

Sequencing MARSSIM Final Status Surveys To Achieve a Triad Approach

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ABSTRACT

The U.S. Army Corps of Engineers (USACE) is applying guidance from the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) to demonstrate that remedial actions of radiologically contaminated Formerly Utilized Sites Remedial Action Program properties have met dose-based clean-up goals. Manhattan Engineer District ore-processing activities at the Linde site in Tonawanda, NY, resulted in large volumes of contaminated soils being dispersed and buried over the 55 ha (135 acres) site. The principal radionuclides of concern include radium-226 (Ra-226), thorium-230 (Th-230), and total uranium. While characterization data were collected during the remedial investigation, the extent and location of all buried contamination was uncertain at the beginning of the remedial action. As part of the remediation strategy at the Linde site, the USACE followed the Environmental Protection Agency's Triad approach in its application of the MARSSIM final status survey (FSS) process to reduce the uncertainty in the extent of contamination while collecting FSS data. Systematic planning helped develop a conceptual site model, identify data gaps, and target the areas of concern to be addressed before and during site remediation. Pre-remediation sampling and the collection of data from MARSSIM Class 2 areas, consistent with FSS requirements, allowed datasets to support both excavation planning needs and closure requirements in areas where contamination was not encountered above Derived Concentration Guideline Level (DCGL) standards. Real-time technologies such as gamma walkover surveys, large area plastic scintillators, and on-site gamma spectroscopy minimized expensive off-site alpha spectrometry analyses, and at the same time provided the ability to respond to unexpected field conditions. The sequencing of the data collection from various MARSSIM FSS units was optimized to reduce uncertainty and provide most of the Class 2 and Class 3 survey data prior to the completion of the remediation of the Class 1 areas.

INTRODUCTION

The U.S. Army Corps of Engineers (USACE) is conducting cleanup of radiologically contaminated properties as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP). USACE is using guidance provided in the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) for establishing that sites satisfy site-specific cleanup requirements [1]. While MARSSIM's focus is on final status surveys and site closure, it also provides an overall framework for initial site characterization and remediation that mirrors the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process.

In the last few years, the U.S. Environmental Protection Agency (EPA) has presented the Triad approach as a means of streamlining data collection at hazardous waste sites and addressing decision uncertainty in a cost-effective manner. The Triad approach refers to the combination of the following: (1) systematic project planning, (2) dynamic work strategies, and (3) real-time measurement technologies. For sites contaminated with radionuclides, MARSSIM also recognizes and embraces the value of real-time measurement systems and field-deployable analytical techniques where appropriate during pre-remediation data collection and final status survey (FSS) sampling.

The Linde FUSRAP site provides an example of how the Triad approach, executed within a MARSSIM closure framework, was used to support both project planning needs and closure requirements in areas where contamination was not believed to be above cleanup standards. The use of Triad concepts allowed the remediation and closure process to move forward concurrently at Linde despite recognized significant gaps in the initial remedial investigation/feasibility study (RI/FS) datasets.

MARSSIM AND TRIAD

MARSSIM provides an overall framework for conducting data collection programs (also known as final status surveys) to demonstrate compliance with site closure requirements at radionuclide-contaminated sites. MARSSIM assumes that sites have risk- or dose-based standards that must be met, and that there is a site-specific dose or risk pathway model that can convert these standards into activity concentration equivalents. MARSSIM calls these Derived Concentration Guideline Levels (DCGLs). MARSSIM allows for two different types of DCGL requirements, a wide-area average requirement, called the $DCGL_w$, and an elevated measurement comparison (or hot spot) requirement, called the $DCGL_{emc}$. The site is divided into survey units to which the DCGL requirements are applied.

For radiologically contaminated sites, gross gamma scanning, screening, and direct measurement technologies have been used for characterization work. These technologies span a range of analytical quality, including less definitive but quick and cost-effective mobile gross gamma surveys. In recent years, these gross gamma scan detectors have been coupled with Global Positioning Systems and data loggers to enhance their effectiveness and to provide a means for recording and mapping measurements for analysis and documentation. There are more definitive

in situ gamma spectroscopy measurement systems that can provide radionuclide-specific estimates of activity concentrations contained in soils and other materials. These types of technologies all share the common characteristic of being able to provide measurement results in “real-time,” that is quick enough to allow characterization or remedial activities to adapt to the results.

MARSSIM recognizes and endorses the use of real-time measurement technologies as part of the closure process. In fact, MARSSIM assumes that the preferred methodology for establishing compliance with $DCGL_{emc}$ requirements is through the use of scanning technologies, if an appropriate technology exists. Likewise, there is nothing in MARSSIM that prevents the substitution of *in situ* results for discrete sampling to establish compliance with $DCGL_w$ requirements, if one can establish that the direct measurement technique will provide data of suitable quality.

