ENCLOSURE 2

FIELD SAMPLING PLAN

for

TASK ORDER 9
SITE CHARACTERIZATION SERVICES
WEST VALLEY DEMONSTRATION PROJECT
ENVIRONMENTAL CHARACTERIZATION SERVICES
WEST VALLEY, NEW YORK

SEC-FSP
Rev. 0

September 2013

Prepared for:
U.S. Department of Energy
West Valley Demonstration Project (WVDP)
Environmental Characterization Services (ECS)
West Valley, New York

Prepared by:
Safety and Ecology Corporation (SEC)
2800 Solway Road
Knoxville, TN 37931

UNCONTROLLED DOCUMENT

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Field Sampling Plan (FSP)
U.S. Department of Energy,
West Valley Demonstration Project
Environmental Characterization Services
West Valley, New York

Contract No.: DE-EM0001242

FSP APPROVALS

By their specific signature, the undersigned certify that they prepared, reviewed, or provided comments on this Field Sampling Plan for the DOE West Valley Demonstration Project, Environmental Characterization Services, and West Valley, New York.

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

ALARA	As Low As Reasonably Achievable
ASME	American Society Of Mechanical Engineers
BOSF	Balance of Site Facilities
CFR	Code of Federal Regulations
CG	Cleanup Goal
CHBWV	CH2M-Hill/Babcock and Wilcox West Valley
CLP	Contract Laboratory Procedure
cpm	counts per minute
CSAP	Characterization Sampling and Analysis Plan
CV	Coefficient of Variation
DCGL	Derived Concentration Guideline Level
DMS	Data Management System
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DP	Decommissioning Plan
DQO	Data Quality Objective
ECS	Environmental Characterization Services
EDBA	Environmental Database Administrator
EDD	Electronic Data Deliverable
EPA	U.S. Environmental Protection Agency
ES&H	Environmental Safety and Health
FIDLER	Field Instrument for Detection of Low-Energy Radiation
FSP	Field Sampling Plan
FSS	Final Status Survey
FSSP	Final Status Survey Plan
ft	foot
GPS	Global Positioning System
GWS	Gamma Walk-over Survey
HLW	High-level Waste
ID/IQ	Indefinite Delivery/Indefinite Quantity
IDW	Investigation Derived Waste
ISMS	Integrated Safety Management System
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIDAR	Light Detection and Ranging
LLRW	Low-level Radioactive Waste
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NaI	Sodium Iodide
NFS	Nuclear Fuel Services, Inc.
NIST	National Institute of Standards and Technology
NQA	National Quality Assurance
NYSERDA	New York State Energy Research and Development Authority

NYSDOH	New York State Department of Health
PM	Project Manager
PPE	Personal Protective Equipment
PROI	Potential Radionuclide of Interest
QA	Quality Assurance
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
QC	Quality Control
RADCON	Radiation Control
RE	Relative Error
ROI	Radionuclide of Interest
RPD	Relative Percent Difference
RPP	Radiation Protection Program
RSD	Relative Standard Deviation
SEC	Safety and Ecology Corporation
SOP	Standard Operating Procedures
TRU	Transuranic
UTL	Upper Tolerance Level
WNYNSC	Western New York Nuclear Service Center
WVDP	West Valley Demonstration Project

EXECUTIVE SUMMARY

This plan provides the technical basis for the protocols for collection of survey and sample data associated with the characterization of soils for radionuclides at the West Valley Demonstration Project (WVDP) and Western New York Nuclear Service Center (WNYNSC). This field sampling plan (FSP) provides guidance on conducting characterization and sampling and analysis in support of the Phase 1 Decommissioning Plan.[1] A future revision to this plan will incorporate sampling of soils and other media such as concrete, metal, water, and waste and analysis for chemical contaminants as well as radiological contaminants.

This FSP uses a combination of gamma walk-over surveys (GWSs), biased, and systematic samples in support of remedial action surveys and characterization of environmental media. This FSP is structured to implement the Phase 1 Characterization Sampling and Analysis Plan for the WVDP [Characterization Sampling and Analysis Plan (CSAP)][2] and QP-450-01 – Management of Environmental Media – Phase 1 Decommissioning of the West Valley Demonstration Project, Rev. 0[3] (Referred to as the Environmental Media Policy). If Remedial Action Survey data collected using this FSP indicates that a specific area at WVDP meets the Cleanup Goals (CGs) specified in the FSSP, a Final Status Survey (FSS) may be performed, if requested by the U.S. Department of Energy (DOE).The data will be collected in a manner that minimizes sampling and maximizes results. This will be done by recognizing that an ultimate goal at WVDP is to meet the Phase 1 Final Status Survey Plan for the West Valley Demonstration Project (FSSP) Rev. 1[4] requirements for release of the site. Data collected under this FSP will be used to document the condition of soils and to build and grow a data set that directly supports the FSSP thereby minimizing additional sample collection. Alternate characterization criteria may be designated at the discretion of DOE.

1.0 INTRODUCTION

1.1 Site Description

The West Valley Demonstration Project (WVDP) (established to implement the WVDP Act) is located on approximately 167 acres within the 3,345-acre Western New York Nuclear Service Center (WNYNSC), owned by the New York State Energy Research and Development Authority (NYSERDA) in rural Cattaraugus County, about 35 miles south of Buffalo, New York. The WVDP site is complex, involving a large number of potential radionuclides of concern and a variety of historical processes and events that are known to have or may have released contaminants into the environment. Known affected environmental media include surface soils, subsurface soils, groundwater, surface water, and sediments. The decommissioning of the WVDP site will involve a sequential set of activities that will vary significantly depending on the exact location and activity purpose.

The WVDP is a unique operation within the U.S. Department of Energy (DOE). The West Valley Demonstration Project Act of 1980 directed the Secretary of Energy to undertake five major activities, as follows:

- Solidify the liquid high-level waste (HLW) stored at WNYNSC into a form suitable for transportation and disposal (completed);
- Develop containers for the solidified HLW suitable for permanent disposal of the HLW (completed);
- Transport the waste to a federal repository for disposal (pending);
- Dispose of low-level radioactive waste (LLRW) and transuranic (TRU) waste produced by the Project (in progress); and
- Decontaminate and decommission the HLW storage tanks (PUREX and THOREX HLW tanks deactivated, July 2003), the HLW solidification facilities (in progress), and any material and hardware used in connection with the Project (in progress).

1.2 Project Description

DOE has awarded Safety and Ecology Corporation (SEC) an Indefinite Delivery/Indefinite Quantity (ID/IQ) prime contract for Environmental Characterization Services (ECS). The work scope includes, but is not limited to, soil, sediment, and groundwater characterization and environmental monitoring and associated regulatory documentation supporting decommissioning activities at WVDP. The purpose of this ECS contract is to implement the Characterization Sampling and Analysis Plan (CSAP) and Final Status Survey Plan (FSSP).

This Field Sampling Plan (FSP) has been prepared to support ongoing work as part of the *Phase 1 Decommissioning Plan for the West Valley Demonstration Project* (Phase 1 DP). Refer to that document for a discussion of project history and contaminants.

SEC will perform radiological surveys, sampling, and analysis of soils at WVDP in accordance with the CSAP. Additionally, the WVDP site contractor, CHBWV, will be removing on-site facilities, materials, equipment and personal property during the course of the project. CHBWV will identify specific release criteria for various disposition pathways (re-use, recycle, disposal, etc.). The SEC sampling team will perform the characterization surveys after CHBWV has progressed in its removal and survey process. After the completion of the CSAP sampling, SEC may also be required to perform Phase 1 Final Status Surveys (FSSs) in accordance with the FSSP.

SEC will maintain direct, concise, and daily contact/coordination with the DOE Project Manager (PM) and site operating contractor, CHBWV concerning field operations and scheduling field activities. Notations in logbooks and/or in the Work Package Status Log, a requirement of SEC-ISMS-002, *Project Integrated Work Control Plan,* will document this coordination and communication. All field work described in this FSP will follow the Work Control Requirements in SEC-ISMS-002.

1.3 Objective

The objective of this FSP is to perform Remedial Action Surveys and characterization of environmental media to support decisions for materials, equipment, personal and real property, facilities, structures, and associated foundations at WVDP. The remedial action surveys and characterization surveys will be performed in accordance with the CSAP. The required surveys include gamma walk-over surveys (GWSs), biased and systematic surface and subsurface soil sampling. The biased and systematic soil samples will be analyzed for the 18 radionuclides of interest (ROIs) and the 12 potential radionuclides of interest (PROIs) as described in the CSAP. Where possible, and only with approval of the DOE PM, surrogate radionuclides such as Cs-137 and Sr-90, will be used to limit the analyte list. This will be done if and when it can clearly be shown that if the surrogate radionuclides do not exceed their cleanup goal (CG), then it is highly unlikely that other ROIs or PROIs exceed their CG. Selection of surrogate radionuclides will only be considered after work according to this FSP progresses and a sufficient body of knowledge is obtained to justify their use.

An ultimate goal at WVDP is to meet FSSP requirements for release of the site. This end goal was used to structure the data collection specified in this FSP. Data collected under this FSP will be used to build and grow a data set that directly supports the FSSP thereby minimizing additional sample collection. The GWS, which collects data for surface soils, is sensitive enough to detect the cleanup goal (CG) – Elevated Measurement Concentration (CG_{emc}) established in the FSSP for 1 square meter (m^2) areas for all gamma-emitting radionuclides. The GWS is sensitive enough to detect the CG_{emc} for 100 m^2 areas for most gamma-emitting radionuclides when on the soil surface and to a depth of approximately 5 cm, depending on the specific radionuclide. Those that cannot be detected on the surface or at depth at the CG_{emc} for 100 m^2 areas, such as I-129, are likely to be comingled with those that can be detected such that they will likely be detected by biased sampling. If radionuclides that cannot be detected by the GWS are not collocated with radionuclides that can be detected by the GWS, this information helps refine the sampling strategy for the FSS for the site.

The CG_{emc} refers to radionuclide-specific activity concentrations that must be met over areas smaller than individual survey units as defined in the FSSP. The CG_w refers to radionuclide-specific activity concentrations that must be met, on average, for each individual survey unit. The objective of the GWS is to determine if localized areas exceed the CG_{emc} (either for 1 m^2 or 100 m^2) and to provide an indicator of whether the area exceeds the CG_w by comparing detector response to background. Even though the GWS data is not necessarily sensitive enough to detect the CG_w for all gamma-emitting ROI or PROI, the technique, when compared to the local gamma background, will provide an indicator of whether the CG_w is met.

The objective of biased soil sampling is to validate the GWS indication that the CG_{emc} was exceeded and to establish location(s) for subsurface soil sampling. A subsurface sample obtained at a location with a higher surface radionuclide concentration provides an indicator of the depth of contamination in the localized area from which it was obtained.

The objective of systematic soil sampling is to assess the average concentration of ROI and PROI in the area for comparison to the CG_w. Systematic samples are also needed to determine the concentration of ROI and PROI that do not emit gamma radiation and thus cannot be measured by the GWS. Systematic samples evaluated in conjunction with the GWS also provide an indication of the areal extent of contamination.

1.4 Scope

This section identifies the overall scope and the specific objectives of Task Order No. 9 and the field measurement and sampling activities that will be used to satisfy this scope. The guidance contained herein serves to ensure the following:

- That the data collected during this effort will be of sufficient quantity and quality to accurately determine the presence or absence of contamination in excess of CGs, to help define the depth and lateral extent of contaminated areas, and to help define the lateral extent of areas requiring no further remediation.
- When appropriate, the data collected will be of the quantity and quality to support FSS.
- That the characterization of environmental media to support decisions for materials, equipment, personal and real property, facilities, structures, and associated foundations is consistent with the CSAP and QP-450-01.

SEC will mobilize the appropriate equipment and qualified personnel to perform the required data collection activities associated with the task. This FSP discusses the gamma walkover survey methods, civil surveying, field instrumentation, soil sampling methods, sample chain of custody documentation, quality assurance (QA)/quality control (QC) procedures, laboratory analytical methods, and statistical data evaluation methods.

1.5 Radionuclides of Interest and Cleanup Goals

The Phase 1 DP identified 18 ROIs for the project premises, and Derived Concentration Guideline Level (DCGL) values for each of the ROIs were developed to meet the unrestricted release criteria of 25 millirem per year (mrem/y) in 10 Code of Federal Regulations (CFR) 20.1402. The DCGL requirements included a DCGLw value to be applied as an area-averaged goal to FSS units and $DCGL_{emc}$ values applicable to areas of 100 square meters (m^2) and 1 m^2. The Phase 1 DP also provides area factors that can be used to calculate additional $DCGL_{emc}$ requirements for areas smaller than FSS units. In addition, the Phase 1 DP distinguishes between DCGL values for surface soils (defined as soils to a depth of 1 m), subsurface soils (defined as soils at a depth greater than 1 meter that would be temporarily exposed by proposed Phase 1 excavation activities), and streambed sediments.

These DCGL values were further refined to reflect cumulative dose concerns, resulting in a final set of DCGL values listed in Table 5-14 of the Phase 1 DP. Table 5-14 refers to these as cleanup goals (CGs). The CGs are more conservative than the DCGL requirements since they account for the possibility of cumulative dose. To be consistent with the Phase 1 DP terminology, from this point forward, the term "cleanup goals" or CGs will be used to refer to the requirements that must be met. Specifically, the term CG_w refers to radionuclide-specific activity concentrations that must be met, on average, for each individual survey unit, and the term CG_{emc} refers to radionuclide-specific activity concentrations that must be met over areas smaller than individual survey units. Table 5-14 of the Phase 1 DP is reproduced as Table 1-1 in this FSP.

