FINAL

CHARACTERIZATION SURVEY WORK PLAN

DEFENSE NATIONAL STOCKPILE CENTER
NEW HAVEN DEPOT

NEW HAVEN, INDIANA

Prepared for:

U.S. ARMY JOINT MUNITIONS COMMAND
ROCK ISLAND, IL

On behalf of:

DEFENSE LOGISTICS AGENCY
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LIST OF ACRONYMS

Army	United States Army
bgs	Below ground surface
CABRERA	Cabrera Services, Inc.
cm	Centimeter
COC	Chain of Custody
CHSM	Corporate Health and Safety Manager
CRSM	Corporate Radiation Safety Manager
^{137}Cs	Cesium-137
DCGL or $DCGL_W$	Derived Concentration Guideline Level
Depot	New Haven Depot
DLA	Defense Logistics Agency
DNSC	Defense National Stockpile Center
DoD	Department of Defense
dpm/100 cm^2	Disintegrations per Minute per 100 Square Centimeters
DQI	Data Quality Indicators
DQO	Data Quality Objectives
EPA	U. S. Environmental Protection Agency
ERS	Environment Radiation Safety
FSS	Final Status Survey
GPS	Global Positioning System
GSA	General Services Administration
GWS	Gamma Walkover Survey
HSA	Historical Site Assessment
JMC	Joint Munitions Command
IDW	Investigation-Derived Waste
m^2	Square Meters
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC or MDC_{SCAN}	Minimum Detectable Concentration
NaI	Sodium Iodide
NIST	National Institute of Standards and Technology
NORM	Naturally Occurring Radioactive Material
NRC	U.S. Nuclear Regulatory Commission
ORPP	Occupational Radiation Protection Program
Pangea	Pangea Group
pCi/g	Picocuries Per Gram
PM	Project Manager
POC	Point of Contact
PPE	Personal Protective Equipment
QA	Quality Assurance
QAC	Quality Assurance Coordinator
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAM	Radioactive Materials
RCOPC	Radionuclide Contaminant of Potential Concern
SOP	Standard Operating Procedure
SRSM	Site Radiation Safety Manager
SSHP	Site Safety and Health Plan
SU	Survey Unit
^{99}Tc	Technitium-99
^{230}Th	Thorium-230
^{232}Th	Thorium-232
^{238}U	Uranium-238
WP	Characterization Survey Work Plan

1.0 PROJECT DESCRIPTION

Cabrera Services, Inc. (CABRERA) has prepared this Characterization Survey Work Plan (WP) for the New Haven Depot (Depot) in New Haven, Indiana. This document is based on the New Haven Depot Historical Site Assessment (HSA) (CABRERA, 2006). The DNSC, through the United States Army (Army) Joint Munitions Command (JMC) and their contractor(s), will evaluate the type and locations of residual radioactivity at the Depot site in support of decommissioning. Due to the nature of operations at the Depot, the greatest hazard potential is the presence of residual radioactive materials (RAM) that remain at the facility due to previous storage of commodities containing naturally occurring radioactive materials (NORM).

1.1 Site History and Contaminants

1.1.1 Site History

The Depot is located on 268 acres 3 miles east of New Haven, Indiana. It is currently owned by the General Services Administration (GSA), and operated by the Department of Defense, Defense Logistics Agency (DLA), DNSC. A series of rail spurs extending off the Norfolk Southern rail line crosses the site along its east-west axis, converging at the site's southwestern and southeastern corners. Vehicular access is made from State Route 14 near the center of the site. A 6-foot high fence topped with three-strand barbed wire surrounds the site. A security officer controls access to the site.

Historically, the Depot's primary mission has been storage of metallurgical ores and materials necessary for manufacturing defense and/or strategic materials. Throughout the system of warehouses and outdoor areas at the Depot, the DNSC has stored columbium/tantalum ores and concentrates, tungsten ores and concentrates, zirconium ore, rare earth sodium sulfate, monazite, tungsten metal scrap, and bastnasite, all containing sufficient amounts of natural uranium and thorium to require licensing under U.S. Nuclear Regulatory Commission (NRC) rules. The DNSC stored these materials under the authority of NRC License STC-133. The materials were typically stored in outdoor piles (zirconium ore) and in wooden boxes or drums (thorium and uranium) in designated bays inside large warehouses.

Due to the large volume stored and the fact that it was stored in an open storage yard, zirconium ore represents the greatest potential of radioactive contamination at the site. Zirconium ore (baddeleyite) is a natural zirconium oxide found in Brazil and Ceylon. The ore contains NORM in the form of uranium and thorium. The zirconium ore at the Depot was stored in two piles designated 111 and 111A in open Area 7A in the northwest corner of the Depot (see Figure 1-1). Pile 111 contained 31,981,402 pounds of the ore. Pile 111A contained soil contaminated with the ore from the transfer of 2,783,706 pounds of zirconium ore from other DNSC depots. Pile 111 stood 28 feet high, 296 feet long, and 60 feet wide. Pile 111A was 28 feet high, 104 feet long, and 50 feet wide. Approximately half of the zirconium ore in Pile 111 was shipped to the Depot in 1988 from the DNSC depots at Jeffersonville, Indiana and Columbus, Ohio. The contaminated soils at the base of the piles at these depots comprised the contents of Pile 111A.

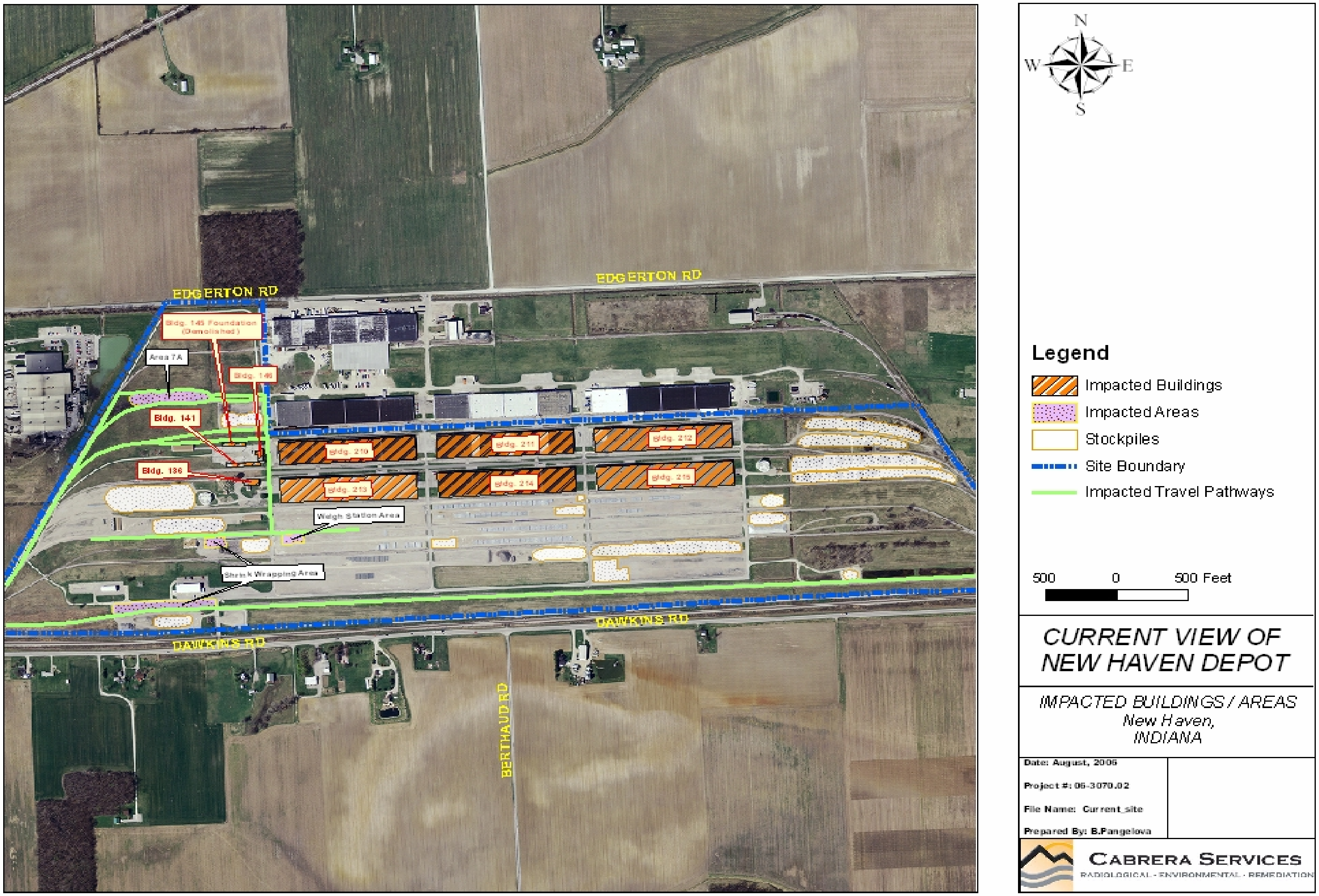

FIGURE 1-1: LOCATIONS OF IMPACTED BUILDINGS/AREAS OF INTEREST AT NEW HAVEN DEPOT

In 1999, DNSC sampled the piles of zirconium ore to determine the percent abundance of thorium and uranium. The analysis showed that the percent abundance of thorium and uranium for the piles met the criteria established by the NRC to require licensing. Pile 111 contained 0.091% thorium and 0.204% uranium by weight. Pile 111A contained 0.081% thorium and <0.004% uranium by weight. Because of the abundance of thorium and uranium, the zirconium ore was controlled by the DNSC under a license STC-133 issued by the NRC.

The zirconium ore was sold in October 2000 and was loaded directly into rail cars at the Area 7A storage location (Figure 1-1) by a front-end loader. The rail cars were then moved to the rail scale (Weigh Station, Figure 1-1) where the amount of ore in the car was adjusted to maintain an acceptable weight. After achieving the maximum weight, the cars were moved to Building 111 (Shrink-wrapping Area, Figure 1-1) where the tops were shrink-wrapped to preclude loss of the ore during offsite transit. During the loading process, it is likely that quantities of the ore were inadvertently released onto the ground surface. The areas potentially impacted during this process were the railway and roadways used for the transport of the ore, the rail scale area, and the building used for shrink-wrapping the rail cars.

The zirconium ore stored at the Depot was clastic (pebble sized clasts and finer grained fragments) and thus, was not easily dispersible in the air. Spillage of the ore occurred from either the front-end loader or from the bottom of the rail cars. The paved road from open Area 7A to the rail scale, the rail scale, and the railroad tracks at the southern end of the Depot in front of Building 111, had the largest accumulations of discrete zirconium ore piles. Spillage accumulations in these areas consisted of 50 or more rocks in a single location. Spillage in areas where the ore was handled (along other rail lines on the western side of the Depot) consisted of smaller discrete accumulations of ore containing 1 to 20 rocks.

In addition to the zirconium ore piles, other historically stored materials at the Depot included licensable quantities of thorium and uranium that were packaged in either wooden boxes or drums. The boxes and drums were stacked in various bays throughout a series of six storage buildings (Warehouses 210 through 215) as well as other smaller buildings at the Depot. These warehouses are each 180 feet wide by 960 feet long, with wood, concrete, or concrete-block structural framing supporting wood roof decks. Each warehouse building has an aggregate floor space capacity of approximately 1,037,000 square feet. The warehouses are subdivided into four equal 180-foot by 240-foot sections. Each section is accessed through four overhead roll-up metal doors and is divided into 79 storage bays (each approximately 25 feet by 20 feet). Additional buildings where licensed radioactive material was handled and/or stored, and considered impacted, include buildings 136, 141, 145 (currently only the footprint remains) and 146.

1.1.2 Radionuclide Contaminants of Potential Concern

Based on the composition of the metallurgical ores stored at the Depot, the radionuclide contaminants of potential concern (RCOPCs) in the survey effort described in this WP are natural thorium and uranium. Since the ores containing these radionuclides of concern were simply stored at the Depot and never processed, the radioactive decay products in both the natural thorium and natural uranium chains would have remained in secular equilibrium with the parent radionuclide, as they were in nature.

The parent radionuclides in the natural thorium and natural uranium decay chains, thorium-232 (^{232}Th) in the natural thorium decay chain, uranium-238 (^{238}U) and uranium-235 (^{235}U) in the natural uranium decay chain, emit alpha particles. The daughter products in both chains decay by emission of alpha or beta particles, some with accompanying emission of gamma rays. The decay schemes for both the natural thorium and natural uranium chains are very well documented, and this knowledge is used in the design of the characterization surveys and sampling approach described in this WP, as well as in the selection of appropriate survey instruments and analysis methods.

1.2 Previous Investigations/Remediation Efforts

In 2002, Environment Radiation Safety Solutions (ERS) conducted a final status survey (FSS) of all impacted outdoor areas at the Depot, excluding open Area 7A where the zirconium ore was stored at the time. Based on the results of the survey, remediation efforts were conducted at each survey unit (SU) in 2002 by ERS.

For the efforts at the rail scale and in front of Warehouse 211, a backhoe was used for the removal of 33 cubic yards of debris. In the remaining affected areas, removal was performed by picking up the rocks by hand and placing the debris in buckets. All debris removed was placed in open Area 7A. After completion of the remediation efforts, surveys were performed of all areas to demonstrate successful removal of the ore and to ensure residual radioactivity was consistent with background (ERS, 2002).

The NRC evaluated the FSS conducted by ERS and concluded that additional information was needed to adequately demonstrate that the Depot areas surveyed met the requirements of 10 CFR 20.1402 for unrestricted release (NRC, 2003a). Some of the specific findings included:

- Radioactivity associated with background may not have been sufficiently characterized
- Soil samples were not collected to verify remediation efforts
- Fluorspar next to survey areas makes scan surveys by themselves impractical
- Scan criteria used for Derived Concentration Guideline Levels (DCGLs) associated with Class 3 SUs were arbitrary
- Surveyed areas requested for FSS release adjacent to open Area 7A will be affected during the open Area 7A FSS

Pangea Group (Pangea) conducted additional removal and remediation of the residual zirconium ore in open Area 7A during the summer of 2004 (Pangea, 2005). After the ore and soils Piles 111 and 111A were loaded and transported, as described in Section 1.1.1, Pangea removed at least the top 6 inches of soil and residual contamination from the entire 7A area, including the eastern access road and the railroad track bed to the south. After further contamination significantly above background was detected, soil was removed to a depth of 9 inches in the most contaminated areas in open Area 7A. Excavation was then discontinued per contract specifications. Test pits that were dug in open Area 7A showed further contamination to a depth of 3 feet.

ERS performed a field audit of Pangea's remediation efforts on July 12 and 13, 2004 (ERS, 2004). Elevated gamma results were found along the outside of the planned excavated area during the audit.

1.3 Conceptual Models

The above historical and investigation/remediation information has aided in the development of two conceptual models for the nature and extent of contamination at the Depot: one model for contamination associated with building and structures and one model for outside contamination. The assumptions for both conceptual models are presented below.

