CONFIRMATORY SURVEY RESULTS FOR PORTIONS OF THE ABB COMBUSTION ENGINEERING SITE IN WINDSOR, CONNECTICUT DURING THE FALL OF 2011

W. C. Adams

Prepared for the
U.S. Nuclear Regulatory Commission

ORISE

The Oak Ridge Institute for Science and Education (ORISE) is a U.S. Department of Energy facility focusing on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists. ORISE is managed by Oak Ridge Associated Universities.

NOTICES

CONFIRMATORY SURVEY RESULTS FOR PORTIONS OF THE ABB COMBUSTION ENGINEERING SITE IN WINDSOR, CONNECTICUT DURING THE FALL OF 2011

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FINAL REPORT

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ACRONYMS

ABB Inc.	Asea Brown Boveri Incorporated
CA	controlled area
CE	Combustion Engineering
CFR	Code of Federal Regulations
cpm	counts per minute
CU	confirmatory unit
DCGL	derived concentration guideline level
DP	decommissioning plan
EPA	U.S. Environmental Protection Agency
FSS	final status survey
FSSP	final status survey plan
GPS	global positioning system
IA	Impacted Area
IEAV	Independent Environmental Assessment and Verification
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
NaI(Tl)	sodium iodide (thallium-activated)
NIA	Non-Impacted Area
NRC	U.S. Nuclear Regulatory Commission
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
PPE	personal protective equipment
PSR	Partial Site Release
ROC	radionuclide of concern
RSS	Ranked Set Sampling
SOR	Sum-of-Ratios
SU	survey unit
VSP	Visual Sample Plan

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CONFIRMATORY SURVEY RESULTS FOR PORTIONS OF THE ABB COMBUSTION ENGINEERING SITE IN WINDSOR, CONNECTICUT DURING THE FALL OF 2011

1. INTRODUCTION AND SITE HISTORY

From the mid-1950s until mid-2000, the Combustion Engineering, Inc. (CE) site in Windsor, Connecticut (Figure A-1) was involved in the research, development, engineering, production, and servicing of nuclear fuels, systems, and services. The site is currently undergoing decommissioning that will lead to license termination and unrestricted release in accordance with the requirements of the License Termination Rule in 10 CFR Part 20, Subpart E. Asea Brown Boveri Incorporated (ABB) has been decommissioning the CE site since 2001.

The CE Windsor site (Figure A-2) is located on 613 acres. A Partial Site Release (PSR) for unrestricted use was completed on approximately 365 acres during the spring of 2008 (ORISE 2008a). The balance of the site—contained within the PSR boundary—remains under U.S. Nuclear Regulatory Commission (NRC) license 06-00216-06, and is referred to as the "controlled area" (CA). Currently, the remaining areas are undergoing remediation and final status surveys (FSS). Remediation of the remaining impacted areas (IAs) will include the decontamination of buildings, demolition of structures to ground surface, removal of floor slabs and footings three (or four) feet below ground surface, as well as the removal of underground utilities and any soils impacted above the derived concentration guideline levels (DCGLs) (MACTEC 2010a).

Personnel from the NRC and the State of Connecticut have been to the CE site on numerous occasions prior to the backfilling and restoration of FSS survey units (SUs) and collected in-process confirmatory split samples from multiple FSS SUs during excavation and FSS survey activities. These confirmatory samples were sent to the Oak Ridge Institute for Science and Education (ORISE) radiochemistry laboratory; analytical results were reported to the NRC.

At the request of the NRC's Headquarters and Region I Offices, the Independent Environmental Assessment and Verification Program (IEAV) of ORISE performed confirmatory radiological survey activities of the areas designated by ABB for unrestricted release at the ABB CE site in Windsor, Connecticut. During the time of the ORISE survey activities, many of these areas had already been backfilled and remedial restorations of the soil surfaces had been completed. The confirmatory survey activities were scheduled to occur in two phases: the Fall 2011 phase (relating to

this report) consisted of the Woods Area, the Burning Grounds, the Drum Burial Pit, and the Clamshell Pile, while the Spring 2012 phase will consist of the Equipment Storage Yard, Buildings 3 and 6 Complexes, the Debris Piles, and the Site Brook.

2. SITE DESCRIPTION

The CE Windsor site is located on 2000 Day Hill Road in the Town of Windsor, in Hartford County, approximately eight miles north of Hartford, Connecticut (Figures A-1 and A-2). The site is within an industrial zone with nearby property being primarily commercial, agricultural, industrial, and residential areas. The northern and western portions of the property are wooded. Day Hill Road borders the southern portion of the site; tobacco fields and a sand and gravel quarry border the western side; the Windsor/Bloomfield Sanitary Landfill and Recycling Center and the Rainbow Reservoir portion of the Farmington River are to the north. Forested land with residential and commercial development is to the east.

Since the ABB FSS SUs scheduled for confirmatory surveys in the Fall of 2011 (the subject areas for these survey activities) have already been backfilled and the soil surfaces have been restored, ORISE grouped combined FSS SUs into the following confirmatory units (CUs): Confirmatory Unit 1 (consisting of the Clamshell Pile FSS Units and the immediately adjacent land areas), Confirmatory Unit 2 (consisting of the Burning Grounds FSS Units and the immediately adjacent land areas), and Confirmatory Unit 3 (consisting of the Drum Burial Pit and Woods Area FSS Units and the immediately adjacent land areas) (refer to Figures A-3 through A-5). The decision to pool the confirmatory survey data for the ABB FSS SUs was based on the site logistics and grouping of contiguous areas. The following descriptions are for those areas that were part of the Fall 2011 survey activities.

2.1 CLAMSHELL PILE AREA – CONFIRMATORY UNIT 1

The Clamshell Pile, CU1, is located in a shallow swale approximately 600 feet north of the Site Brook in the northwestern portion of the property (Figures A-3 through A-5). This area is approximately 15-ft wide × 30- ft long × 6-ft deep, and fills a natural gully. In the late 1950s, clamshells were used to buffer the pH concentration of the Site Brook near the industrial waste outfalls. Because the Site Brook received industrial wastewater, including low-level radioactive wastewater, the shells absorbed some amount of uranium and contained radioactive materials. The

clamshells were removed from the Site Brook during previous remedial actions and were placed at this location. The Clamshell Pile has since been remediated and backfilled.

2.2 BURNING GROUNDS – CONFIRMATORY UNIT 2

The Burning Grounds, CU2, are located north of the Woods Area and west of the Debris Piles (Figures A-3, A-4 and A-5). This area, the former zirconium, magnesium, and thorium burning grounds, is approximately two acres in size. The burning area consisted of a bermed concrete pad. After burning activities ceased, the area was used as a storage area for drums of radiological waste. The Burning Grounds has since been remediated and backfilled.

2.3 DRUM BURIAL PIT – CONFIRMATORY UNIT 3

The Drum Burial Pit, in the northwest section of CU3, is located west of the Woods Area in the northern portion of the site (Figures A-3, A-4 and A-5). The area is approximately one acre in size and was used to dispose of miscellaneous waste material including piping, personal protective equipment (PPE) and soils. These materials were mostly contained in 55-gallon drums that over time became either rusted and/or crushed. The drums eventually decayed and the adjacent soils were pushed over the waste, essentially burying the drums in place (MACTEC 2010a). The Drum Burial Pit has since been remediated and backfilled.

2.4 WOODS AREA – CONFIRMATORY UNIT 3

The Woods Area, southern section of CU3, is located west of East Main Street and east of the Drum Burial Pit Area (Figures A-3, A-4 and A-5) and straddles the access road that runs northwest from former Building 2. The area is approximately seven acres in size. Previous radiological investigations indicated that surface and subsurface soils on both sides of the access road and adjacent to the Waste Pad Area contained residual radiological concentrations above background levels. The Woods Area has since been remediated and backfilled.

3. OBJECTIVES

The objectives of the confirmatory activities were to provide independent contractor field data reviews and to generate independent radiological data for use by the NRC in evaluating the adequacy and accuracy of the contractor's procedures and FSS results.

4. DOCUMENT REVIEW

ORISE has reviewed ABB CE's decommissioning plan (DP), final status survey plan (FSSP) and the applicable soil DCGLs, which were developed based on an NRC-approved radiation dose assessment (MACTEC 2003a, 2003b, 2004, 2008 and 2010b). The DP was specifically reviewed for historical information, to identify the radionuclides of concern (ROCs), and the dose assessment was reviewed for the applicable dose-based DCGLs. ORISE also reviewed preliminary FSS data for the Drum Burial Pit, Burning Grounds, Clamshell Pile and Woods Area specifically to design a statistical survey prior to performing confirmatory surveys (AMEC 2011). The purpose of these reviews was to ensure that regulatory requirements were being met by the ABB CE and to develop the confirmatory survey plan. ORISE also ensured that the current FSS activities within the areas to be released for unrestricted use were adequate and appropriate, taking into account any supporting documentation and *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) guidance (NRC 2000).

5. RADIOLOGICAL SURVEY PROCEDURES

ORISE personnel visited the ABB CE property from October 24 – 27, 2011 to perform visual inspections and independent measurements and sampling. The radiological survey activities were conducted in accordance with a project-specific plan, the ORISE *Survey Procedures Manual* and the Oak Ridge Associated Universities (ORAU) *Quality Program Manual* (ORISE 2011a, 2008b and ORAU 2011).

The SUs were classified—in accordance with MARSSIM guidance (NRC 2000) and the contractor's three classifications for impacted area, based on contamination potential—as either Class 1, 2, or 3. Impacted Areas are areas that have some potential for containing contaminated material. Descriptions for each classification for IAs are as follows:

- **Class 1:** Buildings or land 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 DCGL

- **Class 2:** Buildings or land areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the DCGL

- **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

Non-Impacted Areas (NIAs) are areas that do not have the potential to contain contaminated materials.

Since the ABB FSS SUs scheduled for confirmatory surveys in the Fall of 2011 have already been backfilled and the soil surfaces have been restored, ORISE grouped area ABB FSS Class 1 and Class 2 SUs into Class 2 Confirmatory Units as described in Section 2.

5.1 REFERENCE SYSTEM

Global positioning system (GPS) coordinates were used for referencing measurement and sampling locations. The specific reference system used by the licensee was the Connecticut State Plane Coordinate System (FIPS 0600, feet; North American Datum 83).

5.2 SURFACE SCANS

Medium density gamma radiation surface scans were conducted over the soil surface within each of the CUs. Surface scans were performed using sodium iodide (thallium-activated) [NaI(Tl)] scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Detectors 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 any locations of elevated direct gamma radiation for further investigations that might suggest the presence of residual contamination (Figures A-6 through A-8).

5.3 RANKED SET SAMPLING

In each of the CUs, ORISE performed a Ranked Set Sampling (RSS) approach, following U.S. Environmental Protection Agency (EPA) guidance, for randomly selecting locations for gamma measurements and subsequent soil sampling (EPA 2002). Visual Sample Plan (VSP) software was used to generate the random coordinates comprising the soil investigation and sample selection population. These measurement/sample points were downloaded to the GPS units and were based upon the ORISE-generated reference CUs established for the site (refer to Figures A-9 through A-11).

RSS provides a methodology to determine the necessary number of soil samples to estimate the mean concentration of a population; however, it does not require the assumption of a normal distribution. The process combines random sampling with the use of professional judgment to select sampling locations. Professional judgment relies upon the ability to assess the 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 ROCs. The count rate data obtained were then used to select a specific sampling location.

The RSS process uses a ranking method of the field screening measurement population to create the ranked sets; the first phase of the soil sample location selection process is to randomly partition the gamma measurement locations into sets of equal size. The set size is maintained at three locations to minimize ranking errors. With a set size of three locations, the three sets would then require nine measurement locations that are randomly combined into one cycle. Three soil sample locations are then selected for each cycle based on the following ranking criteria:

- **Set 1:** the lowest of three gamma measurement locations within Set 1 is sampled.
- **Set 2:** the medium of three gamma measurement locations within Set 2 is sampled.
- **Set 3:** the highest of three gamma measurement locations within Set 3 is sampled.

Nine soil samples from each CU were determined to be adequate to estimate the mean concentrations at the 95% confidence level. The estimated Sum-of-Ratios (SOR) mean concentration and variability used to calculate the required number of samples was obtained from the AMEC sample results (AMEC 2011). Therefore, the ABB soil sampling plan required three RSS cycles within each CU from which the nine soil samples were collected.

5.4 GAMMA DIRECT MEASUREMENTS

A one-minute static gamma count rate measurement was performed at each of the 27 RSS locations determined per CU (Figures A-9 through A-11). The data within a given cycle-set were then ranked as exhibiting either the lowest, medium, or highest gamma count; these data are provided in Table B-1.

5.5 SOIL SAMPLING

5.5.1 RSS Sample Locations

Soil samples were then collected in accordance with the RSS process as described in Section 5.3 within the three RSS cycles for each CU: Set 1, lowest gamma radiation location; Set 2, medium location; Set 3, highest location (Figures A-9 through A-11). A total of nine random surface (0 to 15 cm) samples were collected from each CU (Figures A-12 through A-14). Table B-1 provides the RSS method showing field assessment data and the locations selected for soil sampling.

5.5.2 Judgmentally-Selected Locations

Judgmental surface soil samples were not collected since there were no locations of suspected elevated gamma radiation detected during gamma soil surface scans.

5.5.3 Background Soil Samples

For consistency with the data reported by the licensee, background soil samples were not necessary since background concentrations were not to be subtracted from soil samples collected in the CUs.

6. 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 2011b). Soil samples were analyzed by gamma spectroscopy for Co-60, Ra-226, Th-232, U-235 and U-238. The spectra were also reviewed for any other identifiable photopeaks to ensure there were no indications of other potential ROCs. Soil sample results were reported in units of picocuries per gram (pCi/g). Gamma count rate measurement results were reported in units of counts per minute (cpm).The data generated were compared with the NRC-approved release criteria established for each site-specific ROC for the ABB Site and with the ABB/AMEC FSS statistical results for each area. Additional information regarding instrumentation and procedures may be found in Appendices C and D.

7. FINDINGS AND RESULTS

The results for each radiological survey procedure component are discussed in the following sections.