Table 1-1. Phase 1 Cleanup Goals [picocuries per gram (pCi/g)]
(Source: WVDP Phase 1 Final Status Survey Plan Revision 1, Table 1)

Nuclide	Surface Soil		Subsurface Soil		Streambed Sediment	
	CG_w (1)	CG_{emc} (2)	CG_w	CG_{emc}	CG_w	CG_{emc}
Am-241	2.6E+01	3.9E+03	2.8E+03	1.2E+04	1.0E+03	2.1E+04
C-14	1.5E+01	1.6E+06	4.5E+02	8.0E+04	1.8E+02	5.9E+05
Cm-243	3.1E+01	7.5E+02	5.0E+02	4.0E+03	3.1E+02	2.8E+03
Cm-244	5.8E+01	1.2E+04	9.9E+03	4.5E+04	3.8E+03	3.6E+05
Cs-137 (3)	1.4E+01	3.0E+02	1.4E+02	1.7E+03	1.0E+02	9.4E+02
I-129	2.9E-01	6.0E+02	3.4E+00	3.4E+02	7.90E+01	2.0E+04
Np-237	2.3E-01	7.5E+01	4.5E-01	4.3E+01	3.2E+01	1.1E+03
Pu-238	3.6E+01	7.6E+03	5.9E+03	2.84E+04	1.2E+03	1.7E+05
Pu-239	2.3E+01	6.9E+03	1.4E+03	2.6E+04	1.2E+03	1.7E+05
Pu-240	2.4E+01	6.9E+03	1.5E+03	2.6E+04	1.2E+03	1.7E+05
Pu-241	1.0E+03	1.3E+05	1.1E+05	6.8E+05	3.4E+04	7.5E+05
Sr-90 (3)	3.7E+00	7.9E+03	1.3E+02	7.3E+03	4.7E+02	7.1E+04
Tc-99	1.9E+01	2.6E+04	2.7E+02	1.5E+04	6.6E+04	4.2E+06
U-232	1.4E+00	5.9E+01	3.3E+01	4.2E+02	2.2E+01	2.1E+02
U-233	7.5E+00	8.0E+03	8.6E+01	9.4E+03	2.2E+03	4.4E+04
U-234	7.6E+00	1.6E+04	9.0E+01	9.4E+03	2.2E+03	2.1E+05
U-235	3.1E+00	6.1E+02	9.5E+01	3.3E+03	2.3E+02	2.0E+03
U-238	8.9E+00	2.9E+03	9.5E+01	9.9E+03	8.2E+02	8.2E+03

Notes:
(1) CG_w refers to activity concentrations that must be achieved, on average, over areas the size of FSS units.
(2) CG_{emc} refers to activity concentrations that must be achieved, on average, over 1-m^2 areas.
(3) CG requirements provided for this table for Cs-137 and Sr-90 assume one half-life of decay will occur before the possible release of the site in 2041. As part of the FSS process, these values will be decay-corrected reflecting the date of the data collection to ensure that the desired dose standard is achieved.

In addition to the 18 ROIs contained in the Phase 1 DP, another 12 radionuclides have been identified as potentially being of interest; these 12 potential ROIs are listed in Table 1-2. The identification process relied on historical process knowledge; to date none of these 12 has been observed in historical samples at levels that would be of dose concern and the belief is that it is unlikely that any of these 12 exist at significant levels in environmental media.[2] Several of the 12 have short half-lives relative to the history of WVDP/Nuclear Fuel Services, Inc. (NFS) activities; others would have had very low abundance within the spent fuel that would have been processed at the site, compared to Cs-137 and Sr-90. FSP data collection will provide supporting data to determine whether any of these 12 radionuclides should be of interest.

Table 1-2. Twelve Radionuclides of Potential Interest
(Source: WVDP Phase 1 Characterization Sampling and Analysis Plan, Revision 1, Table 3)

Radionuclide	Naturally Occurring		Typical Soil Background Activity Concentrations (pCi/g)	Required Laboratory Sensitivity (pCi/g)
	Yes / No	Half Life (years)		
Ac-227	Yes	21.8	~ 0.05	0.1
Co-60	No	5.3	Not applicable	
Cd-113m	No	14.1	Not applicable	
Eu-154	No	8.6	Not applicable	
H-3	Yes	12.3	Negligible quantities	
Pa-231	Yes	32,760	~ 0.05	0.1
Ra-226	Yes	1,602	~ 1	0.1
Ra-228	Yes	5.8	~ 1	0.1
Sb-125	No	2.8	Not applicable	
Sn-126	No	12.4	Not applicable	
Th-229	No	7,340	Not applicable	
Th-232	Yes	1.4E10	~ 1	0.1

2.0 ENVIRONMENT, SAFETY, HEALTH, QUALITY, AND RADIATION PROTECTION

Work for this FSP will be performed according to the SEC Environment, Safety, Health, Quality and Radiation Protection Programs (RPPs) along with supporting procedures and subordinate plans. These documents have been prepared by SEC and approved by DOE. These approved documents are implementing mechanisms of the SEC *Integrated Safety Management System*, SEC-ISMS, and include the following:

- Worker Safety and Health Program (SEC-WSHP)
- Radiation Protection Program (SEC-RPP)
- Quality Assurance Program (SEC-QAP)
- Environmental Protection Program (SEC-EPP)
- Waste Management Plan (SEC-WMP)
- Emergency Preparedness Plan (SEC-EmPP)
- Conduct of Operations Program (SEC-COP)
- Contractor Assurance Program (SEC-CAP)
- Corporate Operating Experience Program (SEC-COEP)
- Integrated Security Plan (SEC-ISP)

3.0 ROLES AND RESPONSIBILITIES

This section identifies the roles and responsibilities of project personnel.

3.1 Key Project Personnel

Project personnel key to performing this FSP are the PM, Environmental Safety and Health (ES&H) Manager, and Radiological Engineer/Work Group Supervisor. These individuals, at a minimum, will be at the site when soil sampling field work is performed. The Subcontractor Field Lead for performing Geoprobe® sampling is considered a key person and will be at the site whenever sampling with the geoprobe is required. When only GWS data is collected, only the PM or Radiological Engineer and the ES&H Manager must be at the site.

3.1.1 SEC Project Manager

The PM performs the following functions, may assist others with their duties, and has the following responsibilities:

- Serves as the primary point of contact with DOE;
- Ensures coordination of management, safety and health, radiation control (RADCON), and quality assurance (QA) functions;
- Manages the Geoprobe® subcontractor;
- Allocates resources to the project to ensure successful execution and completion of milestones;
- Demonstrates commitment and implementation of Integrated Safety Management System (ISMS) and Quality Assurance Plan (QAP);
- Coordinates with the Radiological Engineer and Site Geologist/QC Coordinator to ensure work is performed with appropriate level of quality and in accordance with specifications and requirements;
- Maintains signature authority to commit SEC;
- Ensures all work and project activities are executed in accordance with established regulatory requirements and SEC programs, plans, and procedures; and
- May function as acting Environmental Safety and Health Manager, provided relevant education and experience is demonstrated.

3.1.2 Radiological Engineer/Work Group Supervisor

The radiological engineer performs the following functions, and may assist others with their duties:

- Manages the collection of field data;
- Maintains field logbooks;
- Produces tables and figures of GWS and Sample Data;
- Provides daily updates to the SEC PM;
- Completes sample chain of custody and ships samples for laboratory analysis;
- Prepares and packages soils; and

- Acts for the Radiological Protection Manager when not at the site to implement the SEC RPP, maintain exposure records, and keep field activities as low as reasonably achievable (ALARA).

3.1.3 SEC Environmental Safety and Health (ES&H) Manager

The ES&H Manager:

- Recognizes, evaluates, recommends, and implements policies and procedures to assure awareness of and compliance with ES&H requirements of the organization;
- Monitors and prevents adverse exposure to chemical, biological, and physical hazards throughout the work sites;
- Directs audits of the ES&H programs to identify and correct program deficiencies, and will keep fully informed on all existing and proposed changes in occupational health and safety regulations;
- Provides basic ES&H training to employees and promotes communication programs to enhance and encourage employee awareness of accident prevention, industrial hygiene, and environmental compliance;
- Ensures all work and project activities are executed in accordance with established regulatory requirements and SEC programs, plans, and procedures; and
- May perform sampling and survey work provided such work does not impede the ability to perform the duties listed above.

3.1.5 Subcontractor Field Lead

The Subcontractor Field Lead:

- Directs the operation of the Geoprobe®,
- Obtains the soil cores, and
- Decontaminates the sampling probe in between sampling locations.

4.0 FIELD ACTIVITIES

A number of field activities will be conducted as part of this effort. The principle activities include:

- GWSs,
- Biased Sampling,
- Systematic Sampling,
- Removed Infrastructure/Overburden Soils Footprint Contamination Sampling, and
- Civil Surveying.

4.1 Gamma Walkover Surveys (GWSs)

GWS measurements will be performed to support remedial action and characterization as specified in the CSAP. GWS data will be collected with at least one detector capable of detecting low-energy gamma-emitting radionuclides such as ^{241}Am [e.g., Field Instrument for Detection of Low-Energy Radiation (FIDLER)]. GWSs will be conducted to provide complete coverage of exposed soil surfaces whether surface soils or soils within excavations or under removed site infrastructure, with a data density of, on average, at least one measurement per square meter. All GWS data will be electronically logged and include coordinates in New York West State Plane (NAD 83). Coordinate quality on the x, y plane will include sub-meter accuracy. Areas that are inaccessible due to terrain or standing water will be clearly demarcated on a map.

GWSs will be performed with a global position system (GPS) capable of recording a survey measurement and a paired position approximately every second. The GPS will be capable of sub-meter accuracy (x, y data). The GWS will focus on ROIs that have photon (gamma ray and x-ray) emissions. Of the 18 ROIs, 14 have photon emissions that will allow them to be detected in the field. Table 4-1 provides a summary of the minimum detectable activities (MDAs) documented in the FSSP associated with the field detection of the 14 ROIs that have photon emissions. It should be noted that assumption is made that radionuclides will be commingled. The GWS will be used to determine areas that are not consistent with background conditions.

GWSs will be performed in accordance with the GWS procedure attached in Appendix A. In general, GWSs will be performed by a technician traversing areas on foot at a rate approximately 0.5 meters per second carrying a backpack mounted GPS and the detectors. In some instances, either where terrain allows or where shielded detectors are required, a cart mounted FIDLER/ GPS or a motorized all-terrain vehicle setup may be deployed. The cart will be pushed by the technician or a detector array will be mounted on the ATV either driven at the same scan rate. The data will have a minimum density of 1 data point per square meter.

The GPS data will produce data with final coordinates in New York State Plan West, North American Datum 1983 (NAD83). Data will be presented graphically and in electronic table form. The data at a minimum will contain counts per minute (cpm), northing and easting (x, y), and dilution of precision (PDOP), date, and time.

Table 4-1. Estimated Scanning Minimum Detectable Activities (MDCs)
(Source: WVDP Phase 1 Final Status Survey Plan Revision 1, Table 5)[3]

Radionuclide	Type of Detector	Scan MDC (pCi/g)
Am-241	FIDLER	30
C-14	NA(1)	
Cm-243	2" x 2" NaI	50
Cm-244	FIDLER	300
Cs-137	2" x 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)	
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 for detection by field scanning instruments.
(2) A specific calculation of the scanning minimum detectable count rate for Cs-137 in soil performed in connection with the preparation of the Phase 1 Decommissioning Plan yielded a value equivalent to 7 pCi/g of 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 are reported elsewhere. The values given here are those expected to be reasonably achievable under field conditions.

If multiple detectors are deployed in a survey, a 100 m^2 area will be surveyed by all instruments with the data logged by coordinate location and stored electronically. Multiple detectors may be deployed as a means of surveying site areas more quickly or resolving elevated gamma radiation signal from nearby buildings, waste containers, or waste storage areas, referred to as "shine." When multiple detectors are used to address localized elevated background, at least one detector will be completely unshielded and one or more detectors will be collimated with lead in an attempt to resolve the signal from the ground surface and elevated localized background signal.

GWSs will use a FIDLER. Resolution of shine will be done other types of sensitive gamma detecting instruments such as 2-inch-by-2-inch sodium iodide (NaI) detectors because their smaller size than the FIDLER makes them more amenable to the use of lead collimators. In addition, static counts will be made with the FIDLER prior to collecting soil samples and the data will be used to evaluate the minimum detectable concentration (MDC) as discussed in Section 4.2.

4.2 Sample Collection

Samples will be collected using hand trowels, Geoprobes® for samples deeper than 15 cm, or with hand augers or power augers. Hand augers shall be used in cases where there are concerns over buried utilities or infrastructure. More details regarding use of the Geoprobes® are presented in Section 4.2.1.

A sufficient volume of soil will be collected to allow all 18 ROIs and the 12 PROIs to be analyzed. Sufficient volume is approximately 900 g (see Table 6-3 where the sum of the minimum volumes equals 825 g) because of the extensive list of ROI and PROI. This will be satisfied by collecting samples from 10-cm (4-inch) diameter holes 15 cm deep, and for deeper samples (either 85 cm or 100 cm), a 5-cm (2-inch) diameter hole will suffice.

Samples of 15 cm depth from ground surface or below hardstand will be collected with a hand auger. The hand auger was chosen for the shallow samples instead of a Geoprobe® to minimize the size (and cost) of the drill rig needed to obtain 10-cm diameter samples. Hand auguring the first 15 cm is also a safety measure to prevent contact with underground utilities that may not have been identified as being present in the area. The auger will bore a hole a minimum of 10 cm in diameter to assure sufficient soil is collected. When hard stand or asphalt makes it difficult to use the hand auger, the drilling subcontractor will first break through the hard stand or asphalt and then the hand auger will be used.

The hand auger sample cuttings will be brought up onto plastic sheeting and placed in stainless steel mixing bowls to be homogenized and packaged as samples. Geoprobe® samples will be collected in acetate liners. The liners will be opened and the sample will be extracted into the mixing bowl for homogenization and sampling. Samples will be collected, handled, and packaged according the procedure shown in Appendix C.

Surface and subsurface samples will be scanned for gamma radiation before they are homogenized. This will help determine if there are discrete horizons of radioactive contamination in the soil cores.

Field notes for biased and systematic samples will include a 30-second static FIDLER count at a distance of 15 cm above the ground surface prior to acquiring the sample. A physical description of the material sampled, date, and time shall be included. Additionally, the location (coordinates) of the sample will be recorded in NY State Plane West NAD83 with a quality of ± a hundredth of a foot (± 0.01 ft) for each sample.

Static readings will be recorded in a fashion that allows them to be paired with the analytical results associated with the sampled location. These paired results will be preserved and reviewed according to the specifications in Section 6.11.1 of the CSAP as work progresses. Data meeting the CSAP specifications (i.e., near or above CG_w requirements for Cs-137) in an area likely affected primarily by Cs-137 impacts, an absence of any shine concerns, no surface cover, relative constant gross activity readings over a small area (2 to 3 m^2), and an area that will unlikely be immediately affected by Phase 1 remediation activities), will be used to allow monitoring of FIDLER performance and determination of field MDC values for the FIDLER detectors by performing regression analyses.