The conceptual model for the inside warehouse storage of RAM assumes the following:

- Depot personnel practiced good housekeeping and maintained the warehouse building in good repair.
- Any spill or leakage was due to container failure, and Depot personnel were responsive mitigating these issues.
- RAM contamination potential may be from fine-grained RAM leaking from the container/package followed by air deposition or forklift/foot tracking elsewhere in the warehouse.
- Residual RAM may be detected on horizontal surfaces and would be concentrated near air vents and warehouse doors.
- Primary exposure pathways are expected to be direct gamma exposure and inhalation.

The conceptual model for the outside areas is focused on Area 7A and residual contamination from piles 111 and 111A. The conceptual model assumes the following:

- The stockpiled ore (piles 111 and 111A), and residual material from other Depots, were not significantly disturbed during the storage period as indicated by the vegetative cover on the piles at the time of removal.
- The stockpiled material consisted of natural ore ranging from cobble-sized fragments to course granular sand.
- The spread of contamination is from the handling of the soil during stockpiling and removal where the loose ore was spilled and tracked around the area of the piles. Strong wind gusts could also contribute to dispersing the finer sand-sized ore fractions short distances away from the pile(s).
- RAM contamination is present on the ground surface and in the shallow subsurface, as evidenced from the recent remedial efforts. The RAM is presumed to be insoluble in the environment and individual radionuclides are expected to adsorb onto the soil.
- Vertical migration in subsurface soils is limited by the presence of confining clay present at a depth of 3 feet below the ground surface.

- The removal of the stockpiled ore and the subsequent remediation has mitigated the bulk of the RAM. Residual RAM is still expected to be present in surface soils and is the focus of this characterization effort.
- Primary future exposure pathways are direct gamma, inhalation, and ingestion from plant uptake. Migration of contaminants to underlying groundwater is not considered a significant contributor to future exposure due to the physical form of the ores (not readily soluble) and the presence of the thick clay confining layer between the surface soils and the drinking water aquifer.

The characterization strategy presented in this plan is based on the above conceptual models. The data generated from characterization efforts will be used to refine these conceptual models. The Final Status Survey Plan will formalize the conceptual models.

1.4 Summary of Historical Site Assessment

Using available information, the Depot design, operating history, previous survey results, and radiological hazards potentially present were reviewed as part of the HSA (CABRERA, 2006). Table 1-1 lists the areas and buildings on the Depot site with a history of RAM storage, as described in the HSA.

Based on information obtained and presented in the New Haven Depot HSA (CABRERA, 2006), the outdoor areas (Table 1-2) and building locations (Table 1-3) are considered impacted in accordance with guidance from NUREG-1757, the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (USEPA 2000).

Survey data and samples will need to be collected in the areas above for a complete assessment of the impacted areas and buildings, as described in Section 5.0, Field Activities. The characterization survey specified in this WP is based on recommendations presented in the New Haven Depot HSA (CABRERA, 2006).

1.5 Scope and Objectives

This document presents the plan for the Depot site characterization survey activities. This WP specifically addresses the surveys and sampling of Depot site soil, paved and unpaved roads, ten buildings, onsite structures, and a railcar scale. The sampling protocol and rationale are presented in Section 3.0 of this WP.

The overall objective of this characterization survey scope is to define the nature and extent of RPCOCs and develop and document a cost-effective approach for the FSS of the Depot.

TABLE 1-1: NEW HAVEN DEPOT AREAS/BUILDINGS WITH RAM HISTORY

Outdoor Areas	Former Radioactive Materials Use/Storage	Current Conditions
7A	Open storage area formerly containing two piles (111 and 111A) of zirconium ore	Field overgrown with vegetation; Pangea conducted remediation in and around footprint of piles.
Rail Scale (Weigh Station Area)	Rail cars and trucks hauling materials sometimes spilled in this area.	Present and functional; Area reportedly has been cleaned, but potential for residual contamination exists.
Entry Road and Paved Road to Rail Scale	Baddelyite ore was transported from open Area 7A to the rail scale along the entry road, and then along the paved road by a front-end loader.	Road still in use; Area reportedly has been remediated, but potential for residual contamination exists.
Railroad Tracks Used for Shrink-wrapping	Rail Car Shrink Wrapping Area	Present, good condition, yet does not appear to be in use; Area reportedly has been remediated, but potential for residual contamination exists.
Railroad Tracks Used for Storage or Transport	Rail cars filled with zirconium ore were either stored or transported here before being sent off site	Present, good condition, yet does not appear to be in use; Area reportedly has been remediated, but potential for residual contamination exists.
Buildings	**Former Radioactive Materials Use/Storage**	**Current Conditions**
136	Former Office Building; likely contained Bastnasite, Monazite, Rare Earth Sodium Sulfate, and Zirconium in contained sample form	Unoccupied; appears to be structurally unsafe.
141	Storage of Zirconium ore	Unoccupied; appears to be structurally unsafe.
145 (Footprint)	Storage of zirconium ore	Demolished (foundation remains).
146	Storage of zirconium ore	Present, but abandoned and appears to be structurally unsafe.
200	Storage of Columbium Tantalum and Rare Earth Sodium Sulfate	Present, but building was sold long ago and is no longer under the responsibility of DLA-DNSC.
201	Storage of Bastnasite, Columbium Tantalum, and Monazite	Present, but building was sold long ago and is no longer under the responsibility of DLA-DNSC.
207	Storage of Columbium Tantalum and Monazite	Present, but building was sold long ago and is no longer under the responsibility of DLA-DNSC.

TABLE 1-2: NEW HAVEN DEPOT IMPACTED OUTDOOR AREAS

Impacted Outdoor Areas	HSA Preliminary MARSSIM Classification
Open Area 7A	Class 1
Rail Scale (Weigh Station Area)	Class 2
Entry Road and Paved Road to Rail Scale	Class 2
Railroad Tracks Used for Shrink-wrapping	Class 2
Railroad Tracks Used for Storage or Transport	Class 2

TABLE 1-3: NEW HAVEN DEPOT IMPACTED BUILDINGS

Building	Impacted Building Location	HSA Preliminary MARSSIM Classification
136	All locations	Class 3
141	All locations	Class 3
145 (Footprint)	All locations	Class 3
146	All locations	Class 3
210	Sections 1, 2 and 3: All locations	Class 3
	Section 4: Bays 2-5, 8, 9, 12-14, 32-33, 35, 43, 45, 46, 48, 52-54, 56, 58, and 76 only	Class 3
211	Sections 1 and 2: All locations	Class 3
212	Section 1: Bays 11, 31, 37, 41, 51, 61, and 71 only	Class 3
	Section 2: Bays 11, 12, and 21 only	Class 3
213	Sections 1 and 4: All locations	Class 3
	Section 2: Bays 12, 13, 15, and 16 only	Class 3
	Section 3: Bays 11, 19, 21, and 29 only	Class 3
214	Section 1, 2 and 4: All locations	Class 3
	Section 3: Bays 3-6, 8, 9, 12-18, 22-28, 31-34, 36-38, 41-44, 48, 56, 57, 75, and 77 only	Class 3
Building 215	Section 1: Bays 2-4, 11, 12, 13, 22, 23, 25-29, 34-37, 41, 43, 44, 45, 62, and 73-75 only	Class 3
	Section 2: Bays 36, 41, 42, 46, 52-54, 62, and 63 only	Class 3
	Section 4: Bays 15, 19, 29, 51-56, 61-65, 68, and 71-79 only	Class 3

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization structure showing relationships of Government and Contractor personnel with key responsibilities for the Depot project is presented below.

Responsibilities for key project personnel are as follows:

- **New Haven Depot Project Management** – Depot project management includes John Olszewski, the Depot Manager, and Mike Pecullan, the DNSC Manager of the ORPP. ORPP management is responsible for overall project objectives. Depot points of contact (POCs) include Lois Huddlestun and Nikki Horther, General Supply Specialists for the Depot.
- **JMC Project Manager** – Bill Metcalf is responsible for the technical execution of the project objectives, including direct management of CABRERA and other Depot project contractors.
- **CABRERA Managing Principal** – Dave Watters is responsible for overall project objectives, scope, budget, and quality of submittals. He will ensure that adequate corporate resources are made available to the Project Manager. Mr. Watters will also provide senior technical review and support. He will communicate directly with JMC management personnel, as necessary.
- **CABRERA Project Manager** – John Eberlin is responsible for planning, coordinating, integrating, monitoring, and managing project activities. He is also responsible for day-to-day management and monitoring of the project budget, schedule, and scope. He will work with the CABRERA Quality Assurance Coordinator to ensure procedural compliance for all tasks. Mr. Eberlin is CABRERA'S primary POC with JMC and the regulatory team members. He will work directly with the Field Site Manager during implementation of onsite activities.
- **Corporate Health and Safety Manager (CHSM)** - Paul Schwartz is a Certified Industrial Hygienist and Certified Safety Professional. He is responsible for the development and overall implementation of the Site Safety and Health Plan (SSHP) (Cabrera, 2006), in accordance with CABRERA's Corporate Health and Safety Program and JMC's safety protocol. He is also responsible for implementing any appropriate medical monitoring programs for this project. In concert with the Corporate Radiation Safety Manager, he will review field monitoring data and authorize upgrades/downgrades in personal protective equipment (PPE). He will also perform field safety audits during field characterization activities.
- **Corporate Radiation Safety Manager (CRSM)** - Henry Siegrist is responsible for the overall implementation of the SSHP with regard to radiological issues. He is also responsible for the implementation of CABRERA's Corporate Radiation Protection Program. He will work closely with the CHSM and Site Radiation Safety Manager to ensure the adequacy and appropriateness of radiation safety measures during field activities, and will perform field audits during field characterization activities.
- **Quality Assurance Coordinator** - Kim Nelson is the Quality Assurance Coordinator (QAC) for this project and is responsible for the overall implementation of quality control (QC) measures in survey design and characterization activities, including the planning documents and the accuracy and precision of field-generated data. The QAC has the authority to impose proper procedures or to halt an operation, as specified in the Quality Assurance Project Plan (QAPP) (reference?). She may conduct periodic audits of onsite procedures.

- **Site Radiation Safety Manager (SRSM)** – The SRSM (TBD) is responsible for supervising all radiation safety and other safety protocols on this project. He/she is responsible for field implementation of any medical monitoring programs under the direction of the CHSM. He/she is also responsible for the calibration and operation of radiological safety monitoring equipment. He will work in concert with the CRSM, Project Health Physicist, and CHSM to ensure that field activities are conducted in accordance with project plans and applicable procedures and regulations.
- **Field Site Manager** - The Field Site Manager (TBD) is responsible for organization, scheduling, and implementation of field activities for the Depot project. He/she will be in frequent communication with the Project Manager and will be the Contractor's primary onsite point of contact for other Project Team personnel. He will be responsible for the activities of field sampling teams and subcontractors. He is responsible for working with other team members with Quality Assurance (QA) responsibility to ensure that all field activities are completed in a safe and efficient manner, in accordance with procedures as outlined in the work plans.
- **Project Health Physicist** – Mike Lambert is responsible for all radiological field activities and has authority to direct such activities, to stop and restart work if necessary, and to take appropriate actions, as required, to address radiological emergency situations. He will work directly with the Field Site Manager, the CRSM, and the SRSM to ensure that radiological survey and sampling activities are properly implemented and followed.

TABLE 2-1 CONTACT INFORMATION

Title	Name	Phone Number	E-mail address
Depot Management	John Olszewski	260.749.9544	john.olszewski@dla.mil
ORPP Management	Mike Pecullan	703.767.7620	michael.pecullan@dla.mil
CABRERA Managing Principal	Dave Watters	860.569.0095	dwaters@cabreraservices.com
Cabrera Project Manager	John Eberlin	314.703.6784	jeberlin@cabreraservices.com
Corporate H&S Manager	Paul Schwartz	860.569.0095	pschwartz@cabreraservices.com
Corporate Radiation Safety Manager	Henry Siegrist	860.569.0095	hsiegrist@cabreraservices.com
Quality Assurance Coordinator	Kim Nelson	410.332.8177	knelson@cabreraservices.com
Project Health Physicist	Joe Weismann	914.489.6128	jweismann@cabreraservices.com
JMC	Bill Metcalf	309.782.2248	metcalfw@afsc.army.mil

3.0 SURVEY DESIGN

The design of this characterization survey incorporates the methods and locations for the performance of sampling and direct measurements in order to assess the nature and extent of RCOPCs.

3.1 Survey Tasks

Sampling, analysis, and direct measurements will be performed to measure and quantify RCOPCs present at the Depot. Sampling and analysis of these media will provide the quantification of contaminant levels in each sample that will then be used to estimate average contaminant levels per survey area. The Depot sampling and analysis will include the following activities.

3.1.1 Task 1 - Mobilization

Mobilization includes survey preparation, travel to the site, and establishment of onsite support facilities for survey performance and sample collection.

3.1.2 Task 2 - Survey Activities

Areas are designated as impacted based on the presence, or potential presence of radiological contamination resulting from storage or transfer of licensed radioactive material. In order to confirm the extent of radiological and non-radiological impacts to these areas, the following field tasks will be implemented.

- Gamma walkover surveys (GWS) of land areas
- Soil sampling and analysis (offsite)
- Scan surveys of building and/or structure surfaces
- Integrated direct surface alpha radioactivity measurements
- Smear sample collection and analysis

3.1.3 Task 3 – Investigation-Derived Waste Management/Disposal

This task involves packaging, removal, disposal, and general management of any investigation-derived waste generated during the Depot characterization process.

3.1.4 Task 4 - Characterization Survey Results

To support overall project planning, the results of the characterization survey activities must be compiled and presented. CABRERA will accomplish this as follows.

The survey results will be submitted in the form of a characterization report. The report will detail the amount, type, and location of RCOPC found during the field effort. Once characterization survey results have been analyzed, the conceptual site model (See Section 1.3) will be revised. The conceptual model will include known and suspected sources of contamination, types of radiological contaminants and affected media, known and potential routes of migration, and known or potential human and environmental receptors. CABRERA will document the revised conceptual site model in the characterization report.

3.2 Rationale

The characterization is intended to identify the radiological hazards that exist at the Depot and, if necessary, provide sufficient information to identify ways to reduce these hazards adequately enough to permit the facility to achieve the desired end state.

This WP addresses radiological hazards through conducting a characterization survey. It provides for:

- verification of HSA determination of impacted areas and structures,
- determination of the aerial extent of contamination on building and/or structure surfaces, including outdoor structures;
- determination of the aerial and vertical extent of contamination present in open land areas;
- determination of appropriate MARSSIM classification of survey units for completion of the FSS;
- determination of the numbers of samples/measurements required for a MARSSIM-type FSS; and
- generation of useful information for:
  - assessing other FSS alternatives;
  - conducting a radiological and environmental risk assessment;
  - determining worker dose projections;
  - waste management planning; and
  - cost-benefit analyses associated with defining the actual scope of the FSS effort.

