FOR INFORMATION ONLY

ENERGYSOLUTIONS

CS-HP-PN-006

Supplemental Characterization Survey Plan for Westinghouse Electric Company Hematite Facility

Revision 0

Authored By:	Paul Ely, Senior Radiological Engineer	11/8/07 Date
Reviewed By:	for Mike Carr, CHP	11/8/07 Date
Approved By	Duane Quayle, Project Manager	11/8/07 Date

[X] New Plan

[ ] Title Change

[ ] Plan Revision

[ ] Plan Rewrite

Effective Date 11/8/07

RECEIVED JUN 1 2 2008

TABLE OF CONTENTS

1.0 SITE INFORMATION

1.1 Site History

The Westinghouse Former Fuel Cycle Facility at Hematite, Missouri, hereafter referred to as the Hematite Decommissioning Project (HDP), is located at 3300 state Road P, approximately 2.5 miles west of MO highway A, in Festus, Missouri. The Site consists of approximately 228 acres. The general arrangement of the impacted portion of the Site (approximately 19 acres) including building locations, potential source areas, and other infrastructure features used during operation is shown on Figure 1-1.

The primary operations of the facility centered upon the manufacturing of uranium metal and uranium compounds from natural and enriched uranium for use as nuclear fuel. Specifically, operations included the conversion of uranium hexafluoride (UF6) gas of various uranium enrichments to uranium oxide, uranium carbide, uranium dioxide pellets and uranium metal. Secondary operations included research and development and uranium scrap recovery processes.

The HDP has ceased operations and is preparing to decommission the facility in accordance with 10 CFR § 70.38(i).

The HDP has previously characterized the site (References 7.1 and 7.2), however there were some areas where additional characterization data is necessary to complete the supporting technical documents and to address any potential health and safety concerns from enriched uranium. This supplemental characterization is designed to provide that additional data.

The areas requiring supplemental characterization include the surfaces of buildings 110, 230 and 231 which are expected to remain after completion of the remediation portion of the decommissioning process. Building 110 serves as the pedestrian entrance into the plant and is located outside the security fence and next to the parking area by State Road P. Buildings 230 and 231 are in the southern portion of the fenced in area and are physically separated from the other older production facilities.

Building 230 has had some remediation and prior surveys (Reference 7.1) but it is still in use and is currently included on the HDP license.

Other areas that are included in the supplemental characterization are outdoor soil areas within the impacted area of the site and soil areas below the process buildings where additional samples could be used to bound areas requiring remediation.

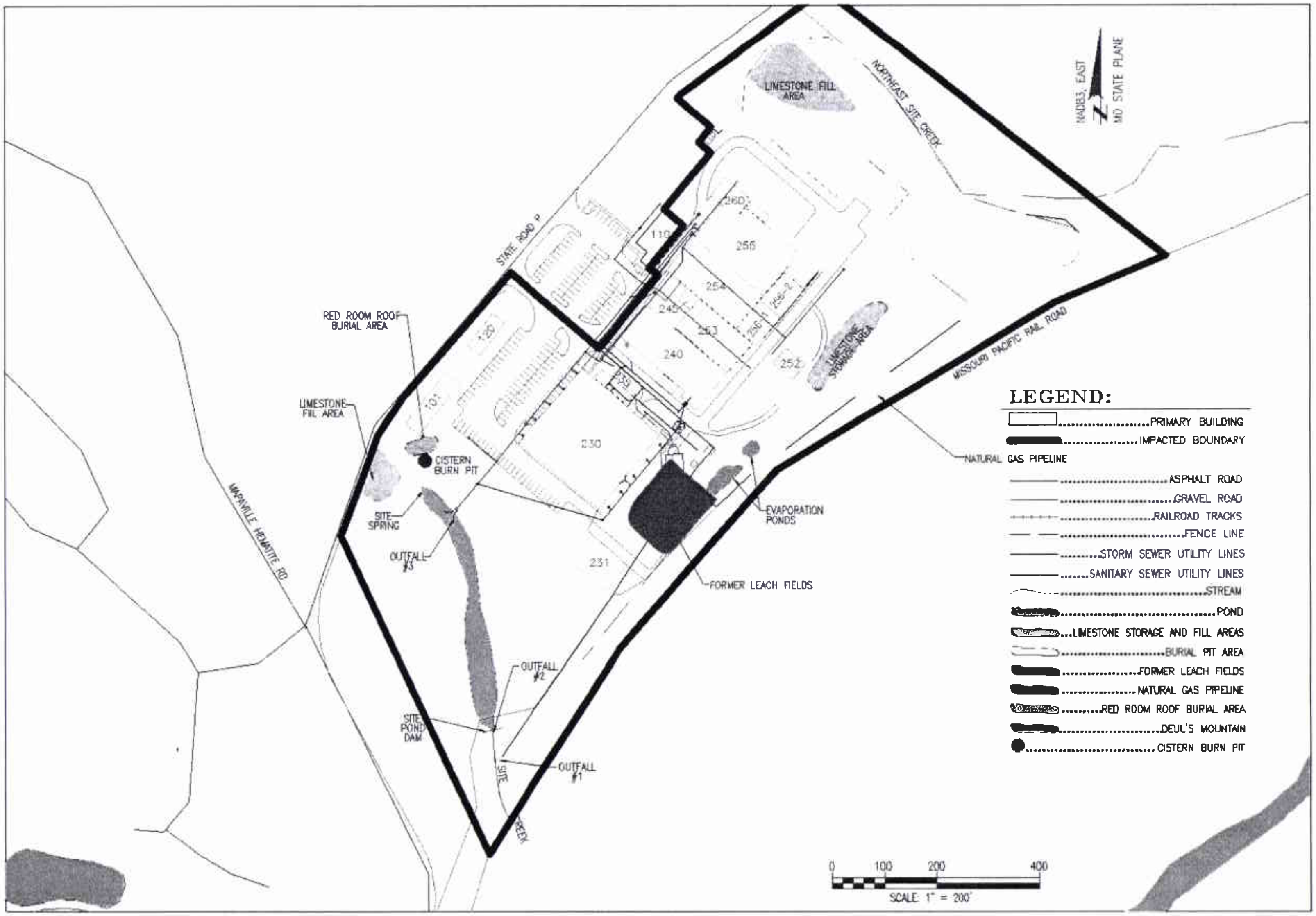

Figure 1-1: Hematite Impacted Site Area

1.2 Building 110 History

Building 110 is the Pedestrian Entrance/Office Building. This building was built in 1970 and serves as the pedestrian entrance into the plant. The building currently has a security station at the entrance, several offices, a conference room, and a kitchen. No work with radioactive or chemical compounds occurred in this building.

1.3 Building 230 History

Building 230 was constructed in 1991 for the purpose of fabricating nuclear fuel rods and assemblies for the nuclear power industry. Activities in Building 230 included the assembly of fuel rods from pellets made within other site facilities. The primary isotopes utilized in the construction of the fuel rods included U-235, U-238, and in some cases gadolinium. The gadolinium included the naturally occurring radioactive isotope Gd-152, an alpha emitter that poses similar radiological hazards to those associated with the uranium isotopes. A diagram of Building 230 depicting the locations of historical activities is included as Figure 1-2.