4.2.1 Geoprobe Sampling

Because of the depth of the average sample terminating at 1 meter, a direct push Geoprobe® or equivalent system will be utilized for samples collected from 15 cm below ground surface or hardstand to 1 meter and for samples collected from ground surface or directly below hardstand to 1 meter below ground surface. This is discussed further in the subsections below.

The Geoprobe® subcontractor's procedure is shown as Appendix B. A direct push system uses a hydraulic or pneumatic pressure to push a sample tube to a required depth. Specific intervals are then sampled as the sample tooling is advanced to depth.

The Macro-Core Sampler is driven one sampling interval into the subsurface and retrieved using the direct push machine. The sample length will be 4 feet. The collected soil core is removed from the sampler along with the acetate inner liner. The liners are cut to the required sample interval; the sample is extracted, homogenized, and packaged.

The direct push core diameter will be a minimum of 5 cm as stated above. Samples will be collected, handled, and packaged in accordance with the procedure shown in Appendix C.

Open tube samplers will be used for stable soils. In the open tube configuration, coring starts at the ground surface with a sampler that is open at the leading end. The sampler is driven into the subsurface and then pulled from the ground to retrieve the sample.

In unstable soils which tend to collapse into the core hole, the sampler will be equipped with a center rod closed-point assembly. The point fits firmly into the cutting shoe and is held in place by the center rod. This prevents collapsed soil from entering the sampler as it is advanced to the bottom of an existing hole, thus ensuring collection of a representative sample. When a closed point sampler is needed, the soil sampler is secured with a vinyl end cap. Loose soils are prevented from falling from the bottom of the sampler as it is retrieved from depth. A core catcher on the bottom of the sample tube prevents loss of unconsolidated material.

Soil samples are removed by unthreading the cutting shoe and pulling out the liner. A few sharp taps on the cutting shoe with a pipe wrench will often loosen the threads to allow hand removal. If needed, the interior of the cutting shoe has wrench flats for attaching a wrench and loosening tight threads. When the cutting shoe is removed, the liner may be removed. Undisturbed samples are collected by cutting the liner.

4.2.2 Biased Soil Sampling

The purpose of biased samples is to determine whether the CG_{emc} is exceeded. Biased samples will be collected to target specific locations where there is concern about exceeding the CG_{emc}. Biased samples will be collected in excavated areas from the excavated ground surface to a depth of 1 meter. In some cases, biased samples may be collected from the side walls of excavations, also using the results of gamma measurements to locate possible lenses of contamination. Biased sampling will be performed as necessary based on locations exhibiting elevated GWS and direct gamma measurements. "Elevated GWS results" is somewhat subjective as it depends on ambient background, type of surface cover, elevation (whether in a ditch or on a rise), and shine from buildings and waste containers. Locations having a gamma signal greater than three standard deviations above local background will be considered for biased sampling. In areas where it is less obvious that there is an elevated gamma signal coming from the soil surface, a normal probability plot will be used to look for gamma signal that is not normally distributed. Background signal tends to be normally distributed. The normal probability plot is a tool used to identify where a second data population (in addition to background) exists. Such a second population would represent gamma signal from contamination plus local background signal.

The collection of biased measurements will be based on the judgment of the PM or the Radiological Engineer at a rate that will not exceed one sample per 100 m^2. The results will be compared to the CG_{emc} for 100 m^2 areas. These samples will be useful to determine the depth of excavation, to support future Phase 2 planning, and the ultimate FSS for the WVDP. The number and location of biased soil samples will be coordinated with the appropriate DOE personnel prior to collection. Concurrence may be signified by notation in the field logbook.

Biased locations will also be chosen in a manner that will most effectively help to determine the maximum depth of contamination. Samples will be collected in a manner that is representative of a 1 meter depth for each location for open excavations.[2] If sample locations are chosen outside of an excavated area footprint, two samples from each location will be collected; one will represent the 0 to 15 cm soil interval and one will represent the 15 to 100 cm deep soil interval, in accordance with the CSAP. Sampling outside an excavated footprint will only be conducted when such sampling is useful to identify the radionuclides causing the elevated GWS signal and only with concurrence of the DOE PM or designated representative. Concurrence may be signified by notation in the field logbook.

A gamma radiation profile will be taken by scanning the entire interval of the sample core with a FIDLER or NaI detector in an attempt to determine if there is a lens of buried contamination. Down-hole gamma logging may also be performed if data suggests that there is indeed a lens of buried contamination.

When sufficient data have been collected during the project, and if that data allows selection of surrogate radionuclides, surrogates such as Cs-137 and/or Sr-90 may be used to limit the list radionuclides requiring analysis. An example of when surrogates may be used would be a case where it could be shown that when the surrogate was less than the CG all other ROI or PROI were also less than the CG. Provided that a percentage of samples (e.g., 10%) were always analyzed for all ROI and PROI and the premise for use of the surrogate continued to hold true, the use of the surrogate would be appropriate. Selection of surrogates will follow guidance in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),[5] Chapter 4. It may also be possible to analyze for total strontium instead of Sr-90 because Sr-89 has a sufficiently short half-life such that it may no longer be present in measurable quantities. Laboratory results for total strontium are obtained approximately one week sooner than results for Sr-90, and this time savings may prove beneficial. The final report will discuss the approach that was applied and the rationale if these techniques are used.

4.2.3 Systematic Soil Sampling

Systematic samples will be collected in accordance with the CSAP in remediated areas and throughout the site when requested by the DOE PM under three conditions:

1) When GWS results and biased sampling data indicate contamination levels likely meet surface soil CG requirements and to confirm that CG_{emc} exceedances are not an issue for the areas each systematic sample represents.[4] This data will support the FSS and will be collected in a manner that meets FSSP requirements.

2) When GWS data and/or biased soil samples indicate contamination exceeds the CG and DOE decides not to excavate the contaminated soil. This data will be collected to help guide Phase 2 planning.

3) When soil in a footprint was excavated at the discretion of DOE to remove contamination. This data will support the FSS and will be collected in a manner that meets FSSP requirements.

When systematic characterization sampling is performed in a remediated area, one sample per 200 m^2 area will be collected to a depth of 15 cm and submitted for analysis in accordance with the CSAP. If a footprint is less than 200 m^2, one sample will still be collected. Systematic locations will be placed on a random start triangular grid.

Systematic soil samples will be used to evaluate compliance with the CG requirements as listed in Table 1-1 or to document the as left conditions when contaminated soil was not removed. Systematic samples will help define the lateral extent of contamination and will be used to support FSSs in locations that are believed to be free of contamination above the CG_w. Systematic samples are also necessary to document contamination levels of radionuclides that cannot be detected by the GWS. A sufficient volume will be collected for all 18 ROIs and the 12 PROIs to be analyzed, if required. Data evaluation will always take into account the potential opportunity to use surrogate radionuclides to lessen the need to analyze for all ROIs and PROIs.

Systematic surface soil samples may also be collected as part of a FSS with a sampling density at a minimum of one sample per 100 m^2 for Class 1 MARSSIM Survey Units. More samples could be required depending on the Type II error probability established and approved by the DOE PM. The Type I error probability is always set at 0.05 in accordance with the FSSP.

Systematic surface soil samples will be collected following MARSSIM guidance for any Class 2 Survey Units that are identified, if any. Systematic surface soil samples will be collected from ground surface to 15 cm below ground surface and then from 15 cm to 100 cm below ground surface at each sampling location. Allowable error probabilities for Class 2 Survey Units are the same as for Class 1 Areas. There are no Class 3 Survey Units expected for purpose of FSS as stipulated in the FSSP.

4.2.4 Removed Infrastructure/Overburden Soils Footprint Contamination Sampling

A number of Phase 1 activities will result in the removal of concrete pads, hardstands, and the like outside the footprint of the WMA 1 and WMA 2 deep excavations. For example fill dirt will be removed to construct the High Level Waste Canister Interim Storage Area. In each of these cases, the presence of this infrastructure or overburden fill soil would or may have precluded thorough characterization of underlying soils by the CSAP data collection prior to removal.

- In some cases, this infrastructure will exist in areas where there is known contamination at depths greater than 1 m. At these locations, the area will not be a candidate for Phase 1 FSS data collection, even if there is not a reason to believe surface soils exposed by infrastructure/overburden soils removal are contaminated above surface soil CG levels. In these cases, the purpose of remedial action survey data collection after infrastructure removal is to document the contamination status of the exposed soils for Phase 2 planning purposes.

- In other cases, the exposed soils themselves may clearly pose surface soil CG concerns. At these locations, DOE may choose to remove contaminated soils as part of Phase 1 activities until surface soil CG standards have been achieved. In these cases, the purpose of remedial action surveys is to support the removal of contaminated soils and to indicate when surface soil CG standards have likely been achieved.

- Finally, there may be cases in which there is no evidence of subsurface contamination at depths greater than 1 m, and the exposed soils resulting from infrastructure/overburden soil removal likely meet surface soil CG requirements. At these locations, the purpose of the remedial action survey data collection is to document the contamination status of the exposed soils in preparation for Phase 1 FSS data collection, should DOE choose to perform Phase 1 FSS activities.

In all three of the cases described above, the following minimum remedial action survey data collection will take place. A logged GWS will be performed consistent with the FSS protocols (as defined in the Phase 1 FSSP). If there are indications of surface soil CG exceedances based on scan results, biased samples will be collected from those locations and may be submitted for quick-turnaround analysis for Cs-137 and Sr-90. If DOE chooses to remove soils exceeding surface soil CG standards, soil removal will take place and logged GWS combined with biased soil sampling will be repeated for the affected areas. If DOE chooses not to remove soils or scan/biased sampling data indicate contamination levels likely meet surface soil CG requirements, one sample per 200 m^2 area will be collected to a depth of 15 cm and may be submitted for quick-turnaround analysis for Cs-137 and Sr-90.

In some instances, there may be concerns about subsurface contamination beneath infrastructure/overburden soil that could not be fully addressed until the infrastructure/overburden soil was removed. In some of these cases, the minimum remedial action survey data collection described above may be supplemented with vertical soil cores to an appropriate depth, with down-hole bore scans every 15 cm and selective biased sampling of specific vertical subsurface soil layers based on scan results. In other cases the minimum remedial action survey data may be supplemented with soil sampling and gamma scanning in areas where infrastructure/overburden soil is being removed or from a pile of the excavated overburden soil. In the case of biased sampling, the samples may be submitted for quick-turnaround analyses of Cs-137 and Sr-90 and/or for analysis of all or a selected suite of ROI and PROI. The basis for selecting a suite of ROI and PROI will be analysis of previously-collected soil samples and their analytical results. If a selected suite of ROI and PROI is chosen, a technical basis will be prepared and submitted to the DOE PM for approval.

When soil samples are collected in an excavation, the number of samples collected will be based on the MARSSIM Survey Unit Class (i.e. Class 1 or 2). The standard MARSSIM Survey Unit size will be used. The number of samples required (N) per survey unit will be based on guidance in MARSSIM. Data collected at WVDP to date indicates that the relative shift is greater than 3. The probability of Type I error will be set to 0.05. The probability of a Type II error will be set depending on the specific circumstances, discussed with, and approved by, the DOE PM.

When soil samples are collected of excavated soil piles, systematic sampling will be performed of stockpiled material. For Class 1 Areas, one sample per 30 m^3 of stockpiled material will be collected and submitted for analysis for all ROI and PROI or a selected suite as discussed above. The basis one sample for 30 m^3 is the CSAP requirement to collect one surface soil sample per 200 m^2 to a depth of 15 cm. MARSSIM Class 2 areas are typically five times larger than Class 1 areas, therefore one sample will be collected per 150 m^3 when soil is excavated from Class 2 Areas. MARSSIM Class 3 areas can be an unlimited size. Soil will be sampled from piles of excavated soil at a rate of one sample per 750 m^3, a multiplier of five times the Class 2 sampling rate. If a stockpile is less than 30 m^3, one sample will still be collected regardless of the MARSSIM survey unit class. Systematic locations of stockpiled material will meet the requirement of a random start point based on the random nature of the excavated material placement.

4.3 Civil Surveying Requirements

A civil surveyor licensed in New York State will be used to collect topographic survey information. A variety of instrumentation may be utilized to collect the positional data including total stations (robotic and manual), kinematic and real-time kinematic GPS, and Light Detection and Ranging (LIDAR). The appropriate technology will be selected based on the logistical parameters associated with the survey. The surveys will be used to identify excavation boundaries, structures, utilities, and sample locations, both systematic and biased samples. Measurements shall record northing, easting, and elevation, and shall be accurate to ± a hundredth of a foot (± 0.01 ft.).

4.4 Decontamination

Sampling equipment used during surface/subsurface soil sampling will be free from contamination and decontaminated prior to use. Field decontamination should be done near the work area. Special precaution should be taken to contain solids and liquids that are created during the decontamination process. Equipment potentially requiring decontamination may include stainless steel scoops, spoons, bowls, core barrels, etc. Other equipment used during sampling activities that does not directly contact sample materials shall be cleaned to remove potential soil contamination.

The Geoprobe® sampler will be free of dirt, mud, oil, or other contaminants before being permitted on-site. An incoming radiological survey will be performed according to procedures supporting the SEC RPP. If the machine has contamination exceeding the limits in SEC-RP-10, *Contamination Control and Monitoring*, it will be turned away from WVDP.

The Geoprobe® split spoon samplers will be decontaminated after each sample location and before proceeding to the next location. Decontamination will also be performed on all sampling tools after each sample is collected. Since sampling is for radionuclides and not chemicals, the effectiveness of decontamination can be determined by field radiological analysis with swipes. It will be acceptable to wipe off sampling equipment with dry or damp cloths or masslin and to verify that there is no contamination detected using field radiological analyses. If contamination is detected or if dirt or debris remains after wipe-down, then soap, water, and brushes may be used. Rinsing with clear water will follow the use of soap. This approach will avoid large quantities of water and cleaning supplies and will save time and effort. In cases where the sample data will be used to support the FSSP, steam cleaning will be required for all tools in between sampling locations.