3.3 Area Classification Based on Contamination Potential

3.3.1 Survey Units

Each impacted outdoor area and building or structure will be designated as one or more survey units following MARSSIM (NRC, 2000) guidance.

Surveys performed in support of the characterization process will be designed, as possible, to further validate the MARRSIM preliminary classification of impacted areas presented in the HSA, as well as support MARSSIM final status surveys.

3.3.2 Reference Areas

Certain radionuclides, such as those in the naturally occurring uranium and thorium series, may occur at significant levels as part of background in the media of interest (soil, building material, etc.). Establishing background concentrations that describe a distribution of measurement data is necessary to identify and evaluate contributions attributable to site operations. A site background reference area will have similar physical, chemical, geological, radiological, and biological characteristics as the survey unit being evaluated. Reference areas provide a location for background measurements, which are used for comparisons with survey unit data. The radioactivity present in a reference area would be ideally the same as the survey unit had it never been contaminated. One or several appropriate reference areas for the Depot site will be selected based on historical site information and will be used to compare with measurement results.

3.4 Survey Criteria

During the characterization survey, the primary materials to be evaluated are the RCOPCs.

3.4.1 Residual Radioactivity Screening Levels

The RCOPCs at the site are natural thorium and uranium, and their associated progeny in secular equilibrium. Screening levels obtained from NRC NUREG 1757 (NRC, 2003b), and NUREG/CR-5512, Volume 3 (NRC, 1999), are presented in Table 3-1.

TABLE 3-1: RCOPCS AND SURVEY ACTION LEVELS

RCOPC	Action Level	Reference
^{232}Th and progeny (soil)	1.1 pCi/g	Screening levels derived using NUREG/CR-1757 Vol.1; Appendix B Table B.2.
^{232}Th and progeny (building surfaces)	36 dpm/100 cm^2	Based on total alpha emissions for parent plus progeny in the decay chain using NUREG/CR-5512, Volume 3, Table 5.19 Screening Limit for P_{crit} of 0.90.
^{238}U, ^{235}U and progeny (soil)	14 pCi/g	Proposed screening levels derived using NUREG/CR-1757 Vol.1; Appendix B Table B.2.
^{238}U, ^{235}U and progeny (building surfaces)	119 dpm/100 cm^2	Based on total alpha emissions for parent plus progeny in the decay chain using NUREG/CR-5512, Volume 3, Table 5.19 Screening Limit for P_{crit} of 0.90.

dpm = disintegrations per minute
cm^2 = square centimeters
pCi/g = picocuries per gram

4.0 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) have been developed for this characterization effort using the U.S. Environmental Protection Agency's (EPA's) seven-step DQO process described in *EPA QA-G4: Guidance for the Data Quality Objective Process* (EPA, 2000). Below is a summary of the seven-step process and the resulting project-specific DQOs.

4.1 Step 1: State the Problem

The problem is determining the nature and extent of RCOPCs present in and around open Area 7A, outside areas associated with the removal of the zirconium ore, and several buildings throughout the Depot due to the previous storage or handling of radioactive commodities. The objective of the characterization activities described in this WP is to obtain data of sufficient quality and quantity to support the decision that areas have or have not been impacted by radiological activities at the Depot site.

4.2 Step 2: Identify the Decision

The principle study question for this project through completion of the FSS is:

- Have areas at the Depot been impacted by the radiological activities at the site?

Potential actions include: additional investigation of radiologically impacted areas (i.e., additional review of existing data, collection of additional environmental data, and/or additional remediation) or release of non-impacted areas from radiological controls. Impacted areas have a possibility of containing residual radioactivity in excess of natural background (NRC, 2000). Non-impacted areas have no reasonable possibility of residual radioactivity. All areas are either impacted or non-impacted.

4.3 Step 3: Identify Inputs to the Decision

In order to resolve the decision statements listed in the previous section, a variety of data is required. The following site characteristics must be determined through site survey and sampling activities in order to resolve the applicable decision statements:

- Radiological survey data indicating the nature and extent of both fixed and transferable surface contamination; and
- Volumetric concentrations of RCOPCs in soil at locations exhibiting surface contamination.

4.4 Step 4: Define the Study Boundaries

Temporal boundaries for the characterization are defined by the period of use of radiological materials at the Depot.

The spatial boundaries of the study include the buildings, materials, and grounds on the Depot site that may be impacted as presented in Table 1-2 and 1-3.

The following constraints must be considered when planning the data collection activities described in this WP:

- Project budget and schedule constraints;

- Inherent limitations associated with the specified instrumentation/analyses;
- General site access restrictions imposed by the DNSC;
- Weather conditions during fieldwork (i.e., rain or snow would interfere with obtaining valid GWS results).

4.5 Step 5: Develop Decision Rules

The primary parameters of interest are natural thorium, natural uranium and associated decay progeny in secular equilibrium.

The decision rules for this characterization effort are as follows:

- If the average radioactivity concentration in a survey unit exceeds the action level (see Table 3-1), then the survey unit will be designated as radiologically contaminated and marked for removal.
- If a survey unit is designated as impacted due to surface or removable (i.e., loose) contamination only, the material comprising the survey unit may be decontaminated and surveyed again, at the discretion of the DNSC.
- If a survey unit is designated as contaminated and the DNSC elects not to decontaminate and reuse the material, it will be disposed as radioactive waste, as appropriate, based on the analytical results for the volumetric samples.

4.6 Step 6: Specify Limits on Decision Errors

To enable testing of data relative to cleanup goals, acceptable decision errors for the project have been established. There are two types of fundamental errors. The Type I (alpha) decision error is that the survey unit will be found to have met the release criteria when, in fact, it does not. The Type II (beta) decision error is that the survey unit will be found not to have met the release criteria when, in fact, it does. The probability of both errors has been set at 0.05.

The following laboratory data quality indicators (DQIs) for precision, accuracy, representativeness, completeness, and comparability have been established for this survey effort.

- Precision will be determined by comparison of replicate data from field measurements and sample analysis; the objective will be a relative percent difference of 30% or less at 50% of the criterion value.
- Accuracy is the degree of agreement with the true or known value; the objective for this parameter is ± 30% at 50% of the criterion value.
- Representativeness and comparability are assured through the selection and proper implementation of systematic sampling and measurement techniques.
- Completeness refers to the portion of the data that meets acceptance criteria and is therefore usable for statistical testing; the objective for this parameter is 90%.

4.7 Step 7: Optimize the Design for Obtaining Data

The survey and sampling activities described in the following sections of this document constitute a characterization approach that can achieve the stated project objectives within the available resource and schedule constraints. This approach represents the optimal design for characterizing the Depot site based on the currently available information.

Field survey techniques, soil sampling methods, instrument selection and detection capabilities, survey and sampling frequency, and the DQO process will be re-evaluated, as appropriate, throughout the data collection effort to focus resources and improve data quality. As data are collected and evaluated, the assumptions in this plan will be reviewed for accuracy. The survey, sampling, and analysis process detailed in this WP will be revisited if initial data indicate that conditions are significantly different from the initial assumptions.

5.0 FIELD ACTIVITIES

Field characterization activities will be performed within the Depot areas presented in Table 1-2 and 1-3.

5.1 Radiological Samples and Measurements

Planned activities performed in support of the radiological characterization include the following.

Outside Areas (see Table 1-2)

- GWS
- Collection and analysis of systematic and biased volumetric samples of surface and subsurface soil

Building and Structure Areas (see Table 1-3)

- Scans of building and/or structure surfaces
- Random and biased direct alpha radiation measurements on structure surfaces
- Collection and analysis of transferable contamination “smear” samples

Since the surface activity screening levels in Table 3-1 are based on total alpha emissions from natural thorium and/or natural uranium, surface scans and static measurements on building and/or structure surfaces will focus on alpha surveys. At locations where a surface sealant (epoxy coating) has been applied, it may be necessary to remove a small section of coating to allow integrated activity measurements of the underlying surface. If this is performed, the coating material will be removed and analyzed for the RPOPCs. Activity determination will be based on the results of direct measurements on the bare surface and analysis of the coating material removed. If time permits, both alpha and beta surface activity measurements (total and removable) will be obtained.

5.2 Outside Areas

5.2.1 Weather Considerations

During characterization activities at the Depot, outside area surveys will be performed with a higher priority than building surveys because adverse weather conditions (snow, frozen ground, extreme cold) could increase the difficulty of surveys performed outdoors as it gets closer to the winter months. Characterization activities that are not completed during this survey effort will be completed during the spring of 2007.

5.2.2 Graded Characterization Approach

The flowchart presented on Figure 5-1 outlines the primary components of a graded characterization approach to determine the extent of contamination at open Area 7A, access roads, rail scale, and shrink-wrapping areas. The graded approach starts with the development of a background reference area to obtain a robust determination of soil background. The graded approach then combines a GWS to guide the collection of biased soil samples with the collection of systematic soil samples (at a density consistent with a Class 2 survey unit) to identify and delineate residual RAM contamination that exceeds the values shown in Table 3-1. In addition, the characterization data from areas determined to be Class 2 survey units will be collected and analyzed in a manner consistent with a MARSSIM Final Status Survey. Parameters and assumptions central to the FSS design are being developed in a separate FSS Plan for the Site. The collection of data from areas determined to be Class 1 will be sufficient to bound the lateral and vertical extent of contamination that requires remediation.

Pangea did not conduct FSS over the remediation area and it is anticipated that the remediation successfully achieved the clean up criteria (Table 3-1) over part of the area. If Cabrera finds portions of Area 7A to satisfy the Clean up criteria, then Cabrera will complete the Class 1 FSS data collection and analysis.

5.2.3 Reference Area

An appropriate reference area for soil samples during this characterization is located in the northwestern corner of the Depot, directly north of the entry road to open Area 7A. There is no evidence of radioactive materials being stored or transported any further north than the entry road in open Area 7A. This reference area has similar geophysical characteristics to open Area 7A. Zirconium ore is not likely to travel through the air in the form of dust, but if airborne transport did occur, the prevailing annual winds are from the southwest at 9.9 miles per hour. With this in mind, other soil sampling reference areas may be established during field activities, especially in proximity to the fluorspar piles (as open Area 7A is), in order to obtain a complete representation of background radioactivity onsite.

Another prospective reference area could exist on the eastern side of the Depot directly to the east of Warehouse 215. There is not a history of any licensable radioactive material on this end of the site, and it has similar physical characteristics to open Area 7A as well.

Prior to soil sampling activities, a GWS will also be completed over 100% of the reference area, as possible. If possible, a shielded NaI detector will be used to minimize the influence from sources of radiation not within the area of interest.

Soil samples will be collected throughout the reference area(s) from 0 to 30 cm bgs, as possible, in 15 cm sample-depth increments. Approximately 17 soil sample locations should be established in the reference area. At each surface soil sample location, a static measurement will be obtained prior to sampling using a Ludlum 2221 with 44-10 detector or equivalent. The static measurement will be for a period of 1 minute, at a distance of 6 inches from the surface of the soil. Soil samples will be analyzed for RPCOCs.

Outdoor survey units may also include impacted areas with gravel, asphalt and/or concrete on the surface. Therefore, additional reference areas should be established on the eastern, non-impacted side of the Depot in order to properly characterize radioactivity attributable to background. Paved areas and rail lines east of Warehouse 215 may be used as reference areas. A GWS will also be completed over 100% of the reference area(s), as possible. If possible, a shielded NaI detector will be used to minimize the influence from sources of radiation not within the area(s) of interest.

5.2.4 Open Area 7A

Prior to the remedial efforts, former piles 111 and 111A were located in open Area 7A. After the removal of the ore piles, surface soil was excavated in open Area 7A, in some locations to a depth of 15 to 30 centimeters (cm). Figure 5-2 shows the size of the pile areas and the location of the primary remediation effort. Open Area 7A is bounded by the entry road on the east, the railroad tracks to the west (and formerly to the south), and the drainage barrier to the north. The area is approximately 940 feet long in an east-west direction and 120 feet long in a north-south direction, creating a curved wedge (Figure 5-2) area of approximately 105,000 ft^2, or 9,755 square meters (m^2). Piles 111 and 111A were located on the eastern side of open Area 7A on a gravel pad, which was approximately 15,000 ft^2, or 1,400 m^2, in size.

The conceptual site model for open Area 7A presents the potential for residual radioactive materials to be present after storage operations and recent remedial efforts (Section 1.3).

Prior to soil sampling activities, Area 7A will be divided into 3 survey units approximately equal in size. A survey grid will be applied to each survey unit to define the location of 17 systematic sample points for characterization within each survey unit. A GWS will then be conducted over 100% of accessible areas. If needed, a shielded sodium iodide (NaI) detector will be used to minimize the influence from sources of radiation not within the area of interest (Fluorspar). The results of the GWS will be used to select biased sample locations in open Area 7A.

Surface soil samples (systematic and biased) will typically be collected by hand. At each systematic and biased surface soil sample location, a static measurement will be obtained prior to sampling using a Ludlum 2221 with 44-10 detector or equivalent. The static measurement will be for a period of 1 minute, at a distance of 6 inches from the surface of the soil. Surface and sub-surface volumetric soil samples from open Area 7A may also be collected using a Geoprobe® or similar sample collection system, especially if samples must be collected from the clay layer at a depth of approximately 90 cm resulting from detection of elevated activity in samples obtained from overlying subsurface soil (30 cm).

Biased soil samples will be collected from 0 to 30 cm below ground surface (bgs), as possible, in 15 cm sample-depth increments, throughout each survey unit in open Area 7A. Biased sample locations will be based primarily on the results of the GWS. Additional biased surface and subsurface soil samples will be obtained from the concrete pad footprint where the zirconium piles were stored (if identified), locations where previous remediation efforts extended to depths below 15 cm, and locations immediately outside the boundary of open Area 7A believed to contain radioactive contamination (if confirmed by the GWS).

Soil samples will be submitted to an offsite laboratory for analysis. If the laboratory measurement results for RCOPCs exceed the action levels in Table 3-1, then approximately 3 to 4 soil sample locations will be established laterally around the initial sample point to bound the aerial extent of contamination. In addition, soil samples will be collected to an additional 30 cm depth at the contaminated soil location, as possible, in 15 cm sample-depth increments.

5.2.5 Entry Road and Paved Road to Rail Scale

This area includes the entry road to the open Area 7A and the paved road to the east of open Area 7A continuing south to the rail scale. Throughout the removal of the zirconium ore pile, the ore was transported from open Area 7A to the rail scale along the entry road, and then along the paved road by a front-end loader (Figure 5-3).

The conceptual site model for these areas presents a low potential for residual radioactive materials to be present after transport operations and recent remedial efforts. This area has a low probability of exceeding an action level in Table 3-1.

A GWS will be completed over the entry road, as possible. If possible, a shielded NaI detector will be used to minimize the influence from sources of radiation not within the area of interest. The results of the GWS will be used to determine if biased samples are necessary. If necessary, biased soil samples will be collected at each sample location from 0 to 15 cm bgs.

