SURVEY REPORT FOR STAGE 3 BUILDING MATERIALS

Bannister Federal Complex
1500 East Bannister Road
Kansas City, MO 64131

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Prepared for:

CenterPoint Properties Trust
1301 Burlington, Suite 200
Kansas City, MO 64116

Prepared by:

Auxier & Associates, Inc.
9821 Cogdill Road, Suite 1
Knoxville, TN 37932
(865) 675-3669

EXECUTIVE SUMMARY

This survey report documents the radiological assessment of select areas within the Bannister Federal Complex on behalf of CenterPoint Properties Trust and in support of the due diligence investigation to limit the risk to a future owner that could be associated with unknown environmental conditions. This survey was performed in late October and early November 2015 by Auxier and Associates (a USA Environment, L.P. Company).

The purpose of the survey was to determine if residual radiological contamination on building surfaces in areas identified as potentially impacted met surface contamination limits, and to evaluate the radiological condition of external surfaces surrounding the Main Manufacturing Building (MMB). The residual radioactivity limits used for this survey are found in the U.S. (former) Atomic Energy Commission Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors. While this report does not address the termination of a license or the free release of a facility, these guidelines are the standard for surface contamination for the Nuclear Regulatory Commission (NRC), state regulators, and they meet or exceed Department of Energy (DOE) requirements.

Surveys were performed in the following areas: Departments 49X, 20, 34C, 3A, 37B; Building 96, the Model Shop, Meseran Lab, Test Cell 11, GC Lab, the RedX lot, roof areas of Departments 49X and 20, and Building 96, in six additional areas (Areas 1-6) where radioactive materials were handled or stored, in select sumps and manholes, and on the grounds surrounding the MMB. Concrete core samples were collected in Departments 20 and 34C, and sump samples were collected from selected sumps.

Surveys confirm the presence of residual radioactive materials above background on floor surfaces in Departments 49X and 20. Remedial activities are scheduled in 2016 to address these areas. The remainder of this document will focus on the survey results in other areas of the facility.

Interior surveys did not reveal any residual radioactivity on building surfaces above the limits published in NRC Regulatory Guide 1.86. In Department 49X, residual radioactivity was detected on walls 2 and 4 above the investigation levels, and column Z38 above the detection limit. In Department 34C, residual radioactivity was detected above the investigation level on column S46. In Area 2, alpha-emitting radionuclides were detected at trace levels on two walls, but are likely due to construction materials. Floor scans in the Model Shop area revealed unusual alpha activity; however static measurements were at background levels. Trace levels of residual radioactivity were detected in a filter-housing located on the north east side of the Department 20 East roof, and under the east hood vent on the roof of Building 96. Further investigation and/or confirmatory measurements are suggested for these areas.

Sump samples were analyzed by gamma spectroscopy and for isotopic uranium and isotopic thorium. Three sump samples were problematic in that they contained very little mass, which increased the error and resulted in inconclusive gamma spectroscopy results. The samples contained thorium and uranium concentrations of 2 picoCuries per gram (pCi/g) or less. Subsequent isotopic radium-226 and radium-228 analyses of the samples demonstrated a maximum combined radium concentration of 10.59 pCi/g from one sample associated with Building 13. Re-sampling of this sump with the goal of collecting a larger sample and more mass is suggested.

Four concrete samples were collected from Department 20 and two from Department 34C. The uranium-238 concentrations in those samples ranged from 0.688 to 3.27 pCi/g. Taking the lowest results as representative of background concrete, the highest net uranium-238 result was 2.58 pCi/g in concrete sample number 2, collected on the east side of Department 20. The incremental lifetime risk (excluding background risk) to an indoor worker assuming continued use of the building was calculated to be approximately 6×10^{-7}. If the building is demolished and the rubble is as surface fill, either on-site or at a landfill, the risk from 2.58 pCi/g uranium-238 to a hypothetical resident was calculated to be approximately 3×10^{-6}. Using a similar approach, the combined risk from radium-226, all isotopic thorium and uranium concentrations in sample 2 to the postulated occupational and residential receptors yielded incremental lifetime risks of 1×10^{-6} and 4×10^{-6}, respectively. These estimates of risk are predicated on several health-protective assumptions and provide reasonable assurance that the slightly elevated radionuclide concentrations seen in the concrete are below EPA's upper-bound risk limit of 10^{-4} set for CERCLA investigations by the NCP. The basis of this observation can be enhanced by collection of concrete samples from a reference area.

The accessible exterior grounds surrounding the MMB were scanned using large area sodium iodide detectors coupled with a GPS. This overland scan of exterior grounds revealed three areas producing significantly higher gamma signatures. Samples were collected in these areas, and in a reference area remote from the MMB and analyzed by gamma spectroscopy and for isotopic uranium and isotopic thorium. Results from the elevated areas were comparable with the sample collected from the reference. Additional investigation (sampling) is necessary to resolve the question but it should be noted that, regardless of the reason, these levels of near-surface exposures do not, by themselves, produce unacceptable doses or risks.

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1. INTRODUCTION

Under the authority of the National Defense Authorization Act of 2014, and an agreement between the National Nuclear Security Agency (NNSA) and CenterPoint Properties Trust (CenterPoint Contract No. DE-NA0002662), CenterPoint is evaluating the potential for transferring portions of the Bannister Federal Complex (BFC), located at 1500 East Bannister Road in Kansas City, Missouri, to a new property owner. Portions of the BFC being considered for transfer are generally those West of the existing Union Pacific railroad tracks. As part of this evaluation, CenterPoint is undertaking a due diligence investigation of the property. This includes a records review, analysis of existing data, and targeted site investigations. The goal of the due diligence investigation is to limit the potential risk to a future owner that could be associated with unknown environmental conditions.

If a transfer occurs, it is anticipated that any future use of the BFC will entail demolition of all buildings, removal of current utilities to the depth of construction, installation of new utilities, and redevelopment. Future land use will be commercial or industrial only; no residential use is planned. Although the due diligence investigation is being completed by CenterPoint Properties, the BFC is currently owned by the U.S. Federal Government. The NNSA's portions of the site are operated by Honeywell, Inc. Other portions of the site are managed by the General Services Administration (GSA). All site activity was coordinated with Honeywell and GSA staff, and was completed in accordance with relevant components of the Site Health and Safety Plans for the BFC.

This survey report, titled *"Survey Report for Select Areas within the Bannister Federal Complex"* (the "Report") documents the findings of the survey of select areas of concern (AOCs) within the BFC.

1.1 SITE DESCRIPTION

The Kansas City Plant (KCP) is located at the BFC within the city limits of Kansas City, Missouri. The BFC is located approximately 10 miles south of the city center at 1500 East Bannister Road, Kansas City, Missouri 64131. The BFC (consisting of approximately 300 acres) is managed by the NNSA and the GSA. NNSA owns the portion of the BFC known as KCP, consisting of about 122 acres and 38 buildings. The 38 buildings NNSA owns comprise about 2.9 million square feet. See Figures 1and 2.

NOTE: The General Services Administration area east of the Union Pacific Railroad tracks is not included in the scope of this project.

The dominant structure on the BFC is the Main Manufacturing Building (MMB), which has about 2.7 million square feet of contiguous space and housed the primary KCP manufacturing operations. NNSA and GSA share this space.

1.2 SITE HISTORY

A detailed history of the BFC site can be found in a number of reports. Most recently, the draft Description of Current Conditions Report (DCCR) (DCCR 2013 & 2015) provides a complete summary.