The Triad approach also recognizes that many of the newer, field-deployable techniques enable the production of real-time data. The availability of real-time information can significantly improve the efficiency of characterization and remediation by keeping efforts as focused on programmatic objectives as possible, changing the direction of work in response to unexpected field conditions as they are encountered. The Triad exploits these potential efficiencies by incorporating real-time measurement technologies within a dynamic work strategy. Dynamic work strategies can be used in characterization, remediation, and monitoring programs.

For radiologically contaminated sites, MARSSIM provides a natural framework for executing a Triad approach to characterizing, remediating, and obtaining site closure.

MARSSIM provides the overarching guidance for how the closure process should be designed. With its implicit flexibility, emphasis on performance-based approaches, and recognition of real-time techniques, MARSSIM facilitates the implementation of Triad-based decision-making. The net result is the ability to deploy streamlined, cost-effective, and technically defensible data collection programs that can be tightly integrated with the overall remediation and closure strategy.

THE LINDE SITE

The Linde site is located in the Town of Tonawanda, near Buffalo, New York. The site comprises about 55 hectares (ha) (135 acres) and consists of various office buildings, fabrication facilities, warehouse storage areas, material laydown areas, and parking lots. The Linde site is currently owned by Praxair, Inc. As a result of Manhattan Engineer District (MED) ore-processing activities onsite, soils and some of the buildings are contaminated with radionuclides. The principal radionuclides of concern include radium-226 (Ra-226), thorium-230 (Th-230), and total uranium.

The Linde Record of Decision (ROD) [2] was based on an Applicable or Relevant and Appropriate Requirements (ARAR) analysis and a radiological dose assessment for the radionuclides of concern (i.e., total uranium, Ra-226, and Th-230). On the basis of this analysis, the Linde ROD contained two requirements. The first requirement was excavation and off-site

disposal of contaminated soils with residual radionuclide concentrations averaged over a 100-square meter area exceeding unity for the sum of ratios (SOR). The SOR calculation was based on the ratio of the total uranium, Ra-226, and Th-230 activity concentrations to their associated concentration limits. These concentration limits, as measured above background, are 554 pCi/g of total uranium, 5 pCi/g of Ra-226, and 14 pCi/g of Th-230 for surface cleanups, and 3,021 pCi/g of total uranium, 15 pCi/g of Ra-226, and 44 pCi/g of Th-230 for subsurface cleanups. The second requirement was that USACE remediate the Linde site to ensure that soils remaining on-site would not exceed a total uranium activity concentration of 600 pCi/g above background. Both requirements resulted in a need to demonstrate compliance over 100 m² areas of the site.

The initial data collection during the RI/FS yielded 1,074 samples from 328 boreholes. The bulk of this characterization activity, however, was concentrated in relatively few locations across the site that were known or suspected to be contaminated. Thus, as shown in Fig. 1., large portions of the facility had not been characterized. Although all of the 1,074 samples collected were analyzed for Ra-226, 932 had U-238 results and only 315 had Th-230 results. Only 88 of the subsurface samples were analyzed for all of the contaminants of concern. The results of the sampling indicated that the depth of contaminated soil varies at the Linde site. Although there is some surficial contamination, most of the soil that is radiologically contaminated is 3 to 7 feet (ft) deep beneath a 2-ft surficial layer of non-impacted backfill (e.g., existing landscaping). This was a major concern at the site because surficial gross gamma walkover surveys would provide limited information about the potential for buried contamination. In many cases subsurface RI/FS samples were collected only to a depth of 3 to 4 ft, potentially missing the contaminated soil. Since the RI/FS sampling targeted only specific areas of the site, one objective was to address the subsurface Class 2 and 3 areas, with limited characterization data, in a cost-effective manner while allowing remedial design and implementation to move forward.