The paved road to the rail scale will be treated as a structure surface, if possible, and scanned for gross alpha activity. However, if the paved surface is damaged or significantly deteriorated due to environmental exposure or equipment traffic, a GWS will be performed. Approximately 20 static surface activity measurements and surface smears will be obtained at biased locations along the paved road.

5.2.6 Rail Scale

This area includes the rail scale and surrounding area west of the paved road mentioned above and extends along the railroad tracks to the paved road on the east and to the adjacent drive area to the south (Figure 5-3).

The conceptual site model for the rail scale area presents a low potential for residual radioactive materials after the storage or transport operations and recent remedial efforts. This area has a low probability of exceeding an action level in Table 3-1.

A GWS will be completed over the rail scale area, as possible. If possible, a shielded NaI detector will be used to minimize the influence from sources of radiation not within the area of interest. The results of the GWS will be used to determine if biased soil samples are necessary.

Solid surfaces, such as concrete, pavement and/or rail structural components, i.e., rail, ties, etc., will be treated as a structure surface, if possible, and scanned for gross alpha activity. Scans will be performed at locations of highest contamination potential (biased) and will cover 10 to 20% of available surface area. Approximately 20 static surface activity measurements and surface smears will be obtained at biased locations on solid surfaces. If necessary, biased soil samples will be collected from 0 to 15 cm bgs. For locations along track, this may require removal of the rail bed (gravel) in order to obtain soil samples.

5.2.7 Shrink-wrapping Areas

The shrink-wrapping areas include a 640-foot long by 20-foot wide stretch the railroad tracks at the southern end of the Depot in front of Building 111, as well as a rail spur at the southern end of the Depot behind Building 124 (Figure 5-3). These areas were used for shrink-wrapping the rail cars filled with zirconium ore prior to transport. There was a possibility of spillage of ore during the shrink-wrapping process.

The conceptual site model for the shrink-wrapping areas presents a low potential for residual radioactive materials to remain after storage or transport operations and the recent remedial efforts. These areas have a low probability of exceeding an action level in Table 3-1.

A GWS will be completed over the shrink-wrapping areas, as possible. If possible, a shielded NaI detector will be used to minimize the influence from sources of radiation not within the area of interest. The results of the GWS will be used to determine if biased soil samples are necessary.

Solid surfaces, such as rail structural components, i.e., rail, ties, etc., will be treated as a structure surface, if possible, and scanned for gross alpha activity. Scans will be performed at locations of highest contamination potential (biased) and will cover 10 to 20% of available surface area. Approximately 20 static surface activity measurements and surface smears will be obtained at biased locations on solid surfaces. If necessary, biased soil samples will be collected at each sample location from 0 to 15 cm bgs. For locations along the railroad tracks, this may require removal of the rail bed (gravel) in order to obtain soil samples.

5.2.8 Storage or Transport Railroad Tracks

This area consists of the railroad tracks along which rail cars filled with zirconium ore were either stored or transported (from the storage area, to the rail scale and finally to the shrink-wrap area) before being sent offsite. It includes the railroad tracks along the western end of the Depot. It also includes a rail spur at the southern end of the Depot behind Building 124 (Figure 5-3). This spur was used to stage loaded and shrink-wrapped cars prior to final shipment.

The conceptual site model for these storage or transport areas presents a low potential for residual radioactive materials to remain after the storage or transport operations were completed, and after the recent remedial efforts. These areas have a low probability of exceeding an action level in Table 3-1.

A GWS will be completed over the storage or transport areas, as possible. If possible, a shielded NaI detector will be used to minimize the influence from sources of radiation not within the area of interest. The results of the GWS will be used to determine if biased soil samples are necessary.

Solid surfaces, such as rail structural components, i.e., rail, ties, etc., will be treated as a structure surface, if possible, and scanned for gross alpha activity. Scans will be performed at locations of highest contamination potential (biased) and will cover 10 to 20% of available surface area. Approximately 20 static surface activity measurements and surface smears will be obtained at biased locations on solid surfaces. If necessary, biased soil samples will be collected at sample locations from 0 to 15 cm bgs.

5.3 Buildings and Structures

All impacted buildings and structures at the New Haven Depot have a very low potential for the presence of surface contamination. Therefore, all buildings and structures have been assigned MARSSIM Class 3. Many of these buildings are sectioned, with various bays within the sections. Impacted buildings and/or *impacted* sections and bays within buildings are identified in Table 1-3. To establish survey units, floors, lower walls up to two meters in height, and upper walls above two meters plus overhead structures will be treated separately. To determine the size of a survey unit, if contiguous bays within a section or contiguous sections within a building are impacted, single survey units may be specified for floors, for lower walls, and for upper walls plus overhead structures. Where impacted bays within a section or sections within a building are not contiguous, separate survey units will be specified for each.

Scans for surface activity will be performed over approximately 10 *to 20*% of available surface area for floor and lower wall survey units. Static measurements and smears will also be obtained. Only static measurements and smears will be obtained from survey units consisting of upper walls and overhead structures.

5.3.1 Building/Structure Reference Areas

Reference areas within non-impacted buildings or structures will be identified for the collection of material, e.g., concrete, wood, etc., background count rates. Reference areas may be established in non-impacted portions of site buildings or structures. This is particularly important for material such as concrete which has many variables affecting the natural radioactivity content of the material. Some of the variables include the aggregate, percent of aggregate in the mix, age of the concrete, etc. Selection of material for background determination within the same structure that contains impacted survey units minimizes the impact of many of these variables, since most should be the same age and, unless replaced over time, contain similar aggregate and aggregate mix.

One location for collection of material background values is within non-impacted sections and/or bays in Warehouse 215. Other locations may be identified, as necessary, during the performance of characterization surveys.

Background surveys within non-impacted portions of buildings and/or structures should include surface activity scans and integrated measurements.

5.3.2 Buildings 136, 141, 145, 146

Building 136 is a 4,315 square foot one-story wooden building, formerly used to house the main administrative office at the Depot. Building 141 is a 5,765 square foot wood structure, formerly used as a storage warehouse. Building 145 has since been demolished, leaving only the concrete pad foundation, and Building 146 is in poor structural condition. Figure 5-3 shows the location and relative size of these buildings.

There is a history of storage of licensed radioactive materials in Building 136, including bastnasite, monazite, sodium sulfate, and zirconium ore. There is a history of storage of zirconium ore in Buildings 141, 145, and 146. These materials were contained and no residual contamination is expected in these buildings. The conceptual site model for these buildings presents a low potential for residual radioactive materials after storage.

Buildings 136, 141, and 146 are all in poor structural condition; some of the roofs and walls are caving in. Surveys will be conducted as possible in the buildings only after the integrity of the structure is determined safe for personnel occupancy.

If the structures become accessible, floors and lower walls up to two meters (separate survey units) will be scanned for gross alpha activity. Scans will be performed at locations of highest contamination potential (biased) and will cover 10 to 20% of available surface area within each survey unit. Approximately 20 static surface activity measurements and surface smears will be obtained at biased locations on solid surfaces within each survey unit. Additional biased integrated surface activity measurements and surface smears will be obtained to evaluate upper wall plus overhead structure survey units.

5.3.3 Warehouse 210

This warehouse stored many materials over the history of the Depot, including several licensed radioactive materials. Columbium tantalum, monazite, and tungsten were stored throughout the warehouse in various quantities. Records could not classify exactly where tungsten was stored in Sections 1, 2, and 3. In Section 4, bays 2-5, 8-9, 12-14, 32-33, 35, 43, 45-46, 48, 52-54, 56, 58, and 76 were all used for storage of columbium tantalum; only these bays and adjacent walls will be surveyed in this section. Other bays are considered non-impacted. The conceptual site model for Warehouse 210 presents a low potential for residual radioactive materials after storage. Figure 5-4 shows the size of the building and the impacted sections of the warehouse.

The structure of Warehouse 210 is in poor condition. During the HSA investigation, the floor was covered with fallen ceiling tiles. Surveys will be conducted as possible in the building only after the integrity of the structure is determined safe for personnel occupancy.

If the structure becomes accessible, floors and lower walls up to two meters (separate survey units) will be scanned for gross alpha activity. Scans will be performed at locations of highest contamination potential (biased) and will cover 10 to 20% of available surface area within each survey unit. Approximately 20 static surface activity measurements and surface smears will be obtained at biased locations on solid surfaces within each survey unit. Additional biased integrated surface activity measurements and surface smears will be obtained to evaluate upper wall plus overhead structure survey units.

5.3.4 Warehouse 211

This warehouse stored many materials over the history of the Depot, including two licensed radioactive materials. Columbium tantalum and tungsten were stored throughout the warehouse in various quantities. Records could not classify exactly where columbium tantalum and tungsten were stored in Sections 1 and 2; these sections will be surveyed. Sections 3 and 4 are considered non-impacted. The conceptual site model for Warehouse 211 presents a low potential for residual radioactive materials after storage. Figure 5-5 shows the size and the impacted sections of Building 211.

Floors and lower walls up to two meters (separate survey units) will be scanned for gross alpha activity. Scans will be performed at locations of highest contamination potential (biased) and will cover 10 to 20% of available surface area within each survey unit. Approximately 20 static surface activity measurements and surface smears will be obtained at biased locations on solid surfaces within the survey units. Additional biased integrated surface activity measurements and surface smears will be obtained to evaluate upper wall plus overhead structure survey units.

5.3.5 Warehouse 212

This warehouse stored many materials over the history of the Depot, including one licensed radioactive material. Columbium tantalum was stored throughout the warehouse in various quantities. In Section 1, bays 11, 31, 37, 41, 51, 61, and 71 were used for storage of columbium tantalum; only these bays and adjacent walls will be surveyed in this section. In Section 2, bays 11, 12, and 21 were used for storage of columbium tantalum; only these bays and adjacent walls will be surveyed in this section. Sections 3 and 4 are considered non-impacted. The conceptual site model for Warehouse 212 presents a low potential for residual radioactive materials after storage. Figure 5-6 shows the size and the impacted sections of Building 212.

Floors and lower walls up to two meters (separate survey units) will be scanned for gross alpha activity. Scans will be performed at locations of highest contamination potential (biased) and will cover 10 to 20% of available surface area within each survey unit. Approximately 20 static surface activity measurements and surface smears will be obtained at biased locations on solid surfaces within the survey units. Additional biased integrated surface activity measurements and surface smears will be obtained to evaluate upper wall plus overhead structure survey units.

5.3.6 Warehouse 213

This warehouse stored many materials over the history of the Depot, including several licensed radioactive materials. Bastnasite, columbium tantalum, monazite, tungsten, and zirconium ore were stored throughout the warehouse in various quantities. Records could not classify exactly where zirconium ore was stored in Sections 1 and 4; these sections will be surveyed. In Section 2, bays 12, 13, 15, and 16 were used for storage of monazite; only these bays and adjacent walls will be surveyed in this section. In Section 3, bays 11, 19, 21, and 29 were used for storage of columbium tantalum; only these bays and adjacent walls will be surveyed in this section. Other bays are considered non-impacted. The conceptual site model for Warehouse 213 presents a low potential for residual radioactive materials after storage. Figure 5-7 shows the size and the impacted sections of Building 213.

Floors and lower walls up to two meters (separate survey units) will be scanned for gross alpha activity. Scans will be performed at locations of highest contamination potential (biased) and will cover 10 to 20% of available surface area within each survey unit. Approximately 20 static surface activity measurements and surface smears will be obtained at biased locations on solid surfaces within the survey units. In locations where an encapsulant (epoxy coating) has been applied to floor surfaces, an area of 200 cm^2 shall be delineated and the coating removed and collected for analysis. A static surface activity measurement shall then be obtained from the remaining bare surface. The presence of surface contamination shall be determined by evaluation of the static measurement and the analytical results for the removed media. Additional biased integrated surface activity measurements and surface smears will be obtained to evaluate upper wall plus overhead structure survey units.

5.3.7 Warehouse 214

This warehouse will continue to store several materials at the start of field activities. The survey of this warehouse will be delayed until the spring of 2007, when field activities resume.

This warehouse stored many materials over the history of the Depot, including several licensed radioactive materials. Bastnasite, columbium tantalum, monazite, sodium sulfate, and tungsten were stored throughout the warehouse in various quantities. Records could not classify exactly where bastnasite and tungsten were stored in Section 1, where columbium tantalum, monazite, and tungsten were stored in Section 2, or where tungsten was stored in Section 4. When field activities commence, these sections will be surveyed in their entirety. In Section 3, bays 3-6, 8-9, 12-18, 22-28, 31-38, 41-44, 48, 56-57, 75, and 77 stored bastnasite, columbium tantalum, rare earth (sodium sulfate), or tungsten at one time; only these bays and adjacent walls will be surveyed in this section. Other bays are considered non-impacted. Figure 5-8 shows the size and the impacted sections in Building 214.

The conceptual site model for Warehouse 214 presents a low potential for residual radioactive materials after storage. Floors and lower walls up to two meters (separate survey units) will be scanned for gross alpha activity. Scans will be performed at locations of highest contamination potential (biased) and will cover 10 to 20% of available surface area within each survey unit. Approximately 20 static surface activity measurements and surface smears will be obtained at biased locations on solid surfaces within survey units. In locations where an encapsulant (epoxy coating) has been applied to floor surfaces, an area of 200 cm^2 shall be delineated and the coating removed and collected for analysis. A static surface activity measurement shall then be obtained from the remaining bare surface. The presence of surface contamination shall be determined by evaluation of the static measurement and the analytical results for the removed media. Additional biased integrated surface activity measurements and surface smears will be obtained to evaluate upper wall plus overhead structure survey units.

5.3.8 Warehouse 215

This warehouse stored many materials over the history of the Depot, including licensed radioactive materials. Bastnasite, monazite, and sodium sulfate were stored throughout the warehouse in various quantities. In Section 1, bays 2-4, 11-13, 22-23, 25-29, 34-37, 41, 43-45, 62, and 73-75 stored bastnasite, monazite, and sodium sulfate at one time. In Section 2, bays 36, 41-42, 46, 52-54, `and 62-63 stored sodium sulfate at one time. In Section 4, bays 15, 19, 29, 51-56, 61-65, 68, and 71-79 stored bastnasite at one time. Only these bays and adjacent walls will be surveyed in these sections. Section 3 is considered non-impacted. Fluorspar, a commodity containing NORM (not at licensed levels), was also stored in the eastern side of the warehouse. According to the HSA, the fluorspar traveled throughout the warehouse in the air and currently coats most surfaces. The conceptual site model for Warehouse 215 presents a low potential for residual radioactive materials after storage. Figure 5-8 shows the size and the impacted sections of Building 215.

Floors and lower walls up to two meters (separate survey units) will be scanned for gross alpha activity. Scans will be performed at locations of highest contamination potential (biased) and will cover 10 to 20% of available surface area within each survey unit. Approximately 20 static surface activity measurements and surface smears will be obtained at biased locations on solid surfaces within survey units. Additional biased integrated surface activity measurements and surface smears will be obtained to evaluate upper wall plus overhead structure survey units.