4.5 Investigation Derived Waste (IDW)

The field activities in this plan will generate IDW. These materials generally contain soils, water, and used personal protective equipment (PPE). When accumulated, these materials must be managed appropriately to minimize the exposure and risks to human health and the environment while adhering to applicable regulatory requirements. IDW will be managed and disposed of consistent with CHBWV plans and procedures. The IDW includes all materials generated during project performance that cannot be effectively reused, recycled, or decontaminated in the field. It consists of materials that could potentially pose a risk to human health and the environment (e.g., sampling and decontamination wastes) and also materials that have little potential to pose risk to human health and the environment (e.g., sanitary solid wastes). Two types of IDW will be generated during the implementation of field activities: indigenous and non-indigenous. Indigenous IDW expected to be generated during FSP activities will primarily be soils or soil-like material. Non-indigenous IDW expected to be generated includes decontamination fluid/water and miscellaneous trash, including PPE. When accumulated, the media will be managed appropriately to minimize exposure and risks to human health and the environment while adhering to applicable regulatory requirements.

In some instances, it may be appropriate to return IDW to its original location; an example of this would be returning trenched soils to their trench after characterization work at a particular location is complete. When this is done, the Environmental Media Policy will be followed. In other cases, returning IDW to its original location is not an option. IDW minimization is a goal.

IDW generated during this FSP will be primarily limited to used PPE and a small volume of decontamination water. This PPE will be characterized for disposal using the results of the soil samples to identify the radioactive contaminants. PPE waste will be appropriately bagged or otherwise containerized, labeled as to its contents, and provided to CHBWV for disposal.

Sampling and drilling tools will be decontaminated. Decontamination will be performed with a steam cleaner in some cases and with a cleaning agent, water, and brushes in others. The steam will not generate any IDW. The quantity of water used will be limited to that squirted onto wipes or dipped onto brushes from a bucket or drum. This water will be allowed to evaporate as possible. If evaporation is not completely successful, the water will be drummed and sampled by dipping a sample from the drum. The sample will be analyzed for radioactivity and the drum contents will be managed and disposed of by CHBWV in accordance with their plans and procedures.

5.0 REFERENCE AREA

Two surface soil reference area(s) have been established and maintained. Two locations are required because of differences in the surface geology between the north and south plateau within the site premises.[3] The reference areas are needed to establish the background of the detectors used for the GWS and to establish soil sample background for ROIs and PROIs that are present in background when the clean-up goals are near background; notably Ra-226 and uranium isotopes. The determination of GWS instrument backgrounds is a necessity to complete this FSP. The reference areas are approximately 2,000 m^2 in size and encompass surface soil types and conditions similar to those expected within WVDP premises. The reference areas have have no historical evidence of contamination from Nuclear Fuel Services or WVDP activities and there will are no reasons to believe such impacts might exist. The perimeter of the reference areas are clearly demarcated, the interior brush has been removed to allow easy access for sampling and gross activity surveying, and the area protected from intrusion or disturbance for the duration of Phase 1 activities. Refer to the *West Valley Demonstration Project Terrestrial Background Study* for information on the results of the background sampling and analysis.[7]

For CSAP pre-remediation decision-making, background comparisons will be based on results from the reference area surface soil sampling. The 95 percent upper tolerance level (UTL) will be estimated for each radionuclide that could be expected to be present in measurable quantities in background soils (i.e., naturally occurring radionuclides and those anthropogenic radionuclides present in background surface soils due to historical fallout) based on the 0- to 15-cm-deep sample results and the 15-cm to 1-m-deep sample results. The raw sample results will be used to perform this calculation regardless of whether sample results are considered detections or not.

Background comparisons will be based on depth (i.e., 15-cm to 1-m-deep samples to 15-cm to 1-m-deep reference area sample results, 15 cm deep samples to 15 cm deep reference area sample results). For surface soils, a sample result will be considered inconsistent with background if the activity concentration of one or more radionuclides exceeds its respective 95 percent UTL. For subsurface soils, the point of comparison will be to 15 cm to 1 m deep reference area sample results. The same rule for surface soils will apply for those radionuclides that are naturally occurring. In the case of the Pu-239, measurement error is expected to be significant with respect to measurable background activity concentrations. If the application of the rule described above results in an unacceptably high rate of false positive "hits" for Pu-239, the comparison process may be modified with DOE concurrence to also account for measurement uncertainty. For those radionuclides that are anthropogenic and site-related, a surface or subsurface soil sample result greater than three times its reported uncertainty will be considered inconsistent with background conditions.

For samples that fail either the 95 percent UTL or the three-times-uncertainty rule (whichever is applicable), re-analyses may take place to verify that the observed result is not a product of analytical error alone.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

SEC will implement QA/QC measures throughout the project to ensure that all decisions are made on the basis of data of acceptable quality. Pursuant to the contractual requirements, a Program QAP, SEC-QAP, has been prepared and submitted under separate cover which discusses specific requirements for quality assessments, non-conformance, the use of procedures, reporting, document control, and records management. The QAP is an "umbrella" document under which all project work is conducted and assessed. The QAP provides the framework for identifying and achieving compliance to American Society of Mechanical Engineers (ASME) National Quality Assurance (NQA) 1-2008 with the NQA-1a-2009 addenda (or a later edition), *Quality Assurance Program Requirements for Nuclear Facilities Applications*. SEC also implements Parts I and Sections 2.7 and 2.21 of Part II of the NQA-1 standard in a graded approach, as applicable to the activity. The QAP is implemented through SEC QA standard operating procedures (SOPs). The QAP and SOPs are designed to achieve compliance with DOE Order 414.1D, *Quality Assurance,* and 10 CFR Part 830.122, *Quality Assurance Criteria.*

Compliance to requirements identified in the Program QAP is mandatory by all SEC employees and subcontractors and will ensure SEC provides a service of known quality during the performance of this contract. The SEC PM and the Field Quality Control Representative shall be responsible for ensuring the execution of the quality requirements during the duration of Task Order 5. All workers are responsible for meeting and following quality requirements.

SEC will maintain direct, concise, and daily contact/coordination with the DOE PM or designee concerning field operations and scheduling field activities. The primary point of contact for all communications regarding the project will be the SEC PM. The SEC PM, or designee, will participate in a weekly project meeting throughout the period of performance of the contract. Participation may be by phone when field activities are not scheduled.

This section of the FSP outlines the QA/QC requirements specific to the field portion of Task Order 9, including equipment and instrumentation, sample collection methodology and laboratory analysis and data management. QA/QC requirements specific to elements of the fieldwork are discussed in detail below and include:

- Instrument Calibration, Testing and Maintenance Quality Requirements
- Gamma Walkover Survey QA/QC requirements
- Field Documentation
  - Field Logbooks
  - Photographs
- Sample QA/QC
  - Sample Collection
  - Sample Numbering
  - Sample Labeling
  - Sample Packaging
  - Additional Requirements for Radiological Samples
  - Chain of Custody Records
  - Sample Shipping
  - Laboratory Receipt of Sample Forms

  - Sample Documentation Process
  - Corrections to Documentation
- Laboratory and Data Quality Assurance/Quality Control
  - Laboratory Analysis
  - Reporting
- Data Verification and Validation
  - Data Verification
  - Data Validation
- Data Quality Objectives/Indicators
  - Precision
  - Accuracy
  - Representativeness
  - Completeness
  - Comparability

6.1 Radiological Instrument Calibration, Testing and Maintenance Quality Requirements

Calibration: Radiological instruments will be calibrated before first use by the manufacturer or a qualified calibration service in accordance with procedures supporting the SEC RPP. Note that calibration is not required for FIDLER and NaI detectors as they read in count rates relative to the gamma signal at the field location. Daily source checks for all instruments (including FIDLER and NaI detectors) will be performed and documented on project QC forms in accordance with the applicable RPP procedure. Additional operational checks will be conducted if an instrument is suspected of malfunction during data collection, is suspected as damaged, or critical data acquisition procedures require more frequent checks. Any piece of equipment that does not perform according to procedural requirements will be tagged out and not used until it is repaired or appropriately replaced.

QC limits for radiological instrument calibration will be determined during the initial setup and tuning of each detector system in accordance with RPP procedures. New QC limits will be established after subsequent calibrations and significant repairs which may have affected detector performance. A lower control limit and an upper control limit will be determined for each FIDLER and NaI detector system at a two or three sigma tolerance level. Control charts to monitor performance of each detector system will be maintained. Calibration checks will ensure that the instruments are functioning within acceptable QC tolerances. All instrument checks will be documented and the PM or designee will review them. Field QC Documentation will be retained on site in project files and will be maintained as project records.

Each operational check will consist of a background and source check set at a fixed and consistent geometry. The source check involves exposing the detection system to a known radioactive sealed source (for example, 10 microcuries of cesium-137) of specific activity for a predetermined duration (typically one minute). These sealed sources will be exempt quantities. If the QC checks fail, the operational check procedure will be repeated. After three failures, the instrument will be taken out of service until the cause of the failure is determined and corrected. Upon resolution, the instrument must pass the operational checks and QC limits before being returned to service.

Calibration Frequency: All detection systems will be calibrated in accordance with the manufacturer's specifications, or annually. The detector systems will be calibrated if it fails a performance check or after repairs potentially affecting its response. Calibration will be performed by either the manufacturer, qualified vendor, or the project team following the manufacturer's calibration specification and procedures in accordance with American National Standard, Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments, N323A-1997 (IEEE 1997) and American National Standard for Calibration of Germanium Detectors for In-Situ Gamma-Ray Measurements, N42.28-2002 (IEEE 2004), if applicable. Calibration sources will be traceable to the National Institute of Standards and Technology (NIST).

Testing, Inspection, and Maintenance Requirements: All instruments and equipment used will be serviced and maintained only by qualified personnel in accordance with the manufacturer's guidelines and recommendations. Routine equipment maintenance and calibration will be as specified by RPP procedures. Instruments will be operated by the project team according to RPP procedures.

Each radiological instrument will receive a unique identification code to allow easy tracking of equipment and to associate data with the appropriate instrument. This tracking system allows data reviewers to identify instruments that may have malfunctioned, track trends in data which may indicate slow degradation of the detection system, and other adverse conditions affecting data quality.

6.2 Gamma Walkover Survey Quality Assurance/Quality Control Requirements

The following minimum QA/QC requirements will be adhered to when implementing the gross Gamma Walkover Surveys:

- Daily Inspection: Each detector used on WVDP premises will undergo a documented check source evaluation each day it is used. The purpose of daily check source evaluation is to identify any deviations in the expected detector response. The evaluations will be documented on a control chart that has been developed and maintained specifically for this purpose. The variability, as measured by the standard deviation, will be used to construct two and three standard deviation error bars for the control charts. Daily readings that are more than two standard deviations away from the mean response will require a second measurement. If the second measurement also is more than two standard deviations away from the mean response or the initial measurement was more than three standard deviations from the mean response, the detector will be evaluated for evidence of potential problems and corrective actions taken as necessary before routine use of the detector is resumed. The inspection records will be maintained onsite as project records.

- Background Reference Area: Background reference areas have been established and will be used for detector data quality evaluation purposes (see Section 5.0), as follows:

  1. The entire 2,000 m^2 background reference area will be surveyed with each detector type (e.g., 2-inch by 2-inch NaI or FIDLER).
  2. The collected data will be logged.

3. A 100 m^2 portion of one of the reference areas has been covered in a manner that maintains relatively stable soil moisture conditions (the cover will be removed prior to each survey). If there are multiple detectors per detector type, each different detector will be used to survey the 100 m^2 area.
4. Another 100 m^2 area will be marked next to the area covered with the tarp. This area will be surveyed with each detector type. These same detectors will also be used to survey under the area that is covered with the tarp. The purpose will be to determine if there is a statistical difference in the detector response amongst the two areas. A student t-test will be used to determine if there is a difference at the 95% confidence level.
5. The data from the reference area (as a whole) will be used to evaluate the range of detector background responses. Data from the covered area will be used to compare responses across detectors. The purpose of these comparisons is to allow the development of scaling factors, as necessary, to be used to standardize gamma walkover data from different detectors. Key parameters of interest are the average activity concentration observed, the standard deviation (as a measure of background variability), and the 95 percent and 99 percent UTL for the background concentration.

- Control Point: A surface soil control point will be established and maintained through the life of Phase 1 D&D activities. Each detector deployed on WVDP premises will have two 30-second measurements taken at the control point each day: one at the start of a day's activities and one at the end. These data will be recorded and a control chart developed and maintained for each detector. The purpose of this activity and the control chart is to identify transient soil/meteorological conditions that may be adversely affecting detector response or trends in detector behavior that may be a concern. The variability, as measured by the standard deviation, will be used to construct two and three standard deviation error bars for the control charts. One or more daily controlled measurements would be obtained and added to the control charts. Daily readings that are more than two standard deviations away from the mean response will require a second measurement. If the second measurement also is more than two standard deviations away from the mean response or the initial measurement was more than three standard deviations from the mean response, the detector will be evaluated for evidence of potential problems and corrective actions taken as necessary before routine use of the detector is resumed.

- Identification of Shine Potential: Prior to surveying an area of interest, the potential for shine will be evaluated. Shine may be the result of proximity to a building or waste storage area with a history of structural contamination, or it may be a product of geometry and contamination in excavation walls (i.e., deep excavations). If shine is identified as a potential concern, the potential shine impact will be assessed through the use of shielding and/or comparing results from 15-cm height readings with 1-m height readings. If it is determined that shine impacts could be significant, a mitigating strategy will be used, such as 1) the use of a shielded detector or 2) the application of shine correction factors to acquired data.

- Review of Data: Data that are collected as part of gross gamma activity surveys will be mapped and reviewed for completeness to ensure that there are no areas that lack survey coverage. The review will also determine any data quality problems, either in coordinate information or detector response. Examples of data quality issues would be mapped data lines that deviate significantly from the known path or data points that clearly fall outside the area being surveyed. Examples of the latter are inexplicable trends in sequential readings that appear to be a function of time rather than location. Any gaps that are identified will be discussed with the DOE PM and corrected prior to demobilization.

6.3 Field Documentation

Data collected in the field includes field logbooks, sample collection data, and location information. SEC personnel responsible for the collection of data during the field portion of Task Order 5 will adhere to the quality requirements outlined for collecting, managing, and recording data. Data will be strictly controlled and, where necessary, checked for accuracy prior to submission to the DOE PM or for use in the Final Project Report. Copies of field data will be maintained in a controlled manner for the duration of the field work. Field log books, chain of custody forms, sample log sheets, photographs, and other pertinent documentation are all considered records and will be managed according to SEC-Q17, *Records Management*.