The DCCR addresses the KCP's history of working with depleted uranium (DU) as a manufacturing material. This work continued in the Machining Area (Department 20) until about 1971.

Beginning in the early 1950s, KCP workers also inspected and assembled natural uranium components, machined uranium slugs, and handled uranium billets and ingots. Department 49X (49X) was established in 1951 in the far northwest corner of the MMB to produce 1,000 slugs of natural uranium per day to fuel Atomic Energy Commission production reactors. In conjunction with this operation, uranium components were inspected and assembled in Department 3A. Department 34C was also used to blend, fabricate and machine certain radioactive materials.

DU components were electrochemically etched in a liquid bath to remove oxides in Building 96, an outbuilding near the MMB (DCCR 2015). Between 1957 and 1979, KCP machined and fabricated classified items made of a magnesium-thorium alloy. Fabrication and machining occurred in Department 20 and later in the Model Shop (also known as Department 851, later renamed Department 823) (ORAU 2014).

1.3 REPORT ORGANIZATION

The remainder of this Report is organized into eight sections. Section 2 contains the residual radioactivity guidelines. Section 3 presents the measurement methods. Section 4 contains results of the Data Evaluation. Section 5 describes the Quality Control measures. and Section 6 lists the references. Field data and analytical results are presented in the appendices.

2. RESIDUAL RADIOACTIVITY GUIDELINES

2.1 SURFACE RESIDUAL RADIOACTIVITY GUIDELINES

The U.S. Nuclear Regulatory Commission's (NRC) Title 10 of the Code of Federal Regulations, Part 20, Subpart 1402 (10 CFR 20.1402) *Radiological criteria for unrestricted use* allows for dose-based criteria as long as the residual radioactivity that is distinguishable from background radiation results in a Total Effective Dose Equivalent to an average member of the critical group that does not exceed 25 millirem (0.25 milliSievert) per year, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable."

U.S. Department of Energy (DOE) Order 458.1 *Radiation Protection of the Public and the Environment* approves the use of dose-based limits for the release of property. Section 6(f)1.b allows for the use of the previously approved surface activity guidelines in DOE Order 5400.5, which are the same as those reflected in NRC Regulatory Guide 1.86.

The potential for residual radioactive contamination at the BFC did not warrant the effort and expense associated with site-specific modeling; therefore, the pre-approved guidelines listed in NRC Regulatory Guide 1.86 and DOE Order 458.1 (5400.5), and shown in Table 1 are appropriate and relevant for building surfaces.

Table 1: Surface Residual Radioactive Guidelines

Nuclide	Total (Fixed + Removable) Average dpm /100 cm^{2}[a]	Maximum dpm /100 cm^2	Removable dpm /100 cm^2
U-nat, U-235, U-238, and associated decay products	5,000 m^2	15,000	1,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-223, I-125, I-129	100 (500 dpm/100cm^2)[b]	300	20
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5000	15,000	1000

[a] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[b] For DOE activities inside the United States, 10 CFR 835 Appendix D allows 500 dpm/100cm^2

The uranium limits are applicable to both uranium ore and processed uranium, and are based on alpha activity. In natural uranium, the decay scheme is U-238 (α) to Th-234 (β) to Pa-234 (β) to U-234 (α), providing a 1:1 ratio of alpha and beta emissions. DU can have a 0.6:1 alpha to beta ratio, but the conservative 1:1 ratio was used.

2.2 INVESTIGATION LEVELS

Interior scan measurements greater than the minimum detectable concentration (MDC), and static measurements and smear results greater than 50% of the residual radioactivity guideline for uranium were flagged for further evaluation. Where measurements exceeded the MDC, static and smear measurements were collected. Where static measurements exceeded 50% of the guideline, 100% scan coverage of 1 m^2 area around measurement was performed and four systematic static measurement locations (4 corners) were collected, and any biased measurements necessary to characterize the area.

2.3 GROUND SURFACE RESIDUAL RADIOACTIVITY EVALUATION

Accessible areas of the KCP grounds were surveyed using a towed array of large area sodium iodide (NaI) geosyncronized gamma detectors and documented with GPS coordinates. Soil areas were too soft to survey with the towed array of large area detectors, so only parking areas were surveyed. The Survey Plan for Select Areas within the Bannister Federal Complex (Plan) specified that the results of the AOCs would be compared with the results of Area 11, the area most remote from MMB operations. The results for Area 11 were too varied for this comparison; therefore the entire population was compared, and areas that were statistically significantly different than the median results were sampled and analyzed by gamma spectroscopy and isotopic uranium and thorium.

2.4 BUILDING SUBSURFACE RESIDUAL RADIOACTIVITY SCREENING LEVELS

The MMB factory floor was originally constructed with 2-inch thick wood block flooring. The block flooring covered the majority of grade-level factory floor. Mastic was used to affix the wood floor to the concrete below. Between the 1950s and 1970s the wooden floor was removed in most areas. A 2-inch thick concrete topping slab was poured to replace the wooden floor (NNSA 2010). Four core samples from Department 20 and two from Department 34C were collected in areas where residual surface contamination had been identified to evaluate the condition of the base concrete/mastic. The intent of the Plan was to collect concrete core samples from a non-impacted area for comparison to the samples from the AOCs. The samples from the non-impacted area were inadvertently not collected.

3. MEASUREMENT METHODS

3.1 INSTRUMENTATION

Table 2 provides a complete list and specifications of the instrumentation used for this survey. The dual phosphor and gas flow proportional probes combined with the Ludlum 2360 provide for simultaneous detection of alpha- and beta-emitting radionuclides. The larger area of the floor monitor reduces the time needed to scan large floors areas. The Ludlum 2929 was used to count smears and discriminates alpha-and beta-emitting radiation from a surface. The sodium iodide (NaI) detectors are configured to measure exposure rates and gamma-emitting radionuclides on surfaces.

Table 2: Instrumentation

Measurement Type	Detector Type	Effective Detector Area/Size	Meter Model	Detector Model	Purpose
Alpha/Beta	Gas flow proportional	582 cm^2 mylar	Ludlum 2360	Ludlum 43-37	Floor Scan
Alpha/Beta	Dual phosphor scintillation	100 cm^2	Ludlum 2360	Ludlum 43-93	Scan and Static
Alpha/Beta	Dual phosphor scintillation	100 cm^2	Ludlum 2360	Ludlum 43-89	Scan and Static
Gamma	NaI Scintillation	1” X 1” NaI (internally housed)	Ludlum 19	NA	Exposure Rate
Gamma	NaI(Tl) scintillation	[a]1” x 1”	Ludlum 2221	Ludlum 44-2	Gamma Scan
Gamma	NaI(Tl) scintillation	[a]3” x 3”	Ludlum 2221	Ludlum 44-20	Gamma Scan
Gamma	NaI(Tl) scintillation	4” X 2” X 16”	Ludlum 2221	Ludlum 44-180	Large Area Gamma Scan
Alpha/Beta	Scintillator/ZnS phoswitch	2” (5.1cm) diameter	Ludlum 2929	Ludlum 43-10-1	Smear Counting

[a] Ludlum 44-20 probes contain a cylindrical NaI crystal doped with thallium measuring 3-inches in diameter by 3-inches tall. This “3x3 NaI(Tl) detector” provides more than three times the volume of more common 2x2 NaI detectors and affords a greater ability to discriminate above-background gamma radiation levels than smaller NaI detectors.

