

**SAFETY EVALUATION REPORT
REQUEST FOR RELEASE OF THE SINCLAIR FARM ANIMAL BURIAL SITE
FOR UNRESTRICTED USE PURSUANT TO 10 CFR 20.1402**

1.0 BACKGROUND

The licensee (Curators of the University of Missouri (MU)) is requesting the release of a small track of land (Tract 7). Tract 7 contained a burial site (Sinclair Animal Burial site (ABS)) for research animals that were contaminated with tritium (H-3) and carbon-14 (C-14), a waste burial site (i.e. Burn Pit (BP)), incinerator building, and waste storage building. The buildings have been demolished in previous actions. The licensee is attempting to sell the site and the release is necessary to complete the action. Tract 7 is part of the University of Missouri-Columbia Sinclair Research Farm (SRF), a 220 hectare [543 acre] property located at South Sinclair Road in Columbia, Missouri. Figure 1 shows the location of Tract 7.

In December 2015, the licensee hired a consultant to perform subsurface sampling of the Sinclair Animal Burial site and Burn Pit. On December 8-9, 2015, the NRC conducted an inspection of the consultant, Chase Environmental, Inc. (ML16004A203). The inspection did not identify any violations of NRC requirements or raise any other concerns.

On July 29, 2016, the licensee submitted information and requested the unrestricted release of the site (ML16221A232). The request was supported by sampling results and an associated radiological dose assessment to demonstrate that public health and safety would be protected from radioactivity remaining at the site under unrestricted release land use scenarios.

The staff evaluated the licensee's submittal to determine if Tract 7 meets the unrestricted release criteria and therefore that Tract 7 can be removed from MU license 24-00513-32.

2.0 SITE EVALUATION

A historical site assessment was performed by the licensee to determine what isotopes may be present at the site. The primary radionuclides of concern were identified as H-3 and C-14, because those were the isotopes used in experiments involving large animals. The historical site assessment indicated that other radionuclides had been buried with the animal carcasses. However, these other radionuclides were very short-lived and had undergone a minimum of 30 half-lives of decay.

The licensee performed sampling of the site to determine the distribution and concentrations of residual radioactivity. The sampling locations are shown in Figure 2. The licensee used a grid pattern over the area of interest supplemented with seven judgmental locations in an attempt to locate discrete areas of higher radioactivity associated with individual bovine carcass disposals. The licensee took 82 samples at 21 borehole locations to a depth of 5 m [15 feet] or refusal within the Sinclair Animal Burial site and an additional 22 samples of the Burn Pit area. The highest sample result was 5.77 pCi/g for C-14 in the ABS and 2.15 pCi/g for H-3 in the BP. The average sample result was 0.13 pCi/g for C-14 in the ABS and 0.36 pCi/g for H-3 in the BP. Most sample results for each area were below minimum detectable concentrations. For comparison, the default screening values used in NUREG-1757 (ML063000243) for release of contaminated surface soils are 12 pCi/g for C-14 and 110 pCi/g for H-3.

3.0 DOSE ASSESSMENT

The licensee completed a dose assessment using RESRAD 7.0 for two scenarios to determine if the site may be released for unrestricted use. Under 10 CFR 20.1402 a site is considered

