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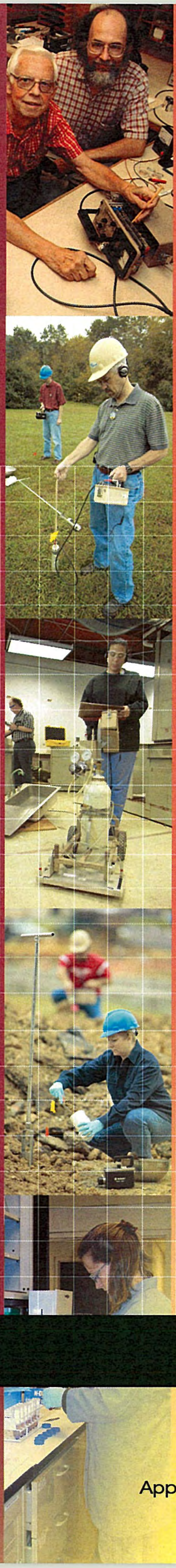

INDEPENDENT CONFIRMATORY SURVEY REPORT FOR THE CONFIRMATORY SURVEY OF THE DEFENSE LOGISTICS AGENCY DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA

E. M. Harpenau

Prepared for the
U.S. Nuclear Regulatory Commission

ORISE
Oak Ridge Institute for Science and Education

CONFIRMATORY SURVEY OF THE DEFENSE LOGISTICS AGENCY DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA

Prepared by

E. M. Harpenau

and

W. C. Adams

Independent Environmental Assessment and Verification Program
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0017

Prepared for the
U.S. Nuclear Regulatory Commission

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CONFIRMATORY SURVEY OF THE
DEFENSE LOGISTICS AGENCY
DEFENSE NATIONAL STOCKPILE CENTER
NEW HAVEN DEPOT
NEW HAVEN, INDIANA

Prepared by: [signature] Date: 2/18/10
E. M. Harpenau, Asst. Project Leader
Independent Environmental Assessment and Verification

Prepared by: Wade C. Adams Date: 2/18/2010
W. C. Adams, Project Leader
Independent Environmental Assessment and Verification

Reviewed by: Erika N. Bailey for Date: 2/19/10
T. J. Vitkus, Survey Projects Manager
Independent Environmental Assessment and Verification

Reviewed by: R. D. Condra Date: 2/19/10
R. D. Condra, Laboratory Manager
Independent Environmental Assessment and Verification

Reviewed by: Ann Templon Date: 2/19/10
F. A. Templon, Quality Manager
Independent Environmental Assessment and Verification

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The authors would like to acknowledge the significant contributions of the following staff members:

FIELD AND SUPPORT STAFF

W. C. Adams
E. M. Harpenau
A. C. Kirthlink
J. A. Viars

LABORATORY STAFF

R. D. Condra
J. S. Cox
W. P. Ivey
W. F. Smith

CLERICAL STAFF

J. L. Clary
R. M. Fink
K. M. Moore
A. Ramsey

ILLUSTRATORS

A. M. Hood
J. A. Viars

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ABBREVIATIONS AND ACRONYMS

cm	centimeter
cpm	counts per minute
DCGL	derived concentration guideline level
DNSC	Defense National Stockpile Center
DOE	U.S. Department of Energy
dpm/100 cm^2	disintegrations per minute per one-hundred square centimeters
EPA	U.S. Environmental Protection Agency
FSS	final status survey
FSSR	final status survey report
GPS	global positioning system
GSA	General Service Administration
ITP	Intercomparison Testing Program
kg	kilogram
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
MeV	million electron volts
m^2	square meter
NAD	North American Datum
NaI	sodium iodide
NHD	New Haven Depot
NRC	U.S. Nuclear Regulatory Commission
NRIP	NIST Radiochemistry Intercomparison Program
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
RAM	radioactive material
RSS	ranked set sampling
SOR	sum-of-ratios
TAP	total absorption peak
Th-232	Thorium-232
U-238	Uranium-238
VSP	Visual Sample Plan

CONFIRMATORY SURVEY OF THE DEFENSE LOGISTICS AGENCY DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA

INTRODUCTION AND SITE HISTORY

In 1946, a National Stockpile program began with the goal of mitigating dependence on foreign sources of vital materials during times of national emergencies. The New Haven Depot (NHD) in New Haven, Indiana, formerly the Casad Depot, was used to store 29 different types of strategic materials. The NHD is owned by the General Services Administration (GSA) and was operated by the Defense National Stockpile Center (DNSC).

Historically, the primary mission at the NHD was to store metallurgical ores and materials necessary for manufacturing defense and/or strategic materials. The DNSC stored columbium/tantalum ores and concentrates, tungsten ores and concentrates, zirconium ore, rare earth sodium sulfate, monazite, tungsten metal scrap, and bastnasite throughout the various warehouses and outdoor areas of the NHD. These materials contained sufficient amounts of natural uranium and thorium to require licensing under U.S. Nuclear Regulatory Commission (NRC) regulations and were stored by the DNSC in accordance with NRC License STC-133.

Materials like zirconium ore were stored in outdoor piles while other materials containing licensable quantities of uranium and thorium packaged in wooden boxes and drums were stored in designated bays within the warehouses located on the site. Specifically, the outdoor storage area for the licensed zirconium material was designated as Pile 111 and was located in the NHD open area designated as 7A. A portion of the zirconium in Pile 111 originated from DNSC depots in Jeffersonville, Indiana and Columbus, Ohio. Pile 111A contained contaminated soils that were removed from the base of the former Jeffersonville and Columbus Depots zirconium piles.

In 2000, all zirconium ore was sold and loaded into railcars at the Area 7A storage location for shipment to the new owner. The loaded railcars were then moved to the rail scale where the railcar loads were adjusted to maximum acceptable weight for transport. After the railcars reached maximum weight, they were moved to a shrink-wrapping area and shrink-wrapped to prevent loss of the material during transport. Some of the material was spilled during the loading operations which resulted in localized contamination of the associated land area. The largest accumulations of zirconium residues were identified on the paved road from Area 7A to the rail scale and the railroad tracks at the southern end of the Depot in front of Building 111. Other handling processes on the western side of the Depot resulted in the spillage of smaller, more discrete ore residues. The containerized licensed materials at NHD were stored in Warehouses 210 through 215 and several other smaller buildings.

The DNSC is in the process of closing a number of depots across the country and requesting license amendments to remove those applicable depots from License STC-133. DNSC contracted with Cabrera Services, Inc. (Cabrera) to remediate remaining impacted areas of the NHD and to perform final status surveys (FSS). Prior to performing the FSS, all licensed radioactive material (RAM) and residual licensed RAM on roadways and the adjacent ground surfaces were removed and the interior structural surfaces were remediated. The radionuclides of concern were natural thorium and uranium and the associated daughter products of the two decay series.

SITE DESCRIPTION

The New Haven Depot consists of 268 acres of land three miles east of Fort Wayne, Indiana off of State Route 14 (Figure A-1). There is a six foot high fence topped with barbed wire that surrounds the site. The site has a security officer controlling access, but is otherwise unoccupied. There are a number of large storage warehouses and other support buildings. The large warehouses used for RAM storage— Warehouses 210 through 215—are approximately 55 meters wide, 293 meters long and are framed with wood, concrete, or concrete-block that support wooden roof decks (Figure A-2). Each warehouse is divided equally into four approximately 55-meter by 72-meter sections. Each section is then further subdivided into 79 equally sized storage bays. Other radiologically impacted buildings where RAM was handled and/or stored included buildings 136, 141, 145 (only the footprint remains) and 146 (Figure A-2). For the former exterior RAM storage piles, Pile 111 has a footprint surface area of 1,650 square meters (m^2) and Pile 111A has a footprint surface area of 650 m^2. The footprints of these piles are outlined by Survey Units 1 through 6 as indicated in Figure A-3.

OBJECTIVES

The objectives of the radiological confirmatory survey were to collect adequate radiological data for use in evaluating the radiological condition of NHD land areas, warehouses, and support buildings. The data generated from the confirmatory survey activities were used to evaluate the results of the Final Status Survey Report (FSSR) submitted by Cabrera Services (Cabrera 2009). Cabrera has stated that all radioactive materials have been removed and that remediation of the open land areas and structure surfaces was complete, and that the NHD meets the criteria for unrestricted use.

DOCUMENT REVIEW

Oak Ridge Institute for Science and Education (ORISE) reviewed the FSS procedures for the NHD and the FSS report. Information was evaluated to assure that FSS procedures were appropriate for the radionuclides of concern and that residual activity levels satisfied the established radiological release criteria.

PROCEDURES

ORISE personnel visited the NHD from October 5 through 8, 2009 to perform visual inspections and independent measurements and sampling. The confirmatory survey activities were conducted in accordance with a site-specific confirmatory survey plan and the ORISE Survey Procedures and Oak Ridge Associated Universities (ORAU) Quality Program Manuals (ORISE 2009a and 2008 and ORAU 2009).

The collective site areas surveyed consisted of nine structural survey units and nine land area survey units totaling approximately 35,000 m^2. Each survey unit was classified in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), based on contamination potential (NRC 2000). A description of each classification is as follows:

Class 1: Areas that have a significant potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiological surveys) that exceeds the expected derived concentration guideline level ($DCGL_W$).

Class 2: Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$.

Class 3: Any impacted areas that are not expected to contain residual contamination, or are expected to contain levels of residual contamination at a small fraction of the $DCGL_W$.

Survey unit information is summarized in the Table 1 and in Figures A-2 and A-3.

TABLE 1: NEW HAVEN DEPOT SURVEY UNIT SUMMARY		
Survey Unit ID	**Type**	**Classification**
145-F	Concrete Pad	3
210-2-1	Building	1
210-2-2	Building	1
210-2-3	Building	1
210-2-4	Building	1
210-2-F	Building	3
210-3-F	Building	3
210-2-F	Building	3
210-2-W	Building	3
215-4-F	Building	3
219A-F	Building	2
1	Land Area	1
2	Land Area	1
3	Land Area	1
4	Land Area	2
5	Land Area	1
6	Land Area	1
8	Rail Scale Concrete Pad	2
9	Land Area	1
210-2-6	Land Area	1

Reference System

Exterior survey results were referenced to prominent site features and/or global positioning system (GPS) coordinates. The coordinate reference system used for the confirmatory survey was: North American Datum (NAD) 1983 State Plane Indiana East FIPS 1301 Feet. Building survey information was referenced to the building number, storage bay designation and/or specific X, Y coordinates from the southwest corner of the respective survey unit floor and lower left corner of walls. A written record of survey information was maintained on site drawings.

Surface Scans

High and medium density gamma radiation surface scans were conducted over all land area survey units (Figures A-4 and A-14). Surface scans were performed using Sodium iodide (NaI) scintillation detectors coupled to ratemeter-scalers with audible indicators. Detectors for exterior surveys were also coupled to GPS systems that enabled real-time gamma count rate and position data capture. Field personnel relied on the audio output to identify and mark for further investigations any locations of elevated direct gamma radiation that might suggest the presence of residual contamination.

Structural surfaces, such as floors, lower walls, and concrete pads were scanned for alpha plus beta and gamma radiation (Figures A-12, A-14 and A-17 through A-19). Scan density was dependent on survey unit classification. Class 1 survey units received high density scans, Class 2 medium density and Class 3 low density. NaI scintillation detectors were used for direct gamma radiation scans and gas proportional detectors for direct alpha plus beta radiation scanning. Detectors were coupled to ratemeters or ratemeter-scalers with audible indicators. Locations of elevated direct radiation were marked for further investigation. Identification of areas requiring additional investigation was based on instrument count rate action levels established at the site.

Surface Activity Measurements

Construction material specific backgrounds were determined in areas without a history of radioactive material use but of similar material and construction. These reference areas included Buildings 141C and 211 Section 1. The selection of these areas was based on program personnel experience and professional judgment in order to have the best possible reference material specific backgrounds. Ambient background measurements were derived from instrument setups.

Direct measurements to quantify total alpha and alpha plus beta activity levels were performed at random locations within each survey unit selected for the confirmatory survey. The number of random measurements was calculated using the FSS data as inputs. Visual Sample Plan (VSP) version 5.4.1 was used to plot six locations for each of the survey units on building surfaces while incorporating a quasi-random approach that minimized spatial clustering of measurement locations. Judgmental direct measurements were made at any locations of elevated direct radiation detected by surface scans. Direct measurements were made using gas proportional detectors coupled to ratemeter-scalers. Direct measurement locations for building survey units are indicated on Figures A-13, A-15, A-16 and A-20 through A-23.

SOIL SAMPLING

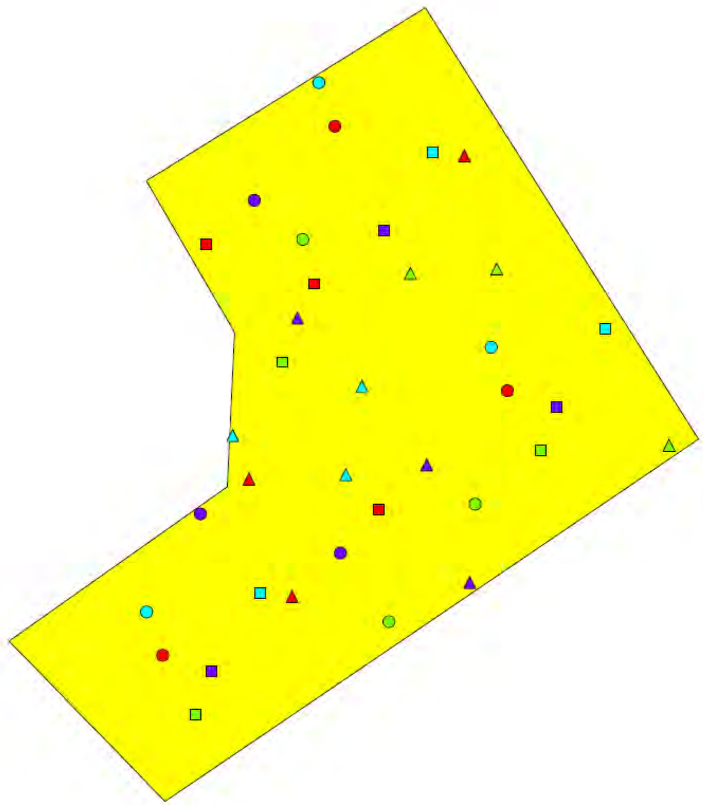
A ranked set sampling (RSS) approach was used to design the confirmatory soil sampling plan (EPA 2002). RSS provided a methodology to estimate the mean concentration of a population without requiring the assumption of a normal distribution. The process combines random sampling with the use of professional judgment to select sampling locations. The professional judgment relied upon the ability to assess the relative magnitude of gamma radiation levels between randomly selected locations. In this case, the gamma count rate data collected at randomly selected locations provided the measurable field screening method that correlates with the relative concentrations of the gamma emitting contaminants of concern. The count rate data obtained were then used to select a specific sampling location.

The following example explains the process:

- The Visual Sampling Plan v.5.4.1 RSS module was used to determine the necessary number of soil samples to estimate the mean. The number of measurements was based on the expected standard deviation and desired confidence level of the estimated mean.
- For this example, assume that the systematic planning process resulted in $n = 12$ soil samples to estimate the mean.
- The next step was to use a replication process on a larger random population from which the locations for the 12 soil samples will be selected.
- The replication process was referred to as a cycle, designated as r.

- Each cycle (*r*) consists of multiple sets; sets were designated as *m*.
- Each set (*m*) is comprised of a set size, or field assessment locations. The data from each set were ultimately the values that were ranked, for this example the ranked values were direct gamma counts. The set size should consist of two to five field assessment locations. For this project, a set size consisted of three locations. The gamma count data collected from the three locations associated with each set were ranked as being either low, medium, or high gamma count locations. The three ranking categories established the set size.
- The total number of repetitive cycles (*r*) is a function of *n* (12) and *m* (3)—or simply defined as $n = m \times r$. *r* for this example would therefore be 4 ($r = 12/3$).
- The number of field assessment locations per cycle, was a function of the set size and is simply m^2. The total number of field assessment locations was then defined as $m^2 \times r$ or in this example $3^2 \times 4 = 36$.
- The 36 locations were then both randomly grouped into cycle/sets and distributed in the survey area. The nomenclature for identifying a specific assessment location was cycle #-set#-arbitrary sequence # (1, 2, or 3). The first location in cycle 1 of set 1 was designated as 1-1-1. Mapping is color coded (based on cycle ID) using geometric shapes (based on set ID) to visually show the population of assessment locations.
- Specific measurement locations were generated via either a pseudo- or quasi-random approach.

FIGURE 1 : EXAMPLE LAND AREA UNIT WITH RANKED SET SAMPLING LOCATIONS



Cycle 1 Gamma Measurement Locations	Cycle 2 Gamma Measurement Locations	Cycle 3 Gamma Measurement Locations	Cycle 4 Gamma Measurement Locations
■, ▲, ●	■, ▲, ●	■, ▲, ●	■, ▲, ●
Set: 1, 2, 3	Set: 1, 2, 3	Set: 1, 2, 3	Set: 1, 2, 3

Figure 1 is an example of an RSS measurement/sampling plan.

One-minute gamma measurements were collected at each of the 36 assessment locations and the data within a given cycle-set were then ranked as exhibiting either the lowest, medium, or highest gamma count. Soil samples were collected in accordance with the following process within each of the four cycles: Set 1, lowest gamma radiation location; Set 2 medium location; Set 3 highest location. Table B-1 provides the RSS method showing field assessment data and the location selected for soil sampling.

Cabrera Services, Inc. survey unit FSS data were used to determine the number of random confirmatory samples necessary to verify the mean concentrations. Specifically, the inputs used were the respective DCGLs for the primary natural radionuclides Thorium-232 (Th-232) + C and Uranium-238 (U-238) + C. There were three area sample planning groups as follows: Survey Units 3, 4 and 9 served as sampling Group 1, Survey Units 1, 2, 5 and 6 were included together as Group 2 and Group 3 was represented by Survey Unit 210-2-6 (a remediated soil area within Building 210 Section 2). The decision to pool the verification data for the survey units was based on the evaluation of the Cabrera Services, Inc.-determined mean concentration and standard deviation of the contaminants of concern for each survey unit. Figures A-5 through A-7 illustrate the RSS gamma measurement locations

Twelve random surface (0 to 15 cm) soil samples were collected from each group. The specific random coordinate sampled was from the preliminary random coordinate pool of 36 locations for each group. Figures A-8, A-10 and A-11 illustrate the random ranking locations and the soil sample locations.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to the ORISE laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORISE Laboratory Procedures Manual (ORISE 2009b). Direct measurement results were reported in units of disintegrations per minute per one-hundred square centimeters (dpm/100 cm^2). Soil samples were analyzed by gamma spectroscopy for Th-232 + C and U-238 + C. The spectra were also reviewed for other identifiable photopeaks. Soil sample results were reported in units of picocuries per gram (pCi/g).