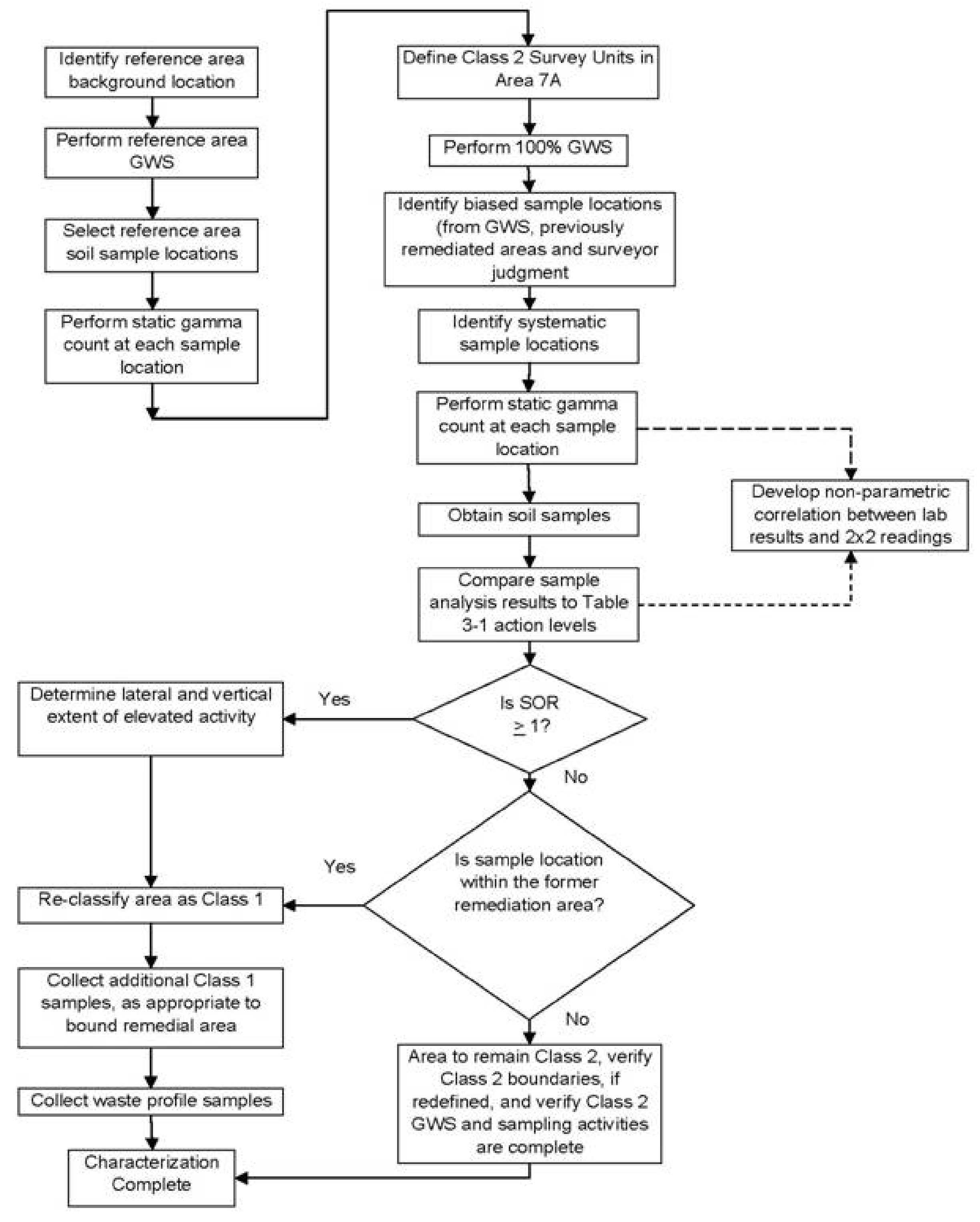

FIGURE 5-1: OUTSIDE AREA 7A GRADED CHARACTERIZATION APPROACH FLOWCHART

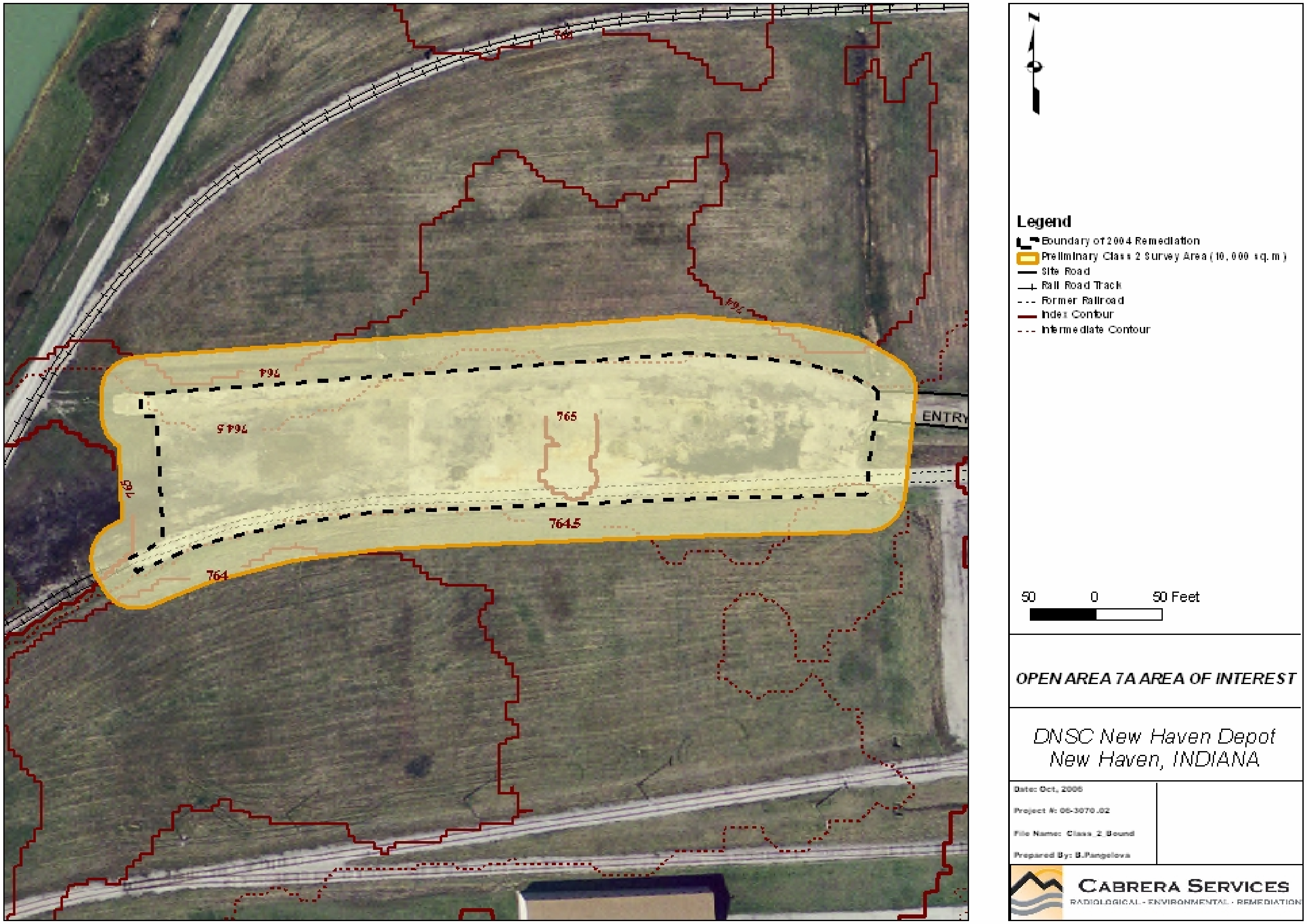

FIGURE 5-2: OPEN AREA 7A AREA OF INTEREST

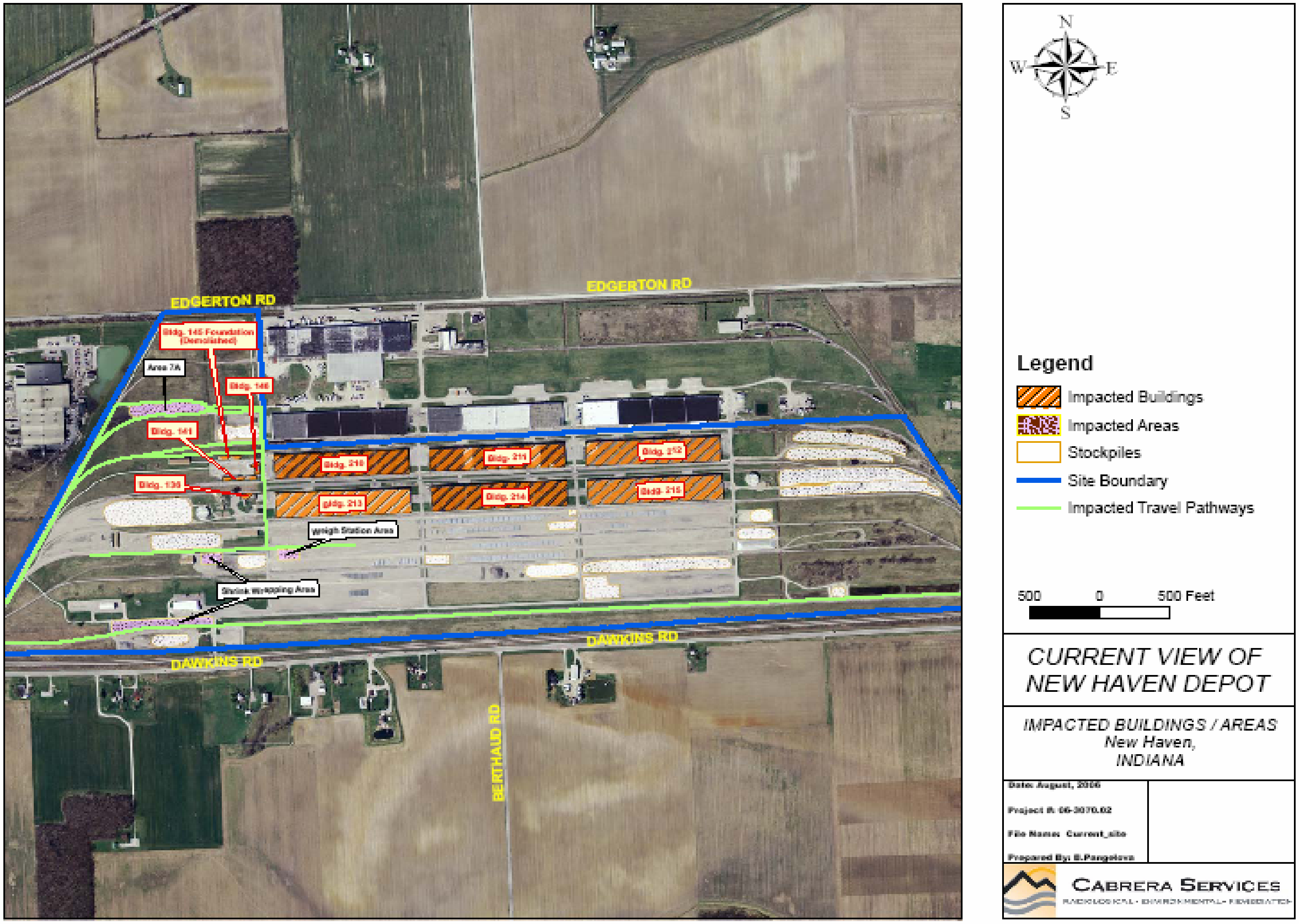

FIGURE 5-3: IMPACTED BUILDINGS AT THE NEW HAVEN DEPOT INCLUDING BUILDINGS 136, 141, 145, AND 146

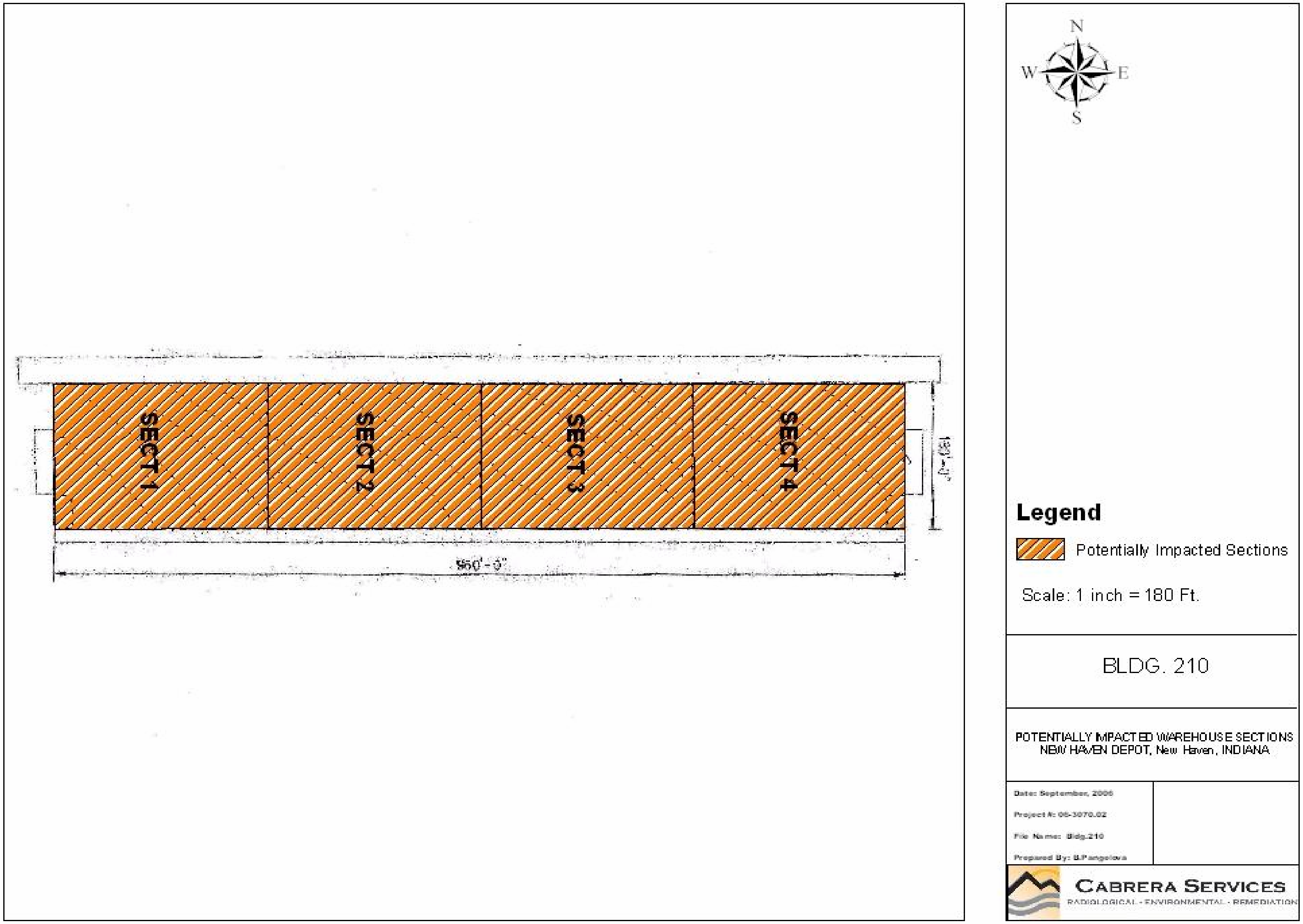

FIGURE 5-4: IMPACTED AREAS IN BUILDING 210

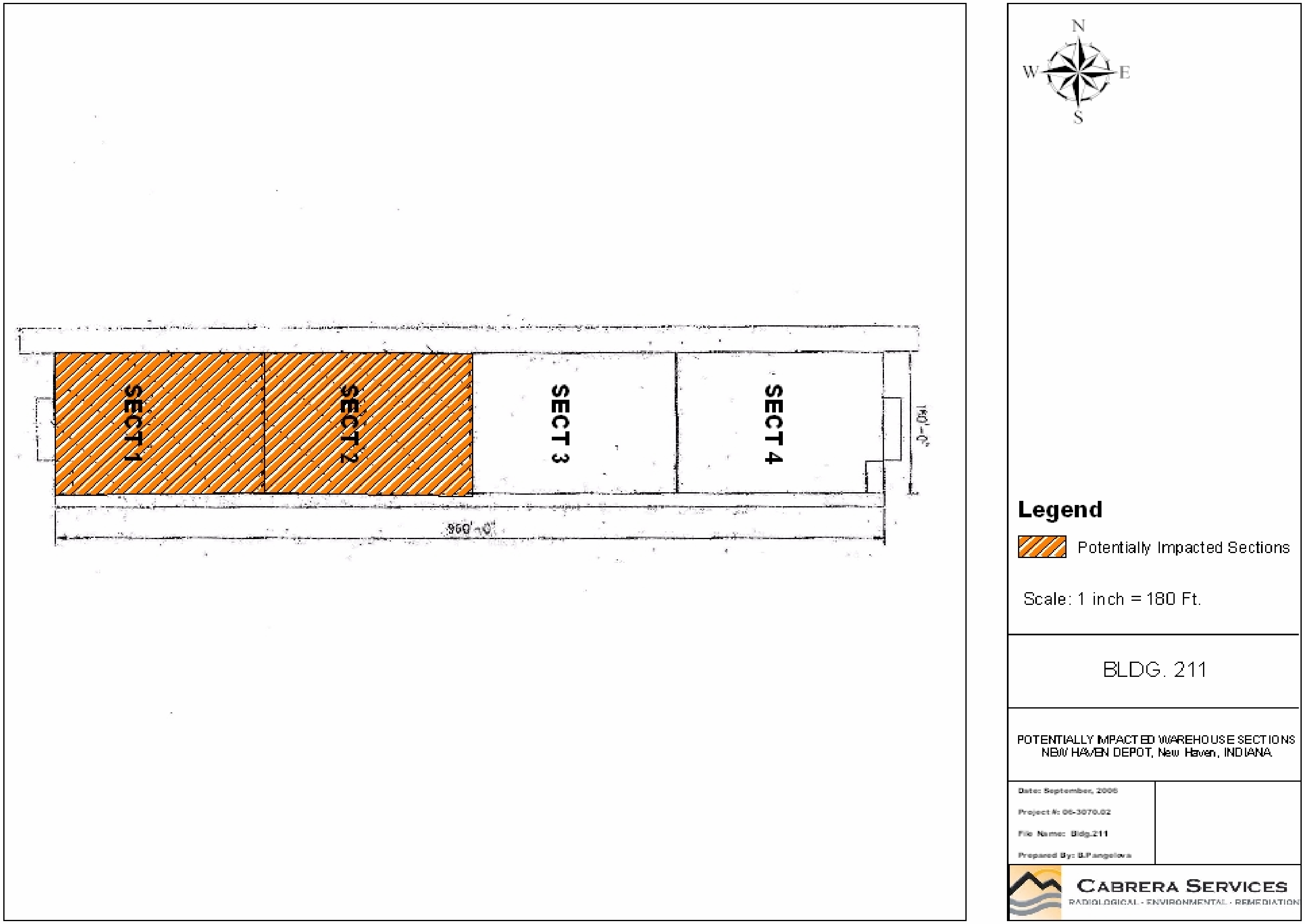

FIGURE 5-5: IMPACTED AREAS IN BUILDING 211

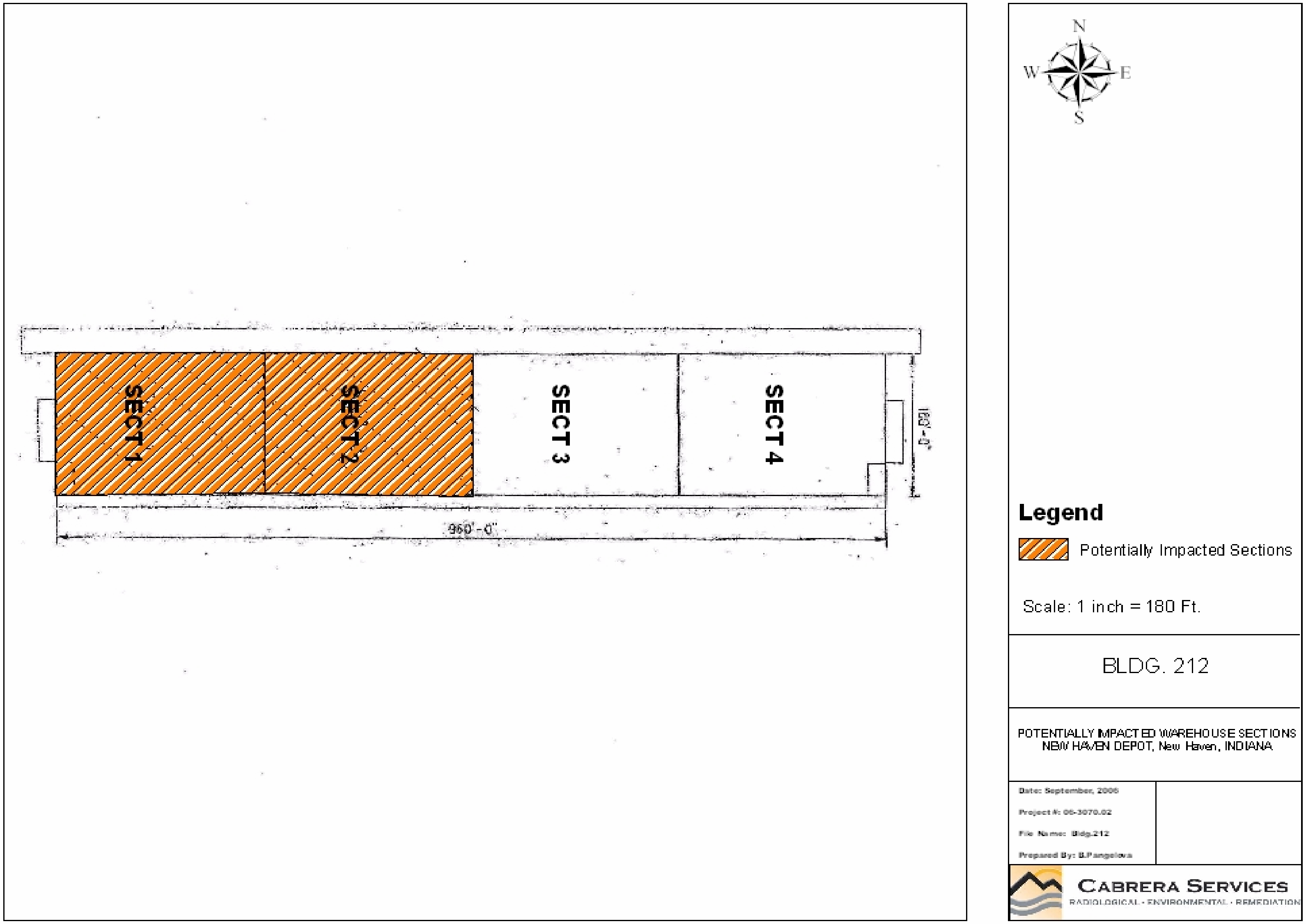

FIGURE 5-6: IMPACTED AREAS IN BUILDING 212

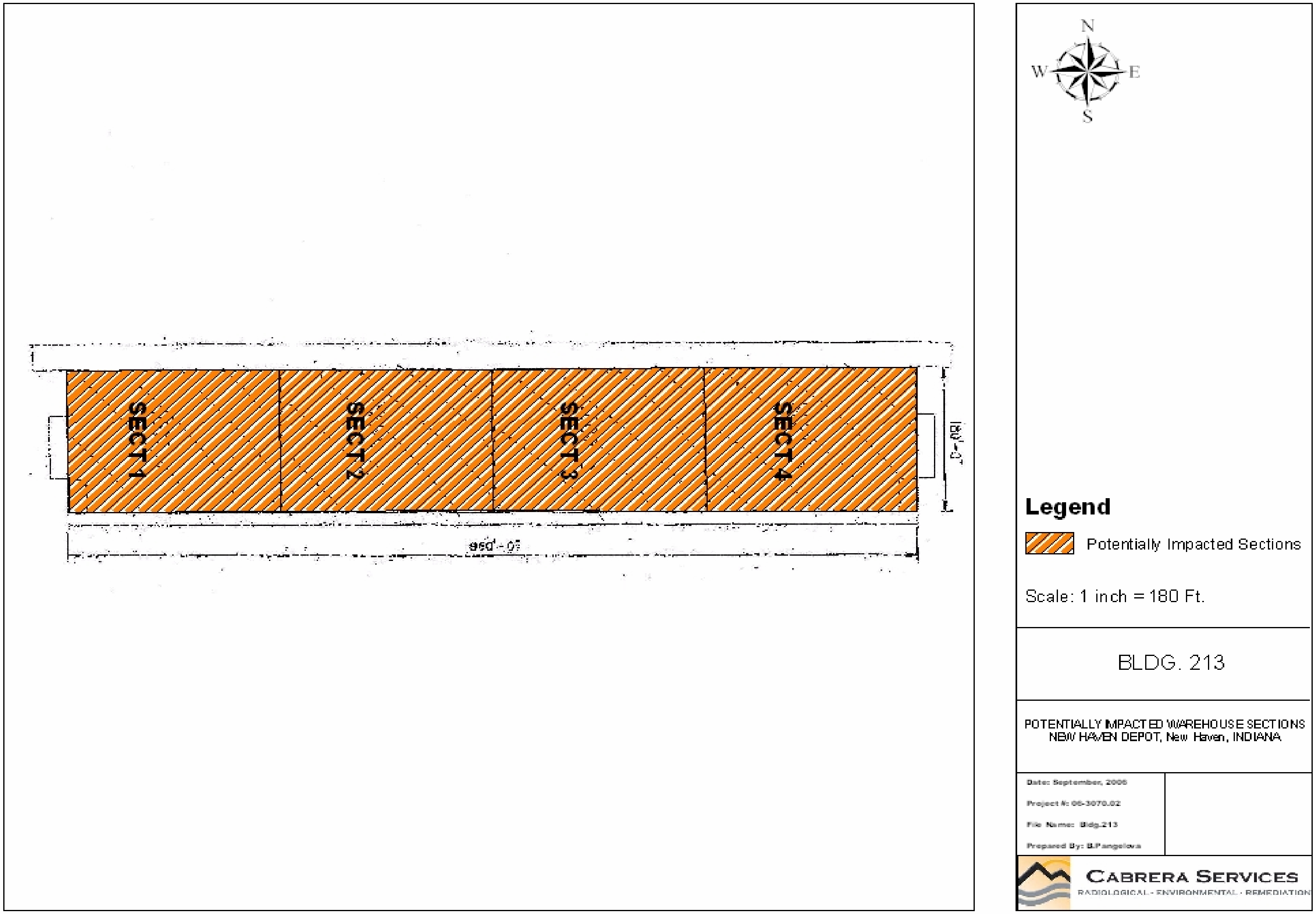

FIGURE 5-7: IMPACTED AREAS IN BUILDING 213

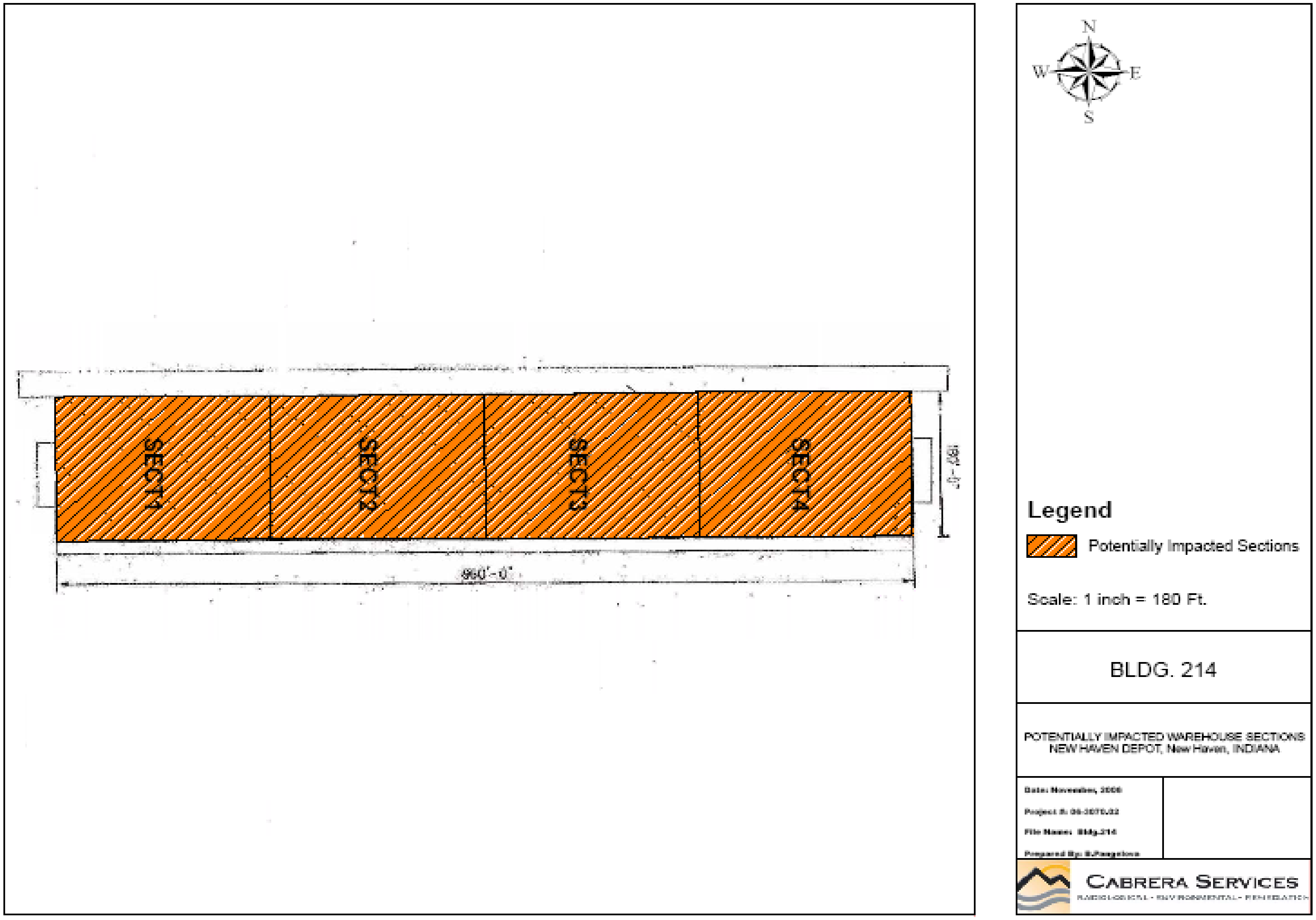

FIGURE 5-8: IMPACTED AREAS IN BUILDING 214

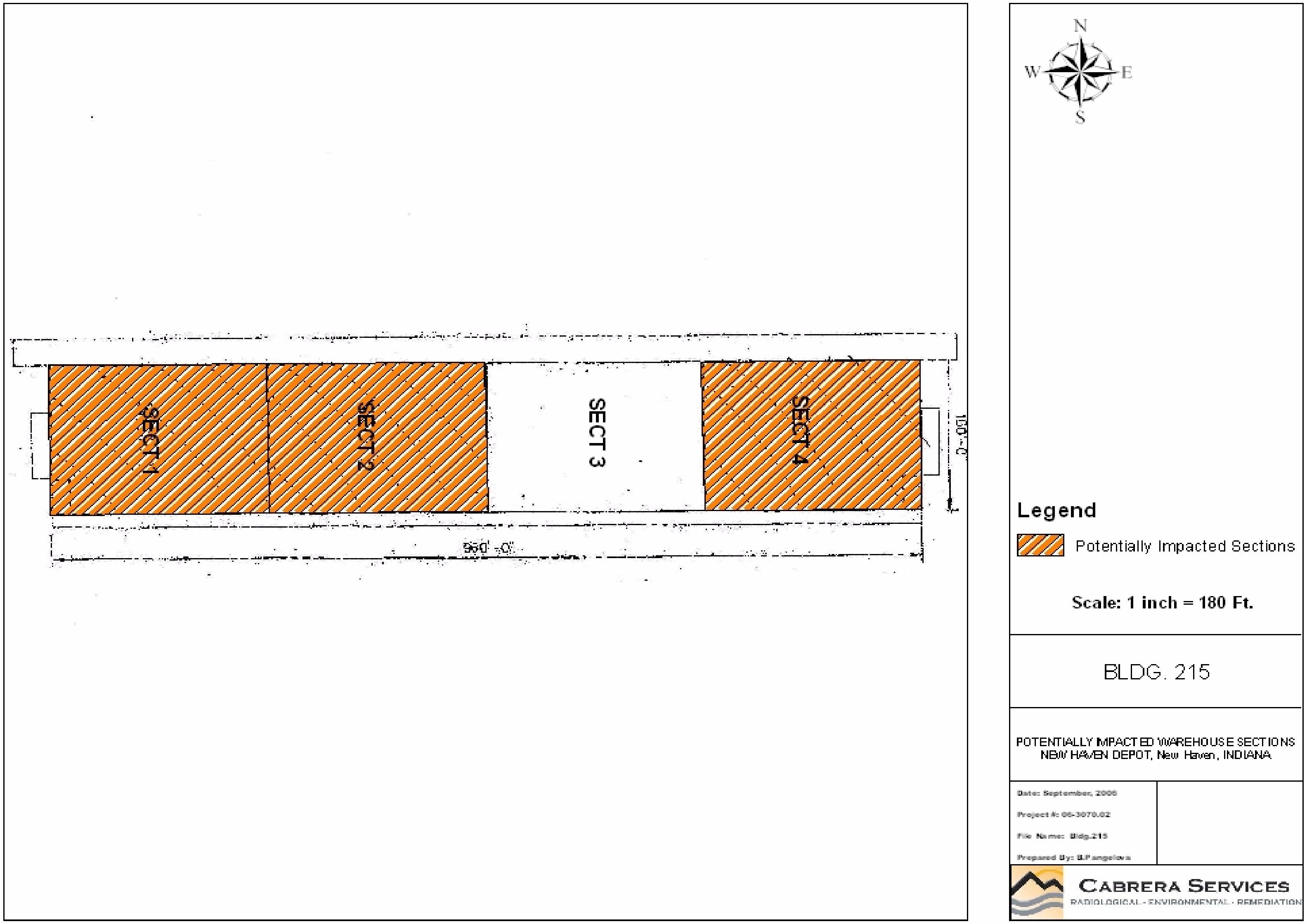

FIGURE 5-9: IMPACTED AREAS IN BUILDING 215

6.0 SAMPLING APPARATUS AND FIELD INSTRUMENTATION

The purpose of this section is to describe survey instruments and methodologies to be used for surveys implemented during the site characterization surveys. Specific measurement/sampling frequencies and approaches are discussed in Section 4.0. A list of applicable CABRERA Standard Operating Procedures (SOPs) for the New Haven Depot characterization is provided in Appendix A.

Gross gamma scanning, static gamma measurements, discrete soil sampling, offsite laboratory analyses, and general area dose rate measurements will be performed to measure radioactivity concentrations of RCOPCs in surface soil.

For enclosed and unenclosed structures, surface scans, integrated direct measurements and surface smears will be performed to measure surface radioactivity concentrations of site RCOPCs. These measurements will be based on alpha emissions. Smears will be analyzed onsite. If it is necessary to submit the smears to an offsite laboratory for analysis, each set of smears obtained from discrete locations (bays, etc.) may be composited, as appropriate, prior to submittal.

Soil sampling equipment will be decontaminated and/or surveyed in accordance with CABRERA SOPs to minimize cross-contamination of samples.

An evaluation of the minimum detectable concentration for the characterization instruments used for the GWS, building and/or structure scan surveys, integrated measurements and smear analysis discussed in the following sections is presented in Appendix B.

6.1 Direct Radiation Measurements

Building and/or structural surfaces will be scanned for total alpha activity. Static or integrated measurements shall also be performed at biased locations. If possible, and equipped, beta measurements will also be obtained, as necessary. Surveys will be performed in accordance with CABRERA SOPs.

Building and/or structural surface scans and integrated measurements will be performed on floors, walls, and ceilings, as possible, at biased locations. These measurements may be performed using a Ludlum Model 43-37 floor monitor (active area of 582 cm^2), or equivalent detector or appropriate hand held detectors. Hand held instrumentation for structure surveys may be equipped with a Ludlum 43-68 alpha/beta gas proportional detector, a Ludlum 43-89 alpha/beta ZnS alpha scintillation detector, or equivalent detector. The Ludlum Model 43-68 gas proportional detector, Ludlum Model 43-89 ZnS scintillation detector, or equivalent detector, will also be used to perform integrated measurements on upper walls, ceilings, and potentially lower walls. Both the 43-37 and 43-68 detectors will be coupled to a Ludlum 2360 Alpha-Beta Data Logger, or equivalent data logger. The 43-89 detector will be coupled to a Ludlum 2224 Alpha-Beta Data Logger, or equivalent. The 43-37, 43-68, and 43-89 will be calibrated to measure both alpha and beta surface activity (i.e., dual channel analysis).

To adequately determine the potential for radioactive contamination on scanned surfaces, the background contribution will first be determined. This is completed by selecting a reference area similar in characteristics to the survey unit. For buildings and/or structure surfaces, approximately 10 areas, each 1 square meter (m^2) in size, will be selected for scanning. The scan will be completed in each of these areas, recording the highest scan measurement value for each. This value will then be used to subtract from the survey unit scans. For outdoor locations, larger scan areas, such as 10 m^2 square meters, may be selected. However, the minimum number of scanned areas remains the same as buildings and/or structures, i.e., 10.