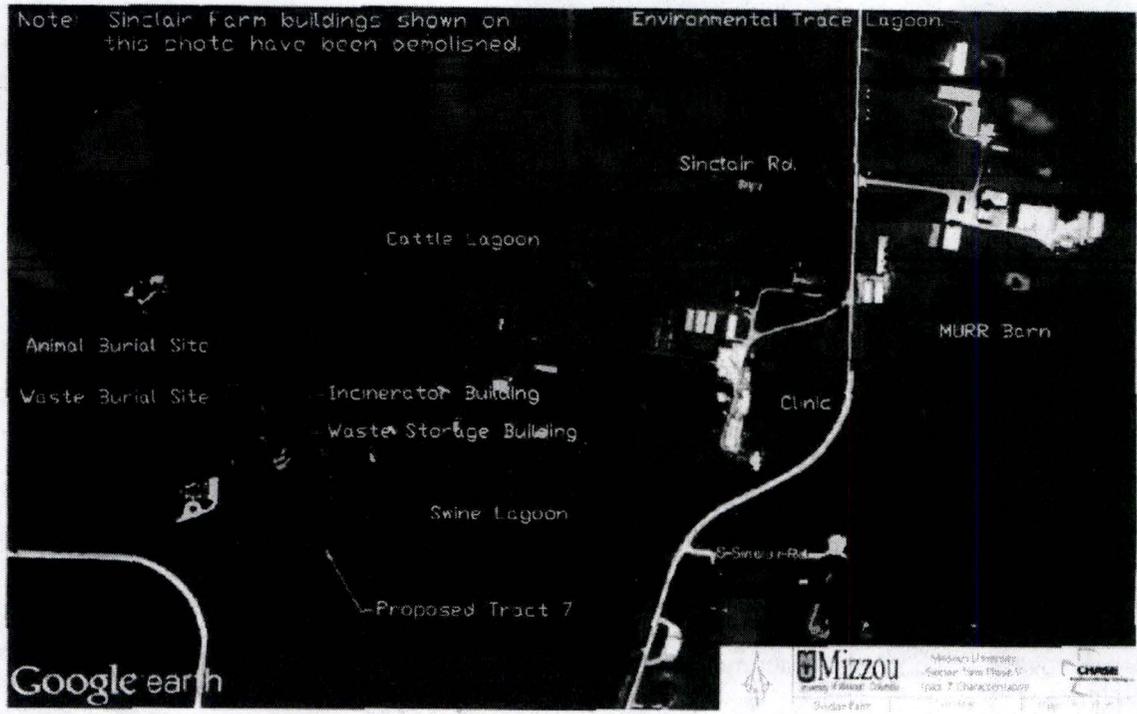


Figure 1 Map of Tract 7 at the Sinclair Farm Site



Figure 2 Map of the Locations of Subsurface Samples of Tract 7. (samples from the grid pattern are shown in red whereas judgmental sample locations are shown in white with the letter 'J')

acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal.

The scenarios the licensee evaluated were a scenario where the material is left in place and a second scenario where the material is excavated and spread in a 15 cm [6 in] layer on the land surface. The receptor evaluated was a resident farmer.

RESRAD default parameters were used except for those associated with the geometry of the source term. Because tritium was only detectable in 3 of 82 samples in the ABS with the highest result of 1.2% of the NUREG-1757 default screening value, the unity rule was not applied and C-14 was the only radionuclide included in the dose assessment. The licensee assumed that any sample location where C-14 was below the minimum detection limit that the concentration, for purposes of the dose assessment, was at the minimum detection limit. This approach raised the overall site average C-14 concentration used in the assessment to 0.889 pCi/g. For the scenario where the burial site remains intact, the area of the contaminated zone was 5,806 m² and the depth of the contaminated zone was 4.57 m. For the scenario where the former burial site is excavated and spread on the surface, the contaminated zone was 174,198 m² and the depth of the contaminated zone was 0.15 m. The licensee performed sensitivity analyses to evaluate the significance of the assigned value of the distribution coefficient for C-14. The licensee provided copies of input and output files.

The licensee estimated the maximum dose to be under 2 mrem/year for both scenarios. For the sensitivity case the distribution coefficient of C-14 was increased to 1.0 ml/g from the RESRAD default value of 0.0 ml/g. The calculated maximum dose for the intact scenario was 1.37 mrem/yr and the calculated maximum dose for the excavation scenario was 0.63 mrem/yr.

4.0 STAFF REVIEW

Staff evaluated the overall sampling approach as well as the specific sampling locations and results. Though the Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM) does not apply to subsurface soils, the licensee considered MARSSIM protocols in its sampling approach. As shown in Figure 2, the licensee used a sampling grid supplemented with judgmental locations. Most sample results were below the minimum detectable concentrations. For the ABS, there is no significant statistical or visual pattern in the observed concentrations of C-14 and H-3 with depth of sample. A higher fraction of the results that were above the minimum detectable concentrations were in the center of the sampled area than at the boundaries.

Because both H-3 and C-14 can be mobile in the subsurface, staff issued a request for additional information (RAI) to the licensee to see what constraints could be placed on the amount of those isotopes that may have been part of the original research experiments (ML17044A076). The licensee responded that while records documenting the animal disposals could not be located, the researcher was authorized for a total possession limit of 10 mCi of C-14 (ML17116A568). Based on the size of the burial site and average observed concentration of C-14, the total amount of C-14 observed corresponds to approximately 5 mCi. Some leaching from the time of disposal to the present would be expected. The

observed concentrations are consistent with the total possession limit. The licensee used an average concentration of C-14 in the dose assessment of 0.889 pCi/g which corresponds to over seven times the total possession limit. In other words, the licensee's representation of the source term for C-14 was very conservative compared to the observed sampling results. The licensee's characterization of the subsurface contamination is adequate.

The licensee also indicated in response to the RAI that while it did not have any data associated with potential vertical and lateral migration of the contaminants in question, that there was chemical monitoring data from the 1990's and 2000's. The subsurface structure includes bedrock and clay and continued movement of chemical contaminants was not observed. Staff did not consider chemical monitoring data in detail as the aforementioned information was sufficient to make a conclusion about the subsurface sampling.