The data generated were compared with the approved release criteria established for the NHD. The Defense Logistics Agency requested site-specific release criteria that allowed soil concentrations to contain up to 2.5 pCi/g of Th-232 and 2.3 pCi/g of U-238. These NRC-approved criteria also applied to any of the radionuclides in the Th-232 or U-238 decay series individually. Additional information regarding instrumentation and procedures may be found in Appendices C and D.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ORISE's review of Cabrera's project documentation indicated that most procedures and methods implemented for the FSS were appropriate and that the resultant data were acceptable. However, when incorporating the MARSSIM based approach for the design of FSS, the 2 pi efficiency of survey instruments combined with a surface efficiency factor is typically the norm used for direct measurements. Cabrera's project documentation used 4 pi efficiencies for their FSS activities. A 4 pi efficiency would result in biasing residual surface activities lower than the 2 pi efficiencies when combined with the surface efficiency factor. The low bias is a result of not accounting for surface attenuation factors. This issue of Cabrera collected data using inappropriate efficiencies was mentioned in the confirmatory survey plan and within correspondence with the NRC site representative on September 30, 2009.

Further review of the FSSR revealed that the survey unit identified as Building 129A was represented incorrectly. The ORISE survey team with the assistance of site personnel determined that Building 129A did not exist at the NHD, and its designation in the FSSR actually referred to Building 219A at the Rail Scale. This correction was made on-site and the appropriate building number was assigned for this report.

SURFACE SCANS

Soil Surfaces

Gamma radiation surface scans identified two locations of elevated activity in Survey Unit 9. The GPS coordinates were recorded and a judgmental soil sample was collected from each location (Figure A-9). Land area scans ranged from 1,200 to 5,651 counts per minute (cpm) with the variability in the ambient gamma radiation levels consistent with the localized area topography and geology. Gamma scan results are illustrated in Figures A-4, A-12 (SU145 pad) and A-14 for each area. Figure A-24 provides a frequency histogram of the combined soil/exterior area gamma scan count rate population.

Structural Surfaces

On interior structural surfaces, alpha + beta scan count rates generally ranged from 951 to 2,300 cpm with the 43-37 large area gas proportional detector, and 200 to 400 cpm using the smaller hand-held gas proportional detector. Data are provided as the gross, observed count rates for alpha + beta scans in Figures A-17 through A-19. Figure A-25 provides a frequency histogram of the combined alpha + beta count rate data population.

SURFACE ACTIVITY LEVELS

Individual total alpha and alpha + beta surface activity measurements are documented in Table B-3. NHD structural surface activity $DCGL_W$ is for alpha activity only; alpha + beta scan range and surface activity measurements were collected to supplement the alpha activity data. The summary data for the confirmatory alpha activity measurements are presented in Table 2.

TABLE 2: SUMMARY RESULTS FOR ALPHA ACTIVITY MEASUREMENTS

Survey Unit	Alpha Activity Range (dpm/100 cm^2)
SU145-F	15 to 134
SU210-2-1	-1 to 39
SU210-2-2	-33 to 31
SU210-2-3	-1 to 174
SU210-2-4	-25 to 38
SU210-2-F	-1 to 39
SU210-3-F	-17 to 31
SU210-W	-10 to 34
SU215-4-F	-17 to 15
SU219A	-13 to 2
SU8 Rail Scale	7 to 174

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES

The data for the ORISE radionuclide concentrations in individual samples and the sum-of-ratios (SOR) are provided in Table B-2. The summary data for the three combined survey groupings are presented in Table 3 as gross soil radionuclide concentration. When calculating the SOR values presented in Table B-2, ORISE determined the Net Concentration values for the confirmatory soil samples by subtracting the average background concentrations as determined by Cabrera in the FSSR.

TABLE 3: RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES SUMMARY RESULTS		
Survey Area Groupings	**Th-232 + C (pCi/g)[a]**	**U-238 + C (pCi/g)[a]**
Group 1: Survey Units 3, 4, 9	0.16 to 1.04	0.74 to 2.75
Mean Concentration	*0.83*	*1.74*
Group 2: Survey Units 1, 2, 5, 6	0.29 to 1.52	0.86 to 3.06
Mean Concentration	*0.67*	*1.69*
Group 3: Survey Units 210-2-6	0.55 to 0.75	1.48 to 2.02
Mean Concentration	*0.64*	*1.66*

[a]Gross soil concentration.

The radionuclide concentrations for the two judgmental soil samples collected from Survey Unit 9 are provided in Table 4. A review of the FSSR indicated that the ORISE judgmental soil sample locations coincide with Cabrera biased soil samples as indicated in Figure 6-6 of the FSSR (Cabrera 2009). It should also be noted that the two judgmental sample locations comprise two different contaminants based on the differences in the Th-232 and U-238 ratios.

TABLE 4: RADIONUCLIDE CONCENTRATIONS IN JUDGMENTAL SOIL SAMPLES SUMMARY RESULTS		
Survey Area Groupings	**Th-232 + C (pCi/g)[a]**	**U-238 + C (pCi/g)[a]**
Judgmental S025	4.38	3.38
Judgmental S026	-0.07	41.5

[a]Gross soil concentration.

COMPARISON OF RESULTS WITH RELEASE CRITERIA

STRUCTURAL SURFACES

Confirmatory survey data for structural surfaces were compared with the structural site-specific gross DCGL for the evaluated SUs. The final resultant surface DCGLs in Tables 5 and 6 were based on surface activity screening values from NUREG/CR-5512 that were further modified based on the total number of alphas emitted in each of the applicable decay chains and the percent contribution from each chain. Then applicable RAM fractions were applied for mixtures of materials stored in different areas of the site.

TABLE 5: STRUCTURE ALPHA $DCGL_W$

Building	Impacted Structure Area	Alpha $DCGL_W$ ($dpm/100cm^2$)
124	All locations	100
136	All locations	38
141	All locations	100
145 (footprint)	All locations	100
146	All locations	100
210	Sections 1, 2 and 3: All locations	38
	Section 4: Bays 2-5, 8, 9, 12-14, 32-33, 35, 43, 45, 46, 48, 52-54, 56, 58 and 76 only	100
211	Section 1 and 2: All locations	55
212	Section 1: Bays 11, 31, 37, 41, 51, 61 and 71	100
	Section 2: Bays 11, 12 and 21	100
213	Section 1: All locations	38
	Section 2: Bays 12, 13, 15 and 16	38
	Section 3: Bays 1, 19, 21 and 29	100
	Section 4: Bays 1, 9, 11, 15, 21, 31, 38, 39, 41, 51, 59, 67, 69, 75, 78 and 79	100
214	Sections 1, 2 and 3: All locations	38
	Section 4: Bays 41-43, 45 51, 59, 61, 69 and 75-79	55
215	Section 1: Bays 2-4, 11, 12, 13, 22, 23, 25-29, 34-37, 41, 43, 44, 45, 62 and 73-75	38
	Section 2: Bays 36, 41, 42, 46, 52-54, 62 and 63 only	38
	Section 4: Bays 15, 19, 29, 51-56, 61-65, 68 and 71-79 only	38
219A	All locations	100

TABLE 6: OUTDOOR AREA ALPHA $DCGL_W$	
Impacted Outdoor Areas	**Alpha $DCGL_W$ (dpm/100cm^2)**
Rail Scale	100
Entry Road and Paved Road to Rail Scale	100
Railroad Tracks Used for Shrink Wrapping	100
Railroad Tracks Used for Storage and Transport	100

Individual direct measurement data are presented within Table B-3. Surface direct measurements for alpha activity within Survey Units 210-2-2, 210-2-W, and 219A were within their applicable $DCGL_W$ and met the release criteria. However, fifteen percent of the direct structural surface activity measurements exceeded the $DCGL_W$ for the evaluated SUs. The survey units where individual alpha surface activity levels exceeded the survey unit's specific $DCGL_W$ are provided in the following paragraphs.

Class 1 survey units identified as having elevated alpha activity in excess of the alpha $DCGL_W$ were SUs 210-2-1, 210-2-3, and 210-2-4. Both SUs 210-2-1 and 210-2-4 had one location of 39 dpm/100 cm^2 that just exceeded the $DCGL_W$ (38 dpm/100 cm^2) and were well within a 1 m^2 $DCGL_{EMC}$. SU 210-2-3 had two locations of elevated alpha activity (79 and 174 dpm/100 cm^2) that exceeded the $DCGL_W$ of 38 dpm/100 cm^2. These locations were approximately 1 m^2 and were less than the calculated alpha activity $DCGL_{EMC}$ of 1,360 dpm/100 cm^2 for an area factor of 36. In addition to the random alpha direct measurements, the gamma and alpha + beta surface scans of the floor in 210-2-3 identified an area of elevated gamma and alpha + beta activity along a crack in the concrete. Judgmental direct alpha and alpha + beta measurements were taken at that location. The direct measurements indicated an elevated alpha + beta activity of 6,522 dpm/100 cm^2 within a borehole along the crack in the concrete. The high gamma activity detected during scans and the elevated alpha + beta activity indicate that a contaminant remains within the borehole for Survey Unit 210-2-3.

Class 2 Survey Unit 8 (Rail Scale) had one location of elevated alpha activity (174 dpm/100 cm^2) that exceeded the $DCGL_W$ of 100 dpm/100 cm^2. This location was on a crack in the concrete surface on the Rail Scale concrete pad. The confirmatory survey activities indicate that this survey unit was incorrectly classified as a Class 2 survey unit.

Class 3 survey units identified as having elevated alpha activity in excess of the alpha $DCGL_W$ were SUs 210-2- F and 145-F. SU 210-2-F had one location of 39 dpm/100 cm^2 that just exceeded the $DCGL_W$ (38 dpm/100 cm^2). SU 145-F, the remaining concrete pad of the former Building 145, had four locations of elevated alpha activity (102, 118, 126 and 134 dpm/100 cm^2) that exceeded the $DCGL_W$ of 100 dpm/100 cm^2. The confirmatory survey activities indicate that these SUs were incorrectly classified as Class 3 survey units.

SOIL SURFACES

Radionuclide concentrations in soil samples were directly compared with the Th-232 + C and U-238 + C release limits of 2.5 pCi/g and 2.3 pCi/g, respectively. The unity rule was applied in the activity calculations for soil when concentrations of natural thorium and natural uranium were present.

For those ORISE RSS soil samples in Table B-2 in which the gross concentration exceeds the $DCGL_W$, the subtraction of the FSSR site background concentrations [1.11 pCi/g of Th-232 and 1.24 pCi/g of U-238 as provided in the *Final Status Survey Report Table 3-11: Reference Area Soil Sample Results* (Cabrera 2009)] would put those samples below the $DCGL_W$. Therefore, all RSS soil sample results and their associated SORs were less than the established release criteria.

Furthermore, the confirmatory mean concentrations across the survey areas, provided in Table 3, were compared with the mean concentrations that ORISE calculated from the site's FSS results for each survey unit. The calculated gross site mean concentrations from Cabrera's soil sample data were 0.67 pCi/g for Th-232 + C and 1.22 pCi/g for U-238 + C. These values were comparable to the confirmatory mean concentrations of 0.64 pCi/g for Th-232 and 1.66 pCi/g for U-238. These data validated the site's FSS results. Additionally, the independent surveys validated the soil area classifications.

The gross concentrations of the two judgmental soil samples collected in Survey Unit 9 exceeded the $DCGL_W$. After background concentrations are subtracted, both of these samples still exceed the $DCGL_W$; one for Th-232 and the other for U-238. The determination of the $DCGL_{EMC}$ for Sample S025 with an area of 1 m^2 provides a $DCGL_{EMC}$ of 32.25 pCi/g for Th-232 and 45.77 pCi/g for

U-238; the sample concentrations are within the EMC values. The determination of the $DCGL_{EMC}$ for Sample S026 with an area of 4 m^2 provides a $DCGL_{EMC}$ of 12.27 pCi/g for Th-232 and 17.46 pCi/g for U-238; the sample concentration for U-238 exceeds the EMC value.

SUMMARY

ORISE performed confirmatory activities for 18 site areas at the DNSC New Haven Depot during the period October 5 through 8, 2009. These activities included the review and assessment of the FSS reports and independent measurements and sampling. The confirmatory survey results indicated that residual activity in excess of the site specific $DCGL_W$ is present in the following survey units ─ Soil Survey Unit 9 and Structural Survey Units: SU 145, SU 210-2-1, SU 210-2-3, SU 210-2-4, SU 210-2-F and SU 8 (Rail Scale).

Of the Class 1 areas (SU 9, SU 210-2-1, SU 210-2-3, and SU 210-2-4), when the elevated measurement comparison (EMC) criteria was applied, soil Survey Unit 9 (specifically soil sample S026) did not meet the EMC criteria. All of the Class 1 structural surfaces met the EMC criteria for alpha activity. However, the elevated gamma radiation and elevated alpha + beta surface activity measurement within a borehole along a crack in SU 210-2-3 demonstrates that residual radioactive contamination remains within this survey unit.

In Cabrera's final status survey report, SU 210-2-F and SU 145-F were classified as Class 3 survey units and SU 8 (Rail Scale) was classified as a Class 2 survey unit. The FSS data results portrayed surface activity levels below the $DCGL_W$ for these areas. However, ORISE confirmatory survey activities indicated that alpha surface activity levels within these survey units exceeded the $DCGL_W$ and that these survey units were incorrectly classified.

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U.S. Nuclear Regulatory Commission. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575; Revision 1. Washington, DC; August 2000.