6.3.1 Field Logbooks

Task Managers, or designees, are required to maintain a field logbook throughout the duration of the project. All information pertinent to field activities, including field instrument calibration data, will be recorded in field logbooks or on the forms specified by SEC RPP procedures. The logbooks will be bound and the pages consecutively numbered. Entries in the logbooks will be made in black waterproof ink and will include, at a minimum, a description of all activities, individuals involved in field activities, dates and times of sampling, weather conditions, any problems encountered, and all field measurements. Instrument calibration information, such as lot numbers, manufacturer names, and expiration dates of standards used for field calibration will also be recorded in field logbooks. The Task Manager will summarize each day's activities in the field logbooks.

Sufficient information will be recorded in the logbooks to permit reconstruction of all field activities conducted. When not being utilized during field work, all field logbooks will be kept in the possession of the Task Manager or designee in a secure place. Upon completion of the field activities, all logbooks will become part of the final project evidence file.

Entries recorded in logbooks will include, but not be limited to, the following information:

- Author, date, and times of arrival to and departure from the work site;
- Purpose of the field activity and summary of daily tasks;
- Names and responsibilities of field crew members;
- Sample collection method;
- Number and volume of samples collected;
- Information regarding sampling changes, scheduling modifications, and change orders;
- Details of sampling locations, including a sketch map illustrating the sampling locations unless they have already been located and identified by global positioning;
- Field observations;
- Types of field instruments used and purpose of use, including calibration methods and results;
- Any field measurements made that were not recorded electronically;
- Sample identification number(s); and
- Sample documentation information.

6.3.2 Photographs

Photographs can be an important source of supplemental information during a site investigation. Examples of when photographs are appropriate include when there is a need for visual evidence of potential contamination, evidence of obstructions that require moving sampling locations, documentation of sampling points, and documentation of anomalous conditions that might affect either data quality or data interpretation.

If photographs are taken to document sampling points to facilitate relocating the point at a later date, two or more permanent reference points should be included within the photograph. In addition to the information recorded in the field logbook, one or more site photograph reference maps will be prepared as required. SEC will provide cameras to DOE personnel at any time during the field work for review and approval of photos taken.

6.4 Sample Quality Assurance/Quality Control

6.4.1 Sample Collection

There are a number of soil samples that are prescribed for collection during the implementation of Task Order 9, as described in Section 4.0. In order to ensure identification and quantification of all sources of error associated with each step of a monitoring program, control samples are collected so that the resulting data will be of known quality.

Soil samples will be collected by using a stainless steel trowel or sampling spoon and will be homogenized in a stainless steel bowl or container prior to containerization. Visually identifiable non-soil components such as stones, twigs, and foreign objects will be manually separated in the field and excluded from the laboratory samples to avoid biasing results low. A label shall be affixed to each sample container in accordance with Section 6.4.3 of this FSP.

Sample QC will be defined with the collection and analysis of field duplicates and matrix spike (MS)/matrix spike duplicates (MSDs) according to the following methodology:

- Field Duplicate: The field duplicate involves collecting two separate (replicate) samples from a single sample location, storing in separate containers, and submitting them for analysis to the laboratory as two separate samples. Samples will be given separate sample numbers and labelled so the laboratory does not know the sample is a duplicate. The field duplicate will provide information on the overall variability or precision of both the sampling technique and the analytical laboratory. The field duplicate samples will be collected at a rate of 1 per 10 samples or at least one sample per designated remedial action footrint area, whichever is more. The sample number will simply be annotated with the letters "DUP" to represent the field duplicate.

- MS/MSD: In order to demonstrate that the extraction or digestion equipment and methods used in the laboratory for sample analysis does not result in contamination of the samples, an additional group of field samples will be analyzed by the laboratory at a rate of 1 per 20 of the same matrix. Normal laboratory procedures are used to analyze spikes and duplicates. This is only applicable to tritium and carbon-14 analysis, as specified in the laboratory procedures. No separate sample is shipped to the laboratory. The laboratory is told on the chain of custody form when a MS is needed. The reason MSs are not performed for alpha spectroscopy analysis is because an isotopic tracer is added to each sample to determine extraction yield. This tracer essentially is the same as a traditional MS for chemical analyses. No MS is performed for gamma spectroscopy because no chemical extraction is performed. The sample is analyzed on a calibrated detector using a calibration source with known quantities of gamma emitting radionuclides.

- A sample log form (Appendix E) will also be completed for each quality sample collected in the field.

6.4.2 Sample Location/Numbering System

A unique sample location and numbering scheme will be used to identify each sample collected for laboratory analysis. The purpose of this numbering scheme is to provide a tracking system for the retrieval of analytical and field data on each sample. Sample identification numbers will be used on all sample labels or tags, field data sheets and/or logbooks, chain of custody records, and all other applicable documentation used during the project.

Location codes for new sampling events must not duplicate location codes that have already been used for a different place at the WVDP Site. Location codes must be unique over the entire Data Management System (DMS) database, including legacy ELIMS data, previously completed site characterization sampling, and future sampling events. The location designations, 01, 02, etc., that were used in Task Order 4 refer to more than one physical sampling location with different map coordinates. Those Task Order 4 locations will need to be differentiated using different location names. To ensure that location codes are not repeated, the following location naming scheme is being proposed:

<task order> - <study> - <sequential location number>

The 'study' abbreviation will be assigned by the WVDP DMS Environmental Database Administrator (EDBA).

For example, the first location code for the Task Order 9 Canister Storage Pad Excavation study would be as follows:

TO9-CSPE-01

The sequential part of the location will include sufficient leading '0's so that all location sequence numbers for the study are the same length. For example:

TO9-CSPE-001, TO9-CSPE-010, TO9-CSPE-100

Sample Identification codes (sample IDs) in new sampling events will not duplicate sample IDs that have already been used in a different sampling event. Sample IDs must be unique over the entire DMS database, including legacy ELIMS data, previously completed site characterization sampling, and future sampling events. To ensure that sample IDs are not repeated, the following naming scheme will be used.

Sample ID format for a normal field sample:

<study area> - < sequential location number> - <sample date> - <matrix code> - <depth interval>

- The <study area> is the first part of the DMS location code where the sample is collected.
- The < sequential location number > is part of the formatted DMS location code where the sample is collected. It is the full DMS location code minus the <task order> and <study>.
- The sample date is in MMDDYY format.
- The sample matrix must be from the NYSDEC EQuIS valid value list for sample matrix.
- The depth interval is the top and bottom of the interval separated by a dash (-).

An example of a study area CSPE sample ID for a soil sample collected on 11/14/2013, location TO9-CSPE-SS01, and at depth interval 0 to 15 cm would be: CSPE-SS01-111413-SS-0-15.

Tables 6-1 and 6-2 below identify the parts of the sample ID that are different for QC samples. The parts of the sample ID that are not identified in the table are the same as for a normal field sample.

Table 6-1. Numbering of Blanks and Duplicates

Sample Type	Sequential Location Number	Depth Interval	Matrix	Example
Field Duplicate	Same as Parent Sample	Same as Parent Sample	Append 'D' to Matrix	CSPE-SS01-111412-SS**D**-0-15
Field Blank	TB1, 2, etc.	none	NYSDEC List	CSPE-FB1-111412-SQ
Trip Blank	FB1, 2, etc.	none	NYSDEC List	CSPE-TB1-111412-SQ
Equipment Blank	EB2, 2, etc.	none	NYSDEC List	CSPE-EB1-111412-SQ

Table 6-2. Numbering of Matrix Spike/Matrix Spike Duplicates Samples

Sample Type	Sample ID
Matrix Spike	Append _MS to parent sample ID
Matrix Spike Duplicate	Append _MSD to parent sample ID

6.4.3 Sample Labeling

Labels will be affixed to all sample containers during sampling activities. The laboratory will provide the labels along with the sample containers. Information will be recorded on each sample container label at the time of sample collection. The information to be recorded on the labels will be as follows:

- Sample identification number;
- Sample type;
- Sampled interval (e.g., 0 to 15 cm);
- Site name and sampling station number;
- Analysis to be performed;
- Date and time of sample collection; and
- Sampler's name and initials.

Personnel collecting the samples will provide sample collection information within the field logbook (i.e. time, location, and sample ID) so that a cross-reference can be made if necessary.

6.4.4 Sample Packaging

Field samples will be placed in wide-mouth 500- or 1,000-ml nalgene containers provided by the laboratory. When samples require more than 1,000-ml, the sample may be placed in two 1,000 ml nalgene jars with both jars placed in the same zip lock plastic bag. Both jars and the bag shall bear the same sample number.

The exterior of the containers will be checked for radioactive contamination and decontaminated if any is detected, prior to filling. The containers will be packaged in thermally insulated rigid-body coolers. Sample packaging and shipping will be conducted in accordance with applicable U.S. Department of Transportation (DOT) specifications. The site geologist/QC or other qualified individual will be responsible for packaging and shipping the samples and will verify completeness of sample shipment preparations. In addition, the laboratory will document the condition of the environmental samples upon receipt. This documentation will be accomplished by using the *Cooler Receipt Checklist* (SEC-FSP-F01) shown in Appendix F.

The site Work Group Supervisor, Radiological Engineer, or other qualified individual is responsible for shipping the samples from the field to the laboratory will be responsible for completing the chain of custody form and noting the date and time of shipment. This individual will also inspect the form for completeness and accuracy. After the form has been inspected and determined to be satisfactorily completed, the responsible individual will sign, date, and note the time of transfer on the form. The chain of custody form will be sealed in a plastic bag and placed inside the cooler used for sample transport after the field copy of the form has been detached. The field copy of the form will be appropriately filed and kept at the project premises for the duration of the activities and managed as a project record.

In addition to the chain of custody form, chain of custody seals will also be placed on each cooler used for sample transport. These seals will consist of a tamper-proof adhesive material placed across the lid and body of the coolers. The chain of custody seals will be used to ensure that no sample tampering occurs between the time the samples are placed into the coolers and the time the coolers are opened for analysis at the laboratory. Cooler custody seals will be signed and dated by the individual responsible for completing the chain of custody form contained within the cooler.

6.4.5 Additional Requirements for Samples Classified as Radioactive Materials

Transportation of radioactive materials is regulated by the DOT under 49 CFR 173.401. Samples generated during project activities will be transported in accordance with procedures that ensure compliance with regulatory requirements. The following will be performed for radioactive materials:

- The cooler must have the shipper and receiver addresses affixed to it in case the courier air bill is lost during shipping.
- Samples will be screened prior to packing to determine whether they meet the definition of a DOT class 7 (radioactive) material.
- For samples that meet DOT requirements for radioactive materials:
  - The cooler will be surveyed for radiation and to ensure the package meets the requirements for limited quantity as found in 49 CFR 173.421.
  - A notice must be enclosed on the inside of the cooler that includes the name of the consignor and the statement: "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910." The outside of the inner packaging, or, if there is no inner packaging, the outside of the package itself must be labeled "Radioactive."
- The following labels will be placed on the cooler:
  - Appropriate hazard class label; and
  - If applicable, "Cargo Aircraft Only."
- The air bill for the shipment will be completed and attached to the top of the shipping box/cooler which will then be transferred to the courier for delivery to the laboratory.

6.4.6 Chain of Custody Records

Chain of custody procedures implemented for the project will provide documentation of the handling of each sample from the time of collection until completion of laboratory analysis. The chain of custody form serves as a legal record of possession of the sample. Chain of custody forms will be managed as project records according to procedure SEC-Q-17, *Records Management.* A sample is considered to be under custody if one or more of the following criteria are met:

- The sample is in the sampler's possession,
- The sample is in the sampler's view after being in possession,
- The sample was in the sampler's possession and then was placed into a locked area to prevent tampering, and
- The sample is in a designated secure area.

Sample custody will be documented throughout the project field sampling activities by use of a chain of custody form initiated on each day that samples are collected. The chain of custody form will accompany the samples from the project premises to the laboratory and will be returned to the laboratory coordinator with the final analytical report. All personnel with sample custody responsibilities will be required to sign, date, and note the time on the chain of custody form when relinquishing samples from their immediate custody (except when samples are placed into designated secure areas for temporary storage prior to shipment).

Bills of lading or air bills will be used as custody documentation during times when the samples are being shipped from the project premises to the laboratory, and they will be retained as part of the permanent sample custody documentation.

Chain of custody forms will be used to document the integrity of all samples collected. A sample chain of custody procedure can be found in Appendix D.

6.4.7 Sample Shipping

All samples collected in the field during the project will be shipped in a timely manner that assures receipt of sample analyses in support of the overall task order schedule and assures that the maximum sample holding time of 45 days for tritium and carbon-14 is not exceeded. During the time period between collection and shipment, all samples will be stored in a secure area. All coolers containing environmental samples will be shipped overnight to the laboratory via Federal Express, similar courier, or laboratory courier.

6.4.8 Laboratory Receipt of Sample Forms

The contracted laboratory will document the receipt of samples by accepting custody of the samples from the approved shipping company. In addition, the contracted laboratory will document the condition of the environmental samples upon receipt on the Cooler Receipt Checklist (SEC-FSP-F01), shown in Appendix F.

6.4.9 Sample Documentation Process

The tracking procedure to be utilized for documentation of all samples collected during the project will involve the following series of steps:

- Collect and place samples into laboratory sample containers.
- Complete sample container label information.
- Complete sample documentation information in the field logbook.
- Complete project and sampling information sections of the chain of custody form(s).
- Complete the airbill for the cooler to be shipped.
- Perform a completeness and accuracy check of the chain of custody form(s).
- Complete the sample relinquishment section of the chain of custody form(s) and place the form(s) into cooler.
- Place chain of custody seals on the exterior of the cooler.
- Package and ship the cooler to the laboratory.
- Receive cooler at the laboratory, inspect contents, and fax (or scan and email) contained chain of custody form(s) and cooler receipt form(s).
- Transmit original chain of custody form(s) with final analytical results from the laboratory.

6.4.10 Corrections to Documentation

All original information and data in field logbooks, on sample labels, on chain of custody forms, and on any other project-related documentation will be recorded in black waterproof ink and in a completely legible manner. Errors made on any accountable document will be corrected by crossing out the error and entering the correct information or data. Any error discovered on a document will be corrected by the individual responsible for the entry. Erroneous information or data will be corrected in a manner that will not obliterate the original entry, and all corrections will be initialed and dated by the individual responsible for the entry.