7.1 Document Review

AMEC radiological survey data were used to determine the number of random soil samples necessary to estimate the mean SOR (for ROCs for each CU) concentrations. Specifically, the inputs used were the AMEC-reported average SOR concentrations and the ORISE-calculated observed variability based on AMEC preliminary FSS data results (AMEC 2011).

7.2 Surface Scans

Gamma radiation surface scans identified several areas of elevated gamma radiation, primarily along the northern fence line. The gamma scan paths within each CU are provided in Figures A-6 through A-8. Figures A-15 through A-17 provide frequency histograms of the walkover gamma count rate data population for each of the CUs. The gamma scans ranged from less than 5,400 to 10,439 cpm for CU1; less than 4,500 to 10,586 cpm for CU2; and less than 4,700 to 14,979 cpm for CU3. The histograms for CU2 and CU3 indicate normal distributions typical of the background concentrations associated with those areas. The histogram for CU1 (Figure A-15) is skewed to the right which represents the presence of slightly elevated gamma radiation levels above typical background levels. ORISE did observe slightly elevated gamma radiation levels over the ground surface where the Clamshell Pile had been remediated and backfilled; however, those levels were not indicative of residual contamination greater than the release criteria for uranium contamination that was the primary ROC within the clamshells.

7.3 Gamma Direct Measurements

The summary data for the three CUs are presented in Table 1; the average background gamma count rate was 7,106 cpm for CU1; 6,970 cpm for CU2; and 7,274 cpm for CU3. The data for the individual direct gamma measurements are provided in Table B-1; the background data is provided in Figures A-15 through A-17.

Table 1. Ranked Set Sampling Gamma Direct Measurements Summary Results

Confirmatory Units	Gamma Direct Measurement (cpm)		
	Minimum	Maximum	Background
Confirmatory Unit 1	5,596	8,485	7,106
Confirmatory Unit 2	5,885	8,678	6,970
Confirmatory Unit 3	5,791	9,639	7,274

7.4 RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES

The summary data for the three CUs are presented in Table 2. The data for the radionuclide concentrations in individual samples are provided in Table B-2. The gamma count rate data used for selecting the appropriate sample locations are shown in Table B-1. All soil results were less than the respective DCGL for each individual soil sample. Also, ORISE CU SOR results compared favorably with the FSS SOR means ORISE calculated using the AMEC preliminary FSS data.

Table 2. Radionuclide Concentrations in RSS Soil Samples Summary Results

Confirmatory Units	Radionuclide Concentrations (pCi/g)				Sum-of-Ratios[a]	ABB/AMEC Sum-of-Ratios[b]
	Co-60	Ra-226	Th-232	Total U		
Confirmatory Unit 1	-0.03 to 0.02	0.48 to 0.69	0.68 to 0.98	1.07 to 4.4	0.00 to 0.01	NA[c]
Mean Concentration	***0.00***	***0.60***	***0.79***	***1.77***	***0.00***	***0.01***
Confirmatory Unit 2	-0.01 to 0.08	0.42 to 0.86	0.63 to 1.22	1.02 to 6.1	0.25 to 0.50	NA
Mean Concentration	***0.02***	***0.62***	***0.91***	***2.55***	***0.37***	***0.36***
Confirmatory Unit 3	-0.03 to 0.08	0.35 to 0.90	0.42 to 1.0	0.97 to 5.6	0.19 to 0.46	NA
Mean Concentration	***0.02***	***0.65***	***0.81***	***1.95***	***0.35***	***0.36***
Site RSS Mean	0.01	0.62	0.84	2.09	0.25	NA
Site RSS Std. Dev.	***0.03***	***0.13***	***0.17***	***1.47***	***0.18***	***NA***

[a]SOR = Sum of Ratios. For CU1, the radiological contaminants were Co-60 and Total Uranium. For CUs 2 and 3, the radiological contaminants were Co-60, Ra-226, Th-232 and Total Uranium.
[b]ABB/AMEC SORs calculated by ORISE based on AMEC preliminary FSS data for each of the FSS Survey Units in the ORISE Confirmatory Unit areas.
[c]NA=not applicable.

8. COMPARISON OF RESULTS WITH RELEASE CRITERIA

The primary ROCs for the site are total uranium (U-234, U-235 and U-238) and Co-60; thorium and radium were characterized within the Burning Grounds and to a much lesser extent in the adjacent Woods Area and the Drum Burial Pit Area. The applicable site-specific soil DCGLs for the ROCs are provided in Table 3 and have been approved by the NRC (MATEC 2003b, 2004 and 2010b). To demonstrate compliance with the Table 3 criteria, each radionuclide concentration should be less than its respective DCGL—with consideration for small areas of elevated activity—as well as application of the unity rule (Sum-of-Ratios). The unity rule requires that the sum of the concentration of each contaminant divided by the respective guideline be less than one.

$$SOR = \frac{Conc_1}{DCGL_1} + \frac{Conc_2}{DCGL_2} + \cdots + \frac{Conc_n}{DCGL_n} \leq 1$$

Table 3. ABB Soil DCGLs[a]	
Radionuclide	**DCGL (pCi/g)**
Total Uranium	557[b]
Co-60	5.0
Thorium (Th-232)	4.0
Radium (Ra-226)	4.5

[a]ABB soil DCGLs are from ABB CE's Derivation of Site-Specific Soil DCGL report (MACTEC 2003b) for uranium and cobalt and from the Addendum to the original Derivation of the Site-Specific Soil DCGL report (MACTEC 2010b).
[b]Total uranium DCGL regardless of enrichment (MACTEC 2004).

Radionuclide concentrations in soil samples were directly compared with the DCGLs provided in Table 3. ORISE also applied the unity rule (SOR) in the activity calculations for each of the soil samples. All of the 27 soil samples were below the individual ROC DCGLs and all SOR were less than one. Also, the calculated CU mean concentrations and ABB Site mean concentrations were less than the respective DCGLs; and, the ABB Site mean (average) SOR for each CU was less than one.

9. SUMMARY

During the period of October 24 – 27, 2011, ORISE performed radiological survey activities for portions of the ABB CE Site in Windsor, Connecticut. The radiological survey results demonstrate that, with the exception of the ground surface immediately over the previously excavated and backfilled Clamshell Pile in Confirmatory Unit 1 which exhibited slightly elevated gamma radiation levels, residual surface soil contamination was not likely to be present above background levels within the confirmatory units surveyed by ORISE. Therefore, it is ORISE's opinion that the radiological conditions for the confirmatory units surveyed by ORISE during the Fall of 2011(refer to Tables 2 and B-2) are commensurate with the site release criteria and unity rule requirement for final status surveys as specified in ABB CE's *Site-Specific Soil DCGLs* and *Derivation of the Site-Specific Soil DCGLs Addendum* reports that were approved by the U.S. Nuclear Regulatory Commission (MACTEC 2003b and 2010b). In addition, the confirmatory results indicated that the ORISE CU SOR results compared favorably with the FSS SOR means calculated by ORISE from the AMEC FSS data (refer to Table 2).

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APPENDIX A
FIGURES

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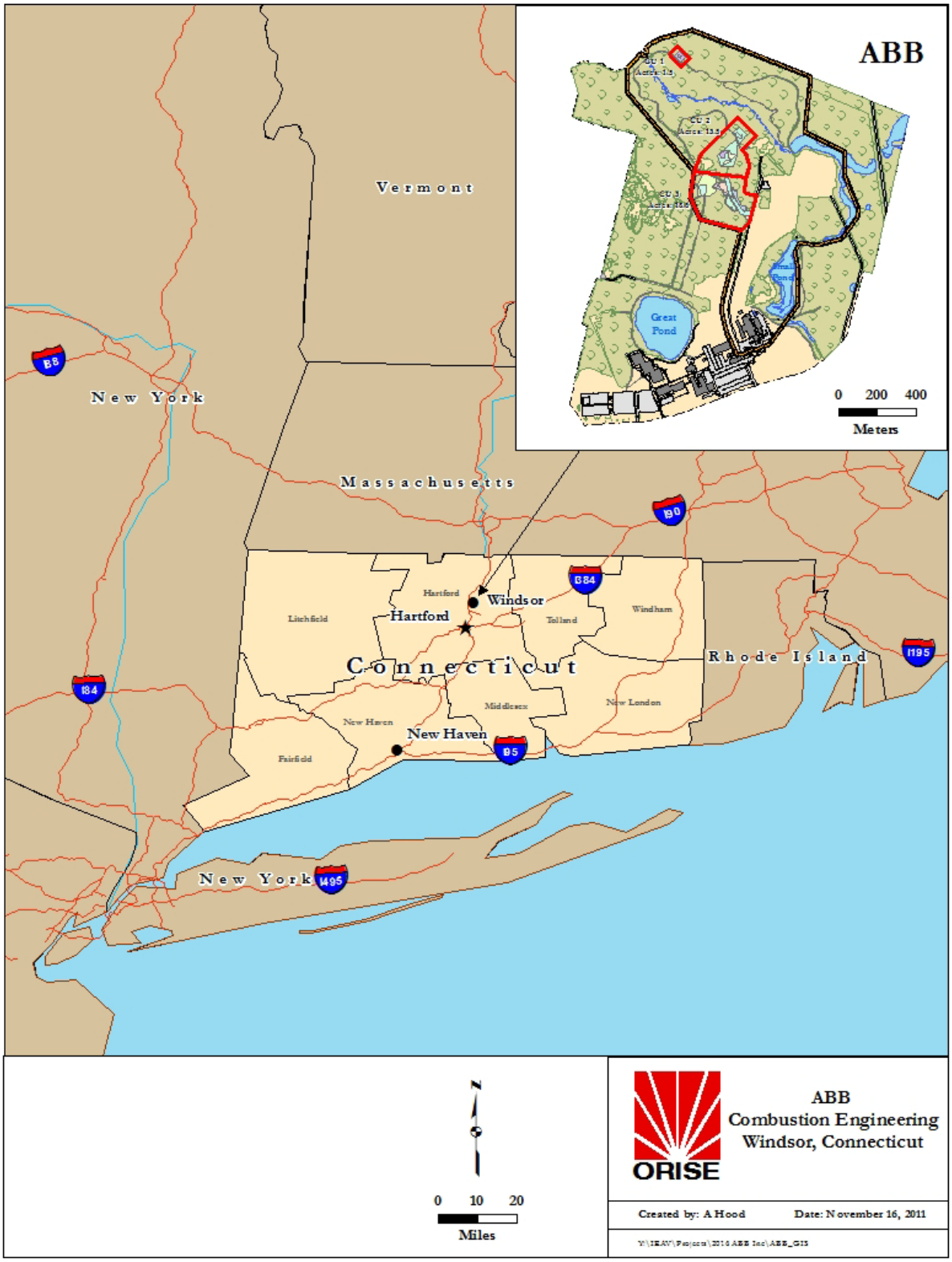