APPENDIX A

FIGURES

Figure A-1: Location of the DNSC New Haven Depot

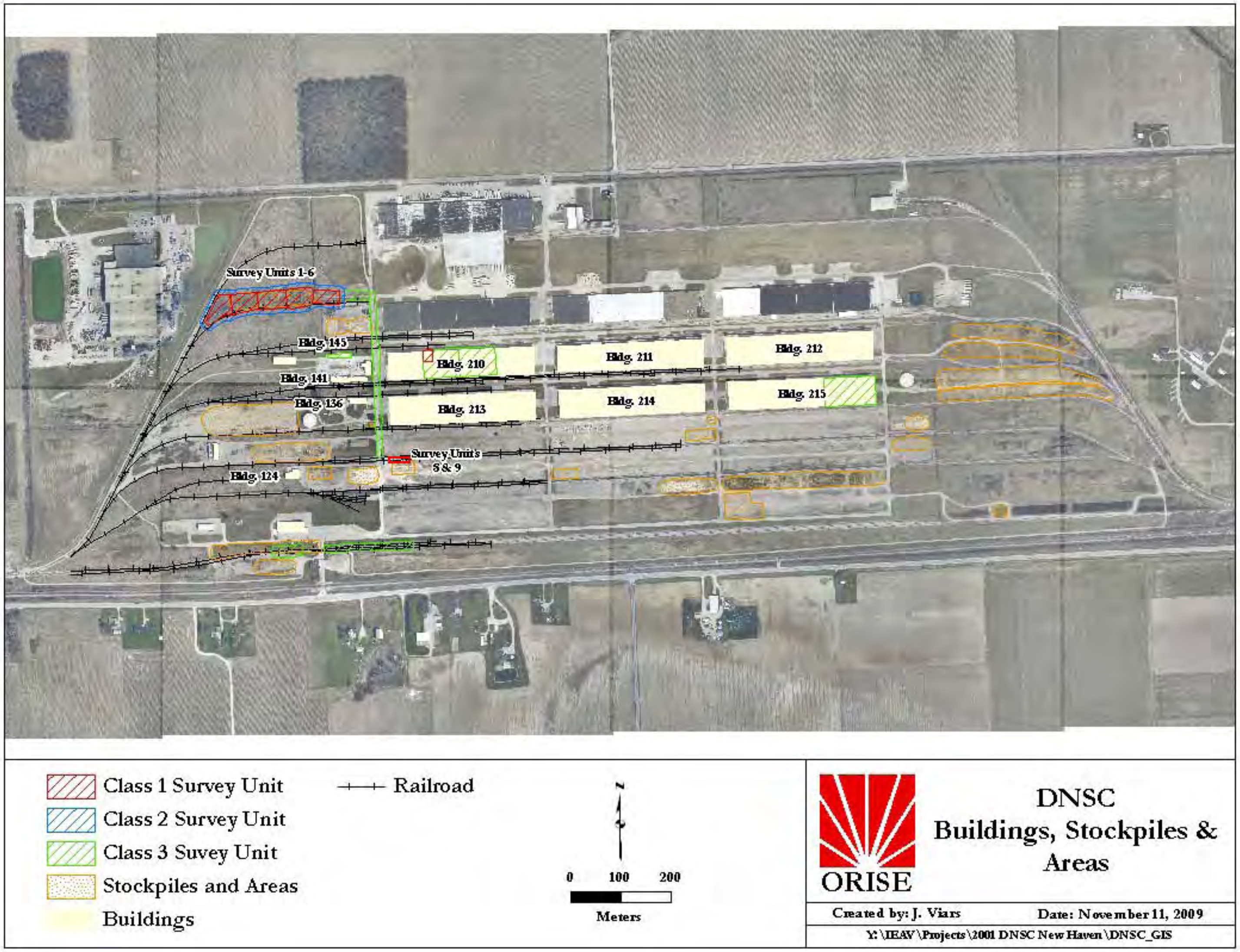


Figure A-2: DNSC New Haven Depot—Buildings, Stockpiles and Areas

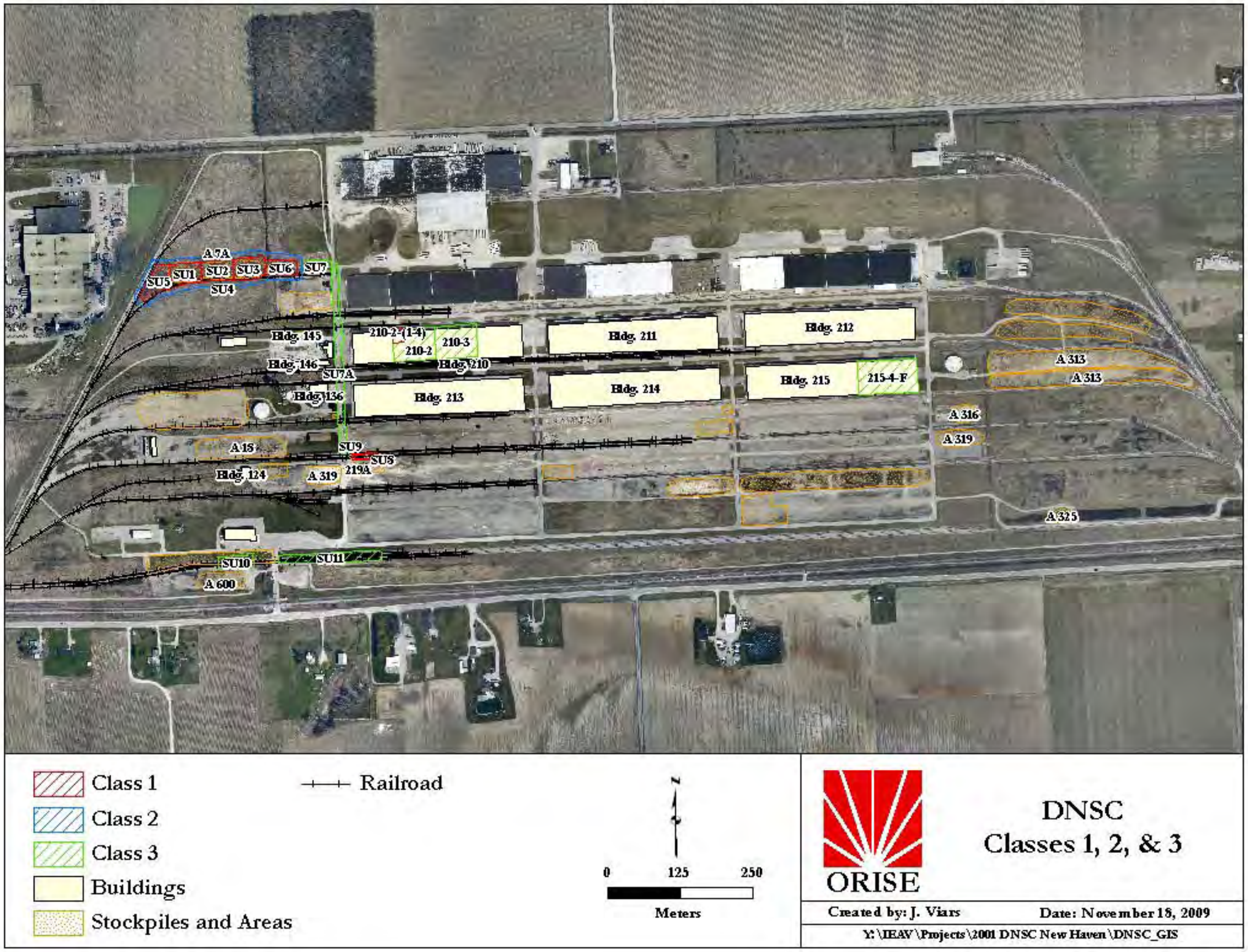


Figure A-3: DNSC New Haven Depot—Outdoor Survey Areas and Survey Unit Classifications

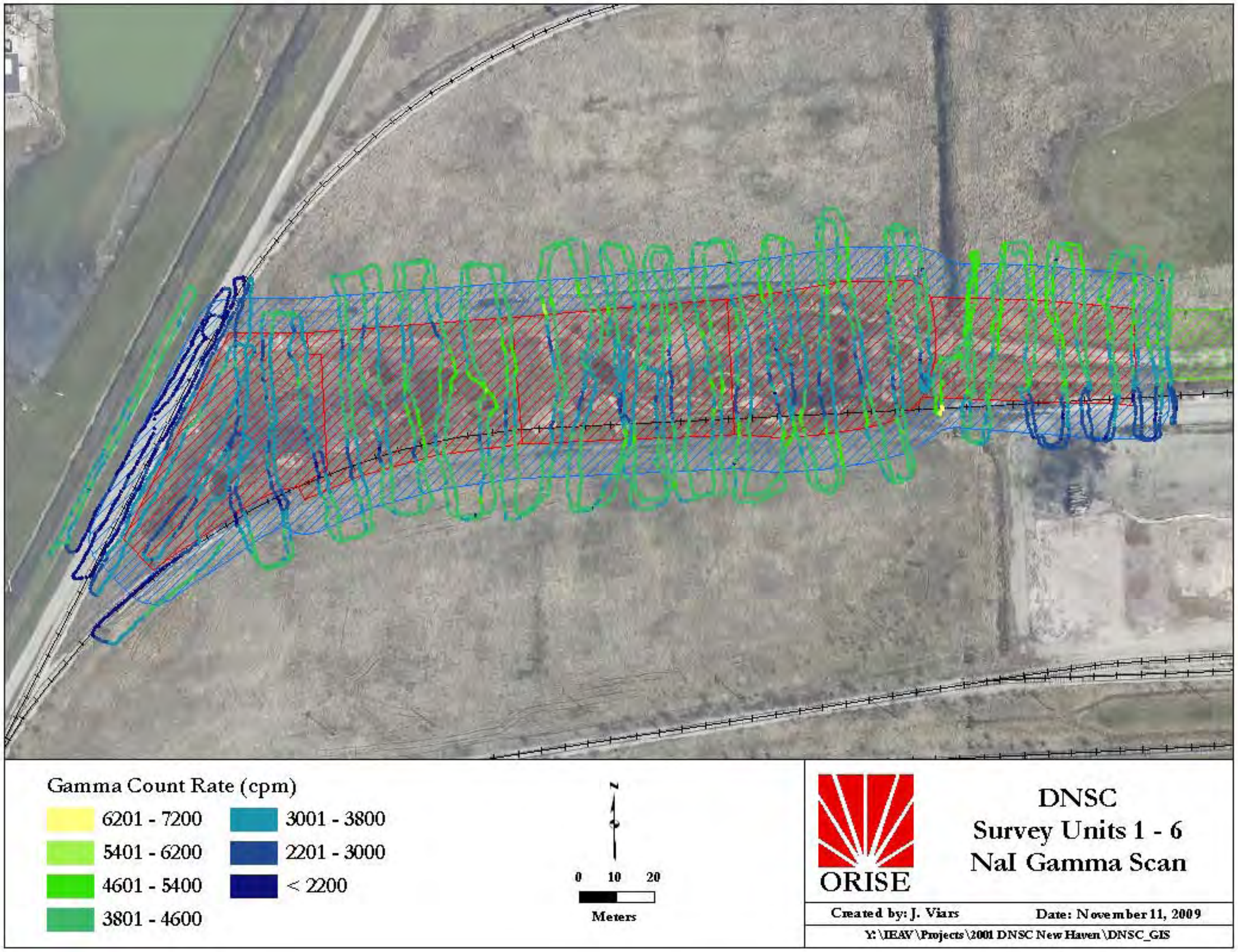


Figure A-4: Survey Units 1-6—Survey Area and Gamma Scans

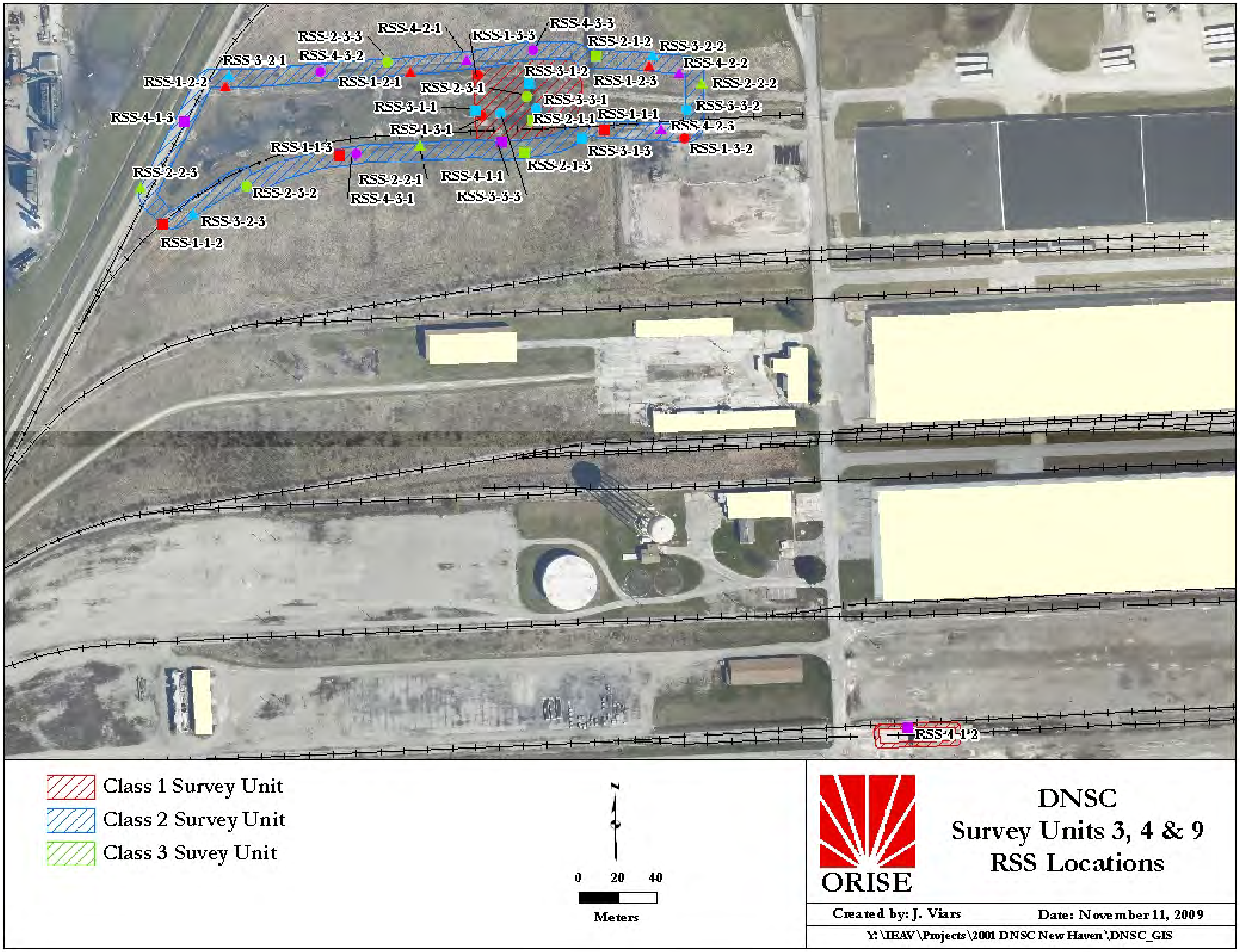


Figure A-5: Group 1 (Survey Units 3, 4 and 9) Confirmation Population, Survey Areas—Ranked Set Sampling Measurement Locations

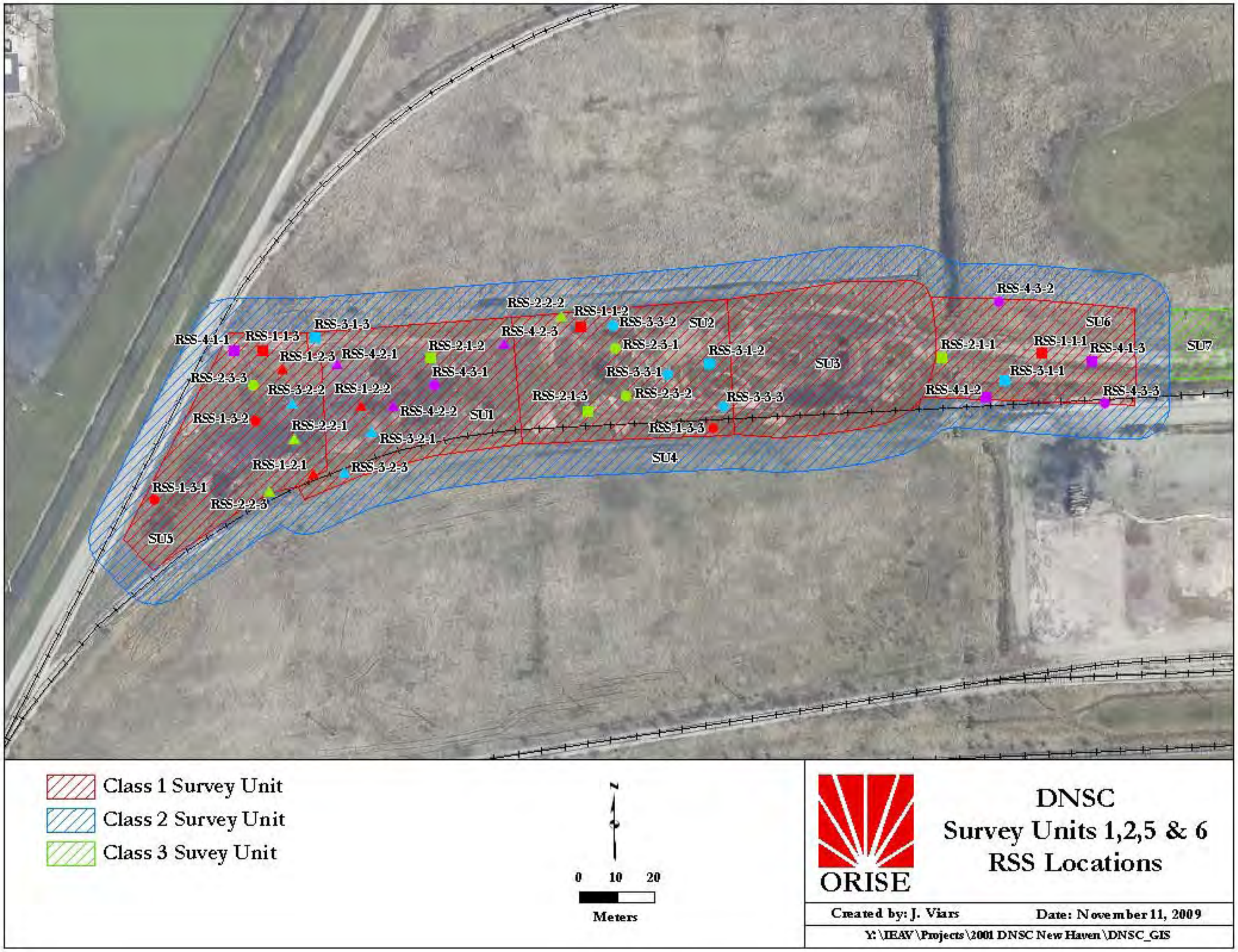


Figure A-6: Group 2 (Survey Units 1, 2, 5 and 6) Confirmation Population, Survey Areas—Ranked Set Sampling Measurement Locations

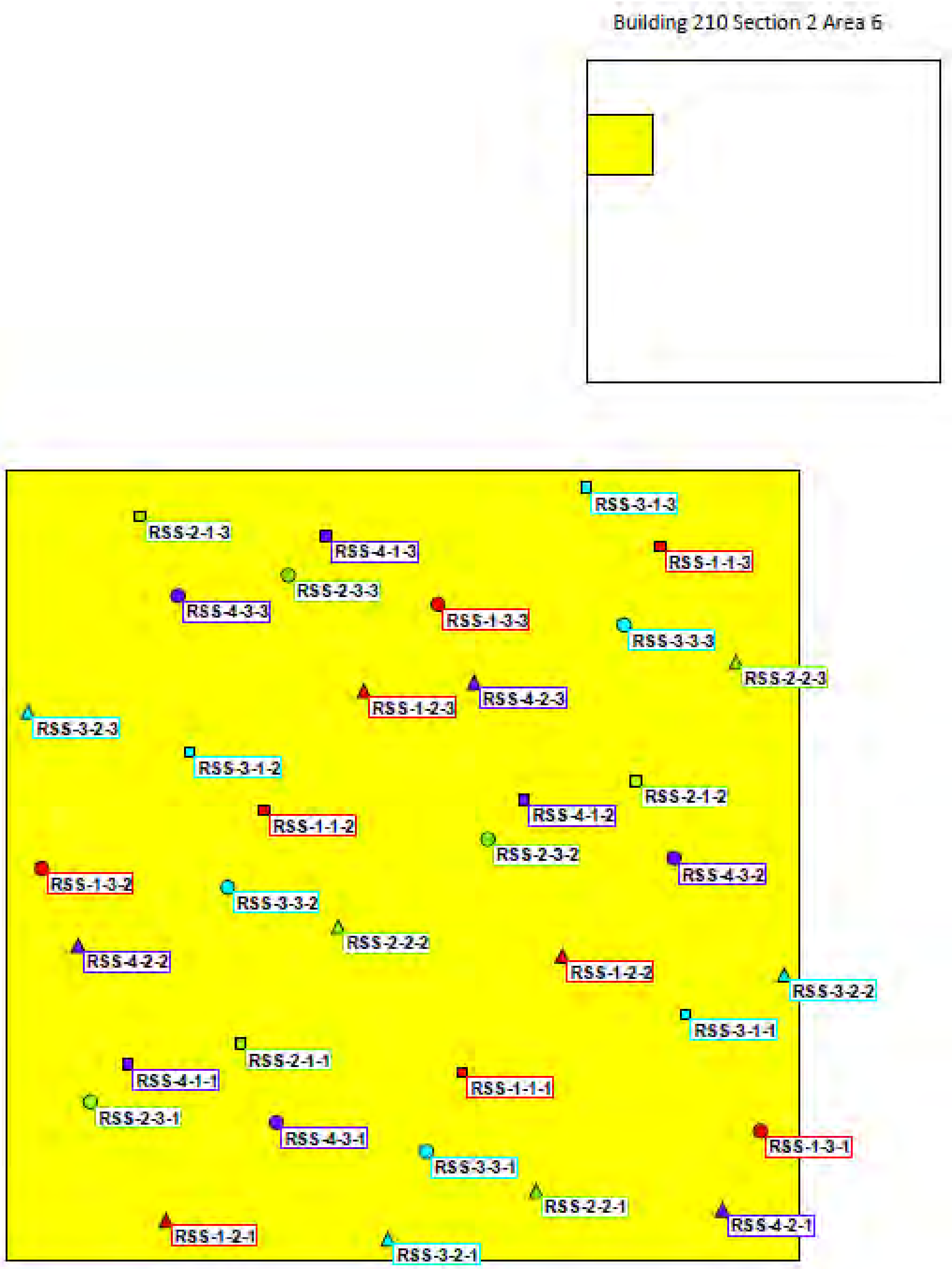


Figure A-7: Group 3 (Survey Unit 210, Section 2, Area 6) Confirmation Population, Survey Areas—Ranked Set Sampling Measurement Locations