3.2 BACKGROUND REFERENCE AREAS

Building materials such as concrete, cinderblock, brick and roofing materials contain varying concentrations of the same naturally occurring radioactive materials as the materials of interest. Walls in the MMB were composed of cinderblock or brick materials, and floors were composed of concrete. Representative material background measurements were performed in radiologically non-impacted areas on brick, cinderblock, and concrete in areas surrounding columns XA44 and XB45. Measurements in an area considered non-impacted, located on the roof east of

Department 20, were collected for comparison with measurements in the roof AOCs. Background measurements were performed for the different media by collecting ten one-minute static measurements for each different medium. Table 3 lists the average background measurements.

Table 3: Average Background Measurements

Medium	43-93 (cpm)	43-89 (cpm)
Concrete	260	280
Cinderblock	380	390
Brick	380	400
Roof Materials	330	NA

3.3 SENSITIVITY

The investigation levels for static and removable measurements of alpha- and beta-emitting surface residual radioactivity are based on one-half the surface residual radioactivity guidelines for average and removable residual radioactivity given in Table 1.

3.3.1 Scan Sensitivity

The minimum detectable concentration (MDC) for scanning (scan MDC), is determined by the background count rate. The background count rate and scan MDC vary for different media. Background measurements were performed for the different media found in interior surfaces by performing ten one-minute static measurements on non-impacted materials.

Guidance on calculating scan MDCs for beta/gamma-emitting radionuclides is provided in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Section 6.7.2.1. The beta/gamma scan MDC for surfaces is based on a 2-stage scanning process consisting of continuous monitoring and stationary sampling when the technician notices an audible increase in the count rate. MARSSIM Equations 6-8, 6-9, and 6-10 are used to calculate the beta-emitting radionuclide scan MDC:

$$Scan\ MDC = \frac{d'\ x\ \sqrt{b_i}\ x\ \frac{60}{i}}{\sqrt{p}\ x\ e_i\ x\ e_s\ x\ \frac{probe\ area}{100\ cm^2}}$$

Where:

d'=index of sensitivity (1.38, 60% false positives for the first stage of scanning, 95% true positive for the second stage of scanning)

b_i=background during counting interval (background /2 sec for 43-93 and 43-89)

i=observation interval (10 cm wide by 5 cm/sec = 2 sec for 43-93 and 43-89)

p=surveyor efficiency (0.5 from MARSSIM)

e_i=instrument efficiency (average 2π efficiency for beta emitters)

e_s=surface efficiency (0.50 from MARSSIM)

probe area =100 cm^2 for 43-93 and 43-89

The maximum background count rate of 430 counts per minute (cpm) results in a scan MDC of approximately 1,100 dpm/100 cm^2 above background. The scan MDC for beta/gamma-emitting radionuclides is adequate for detecting investigative level uranium activity concentration.

3.3.2 Static Measurement Sensitivity

Three concepts are used to estimate the sensitivity of the measurement system. MARSSIM Equations 6-5, 6-6, and 6-7 are used for these calculations. The terms that are used to define detection sensitivity for fixed-point counts and sample analyses are:

Critical Level (LC) $2.33\sqrt{B}$ where B is the background counts

LC should be used when actually taking direct measurement or counting samples. Any response above this level (result > background + LC, or net count > LC) should be considered above background (i.e., a net positive result). This will ensure 95% detection capability for the detection limit.

Detection Limit (LD) $3 + 4.65\sqrt{B}$

The detection limit (LD) is an a priori estimate of the detection capability of a measurement system, and is also reported in units of counts.

Minimum Detectable Concentration (MDC)

The MDC is the LD with the appropriate correction factors applied to convert the counts to the desired activity concentration (i.e., disintegrations per minute/100 square centimeters (dpm/100cm^2). It is the a priori net activity level that an instrument can be expected to detect 95% of the time.

For example, using a background count rate of 300 cpm:

$$\mathrm{MDC} = \frac{3 + 4.65\sqrt{C_B}}{T \times E \times \frac{A}{100\ \mathrm{cm}^2}}$$

Where:
C_B = Background Counts
T = Time interval
E_{total} = 0.2 cpm/dpm
A = Effective window area

$$MDC = \frac{3 + 4.65\sqrt{300}}{1 \times 0.2 \times \frac{100}{100\ cm^2}} = 420\ dpm/100cm^2$$

The static measurement MDC for beta/gamma-emitting radionuclides is adequate for detecting investigative level uranium activity concentrations.

3.4 ACTIVITY CALCULATIONS

Instrument-specific efficiencies provided by a calibration laboratory and using appropriate National Institute of Science and Technology (NIST) traceable radioactive sources were used to calculate activity concentration (dpm/100cm^2). Because the instrument baseline background values were very close the average material-specific background values, raw counts were adjusted for the baseline background values. The 2π average efficiency (technitium-99 and strontium-90) was then applied to each beta static and smear measurement to convert the raw count rate to dpm/100cm^2. A surface efficiency of 0.5 was applied to the static measurements and the result compared directly to the limits in Section 2. Alpha activity concentration was calculated using the thorium-230 efficiency. Static and smear measurements results are shown in Appendix A.

3.5 ACTION LEVEL SUMMARY

Table 4 summarizes the parameters used to evaluate the radioactivity detected during the survey.

Table 4: Action Level Summary

Action Level	Use
Surface Residual Radioactivity Guideline	Remediation is required when residual radioactivity is present above the (average) total, removable or maximum activity.
Investigation Level	This value is set at 50% of the Surface Residual Radioactivity Guideline. More measurements are required to characterize the area.
Scan MDC	This parameter is used to determine if the instrumentation is sensitive enough to detect the target radioactivity below the investigation level during scanning.
Critical Value L_c	Static measurements above this value (in counts) are considered greater than background.
Detection Limit (L_d)	The detection limit is an estimate of the detection capability of the measurements system (for static measurements), in counts.
MDC	The MDC is the detection limit converted to the appropriate units for comparison to the guidelines.

4. SURVEY RESULTS

4.1 STATIC AND SMEAR RESULTS SUMMARY

The locations of the interior AOCs are illustrated in Figure 3 Figure 4. Appendix A contains a complete list of the static and smear measurement results. All negative results are reflected in the table as zero.

Location information and a summary of the levels and types of residual radioactivity detected are represented in Table 5. Surveys indicate the presence of residual radioactive materials above background on floor surfaces in Departments 49X and 20. Remedial activities are scheduled in 2016 to address these areas. This section will focus on summarizing the results of the other targeted areas.

Survey maps are included in Appendix B. Appendix C lists all of the areas surveyed, the approximate size of the area, where static and smear measurements were collected, the approximate area scanned, and an estimate of the inaccessible areas if applicable.

Table 5: Measurements Results above Action Levels

Area	Location	Level
Building 96	Roof	Seven measurements were above the detection limits where the east and west hoods vent onto the roof. Only one measurement was significantly above the detection limit (under the east hood vent).
Dept 49X	Roof	Three measurements were only very slightly above the alpha detection limit. This is likely due to construction materials.
Dept 20 East	Roof	Five measurements were above the beta detection limit, with one measurements in the filter-housing recommended for confirmatory measurements.
Dept 20 West	Roof	Five measurements are slightly above the detection limits, but well below investigation levels.
Sump	Bathroom Trailers	Two measurements only very slightly greater than the alpha detection limit.
Manhole	GSA Bldg 3	One alpha measurement only very slightly greater than the detection limits.
	Roof Elevator	One alpha measurement only very slightly greater than the detection limits.
	2-44	One alpha measurement only very slightly greater than the detection limits.
	T-50	One beta measurement only very slightly greater than the detection limits.
Area 4	Ceiling	One beta measurement only very slightly greater than the detection limits.
49X	Wall 2	Four beta measurements greater than the detection limit, with one above the investigation level.
49X	Wall 4	Two measurements above the investigation level.