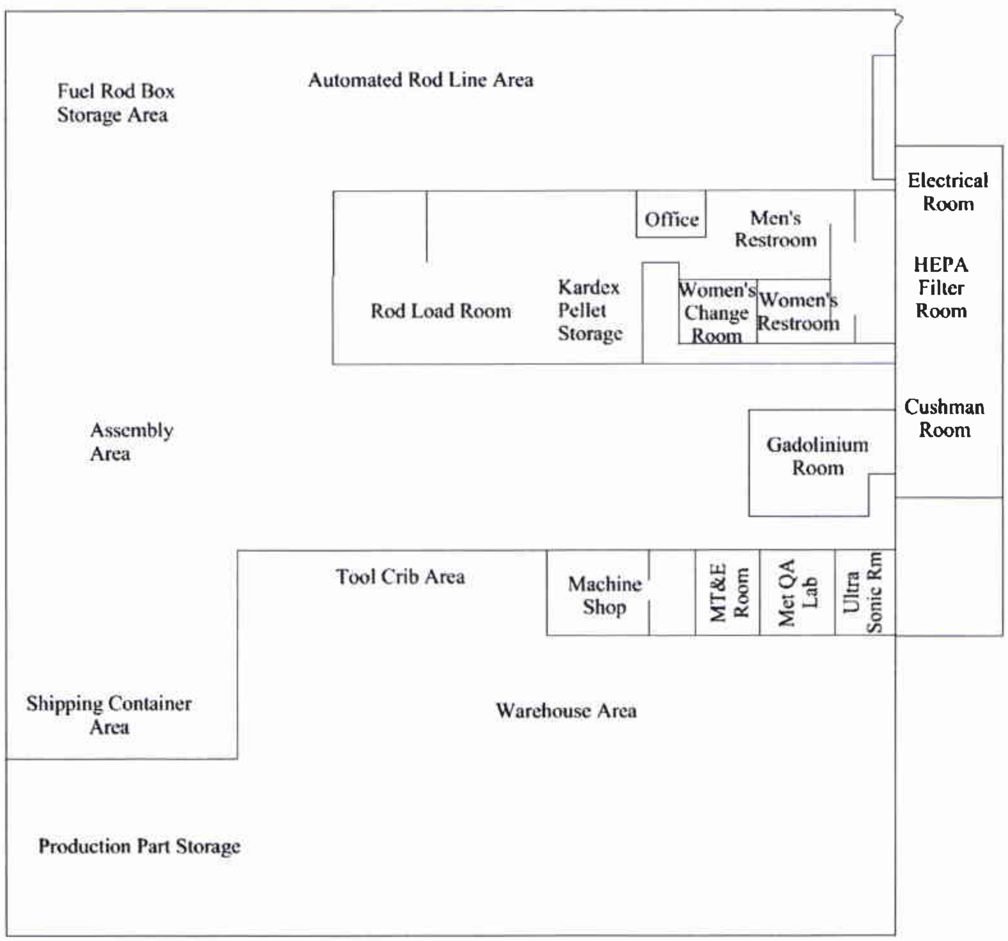

Figure 1-2: Building 230

Fuel pellets were brought into the building in stainless steel transfer boxes via the Cushman Room, and sent into both the Gadolinium Room and the Rod Assembly Room via a conveyor system. The Rod Load Room is located at the center of the "U-shaped" open area and under the mezzanine of Building 230. The trays of pellets were unloaded from the transfer boxes inside the Rod Load Room and stored within the adjacent Kardex system, allowing specific allotments of pellets to be accessed at the appropriate time. The pellets were then loaded into empty zirconium alloy tubes.

Once the zirconium tubes were fully loaded with pellets, they were moved from the Rod Load Room onto the automated rod line in the open area of Building 230. The automated rod line was located directly north of and adjacent to the Rod Load Room. The automated line passed the loaded rods through a series of stations, where end caps were welded, ground flush, and the rods inspected. If any of the rods required further processing, they could be moved back into the Rod Load Room at one of several penetrations through the wall separating the areas.

Once all the rods passed final inspection, they were moved to the assembly Area, which was located in the western end of the "U Shaped" area. The rods were assembled into fuel bundles using a client-specified pattern/array within a vertical metal framework, referred to as the cage. After assembly, they were placed into storage racks until shipped.

Rods containing Gadolinium underwent a similar process in the Gadolinium Room. Rods prepared in the Gadolinium Room sometimes employed depleted or natural uranium pellets. Enriched uranium pellets were not used. The Gadolinium Room is adjacent to and west of the Cushman Room, at the southeast end of the "U-shaped" open area.

1.4 Building 231 History

Building 231 is a warehouse that was erected in 1996 and used to store shipping containers. Some refurbishment of radioactive material shipping containers was performed within this building.

1.5 Impacted Soil Areas

These soil areas were characterized previously (Reference 7.2) consisting of over 80 surface and 50 subsurface soil samples. A systematic triangular grid was utilized to establish these sample locations for most of the impacted area; however, this grid was not extended over this entire impacted area and as a result there were some gaps in the characterization. This supplemental characterization survey plan is designed to provide the additional data thus filling in these gaps. This plan completes the impacted areas for soil characterization with additional surface and subsurface soil samples to be taken from over 40 systematic and 14 biased locations.

1.6 Under Building Contamination

The soil beneath the process building floor slabs, e.g., under building contamination (UBC) was characterized previously (Reference 7.2). Soil samples for UBC were collected and analyzed from 12 building locations. Some of these samples contained elevated concentrations of activity and additional UBC samples are planned to supplement and bound the prior dataset and provide characterization information from beneath slabs not previously sampled. The reference triangular sample grid established for sampling the impacted soil areas was extended to include the soil areas beneath the site buildings. This plan completes the characterization efforts for UBC with additional subsurface soil samples collected from over 17 systematic and 16 biased locations.

2.0 SURVEY OVERVIEW

2.1 Organization and Responsibilities

Energy*Solutions* (ES) will perform this characterization scope under the Hematite *Quality Assurance Program Plan* (Reference 7.3), Hematite *Radiation Protection Program* (Reference 7.4), and Westinghouse Hematite *Health and Safety Plan* (Reference 7.5), and other applicable Westinghouse approved procedures (Attachment 8.1). ES procedures that are compliant with the above Hematite Plans and Programs will also be used. The resources of Energy*Solutions*, including professional engineering and quality assurance staff, will support the ES site manager (SM) and the onsite ES team to ensure successful survey execution and completion.

This characterization survey plan complies with the guidelines of NUREG-1757, "Consolidated Decommissioning Guidance" (Reference 7.6) and NUREG 1575, "MARSSIM" (Reference 7.7).

The onsite team, consisting of an Energy*Solutions* SM and Energy*Solutions* Radiation Protection technicians will be trained, qualified, and experienced in applicable field radiological survey procedures designed to support the overall decommissioning process.

2.1.1 Energy*Solutions* Site Manager

The SM will be the main site point of contact. The SM has overall responsibility for the day to day management of the decommissioning activities and ensuring that all Energy*Solutions* employees and sub-contractors have the proper training and experience to perform their assigned duties.

2.1.2 Energy*Solutions* Radiation Protection Technicians

The Radiation Protection Technicians are responsible for performing surveys and collecting samples. They will be qualified in the use of the survey instruments and surveying in accordance with this plan.

2.2 Data Quality Objectives

The purposes of this supplemental characterization plan include: 1) determining the nature and extent of residual radioactivity, 2) developing input to pathway analysis for risk assessment models for determining site-specific DCGLs, 3) estimating the occupational and public health and safety impacts during decommissioning, and 4) developing input to the remediation efforts, post-remediation surveys and FSS design.

1. Problem Statement

   To gain sufficient information on the residual surface activity levels of Buildings 110, 230 and 231 and UBC activity levels of Buildings 230 and 231 to determine if remediation is required to allow for adequate planning, and to allow for survey and release of these three buildings. Also to gain additional information from the impacted area soils and the UBC of the remaining process building slabs to delineate activity concentrations and radionuclide specific boundaries for remediation efforts for decommissioning.

2. Identify the Decision

   This data collection effort will provide necessary information to guide future planning for remediation (if required) as well as survey and release activities. The output from this study will not result in a specific decision but will provide input appropriate for future planning and the development of the remediation action and post remediation survey plans.

3. Identify the Inputs to the Decision

   - Obtain alpha, beta and gamma surface activity measurements inside of non-impacted Building 110 in order to obtain background activity information that may be utilized to adjust characterization survey results for background surface activity.
   - Obtain soil samples beneath and around concrete floor slabs in Buildings 230 and 231 to define radiological characteristics in order to evaluate the applicability of existing UBC data and to evaluate the need for remediation.
   - Obtain samples of soil below concrete floor slabs in Buildings 240, 252, 253, 254, 255, 256-1, 256-2, and 260 in order to supplement existing radionuclide UBC data.
   - Obtain samples inside Buildings 230 and 231 of areas exhibiting elevated activity levels during alpha, beta and gamma surveys in order to provide radionuclide distribution and correlation information and to evaluate the need for remediation.
   - Obtain alpha, beta and gamma surface activity measurements inside and outside of Buildings 230 and 231 in order to evaluate remediation activities and provide information for the design of the decommissioning documents.
   - Obtain alpha, beta and gamma activity measurements inside the dry portion of drain openings in order to evaluate remediation activities and provide information for the design of the decommissioning documents.

- Obtain scale/sediment samples where possible from the interior of drains/open grating, piping and components included in the characterization effort.
- Obtain surface and subsurface soil samples from the impacted soils area to supplement existing radionuclide concentration activity data.

4. Define the Boundaries of the Study

   This study is limited to those portions of the impacted area that encompass the following:

   - Soil under Buildings 230, 231, 240, 252, 253, 254, 255, 256-1, 256-2 and 260.
   - Interior and exterior of Buildings 110, 230 and 231.
   - Surface and subsurface soil including locations indicated by an extension of a systematic triangular grid and with the addition of biased sample locations.