Figure A-1. Site Location Map – ABB CE Windsor Site, Windsor, Connecticut

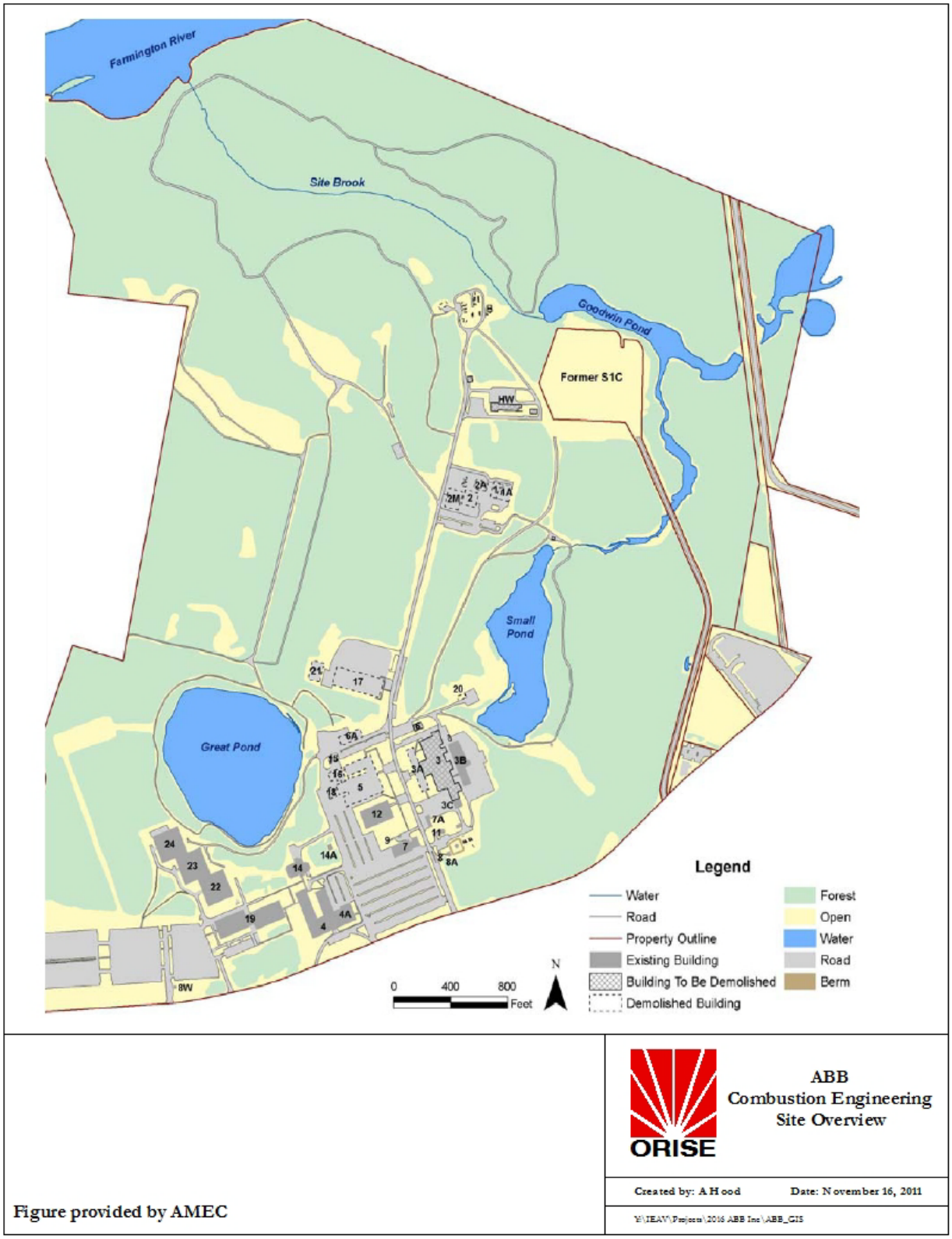

Figure A-2. Site Overview – ABB CE Windsor Site, Windsor, Connecticut

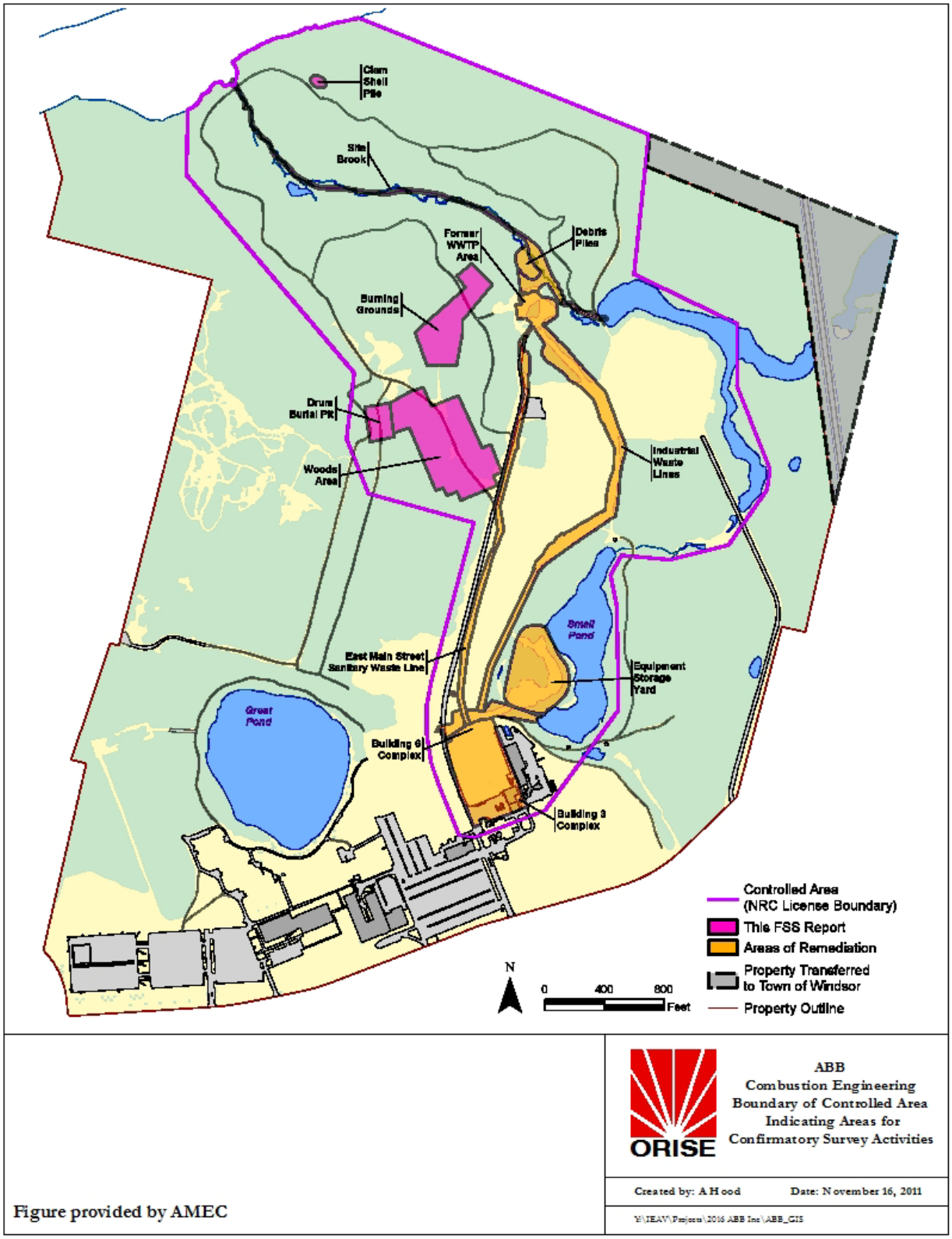

Figure A-3. Boundary of Controlled Area Indicating Areas for Confirmatory Survey Activities

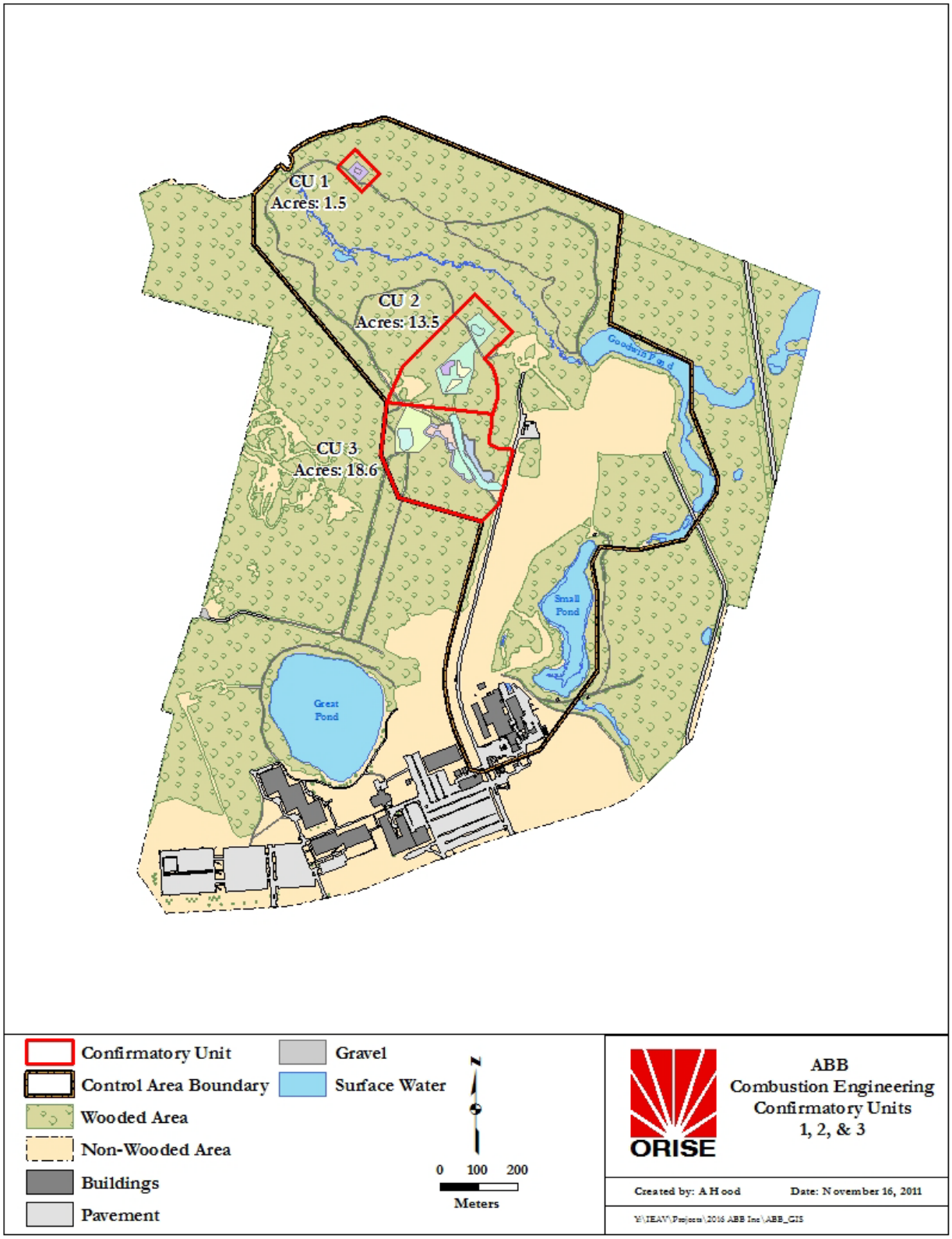

Figure A-4. Confirmatory Units – ABB CE Windsor Site, Windsor, Connecticut

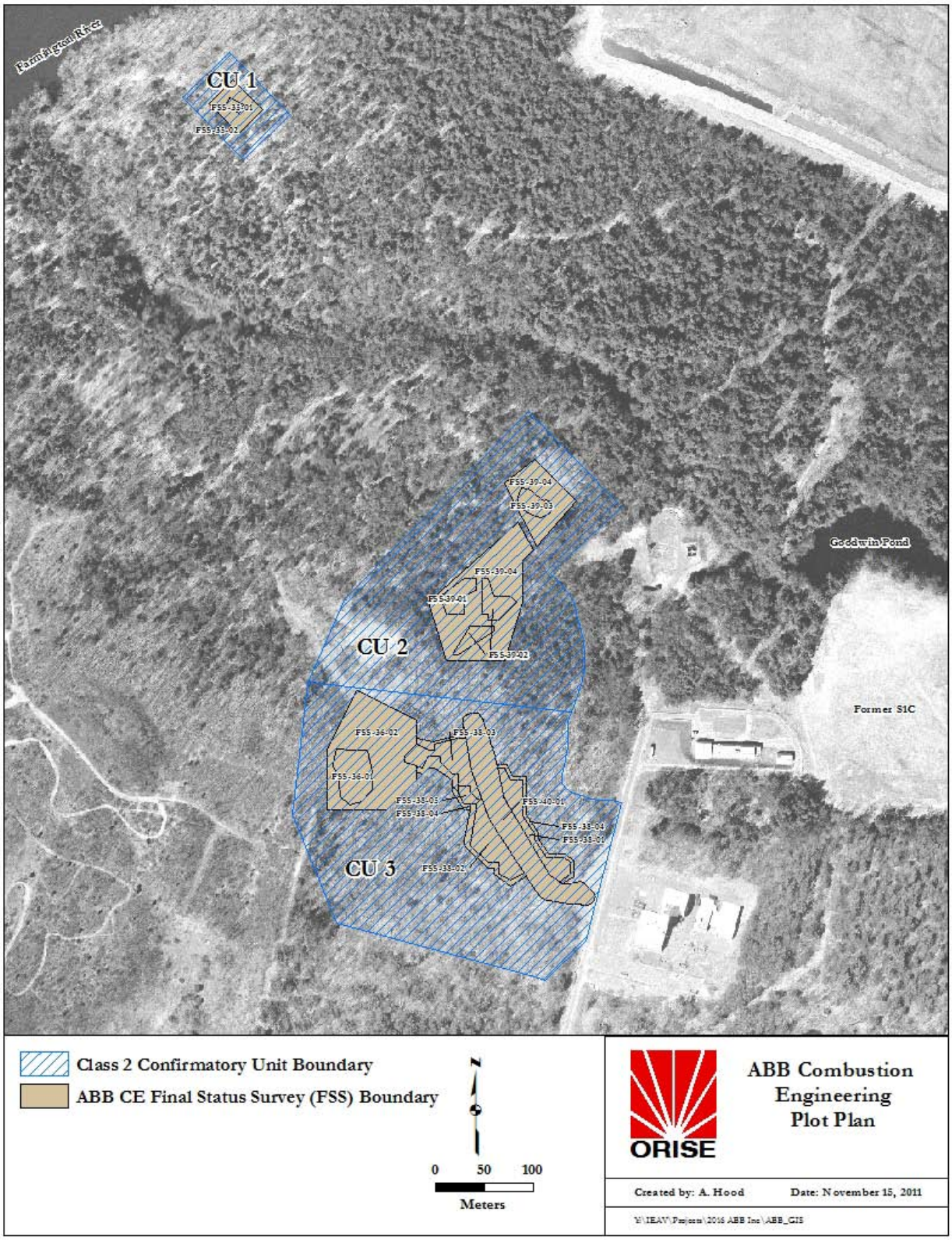

Figure A-5. ORISE Confirmatory Units Boundaries for Fall 2011 – ABB CE Windsor Site