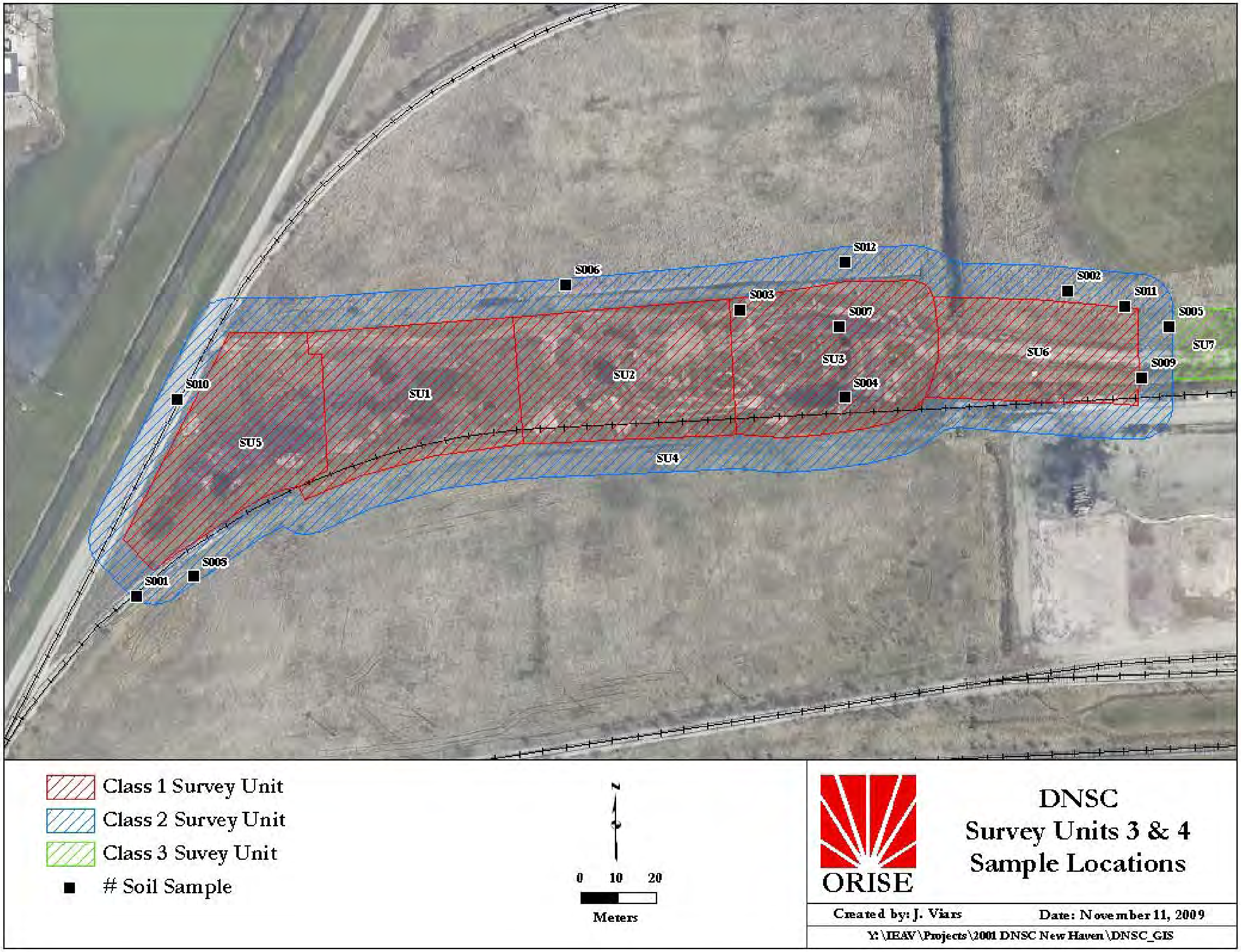


Figure A-8: Group 1 (Survey Units 3 and 4) Confirmation Population, Survey Areas—Soil Sampling Locations

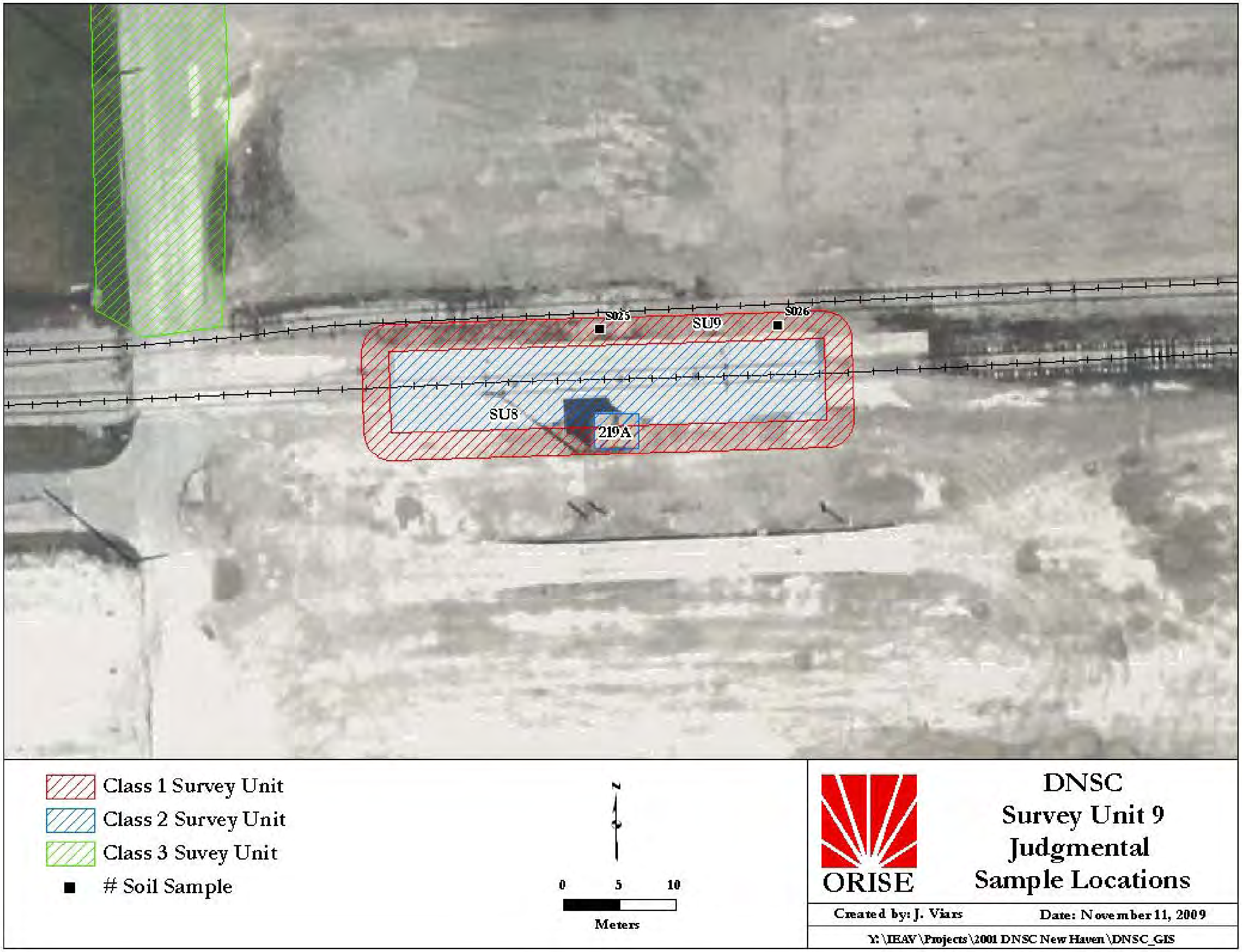


Figure A-9: Group 1 (Survey Unit 9) Confirmation Population, Survey Areas—Judgmental Soil Sampling Locations

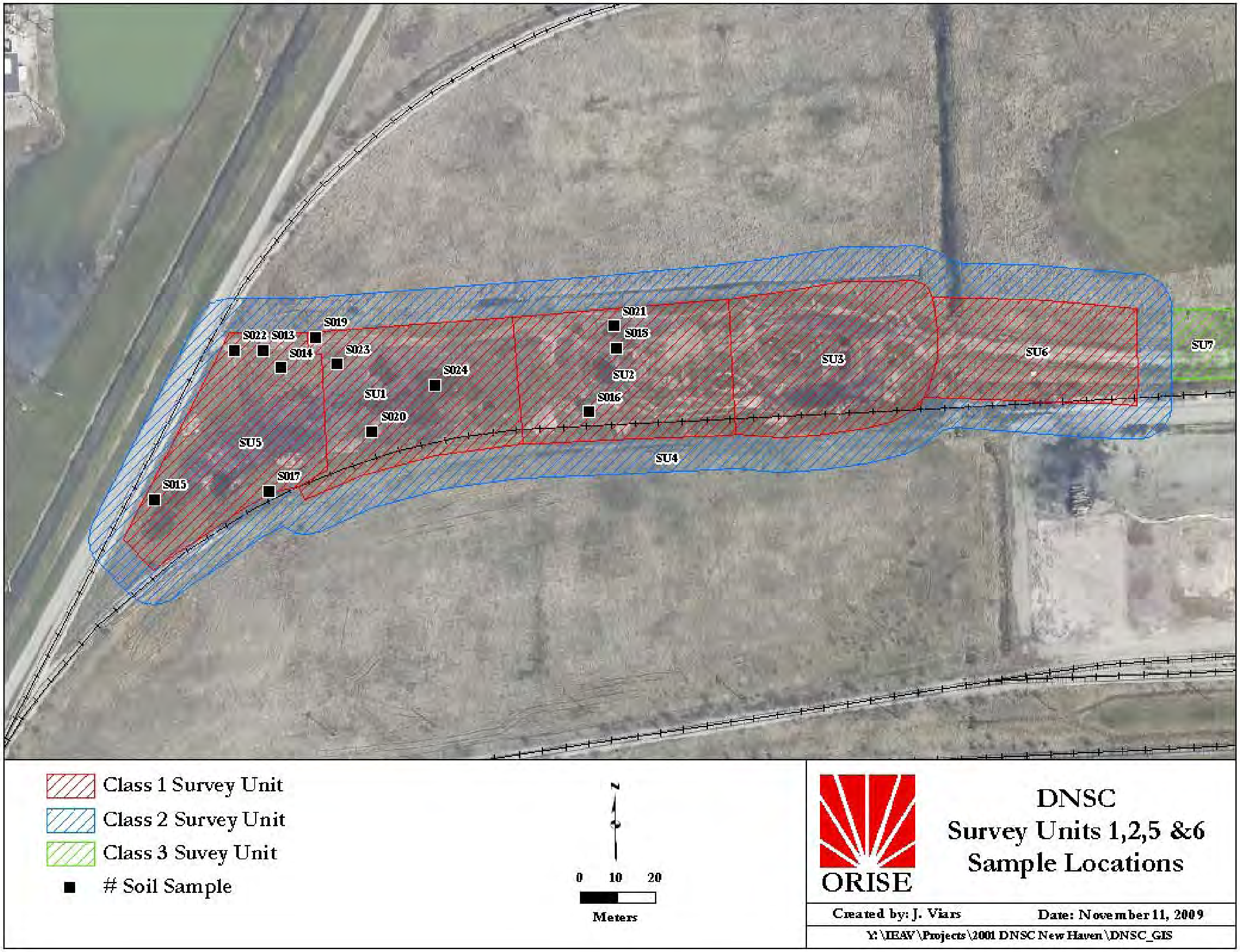
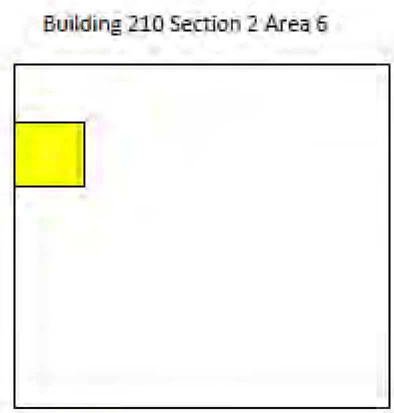


Figure A-10: Group 2 (Survey Units 1, 2, 5 and 6) Confirmation Population, Survey Areas—Soil Sampling Locations



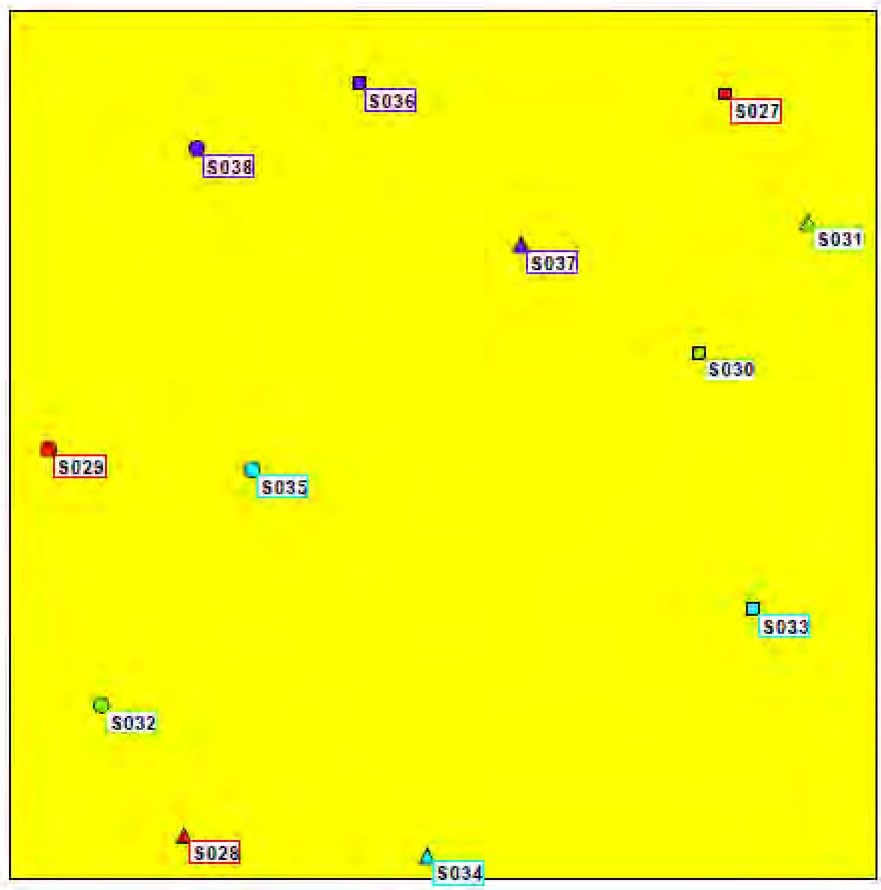


Figure A-11: Group 3 (Survey Unit 210, Section 2, Area 6) Confirmation Population, Survey Areas—Soil Sampling Locations