5. Develop a Decision Rule

   - Soil sample results from the impacted area or beneath building floor slabs (UBC) with activity concentrations in excess of the proposed soil DCGLs will be an indicator that soil contamination is present and may need to be addressed in the remediation action plan to include the delineation of decontamination boundaries.
   - Surface activity measurements in excess of proposed building DCGLs will be an indicator that surface contamination is present and will need to be addressed in the remediation action plan to include the delineation of decontamination boundaries.
   - Material sample results from joints and cracks in excess of proposed soil DCGLs will be an indicator that contamination is present and will need to be addressed in the remediation action plan to include the delineation of decontamination boundaries. Material sample results less the analytical MDCs will be an indicator that contamination is not present in joints and cracks. Sample results between these levels will be evaluated to determine if remediation is required. Material samples may be used to develop radionuclide ratios for the development of a gross activity DCGL for the Buildings.
   - Material sample results from joints and cracks in excess of analytical MDCs will be reviewed for possible use in the development of building DCGLs. Material samples may be used to develop radionuclide ratios for the development of a gross activity DCGL for the Buildings.
   - Material sample results from joints and cracks less than the analytical MDCs will be an indicator that building DCGLs will need to be

developed based upon conservative assumptions and historic building use information from the historical site assessment.

6. Specify Limits on Decision Errors

   The probability of making Type I and Type II decision errors is set at 0.05

7. Optimize the Design for Collecting Data

   Calculations were performed to determine the minimum number of sample points required for measurements to meet building survey objectives. Based on the prior survey data (Reference 7.1) the average activity level was 600 ± 200 dpm/100cm^2 with a proposed DCGL >20,000 dpm/100cm^2 for U-235 (the most restrictive DCGL for building surfaces). The relative shift (Δ/σ or DCGL – LBGR with LBGR initially set at 50% of the DCGL) ≅ 10,000/200 ≅ 50; however, MARSSIM recommends that relative shift not exceed a value of 3. Using Δ/σ =3 and Table 5.5 of MARSSIM, the minimum number of samples, N, was determined to be 14 (including the 20% increase recommended by MARSSIM).

   Calculations were performed to determine the minimum number of sample points required for measurements to meet survey objectives for UBC soils. Based on the prior survey data (Reference 7.7) the average fractional activity (relative to the proposed DCGLs) was 0.262 ± 0.118 with a DCGL of 1. $\Delta/\sigma \cong 1/0.118 \cong 8.5$; however, MARSSIM recommends that Δ/σ not exceed a value of 3. Using Δ/σ =3 and Table 5.5 of MARSSIM, the minimum number of samples, N, was determined to be 14 (including the 20% increase recommended by MARSSIM).

   The subsurface soil sampling plan, based on the DCGL development model, is optimized to characterize radionuclides in three specific areas of interest, surface (0-6in depth), near surface (6-in to 4.5-ft depth) and deep (4.5-ft to groundwater, refusal or 20-ft maximum).

2.3 Characterization Strategy

2.3.1 Buildings 110, 230 and 231

The three buildings will be surveyed and soil samples collected from beneath floor slabs and around the perimeters of buildings 230 and 231. The overall strategy is to collect systematic and biased surface activity measurements and soil samples to locate and identify any potential residual contamination including UBC. Based on historical operational information it is anticipated that no residual surface activity will be greater than the proposed Building DCGLs and that the surface activity characterization data may serve as the dataset for the final status survey of these buildings. It is also anticipated that UBC soil samples will be below the proposed soil DCGLs; however, if the data indicates otherwise, decisions will be made prior to the development of the remediation plan to determine if the final end use of these buildings is to stay erect or to be demolished.

This characterization effort is focused on locating potential areas of elevated activity, if they exist, and document the current activity levels to facilitate any required remediation and the design of the final status surveys for these buildings. The sampling of soils under and around these buildings is an important aspect of this characterization as UBC was not characterized previously for this scope as the buildings were originally slated for demolition. Gamma radiation scans will be conducted in areas likely to contain residual activity, based on the results of the HSA and scoping survey.

The survey will consist of the following elements:

- Identify areas of elevated radiation levels using a μR and/or NaI focusing on joints, cracks, pits and drains. If locations of elevated radiation levels are identified, then samples of materials from these areas will be collected for analysis.
- Perform beta scan surveys of joints and cracks for elevated radiation levels. If locations of elevated radiation levels are identified, then samples of material from these areas will be collected for analysis.
- Perform alpha and beta surveys of overhead horizontal surfaces within process areas of the building for direct and removable alpha and beta activity.
- Bore through the floor surface in Bldg 230 at the locations indicated in Figure 2-1 (blue triangles for systematic locations and red circles for biased locations). Additional bias samples may be collected from the central area where fuel operations took place and focusing around expansion joints, cracks and drain lines. Samples will be collected below the floor slab at these locations to groundwater, refusal or 20-ft maximum.

  The survey will consist of the following elements:

  - Bore through building floor surfaces at the locations indicated in Figure 2-2 (blue triangles for systematic locations and red circles for biased locations). Obtain a surface soil sample (0 to 6-in depth).
  - Obtain Geoprobe samples at these locations to groundwater, refusal or 20-ft maximum.
  - Three soil samples will be obtained from each sample location, a surface sample (0 to 6-in depth), a near surface composite sample (6-in to 4.5-ft depth) and deep composite sample (4.5-ft to groundwater, refusal or 20-ft maximum).
  - The surface soil samples and the near surface composite samples will each have a gamma spec analysis, an alpha spec analysis and a Tc-99 analysis. The deep composite samples will each have a gamma spec analysis and 10% of the total number of deep samples will have an alpha spec analysis and a Tc-99 analysis.

- Surveys on the roofs of the buildings for alpha and beta activity including smears at elevated reading locations with a minimum of 30 smears from systematic and biased locations. For Building 230, biased surveys will be conducted in the area around the HEPA ventilation exhaust. Direct surveys and smears will be taken from inside the exhaust stack and ducts at accessible locations.
- Survey of building exterior walls for alpha and beta activity and smears taken at elevated activity locations.
- Survey of drain openings and inside drains for alpha and beta activity as far as they are dry and to include smears/swabs.

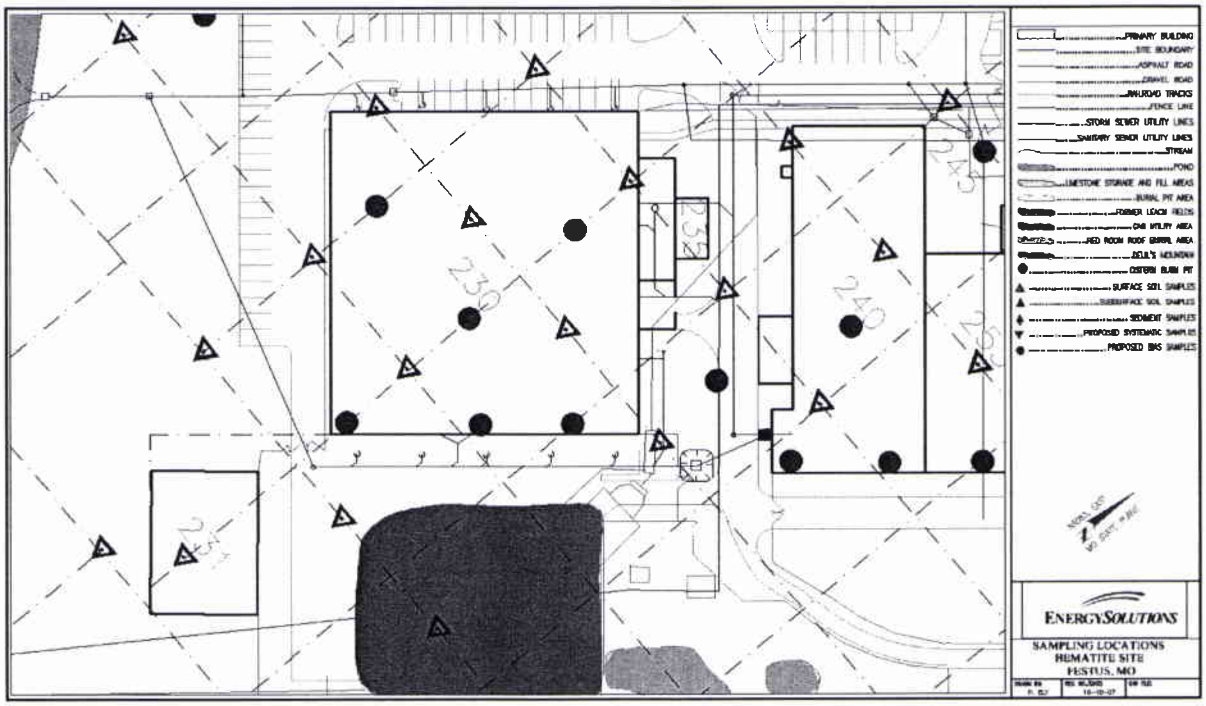

Figure 2-1: Building 230 and 231 Sample Locations

2.3.2 Soil Beneath Buildings 240, 253, 254, 255, 256-1, 256-2, and 260

Soil samples will be collected from beneath floor slabs in these process buildings. The overall strategy is to collect systematic and biased samples to locate and delineate areas of UBC.

