measurements will typically include exposure rates, removable contamination, and total contamination.

Justification for Planned Survey Measurements. These are the appropriate measurements necessary to facilitate radiation protection and support decommissioning activities and waste management.

Characterization of Subsurface Piping in WMA 5

Within WMA 5 is underground piping running from the Remote-Handled Waste Facility to Tank 8D-3. Portions of this piping within the bounds of the building excavation will be removed, packaged and disposed of at offsite disposal facilities. As indicated in Section 7, the portion of the piping outside of the building excavation will remain in place unless it has been impacted by radioactivity.

When these lines become exposed during excavation to remove the Remote-Handled Waste Facility, measurements will be taken to confirm the radiological status for waste characterization purposes for lines removed and to provide data to support Phase 2 decision-making for the portions of the piping to remain in place.

Description of Survey Measurements. Measurements will be taken after the interior surfaces of the lines are exposed when the lines are cut. Two types of measurements will be taken: (1) removable alpha and beta contamination in the end of the pipe measured by smears, and (2) exposure rates of the accessible piping.

Justification for Survey Measurements. These measurements will provide information to support for waste characterization purposes and to support decision-making for Phase 2 of the decommissioning.

In-Process Surveys

In-process surveys will be performed during remediation of the Remote-Handled Waste Facility and the Lag Storage Addition 4/Shipping Depot as specified in Section 9.5. In-process surveys of subsurface piping will also be performed as specified in Section 9.5 as this piping is encountered during remediation of the Remote-Handled Waste Facility.

Radiological Status Surveys of the Excavations Where Facilities Are Removed

As explained previously, the Remote-Handled Waste Facility will be completely removed. After decommissioning activities are completed, including demolition and removal of the floor slab and foundation and removal of the empty underground tank vault, radiological status surveys of the exposed excavation surface will be performed in accordance with the Characterization Sample and Analysis Plan. Similar surveys will be performed in the shallow excavation where the Lag Storage Addition 4/Shipping Depot is removed.

Confirmatory Surveys of the Excavations Where Facilities Are Removed

After the radiological status surveys are completed in the areas where the Remote-Handled Waste Facility and the Lag Storage Addition 4/Shipping Depot were removed, arrangements will be made to have any desired confirmatory surveys accomplished by the NRC or its contractor. Arrangements will also be made for any confirmatory surveys NRC desires to be accomplished at the time when the piping ends in the Remote-Handled Waste Facility excavation are accessible, prior to the excavation being filled in.

Radiological Status and Confirmatory Surveys of Other Floor Slabs and Foundations

Also considered in the radiological status surveys and confirmatory surveys will be the soil surfaces exposed following excavations of remaining floor slabs and foundations of impacted facilities removed prior to the start of decommissioning. The facilities of interest are the Lag Storage Building and its additions, the Chemical Process Cell Waste Storage Area, and several hardstands and gravel pads.

After surveys specified in the Characterization Sample and Analysis Plan are completed, the areas of interest will be made available to NRC or its contractor for any desired confirmatory surveys.

9.7.5 WMA 6 Central Project Premises

In WMA 6, the facilities to be removed during Phase 1 include the Sewage Treatment Plant, the Equalization Tank, the Equalization Basin, the two demineralizer sludge ponds, and the south Waste Tank Farm Test Tower, along with remaining floor slabs and foundations, including the underground structure of the Cooling Tower. The Equalization Basin and the two demineralizer sludge ponds are addressed along with other environmental media in Section 9.7.12.

Characterization of the Remaining Part of the Cooling Tower

The only WMA 6 structure known to have been impacted by radioactivity as of 2008 is the remaining part of the Cooling Tower. Characterization measurements will be performed in this structure commensurate with plans for its disposition, which is removal.

Description of Planned Survey Measurements. Measurements will typically include exposure rates, removable contamination, and total contamination. Representative smears will be analyzed for radionuclides of interest.

Justification for Planned Survey Measurements. These are the appropriate measurements necessary to facilitate radiation protection and support decommissioning activities and waste management.