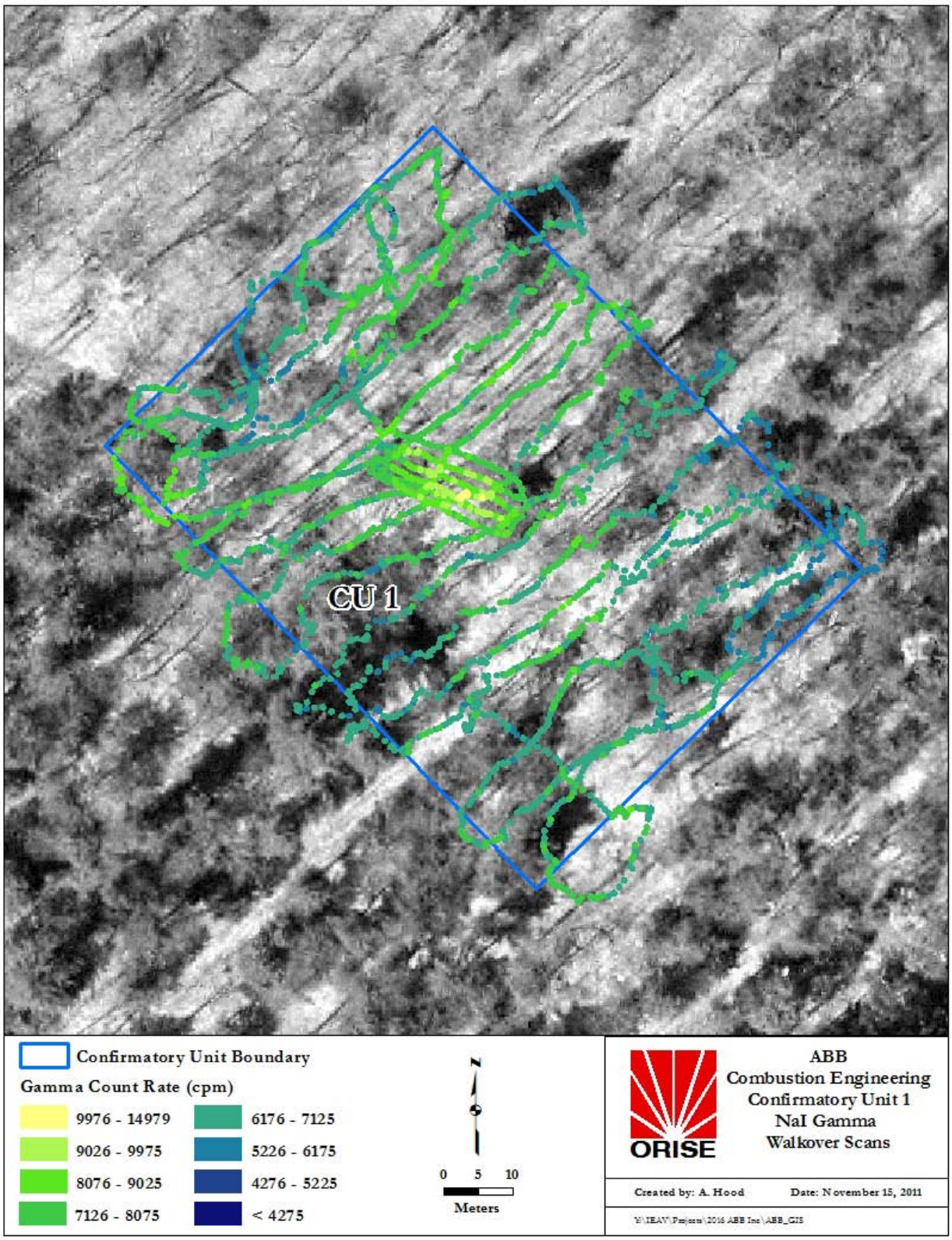

Figure A-6. Confirmatory Unit 1, Clamshell Pile Area – Gamma Scans

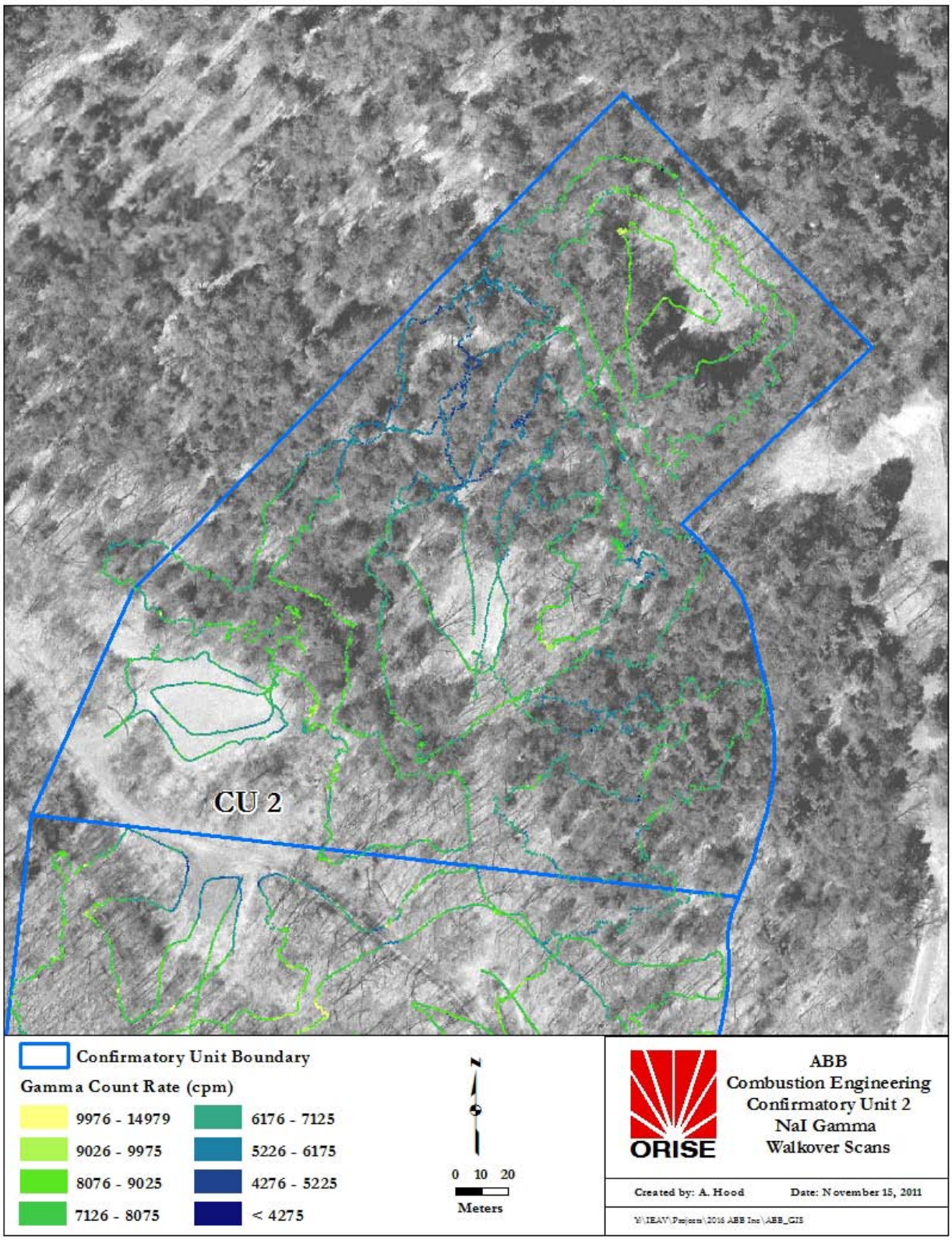

Figure A-7. Confirmatory Unit 2, Burning Grounds – Gamma Scans

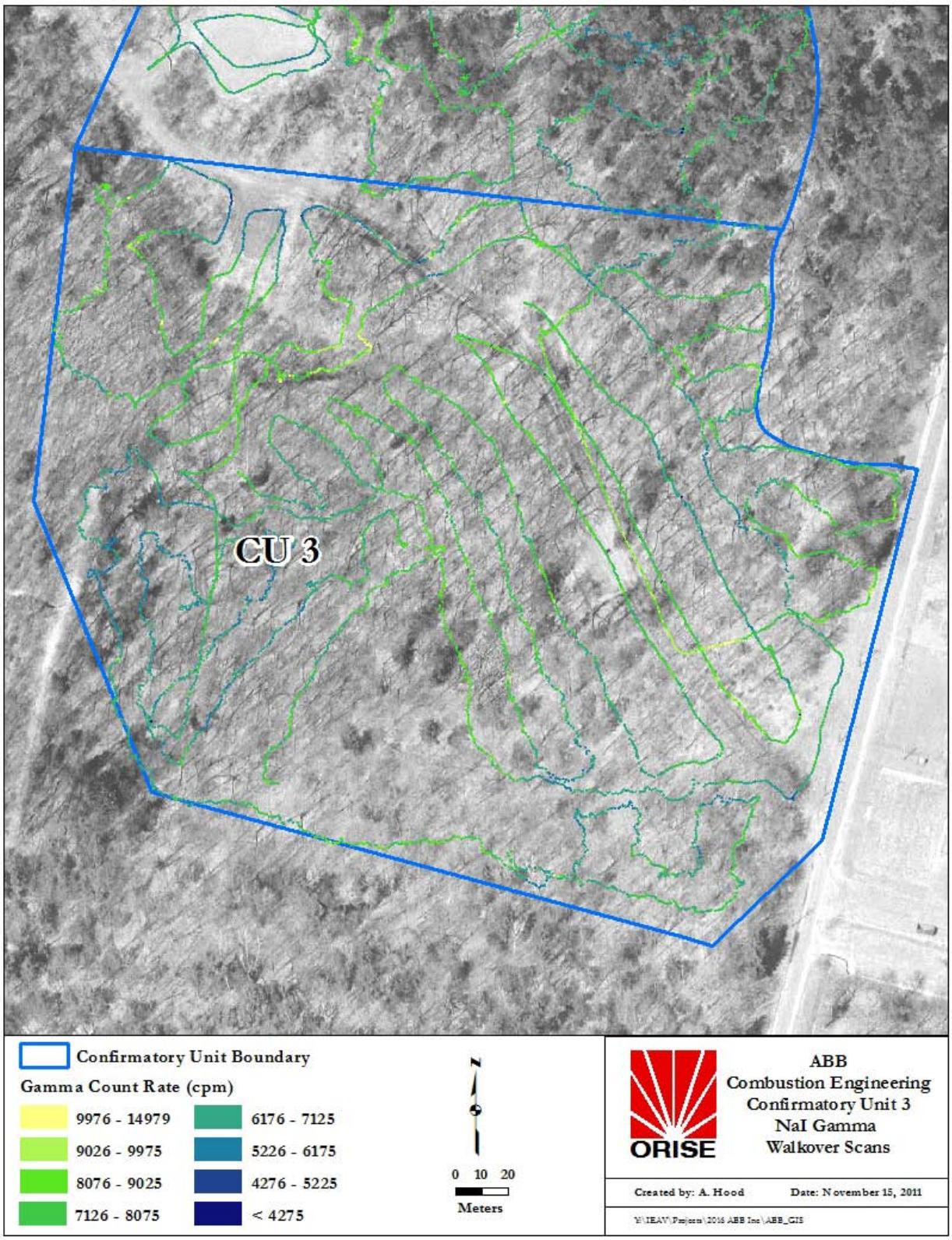

Figure A-8. Confirmatory Unit 3, Drum Burial Pit and Woods Area – Gamma Scans

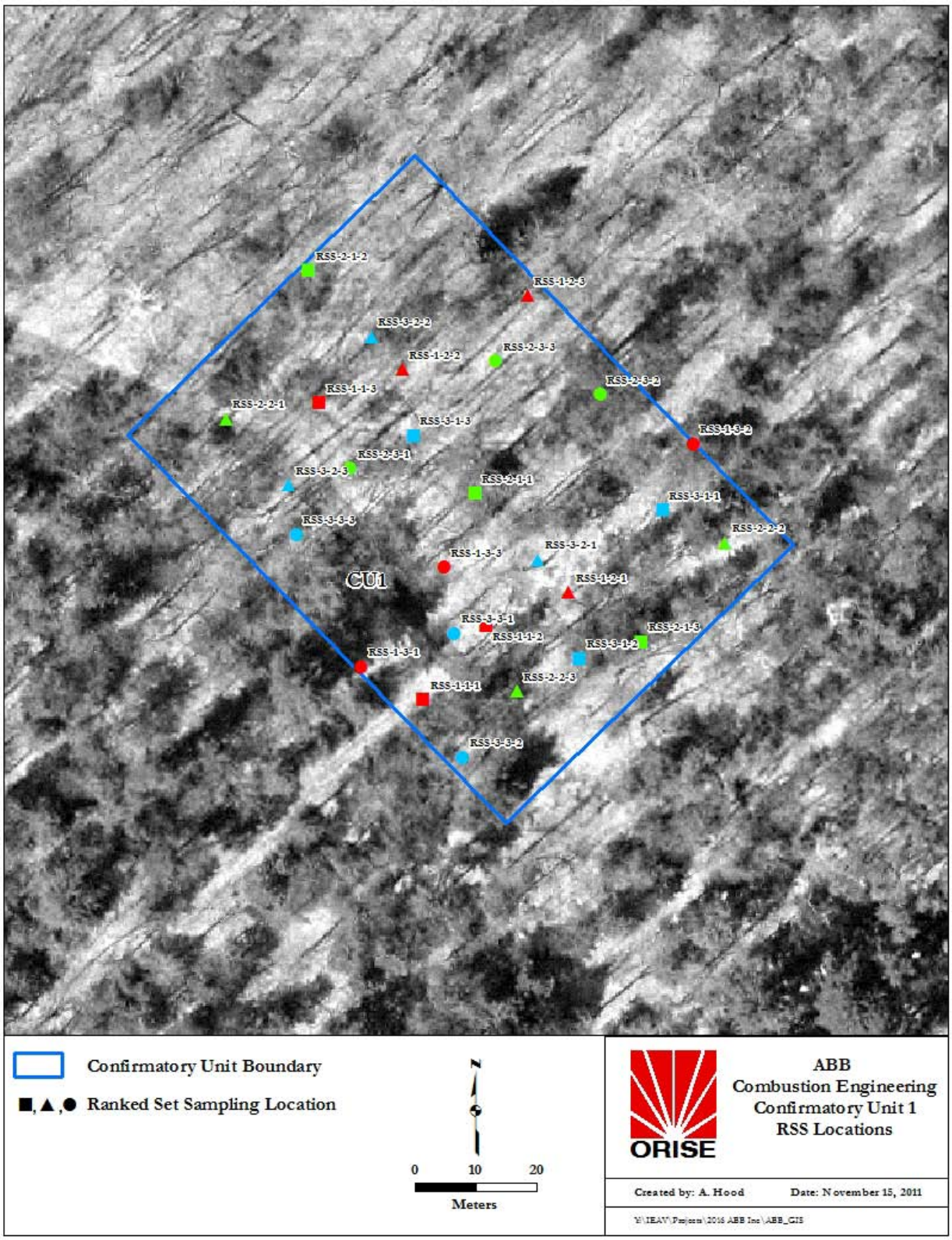

Figure A-9. Confirmatory Unit 1, Clamshell Pile Area – Ranked Set Sampling Locations