Area	Location	Level
49X	Column Z38	Five measurements above the detection level.
34C	Column S46	Three measurements above the detection limit, with one above the investigation level.
Area 2	Wall 3	Three alpha measurements slightly above the detection limit.
Area 2	Wall 5a	Four measurements above the alpha detection limit.

4.2 EXPOSURE RATE MEASUREMENTS AND GAMMA SURVEYS

All exposure rate measurements fell between 8 and 14 microR/hour, which is within the expected variation of background gamma exposure rates, and very close to the values of the established instrument baseline and daily background checks. With the exception of the gamma measurements discussed in Section 4.1.2, all gamma measurements were comparable with measurements collected in non-impacted areas and the background baseline values established for each instrument.

4.3 SUMPS SAMPLE RESULTS

Seven sanitary sewer sumps were identified as being situated along the potential pathway of wastewater from the areas where radioactive materials were handled. Figure 5 shows the location of the sumps, and Figure 6 provides the naming convention used to label the samples for laboratory analysis. These sumps were temporarily drained where possible, and scan and static measurements of gamma- alpha- and beta-emitting surface residual radioactivity were collected from the top of the sump. Smear samples were collected at each measurement location and analyzed for gross alpha and beta radioactivity. There were no confined space entries of the sumps. Sediment samples were not available in Sumps D20 and 37B, but there was enough material to sample in Building 74 Sump, Bathroom Trailers Sump, 49X Sump, Building 92 Sump, and Building 13 Sump.

A Ludlum Model 2221 digital rate meter paired with a Ludlum 44-20 3x3 NaI detector was used to perform gamma scans of sumps. An area surrounding 49X sump demonstrated gamma levels at ~ 2 times background levels. A subsequent investigation did not reveal elevated levels of alpha- and beta-emitting radioactivity.

Sump samples were collected and analyzed by gamma spectroscopy and for isotopic uranium and thorium. Three of these samples were problematic in that they contained very little mass, which increased the error and resulted in inconclusive gamma spectroscopy results. The isotopic analyses revealed thorium and uranium concentrations of 2 picoCuries per gram (pCi/g) or less. Subsequent isotopic radium-226 and radium-228 analyses of the samples demonstrated a maximum combined radium concentration of 10.59 pCi/g from one sample associated with Building 13. Re-sampling of this sump with the goal of collecting a larger sample and more mass is suggested.

4.4 CONCRETE SAMPLES

Four concrete samples were collected from Department 20 and two from Department 34C. The uranium-238 concentrations in those samples ranged from 0.688 to 3.27 pCi/g. Taking the lowest results as representative of background concrete, the highest net uranium-238 result was 2.58 pCi/g in concrete sample number 2, collected on the east side of Department 20. The incremental lifetime risk (excluding background risk) to an indoor worker assuming continued use of the building was calculated to be approximately 6×10^{-7}. If the building is demolished and the rubble is used as surface fill, either on-site or at a landfill, the risk from 2.58 pCi/g uranium-238 to a hypothetical resident was calculated to be approximately 3×10^{-6}. Using a similar approach, the combined risk from radium-226, all isotopic thorium and uranium concentrations in sample 2 to the postulated occupational and residential receptors yielded incremental lifetime risks of 1×10^{-6} and 4×10^{-6}, respectively. These estimates of risk are predicated on several health-protective assumptions and provide reasonable assurance that the slightly elevated radionuclide concentrations seen in the concrete are below EPA's upper-bound risk limit of 10^{-4} set for CERCLA investigations by the NCP. The basis of this observation can be enhanced by collection of concrete samples from a reference area.

4.5 EXTERIOR AOCS

4.5.1 Manholes

Six manholes were identified as access points to potential waste pathways as shown in Figure 5. A graded approach was used to survey the manholes. Select manholes were gamma logged to the extent possible using the Ludlum 44-2 1x1 detector. The results ranged from 1,800-5,000 cpm. At least one static measurement and smear were collected at the location of the highest reading. Static measurements listed in Table 5 are only slightly greater than the detection limits and are likely due to construction material. The gamma readings greater than 2000 cpm are likely due to geometrical considerations and do not indicate unexpected residual radioactivity.

4.5.2 Exterior Grounds

Exterior grounds surrounding the MMB, including the Red X lot was scanned using the Model 2221/Model 44-180 instrument combinations. The detectors were mounted on a trailer approximately six inches above the ground surface and advanced at a rate of 0.5 meters per second. Separation between the scanned transit lines were approximately 1.5 meter which produced 100% coverage unless influenced by terrain. During wide-area scans, the data from the Ludlum Model 2221 meters were output in cpm units through RS-232 ports to Trimble GeoPositioning Systems which stored each gamma reading and the location of that reading at the rate of once per second[1]. Similar instrument packages are sometimes called GeoPositioning Radiometric Scanning systems, or "GPRS" (pronounced "Geepers").

Stored data were downloaded and processed using commercially available software applications and plotted on a map of the study area. Individual points were assigned colors based on the magnitude of the instrument's response at that location.

Figure 10 shows the areas selected for overland surveys, and Figure 11 presents a color-coded overlay of the data on a site photo. The colored plot in Figure 11 is configured such that the blue and light blue dots signify instrument responses that were within two standard deviations of the mean. As such, these results are considered unremarkable. Green dots on the map indicate results that were within three standard deviations of the mean for the survey population. Large clusters of green dots indicate the radiological condition of that area is different than the surrounding areas. In this case, these are likely due to a change in the surface materials in the "green" area. This change could be due to natural variations in fill in the scanned area or it could be attributable to site-related activities. Additional investigation (sampling) is necessary to resolve the question but it should be noted that, regardless of the reason, these levels of near-surface exposures do not, by themselves, produce unacceptable doses or risks.

Three areas produced small clusters of results indicative of higher (> 3 sigma) gamma signatures. Concentrations of radionuclides in surface samples collected from these areas; were comparable with those in the sample collected from the reference area (Area 11). It is likely these areas contain subsurface deposits of soil producing anomalous levels of radioactivity. It cannot be determined at this time if these anomalies are site related.

In addition to the gamma scan, 10 static measurements for gross alpha and beta activity and smears a were collected at the Red X lot, an 800 ft^2 covered concrete pad located just north and west of Building 96. All static and smear measurements were less than detection limits. Scan measurements indicate expected levels of naturally occurring radioactive materials.

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[1] The Ludlum Model 2241-3 meters to be used during this survey were modified by the manufacturer to integrate and "dump" data from the detector at a rate of once per second (the standard configuration uses a 2-second cycle interval). This reduction in the integration interval allows for finer discrimination between areas with different radiation fluxes.

5. QUALITY CONTROL

5.1 INSTRUMENTATION QUALITY CONTROL

5.1.1 Calibration

All instrumentation used for this project was calibrated prior to use at a calibration laboratory using NIST traceable radioactive sources to establish efficiencies, and test and set operational parameters. Calibration is performed on an annual basis or when major components are replaced or significant repairs are performed. Calibration certificates are included in Appendix D.

5.1.2 Baseline Set-up

Control limits were established using an appropriate check source prior to use. Twenty measurements were made with the check source, and the mean and two standard deviations (σ) and three standard deviations (σ) from the mean were calculated. Background response was established by collecting twenty measurements without the check source in place. Baseline set-up results are included in Appendix D.