Differential Global Positioning System (GPS) will be used to locate survey/sample points for outside areas. GPS is accurate to less than 1 meter, but must have line of sight between the measurement location and at least four satellites in the NAVSTAR constellation, which is deployed and maintained by the Department of Defense (DoD).

6.1.1 Integrated Surface Radioactivity Measurements

For integrated measurements, an instrument is held in a stationary position for a set period of time to obtain an integrated measurement at a systematic or biased location.

6.1.1.1 Integrated Measurements

Integrated measurements will be performed at systematic or biased locations during characterization efforts. The Ludlum 44-10 NaI detector, or equivalent, is typically used for collection of static gross gamma measurements. The Ludlum 43-68 or 43-37 probe, or equivalent, with a Ludlum 2360 data logger for alpha and beta activity, or equivalent, will be used to perform integrated alpha and/or beta measurements. The Ludlum 43-89 probe, or equivalent, with a Ludlum 2224, or equivalent, may also be used to perform integrated measurements.

Static (or integrated) gross gamma measurements will be performed in the reference area background and the applicable survey unit with characteristics similar to the background location. The background static measurement and survey unit measurement shall be performed in the same detector orientation, position above the surface and integration time period (typically 1 minute). The gross gamma static measurement radioactivity in the survey unit is then determined by subtracting the reference area static measurement result from the result obtained from the survey unit.

Static (or integrated) gross alpha and beta measurements will consider two factors that contribute to background:

- The first is the background contribution due to cosmic sources and sources of radioactivity near the survey unit, but not directly from the surface of interest. To address the first component, one background alpha and beta measurement is performed in the survey unit in a shielded configuration. This is completed by performing a static measurement (typically 1 minute integration time) with a piece of wood or similar material between the detector face and the surface of interest.
- The second component of background results from the activity measured that is due to the natural radioactivity present in the material of interest. This is addressed by selecting reference areas of similar material types (concrete, wood, gypsum, asphalt, etc.) and performing a set of static measurements for each type of material. This is first performed by completing a shielded measurement on the reference area material as discussed in the previous paragraph. The shielding is then removed and a second or total background measurement is conducted directly on the reference area material. The background due to

the material of interest is then the total background measurement result minus the shielded measurement result. Typically a set of 10 reference area background measurements are collected for each material of interest type.

- Static measurements are then performed in the applicable survey unit. The final result is determined by subtracting the shielded measurement result and the material background. This result is then compared to the survey unit limit or DCGL.

Biased measurements of surface radioactivity will be considered at the following locations:

- Cracks in floors or walls,
- Corners of floors and walls,
- Openings in floors or walls such as drains and ducts,
- Horizontal structures with surfaces where airborne contamination may have settled (e.g., building joists, etc.), and
- Additional areas where contamination would be expected to accumulate.

Integrated measurements will be performed in accordance with CABRERA procedures OP-020 “Operation of Contamination Survey Meters,” OP-021 “Alpha-Beta Counting Instrumentation,” and CABRERA standard radiation instrumentation templates “Alpha/Beta Counting and Smear Worksheet.”

6.2 Smear Sample Collection and Analysis