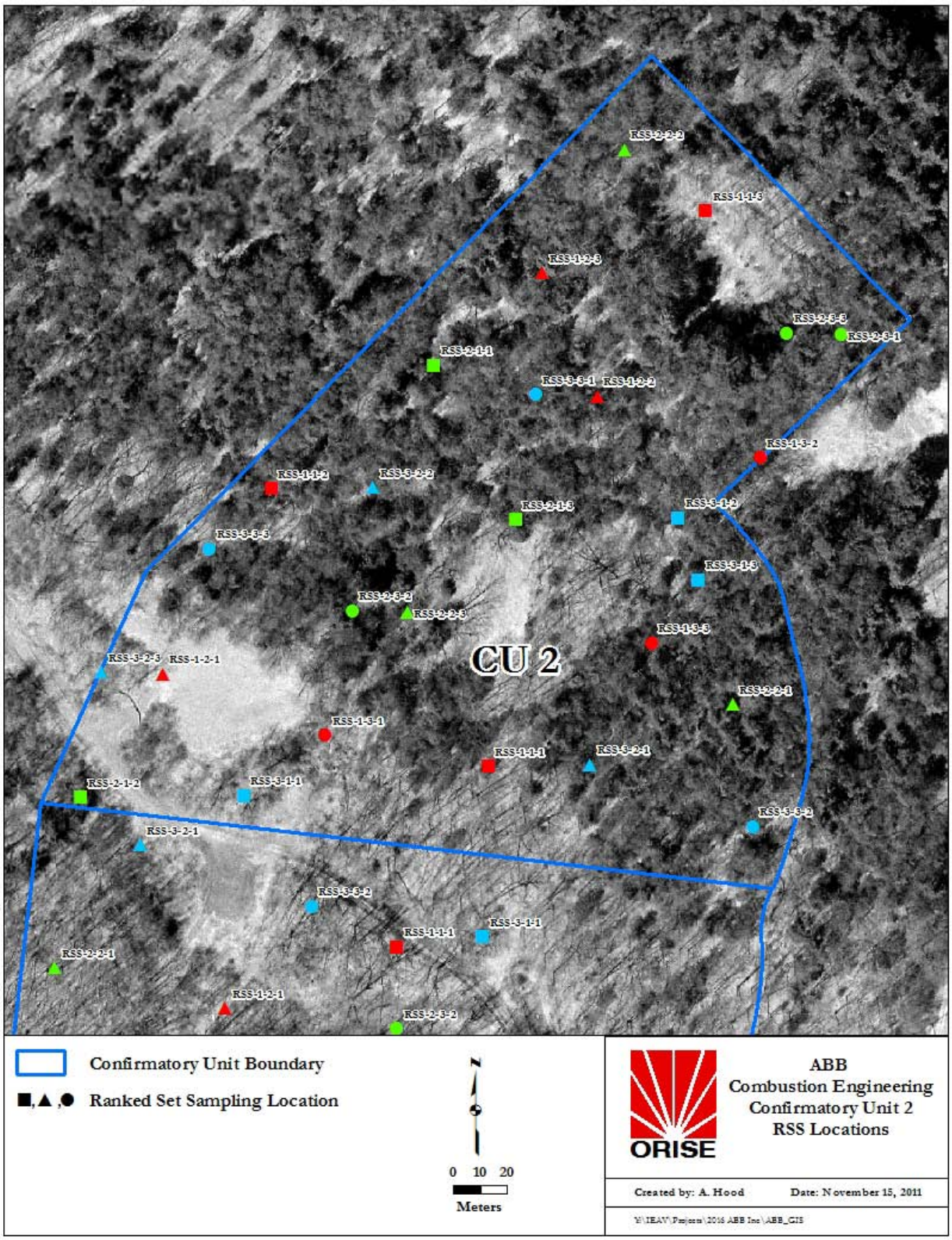

Figure A-10. Confirmatory Unit 2, Burning Grounds – Ranked Set Sampling Locations

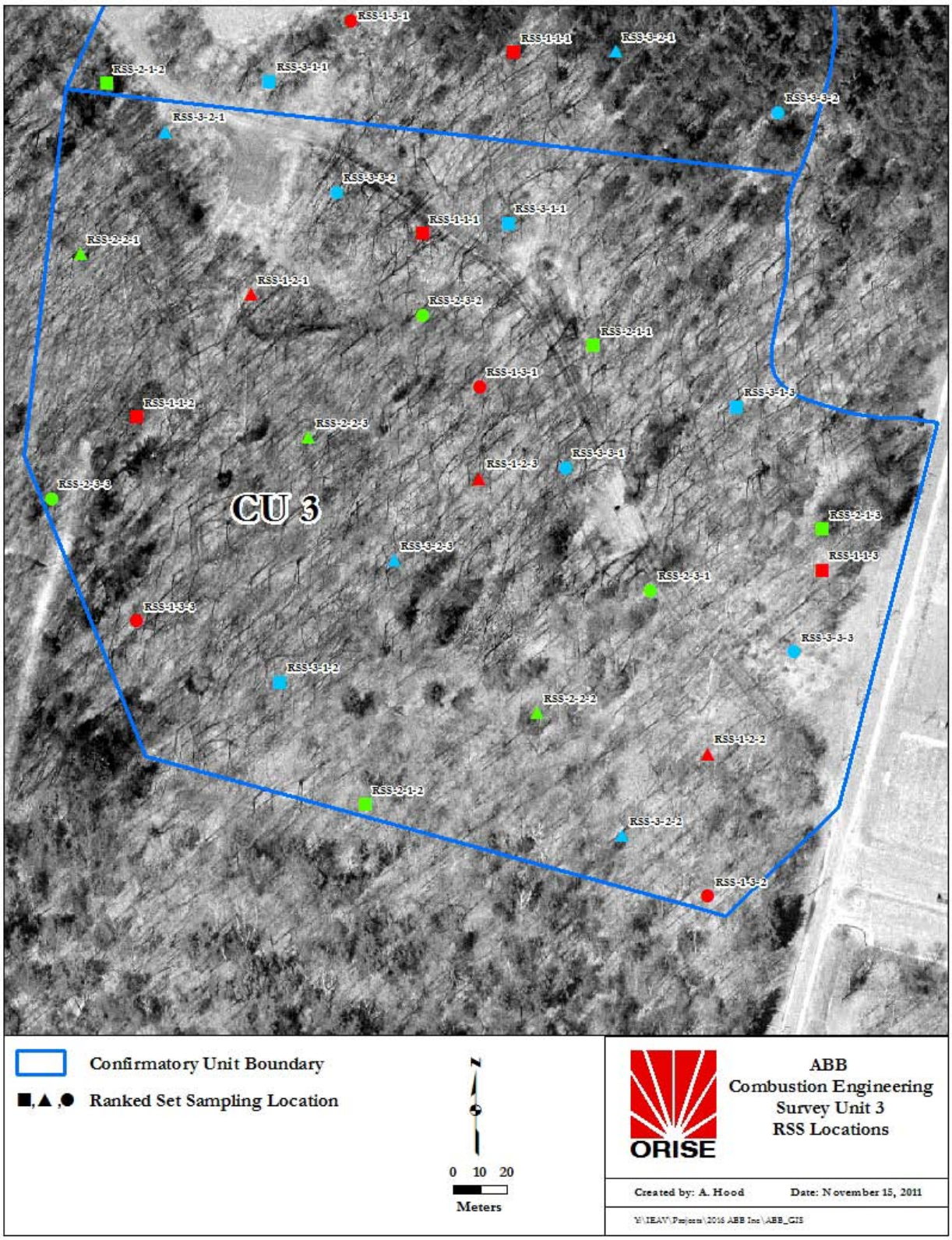

Figure A-11. Confirmatory Unit 3, Drum Burial Pit and Woods Area – Ranked Set Sampling Locations