The survey will consist of the following elements:

- Bore through building floor surfaces at the locations indicated in Figure 2-2 (blue triangles for systematic locations and red circles for biased locations). Obtain a surface soil sample (0 to 6-in depth).
- Obtain Geoprobe samples at these locations to groundwater, refusal or 20-ft maximum.

- Three soil samples will be obtained from each sample location, a surface sample (0 to 6-in depth), a near surface composite sample (6-in to 4.5-ft depth) and deep composite sample (4.5-ft to groundwater, refusal or 20-ft maximum).
- The surface soil samples and the near surface composite samples will each have a gamma spec analysis, an alpha spec analysis and a Tc-99 analysis. The deep composite samples will each have a gamma spec analysis and 10% of the total number of deep samples will have an alpha spec analysis and a Tc-99 analysis.

2.3.3 Supplemental Characterization of Impacted Soil Areas

Outdoor soil areas within the impacted area will be sampled to supplement existing characterization data. The overall strategy is to collect systematic and bias samples to locate and delineate areas of known contamination for remediation efforts.

The survey will consist of the following elements:

- Obtain Geoprobe samples at the locations indicated in Figure 2-3 (blue triangles for systematic locations and red circles for biased locations).
- Three soil samples will be obtained from each sample location, a surface sample (0 to 6-in depth), a near surface composite sample (6-in to 4.5-ft depth) and deep composite sample (4.5-ft to groundwater, refusal or 20-ft maximum).
- For the samples taken between the buildings and the railroad tracks: the surface soil samples and the near surface composite samples will each have a gamma spec analysis, an alpha spec analysis and a Tc-99 analysis; the deep composite samples will each have a gamma spec analysis and 10% of the total number of deep samples will have an alpha spec analysis and a Tc-99 analysis.
- For the remaining sample locations: all samples will each have a gamma spec analysis and 10% of the total number of deep samples will have an alpha spec analysis and a Tc-99 analysis.