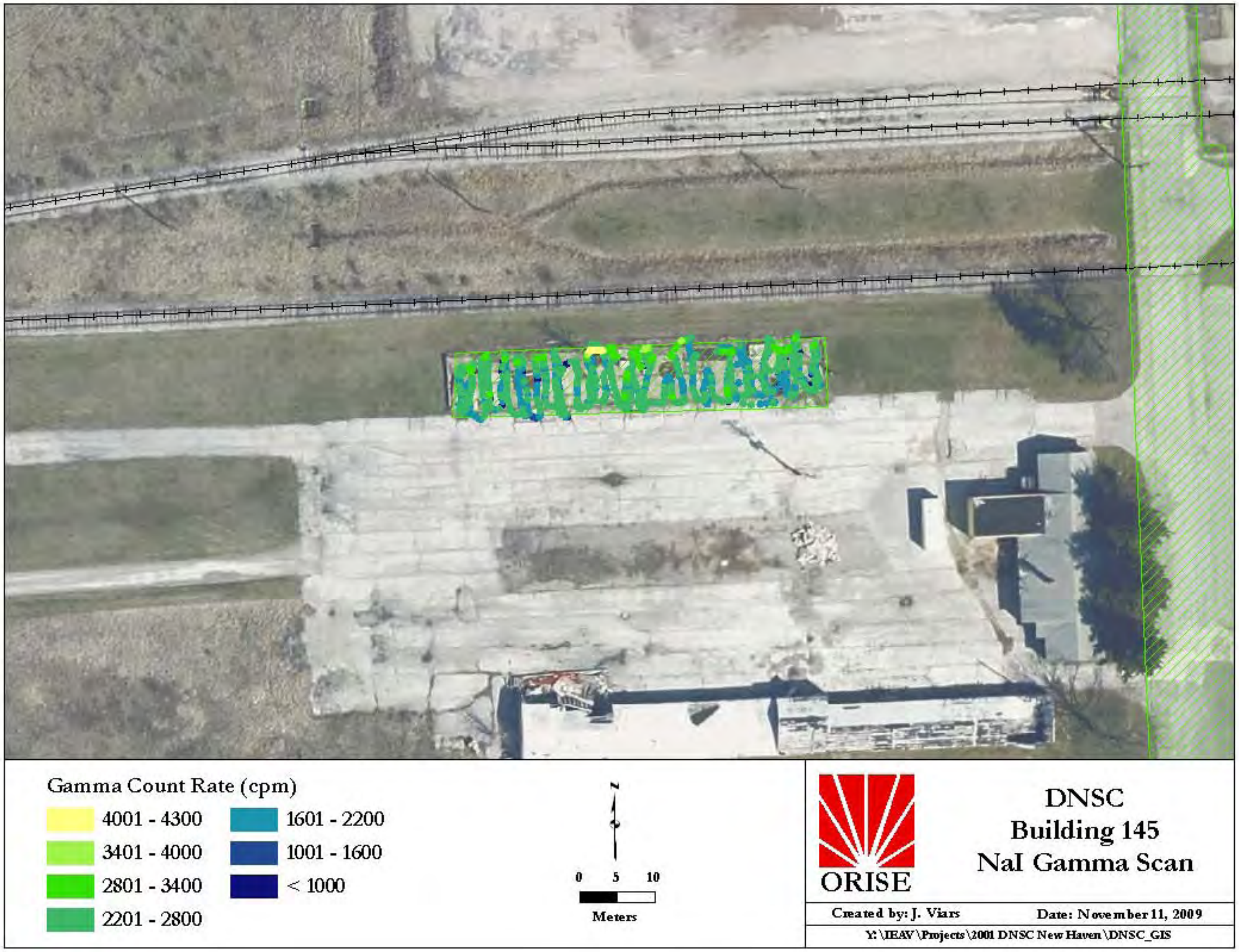


Figure A-12: Survey Unit 145—Survey Area and Gamma Scans

Figure A-13: Survey Unit 145—Direct Measurement Locations

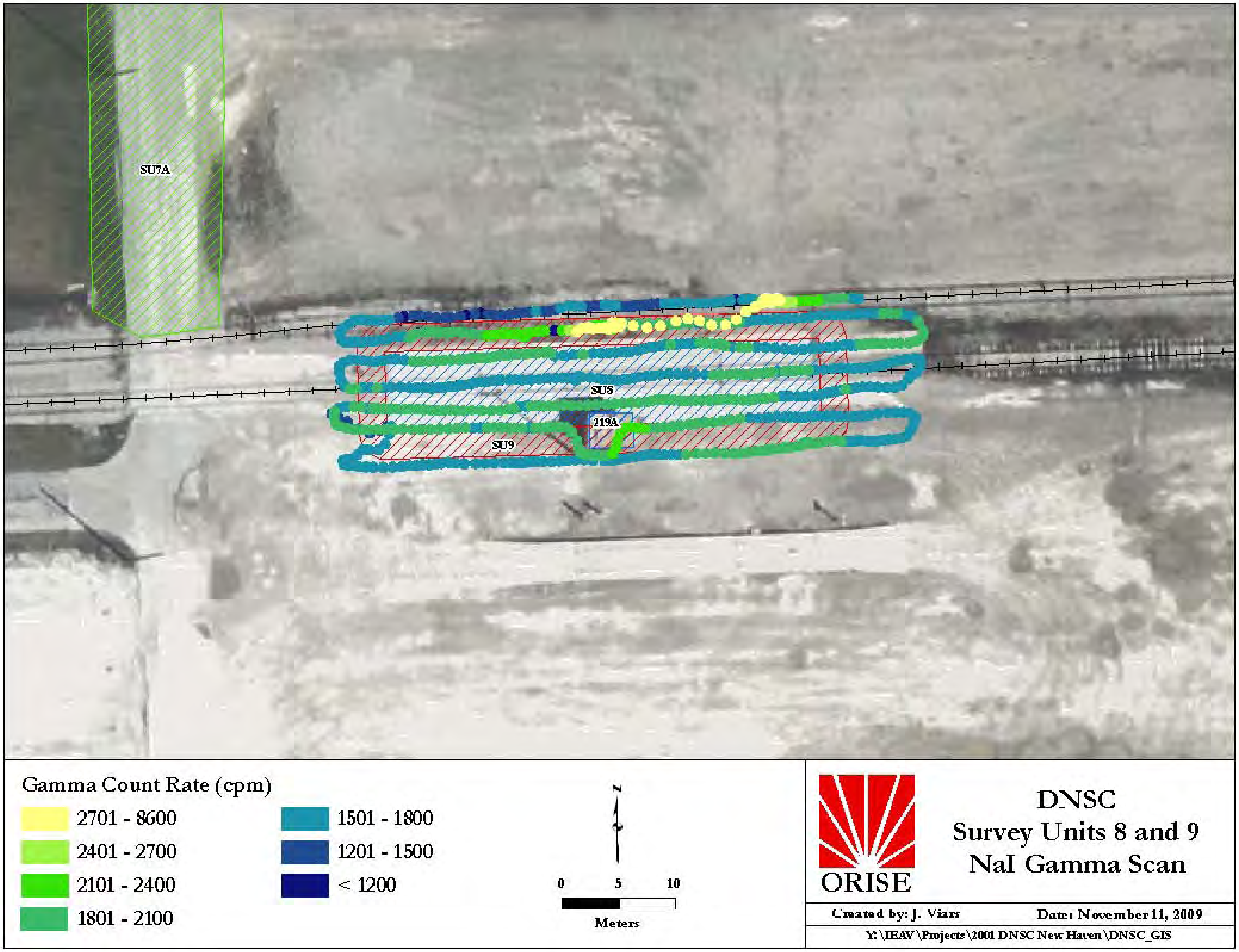


Figure A-14: Survey Units 8 and 9—Survey Area and Gamma Scans

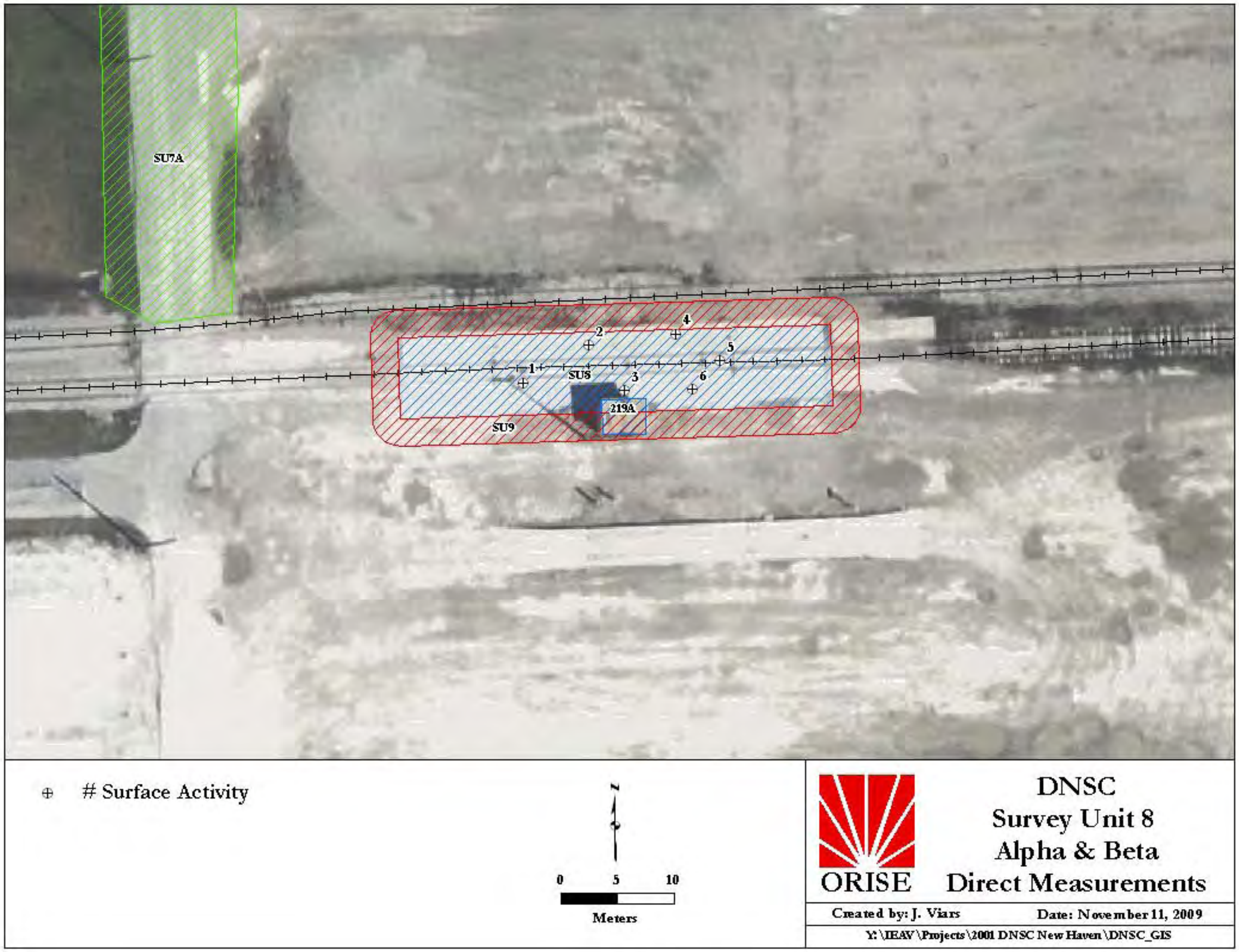


Figure A-15: Survey Unit 8, Rail Scale—Direct Measurement Locations

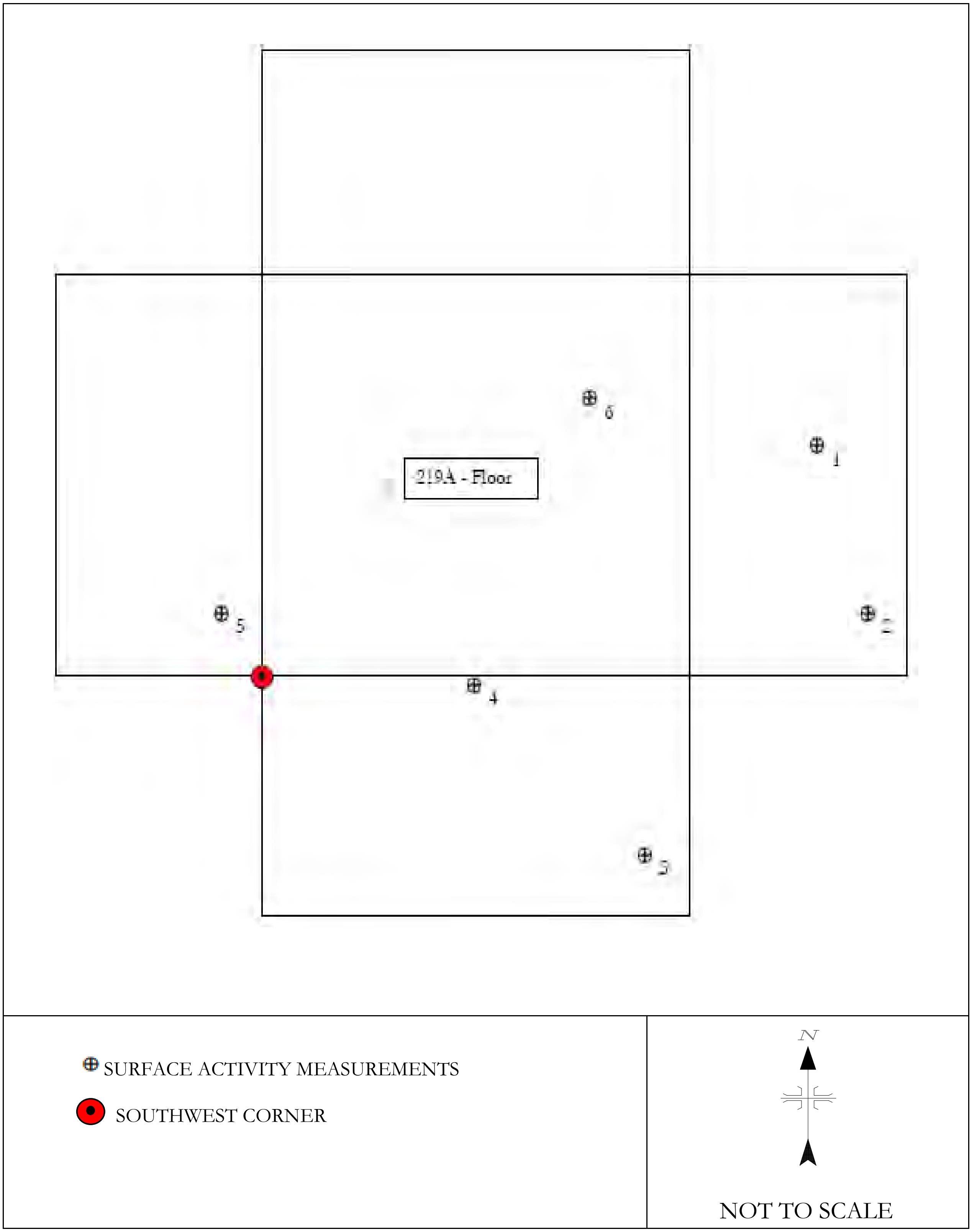


Figure A-16: Survey Unit 219A—Direct Measurement Locations