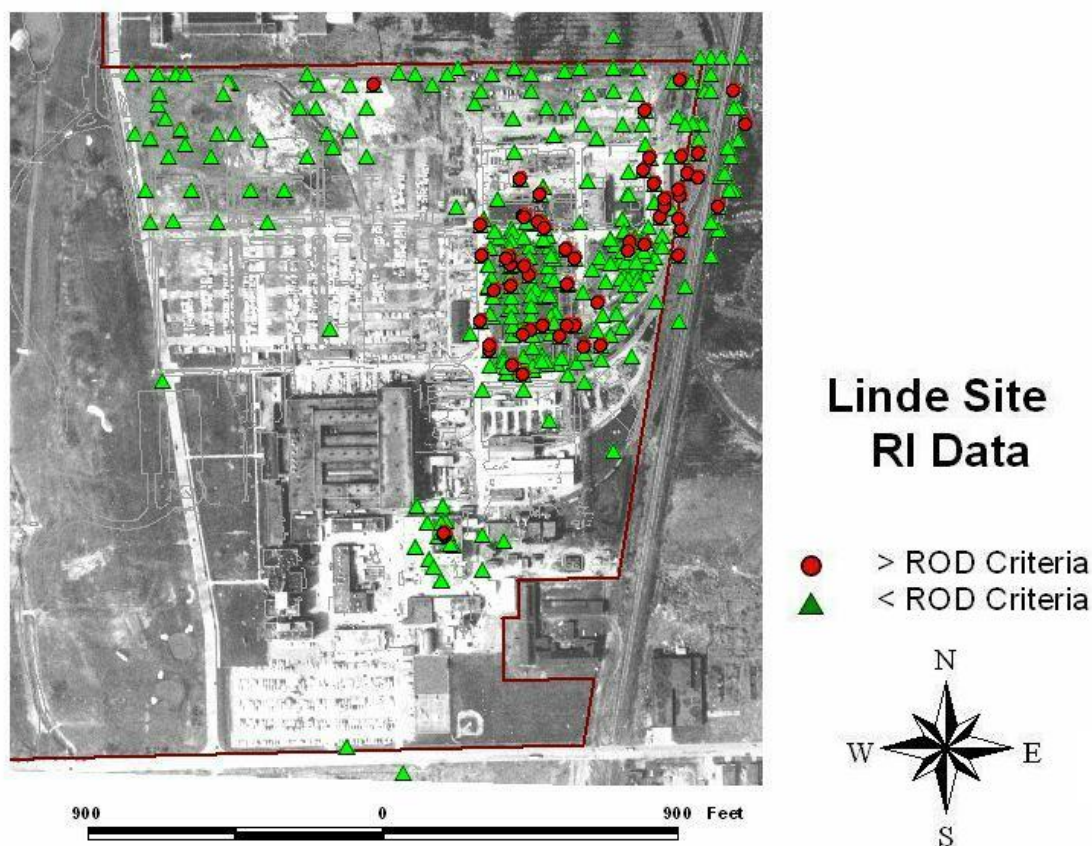


Fig. 1. RI/FS soil sample locations at the Linde site.

To delay the remedial action in order to collect additional characterization data was not a viable option. When the USACE assumed responsibility for the remediation of the Linde site after the RI/FS phase, there was considerable pressure from stakeholders to move forward with remediation and closure activities. The approach was to utilize the MARSSIM closure process. The challenge of implementing MARSSIM was that the classification of the site into Class 1, Class 2, and Class 3 areas was based on the limited RI/FS database. MARSSIM Class 1 areas include areas that either need remediation or are likely to contain contamination above DCGL requirements. Class 2 areas are areas for which there is no evidence that contamination exists above DCGL requirements, but where there remains a possibility that this is the case. Class 3 areas are areas where there is no expectation that contamination exists above cleanup requirements.

Consistent with MARSSIM, the Linde site was partitioned into Class 1, Class 2, and Class 3 areas based on RI/FS data. Initial excavation footprints (in Class 1 areas) were estimated based on the RI/FS dataset, and the remaining portions of the site were classified as Class 2 and Class 3 areas. To address specifically those areas without characterization data, the approach was to collect more FSS data within the Class 2 areas than might otherwise have been required (based on MARSSIM guidance), and to start the FSS work in Class 2 and Class 3 areas before excavation work was complete in the known Class 1 areas. Since ROD compliance had to be demonstrated over a 100-m² area, the Class 2 survey unit boundaries could be retroactively

determined as the sample density of the 100-m² grid sample points were consistent with MARSSIM guidance. Thus, if unexpected contamination was encountered in Class 2 areas, the contaminated area could be reclassified as a Class 1 area and designated for excavation while remedial activities were still underway in known Class 1 areas.

CLASS 2 AND 3 FINAL STATUS SURVEY ACQUISITION

It was not immediately apparent how to implement demonstration of ROD requirements in the context of subsurface soils or the type of data collection and decision processes required for demonstrating closure. In Class 1 areas (i.e., areas where remediation was taking place), the presumption was that residual subsurface contamination above cleanup requirements would not be an issue because excavation would continue until clean soils were encountered. The issue of potential subsurface contamination applied to Class 2 and Class 3 areas.

The approach selected was to apply the subsurface SOR ROD requirement to each 15 centimeter (cm) interval at depth. Establishing compliance for each 100-m² area and each 15-cm depth down to native soil in Class 2 and 3 areas again presented a potentially enormous number of physical samples. Fortunately, the cleanup requirements for subsurface soils in the ROD allowed the use of real-time screening techniques to be applied to subsurface soil cores. A customized core scanner was developed (see Fig. 2.), and a Geoprobe system was used to obtain cores.



Fig. 2. The Linde core scanner.