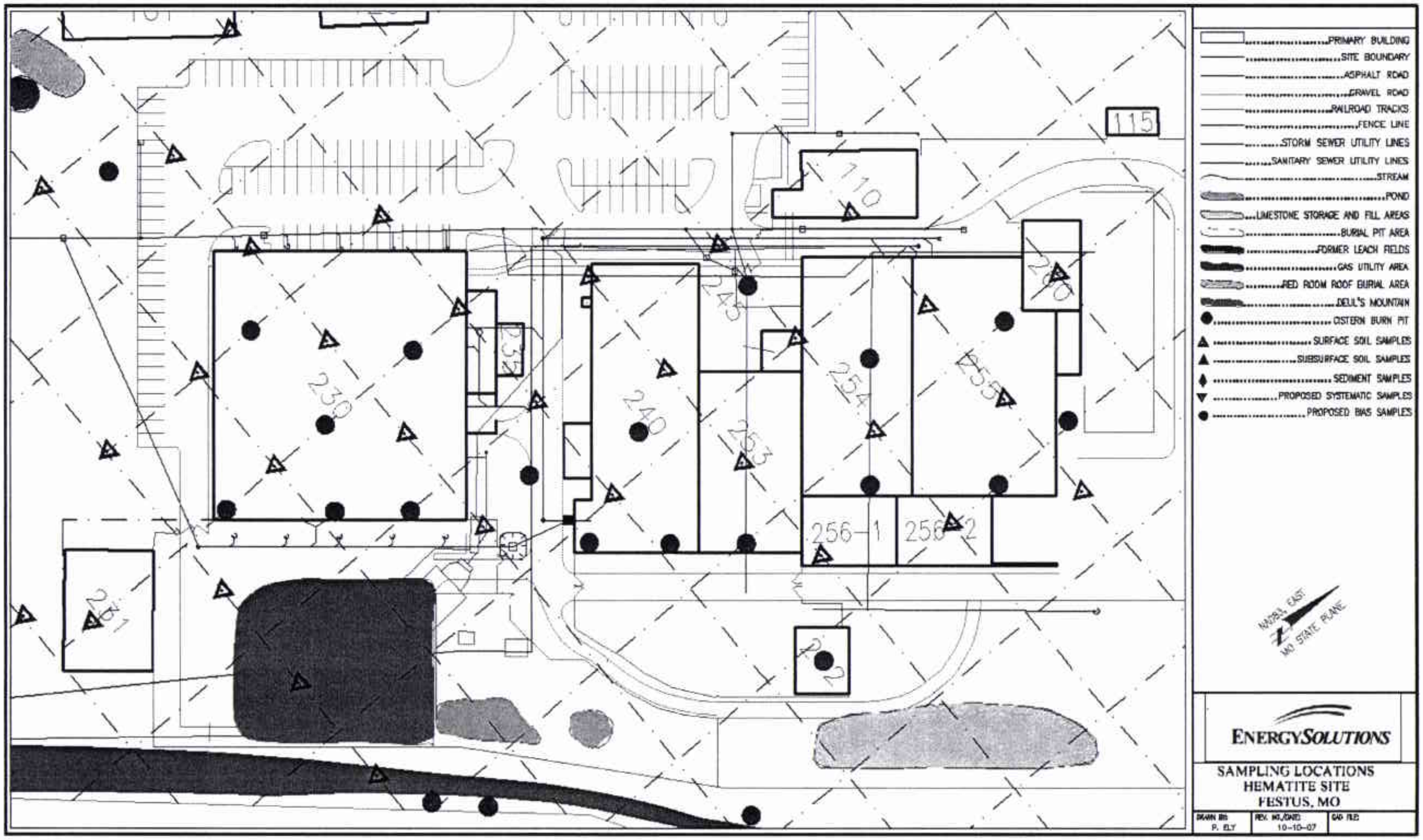

Figure 2-2: Building 240, 253, 254, 255, 256-1, 256-2, and 260 Sample Locations

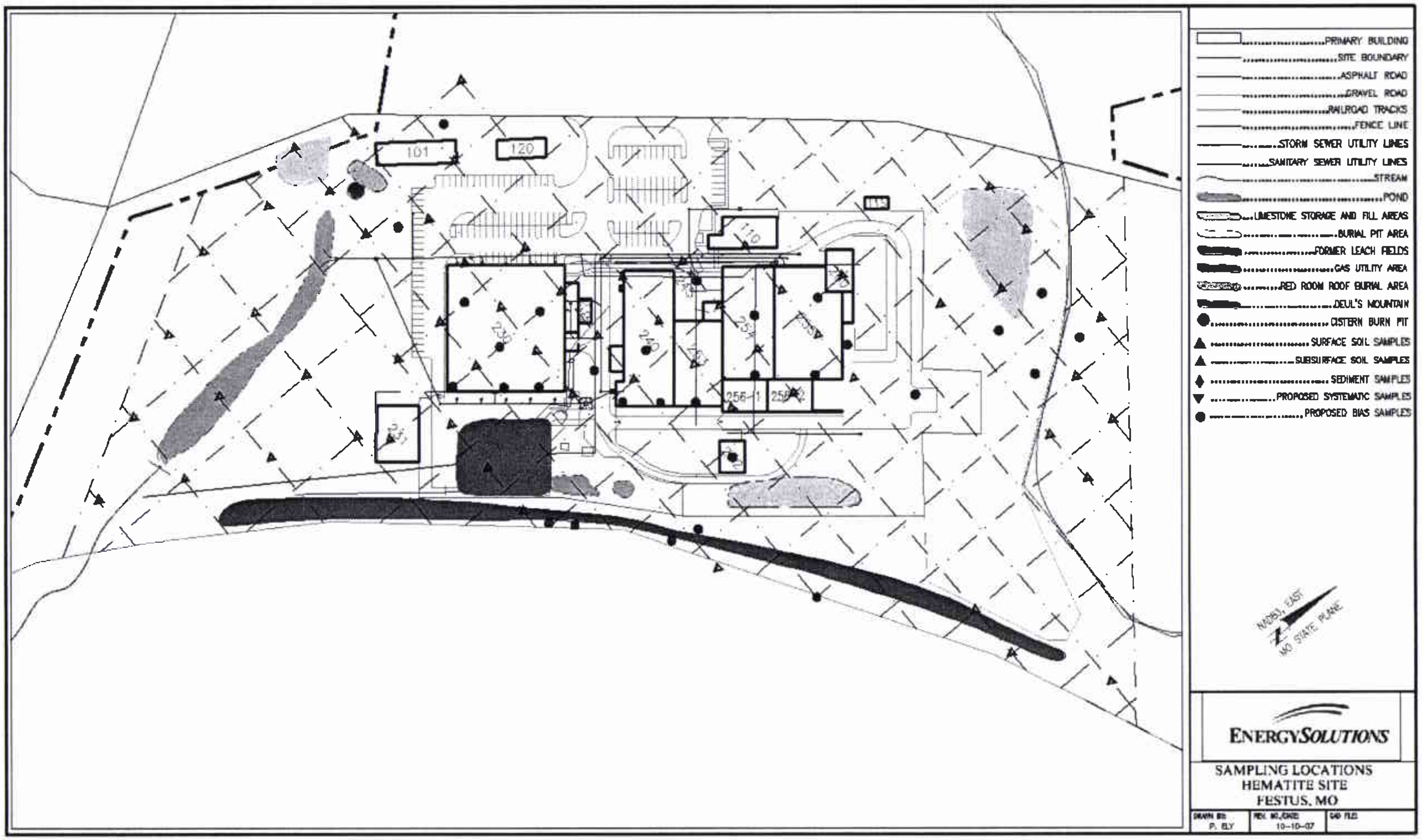

Figure 2-3: Impacted Area Sample Locations

2.4 Radionuclides of Concern

Based on site historical operational information, the primary radionuclides of concern within these buildings are uranium at various levels of commercial enrichment and Tc-99. Note other radionuclides associated with uranium may be present in trace quantities, such as: Am-241, Np-237, Pu-239, and Th-232. These radionuclides are listed because DOE historical reports indicate that they "may have" provided contaminated UF_6 with enriched uranium and they have been found in soil samples in other areas. There is no expectation to find these radionuclides within buildings during this characterization survey but there is a potential that they may be found in soil samples during this characterization surveys. Gd-152 is another radionuclide that may be present in trace quantities based on its occasional use in fuel within Building 230. It was not found in previous characterization surveys.

3.0 SURVEY INSTRUMENTATION

Survey instrumentation is considered Measuring and Test Equipment in the Hematite Quality Assurance Program Plan Section 7.12 (Reference 7.3). The Control of Inspection, Measuring, and Test Equipment (Section 7.12) addresses the requirements placed on the survey instrumentation used to perform this characterization survey. The following detail on survey instrumentation complies with the requirements of the Hematite QA Plan (Reference 7.3) including: Identification of Measuring and Test Equipment, Calibration Procedures, Records, Adequacy of Measurement Reference Standard, Environmental Controls, Intervals of Calibration, Traceability, and Labeling.

Selection and use of instruments will ensure sensitivities are sufficient to detect the identified primary radionuclides at the minimum detection requirements. The instruments will have an MDC of 50% of the proposed DCGL's or less. Table 3-1 provides a list of the instruments, types of radiation detected, and calibration sources that may be used.

Energy*Solutions* will use the Ludlum Model 2350-1 Data Logger or equivalent alpha and/or beta instruments with a variety of detectors for direct measurements of total alpha and beta surface activity and exposure rate measurements.

Detector selection will depend on the surface to be surveyed, e.g. surface contour and area. The project team will normally use the Ludlum 43-68, a 126 cm^2 gas-flow proportional detector, for direct alpha and beta measurements and a Ludlum 44-10, a 2"×2" Sodium Iodide (NaI) gamma scintillation detector, for exposure rate measurements. Other instruments and detectors may be used based on the progress of survey activities. Smears for removable activity will be analyzed using a Ludlum Model 2929 or equivalent or sent off site to an independent laboratory for analysis.

Table 3-1: Survey Instrumentation

Instrument/Detector	Detector Type	Radiation Detected	Calibration Source	Use
Ludlum Model 2350/43-68 or 43-106	Gas-flow proportional ($126\ cm^2$)	Alpha or beta	^{230}Th (α) ^{99}Tc (β)	Direct measurements
Ludlum Model 2350/44-10	2" x 2" NaI scintillator	Gamma	^{137}Cs (γ)	Gamma exposure rate
Eberline RO-20	Ionization chamber	Beta-Gamma	^{137}Cs (γ)	Gamma exposure rate
Ludlum Model 2929	ZnS/Plastic scintillator	Alpha or beta	^{230}Th (α) ^{99}Tc (β)	Smear counting

3.1 Instrument Calibration

Survey instruments, counting devices and other equipment used for radioactivity detection and measurement shall be cared for and maintained according to ES-AD-PR-009 and CS-FO-PR-002 (Listed in Attachment 8.1). These Energy*Solutions* procedures comply with the requirements of Hematite Quality Assurance Program Plan Section 7.12.2 "Calibration Procedures", 7.12.3 "Records", 7.12.4 "Adequacy of Measurement Reference Standard", 7.12.5 "Environmental Controls", 7.12.6 "Intervals of Calibration", 7.12.7 "Traceability" and 7.12.8 "Labeling"(Reference 7.3).

Energy*Solutions* calibrates the data loggers and associated detectors used at Hematite on an semi-annual basis using National Institute of Standards and Technology (NIST) traceable sources and calibration equipment.

The instrument calibration includes:

- high voltage calibration,
- discriminator/threshold calibration,
- window calibration,
- alarm operation verification, and
- scaler calibration verification.

The detector calibration includes:

- operating voltage determination,
- calibration constant determination, and
- dead time correction determination.

Calibration labels showing the instrument identification number, calibration date, and calibration due date are attached to all portable field instruments. The user will check the instrument calibration label before each use.

3.2 Radioactive Sources

All radioactive sources used for calibration or efficiency determinations for the survey will be representative or conservative to the instrument's response of the identified nuclides and are traceable to NIST.

Note that Energy*Solutions* radioactive source handling shall comply with the applicable requirements of HDP programs and procedures.

3.3 Minimum Detectable Concentration Calculations

3.3.1 Total Surface Activity

Minimum Detectable Concentration (MDC) is defined as the smallest concentration of radioactive material in a sample that will yield a net positive count with a 5% probability of falsely interpreting background responses as true activity. The MDC is dependent upon the counting time, geometry, sample size, detector efficiency, and background count rate. The equation used for calculating the MDC, in dpm/100 cm^2, for total surface activity is:

$$MDC = \frac{3 + 3.29\sqrt{R_B t_S \left(1 + \frac{t_S}{t_B}\right)}}{(\varepsilon_s)(\varepsilon_i)(t_S)\left(\frac{probe.area}{100cm^2}\right)} \qquad \text{(Equation 3-1)}$$

where:

R_B = background count rate (counts per minute [cpm])
t_S = sample count time (min)
t_B = background count time (min)
ε_S = surface efficiency (determined using ISO-7503)
ε_i = 2π instrument efficiency

3.3.2 Removable Surface Activity

The equation for determining the MDC, in dpm, for smear counters (removable surface activity) is similar to the equation for total surface activity (Equation 3-1). The difference is that the probe area variable is not required because smears are collected from an area of 100 cm^2. Refer to variable definitions for Equation 3-1.

$$MDC = \frac{3 + 3.29\sqrt{R_B t_S \left(1 + \frac{t_S}{t_B}\right)}}{(\varepsilon_s)(\varepsilon_i)(t_S)} \qquad \text{(Equation 3-2)}$$

3.3.3 Scanning Measurements

The MDC values for scanning (ScanMDC) depend on many variables including the sensitivity of the instrument, speed of the scan, size of the detector, distance from the surface, and several other factors. Scanning actually consists of two distinct measurement phases, each carrying its own MDC. The first of these phases is the actual scan measurement. The second phase is a "second look" stationary measurement of an area where an increased scan reading draws the attention of the operator.

The index of sensitivity (*d'*) represents the difference between the mean of the background and mean of the background plus signal. The value of *d'* depends upon the selection of the acceptable false positive and true positive rates. For this project, a 60% acceptable false positive rate and a 95% true positive rate for the first phase of scanning will be used. The resultant *d'* is 1.38 for the first phase of scanning (Table 6.5 in MARSSIM). For the second phase of scanning, a 20% acceptable false positive and 95% true positive rates will be used resulting in a *d'* of 2.48.

Using the more conservative first phase scanning parameters, the equation for the scanning MDC, in dpm/100 cm^2, is provided below (Reference 7.7):

$$ScanMDC = \frac{(d')\left(\frac{60}{i}\sqrt{R_B \frac{i}{60}}\right)}{\sqrt{p}\,(\varepsilon_s)(\varepsilon_i)\left(\frac{probe.area}{100cm^2}\right)} \qquad \text{(Equation 3-3)}$$

where:

- d' = index of sensitivity
- i = observation interval (sec)
- R_B = background count rate (cpm)
- 60 = seconds per minute
- p = surveyor efficiency (0.5 is standard default value provided in NUREG/CR-6364)
- ε_s = surface efficiency
- ε_i = 2π instrument efficiency

4.0 SURVEY/SAMPLING DESIGN

4.1 Introduction

The Energy*Solutions* project team will perform surveys according to Energy*Solutions* procedures, this plan, and all applicable requirements of HDP programs and procedures. The procedures identify survey instrument requirements, measurement and sample collection, and data reduction and evaluation methods, while this plan identifies the survey protocols. Implementation of this plan will include the following:

- The ES team will take survey measurements and analyze samples as defined in this survey plan. Measurements will be performed using appropriate calibrated instruments.
- Daily instrument quality control (QC) checks will be performed before and after each day's work.
- The project team will mark or map survey locations as applicable.
- Survey data collected during the project will be downloaded from the survey instrument into a database for storage, analysis, and reporting.