Smear samples will be collected at locations, as appropriate, to quantify transferable surface alpha and beta radioactivity, typically at locations of biased and systematic static measurement locations. Smear samples are not obtained from soil measurement locations. Smear samples will be collected over approximately 100 cm^2. Smear samples will be analyzed for alpha and beta radioactivity using a Ludlum 2929 alpha/beta scintillation counter or equivalent in accordance with CABRERA procedure OP-021 *“Alpha-Beta Counting Instrumentation.”* Smear locations and results will be recorded on proper survey forms.

Smears may require decay (i.e., radon progeny decay) prior to counting under certain conditions. Smears that must be counted immediately will be recounted after at least 24 hours of decay time if radon activity becomes a problem.

Smear sample count times shall be determined daily, with a minimum detectable concentration not exceeding 10% of the thorium surface screening level presented in Table 3-1, unless it can be clearly demonstrated that the radionuclide(s) of concern in the survey unit are limited to uranium.

6.3 Volumetric Sample Collection and Analysis

Volumetric samples of soil will be collected and analyzed at an off-site laboratory. Quality control samples (duplicates and/or split samples) will be collected at a frequency sufficient to evaluate the adequacy of sample preparation and analysis. During the collection of soil samples, large twigs, stones and other similar items will be removed. Chain of custody (COC) forms will be maintained in accordance with CABRERA SOPs.

6.3.1 Volumetric Surface Soil and Subsurface Soil for RCOPCs

Surface and subsurface soil samples will be collected. The following equipment (or equivalent) will be required for this task.

- GeoProbe® rig and ancillary rods and sampling equipment (as necessary);
- Hand auger, or other proper sampling method;
- Large stainless steel mixing bowl;
- Stainless steel utensil for removal of soil core from soil core rod or hand auger after sample is retrieved and for mixing and packaging samples in containers;
- Sample containers and COC forms/seals.

Sample results will be used to quantify surface soil contaminant concentrations at discrete locations. All surface and subsurface samples will be analyzed for RCOPCs at the onsite laboratory and the results will be used to facilitate statistical testing. At least 10% of soil samples will be submitted to an offsite laboratory as confirmation of the results of the onsite laboratory. At approximately 5% of all sample locations, CABRERA will collect duplicate samples for QA considerations.

A gross gamma static measurement will be performed at each surface soil sample location prior to obtaining the soil sample. A minimum of 750 grams of soil will be obtained for each discreet sample. Samples will be marked to show the sample identification number. Sample identification numbers and other pertinent data will be recorded on appropriate field data recording sheets. Samples will be collected in accordance with the laboratory's applicable COC procedures.

6.4 Soil Sample Analysis

6.4.1 General

Soil samples will be analyzed by an off-site laboratory analyses primarily via gamma spectroscopy. Samples shall be prepared and packaged to meet laboratory requirements and, if Class 7 radioactive material, to meet U.S. Department of Transportation (DOT) regulations for transportation.

Soil samples will be collected at selected locations at the Depot site. Personnel collecting samples will ensure each sample is placed into a clean, unused container. For each single sample or related batch of samples, a sample chain-of-custody form will be filled out. The samples will be either individually listed or batch listed (by chain of custody form number) in the Project Logbook. Samples awaiting shipment to the contract offsite laboratory will be stored in a designated, secure location. Original chain-of-custody forms will remain with the samples to which they apply throughout their life cycle and will be annotated with the shipper's tracking number during times when they are in transit.

6.5 Gamma Walkover Surveys

Outdoor gamma survey measurements will be performed during the characterization survey using a NaI detector coupled to a ratemeter. The detector will be coupled to a Trimble Pro XR, or equivalent, GPS.