6.5 Laboratory and Data Quality Assurance/Quality Control

6.5.1 Laboratory Analysis

Onsite Laboratory Services: The soil samples collected in the field may be screened by an on-site laboratory at the discretion of the DOE PM to verify the absence of significant contamination issues (e.g., gamma spectroscopy for Cs-137 and/or liquid scintillation for Sr-90). This would allow real-time decisions to be made regarding continuing excavation, and potentially would reduce the potential for committing resources to off-site laboratory analysis. Data from an onsite-laboratory would not be used to demonstrate CG compliances unless a QA/QC program is established and demonstrated to produce results equivalent to those of an off-site contract laboratory.

Off-site Laboratory Services: Soil samples will be shipped off-site to an approved 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 (NYSDOH) Environmental Laboratory Approval Program certification or equivalent. Table 6-3 indicates the target MDCs for radionuclides in laboratory analyses of soil samples as well as the analytical methods to be used. MDC requirements are set to whichever is lower: (1) approximately 10% of the most restrictive radionuclide-specific CG, (2) 25% of background for naturally occurring radionuclides, or (3) standard laboratory MDCs. All laboratory instrumentation will be calibrated by using NIST-traceable standards.

Soil sample results will be reported as dry weight corrected. Reported results will include, at a minimum, the sample identifier, the matrix analyzed, the date of analysis, the parameter analyzed for, the method used, the estimated activity concentration in pCi/g, the error associated with the estimated activity concentration, any laboratory qualifiers associated with the measurement, an indication if the result is an original analysis or a QC analysis (e.g., replicate), the moisture content, and any sample dilution necessary. Table 6-3 provides the analytical methods required by radionuclide.

Table 6-3. Analytical Methods and Minimum Volumes[4]

Nuclide	Analysis Method	Minimum Volume
Am-241	EML HASL 300 A-01-R	5 g
C-14	EERF C-01-1	100 g
Cm-234	EML HASL 300 A-01-R	-
Cm-244	EML HASL 300 A-01-R	-
Cs-137	EML HASL 300 Ga-01-R	500 g
I-129	EML HASL 300 Ga-01-R	100 g
Np-237	EML HASL 300 A-01-R	5 g
Pu-238	EML HASL 300 A-01-R	5 g
Pu-239	EML HASL 300 A-01-R	-
Pu-240	EML HASL 300 A-01-R	-
Pu-241	EML HASL 300 A-01-R	-
Sr-90	EML HASL 300 Sr-03-RC	5 g
Tc-99	EML HASL 300 TC-02-RC	-
U-232	EML HASL 300 A-01-R	5 g
U-233/234	EML HASL 300 A-01-R	-
U235	EML HASL 300 A-01-R	-
U-238	EML HASL 300 A-01-R	-
Secondary ROIs		
Ac-227	EML HASL 300 Ga-01-R	-
Co-60	EML HASL 300 Ga-01-R	-
Cd-113m	EML HASL 300 Ga-01-R	-
Eu-154	EML HASL 300 Ga-01-R	-
H-3	EML HASL 300 H3-04-RC	100 g
Pa-231	EML HASL 300 Ga-01-R	-
Ra-226	EML HASL 300 Ga-01-R	-
Ra-228	EML HASL 300 Ga-01-R	-
Sb-126	EML HASL 300 Ga-01-R	-
Sn-126	EML HASL 300 Ga-01-R	-
Th-229	EML HASL 300 Ga-01-R	-
Th-232	EML HASL 300 Ga-01-R	-

6.5.2 Correspondence and Reporting

All field collected data will be available for DOE review at any point during data collection. Prior to the delivery of the finalized data sets, electronic versions will be transmitted to DOE in suitable format (e.g., Excel spreadsheet for laboratory results, PDF format for supporting laboratory QC documentation) when delivered by the laboratory, recognizing that data are draft and subject to change, replacement, or correction. The purpose of the DOE access and review is to assure that data quality requirements are being achieved while work is underway.

Regular status updates in the form of a monthly report, along with field activity data sheets, to support invoice claims will be provided. Field activity data sheets shall include, at a minimum, number of personnel working on-site, equipment utilized, subcontractor's activities, and a summary of work performed.

A Draft Report summarizing activities and findings will be prepared and provided to DOE WVDP after each site visit within 20 calendar days of sample analysis completion. Any comments received will be addressed and incorporated into the Final Report. The revised report will be submitted to DOE WVDP within 14 calendar days of receiving comments.

6.6 Data Verification and Validation

6.6.1 Data Verification

Data verification will be performed on 100% of the laboratory analytical data. Verification will be performed to assure that samples sent for analysis were analyzed with results returned in hard copy and as an Electronic Data Deliverable (EDD). Verification of completeness of chain of custody records will be performed. Verification that hard copy records from the laboratory match the EDD will be performed.

6.6.2 Data Validation

Data deliverables will meet U.S. Environmental Protection Agency (EPA) Level IV quality. Contract Laboratory Procedure (CLP)-like data packages with raw data will be provided to support independent third party validation. Ten percent of analyses will be validated by an independent third party. The independent third party will be obtained via subcontract to SEC. The subcontract will be awarded before the first set of sample analyses is completed.

EPA Level IV quality data packages should be transmitted to DOE by CD for all samples as part of the sample quality records.

6.7 Data Quality Objectives/Indicators

Project data quality objectives (DQOs) for this FSP are to characterize soil areas to support site remediation and/or implementation of the CSAP to determine if contamination exists in excess of the CGs. If the CGs are exceeded or are likely exceeded, the characterization data will be used to guide further soil excavation during Phase 1 D&D work or to plan Phase 2 remediation. If the characterization data indicate that the CGs are likely satisfied, the data will be used to build and grow a data set that will support a FSS. This will be achieved by guiding and basing sampling efforts on the DQO presented in Section 3.0 of the FSSP.

DQOs are qualitative and quantitative statements that specify the quality of data required supporting decisions during remediation. Overall, the objective is to assure that the data collected during the sampling effort meets qualitative sufficiency standards for adequacy (i.e., how "good" is the data) and to meet quantitative values to document/confirm compliance of the "good" data with respect to some reference standards or values. This requires that data meet certain basic characteristics of satisfactory usability (e.g., precision, accuracy, representativeness, completeness, and comparability) for the intended purpose (i.e., meet or exceed the CG).

The characteristics of precision, accuracy, representativeness, completeness, comparability, and sensitivity are discussed in Sections 6.7.1 through 6.7.5, respectively.

6.7.1 Precision

Precision is a measure of the degree to which two or more measurements are in agreement. Precision in the laboratory results and in direct reading instruments is assessed through the calculation of relative percent differences (RPDs) and relative standard deviations (RSDs) for two or more replicate samples. Precision can be expressed as standard deviation. Precision for laboratory analyses will be established via field duplicates, laboratory duplicates, and spike duplicates. According to the CSAP, precision reflects measurement variability as observed in repeated measurements of the same subsample; for radio-analytical methods, the required precision is reflected by required method detection limits. In other words, specifying the required detection limits is equivalent to specifying the required method precision; therefore, specific tolerance limits for precision are not set in this FSP. The results of precision evaluations will simply be reported after data have been collected and analyzed.

Field duplicates will be the least precise because they introduce all sample uncertainty introduced from field sample collection through laboratory analysis. Field duplicates are collected as sample splits from the same sample mass. Two samples are extracted after homogenization with hand tools. These two samples are sent separately for laboratory analysis and the results are compared to establish a measure of precision.

Laboratory duplicates are obtained by analyzing the same sample twice. Once received from the field, actual samples are analyzed twice. Spike duplicates are samples where a known amount of a tracer is analyzed, and this sample is analyzed twice.

Precision for direct reading instruments is established by taking multiple measurements at the same location and/or with the same radiation check source with the same instrument over the course of days, weeks, and longer. Precision for a single instrument and as compared to other same type instruments will be established and reported. Control charts will be plotted to observe instrument performance over time.

Control limits for control sample analyses, acceptability limits for replicate analyses, and response factor agreement criteria specified for calibration and internal QC checks for laboratory analyses subject to duplicate analysis are based upon precision in terms of the coefficient of variation (CV) or the RPD. The standard deviation (S) of a sample set is calculated as:

$$S = \sqrt{\frac{\sum\left(x - \bar{x}\right)^2}{(n-1)}}$$

Where:
x = Individual measurement result,
$\bar{x}$ = Mean value of individual measurement results, and
n = Number of measurements.

The CV as a % is then calculated as:

$$CV = \left(\frac{S}{\bar{x}}\right) \times 100$$

The RPD calculation allows for the comparison of two analysis values in terms of precision with no estimate of accuracy. RPD is calculated as:

$$RPD = \left(\frac{m - M}{\overline{M}}\right) \times 100$$

Where:
m = First measurement value,
M = Second measurement value, and
M = Mean value of M and m.

CV is related to RPD for duplicate measurements by the following:

$$CV = \frac{RPD}{\sqrt{2}}$$

Duplicates are also evaluated using a *Normalized Absolute Difference (DER)*: The Normalized Absolute Difference between the laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) is used to determine that the results do not differ significantly (at the 99% confidence interval) when compared to their respective combined standard uncertainty. A DER of less than or equal to 3 is considered acceptable.

$$DER = \frac{|S - D|}{\sqrt{(CSU_S)^2 + (CSU_D)^2}}$$

Where:

S	=	LCS result
D	=	Duplicate result
CSU_S	=	Combined Standard Uncertainty of the LCS
CSU_D	=	Combined Standard Uncertainty of the duplicate

Combined standard uncertainty includes all sources of error including counting error and the error in the quantity of radioactivity included in the laboratory control sample.

Note: A TEST VALUE OF '3' CORRESPONDS TO A 99+% CONFIDENCE LEVEL.

6.7.2 Accuracy

Accuracy addresses the potential for bias and lack of precision in laboratory analytical results and is typically monitored through the use of standards, spikes, blanks, and control charts, as appropriate, depending on the method. The accuracy requirement for off-site laboratory analyses set in the CSAP is a relative standard error of 10%, as measured at the CGw value, after correcting for precision.

Two types of analytical check samples can be used: LCS (a blank spike) and MS. Analytical accuracy is expressed as the % recovery of an analyte that has been added to the control samples or a standard matrix (e.g., blank soil, analyte-free water, etc.) at a known concentration prior to analysis.

The accuracy of data is typically summarized in terms of relative error (RE). This calculation reflects the degree to which the measured value agrees with the actual value, in terms of % of the actual value. RE is calculated as:

$$\% \text{ RE} = \frac{\text{Measured Value} - \text{Actual Value}}{\text{Actual Value}} \times 100$$

This way of expressing accuracy allows for a comparison of accuracy at different levels (e.g., different concentrations) and for different parameters of the same type (e.g., different compounds analyzed by the same method). Control sample analyses are typically evaluated using this calculation.

Another calculation is frequently used to assess the accuracy of a procedure. Percent recovery is a calculation used to determine the performance of many of the QC checks, where:

$$\% \text{ Recovery} = \frac{\text{Measured Value}}{\text{Actual Value}} \times 100$$

Another similar calculation used to determine the performance of a method for recovery of a spike concentration added to a sample is the % spike recovery calculation. The % spike recovery is determined as:

$$\% \text{ Spike Recovery} = \frac{[(\text{Measured Sample Value Plus Spike}) - (\text{Measured Sample Value})]}{(\text{Value of Spike Added})} \times 100$$

6.7.3 Representativeness

Representativeness is guaranteed by appropriate sampling and analytical protocols and by collecting sufficient samples or obtaining sufficient measurements such that uncertainties introduced by the heterogeneity of contaminated media are sufficiently controlled for decision making purposes. There is no formal quantitative requirement for representativeness; representativeness is monitored by ensuring that sampling and analytical protocols are, in fact, carried out during field and laboratory work and that the quantity of data collected are sufficient to allow decision-making with the necessary level of confidence.

6.7.4 Completeness

Completeness is a measure of the degree to which the amount of sample data collected meets the scope and a measure of the relative number of analytical data points that meet the acceptance criteria, including accuracy, precision, and any other criteria required by the specific analytical method used. Completeness is defined as a comparison of the actual numbers of valid data points and expected numbers of points expressed as a %. The data completeness goal for the CSAP is 80%, consistent with the Phase 1 FSSP.

Completeness is calculated after the QC data have been evaluated, and the results applied to the measurement data. In addition to results identified as being outside of the QC limits established for the method, broken or spilled samples, or samples that could not be analyzed for any other reason, are included in the assessment of completeness. The % of valid results is reported as completeness. The completeness will be calculated as follows:

$$\text{Completeness}(\%) = \frac{T-(I+NC)}{T} \times 100$$

Where:

T = Total number of expected measurements for a method and matrix;
I = Number of invalidated results for a method and matrix; and
NC = Number of results not collected (e.g., bottles broken, etc.) for a method and a matrix.

6.7.5 Comparability

Comparability refers to how well data sets generated by CSAP work pertain to the decisions that need to be made. Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. The comparability of the data, a relative measure, is influenced by sampling and analytical procedures. By providing specific protocols to be used for obtaining and analyzing samples, data sets should be comparable regardless of who obtains the sample or performs the analysis. Comparability (or the lack thereof) is an aggregate QA measure that reflects the overall level of accuracy, precision, completeness, and representativeness.

Data collection will use a variety of on-site and field-based data collection methods. A component of field data collection will be to establish site-specific performance for these methods to ensure data of sufficient quality to satisfy decision-making requirements.

7.0 REFERENCES

1. Phase 1 Decommissioning Plan for the West Valley Demonstration Project, Washington Safety Management Solutions, URS Washington Division, and Science Applications International Corporation, December 2009.

2. Phase 1 Characterization Sampling and Analysis Plan, West Valley Demonstration Project, Argonne National Laboratory Environmental Science Division, 9700 South Cass Avenue, Argonne, IL 60439, June 2011.

3. QP-450-01 – Management of Environmental Media – Phase 1 Decommissioning of the West Valley Demonstration Project, Rev. 0

4. Phase 1 Final Status Survey Plan for the West Valley Demonstration Project, Argonne National Laboratory Environmental Science Division, 9700 South Cass Avenue, Argonne, IL 60439, May 2011.

5. The Procedures Manual of the Environmental Measurements Laboratory, 28th Edition, February, 1997.

6. Multi-Agency Radiation Survey and Site Investigation Manual, Rev. 1, NUREG 1575, August 2000.

7. West Valley Demonstration Project Terrestrial Background Study, for Task Order 5, Safety and Ecology Corporation, February 2013.

UNCONTROLLED DOCUMENT

APPENDIX A

Gamma Walkover Procedure

1.0 Definitions

A **gamma walkover survey** refers to the practice of walking or driving over a land surface and scanning for gamma anomalies or areas of elevated count rates.