- Supervisory personnel will review the completed survey packages to ensure that all required surveys have been performed and that the completed survey packages contain all necessary information.
- All sample results will be evaluated and additional measurements/samples may be considered depending on measurement/sample location and measured activity level.

4.2 Survey Requirements

For the purposes of this characterization survey, the Buildings 110, 230 and 231 have been classified in accordance with NUREG 1575, *Multi Agency Radiation Survey and Site Investigation Manual MARSSIM,* based upon historical information. Building 110 is a non-impacted area; however, for the purposes of this characterization, it is being surveyed similar to that of a Class 3 area. Building 230 classification is outlined per Figure 4-1, and Building 231 is a Class 2 area. The classifications in Building 230 are the same as those used for the post remediation survey performed for this building (Reference 7.1).

Proposed soil sample locations in and around site buildings are also shown in Figure 4-2. If there are interferences at these locations they may be offset to avoid the interference as necessary.

Proposed outdoor soil sample locations within the impacted area are shown in Figure 4-3. If there are buried utilities or other interferences at these locations they may be offset to avoid the interferences as necessary.

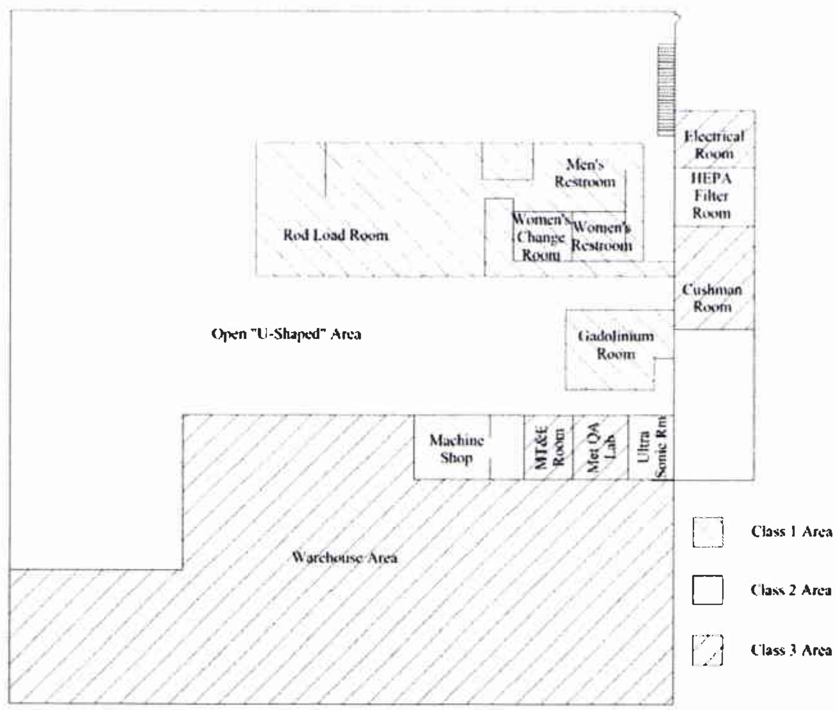

Figure 4-1: Building 230 Impacted Areas

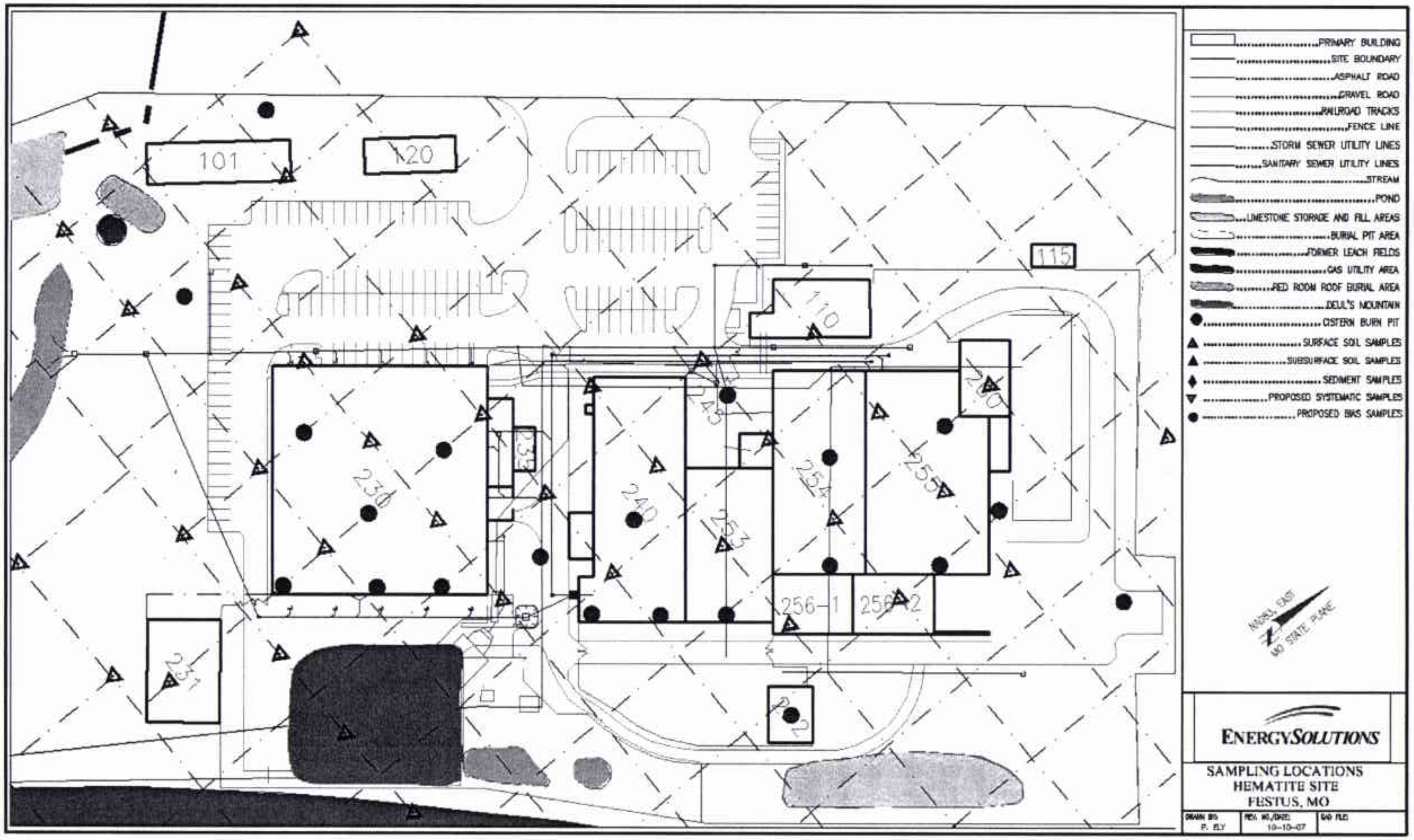

Figure 4-2: Proposed Building Soil Sample Locations for UBC

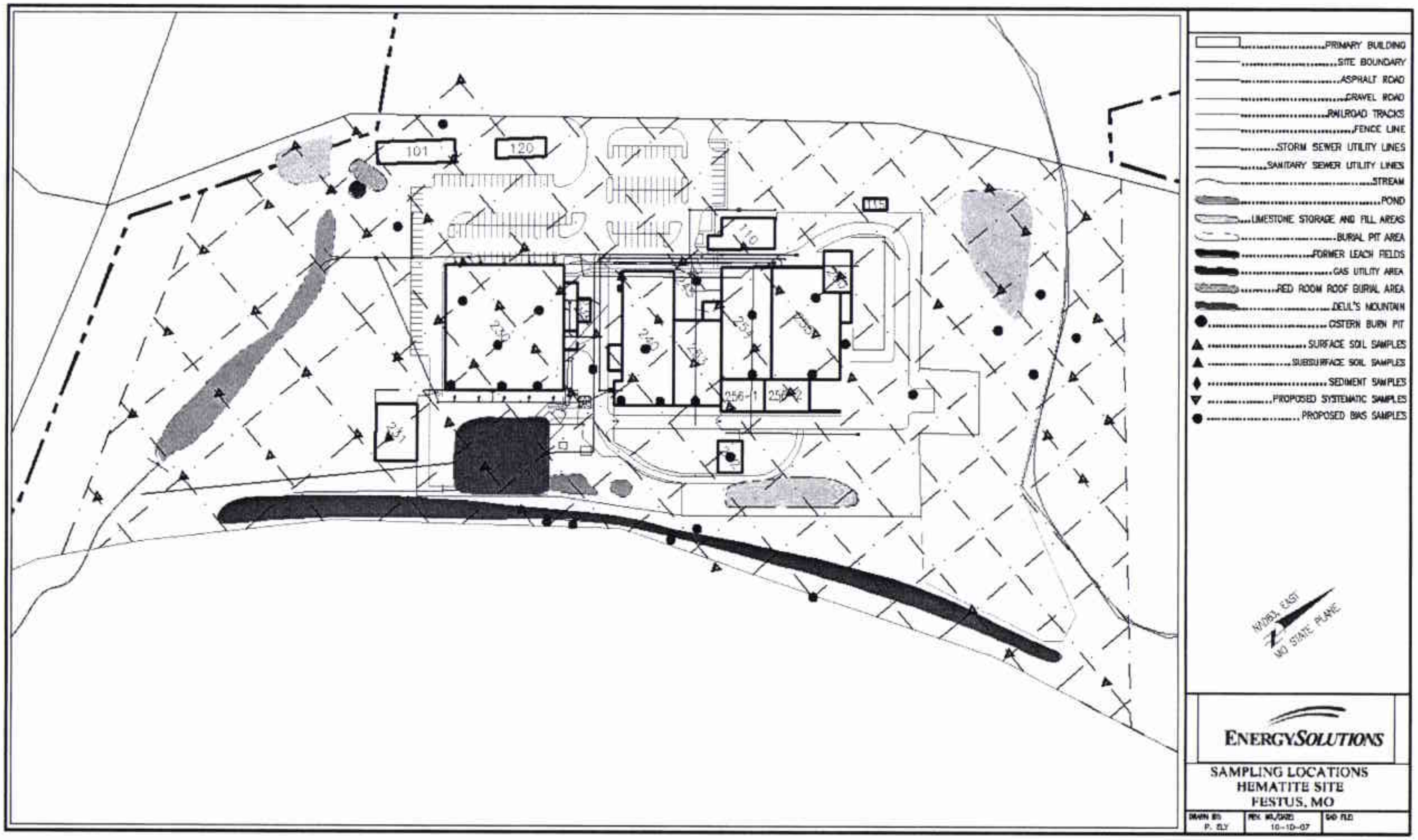

Figure 4-3: Proposed Impacted Area Soil Sample Locations

4.2.1 Background

No material-specific background corrections for buildings will be performed for total alpha measurements. For total beta measurements, a minimum of 10 shielded and unshielded measurements will be performed in a room of the non-impacted Building 110. The 10 measurement minimum is based on professional judgment as this is standard practice in establishing standard deviation calculations. All total beta measurements will be corrected for material specific background.

The variability in background measurements will be evaluated to determine whether outliers exist that should be excluded. The EPA ProUCL software will be used in evaluating the background measurement data.

A minimum of 10 exposure rate measurements will be performed in a room of the non-impacted Building 110.

4.2.2 Reference Coordinate System

A reference coordinate system will be established for buildings 110, 230 and 231 to facilitate the selection of measurement and sampling locations. The grid will consist of intersecting lines, referenced to a fixed site location or benchmark such as a room corner. A survey map will be generated that indicates the location of grids and fixed activity measurement locations. The grid lines will be marked by either indicating the intersection of lines on the floor or wall surface. The marking will be made using removable material such as stick-on dots, wax, or chalk. The location of fixed and removable activity measurements will be marked on the surface and on a survey map.

4.2.3 Building 110, 230 and 231 Measurement and Sampling Locations

The minimum number of measurement and sampling locations that will be collected (smears for removable activity and soil samples) are identified in Table 4-1 below. Measurements and sampling will also be performed at locations of elevated radiation as identified during surface scans for all areas.

Table 4-1: Survey Measurements

Measurement Type	**Minimum Survey Requirements[1]**				
	Bldg 110	**Bldg 230**			**Bldg 231**
	Class 3	**Class 1**	**Class 2**	**Class 3**	**Class 2**
Soil samples through floor slab	0	4	3	3	3
Building perimeter soil samples	0	3	0	0	NA
Floor and lower wall α and β scan surveys	10%	10%	10%	10%	10%
Floor α and β fixed point surveys	20	20	20	20	20

Measurement Type	Minimum Survey Requirements[1]				
	Bldg 110	Bldg 230			Bldg 231
	Class 3	Class 1	Class 2	Class 3	Class 2
Floor α and β smear surveys	20	20	20	20	20
Upper wall and ceiling α and β scan surveys	10%	10%	5%	5%	10%
Upper wall and ceiling α and β fixed point surveys	20	20	20	20	20
Upper wall and ceiling α and β smear surveys	20	20	20	20	20
Overhead horizontal surfaces α and β scan surveys	10%	10%	5%	5%	10%
Overhead horizontal surfaces α and β fixed point surveys	20	20	20	20	20
Overhead horizontal surfaces α and β smear surveys	20	20	20	20	20
Roof α and β scan surveys	10%	10%	10%	10%	10%
Roof α and β fixed point surveys	20	20	20	20	20
Roof α and β smear surveys	20	20	20	20	20