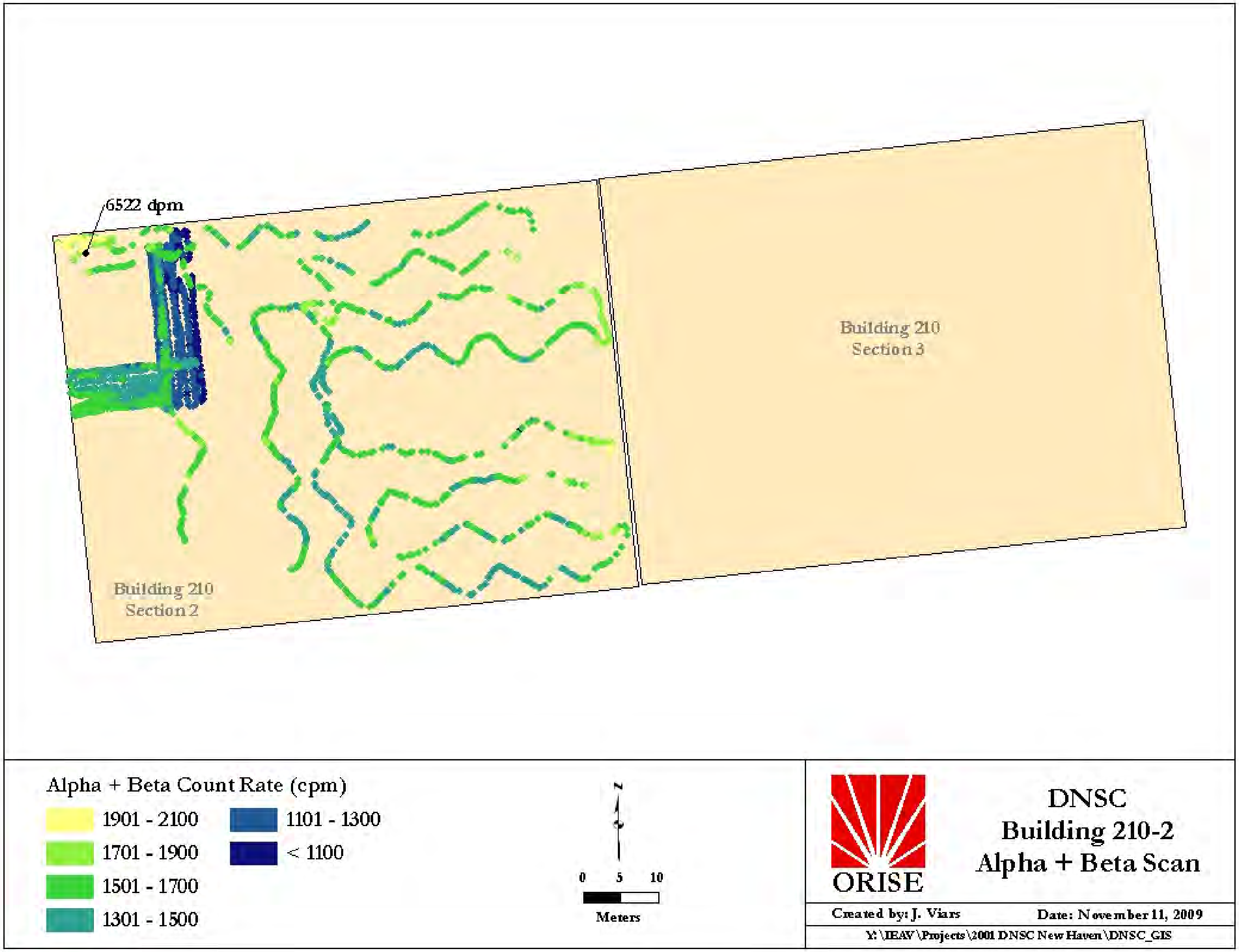


Figure A-17: Building 210 Section 2—Survey Area and Alpha plus Beta Scans

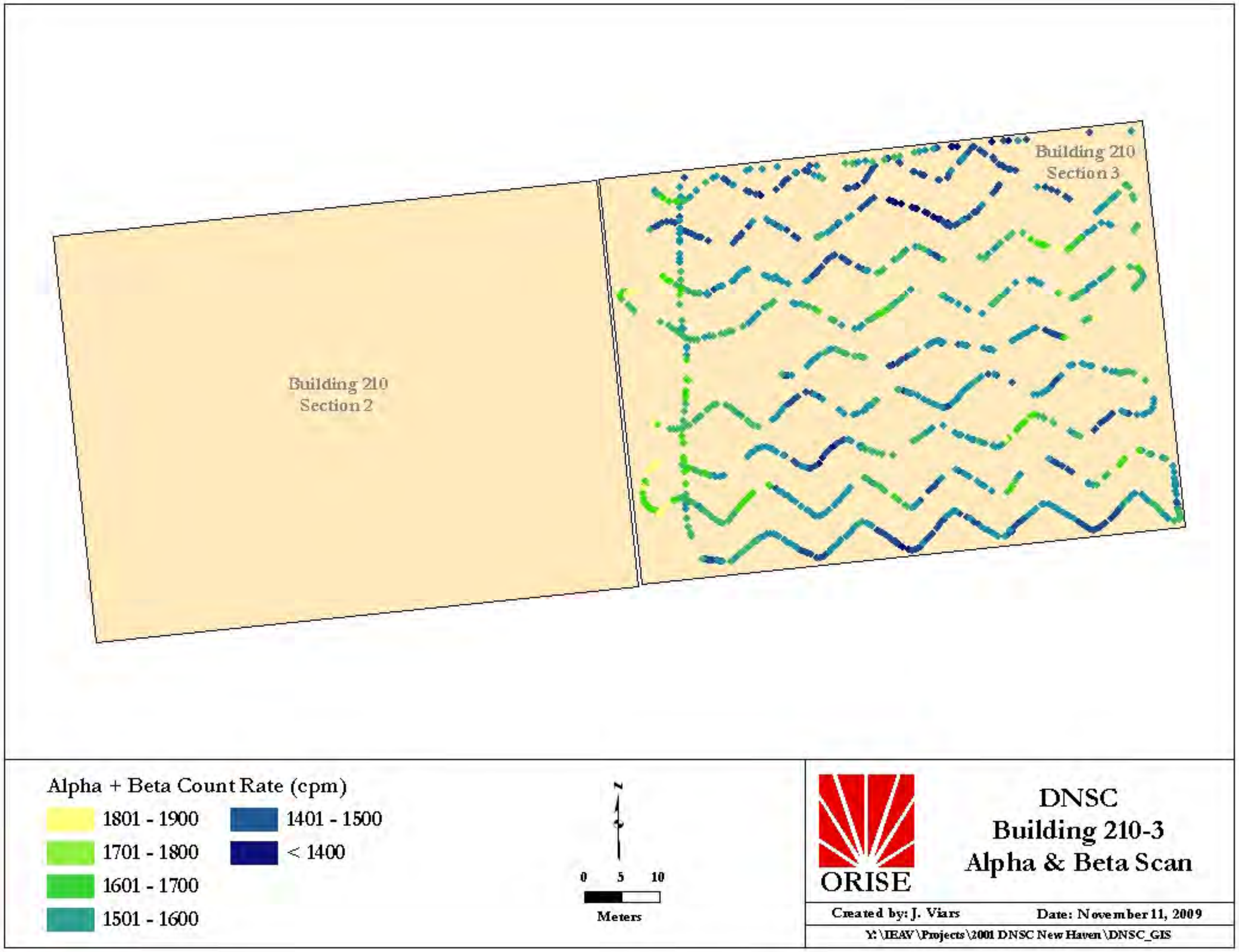


Figure A-18: Building 210 Section 3—Survey Area and Alpha plus Beta Scans

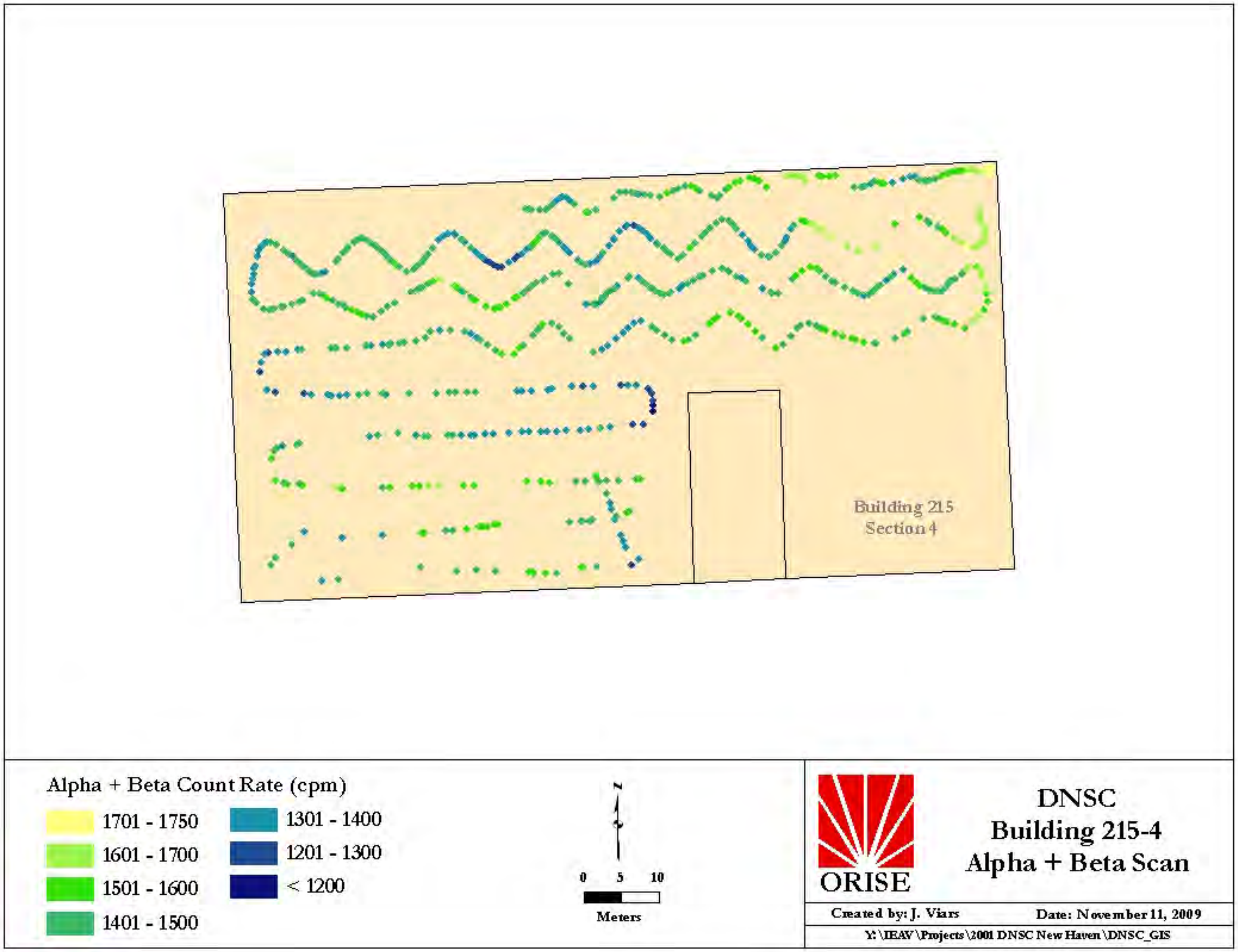


Figure A-19: Building 215 Section 4—Survey Area and Alpha plus Beta Scans

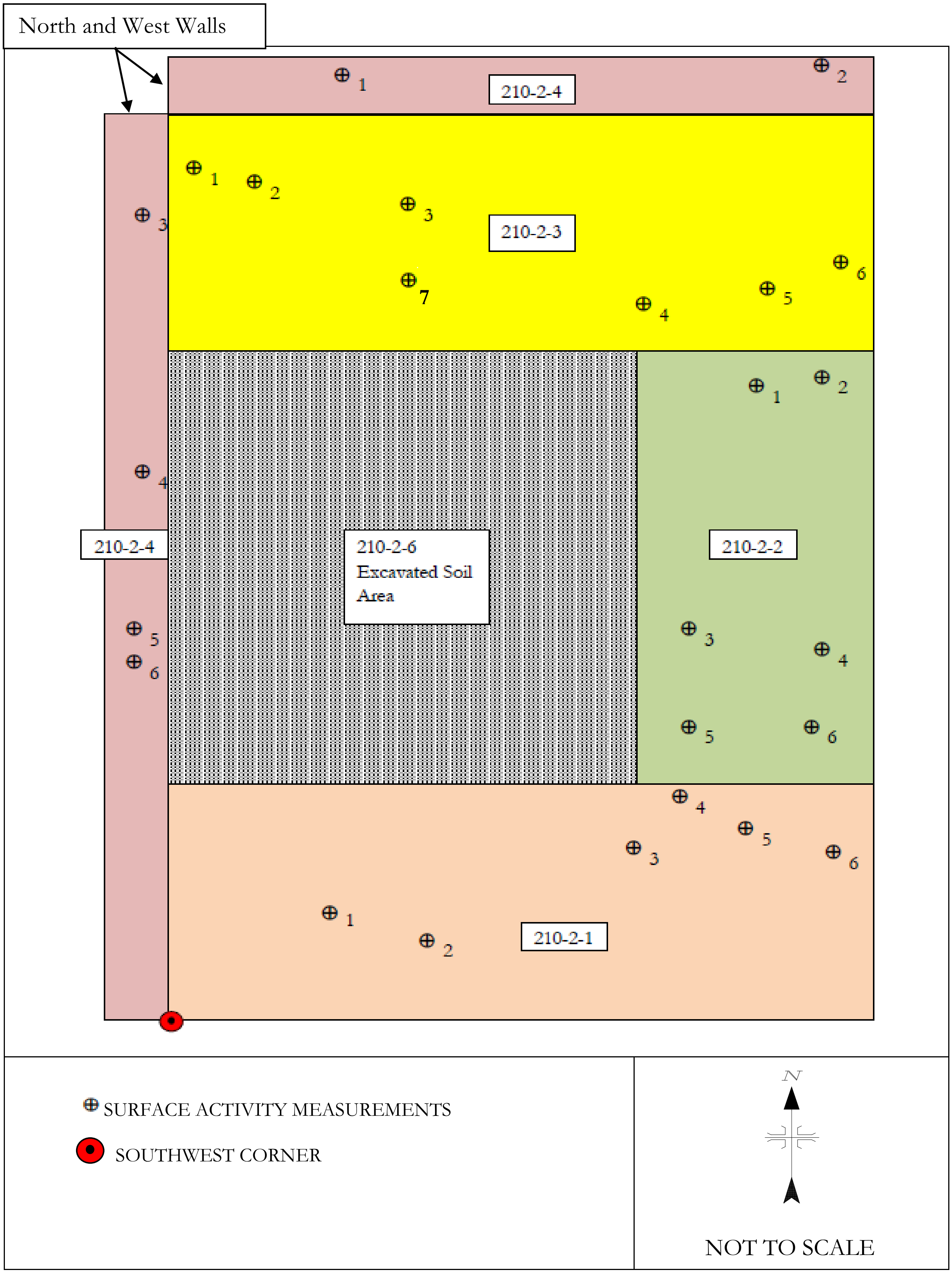


Figure A-20: Building 210 Section 2 Class 1 Survey Units—Direct Measurement Locations