GWS will be performed over accessible areas in each impacted outside area. The purpose of the GWS is to identify surface soil radiological activity. In addition, GWS is used to gather information over selected outside concrete pad and asphalt covered areas. These surveys will provide position-correlated gross gamma count rate data that is proportional to the gross gamma fluence rate from these ground-level surfaces.

The results of these surveys will be used to identify and locate radioactive materials that may have been inadvertently incorporated into soils, concrete and asphalt structures. Areas identified as exceeding criteria will be used to select locations for biased soil sampling.

Equipment required for performing the GWS survey includes the following:

- Trimble Pathfinder Pro XRS GPS system (or equivalent)
- NaI gamma scintillation detector coupled to a rate meter, equipped with appropriate download port

The survey will be performed following MARSSIM (NRC, 2000) protocol by walking straight parallel lines at a speed of 0.5 meters (m) per second over an area with the detector and GPS unit affixed to a three-wheeled cart with the detector mounted approximately 0.10 m (4 in) above the ground surface. Survey passes will be approximately 0.5 m apart. Data from the ratemeter/scaler will be automatically logged into the GPS unit every second. The gamma detection systems will be set up to measure gamma interactions in the NaI crystal that are discernible from electronic noise. Specifically, the detection systems will be calibrated with no lower level discriminator and no upper level discriminator (i.e., open window). This system will log the gross gamma reading and position (in State Plane Coordinates) every 1 second.

After completion of the survey, the raw data will be downloaded from the GPS and transmitted to a data processing specialist for export into a geospatial software program.

7.0 CALIBRATION PROCEDURES AND FREQUENCY

7.1 Radiation Detection Instrument Calibration and Field Checks

Instruments used during the survey will have current calibration/maintenance records kept onsite for review and inspection. The records will include, at a minimum, the following:

- Name of the equipment
- Equipment identification (model and serial number)
- Manufacturer
- Date of calibration
- Calibration due date

Instrumentation shall be maintained and calibrated to manufacturers' specifications to ensure the instruments have the required traceability, sensitivity, accuracy, and precision. Instruments shall be calibrated using NIST-traceable sources. Instruments will be operationally checked daily (QC, or source checks) to ensure they respond in a consistent manner when exposed to known radiation sources. Records of daily source checks will be maintained and filed in the project file, along with control charts associated with each instrument. The following subsections describe initial setup and daily QC checks performed on each type of radiation detection instrument listed above.

7.1.1 Sodium Iodide Gross Gamma Systems

NaI detectors coupled to count rate meters and GPS systems will be used to perform gamma scan surveys and integrated fixed location measurements. Instruments shall be calibrated at least annually using a NIST-traceable radioactive source.

Instruments will be response checked daily by comparing the instrument response to an appropriate gamma emitting source, such as Cesium-137 (^{137}Cs). Response checks will consist of a 1-minute integrated count of the source positioned in a reproducible geometry (i.e., a jig). The acceptance criterion for these instrument response checks is within ± 20% of the mean response generated using ten initial source checks and ten measurements of ambient background. A response check outside these criteria will be cause for evaluation of conditions (e.g., instrument operation, source/detector geometry). If the instrument fails the initial response check, the check may be repeated a second time. Instruments that fail the second response check will be removed from service if the cause cannot be determined and corrected. During daily response checks, instruments will be inspected for physical damage, battery voltage levels, current calibration and erroneous readings.

Background checks will be performed daily for each instrument. These checks are implemented to monitor fluctuations in ambient gamma background that could impact the interpretation of the gross gamma measurements; they are not conducted to monitor the performance of the instruments. The results of the background measurements will be recorded and presented on a control chart.

7.1.2 Alpha/Beta Measurement Instruments

Typically, large area surface scans of structures will be performed using the Ludlum Model 43-37 floor monitor (active area of 582 cm^2), or equivalent detector. In certain instances where accessibility may be an issue or the size or configuration of the area does not warrant use of the floor monitor, it may be replaced with a Ludlum 43-68 handheld alpha/beta gas proportional detector, a Ludlum 43-89 handheld alpha/beta ZnS alpha scintillation detector, or equivalent detector. The Ludlum Model 43-68 gas proportional detector, Ludlum Model 43-89 ZnS scintillation detector, or equivalent detector, will also be used to perform scan measurements on upper walls, ceilings, and potentially lower walls. Both the 43-37 and 43-68 detectors will be coupled to a Ludlum 2360 Alpha-Beta Data Logger, or equivalent data logger.

A Ludlum 2360 Alpha-Beta Data Logger with Model 43-37 floor monitor, or equivalent detector, Ludlum 2360 Alpha-Beta Data Logger with Ludlum 43-68 handheld alpha/beta gas proportional detector, or Ludlum 2224 scaler/rate meter with Model 43-89 handheld alpha/beta scintillation detector, or equivalent, will be used to conduct static measurements. The instrument used shall be calibrated at least annually using NIST-traceable standards.

QC source checks for the Ludlum 43-37, 43-68, and 43-89 will consist of a 1-minute integrated count with the designated an appropriate alpha emitting radioactive source, such as Thorium–230 (^{230}Th) and beta emitting radioactive source, such as Technetium-99 (^{99}Tc) sources. The acceptance criterion for this instrument response is within ± 20% of the average response generated using ten initial source checks and ten measurements of background performed at the beginning of the project. A response check outside these criteria will be cause for evaluation of conditions (e.g., instrument operation, source/detector geometry), and the response check will be repeated once prior to field use of that instrument. Instruments that fail the second successive response check will be removed from service and corrective actions will be taken.

A QC source check may also be performed on the 43-37, 43-68, and 43-89 detectors after 3 to 4 hours of use in the field to ensure quality data is being collected throughout the day.

Only Field Site Managers can return a failed instrument back to service after proper corrective actions are taken and documented.

7.1.3 Smear Counter

A Ludlum Model 2929 smear counter will be used for onsite analysis of radiological contamination smears. The instrument shall be calibrated at least annually using NIST-traceable standards.

Instruments will be checked daily for QC by comparing response to designated an appropriate alpha emitting radioactive source, such as ^{230}Th, and beta emitting radioactive source, such as ^{99}Tc. Background measurements will also be performed daily. Response checks will consist of a 1-minute count of the alpha source and a 1-minute count of the beta source positioned in a reproducible geometry. Background measurements will be performed in an identical manner, however, with the source removed.

The acceptance criteria for instrument response will be set to two and three-sigma of the mean response generated using ten initial source checks and ten measurements of ambient background. A response check outside the two-sigma, but within the three-sigma criteria will be cause for a recount prior to further evaluation. A response check outside the two sigma range on the second count or the three-sigma range on the initial count will be cause for further evaluation prior to continued use. A response check outside these criteria is cause for notification of the Field Site Manager and evaluation of conditions (e.g., instrument operation, source/detector geometry) prior to further counts and/or removal of the instrument from service. Instruments must pass a response check prior to field use. During daily response checks, instruments used to obtain radiological data will also be inspected for physical damage, battery voltage levels, current calibration and erroneous readings in accordance with CABRERA SOPs.

8.0 SAMPLE CHAIN OF CUSTODY/DOCUMENTATION

8.1 Field Log

Project data will be recorded in a Field Data Logbook (or other equivalent method of data record) and subsequently transferred to an electronic format. Field Data Logbook records will be sufficient to allow data transactions to be reconstructed after the project is completed. The CABRERA project manager (PM), or designee, is responsible to ensure logbook(s) entries are completed appropriately. The CABRERA designee will review the Project Logbook at least weekly and will report significant issues to the CABRERA PM.

Each survey team will maintain a logbook to document their field activities. The following information, at a minimum, will be recorded:

- Instrument (e.g., meter/detector) model and serial numbers
- Names of field survey personnel
- Identification of area surveyed, including material type, i.e, soil, wood floor, concrete, asphalt, etc., and any nearby structures or material that may affect the survey results, i.e., GWS of soil requiring survey close to or adjacent to concrete structures.
- Description of large obstacles or geographic features that limit accessibility to the areas to be surveyed
- Notes regarding equipment performance (e.g., loss of satellite signal, technical malfunction, etc.)
- Notes regarding any issue related to the survey and requiring documentation

Field Data Logbooks will be permanently bound and the pages will be numbered. Pages may not be removed from logbooks under any circumstances. All entries are to be made in blue or black ink. Entries will be legible, factual, detailed, and complete and should be signed and dated by the individual(s) making the entries. If a mistake is made, the error will be denoted by placing a single line through the erroneous entry and initialing the deletion. Under no circumstances will any previously entered information be completely obliterated. Use of whiteout in data logbooks is not permitted for any reason.

8.1.1 Project Log Book

All significant events which occur during this characterization survey should be documented and retained for future reference. While many types of project events have specific forms on which they are documented, many events occur on a routine basis during survey field activities that must be documented as they occur. Additionally, project data transactions must also be recorded as they occur. To provide a practical means of capturing this information, a project logbook will be initiated upon project commencement.

Significant project events, including data transactions involving project electronic data, should be recorded in the Project Logbook. Data transactions are defined as any transfer, download, export, copy, differential correction, sort, or other manipulation performed on project electronic data. Project Logbook records should be sufficient to allow data transactions to be reconstructed after the project is completed.

The Field Site Manager is responsible for maintaining the Project Logbook and should review the Project Logbook at least daily to report significant issues.

The Project Logbook is considered a legal record and should be permanently bound and the pages should be pre-numbered. Pages may not be removed from the logbook under any circumstances. Entries should be legible, factual, detailed, and complete and will be signed and dated by the individual(s) making the entries. If a mistake is made, the individual making the entry will place a single line through the erroneous entry and will initial and date the deletion. Under no circumstances will any previously entered information be completely obliterated. Use of whiteout in the Project Logbook is not permitted for any reason. Only one Project Logbook will be maintained. If a Project Logbook is completely filled, another volume will be initiated. In this case, each volume will be sequentially numbered.

8.1.2 Project Electronic Data

Much of this characterization survey will rely on data collected and stored electronically. Electronic data is subject to damage and/or loss if not properly protected. As such, all project electronic data will be downloaded from its collection device (e.g., laptop computers, data loggers, etc.) on at least a daily basis.

Data files will be named according to a naming protocol designated by the Field Site Manager. No variations from this protocol will occur without the prior concurrence of the field supervisor. During data download and transfer transactions, the applicable data file name(s) will be included in project data logbook entries.

8.2 Photographs

CABRERA plans to take photographs at the Depot site during field activities. A photograph log-sheet will be used to manage photo numbers and locations. The photographic log-sheet will include the following items:

- Date
- Time
- Photographer
- Name of site
- General direction faced and description of the subject and area
- Sequential number of the photograph

8.3 Sample Documentation

This section describes the standard practices and procedures to be used when documenting a sampling event and for maintaining sample control. When samples are collected for radiological analysis, documentation such as sample labels, COC forms (if they are to be sent offsite for analysis), and field logbooks will be completed. The information presented in this section enables the maintenance of sample integrity from the time of the sample collection through transport to the laboratory. All documentation will be completed with indelible ink.

8.3.1 Sample Labels and/or Tags

Sample labels should include the following items:

- Client name
- Project name
- Sample location
- Date/time
- Sample collector
- Sample identification
- Preservation
- Analyses requested

The sample labels and COCs should be generated using an electronic database management system to more accurately and precisely manage the sample identification numbers, labeling, and COC.

8.3.2 Chain of Custody Records

A COC form will be completed and will accompany the samples being sent offsite. The following information should be provided on the COC:

- Site name
- Laboratory name and contact.
- Turnaround time (only if site-specific conditions require non-standard turnaround time).
- Sample ID, matrix, sample date, and collection time.
- Parameters, analytical methods, bottle type, bottle volume, sample type, and preservative.
- Signed release on bottom of COC.

8.3.3 Receipt for Sample Forms

The analytical services laboratories should analyze the condition of the samples upon receipt. This information will be recorded on a form. The form will include the date, client's name, cooler number, temperature of samples, etc. The laboratory sample custodian or manager will sign and date the form. The form should be returned to the Project Manager via facsimile or email within 24 hours of receiving the samples.

8.4 Field Records

Field analytical records should include the following field data forms for recording the results/measurements and QA/QC checks for field surveys:

- GWS measurements.
- Building and/or structure scans.

- Static measurement results.
- Smear analytical results.
- Radiological screening instrument QC checks.
- Instrument calibrations.

9.0 SAMPLE PACKAGING AND SHIPPING

9.1 Sample Handling

The Field Site Manager will arrange for delivery of all coolers, labels, and sample containers prior to conducting field activities. Sample containers will be labeled using preprinted labels. The labels should include the project name and number, unique sample ID, sample date and time of collection, sample procedure (i.e., composite, grab), preservative used, analysis requested, and sampler's initials. All samples should be screened to determine if the concentration and total activity in a conveyance requires shipment as Class 7 radioactive material. If so, the samples shall be packaged, labeled, if necessary, marked, and transported in accordance with U.S. DOT regulations.

9.2 Sample Transport

Samples should be shipped to the laboratory via overnight carrier, or, if possible, the laboratory may arrange for sample pickup at the site. The Field Site Manager will coordinate the transport of samples.

10.0 INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) is expected to be minimal as a result of this investigation. IDW will be generated from the use of PPE, disposable sampling equipment, and decontamination fluids during field investigation activities, and possibly from excess soil during sampling activities. IDW will be containerized and staged at the site until characterization results are received from the laboratory and the final disposition of the waste is determined. IDW will be stored in Type 7A steel drums placed on pallets (or other standard and appropriate containers). The containers will be labeled with the type and volume of the contents, date, and contact information. Depending on the constituents of concern, fencing or other special marking may be required. The containers will be inspected on a routine basis to ensure that they are properly sealed and intact, and that markings remain clearly visible.

IDW that has not come in contact with significant contamination such as paper towels, and packaging will be collected on an as-needed basis to maintain the site in a clean and orderly manner. This waste will be containerized and transported to a designated collection bin. Acceptable containers will be sealed boxes or plastic garbage bags.

11.0 REFERENCES

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APPENDIX A

Cabrera Services, Inc. Standard Operating Procedures

(Provided on accompanying electronic compact disc)

LIST OF SOPs

Radiation Safety Procedure for ALARA AP-005 Revision 1

Radiation Safety Procedure for Radiological Surveys OP-001 Revision 1

Radiation Safety Procedure for Air Sampling and Analysis OP-002 Revision 0

Radiation Safety Procedure for Use and Control Radioactive Check Sources OP-009 Revision 0

Radiation Safety Procedure for Decontamination of Equipment and Tools OP-018 Revision 0

Radiation Safety Procedure for Alpha -Beta Counting Instrumentation OP-021 Revision 0

Radiation Safety Procedure for Operation of Contamination Survey Meters OP-O20 Revision 0

Radiation Safety Procedure for Operation of Micro-R Meters OP-O23 Revision 0

APPENDIX B
Instrument Sensitivity Calculations