Radiological Status and Confirmatory Surveys Following Removal of Floor Slabs and Foundations

After the structures and their floor slabs and foundations have been removed, the exposed soil surface of the resulting excavations will be considered in the radiological status surveys. After surveys specified in the Characterization Sample and Analysis Plan are completed, the areas of interest will be made available to NRC or its contractor for any desired confirmatory surveys.

Radiological Status Surveys of Equalization Tank Excavation

Even though the equalization tank was not known to be impacted by radioactivity in mid-2009, as indicated in Section 7, radiological status surveys will be performed in the excavation made to remove the tank as a good practice. These surveys will be performed as specified in Characterization Sample and Analysis Plan and will typically include measurements with a sensitive gamma detector.

After surveys specified in the Characterization Sample and Analysis Plan are completed, the area will be made available to NRC or its contractor for any desired confirmatory surveys.

9.7.6 WMA 7 NDA and Associated Facilities

No additional characterization will be performed in the NDA itself. Table 4-10 summarizes the estimated NDA radionuclide inventory. In WMA 7, only removal of concrete and gravel pads associated with the NDA Hardstand is within the scope of this plan.

WMA 7 Facility Characterization Surveys

Characterization measurements of the hardstand will be performed in connection with decommissioning activities.

Description of Planned Survey Measurements. Measurements will typically include exposure rates and material samples analyzed for radionuclides of interest.

Justification for Planned Survey Measurements. These are the appropriate measurements necessary to facilitate radiation protection and support decommissioning activities and waste management.

WMA 7 In-Process Surveys

In-process surveys will be performed during remediation as specified in Section 9.5.

WMA 7 Radiological Status Surveys

Surveys of the resulting exposed excavation surfaces will be performed in accordance with the Characterization Sample and Analysis Plan.

WMA 7 Confirmatory Surveys

Arrangements will be made for any confirmatory surveys desired by NRC or its

contractor before the excavation is filled in.

9.7.7 WMA 8, State Licensed Disposal Area

There are no facilities within WMA 8 that are within plan scope.

9.7.8 WMA 9, Radwaste Treatment System Drum Cell Area

Phase 1 decommissioning activities in WMA 9 include total removal of the building, floor slabs and foundations of the Radwaste Treatment System Drum Cell, the NDA trench soil container area, and the subcontractor maintenance area.

Characterization of the Radwaste Treatment System Drum Cell Area

Characterization measurements will be performed in this building commensurate with plans for its disposition, which is removal. Characterization measurements will also be taken in the trench soil container area and the subcontractor maintenance area.

Description of Planned Survey Measurements. Measurements will typically include exposure rates, removable contamination, and total contamination.

Justification for Planned Survey Measurements. These are the appropriate measurements necessary to facilitate radiation protection and support decommissioning activities and waste management.

In-Process Surveys Related to the Radwaste Treatment System Drum Cell

In-process surveys will be performed during removal activities as specified in Section 9.5.

Radiological Status Surveys of the Radwaste Treatment System Drum Cell

Following building demolition and removal of the floor slab and foundation, radiological status surveys on the exposed excavation surface will be performed in accordance with the Characterization Sample and Analysis Plan.

Confirmatory Surveys of the Radwaste Treatment System Drum Cell Excavation

After the radiological status surveys are completed, arrangements will be made to have any desired confirmatory surveys accomplished.

The NDA Trench Soil Container Area and the Subcontractor Maintenance Area

Characterization measurements will be performed in these areas commensurate with plans for their disposition, which is removal.

Description of Planned Survey Measurements. Measurements will typically include exposure rates and soil samples analyzed for radionuclides of interest.

Justification for Planned Survey Measurements. These are the appropriate measurements necessary to facilitate radiation protection and support decommissioning activities and waste management.

Other surveys of this area will include in-process surveys in accordance with Section 9.5, radiological status survey of the excavations in accordance with the Characterization Sample and Analysis Plan, and any confirmatory surveys desired by the regulators.

9.7.9 WMA 10, Support and Services Area

Neither of the facilities within WMA 10 within plan scope, the New Warehouse and the former Waste Management Storage Area, nor the remaining concrete floor slabs and foundations to be removed, had been impacted by radioactivity as of mid-2009.