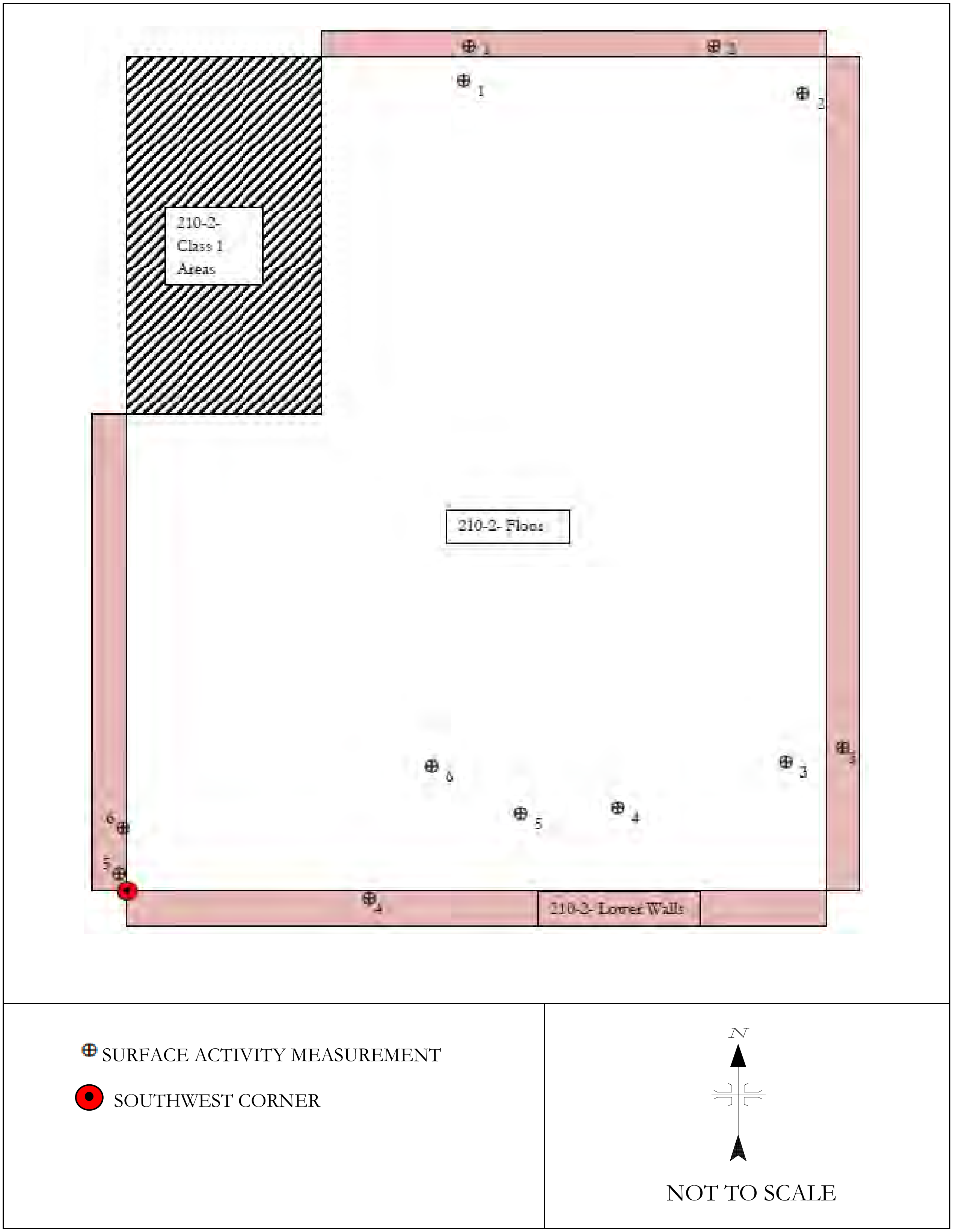


Figure A-21: Building 210 Section 2 Floor and Walls—Direct Measurement Locations

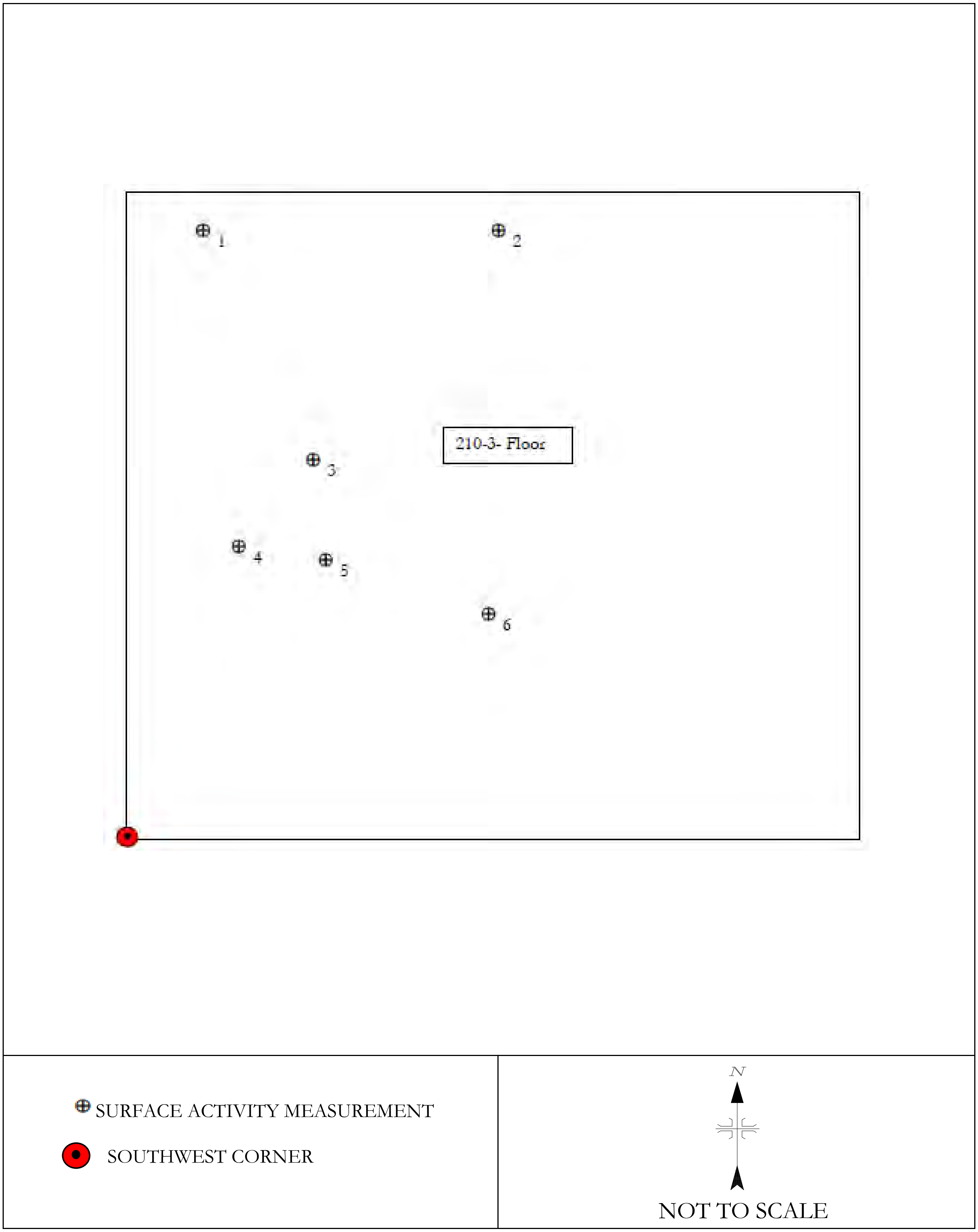


Figure A-22: Building 210 Section 3 Floor—Direct Measurement Locations

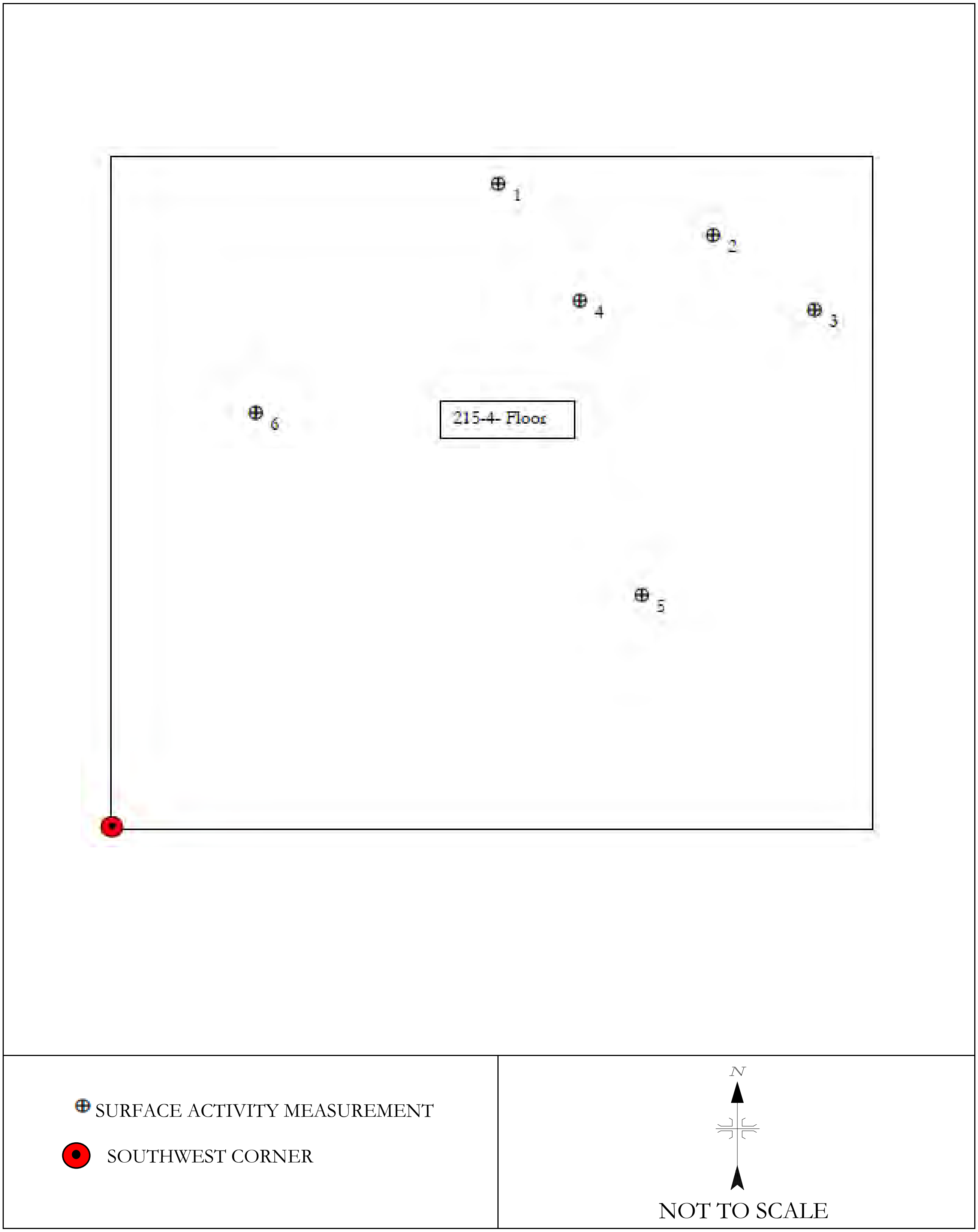


Figure A-23: Building 215 Section 4—Direct Measurement Locations

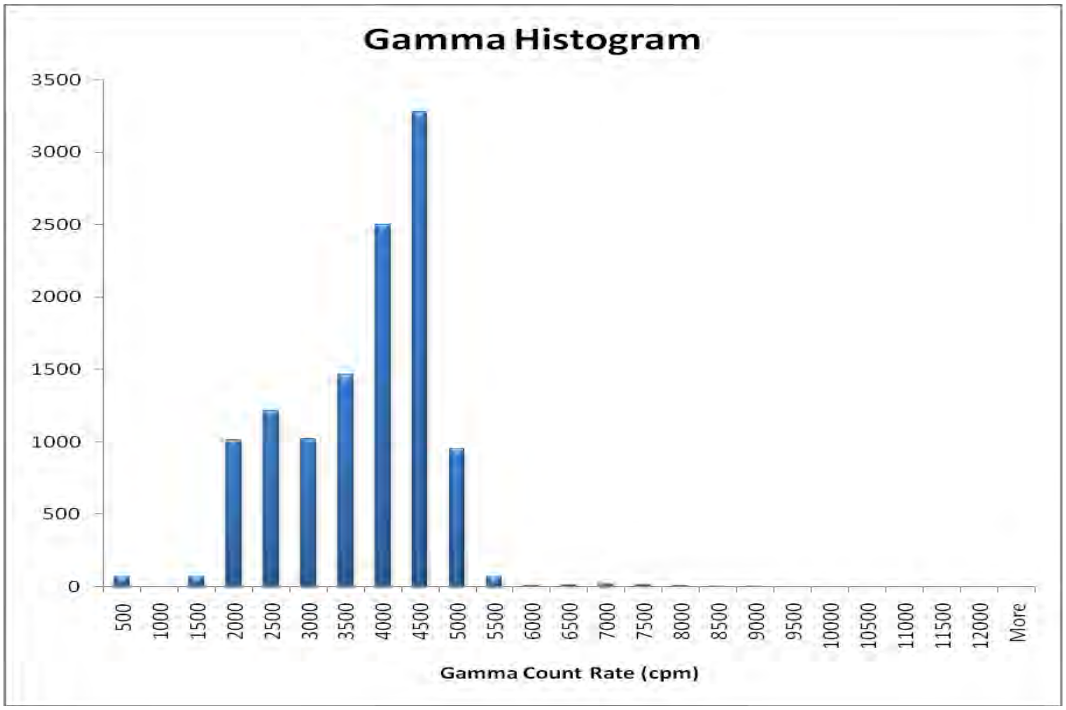


Figure A-24: Verification Outdoor Gamma Scan Count Rate Histogram (Combined Data)

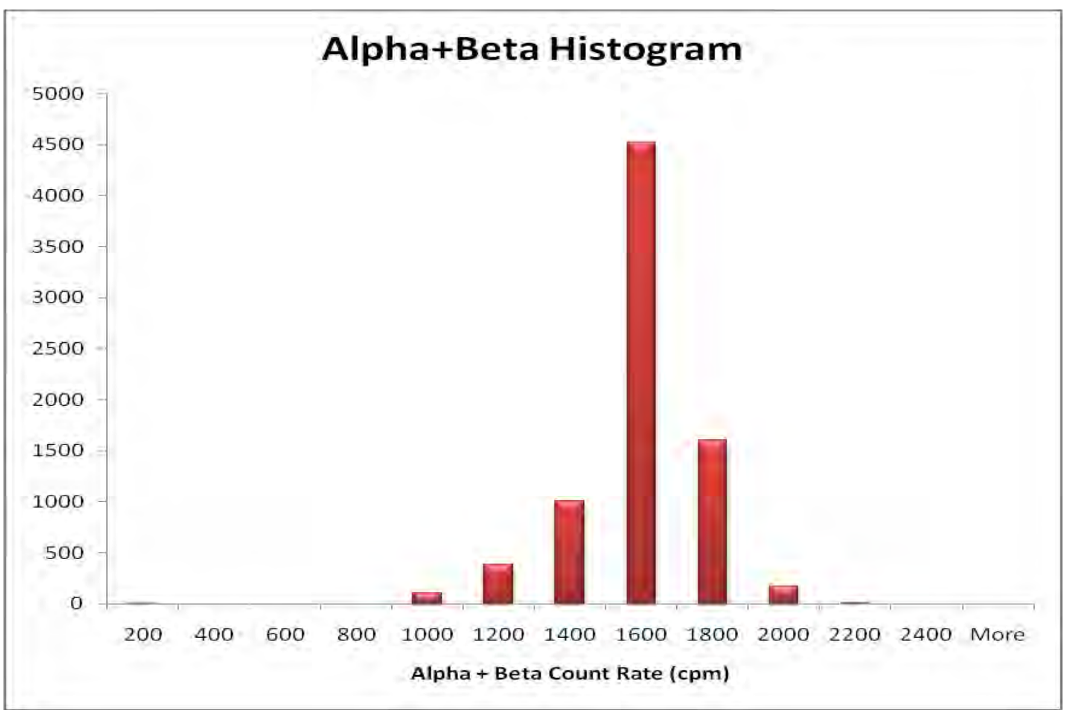


Figure A-25: Verification Indoor Alpha plus Beta Scan Count Rate Histogram (Combined Data)

APPENDIX B

TABLES

TABLE B-1: RANKED SET SAMPLING GAMMA MEASUREMENTS DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA						
Location			Ranked Set Sampling	Sample Select L=Low M=Medium H=High	Sample ID[a,b]	Gamma (cpm)
Area	Northing/X	Easting/Y				Before
Group 1 (Survey Units 3, 4, 9)						
SU349	2123858	525627	1-1-1			3933
SU349	**2123700**	**524889**	**1-1-2**	**L**	**2001S001**	**2917**
SU349	2123815	525185	1-1-3			5056
SU349	2123954	525303	1-2-1			5726
SU349	2123931	524993	1-2-2			4236
SU349	**2123966**	**525701**	**1-2-3**	**M**	**2001S002**	**5057**
SU349	2123882	525422	1-3-1			3676
SU349	2123842	525760	1-3-2			3068
SU349	**2123950**	**525416**	**1-3-3**	**H**	**2001S003**	**4818**
SU349	**2123873**	**525507**	**2-1-1**	**L**	**2001S004**	**3481**
SU349	2123981	525613	2-1-2			4467
SU349	2123819	525495	2-1-3			5130
SU349	2123831	525317	2-2-1			5368
SU349	**2123935**	**525790**	**2-2-2**	**M**	**2001S005**	**4997**
SU349	2123761	524851	2-2-3			2711
SU349	2123914	525497	2-3-1			4110
SU349	2123763	525028	2-3-2			4919
SU349	**2123972**	**525264**	**2-3-3**	**H**	**2001S006**	**5148**
SU349	2123889	525411	3-1-1			5354
SU349	**2123935**	**525502**	**3-1-2**	**L**	**2001S007**	**4894**
SU349	2123844	525589	3-1-3			6887
SU349	2123948	524998	3-2-1			4777
SU349	2123983	525707	3-2-2			5032
SU349	**2123717**	**524939**	**3-2-3**	**M**	**2001S008**	**4784**
SU349	2123894	525514	3-3-1			3494
SU349	**2123891**	**525766**	**3-3-2**	**H**	**2001S009**	**4418**
SU349	2123886	525454	3-3-3			3676
SU349	2123836	525456	4-1-1			6333
SU349	2122857	526134	4-1-2			3003
SU349	**2123871**	**524924**	**4-1-3**	**L**	**2001S010**	**2965**
SU349	2123975	525397	4-2-1			5133

TABLE B-1: RANKED SET SAMPLING GAMMA MEASUREMENTS DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA						
Location			Ranked Set Sampling	Sample Select L=Low M=Medium H=High	Sample ID[a,b]	Gamma (cpm)
Area	Northing/X	Easting/Y				Before
SU349	**2123952**	**525751**	**4-2-2**	**M**	**2001S011**	**5056**
SU349	2123860	525721	4-2-3			2891
SU349	2123817	525212	4-3-1			5106
SU349	2123956	525153	4-3-2			4838
SU349	**2123991**	**525507**	**4-3-3**	**H**	**2001S012**	**5488**
SU349	**2122848**	**526146**	**Judgmental**	**--**	**2001S025**	**9000**
SU349	**2122871**	**526205**	**Judgmental**	**--**	**2001S026**	**13000**
Group 2 (Survey Units 1, 2, 5, 6)						
SU1256	2123912	525681	1-1-1			3868
SU1256	2123935	525278	1-1-2			5013
SU1256	**2123914**	**525000**	**1-1-3**	**L**	**2001S013**	**3049**
SU1256	2123807	525044	1-2-1			2720
SU1256	2123866	525086	1-2-2			3670
SU1256	**2123899**	**525016**	**1-2-3**	**M**	**2001S014**	**3430**
SU1256	**2123784**	**524905**	**1-3-1**	**H**	**2001S015**	**3753**
SU1256	2123853	524994	1-3-2			3316
SU1256	2123846	525394	1-3-3			2978
SU1256	2123908	525594	2-1-1			5000
SU1256	2123908	525147	2-1-2			4741
SU1256	**2123860**	**525284**	**2-1-3**	**L**	**2001S016**	**2951**
SU1256	2123837	525027	2-2-1			2971
SU1256	2123945	525260	2-2-2			4211
SU1256	**2123791**	**525005**	**2-2-3**	**M**	**2001S017**	**3194**
SU1256	**2123917**	**525309**	**2-3-1**	**H**	**2001S018**	**3464**
SU1256	2123875	525318	2-3-2			3296
SU1256	2123884	524991	2-3-3			3233
SU1256	2123888	525649	3-1-1			5060
SU1256	2123903	525391	3-1-2			3707
SU1256	**2123926**	**525046**	**3-1-3**	**L**	**2001S019**	**2845**
SU1256	**2123843**	**525095**	**3-2-1**	**M**	**2001S020**	**3282**
SU1256	2123868	525025	3-2-2			4218
SU1256	2123807	525070	3-2-3			2434

TABLE B-1: RANKED SET SAMPLING GAMMA MEASUREMENTS DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA						
Location			Ranked Set Sampling	Sample Select L=Low M=Medium H=High	Sample ID[a,b]	Gamma (cpm)
Area	Northing/X	Easting/Y				Before
SU1256	2123893	525354	3-3-1			3865
SU1256	**2123936**	**525306**	**3-3-2**	**H**	**2001S021**	**5275**
SU1256	2123865	525403	3-3-3			2665
SU1256	**2123914**	**524975**	**4-1-1**	**L**	**2001S022**	**2860**
SU1256	2123874	525632	4-1-2			4446
SU1256	2123905	525725	4-1-3			3773
SU1256	**2123902**	**525064**	**4-2-1**	**M**	**2001S023**	**4379**
SU1256	2123867	525113	4-2-2			4501
SU1256	2123920	525211	4-2-3			4320
SU1256	**2123884**	**525150**	**4-3-1**	**H**	**2001S024**	**4796**
SU1256	525643	2123957	4-3-2			4564
SU1256	525736	2123868	4-3-3			3055
Group 3 (Survey Unit 210-2-6)						
210-2-6	7.01	2.89	1-1-1			4812
210-2-6	3.96	6.95	1-1-2			5866
210-2-6	**10.06**	**11.02**	**1-1-3**	**L**	**2001S027**	**4615**
210-2-6	**2.43**	**0.63**	**1-2-1**	**M**	**2001S028**	**5130**
210-2-6	8.53	4.69	1-2-2			4668
210-2-6	5.48	8.76	1-2-3			5315
210-2-6	11.58	1.99	1-3-1			4297
210-2-6	**0.52**	**6.05**	**1-3-2**	**H**	**2001S029**	**5320**
210-2-6	6.62	10.12	1-3-3			5139
210-2-6	3.57	3.34	2-1-1			5770
210-2-6	**9.67**	**7.41**	**2-1-2**	**L**	**2001S030**	**4483**
210-2-6	2.05	11.47	2-1-3			5482
210-2-6	8.15	1.08	2-2-1			4697
210-2-6	5.10	5.15	2-2-2			5536
210-2-6	**11.20**	**9.21**	**2-2-3**	**M**	**2001S031**	**4730**
210-2-6	**1.29**	**2.43**	**2-3-1**	**H**	**2001S032**	**5786**
210-2-6	7.39	6.50	2-3-2			4836
210-2-6	4.34	10.57	2-3-3			5339
210-2-6	**10.44**	**3.79**	**3-1-1**	**L**	**2001S033**	**4506**
210-2-6	2.81	7.86	3-1-2			5302

TABLE B-1: RANKED SET SAMPLING GAMMA MEASUREMENTS DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA						
Location			Ranked Set Sampling	Sample Select L=Low M=Medium H=High	Sample ID[a,b]	Gamma (cpm)
Area	Northing/X	Easting/Y				Before
210-2-6	8.91	11.92	3-1-3			4537
210-2-6	**5.86**	**0.33**	**3-2-1**	**M**	**2001S034**	**5268**
210-2-6	11.96	4.39	3-2-2			4618
210-2-6	0.33	8.46	3-2-3			5368
210-2-6	6.43	1.68	3-3-1			5146
210-2-6	**3.38**	**5.75**	**3-3-2**	**H**	**2001S035**	**5341**
210-2-6	9.48	9.82	3-3-3			4450
210-2-6	1.86	3.04	4-1-1			5648
210-2-6	7.96	7.10	4-1-2			5700
210-2-6	**4.91**	**11.17**	**4-1-3**	**L**	**2001S036**	**4908**
210-2-6	11.01	0.78	4-2-1			4715
210-2-6	1.10	4.84	4-2-2			5765
210-2-6	**7.20**	**8.91**	**4-2-3**	**M**	**2001S037**	**5059**
210-2-6	4.15	2.13	4-3-1			5407
210-2-6	10.25	6.20	4-3-2			4488
210-2-6	**2.26**	**10.27**	**4-3-3**	**H**	**2001S038**	**5415**

[a]Refer to Figures A-5 through A-7.
[b]Sample ID code specifies which location is sampled for a given cycle/set based on the gamma count rate.