5.1.3 Daily Quality Control Checks

Instrument performance was evaluated against established limits prior to and after use each day of data collection. If the response of the instrument was between one and two σ of the mean, the source check was repeated. Instruments that continued to respond outside two or three σ of the meanwere removed from service. The daily quality control checks are included in Appendix D.

5.2 LABORATORY QUALITY CONTROL

Eberline Analytical in Oak Ridge, Tennessee is a National Environmental Laboratory Accreditation Program and State of Missouri certified laboratory. Each analytical work order contains three quality control samples:

- Laboratory control samples to evaluate potential bias in the measurement results.
- Replicate samples to evaluate the precision and the effectiveness of sample preparation techniques.
- Reagent blank samples to evaluate the potential for laboratory contamination.

Laboratory results are presented in Appendix E and Laboratory Validation Packages are included in Appendix F.

6. REFERENCES

DCCR 2013	"Description of Current Conditions Report for the Bannister Federal Complex (Draft).," U.S. Department of Energy and General Services Administration, 2013.
DCCR 2015	"Description of Current Conditions Report for the Bannister Federal Complex (Draft)," U.S. Department of Energy and General Services Administration, 2015. (Section 7: Depleted Uranium and Beryllium, Revised).
MARSSIM 2001	"Multi-Agency Radiation Survey and Site Manual (MARSSIM)", Dept. of Defense, Washington, DC; Dept. of Energy, Washington, DC; USEPA, Washington, DC; and the USNRC, Washington, DC. August 2000.
ORAU 2014	**"**SEC Petition Evaluation Report" Pat McCloskey, January 7, 2014.
NNSA 2014	"Historical Site Assessment/Scoping Survey Normal Uranium Operations", United States Department of Energy Kansas City Plant, June 16, 2014.
NRC 1974	**"**Termination of Operating Licenses for Nuclear Reactors", Regulatory Guide 1.86, U.S. Atomic Energy Commission, 1974
DOE 2011	"Radiation Protection of the Public and the Environment", DOE O 458.1, Department of Energy, 2011.
Auxier 2015	"Survey Plan for Select Areas within the Bannister Federal Complex", Auxier and Associates, 2015.

FIGURES

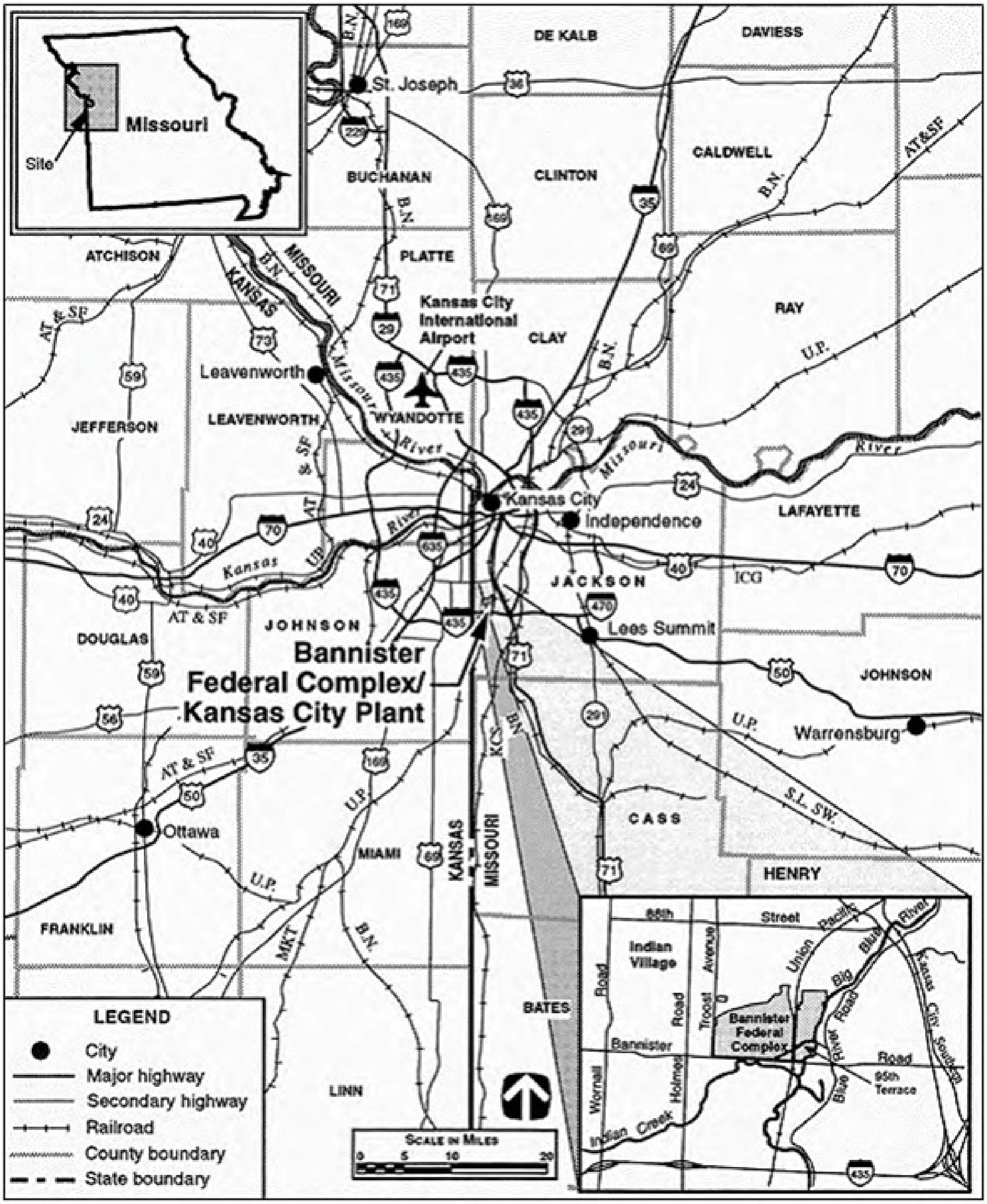


Figure 1: Site Location

Figure 2: NNSA/DOE and GSA Properties at the BFC

(Source: DOE, May 2013)

Figure 3 Areas of Bannister Federal Complex where Radiological Materials May Have Been Managed (after Honeywell/Antech)