WMA 10 Facility Characterization Surveys

Characterization measurements will be performed in these facilities, floor slabs, and foundations in connection with decommissioning activities.

Description of Planned Survey Measurements. Measurements will typically include exposure rates, removable contamination, and total contamination.

Justification for Planned Survey Measurements. These are the appropriate measurements necessary to facilitate radiation protection and support decommissioning activities and waste management.

WMA 10 Facility In-Process Surveys

In-process surveys will be performed during remediation as specified in Section 9.5.

WMA 10 Facility Radiological Final Status Surveys

Radiological status surveys on the exposed excavation surfaces will be performed in accordance with the Characterization Sample and Analysis Plan.

Radiological status surveys will be performed in the Security Gatehouse as a good practice because of the proximity of this facility to the Process Building. These surveys will be judgmental in scope and include scan surveys with a sensitive gamma detector such as a Bicron Micro Rem instrument.

Confirmatory Surveys of WMA 10 Facilities

Arrangements will be made for any confirmatory surveys desired by NRC or its contractor.

9.7.10 WMA 11, Bulk Storage Warehouse and Hydrofracture Test Well Area

No facilities in WMA 11 are within plan scope. Neither characterization nor Phase 1 final status surveys are planned in this area.

9.7.11 WMA 12, Balance of the Site

No facilities in WMA 12 are within plan scope. However, characterization surveys are planned for soil and for the banks and streambeds of Erdman Brook and Franks Creek in the portion of WMA 12 that lies within the project premises.

9.7.12 Environmental Media

Environmental media to be considered includes soil, sediment, groundwater, and surface water on the project premises.

Existing Characterization Data

Description of Previous Survey Measurements. As explained in Section 4.2, existing data on radioactivity in environmental media comes from three principal sources: (1) the site environmental monitoring program, (2) a series of RCRA facility investigations completed in the mid-1990s, and (3) Geoprobe® investigations of the north plateau groundwater plume. Data are also available on surface radiation levels that are indicative of soil contamination in some areas from 1984 and earlier aerial surveys and a 1990 overland survey that measured gamma radiation levels.

As explained in Section 4.2, data on radioactivity in environmental media were obtained using methods such as laboratory analysis of soil and groundwater samples and measuring exposure rates using sensitive gamma detectors.

Justification for Previous Survey Measurements. The measurements were made for several purposes, including regular monitoring of the environment and specific investigations related to hazardous materials and the north plateau groundwater plume.

Soil and Sediment Characterization Surveys

Surface soil, subsurface soil, and sediments in the Phase 1 areas will be surveyed and sampled for laboratory analysis. However, subsurface soil in the non-source area of the plume and in other Phase 2 areas will not be addressed at this time.

Description of Survey Measurements. The process to be utilized will include:

- Consideration of available characterization data;
- Surface scans for gamma activity in areas likely to contain residual contamination;
- Surface and near-surface[6] soil samples, with the samples analyzed for the radionuclides of interest;
- Subsurface soil samples where indicated by contamination potential, including locations of subsurface features such as tanks and process lines;
- Additional subsurface samples in the top portion of the Lavery till in the WMA 1 and WMA 2 excavation footprints as specified in Section 7.2.2; and
- Sediment samples where indicated by contamination potential, including sediment in Erdman Brook and the portion of Franks Creek within the project premises security fence.

Special attention will be paid to the lagoons, basins, and discharge ponds, including the area of Lagoon 1 where previously buried radioactive debris will be removed. Details will appear in the Characterization Sample and Analysis Plan. To facilitate development

[6] Near-surface in this context means a few feet below the surface.

of the Characterization Sample and Analysis Plan, DOE had a set of goals developed for this plan and considered the input of other agencies on these goals as the Characterization Sample and Analysis Plan was prepared.

Justification for Survey Measurements. These measurements will provide information on soil and sediment contamination to support decontamination activities, facilitate radiation protection, and waste disposal plans.

Phase 1 Final Status Surveys of Soil Areas

Description of Survey Measurements.