Global Positioning System (GPS) is method of land surveying utilizing satellites to provide an accurate land position.

Differential Global Positioning (DGPS) is an accurate measurement of the relative positions of two receivers tracking the same GPS signals. The roving receiver collects the survey data, while a fixed or receiver (base station) collects data simultaneously. The base station broadcasts a fixed position based on the errors it records in it position versus its actual location.

2.0 Applicability

This SOP provides guidance on completing characterization surveys of open lands using gamma walkover scanning in combination with a global positioning system. The procedure provides the information necessary to produce initial site characterizations and data packages. Survey packages will be assembled under the Work Plan. This procedure directs the performance of individual surveys.

3.0 References

3.1	Differential GPS Explained	Trimble, 1993
3.2	DOE O 458.1	Radiation Protection of the Public and the Environment.
3.3	10CFR835	Occupational Radiation Protection
3.4	MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual

4.0 Notes and Precautions

4.1 The objective of the task is to delineate and map the existing radiation levels over a specified area.

4.2 Radiological instrumentation types should remain constant throughout the survey. Radiological instrumentation should be determined based on the radionuclides of interest.

4.3 The measurement method affects the scan path spacing. For example, a walking scan with approximately one meter of detector swing, covers a one meter wide strip and the spacing between path should be one meter. Surveying should be conducted with the goal of collecting at least one measurement every square meter.

4.4 If multiple probes are used to collect data in the same survey, a 100 m^2 area at the site will be surveyed with each detector. Data will be normalized according to Section 5.3 of the Phase 1 West Valley Demonstration Project (WVDP) Final Status Survey Plan (FSSP).

4.5 If necessary, the survey may be conducted in two perpendicular directions or with a mixture of riding and walking. For example, a survey area might be surveyed with a North-South pattern, but geography inhibits 100% coverage of a subarea. In this case, the subarea might then be surveyed again in an East-West pattern or the subarea in question might be surveyed by walking. If the survey unit is less than one acre and the method is driving, consider driving the area twice with perpendicular directions to ensure 100% coverage.

5.0 Gamma Walkover Surveys in Concert with GPS Navigational Systems

5.1 Background Determination

A reference area should precede the initial characterization to ensure that instruments and recorders are operable, and that reporting systems are appropriate, per the following guidance.

1) The reference area will be surveyed with the detector and data will be logged consistent with protocols to be used for final status survey (FSS) data collection purposes. These data will be reviewed and compared with existing data sets from similar detectors (if available) to confirm consistency in general detector behavior (average gross activity concentration recorded and observed variability in detector response).

2) Quality Control (QC) data will be obtained from a fixed QC point at a height of six inches above exposed soils from a point established for this purpose outside any areas expected to be remediated. These data will be used to construct a control chart that can be used for QC purposes for subsequent deployments of the detector as part of FSS work.

5.2 Daily Quality Control

1) A stationary reading will be taken from the QC point at the start and end of each day a detector is in use. These QC data will be compared to the control chart to determine that the detector response is consistent with historical responses from that location. If a QC measurement results in a detector response "out of control" at the start of the day, the measurement will be repeated. If the subsequent measurement is still out of control, the reason for the discrepancy will be established before the detector is used. If the out-of-control event occurs at the end of the day and is verified by a subsequent measurement, the reason for the discrepancy will be established before the data collected that day with that detector are considered acceptable for FSS purposes. "Out of control" is defined as a result that is more than two standard deviations above or below the average historical detector response at that control point.

2) Electronically logged data will be reviewed for completeness (e.g., evidence of spatial "holes" in collected data), evidence of erratic detector behavior (e.g., sequential readings during a moving survey that show a marked increase or decrease in gross activity not confirmed by spatially adjacent measurements), or evidence of shine (e.g., systematically elevated readings proximal to structures, buildings, soil piles, storage units or excavated soil walls). In the case of incomplete data, data collection will be conducted to fill the gap. In the event of erratic behavior, the cause will be investigated, suspect data will be flagged as such, and additional data collection will be conducted to address affected areas as appropriate.

5.3 Site Specific Information

Data presentation should be considered prior to collection of data. Ensure that the correct coordinate system used. The data format will be GPS coordinates in NAD 1983 State Plane New York West FIPS 3103.

5.4 Establishing a Daily Survey Area

The daily survey area will depend on the topography and landmarks of the survey unit. The objective is to systematically survey all anomalies or random survey units in each Grid Unit. The survey supervisor will assign data packages. Ensure that the coordinates and photographs match the actual field survey conditions. Cover the survey unit with a maximum one m path spacing at speeds not to exceed 0.5 m/s.

6.0 Data Quality and Presentation

6.1 To ensure the accuracy of GPS survey, files must be differentially corrected. Differential correction is a means of comparing data from a roving receiver with a base station. The base station continuously collects positional information. These observed positions are compared to a known coordinate. The difference between the observed position and the actual position is error cause by the atmosphere or selectively induced errors. Differential correction applies the same offsets to increase the accuracy of the roving receiver.

6.2 Data will be plotted using ArcView in one second increments and organized in a spreadsheet form.

6.3 The daily data submittal will include field notes, quality control tests, and survey graphics.

APPENDIX B

Geoprobe Procedure

UNCONTROLLED DOCUMENT

NATURE'S WAY ENVIRONMENTAL CONSULTANTS & CONTRACTORS, INC.

3553 Crittenden Road, Alden, NY 14004
716-937-6527 Fax 716-937-9360

7 Zuk-Pierce Drive, Central Square, NY 13036
315-668-1031 Fax 315-668-1009

Direct Push Drilling Procedure
Standard Operations Procedure

This document will serve as the standard operation procedure to be followed by personnel of NWEC&C, Inc. Each NWEC&C employee conducting direct push drilling activities is responsible for understanding and managing the direct push unit.

This document is intended to supplement the Simco Drilling Equipment, Inc., (manufacture) Operators Manual for the Earthprobe 200.

The Simco Earthprobe 200 is a hydraulically powered device, capable of driving steel probe rods into the ground for the purpose of sample collection. A 2" OD diameter open 4' long macro-core sampler, fitted with a four foot acetate liner is attached onto the leading probe rod, and advanced (driven) from ground surface to four feet below ground surface. The sampler is then retrieved, the acetate liner containing the sample is removed, and the macro-core sampler is decontaminated. A macro-core sampler is refitted with an acetate liner with extension probe rods attached as necessary to complete this sampling methodology with samples driven and secured to prescribed depth(s).

Macro Core Sampling Operations
Prior to raising the mast, examination of the site for obstruction must be completed. Once the mast is raised the probe hammer assembly is lifted to the highest position to allow for alignment of the sampler. A drive cap is connected to the top end of the sampler (acetate liner fitted macro-core sampler) or probe rod, dependant on sample depth. The sampler (and/or probe rod) is advanced using down feed pressure, and activated hammer as necessary. For sampling continuous intervals (below 4.0' below ground surface), the sampler is lowered down the open hole, extended to surface with additional probe rods to prescribed depth.

To extract the sampler, the drive cap is removed from the sampler/rod, and replaced with a pull cap. The pull plate is lowered, and the sampler is removed utilizing upward feed pressure.

Once the sampler has been removed, the cutting shoe is removed (unscrewed), and the liner is pulled out. The liner may either be cut open for visual classification, or capped to allow for future observation or sample submission. The macro-sampler and cutting shoe are then decontaminated with a non-phosphate soap and clean water rinse, and re-fitted with an acetate liner and cutting shoe.

Hard Surface Operations
Prior to initiating hard surface drilling, the anvil is removed from the hammer assembly, and replaced with the required star bit. A compressed air line is connected to the hammer assembly, allowing circulation of air into the hammer assembly, through the hollow drill steel and out the star bit. The air valve is opened to enable rotation, and operated through use of the down feed pressure and activated hammer as necessary.

APPENDIX C

Soil Sampling Procedure

1.0 PURPOSE

The objective of this procedure is to detail the appropriate methods for the collection of surface and subsurface soil samples.

2.0 SCOPE

This procedure applies to the collection of surface and subsurface soil samples for trace contaminant analysis, which includes volatile organic compounds (VOC), semi-volatile organic compounds (SVOC), pesticides/PCBs (collectively, organic compounds), metals (inorganic), and radiological analyses. Sampling locations, depths and intervals should be defined in the Field Sampling Plan (FSP). Samples for geotechnical or other analyses not considered trace analyses do not need to meet requirements for trace contaminant analyses sampling.

3.0 REFERENCES AND DEFINITIONS

3.1 References

- SEC-ISMS, Integrated Safety Management System
- EPA/R04/SOP/NRN-9102, 1996, "Environmental Investigations Branch Standard Operating Procedures and Quality Assurance Manual," Athens, GA
- 29 CFR 1910.120
- 40 CFR Part 136 Table II
- SEC-EM-309

3.2 Definitions

- Surface soil sample: a soil sample that includes the upper interval or surface material (typically 0-15cm).
- Subsurface soil sample: a soil sample that is collected from soils that is below ground surface (typically 15-100 cm)

4.0 GENERAL

4.1 Responsibilities

4.1.1 Project Manager or Designee

The Project Manager or designee is responsible for obtaining the sample in compliance with this procedure and the Field Sampling Plan (FSP). It is also the responsibility of the Project Manager or designee to follow all requirements for sample containers and holding times, maintaining chain of custody (COC), documenting sampling activities, and quality assurance as required by other procedures.

4.1.2 Radiological Engineer (Sampling Team Lead)

The Sampling Team Lead is the primary supervisor of the sampling team and is responsible for:

- Providing technical direction for the collection of samples and subsequent analyses, field measurements, and field tests
- Overall team supervision
- Obtaining copies of the appropriate work-controlling documents
- Fully understanding this sampling procedure
- Maintaining the field logbook and/or relevant field data acquisition forms
- Responsible for assuring the COC forms are completed and maintained
- Maintaining data quality

- Obtaining all field Quality Control (QC) samples as specified in this procedure
- Maintaining sampling instructions while in the field, including confirmation or performance of functional requirements
- Checks/proper calibration as required by procedure and/or instrument manufacturer instructions

4.1.3 Sampling Technician

Sampling Technician(s) shall receive all instructions from the Sampling Team Lead and actually implement the procedurally prescribed work processes.

4.2 Prerequisites

Personnel collecting samples shall be trained in the use of the specific equipment outlined in this procedure. All sampling personnel shall have the requisite medical examinations, training, and site-specific training in accordance with 29 CFR 1910.120 as described in the Safety and Ecology Corporation (SEC) ISMS and implementing plans and procedures. All waste management and ES&H practices shall follow applicable SEC work controlling documents.

4.3 Precautions

Samples are to be considered potentially contaminated. The following precautions shall be taken:

- Avoid contact with the sample media
- Wear boots and phthalate-free rubber or plastic gloves
- Wear eye protection
- Do not transfer contaminants to other surfaces

Some contaminants can be detected in the parts per billion and/or parts per trillion ranges. Extreme care shall be taken to prevent cross-contamination of these samples. The following precautions shall be taken when trace contaminants are of concern:

- Sampling equipment used for sampling for trace contaminants should be constructed of glass, Teflon, or stainless steel where possible. Plastic equipment should be generally avoided except for inorganic contaminants. Sampling equipment and containers shall be protected from sources of contamination prior to use.
- Sampling equipment should be properly decontaminated in accordance with Procedure SEC-EM-309 prior to use.
- Stage sampling equipment and supplies on plastic sheeting or equivalent to prevent contact with potentially contaminated surfaces. Don a new pair of disposable gloves immediately prior to sampling.
- Samples suspected of containing high concentrations of contaminants shall be placed in separate plastic bags and shall not be stored with environmental samples.
- Sample collection activities should proceed progressively from the suspected least contaminated area to the suspected most contaminated area when possible.
- Some sample tags are equipped with wire ties. Wire ties can rust and/or contaminate the neck and threaded area of sample containers and contaminate the sample. Therefore, wire ties shall not be used.

4.4 Apparatus

While site-specific requirements may vary, apparatus may include:

- Stainless steel hand auger or other soil sampling device
- Stainless steel spoon and bowl (or Pyrex glass pan)
- Decontamination equipment
- Aluminum foil or plastic sheeting (for laying clean equipment on)
- Chemically resistant surgical gloves (i.e., rubber, vinyl, neoprene, etc.)
- Appropriate containers, tags/labels, and custody seals

- COC record and logbook
- Sample cooler, plastic bag, and paper towels
- Packing materials
- HNU/OVA type detector (as appropriate per ES&H plan)

4.5 Records

Chain of Custody record and logbook(s) shall be used to document sample collection. Any data generated from these samples shall be included in the project records' management files. Any end-user data assessment shall also be maintained in the records' management files.

5.0 PROCEDURE

The following is applicable unless otherwise specified in specific work-controlling documents.

5.1 Environmental Safety and Health Guidelines

All environmental safety and health requirements, as listed in the applicable ES&H Plan, shall be met before sampling may proceed. Equipment and supplies shall be handled and/or staged to avoid or minimize contact with potentially contaminated surfaces. When handling onsite surface waters, groundwater, soils, debris, or waste materials, chemically protective gloves shall be worn.

5.2 Sample Identification

Sample containers must be labeled, tagged or marked showing sample identification. Temporarily unmarked samples (in sampling devices, unlabeled jars, etc.) shall not be placed in the vicinity of other similar unmarked samples. Sample data can be invalidated if sample identification is not clear. Documentation of the sample, sampling activity, and sample handling shall be in accordance with the pertinent SAP and procedures.

5.3 Soil Sampling Procedures

A variety of soil sampling tools, typically made of stainless steel, are available for collection of soil samples (e.g., hand augers, split spoons, coring devices, scoops, spoons, etc.). Boreholes for subsurface soil samples may be advanced by hand boring devices (hand augers), portable powered augers, drilling rig, Geoprobe®, or hammering equipment. This procedure primarily references hand augers but is applicable to other soil sampling equipment.