Figure 3: Areas of Concern

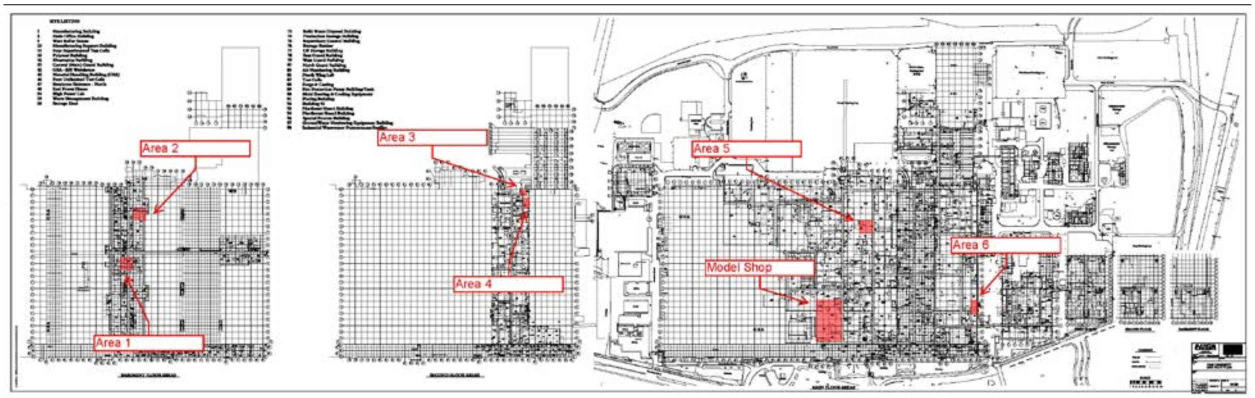
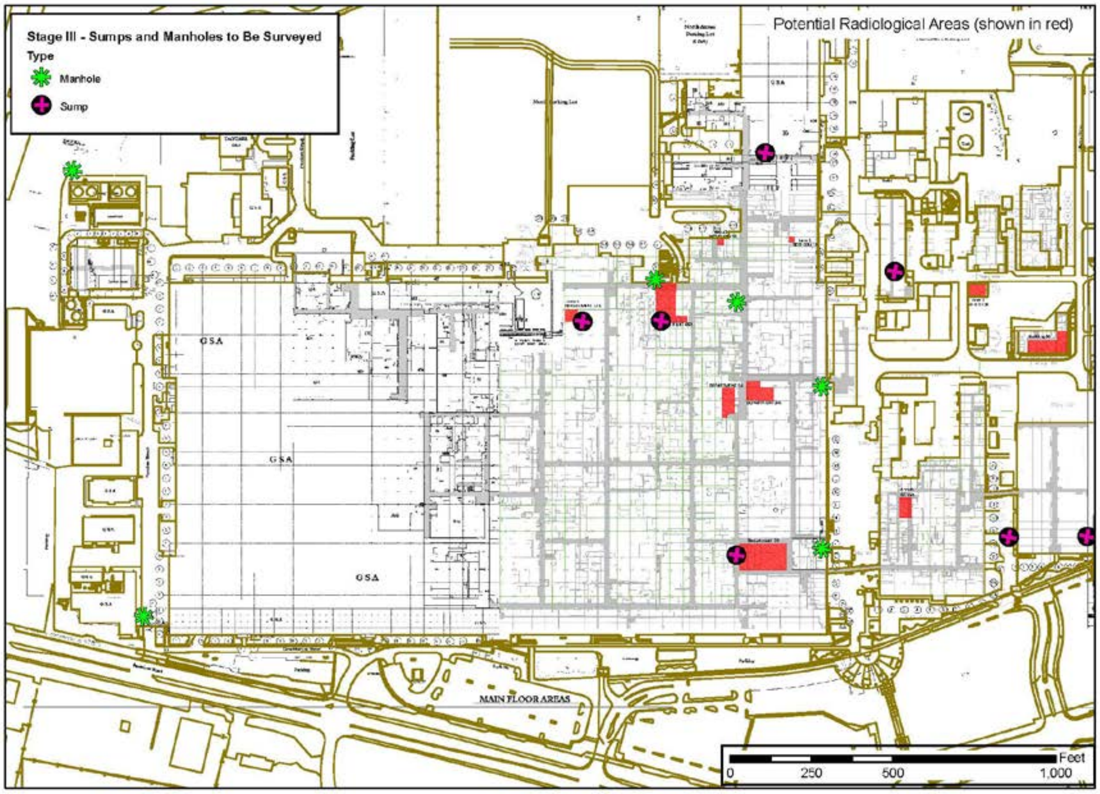