Tritium in the Burn Pit area was only detected in 4 of 22 samples. Those results show contamination with deeper samples. All samples with detectable contamination were from the 3 - 4 m [9 - 13 ft] depth interval. In general, tritium is more mobile in the environment than C-14. Therefore one would expect to find tritium deeper than C-14. The rate at which a contaminant is mobilized from the contaminated zone is a complex function of many factors, including but not limited to the infiltration rate, waste release rates, and the geochemistry (e.g. distribution coefficients) of the system. If the release rate of H-3 was large, H-3 would not be expected to be observed in the contaminated zone because the disposals occurred more than 30 years ago; tritium would have been flushed from the system. The fact that tritium is observed towards the bottom of the sampling interval, but it is still present, places a technical constraint on how much tritium may have been originally present. Tritium would need to be over 250 times higher in the subsurface at depth in order to approach the 10 CFR 20.1402 unrestricted release criteria of 25 mrem/yr for the scenarios evaluated. This is not plausible given the maximum observed sampling result is approximately 2 pCi/g.

When default screening values are used for surface contamination a dose assessment is not necessary. In the case of the ABS and BP, the potential contamination is subsurface contamination. Therefore the licensee completed dose assessments for two scenarios to evaluate the subsurface contamination in the ABS. The licensee was making the assumption that because the concentrations of C-14 were a much larger fraction of the default screening values that the dose assessment of the ABS would bound the impacts from the BP. The licensee used RESRAD default parameters instead of developing site-specific parameters. Therefore the receptor was a resident farmer. There is a current resident located less than a few hundred meters from the boundary of the site, so a residential land use scenario is appropriate. A resident farmer scenario is likely to be conservative given current land use in the area.

Normally a licensee would use site-specific parameters for the dose assessment. However, because the levels of contamination are low (considerably below the surface contamination screening values) and the licensee used a very conservative representation of the amount of C-14 in the contaminated zone, it was appropriate to use the RESRAD default parameters in the assessment. The key RESRAD default parameters, such as the precipitation rate at 1 m/yr, are reasonable for the Sinclair Farm site. There are numerous sources of conservatism in the use of the default RESRAD parameters for the assessment of Tract 7. For example, consumption of contaminated fish is included in the assessment while no known surface water bodies were observed on the site maps of the area being assessed. The fish pathway contributed approximately half of the total dose in the current assessment.

Staff was able to verify the results provided by the licensee for the intact and excavation scenarios, achieving identical dose results. In addition, staff evaluated other scenarios to examine potential impacts from C-14 and H-3 that may have been leached from the contaminated zone prior to the characterization activities. Staff did not identify any scenario where the 10 CFR 20.1402 unrestricted release criteria could be exceeded. Staff also used the State of Missouri resources (which link to the United States Geologic Survey) to identify if any wells used for groundwater were located in the vicinity of Tract 7. None were identified in the search.

The residual radioactivity is at low concentrations and is located in the subsurface. Based on a conservative representation of the source term, the projected doses to a member of the public is a small fraction of the unrestricted release criteria. The residual radioactivity has been reduced to levels that are as low as reasonably achievable.

5.0 FINDINGS

Characterization results for the site were consistent the historical assessment. The subsurface sampling was sufficient to identify the contaminants present and their concentrations. The licensee's dose assessment demonstrates that public health and safety will be protected if the site is released for unrestricted use. Tract 7 meets the unrestricted release criteria found in 10 CFR 20.1402 and therefore Tract 7 can be removed from MU license 24-00513-32.

6.0 REFERENCES

NRC, "Standards for Protection Against Radiation," 10 CFR Part 20.

NRC, "Consolidated NMSS Decommissioning Guidance. Decommissioning Process for Materials Licensees, Final Report," NUREG-1757, US Nuclear Regulatory Commission, 2006, ML063000243

NRC, "Safety Inspection Report and Compliance Inspection – Chase Environmental Group Inc, December 8-9, 2015," NRC Form 591M, US Nuclear Regulatory Commission, 2016, ADAMS # ML16004A203.

NRC, "Sinclair Animal Burial Site – Request Additional Information (RAI)," US Nuclear Regulatory Commission, 2017, ML17044A076.

University of Missouri, Letter from Jack Crawford to Mike Lafranzo (NRC) – SUBJ: Request Release of Sinclair Farm Animal Burial Site for Unrestricted Use, July 29, 2016, ML16221A232.

University of Missouri, Letter from Felicity Beckfield to Mike Lafranzo (NRC) – Re: Additional Information to Control Number 596692 – Sinclair Animal Burial Site RAIs, March 22, 2017, ML17116A568.

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