5.3.1 Sample Collection

1) For surface soil samples (i.e., 0-15 cm, 0-100 cm):
   a) Using a stainless steel hand auger or other soil sampling device (which has been decontaminated), auger, push, or core into the material that is being sampled, to the depth specified in the FSP, and retrieve the sample.
2) For subsurface soil samples:
   a) Using a hand auger or other boring or drilling, or sampling device (which has been decontaminated), advance the borehole or sample device to the appropriate sampling depth. Use a decontaminated hand auger or sampling device, such as a thin walled tube or split spoon sampler, to collect the sample. Prior to collecting the sample, remove and/or minimize cuttings/cavings from the borehole to avoid collection of material that is not from the sampling interval. After retrieving the sampler, trim the upper portion of the sample to remove any cuttings or cavings that may be present with the sample. OR
   b) Using a cone penetrometer, or Geoprobe® rig with a split-spoon sampler, push to above the desired depth using a dummy one. Retract the rod and replace the dummy cone with the sampler. Push to below the desired depth to collect the sample. Retract the rod and sampler. Open the two halves of the split spoon and remove the sample. Trim the upper portion to remove any carvings that might be present. OR
   c) Using a backhoe to remove soil from the excavation, use a stainless steel trowel to collect soil not in contact with the bucket surface and place it in the pan (or sample container if VOC analyses are to be conducted on the sample).

3) Samples for VOC analysis should be collected first, without mixing, and placed directly into the appropriate (septa lid) sample container leaving no head space. Care should be taken when filling the container to disturb the sample as little as possible.
   a) These samples shall be collected in a manner that minimizes loss of VOCs.
   b) The VOC sample may be collected directly from the sampling device or immediately after the soil is emptied into the pan.
   c) VOC samples should be containerized immediately upon retrieval.
4) Mix the remaining soil in the bowl or pan by quartering the sample, mixing each quarter, and mixing all quarters together. With the exception of VOC samples, it is important that soil samples be mixed as thoroughly as possible to ensure that the sample is representative of the sample interval. A common method of mixing is referred to as quartering:
   a) The soil in the sample pan is divided into quarters.
   b) Each quarter is mixed, and then all quarters are mixed into the center of the pan.
   c) This procedure is followed several times until the sample is adequately mixed.
   d) If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion and occasionally turning the material

Note:

If samples are predominantly moist and clayey (i.e., cohesive), extra effort may be necessary to produce a homogenous mixture.

5) Fill and cap the remaining sample containers, leaving about 10% head space, and wipe the exteriors of the containers to remove any potential residue.
6) Label or tag the containers as appropriate and custody seal the closure. Place the containers in plastic bags and chill the samples on ice in a sample cooler (or equivalent) as soon as practical for storage and/or transport. It is not necessary to chill samples only for inorganic radionuclides.
7) Document sampling activities, including sample depth and interval, in the field logbook and CO form.

5.4 Quality Assurance/Quality Control Requirements

All provisions of the applicable Quality Assurance Project Plan shall be followed during sampling activities, including collection of appropriate number and types of QC samples. Verify that all equipment has been properly decontaminated prior to sampling. After sampling verify that samples are properly labeled and preserved, and the chain-of-custody forms are completed.

5.4.1 Quality Control Samples

This section describes various additional samples that are required for field sampling quality control. The quality control samples shall be collected and handled taken at the same time and in the same manner as the other samples.

5.4.1.1 Field Duplicate Sample

The time and location of the field duplicate samples will be designated by the sampling team lead. The duplicate sample will be taken at a frequency of at least five percent (one for every 20 samples taken) and be analyzed for the same analyte as the original sample.

A field duplicate will be collected by taking half of the soil sampled from the selected sampling interval after homogenization as described above in Section 5.3.1, 4. This duplicate will be collected in the same manner as the original sample.

5.4.1.2 Matrix Spike

A matrix spike will be collected when samples are collected for chemical parameter analyses and consist of a triple volume from one sample location. Regulatory authority or project-specific requirements will determine whether radiological analyses require matrix spikes. See project specific FSP or other work controlling document for project-specific QC requirements.

> **Note:**
> The triple volume shall be separated into three individual containers. The three individual containers enable the laboratory to perform the analysis on the original sample and on two samples that the lab "spikes." These are the "matrix spike" and "matrix spike duplicate."

A matrix spike/matrix spike duplicate shall be collected from at least one sampling location for every 20 locations sampled.

5.4.1.3 Trip Blanks – FOR CHEMICAL (VOLATILE ORGANIC ANALYSES) ONLY

Trip blanks will meet the following requirements:

1) Prepared and used whenever collecting samples for **volatile organic analyses** (not required for other analyses),
2) Prepared using analyte-free water prior to the sampling event and are kept with the investigative samples throughout the sampling event,
3) Be sealed in 40 ml glass vials with Teflon lined septum caps,
4) Completely filled vials with no headspace, and
5) Shall be sent to the laboratory for analysis at a frequency of one per day and must be shipped to the analytical subcontractor with all samples associated to the trip blank. It does not matter in which cooler it is shipped.

> **Note:**
> One trip blank consists of two 40 ml vials of analyte-free water. Rinse and trip blanks do not require separate matrix spike analyses.

5.4.1.4 Rinse Blanks

A rinse blank shall meet the following requirements:

1) Rinse blanks are not required for radiological soil samples except for tritium.
2) A rinse blank should be obtained by collecting demonstrated analyte-free water that has been poured into, over, and/or pumped through decontaminated sampling equipment that will be used to sample,
3) Be analyzed for all analyte of interest (determined prior to the sampling event by the characterization lead or designee),
4) Be required for non-dedicated pumps and tubing,
5) Be required for filtration devices (excluding the filter),
6) It is permissible to use the same aliquot of water on all equipment associated with a particular sample matrix and analysis,
7) If tritium is being measured, a tritium blank, made of the water used for rinse blanks, should be submitted along with the rinse blank to quantify the amount of tritium in the blank, and
8) A minimum of one rinse blank will be required for every 20 samples or approximately 5% of the total number of samples at a minimum of one per matrix (i.e., soil).

> **Note:**
> Rinse and trip blanks do not require separate matrix spike analyses.

5.5 Waste Disposal

Waste generated from sampling operations will be managed as required by the FSP, WMP, or other work-controlling document.

6.0 APPENDICES

6.1 Recommended Containers, Holding Times, and Preservation

Appendix A

Recommended Containers, Holding Times, and Preservation[1]

ANALYSIS	SOIL/SEDIMENT		
	Container	**Preservative**	**Holding Time**
Radionuclides (except H-3/C-14)	8G or naglene	N/A	180
Tritium/C-14	8G	Ice (4 ° C)	45

Pre-Cleaned Containers:
8G - 8 oz. wide mouth glass (Teflon lid). Nalgene bottles up to 1000 ml or larger may be used.

Holding Times: in days

APPENDIX D

Laboratory Requests and Chain of Custody

1.0 PURPOSE

This document is designed to provide guidance for the identification and documentation of the possession history of a sample from collection through analysis by using the appropriate laboratories' Request and Chain of Custody Forms.

2.0 SCOPE

This procedure applies to all samples that are collected for laboratory analysis in support of SEC Field Projects.

3.0 REFERENCES AND DEFINITIONS

3.1 References

- Title 10, *Energy*, Code of Federal Regulations (CFR), Part 830, *Nuclear Safety Management*, Section 120, *Quality Assurance Requirements*
- Department of Energy (DOE) Order 414.1D, *Quality Assurance*
- American Society of Mechanical Engineers (ASME), Nuclear Quality Assurance (NQA)-1, *Quality Assurance Program Requirements for Nuclear Facilities*

3.2 Definitions

- Custody: a sample that is in a particular individual's custody if it is in that person's physical possession, in view of the person who takes possession, secured by that person so that no one can tamper with it, or secured by that person in an area to which access is restricted to authorized personnel.
- Chain of Custody: an unbroken trail of accountability that ensures the physical security of samples, data, and records
- Laboratory Request Form: a record that identifies requested sample analysis.

4.0 GENERAL

4.1 Discussion

The laboratories analyzing the field samples should provide Laboratory Request Forms and Chain of Custody Forms. This procedure provides guidance on handling and completing these forms. Each time the samples are transferred to another custodian, signatures of the persons relinquishing the sample and receiving the sample, the reason for relinquishing the sample, the time, and date shall be documented.

Records for sampling activities shall be maintained in project records' management files. These records shall be retained as part of the project record. Logbook and other documents, if used for sampling activities, shall also be maintained as project records' management files.

4.2 Responsibilities

The individual who collects and packages the samples or the appropriate group leader is responsible for completing the Chain of Custody section of the Request for Analytical Services Request form.

Any individual who takes custody of the samples is responsible for completing the appropriate area(s) of the form.

The Sampling Team Lead is responsible for reviewing all field activities to ensure that prescribed custody procedures were followed.

5.0 PROCEDURE

5.1 Completing the Request for Analytical Services Form

The Laboratory Request Form, SEC-EM-308-F01, is included with this plan as an example. The forms provided by the actual laboratories performing the analyses should look similar. Each area of these forms needs to be completed. If one of these laboratory forms has not provided, use the form attached to this procedure (Form SEC-EM-308-F01).

Complete the Request for Analytical Services Form as follows

1)	Date:	The date the laboratory request is completed.
2)	Shipped To:	The address of the vendor laboratory
3)	Priority:	Select the turn-around required on the sample analysis. This should be cleared through the project cost manager before completing the form.
4)	Special Instructions:	Provide the vendor any special instructions.
5)	Sample ID:	The site-specific sample identification numbering system.
6)	Location ID:	This may be used to further specify the sample location data. This can be a building number, room number, coordinate, or any other designator that is useful to the site.
7)	Sample Date:	The sample collection date.
8)	Analysis:	The analysis requested from the vendor. Often, the analysis requested may be pre-selected.
9)	Matrix:	The media from which the sample is collected (i.e., soil, water, paint scrapings, swipes, air samples, oil, sediment, etc.).
10)	Comments:	Used to provide additional sample parameters. This could be information on quality control, (i.e., duplicate, trip sample, blank, spike, rinsate, etc.).
11)	Sampled By:	The person who collected the samples or who oversaw the collection of samples.
12)	Date:	The date of the sample collection.
13)	Signature:	Signature of the person who collected the sample.
14)	Project Manager:	Person who has the authority to authorize the expenditure of funds to pay for the analysis.
15)	Project Group Leader	Signature verifies that the technical attributes of the request have been correctly completed.

5.2 Completing the Chain of Custody Section

16)	Signatures:	The signatures of the person transferring custody and the person receiving custody are required on the Chain of Custody. The time and date of the signatures is also required.
17)	Comments:	The lower comments box may be used to specify analysis specifics or other shipping requirements.
18)	Package Dose Rate:	Documents that the package containing the sample meets the requirements for a limited-quantity shipment.
19)	Instrument:	The technician completing the form should enter the instrument model and serial number.
20)	Technician:	The technician completing the dose rate.

6.0 APPENDICE

6.1 Appendix A - Laboratory Request and Chain of Custody, Form EM-308-01

Appendix A

Revision 1	LABORATORY REQUEST AND CHAIN OF CUSTODY FORM FORM EM-308-01				October 25, 2002
Date:			**Turn Around Time (days):** ☐ 2 ☐ 4 ☐ 7 ☐ 14 ☐ 21 ☐ 30		
Shipped To:					
Special Instructions:					
Sample ID Number	**Location**	**Sample Collection Date**	**Analysis Requested**	**Matrix**	**Comments**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Sampled by (print):	**Project Manager**	**Date:**
Date:	**Project Group Leader:**	**Date:**
Signature:		

Relinquished by (signature)	**Received by (signature)**		**Date** **Time**	**Comments**
			Date **Time**	
			Date **Time**	
Package Dose Rate	**Instrument**	**Technician**		

***Add additional chain of custody forms as needed.**

APPENDIX E

Sample Log Sheet

UNCONTROLLED DOCUMENT

UNCONTROLLED DOCUMENT

West Valley Demonstration Project Sample Log Sheet

Sample Identification			Laboratory Instructions:		
			Onsite Laboratory (Y/N)		
			Offsite Laboratory (Y/N)		
Date / Time					
Easting (x)			Radionuclides for Analysis		
Northing (y)			18 Radionuclides of Concern (Circle)		
Elevation (Z)					
Position Description			Am-241	Np-237	Tc-99
Backpack (circle one) or Surveyor (circle one)	ProXR/ProXT Total Station / GPS	PDOP:	C-14	Pu-238	U-232
			Cm-243	Pu-239	U-233
			Cm-244	Pu-240	U-234
			Cs-137	Pu-241	U-235
In-Situ Count Rate (cpm)			I-129	Sr-90	U-238
Depth Relative to Ground Surface (Start Depth)		End Depth			
			12 Potential Radionuclides of Concern (Circle)		
Instrument Information			Ac-227	H-3	Sb-125
Instrument	Model Number:		Co-60	Pa-231	Sn-126
	Serial Number:		Cd-113m	Ra-226	Th-229
	Calibration Due:		Eu-154	Ra-228	Th-232
Detector	Model Number:		Chain of Custody if Offsite Laboratory		
	Serial Number:				
	Calibration Due:		Laboratory:		

Notes: Please include sample description, reasons for taking, general location information, etc.

Internal Custody:

Sampler (Relinquished By)	Sign	Print	Date/Time	
Received By	Sign	Print	Date/Time	

Rev. 03/05/12

APPENDIX F

Cooler Receipt Checklist

UNCONTROLLED DOCUMENT

Cooler Receipt Checklist

SEC-FSP-F01
Rev. 0

Instructions: Please complete this form when a cooler containing samples is received from the Safety and Ecology Corporation (SEC) West Valley Demonstration Project (WVDP) Environmental Characterization Services (ECS) Contract. Please do the following:

1. Note the date cooler receipt checklist and chain of custody were completed by SEC.
2. Note that the date shown on the checklist matches the date shown on the chain of custody form.
3. Enter the date the samples were received at the lab for analysis.
4. Enter the date the Cooler Receipt Checklist was completed.
5. Make a check indicating the condition of the cooler upon receipt.
6. Check whether the samples specified on the chain of custody were received in the cooler.
7. List the sample containers that were damaged, or check none damaged.
8. If samples were damaged, telephone Steve Green at 509.737.7047 within 24 hours of completing the checklist.
9. Scan the checklist and email to sgreen@perma-fix.com.
10. Transmit the original cooler receipt checklist along with the hard copies of the sample results.

Item Number	Item	Make a check mark if satisfactory, otherwise leave blank
1	Date cooler and chain of custody was shipped.	<completed by SEC>
2	Date shown for item 1 matches chain of custody.	
3	Date samples received at lab.	
4	Date Cooler Receipt Checklist was completed.	
5	Cooler received in good condition.	
6	All samples listed on chain of custody were received in the cooler.	
7	List sample containers by identification number that were damaged, or enter a check if none were damaged.	