TABLE B-2: RANKED SET SAMPLING SOIL SAMPLE CONCENTRATIONS DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA										
Location[a]			Post-Sample Collection Gamma (cpm)	Gross Soil Analysis (pCi/g)						Sum of Ratios (SOR)[b]
Sample ID	Northing	Easting	After Sample	^{232}Th			^{238}U			
Group 1 (Survey Units 3, 4, 9)										
2001S001	2123700	524889	5232	0.94	±	0.16[c]	1.50	±	0.53[c]	0.05
2001S002	2123966	525701	5676	0.82	±	0.17	2.68	±	0.71	0.51
2001S003	2123950	525416	5009	0.89	±	0.14	1.45	±	0.36	0.00
2001S004	2123873	525507	3026	0.28	±	0.10	1.13	±	0.41	-0.38
2001S005	2123935	525790	5896	0.99	±	0.16	1.91	±	0.53	0.24
2001S006	2123972	525264	5891	1.01	±	0.15	1.71	±	0.38	0.16
2001S007	2123935	525502	5247	0.90	±	0.16	2.75	±	0.54	0.57
2001S008	2123717	524939	5992	1.01	±	0.17	1.53	±	0.54	0.09
2001S009	2123891	525766	4403	0.90	±	0.14	1.74	±	0.40	0.13
2001S010	2123871	524924	2181	0.16	±	0.11	0.74	±	0.38	-0.60
2001S011	2123952	525751	5413	1.04	±	0.18	1.78	±	0.51	0.21
2001S012	2123991	525507	6293	0.99	±	0.15	1.95	±	0.40	0.26
2001S025[d]	2122848	526146	3400	4.38	±	0.48	3.38	±	0.59	2.24
2001S026[d]	2122871	526205	3900	-0.07	±	0.55	41.5	±	3.4	17.03
Group 2 (Survey Units 1, 2, 5, 6)										
2001S013	2123914	525000	3766	0.54	±	0.13	1.29	±	0.47	-0.21
2001S014	2123899	525016	4111	0.60	±	0.16	1.46	±	0.67	-0.11
2001S015	2123784	524905	5015	1.08	±	0.25	2.25	±	0.52	0.43
2001S016	2123860	525284	2666	0.29	±	0.10	1.43	±	0.41	-0.25
2001S017	2123791	525005	2549	0.28	±	0.08	0.86	±	0.27	-0.50
2001S018	2123917	525309	4652	0.50	±	0.10	1.38	±	0.37	-0.18
2001S019	2123926	525046	3710	0.57	±	0.13	1.30	±	0.45	-0.19
2001S020	2123843	525095	3156	0.30	±	0.19	0.98	±	0.46	-0.44
2001S021	2123936	525306	5761	1.14	±	0.70	3.06	±	0.48	0.80
2001S022	2123914	524975	2781	0.32	±	0.10	1.17	±	0.44	-0.35
2001S023	2123902	525064	4358	0.93	±	0.18	2.35	±	0.64	0.41
2001S024	2123884	525150	5499	1.52	±	0.21	2.75	±	0.49	0.82

TABLE B-2: RANKED SET SAMPLING SOIL SAMPLE CONCENTRATIONS DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA										
Location[a]			Post-Sample Collection Gamma (cpm)	Gross Soil Analysis (pCi/g)						Sum of Ratios (SOR)[b]
Sample ID	X Coord	Y Coord	After Sample	^{232}Th			^{238}U			
Group 3 (Survey Unit 210-2-6)										
2001S027	10.06	11.02	5100	0.73	±	0.13	1.76	±	0.43	0.07
2001S028	2.43	0.63	5800	0.64	±	0.13	2.02	±	0.52	0.15
2001S029	0.52	6.05	6300	0.75	±	0.12	1.76	±	0.35	0.08
2001S030	9.67	7.41	5500	0.62	±	0.11	1.49	±	0.33	-0.09
2001S031	11.20	9.21	5500	0.64	±	0.13	1.58	±	0.44	-0.04
2001S032	1.29	2.43	6600	0.55	±	0.11	1.57	±	0.44	-0.08
2001S033	10.44	3.79	6800	0.58	±	0.12	2.00	±	0.49	0.12
2001S034	5.86	0.33	6400	0.65	±	0.11	1.48	±	0.31	-0.08
2001S035	3.38	5.75	6200	0.60	±	0.11	1.51	±	0.42	-0.09
2001S036	4.91	11.17	5800	0.64	±	0.12	1.68	±	0.39	0.00
2001S037	7.20	8.91	5900	0.71	±	0.14	1.59	±	0.53	-0.01
2001S038	2.26	10.27	6400	0.57	±	0.10	1.49	±	0.31	-0.11

[a]Refer to Figures A-8 through A-11.
[b]Sum of Ratios (SOR) are reported as the net value of ORISE sample data after the SOR of average background values from Cabrera soil samples had been subtracted.
[c]Uncertainties are total propagated uncertainties, based on the 95% confidence interval.
[d]Judgemental soil samples from Survey Unit 9.

TABLE B-3: STRUCTURAL SURFACE ACTIVITY MEASUREMENTS DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA								
LOCATION[a]	DIRECT DETECTOR MEASUREMENTS							Meets $DCGL_w$
	VSP Coordinates (m)			Surface	Surface Material	Alpha Activity	Alpha + Beta Activity	
	Northing/X	Easting/Y	Z			(dpm/100 cm^2)	(dpm/100 cm^2)	
SU 210-2-1 (Class 1): Alpha $DCGL_W$ = 38 dpm/100 cm^2								
1	4.67	3.04	NA	Floor	Concrete	39	-243	>
2	7.5	1.73	NA	Floor	Concrete	-1	-323	≤
3	12.03	4.73	NA	Floor	Concrete	15	-357	≤
4	13.26	5.92	NA	Floor	Concrete	-1	-323	≤
5	14.48	5.01	NA	Floor	Concrete	7	-345	≤
6	16.79	4.36	NA	Floor	Concrete	15	-335	≤
SU 210-2-2 (Class 1): Alpha $DCGL_W$ = 38 dpm/100 cm^2								
1	3.28	11.39	NA	Floor	Concrete	31	-291	≤
2	4.77	11.44	NA	Floor	Concrete	-25	-399	≤
3	1.15	3.39	NA	Floor	Concrete	-25	-316	≤
4	4.73	2.84	NA	Floor	Concrete	-33	-399	≤
5	1.48	1.12	NA	Floor	Concrete	23	-288	≤
6	4.23	0.89	NA	Floor	Concrete	-17	-240	≤
SU 210-2-3 (Class 1): Alpha $DCGL_W$ = 38 dpm/100 cm^2								
1	0.38	5.11	NA	Floor	Concrete	-1	-65	≤
2	1.53	5.05	NA	Floor	Concrete	79	728	>
3	6.93	3.65	NA	Floor	Concrete	174	827	>
4	12.15	0.52	NA	Floor	Concrete	23	-116	≤
5	16.48	1.33	NA	Floor	Concrete	15	-253	≤
6	18.04	1.54	NA	Floor	Concrete	7	-265	≤
Judgmental	7.00	3.00	NA	Floor	Concrete	7	6522[b]	>

TABLE B-3: STRUCTURAL SURFACE ACTIVITY MEASUREMENTS DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA								
LOCATION[a]	DIRECT DETECTOR MEASUREMENTS							Meets $DCGL_w$
	VSP Coordinates (m)			Surface	Surface Material	Alpha Activity	Alpha + Beta Activity	
	Northing/X	Easting/Y	Z			(dpm/100 cm^2)	(dpm/100 cm^2)	
SU 210-2-4 (Class 1): Alpha $DCGL_W$ = 38 dpm/100 cm^2								
1	6.15	24.65	1.33	North Wall	Wood	-21	-6	≤
2	17.23	24.65	1.72	North Wall	Drywall	10	-58	≤
3	0	20.1	0.52	West Wall	Brick	38[c]	-42	>
4	0	13.18	0.38	West Wall	Brick	-25	-39	≤
5	0	10.21	0.38	West Wall	Brick	14	-125	≤
6	0	9.2	0.55	West Wall	Brick	30	18	≤
SU 210-2-F (Class 3): Alpha $DCGL_W$ = 38 dpm/100 cm^2								
1	32.56	51.89	NA	Floor	Concrete	15	-103	≤
2	72.14	47.86	NA	Floor	Concrete	7	-123	≤
3	71.9	13.23	NA	Floor	Concrete	-1	-135	≤
4	51.19	6.16	NA	Floor	Concrete	-1	-123	≤
5	38.35	4.93	NA	Floor	Concrete	31	-126	≤
6	30.91	9.07	NA	Floor	Concrete	39	-183	>
SU 210-2-W (Class 3): Alpha $DCGL_W$ = 38 dpm/100 cm^2								
1	32.51	54.86	0.79	North Wall	Drywall	10	-226	≤
2	60.87	54.86	0.49	North Wall	Metal	-6	-210	≤
3	73.15	7.39	0.73	East Wall	Brick	-10	-204	≤
4	29.36	0	1.93	South Wall	Drywall	34	-175	≤
5	0	0.38	0.15	West Wall	Metal	26	-90	≤
6	0	4.46	0.4	West Wall	Metal	10	34	≤

TABLE B-3: STRUCTURAL SURFACE ACTIVITY MEASUREMENTS DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA								
LOCATION[a]	DIRECT DETECTOR MEASUREMENTS							Meets $DCGL_w$
	VSP Coordinates (m)			Surface	Surface Material	Alpha Activity	Alpha + Beta Activity	
	Northing/X	Easting/Y	Z			(dpm/100 cm^2)	(dpm/100 cm^2)	
SU 210-3-F (Class 3): Alpha $DCGL_W$ = 38 dpm/100 cm^2								
1	13.99	49.06	NA	Floor	Concrete	15	-110	≤
2	39.57	45.72	NA	Floor	Concrete	-1	-81	≤
3	19.05	30.79	NA	Floor	Concrete	31	4	≤
4	9.81	24.66	NA	Floor	Concrete	15	4	≤
5	20.28	24.2	NA	Floor	Concrete	-17	1	≤
6	36.13	18.92	NA	Floor	Concrete	-9	20	≤
SU 215-4-F (Class 3): Alpha $DCGL_W$ = 38 dpm/100 cm^2								
1	39.02	53.86	NA	Floor	Concrete	15	-62	≤
2	56.55	47.57	NA	Floor	Concrete	-9	-275	≤
3	66.7	38.12	NA	Floor	Concrete	-9	-69	≤
4	44.22	41.86	NA	Floor	Concrete	-17	-88	≤
5	44.57	15.52	NA	Floor	Concrete	-9	-123	≤
6	10.41	34.37	NA	Floor	Concrete	-9	-34	≤
SU 145-F (Class 3): Alpha $DCGL_W$ = 100 dpm/100 cm^2								
1	2123544	525817	NA	Slab	Concrete	118	258	>
2	2123540	525811	NA	Slab	Concrete	126	147	>
3	2123523	525784	NA	Slab	Concrete	134	268	>
4	2123544	525757	NA	Slab	Concrete	102	265	>
5	2123558	525731	NA	Slab	Concrete	15	4	≤
6	2123521	525699	NA	Slab	Concrete	31	109	≤

TABLE B-3: STRUCTURAL SURFACE ACTIVITY MEASUREMENTS DEFENSE NATIONAL STOCKPILE CENTER NEW HAVEN DEPOT NEW HAVEN, INDIANA								
LOCATION[a]	DIRECT DETECTOR MEASUREMENTS							Meets $DCGL_w$
	VSP Coordinates (m)			Surface	Surface Material	Alpha Activity (dpm/100 cm^2)	Alpha + Beta Activity (dpm/100 cm^2)	
	Northing/X	Easting/Y	Z					
SU 8 (Rail Scale) (Class 2): Alpha $DCGL_W$ = 100 dpm/100 cm^2								
1	2.8	2.3	NA	Pad	Asphalt	7	-256	≤
2	6.5	4.4	NA	Pad	Concrete	71	-240	≤
3	10.3	0.7	NA	Pad	Concrete	47	33	≤
4	14.1	5.5	NA	Pad	Concrete	174	-8	>
5	19	3.3	NA	Pad	Asphalt	63	373	≤
6	16.5	1.3	NA	Pad	Concrete	39	81	≤
SU 219A (Class 2): Alpha $DCGL_W$ = 100 dpm/100 cm^2								
1	1.39	1.05	NA	East Wall	Wood	-12	-102	≤
2	2.1	1.49	NA	East Wall	Metal	-13	-302	≤
3	0.52	1.86	NA	South Wall	Glass	-13	-128	≤
4	2.04	0.16	NA	South Wall	Drywall	-5	-296	≤
5	0.24	0.38	NA	West Wall	Drywall	2	-258	≤
6	1.28	0.94	NA	Floor	Wood	-5	197	≤

[a]Refer to Figures A-13, A-15, A-16 and A-20 through A-23.
[b]Indication of elevated beta activity. Survey Plan did not have an established beta contamination $DCGL_W$.
[c]Activity exceeds the $DCGL_W$ when additional significant figures are added; 38 is the rounded down value for the measurement result.

APPENDIX C
MAJOR INSTRUMENTATION

APPENDIX C

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

SCANNING AND MEASUREMENT INSTRUMENT/DETECTOR COMBINATIONS

Gamma

Victoreen NaI Scintillation Detector Model 489-55, Crystal: 3.2 cm x 3.8 cm
(Victoreen, Cleveland, OH)
coupled to:
Ludlum Ratemeter-scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to:
Trimble GeoXH Receiver and Data Logger (Trimble Navigation Limited, Sunnyvale, CA)

Alpha and Alpha plus Beta

Ludlum Gas Proportional Detector Model 43-68, 126cm^2 active surface area
Ludlum Gas Proportional Detector Model 43-37, 582cm^2 active surface area
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to:
Ludlum Ratemeter-scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)coupled to:
Trimble GeoXH Receiver and Data Logger (Trimble Navigation Limited, Sunnyvale, CA)

LABORATORY ANALYTICAL INSTRUMENTATION

High Purity Extended Range Intrinsic Detector
CANBERRA/Tennelec Model No: ERVDS30-25195
(Canberra, Meriden, CT)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
Canberra's Apex Gamma Software
Dell Workstation
(Canberra, Meriden, CT)

LABORATORY ANALYTICAL INSTRUMENTATION (CONTINUED)

High Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5
(AMETEK/ORTEC, Oak Ridge, TN)
used in conjunction with:
Lead Shield Model SPG-16-K8
(Nuclear Data)
Multichannel Analyzer
Canberra's Apex Gamma Software
Dell Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-30-P4, 30% Eff.
(AMETEK/ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
Canberra's Apex Gamma Software
Dell Workstation
(Canberra, Meriden, CT)

APPENDIX D
SURVEY AND ANALYTICAL PROCEDURES

APPENDIX D
SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

The proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in current job hazard analyses. Additionally, upon arrival on site, a walk-down of the site was performed to identify hazards present and a pre-job integrated safety management checklist was completed and discussed with field personnel. All survey and laboratory activities were conducted in accordance with ORISE health and safety and radiation protection procedures.

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to National Institute of Standards and Technology (NIST).

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Independent Environmental Assessment and Verification Program:

- Survey Procedures Manual (ORISE 2008)
- Laboratory Procedures Manual (ORISE 2009)
- Quality Program Manual (ORAU 2009)

The procedures contained in these manuals were developed to meet the requirements of Department of Energy (DOE) Order 414.1C and the U.S. Nuclear Regulatory Commission *Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards* and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.

- Participation in Mixed Analyte Performance Evaluation Program (MAPEP), NIST Radiochemistry Intercomparison Program (NRIP), and Intercomparison Testing Program (ITP) Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits

SURVEY PROCEDURES

Surface Scans

A NaI scintillation detector was used to scan for elevated gamma radiation. Identification of elevated radiation levels was based on increases in the audible signal from the recording and/or indicating instrument. Additionally, the detectors were coupled to GPS units with data loggers enabling real-time recording in one- or two-second intervals of both geographic position and the gamma count rate. Position and gamma count rate data files were transferred to a computer system, positions differentially corrected, and the results plotted on geo-referenced aerial photographs. Positional accuracy was within 0.5 meters at the 95th percentile.

The scan minimum detectable concentrations for the NaI scintillation detectors were 2.8 pCi/g for Th-232, as provided in NUREG-1507, and approximately 4.5 pCi/g for U-238.

Surface Activity Measurements

Measurements of total activity levels were performed using gas proportional detectors with portable ratemeter-scalers. Surface activity measurements were performed on floors, lower walls and at locations of elevated direct radiation.

Count rates (cpm), which were integrated over one minute with the detector held in a static position, were converted to activity levels (dpm/100cm^2) by dividing the net rate by the total efficiency ($e_i \times e_s$) and correcting for the active area of the detector. The 2 pi instrument efficiencies (e_i) were as follows: 0.40 to 0.42 for the gas proportional detectors calibrated to Th-230; and 0.48 to 0.49 for the gas proportional detectors calibrated to Tl-204. The release criteria for structures and surfaces at the NHD were based on alpha emitting radionuclides. As a conservative approach, alpha plus beta measurements were collected at the precise alpha measurement locations in an attempt to establish a direct correlation between alpha and alpha plus beta activities. Therefore, the source efficiency factors (e_s) were 0.25 for the alpha calibration source and 0.5 for the beta calibration source. The total efficiencies for alpha and alpha plus beta respectively were 0.10 and 0.25.

Because different building materials (poured concrete, brick, wood, metal, glass, drywall and asphalt) may have different background levels, average background count rates were determined for each material encountered in the surveyed area at a location of similar construction and having no known radiological history. The alpha activity background count rates for the gas proportional detector averaged 3 cpm for metal, glass and drywall; 5 cpm for wood and 6 cpm for poured concrete and asphalt. The alpha plus beta activity background count rates for the gas proportional detector averaged 247 for metal, glass and drywall; 193 cpm for wood and 385 for poured concrete and asphalt. The alpha minimum detectable concentration (MDCs) were 88 dpm/100cm^2 for metal, glass and drywall; 106 dpm/100cm^2 for wood and 114 dpm/100cm^2 for poured concrete and asphalt. The alpha plus beta MDCs were 242 dpm/100cm^2 for metal, glass and drywall; 215 dpm/100cm^2 for wood and 299 dpm/100cm^2 for poured concrete and asphalt. The physical probe area for the gas proportional detectors was 126 cm^2.

Soil Sampling

Approximately 0.5 to 1 kilogram (kg) of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ORISE survey procedures.

RADIOLOGICAL ANALYSIS

Gamma Spectroscopy

Samples of soil were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in a 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All total absorption peaks (TAP) associated with the radionuclides of concern were reviewed for consistency of activity.

TAPs used for determining the activities of radionuclides of concern and the typical associated MDCs for a one-hour count time were:

TABLE D-1: MDC DERIVED FROM TOTAL ABSORPTION PEAK		
Radionuclide	**TAP (MeV)**	**MDC (pCi/g)**
Th-232	0.911 MeV	0.14
U-238	0.0633 MeV	0.75

Spectra were also reviewed for other identifiable TAPs. The determination of MDCs was derived from the progeny of Th-232 and U-238. Actinium-228 for Th-232 and thorium-234 for U-238. Soil concentration calculations were based on the assumption that actinium-228 and thorium-234 were in equilibrium with their parent isotopes.

DETECTION LIMITS

Detection limits, referred to as minimum detectable concentrations, were based on 95% confidence level via NUREG 1507 method; Equation 3-10:

$$MDC\,(dpm/100cm^2) = \frac{3 + 4.65\sqrt{(C_b)}}{KT}$$

Where:

C_b=	Average background count in time
K =	Constant for detection efficiency and probe geometry
T =	Paired observations of the sample and blank.

Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.