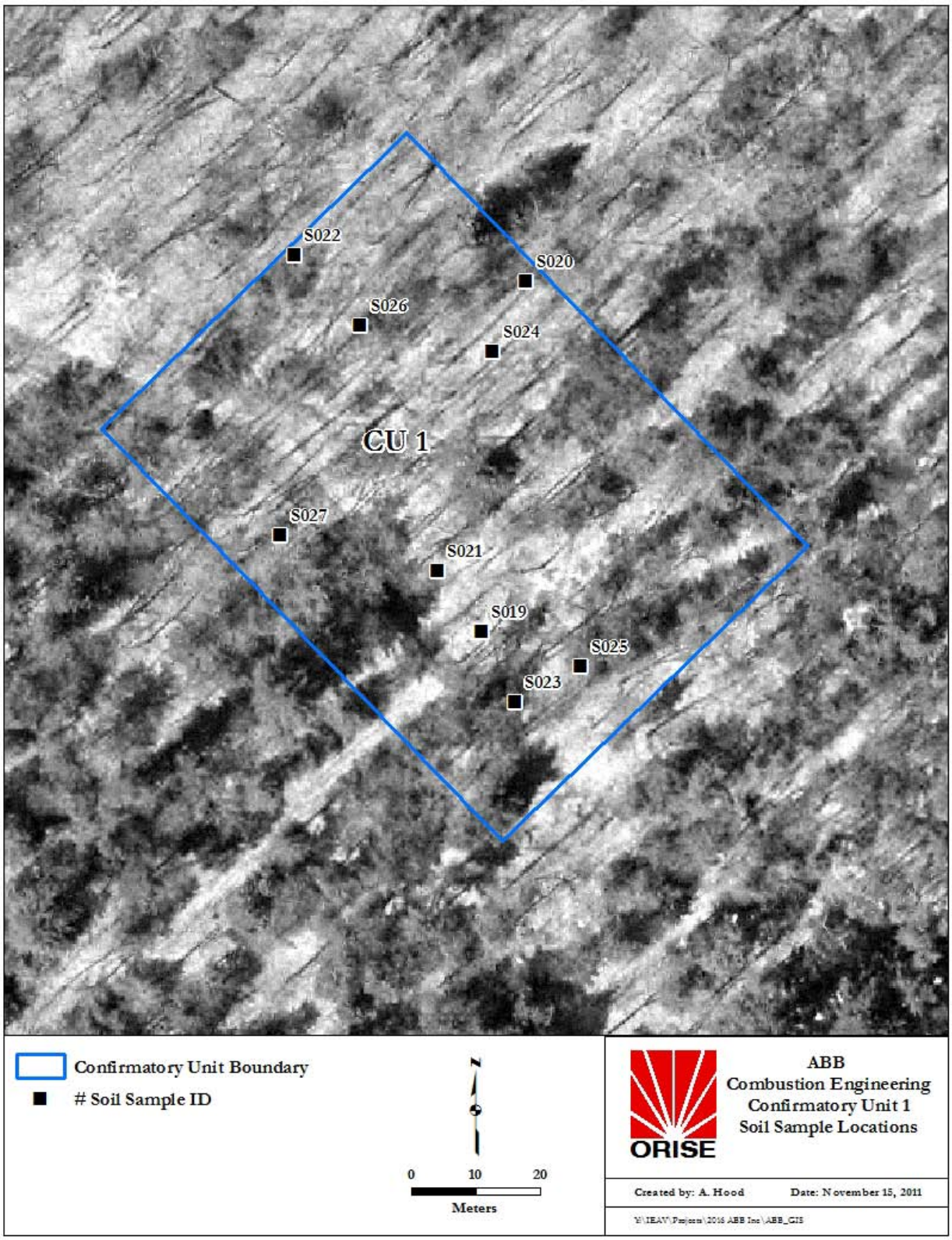

Figure A-12. Confirmatory Unit 1, Clamshell Pile Area – Soil Sample Locations

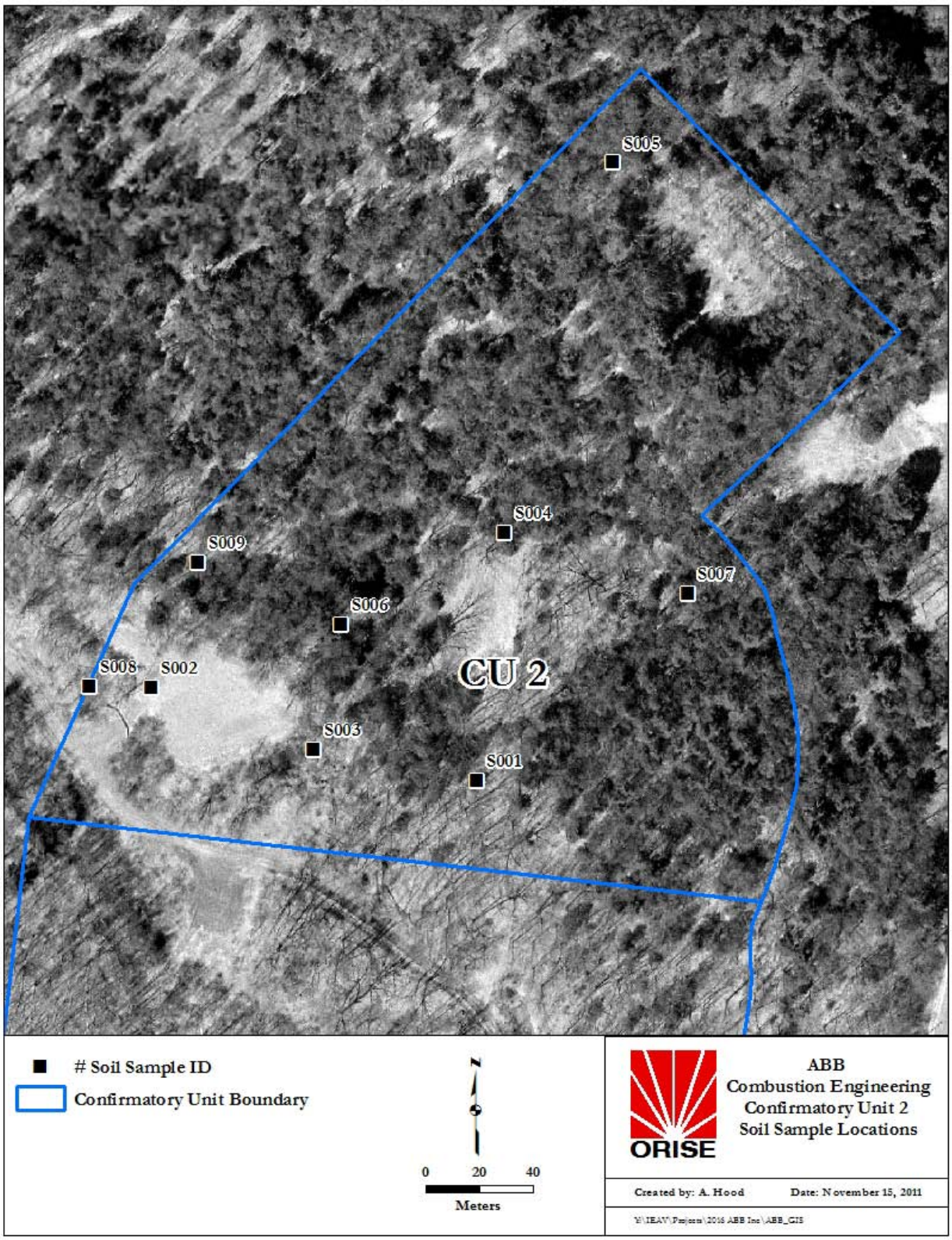

Figure A-13. Confirmatory Unit 2, Burning Grounds – Soil Sample Locations

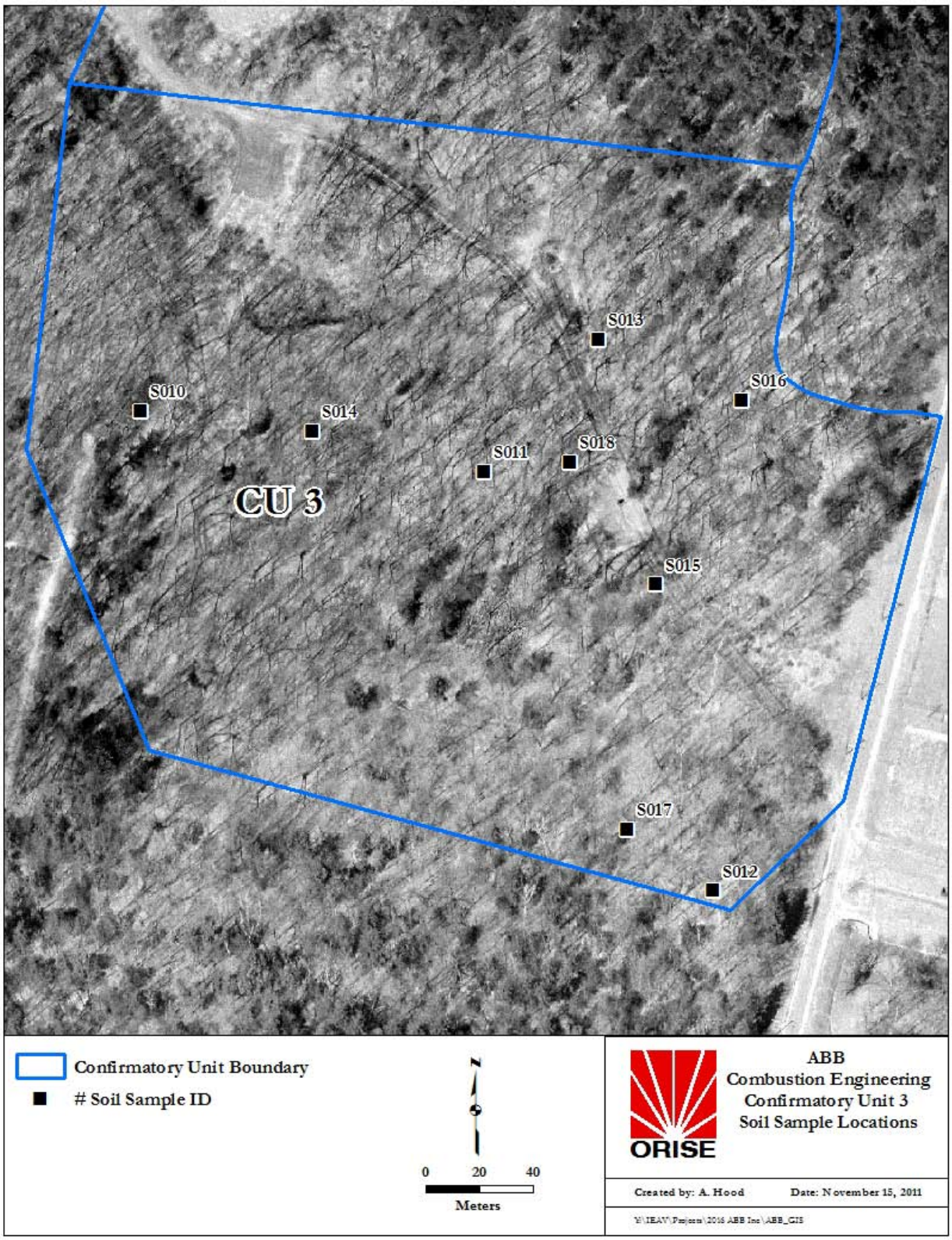

Figure A-14. Confirmatory Unit 3, Drum Burial Pit and Woods Area – Soil Sample Locations

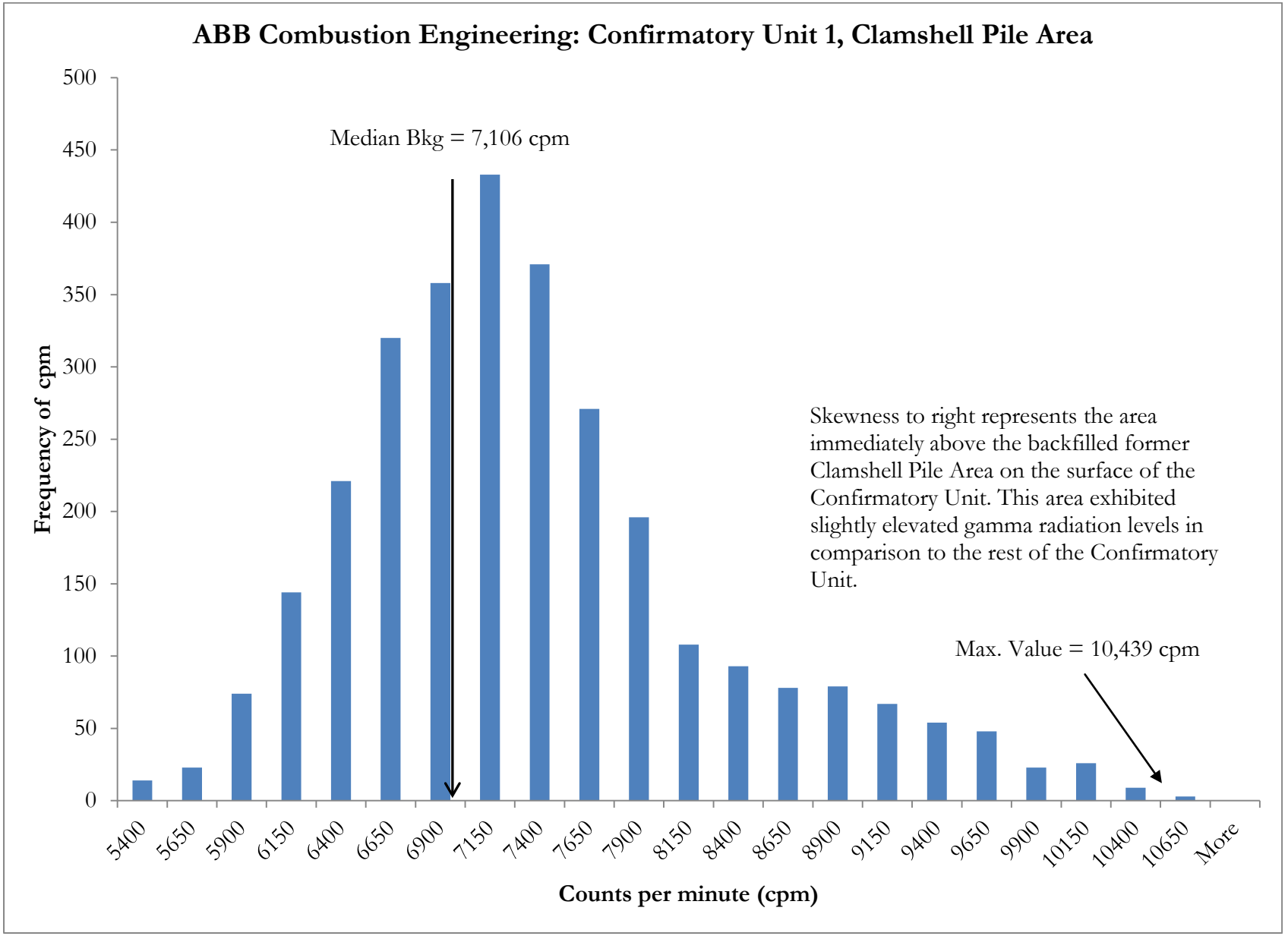

Figure A-15. Confirmatory Unit 1, Clamshell Pile Area – Gamma Scan Count Rate Distribution

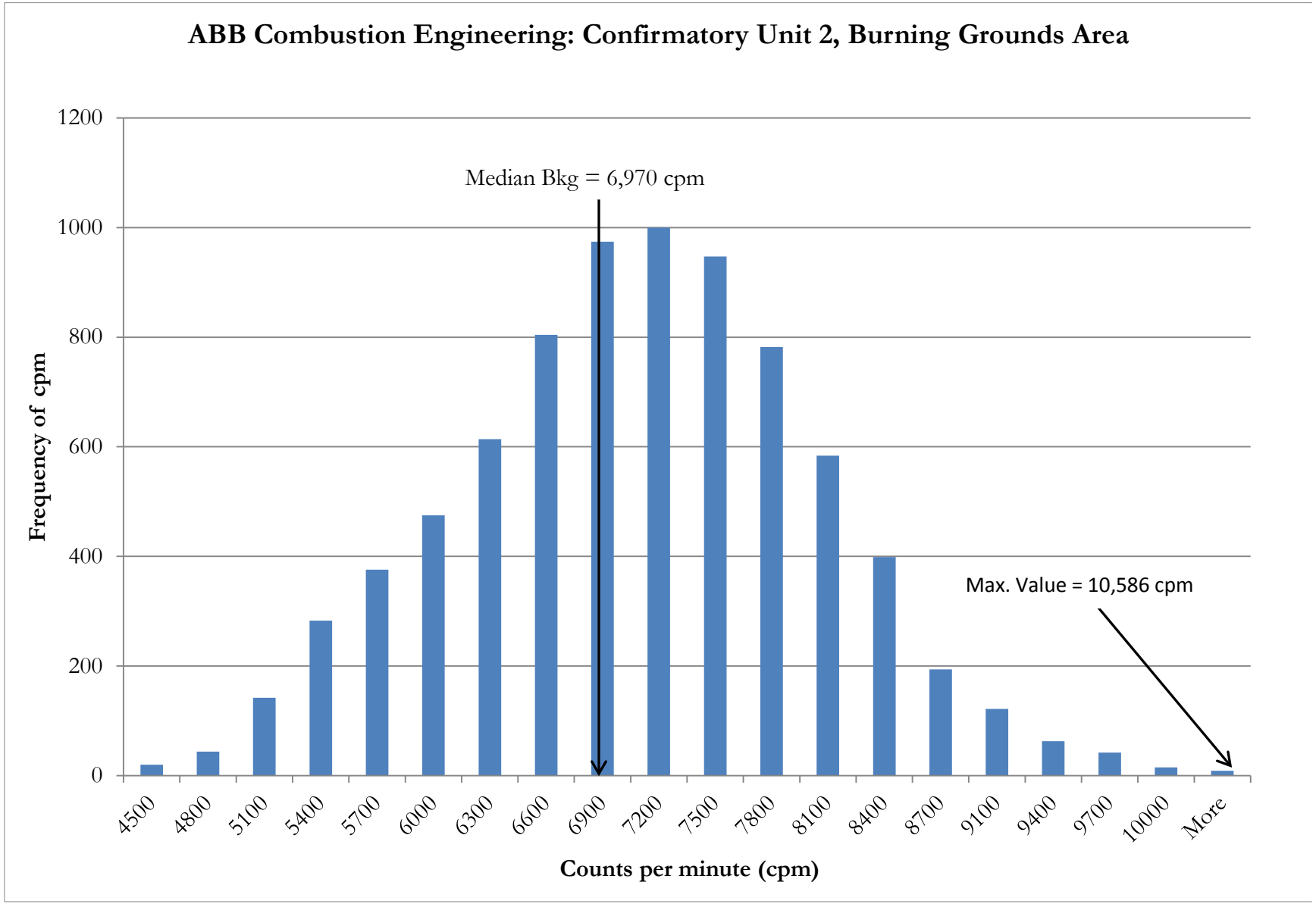

Figure A-16. Confirmatory Unit 2, Burning Grounds Area – Gamma Scan Count Rate Distribution