Exterior wall α and β scan surveys	10%	10%	10%	10%	10%
Exterior wall α and β fixed point surveys	20	20	20	20	20
Exterior wall α and β smear surveys	20	20	20	20	20
Vent duct α and β scan surveys	Yes[2]	Yes[2]	NA	NA	NA
Vent duct α and β fixed point surveys	15	15	NA	NA	NA
Vent duct α and β smear surveys	15	15	NA	NA	NA
HEPA Exhaust α and β scan surveys	NA	100%	NA	NA	NA
HEPA Exhaust α and β fixed point surveys	NA	15	NA	NA	NA
HEPA Exhaust α and β smear surveys	NA	15	NA	NA	NA

[1]A minimum number data points, N, was calculated using the MARSSIM methodology with α and β errors set to 0.05, a proposed building surface DCGL of 26,000 dpm/100 cm^2, and using prior building surface data to calculate the relative shift. A minimum number of data points, N was calculated to be 14.
[2]Scan surveys of vent duct interiors will be performed at accessible locations as determined and documented by the surveyor.

4.2.4 Sample identification and control is covered in the Hematite Quality Assurance Program Plan Section 7.8 (Reference 7.3). This section addresses the requirements placed on samples obtained during this characterization survey. The following detail on sample identification and control complies with the requirements of the Hematite QA Plan (Reference 7.3) including: Identification of Samples, Traceability of Samples, Storage of Samples, and control of Samples.

4.2.5 All samples will be identified using an alphanumeric code for the purpose of identification and traceability as indicated in EnergySolutions procedure CS-FO-PR-003 (Listed in Attachment 8.1).

4.2.6 All samples will be identified using an alphanumeric code to allow traceability and clear association with sample location as indicated in EnergySolutions procedure CS-FO-PR-003 (Listed in Attachment 8.1).

4.2.7 All samples will be stored in a controlled area provided by HDP as provided in Energy*Solutions* procedure CS-FO-PR-003 (Listed in Attachment 8.1). Samples will be inspected prior to being placed in the storage area for identification, damage, packaging, and traceability to records. Packaging and identification shall be consistent with the duration and conditions of storage. An inventory and sample retention time shall be maintained throughout the storage period.

4.2.8 All samples will be tracked from the time the sample is obtained through final disposition or disposal of the sample. All samples will be retained indefinitely unless authorization for disposal is provided by HDP. This tracking includes the use of a Chain-of-Custody Record or similar form to track samples that are sent offsite for analysis as indicated in Energy*Solutions* procedure CS-FO-PR-003 (Listed in Attachment 8.1).

4.2.9 Survey Notes

- Surveys of soil will be completed by marking sample locations as indicated in this plan. HDP will review these locations for potential buried utilities interferences. If there are interferences, the sample locations will be offset.
- Under building and outdoor soil samples will be obtained using a Geoprobe to obtain the samples with sampling to a depth of groundwater, refusal or 20-feet maximum. Samples will be generated for three areas of interest, surface (0 to 6-in depth), near surface (6-in to 4.5-ft depth) and deep (4.5-ft to groundwater, refusal or 20-ft maximum). For sample locations where Tc-99 activity levels are of special interest, the near surface sample (6-in to 4.5-ft depth) will be divided into 6-in to 2.5-ft depth and 2.5-ft depth to 4.5-ft depth sections prior to analysis. After sampling, the holes will be filled with an appropriate material to preclude the vertical mobility of any contaminants via the sample hole.
- Soil sample cores will be scanned for beta activity as they are removed and labeled and packaged in containers for analysis offsite.
- The soil beneath buildings 240, 252, 253, 254, 255, 256-1, 256-2, and 260 will have each sample analyzed for gamma spec analysis, an alpha spec analysis and a Tc-99 analysis for the surface soil samples and the near surface composite samples. The deep composite sample will each have a gamma spec analysis and 10% of them will have an alpha spec analysis and a Tc-99 analysis.
- For soil samples from outdoor areas within the impacted soils area taken between the buildings and the railroad tracks: the surface soil samples and the near surface composite samples will each have a gamma spec analysis, and alpha spec analysis and a Tc-99 analysis; the deep composite sample will each have a gamma spec analysis and 10% of them will have an alpha spec analysis and a Tc-99 analysis.
- The laboratory analysis MDC's will be less than 50% of the proposed DCGL's with a target of 10% of the proposed DCGL.