Figure 4: Additional Areas of Concern



Proposed Stage III Sump and Manhole Locations for Rad Survey

Figure 5: Locations of Sumps and Manholes

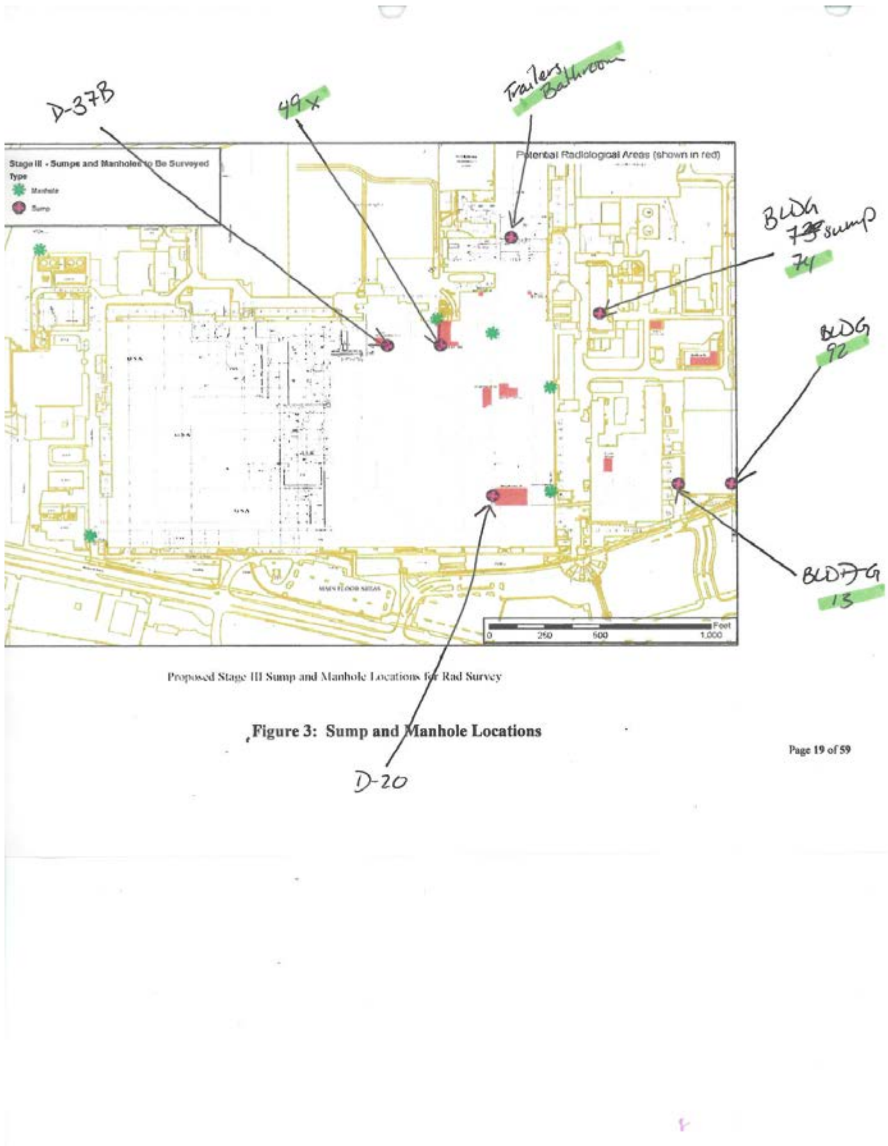


Figure 6: Naming Convention for Sump Locations

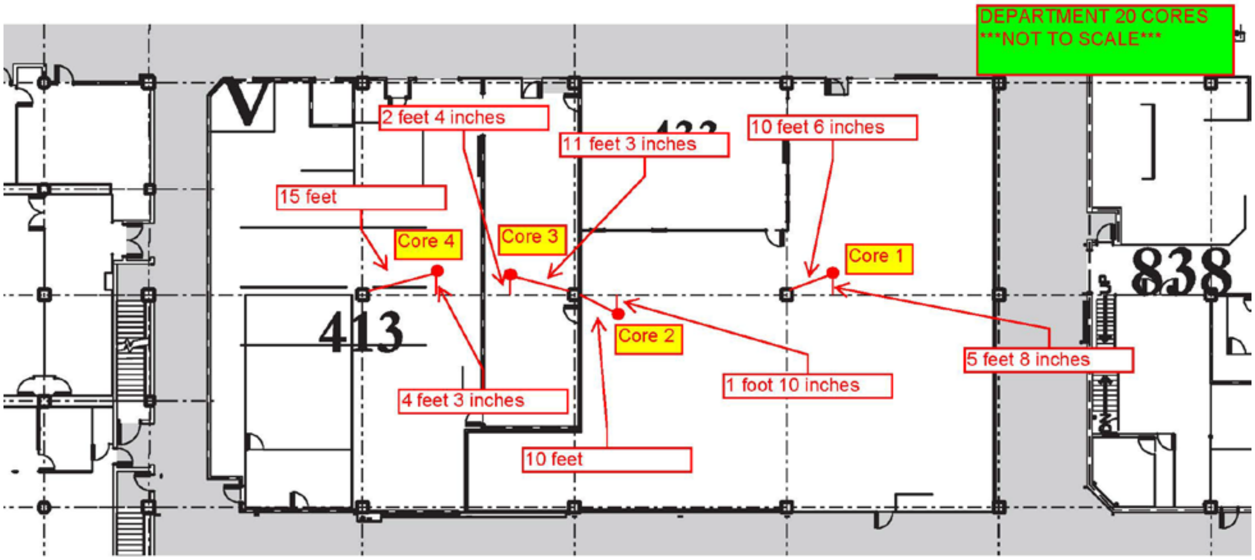


Figure 7: Concrete Core Sample Locations Department 20