Selected surface soil areas will undergo Phase 1 final status surveys, as explained in Section 7. The process to be utilized will be similar to that for characterization surveys, with details included in the Phase 1 Final Status Survey Plan. If grids were established for characterization surveys, the same grids will be reestablished and used where practicable. Characterization data will be considered in the survey design and used for Phase 1 final status survey purposes where practicable.

Also, radiological status surveys will be performed as specified in the Characterization Sample and Analysis Plan in the excavations made to remove the Equalization Basin and the two demineralizer sludge ponds.

Justification for Survey Measurements. These measurements will provide information on soil and sediment contamination to demonstrate that release criteria are achieved as applicable.

Confirmatory Surveys of Soil Areas and Areas Containing Sediment

Arrangements will be made for confirmatory surveys by NRC or its contractor after the Phase 1 final status surveys and radiological status surveys are completed.

Groundwater

Radioactivity in groundwater will continue to be monitored during Phase 1 of the decommissioning by laboratory analysis of samples drawn from the network of monitoring wells. Appendix D addresses monitoring of groundwater following the completion of Phase 1 decommissioning activities. Limited characterization surveys will be performed for groundwater.

Surface Water/Stream Sediment

Radioactivity in surface water and associated stream sediment will continue to be monitored during the decommissioning in connection with the environmental monitoring and control program outlined in Section 1.8 and Appendix D. The characterization program will includes surveys and sampling of the banks and beds of Erdman Brook and the portion of Franks Creek on the project premises, as noted previously.

9.8 Phase 1 Final Status Survey Report Requirements

The requirements for the Phase 1 Final Status Survey Report will be identified in the Phase 1 Final Status Survey Plan. As indicated previously, because of the site complexity

there may be multiple Phase 1 Final Status Survey Plans. Consequently there may be multiple Phase 1 Final Status Survey Reports. The content and coverage of the plans and reports will be determined using the DQO Process in the project planning cycle. These report requirements will include the following.

9.8.1 Overview of Results

The report will summarize the results of the surveys.

9.8.2 Discussion of Changes

The report will include a discussion of any changes that were made in the Phase 1 final status survey from what was described in this plan or other prior submittals.

9.8.3 Description of How Numbers of Samples Were Determined

The report will include a description of the method by which the number of samples was determined for each survey unit.

9.8.4 Sample Number Determination Values

The report will include a summary of the values of site parameters and data statistics used to determine the number of samples and a justification for these values.

9.8.5 Results for each Survey Unit

The report will include the survey results for each survey unit, including:

- The number of samples taken for the survey unit;
- A map or drawing of the survey unit showing the reference system and random start systematic sample locations[7] for Class 1 and 2 survey units and random locations shown for Class 3 survey units and reference areas;
- The measured sample concentrations;
- The statistical evaluation of the measured concentrations;
- Judgmental and miscellaneous sample data sets reported separately from those samples collected for performing the statistical evaluation;
- A discussion of anomalous data, including any areas of elevated direct radiation detected during scanning that exceeded the investigation level or measurement locations in excess of $DCGL_W$ and any actions taken to reduce them, if any, upon detection[8]; and
- A statement that a given survey unit satisfied the $DCGL_W$ and the elevated measurement comparison if any sample points exceeded the $DCGL_W$.

9.8.6 Survey Unit Changes

[7] This will include the location of "increment" samples used to form composite samples as described in Appendix G.

[8] This will include application of the as low as reasonably achievable (ALARA) principal as discussed in Section 6.

The report will include a description of any changes in initial survey unit assumptions relative to the extent of residual radioactivity.

9.8.7 ALARA Practices

The report will include a description of how ALARA practices were employed to achieve final activity levels.

9.8.8 Actions Taken for Failed Survey Units

If a survey unit fails, a description of the investigation conducted to ascertain the reason for the failure and a discussion of the impact that the failure has on the conclusion that the facility is ready for Phase 1 final radiological surveys will be included in the report.

9.8.9 Impact of Survey Unit Failures

For any survey units that fail, the report will include a discussion of the impact that the reason for the failure has on other survey unit information.

9.9 References

DOE Orders, Policies, Manuals, and Standards

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, Change 2. U.S, Department of Energy, Washington, D.C., January 7, 1993.

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