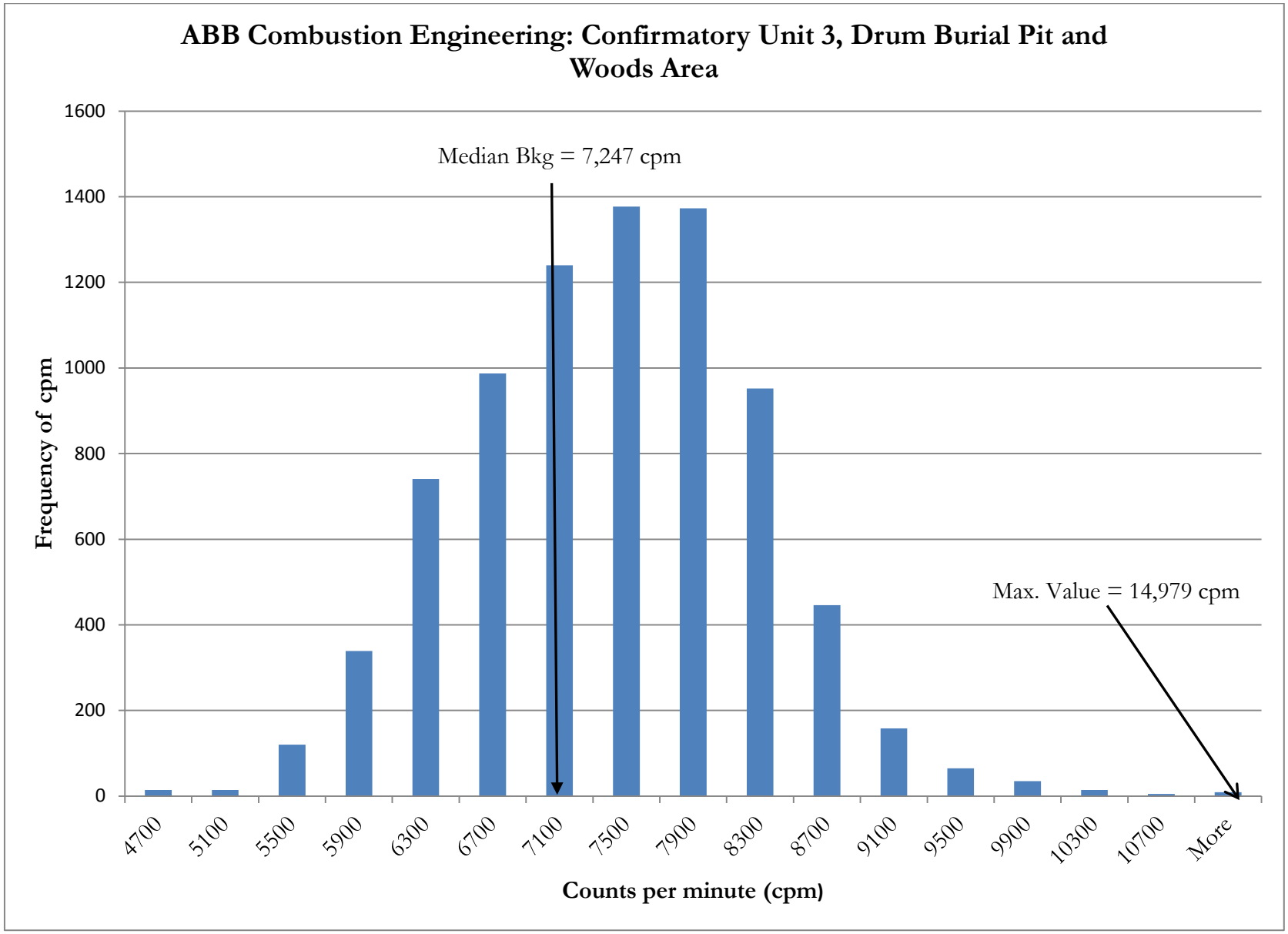

Figure A-17. Confirmatory Unit 3, Drum Burial Pit and Woods Area – Gamma Scan Count Rate Distribution

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APPENDIX B
TABLES

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Table B-1. Ranked Set Sampling Gamma Measurements Fall 2011 Confirmatory Survey Activities ABB Combustion Engineering Windsor, Connecticut									
East (ft)	North (ft)	RSS Measurement Location[a]				Gamma Count Rate (cpm)[b]	Code[c]	Surface Soil Sample ID[d]	Subsurface Gamma Counts (cpm)
		Cycle	Set	#	Symbol				
Confirmatory Unit 1: Clamshell Pile Area[e]									
1007974.0	886157.9	1	1	1	■	7,138	L	---[f]	---
1008007.7	886198.0	1	1	2	■	7,038	**L**	S019	8,739
1007917.9	886318.3	1	1	3	■	7,657	L	---	---
1008052.6	886215.8	1	2	1	▲	6,894	M	---	---
1007962.8	886336.1	1	2	2	▲	7,433	M	---	---
1008030.1	886376.2	1	2	3	▲	7,097	**M**	S020	8,234
1007940.3	886175.7	1	3	1	●	6,393	H	---	---
1008119.9	886296.0	1	3	2	●	5,972	H	---	---
1007985.2	886229.2	1	3	3	●	6,708	**H**	S021	7,916
1008002.0	886269.3	2	1	1	■	8,485	L	---	---
1007912.2	886389.6	2	1	2	■	6,561	**L**	S022	8,157
1008091.8	886189.1	2	1	3	■	6,623	L	---	---
1007867.3	886309.4	2	2	1	▲	7,018	M	---	---
1008136.7	886242.5	2	2	2	▲	5,596	M	---	---
1008024.5	886162.3	2	2	3	▲	6,953	**M**	S023	7,258
1007934.7	886282.6	2	3	1	●	6,740	H	---	---
1008069.4	886322.7	2	3	2	●	6,488	H	---	---
1008013.3	886340.6	2	3	3	●	7,292	**H**	S024	8,690
1008103.1	886260.4	3	1	1	■	6,696	L	---	---
1008058.2	886180.2	3	1	2	■	6,586	**L**	S025	7,293
1007968.4	886300.5	3	1	3	■	8,152	L	---	---
1008035.7	886233.6	3	2	1	▲	6,765	M	---	---
1007945.9	886353.9	3	2	2	▲	7,218	**M**	S026	8,582
1007901.0	886273.7	3	2	3	▲	7,819	M	---	---
1007990.8	886193.5	3	3	1	●	6,508	H	---	---
1007995.0	886126.7	3	3	2	●	6,786	H	---	---
1007905.2	886247.0	3	3	3	●	6,797	**H**	S027	8,097

Table B-1. Ranked Set Sampling Gamma Measurements (Cont.) Fall 2011 Confirmatory Survey Activities ABB Combustion Engineering Windsor, Connecticut									
East (ft)	North (ft)	RSS Measurement Location[a]				Gamma Count Rate (cpm)[b]	Code[c]	Surface Soil Sample ID[d]	Subsurface Gamma Counts (cpm)
		Cycle	Set	#	Symbol				
Confirmatory Unit 2: Burning Grounds Area[e]									
1008778.6	884375.6	1	1	1	■	8,002	**L**	S001	8,919
1008514.3	884713.4	1	1	2	■	8,155	L	---	---
1009042.9	885051.2	1	1	3	■	8,500	L	---	---
1008382.1	884488.2	1	2	1	▲	6,826	**M**	S002	6,877
1008910.8	884826.0	1	2	2	▲	6,829	M	---	---
1008844.7	884976.2	1	2	3	▲	6,371	M	---	---
1008569.0	884395.0	1	3	1	●	6,930	**H**	S003	7,039
1009109.0	884751.0	1	3	2	●	6,730	H	---	---
1008976.9	884525.8	1	3	3	●	6,753	H	---	---
1008712.5	884863.6	2	1	1	■	6,732	L	---	---
1008283.0	884338.1	2	1	2	■	6,840	L	---	---
1008811.7	884675.9	2	1	3	■	6,501	**L**	S004	6,937
1009076.0	884450.7	2	2	1	▲	8,678	M	---	---
1008943.8	885126.3	2	2	2	▲	7,710	**M**	S005	9,476
1008679.5	884563.3	2	2	3	▲	7,299	M	---	---
1009208.2	884901.1	2	3	1	●	7,457	H	---	---
1008613.4	884565.1	2	3	2	●	8,553	**H**	S006	9,543
1009142.1	884902.9	2	3	3	●	8,179	H	---	---
1008501.0	884347.0	3	1	1	■	7,682	L	---	---
1009009.9	884677.7	3	1	2	■	7,454	L	---	---
1009034.7	884602.7	3	1	3	■	7,012	**L**	S007	8,702
1008902.5	884377.5	3	2	1	▲	7,006	M	---	---
1008638.2	884715.3	3	2	2	▲	8,148	M	---	---
1008247.0	884496.0	3	2	3	▲	7,605	**M**	S008	9,309
1008836.4	884827.9	3	3	1	●	5,885	H	---	---
1009100.8	884302.4	3	3	2	●	7,506	H	---	---
1008439.9	884640.2	3	3	3	●	8,426	**H**	S009	9,584

Table B-1. Ranked Set Sampling Gamma Measurements (Cont.) Fall 2011 Confirmatory Survey Activities ABB Combustion Engineering Windsor, Connecticut									
East (ft)	North (ft)	RSS Measurement Location[a]				Gamma Count Rate (cpm)[b]	Code[c]	Surface Soil Sample ID[d]	Subsurface Gamma Counts (cpm)
		Cycle	Set	#	Symbol				
Confirmatory Unit 3: Drum Burial Pit and Woods Area[e]									
1008667.2	884155.4	1	1	1	■	8,216	L	---	---
1008319.9	883931.9	1	1	2	■	7,313	**L**	S010	9,178
1009153.5	883745.7	1	1	3	■	8,500	L	---	---
1008458.8	884080.9	1	2	1	▲	8,993	M	---	---
1009014.5	883522.3	1	2	2	▲	7,679	M	---	---
1008736.7	883857.5	1	2	3	▲	8,665	**M**	S011	9,365
1008737.1	883969.2	1	3	1	●	7,959	H	---	---
1009014.9	883348.4	1	3	2	●	7,984	**H**	S012	9,666
1008320.3	883683.6	1	3	3	●	7,870	H	---	---
1008876.0	884018.9	2	1	1	■	8,064	**L**	S013	10,232
1008598.1	883460.2	2	1	2	■	9,411	L	---	---
1009153.9	883795.4	2	1	3	■	8,527	L	---	---
1008250.8	884130.6	2	2	1	▲	8,988	M	---	---
1008806.5	883571.9	2	2	2	▲	7,604	M	---	---
1008528.7	883907.1	2	2	3	▲	8,139	**M**	S014	8,492
1008945.5	883720.9	2	3	1	●	9,306	**H**	S015	9,589
1008667.6	884056.1	2	3	2	●	8,695	H	---	---
1008216.1	883832.6	2	3	3	●	7,875	H	---	---
1008771.8	884167.8	3	1	1	■	8,810	L	---	---
1008494.0	883609.2	3	1	2	■	8,714	L	---	---
1009049.7	883944.4	3	1	3	■	5,791	**L**	S016	6,939
1008355.0	884279.6	3	2	1	▲	7,775	M	---	---
1008910.7	883422.9	3	2	2	▲	8,016	**M**	S017	8,937
1008632.9	883758.1	3	2	3	▲	9,572	M	---	---
1008841.3	883869.9	3	3	1	●	9,639	**H**	S018	11,015
1008563.4	884205.1	3	3	2	●	8,672	H	---	---
1009119.1	883646.4	3	3	3	●	9,192	H	---	---

[a]RSS description, color and symbol codes explanation provided in Appendix E.
[b]Gamma counts represent the one-minute gamma count rate at the soil surface for the location.
[c]Sample select code specifies which location is sampled for a given cycle/set based on the gamma count rate.
[d]Soil sample locations are provided on Figures A-12, A-13 and A-14 for Confirmatory Units 1, 2 and 3, respectively.
[e]For Confirmatory Unit 1 refer to Figure A-9 and for Confirmatory Unit 2, refer to Figure A-10, and for Confirmatory Unit 3 refer to Figure A-11.
[f]Measurement/sample not required.

Table B-2. Radionuclide Concentrations in RSS Soil Samples

Fall 2011 Confirmatory Survey Activities
ABB CE Windsor Site
Windsor, Connecticut

Sample ID[a]	East (ft)	North (ft)	Co-60	Ra-226	Th-232	U-235	U-238	Total U[b]	SOR[c]
CU1: Clamshell Pile Area									
S019	1008007.7	886198.0	-0.01 ± 0.06[d]	0.60 ± 0.07	0.68 ± 0.13	-0.01 ± 0.16	0.54 ± 0.29	1.07 ± 0.60	0.00[e]
S020	1008030.1	886376.2	-0.01 ± 0.05	0.69 ± 0.07	0.86 ± 0.20	0.07 ± 0.19	0.95 ± 0.61	2.23 ± 0.99	0.00
S021	1007985.2	886229.2	0.02 ± 0.05	0.55 ± 0.06	0.69 ± 0.12	-0.06 ± 0.13	0.66 ± 0.28	1.26 ± 0.57	0.01
S022	1007912.2	886389.6	0.01 ± 0.06	0.62 ± 0.08	0.82 ± 0.15	-0.04 ± 0.16	0.59 ± 0.33	1.14 ± 0.68	0.00
S023	1008024.5	886162.3	-0.01 ± 0.04	0.58 ± 0.06	0.77 ± 0.12	0.16 ± 0.15	0.76 ± 0.25	4.4 ± 3.3	0.00
S024	1008013.3	886340.6	0.02 ± 0.06	0.65 ± 0.08	0.79 ± 0.16	0.04 ± 0.16	0.83 ± 0.37	1.70 ± 0.76	0.01
S025	1008058.2	886180.2	-0.03 ± 0.06	0.48 ± 0.07	0.73 ± 0.14	0.06 ± 0.15	0.70 ± 0.35	1.46 ± 0.72	0.00
S026	1007945.9	886353.9	-0.01 ± 0.05	0.67 ± 0.07	0.98 ± 0.16	-0.10 ± 0.20	0.73 ± 0.29	1.36 ± 0.61	0.00
S027	1007905.2	886247.0	0.01 ± 0.04	0.52 ± 0.06	0.76 ± 0.13	0.08 ± 0.12	0.62 ± 0.29	1.32 ± 0.59	0.00
CU1 Average			*0.00*	*0.60*	*0.79*	*0.02*	*0.71*	*1.77*	*0.00*
CU1 Standard Deviation			*0.02*	*0.07*	*0.09*	*0.08*	*0.13*	*1.05*	*0.00*
CU2: Burning Grounds Area									
S001	1008778.6	884375.6	0.00 ± 0.06	0.62 ± 0.07	0.88 ± 0.14	-0.04 ± 0.14	0.61 ± 0.32	1.18 ± 0.66	0.36
S002	1008382.1	884488.2	0.02 ± 0.04	0.52 ± 0.05	0.84 ± 0.12	0.19 ± 0.14	0.80 ± 0.26	5.1 ± 3.1	0.34
S003	1008569.0	884395.0	0.01 ± 0.04	0.42 ± 0.05	0.63 ± 0.12	0.04 ± 0.12	0.49 ± 0.21	1.02 ± 0.44	0.25
S004	1008811.7	884675.9	-0.01 ± 0.07	0.48 ± 0.08	1.16 ± 0.21	-0.08 ± 0.21	0.62 ± 0.41	1.16 ± 0.85	0.40
S005	1008943.8	885126.3	0.02 ± 0.06	0.72 ± 0.08	1.03 ± 0.17	0.16 ± 0.21	1.25 ± 0.40	2.66 ± 0.83	0.43
S006	1008613.4	884565.1	0.08 ± 0.06	0.79 ± 0.12	0.82 ± 0.19	0.23 ± 0.22	0.88 ± 0.51	6.1 ± 4.8	0.41
S007	1009034.7	884602.7	0.01 ± 0.05	0.56 ± 0.06	0.76 ± 0.13	0.06 ± 0.13	0.71 ± 0.30	1.48 ± 0.61	0.32
S008	1008247.0	884496.0	0.03 ± 0.04	0.60 ± 0.06	0.89 ± 0.14	-0.03 ± 0.18	1.09 ± 0.27	2.15 ± 0.57	0.37