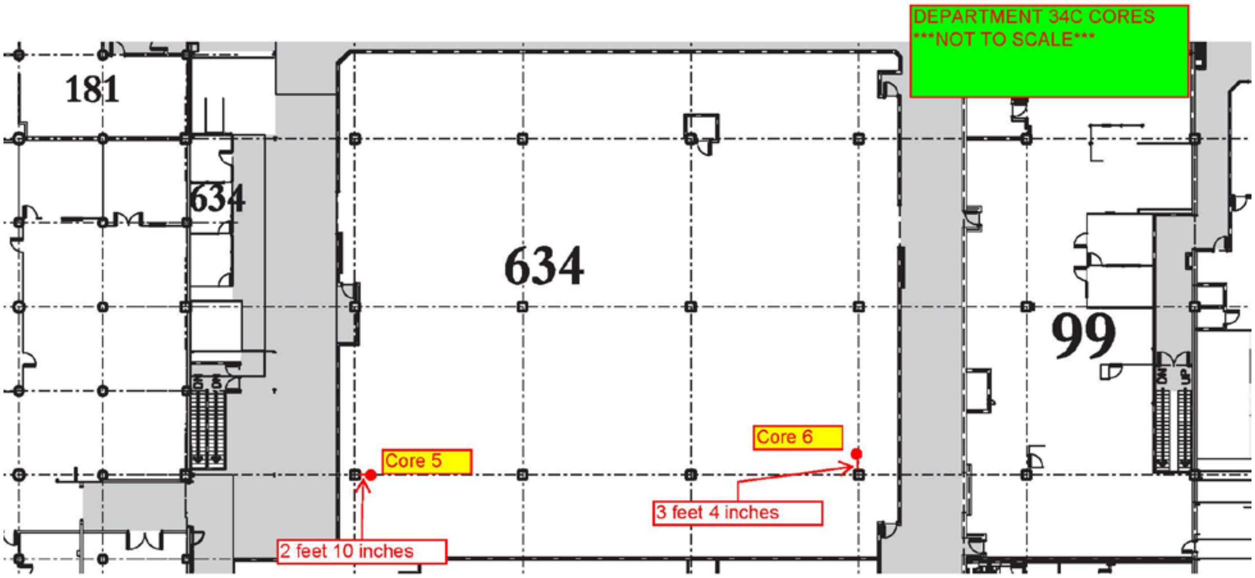


Figure 8: Concrete Core Sample Locations Department 34C

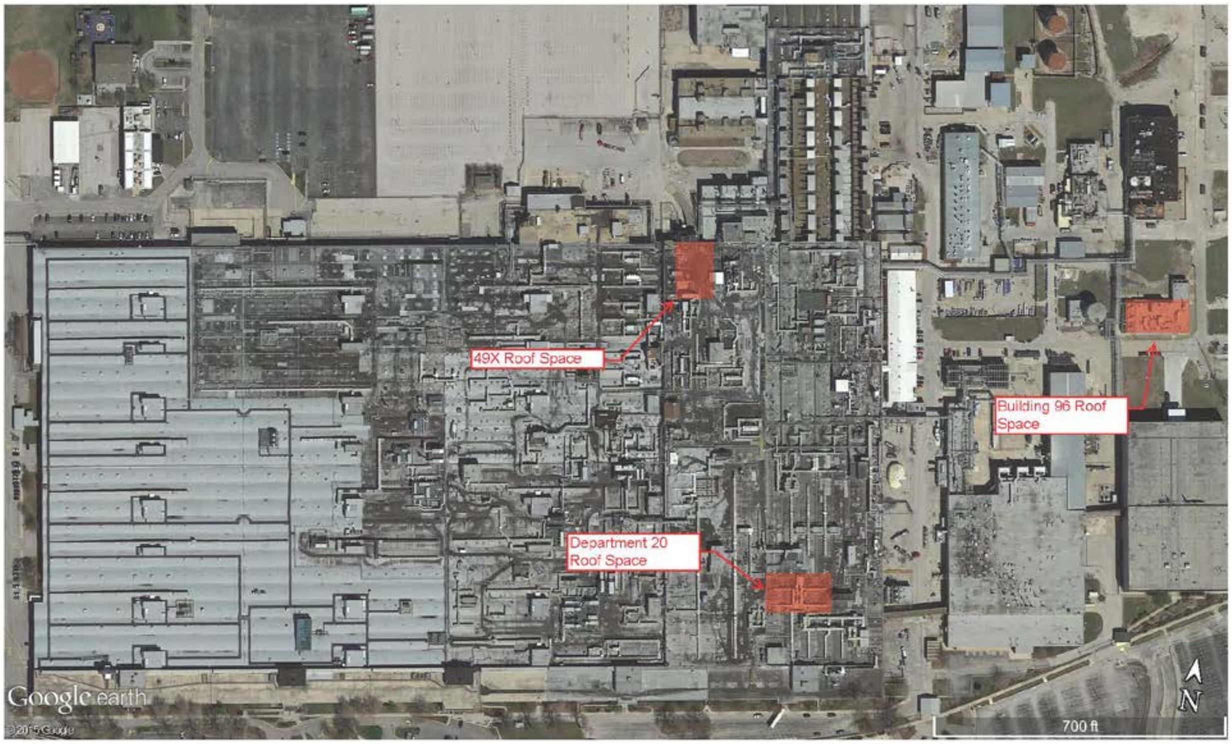


Figure 9: Roof Survey Locations

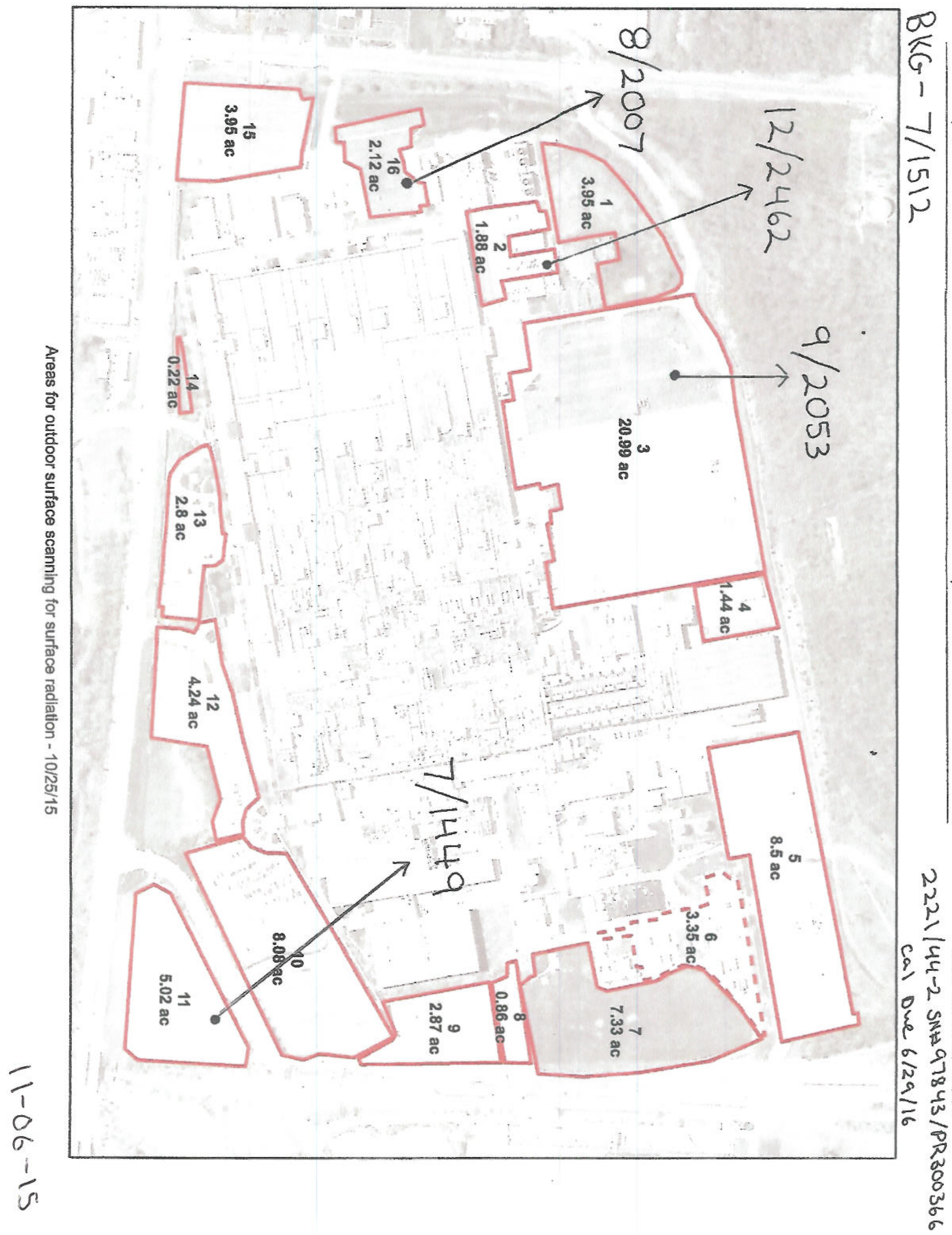


Figure 10: Outdoor Sample Locations

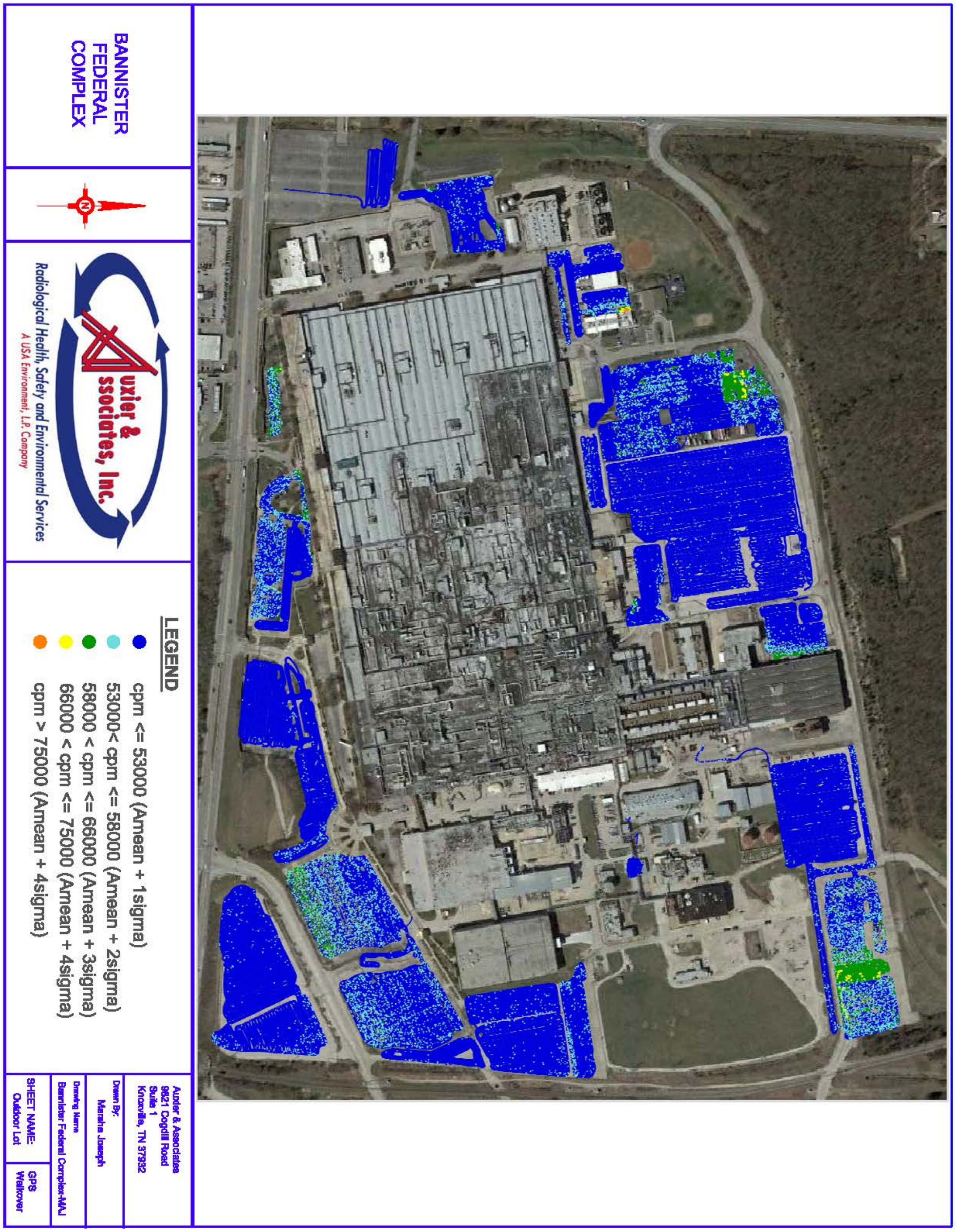


Figure 11: Over Grounds Survey Results