- For other soil samples from outdoor areas within the impacted soils area all samples will each have a gamma spec analysis and 10% of them will have an alpha spec analysis and a Tc-99 analysis.
- A gamma spectroscopic system is available for use onsite; therefore a screening analysis may be performed on all soil samples collected.
- Surveys for elevated areas of radiation in buildings 110, 230 and 231 will focus on joints, cracks, pits and drains. If any areas are identified, then samples may be collected for analysis.
- Scans in buildings 110, 230 and 231 will be conducted in areas likely to contain residual activity, based on the results of the HSA and prior surveys. Beta scan surveys will include joints and cracks and formerly contaminated areas. If elevated activity levels are found, then the material will be sampled for analysis.
- For Building 230 an area of interest is the HEPA ventilation exhaust because experience has indicated that there is an increased probability of residual activity in the vicinity of HEPA system exhausts. Surveys and smears will be taken from inside the exhaust stack and ducts at accessible locations.
- In order to survey building 110, 230 and 231 interior and exterior walls, a scissors lift or bucket lift will be required to reach upper wall areas and overhead horizontal surfaces. If a designated survey point is located too high for access even with a lift, then an offset of the survey point will be modified to a reachable elevation for survey and document accordingly.
- The ceilings in Buildings 110, 230, 231 will be surveyed.
- Survey drains openings and inside drains for alpha and beta activity as far as they are dry and take smears/swabs from all drain openings.

4.3 Survey Records

The project team will maintain records of surveys for each area according to project procedures. The survey records may include the following information depending upon the survey design and protocols:

- Worksheet providing identification, survey location information, general survey instructions, and any specific survey instructions.
- Comments from the survey technician regarding any unusual situation encountered while surveying.
- Diagram/map of the area surveyed as available.
- Photographs of the survey area, as necessary, to show special or unique conditions.
- Printout of laboratory analysis results (if performed).
- Survey data files and values for all radiation survey measurements.

The survey team will take direct measurements for total alpha and beta surface activity using the Ludlum Model 2350-1 Data Logger system or equivalent.

Data and document control will include the maintenance of the raw data files, translated data files, and documentation of corrections made to the data. The data files will be backed up on a daily basis.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

All work will be performed in a quality manner and under the auspice of the Hematite *Quality Assurance Program Plan* (Reference 7.3) along with this survey plan, Hematite work package requirements (Reference 7.8) and Energy*Solutions* implementing procedures.

The following Quality Control measures will be utilized as an integral part of the survey process.

5.1 General Provisions

5.1.1 Selection of Personnel

Project management and supervisory personnel are required to be familiar with Plan procedures, the Quality Plan, and be familiar with the requirements of this work plan.

Personnel for this project will be selected based upon their experience and familiarity with area remediation and decontamination activities. Likewise, health physics technicians who will perform the surveys will be selected based upon their qualifications and experience.

5.1.2 Written Procedures

Procedures and this Westinghouse approved Plan shall control all survey tasks performed to ensure survey data quality. A list of Energy*Solutions* plans and procedures is provided in Attachment 8.1.

5.1.3 Instrumentation Selection, Calibration, and Operation

Energy*Solutions* has selected instruments proven to reliably detect the radionuclides present for the subject areas. Energy*Solutions* will calibrate instruments or use qualified vendors under approved procedures using calibration sources traceable to the NIST. All detectors are subject to daily response checks when in use.

Westinghouse approved procedures for calibration, maintenance, accountability, operation, and quality control of radiation detection instruments implement the guidelines established in American National Standard Institute (ANSI) standard ANSI N323-1978 and ANSI N42.17A-1989.

Instrument selection calibration and operation were also discussed in sections 3.0 and 3.1 of this plan.

5.1.4 Survey Documentation

Records of surveys will be documented and managed in accordance with *EnergySolutions* procedure CS-FO-PR-001(Listed in Attachment 8.1). Each survey measurement will be identified by the date, technician, instrument type and serial number, detector type and serial number, location code, type of measurement, mode of instrument operation, and QC sample number, as applicable.

The field data collected will be managed using forms and bound field notebooks. Laboratory data will be transcribed onto a computer-based management system. This data will be summarized in a manner that provides efficiency in data reduction, tabulation, and evaluation. All measurements taken during this project will be identified by source, type, and sample location to avoid ambiguity. Field records will include the following minimum information:

- A chronological listing of significant site events and sampling activities.
- Site Name, field team members, signature, and date on each page
- Site conditions, notes or sketches of sampling locations and sample descriptions
- Sample times
- Record of all measurements (e.g. field screening parameters).
- Photographic Log (if taken)

5.1.5 Chain of Custody

Responsibility for the custody of samples from the time of collection until results are obtained is provided for in *EnergySolutions* procedure CS-FO-PR-001(Listed in Attachment 8.1). Any samples shipped offsite for analysis will be accompanied by a chain-of-custody record to track each sample.

5.1.6 Records Management

Generation, handling, and storage of survey data packages are controlled by *EnergySolutions* procedure CS-AD-PR-002 (Listed in Attachment 8.1).

5.1.7 Independent Review of Survey Results

The survey package and survey data from each area will receive an independent review to verify all documentation is complete and accurate as provided for in *EnergySolutions* procedure CS-FO-PR-001 (Listed in Attachment 8.1).

5.2 Training

All project personnel will receive site specific training to identify the specific hazards present in the work and survey areas. Training will also include a briefing and review of this Plan, applicable Energy*Solutions* procedures (see Attachment 8-1), the *Hematite Quality Assurance Program Plan* (Reference 7.3), the *Westinghouse Health and Safety Plan* (Reference 7.5), and the *Radiation Protection Plan* (Reference 7.4). Copies of all training records will be maintained onsite through the duration of onsite activities and in accordance with all Westinghouse programs and procedures.

During site orientation and training, survey personnel will become familiar with site emergency procedures. In the event of emergency, personnel will act in accordance with all applicable site emergency procedures and the *Westinghouse Health and Safety Plan.*

6.0 SURVEY REPORT

Energy*Solutions* will begin preparing a Supplemental Characterization Survey Report in parallel with characterization activities while onsite. This report will include all relevant supplemental characterization data including all survey and sample analysis data. The report will also contain survey forms, survey and sampling maps, instrument calibration information, and other information necessary to support the validity of the data. The report will also detail any Westinghouse approved deviations from this Plan that may become necessary as all surveys are by nature an iterative work process.

7.0 REFERENCES

7.1 LVI Services, Inc. HE-R-01 MARSSIM Survey Methodology for Final Status Surveys of Building 230, Rev. 1, February 2004.

7.2 Westinghouse Electric Company LLC, DO-04-010 HEMATITE Radiological Characterization Report, Rev. 1.1.

7.3 Westinghouse Electric Company LLC, PO-QA-001 Hematite Quality Assurance Program Plan Rev. 0.

7.4 Westinghouse Electric Company LLC, PO-HO-001 Radiation Protection Plan, Rev. 0.

7.5 Westinghouse Electric Company LLC, PO-EHS-001 Health and Safety Plan, Rev. 3.

7.6 U.S. Nuclear Regulatory Commission. NUREG-1757*, Consolidated Decommissioning Guidance – Decommissioning Process for Materials Licensees*, includes the September 2006 updates.

7.7 U.S. Nuclear Regulatory Commission. NUREG 1575, Revision 1, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM); August 2000, includes the June 2001 updates.

7.8 Westinghouse Electric Company LLC, PR-DO-023 Site Work Control, Rev. 0.

8.0 ATTACHMENTS

8.1 Energy*Solutions* Plans and Procedures

Attachment 8.1
Energy*Solutions* Plans and Procedures

Procedure Number	Procedure Title
CS-AD-PR-002	Commercial Services Project Records Procedure
CS-FO-PR-001	General Radiological Survey and Air Sampling Procedure for Field Projects
CS-FO-PR-002	Calibration and Maintenance of Radiological Survey and Sampling Equipment Procedure
CS-FO-PR-003	Soil Surveys; Collection of Water, Sediment, Vegetation and Soil Samples; and Chain-of-Custody Procedure
CS-RS-PR-003	Commercial Services Radiation Worker and Authorized User Training Proc.
CP-CSA-203	Ludlum Model 2350-1 Series Data Logger Download
CP-INST-201	Operation of the Ludlum Model 2350-1 Series Data Loggers
ES-AD-PR-009	Control of Measuring and Test Equipment