Table B-2. Radionuclide Concentrations in RSS Soil Samples

Fall 2011 Confirmatory Survey Activities
ABB CE Windsor Site
Windsor, Connecticut

Sample ID[a]	East (ft)	North (ft)	Co-60	Ra-226	Th-232	U-235	U-238	Total U[b]	SOR[c]
S009	1008439.9	884640.2	-0.01 ± 0.06	0.86 ± 0.09	1.22 ± 0.21	-0.14 ± 0.20	1.10 ± 1.10	2.1 ± 2.2	0.50
CU2 Average			*0.02*	*0.62*	*0.91*	*0.04*	*0.84*	*2.55*	*0.37*
CU2 Standard Deviation			*0.03*	*0.15*	*0.19*	*0.13*	*0.26*	*1.83*	*0.07*
CU3: Drum Burial Pit and Woods Area									
S010	1008319.9	883931.9	0.03 ± 0.06	0.55 ± 0.07	0.65 ± 0.13	-0.09 ± 0.16	0.59 ± 0.38	1.09 ± 0.78	0.29
S011	1008736.7	883857.5	-0.01 ± 0.06	0.69 ± 0.08	0.95 ± 0.16	-0.11 ± 0.24	0.60 ± 2.20	1.1 ± 4.4	0.39
S012	1009014.9	883348.4	0.08 ± 0.05	0.90 ± 0.11	0.95 ± 0.19	0.00 ± 0.20	0.91 ± 0.39	1.82 ± 0.81	0.46
S013	1008876.0	884018.9	-0.03 ± 0.06	0.64 ± 0.07	0.91 ± 0.15	0.02 ± 0.15	0.57 ± 0.45	1.16 ± 0.91	0.37
S014	1008528.7	883907.1	0.04 ± 0.04	0.57 ± 0.06	0.69 ± 0.12	-0.02 ± 0.18	0.56 ± 0.26	1.10 ± 0.55	0.31
S015	1008945.5	883720.9	0.01 ± 0.04	0.64 ± 0.07	0.89 ± 0.15	0.19 ± 0.02	1.29 ± 0.31	5.60 ± 0.53	0.38
S016	1009049.7	883944.4	0.04 ± 0.05	0.35 ± 0.06	0.42 ± 0.11	0.01 ± 0.15	0.48 ± 0.33	0.97 ± 0.68	0.19
S017	1008910.7	883422.9	0.01 ± 0.05	0.65 ± 0.07	0.83 ± 0.13	0.14 ± 0.18	1.17 ± 0.33	2.48 ± 0.68	0.36
S018	1008841.3	883869.9	0.01 ± 0.04	0.83 ± 0.08	1.00 ± 0.16	0.13 ± 0.07	1.06 ± 0.68	2.2 ± 1.4	0.44
CU3 Average			*0.02*	*0.65*	*0.81*	*0.03*	*0.80*	*1.95*	*0.35*
CU3 Standard Deviation			*0.03*	*0.16*	*0.19*	*0.10*	*0.31*	*1.48*	*0.08*

[a]Refer to Figures A-12 to A-14.
[b]Total Uranium calculations for natural uranium were 2*U-238 + U-235. For enriched uranium results (those in red text) the calculation was U-238 + U-235 + 21.7*U-235.
[c]SOR = Sum of Ratios. DCGLS were 5 pCi/g for Co-60; 4.5 pCi/g for Ra-226; 4.0 pCi/g for Th-232; and, 557 pCi/g for Total Uranium. For CU1, the radiological contaminants were Co-60 and Total Uranium. For CUs 2 and 3, the radiological contaminants were Co-60, Ra-226, Th-232 and Total Uranium.
[d]Uncertainties represent the 95% confidence level, based on total propagated uncertainties.
[e]Zero values are due to rounding.

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APPENDIX C
MAJOR INSTRUMENTATION

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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.

C.1 SCANNING AND MEASUREMENT INSTRUMENT/DETECTOR COMBINATIONS

C.1.1 Gamma

Ludlum NaI Scintillation Detector Model 44-10, Crystal:2 in x 2 in
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)

C.1.2 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)

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)

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APPENDIX D
SURVEY AND ANALYTICAL PROCEDURES

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D.1 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 (JHA). All survey and laboratory activities were conducted in accordance with ORISE health and safety and radiation protection procedures (ORISE 2008b and 2010).

Pre-survey activities included the evaluation and identification of potential health and safety issues. Survey work was performed per the ORISE generic health and safety plans and a site-specific Integrated Safety Management (ISM) pre-job hazard checklist. ABB and AMEC personnel also provided site-specific safety awareness training. An ORISE safety walk down of the site indicated that the land clearing activities and restoration activities by ABB/AMEC personnel left uneven terrain in some areas typical for outdoor survey activities.

D.2 CALIBRATION AND QUALITY ASSURANCE

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

Analytical and field survey activities were conducted in accordance with procedures from the following ORAU and ORISE documents:

- Survey Procedures Manual (May 2008)
- Laboratory Procedures Manual (August 2011)
- Quality Program Manual (August 2011)

The procedures contained in these manuals were developed to meet the requirements of 10 CFR 830 Subpart A, *Quality Assurance Requirements*, Department of Energy Order 414.1C *Quality Assurance*, 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 Testing Program (NRIP), and Intercomparison Testing Program (ITP) Laboratory Quality Assurance Programs.

- Training and certification of all individuals performing procedures.

- Periodic internal and external audits.

D.3 SURVEY PROCEDURES

D.3.1 SURFACE SCANS

A NaI(Tl) 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-second intervals of both geographic position and the gamma count rate. Positioning data files were downloaded from field data loggers for plotting using commercially available software (http://trl.trimble.com/docushare/dsweb/Get/Document-261826/GeoExpl2005_100A_GSG_ENG.pdf). 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 95^{th} percentile.

ORISE Survey Procedures (ORISE 2008b) require a minimum scan speed of 0.5 to 1 meter per second (m/s) based on the site contaminant and the DCGL for the primary contaminant of concern. A review of the gamma scan walkover data points relative to the scan area coverage indicate that the scan speed was less than 0.5 m/s (20,630 data points within an approximately 8,500 m^2 area with one data point recorded each second). The scan minimum detectable concentrations for the NaI scintillation detectors were 3.4 pCi/g for Co-60, 2.8 pCi/g for Ra-226, 1.8 pCi/g for Th-232, and -230 and 1.8 pCi/g for Th-232, and ranged from 80.0 pCi/g for natural uranium to 132 pCi/g for highly enriched uranium as provided in NUREG-1507 (Table 6.4). Any audible increase in radiation levels were investigated by ORISE. It is standard procedure for the ORISE staff to pause and investigate any locations where gamma radiation is distinguishable from background levels.

D.3.2 SOIL SAMPLING

Approximately 0.5 to 1 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. The RSS samples were collected as individual samples from the randomly selected soil sample locations as determined by VSP.

D.4 RADIOLOGICAL ANALYSIS

D.4.1 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 and volumes 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 ROCs were reviewed for consistency of activity. TAPs used for determining the activities of ROCs and the typical associated minimum detectable concentration (MDCs) for a one-hour count time were:

Radionuclide	TAP[a] (MeV)	MDC (pCi/g)
Co-60	1.173	0.09
Ra-226 by Pb-214	0.352	0.08
Th-232 by Ac-228	0.911	0.17
U-235	0.143	0.30
U-238 by Th-234	0.063	0.96

[a]Spectra were also reviewed for other identifiable TAPs that would not be expected at this site.

D.4.2 UNCERTAINTIES

The uncertainties associated with the analytical data presented in the tables of this report represent the total propagated uncertainties for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels.

D.4.3 DETECTION LIMITS

Detection limits, referred to as minimum detectable concentrations, were based on 3 plus 4.65 times the standard deviation of the background count [$3 + (4.65\ (BKG)^{1/2})$]. 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.

APPENDIX E
ORISE STATISTICAL SURVEY DESIGN FOR THE ABB COMBUSTION ENGINEERING SITE FALL 2011 SURVEY ACTIVITIES IN WINDSOR, CONNECTICUT

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E.1 SURVEY DESIGN SUMMARY

ORISE used available preliminary final status survey data to develop a defensible statistical sampling and survey design for the ABB Combustion Engineering Site property in Windsor, Connecticut surveyed during the Fall of 2011. A Ranked Set Sampling (RSS) design was selected using associated statistical assumptions as well as general guidelines for conducting post-sampling data analysis. The selected RSS statistical approach, as set forth in U.S. Environmental Protection Agency (EPA) QA/G-5S, calculates the number of samples required to determine a confidence interval for the mean that meets the boundaries provided by the user (EPA 2002). ORISE used the RSS data inputs, in conjunction with Visual Sample Plan (VSP), to determine how many sampling locations to choose and where within the sampling area to collect RSS gamma measurements and soil samples.

The following table summarizes the balanced RSS design developed.

Summary of Sampling Design for Each Area	
Primary Objective of Design	**Estimate the population mean**
Sample Placement (Location) in the Field	Simple random sampling
Formula for calculating number of sampling locations	Balanced ranked set sampling equations in EPA QA/G-5S (EPA, 2002)
Number of Ranks (m)(Chosen Set Size)	3
Calculated Number of Cycles (r)	3
Number of Samples to Analyze (m x r)	9
Number of Field Locations to Rank(m^2 x r)	27
Number of selected sample areas[a]	3
Specified sampling area [b]	1,461,049 ft^2

[a]The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[b]The sampling area is the total surface area of the selected colored sample areas on the map of the site.

Figure E-1 demonstrates the detailed VSP measurement locations in the field for the three Confirmatory Units. There were 27 RSS measurement locations within each confirmatory unit from which nine soil samples were collected from each survey unit.

Table B-1 lists the sampling coordinates generated by VSP that were identified in the field.

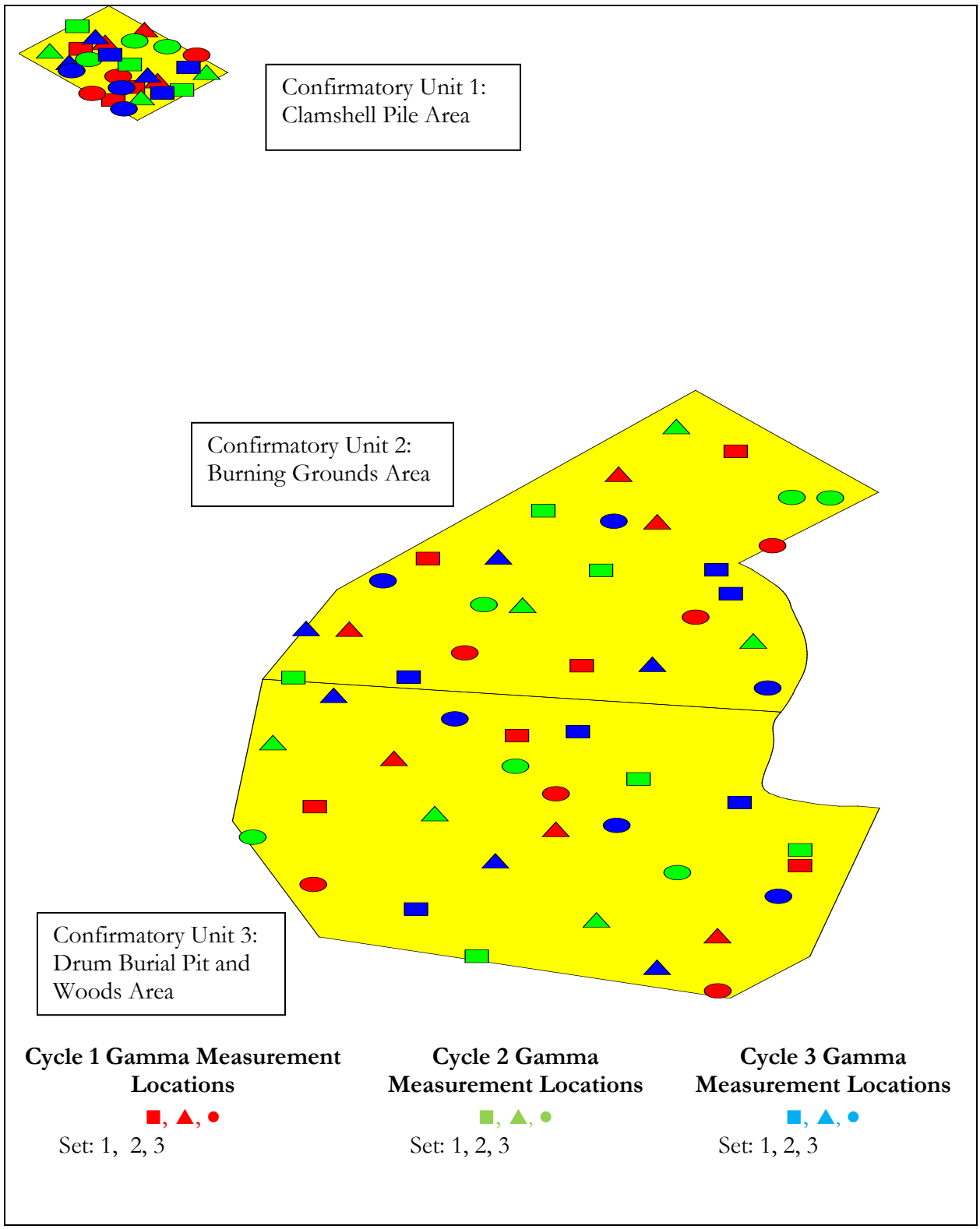

Figure E-1. Example of the RSS Measurement/Sampling Plan for the ORISE Confirmatory Units