Gross gamma investigation levels were developed for the core scanner by comparing scan results to laboratory results that provided a 95% confidence level for detecting potential ROD exceedances in any given 15-cm interval. Intervals that failed the scan were sampled and analyzed using gamma and alpha spectroscopy. In addition, a limited number of vertically composited soil samples were collected across each Class 2 and Class 3 unit and analyzed by alpha spectroscopy to allow a determination of the average residual contamination present.

A site-wide Class 2 100-m² grid was designed for the site. Class 2 FSS data collection activities began while the Class 1 excavation work was ongoing in known areas of contamination. There were approximately 1,600 soil cores collected from the site-wide Class 2 areas as shown in Fig. 3.

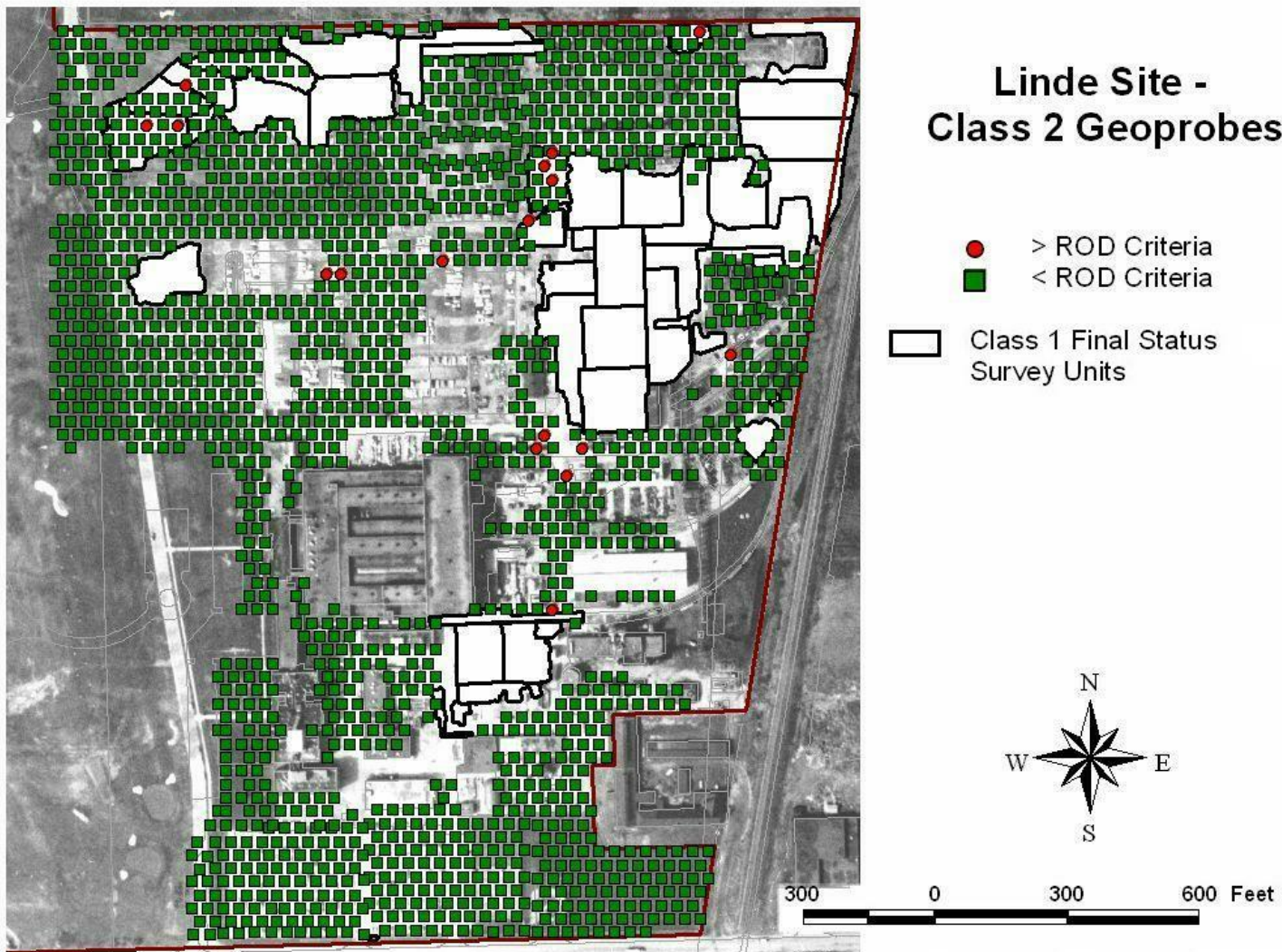


Fig. 3. Class 2 Geoprobe sample locations.

There were several areas where the scanning and sampling results of the Class 2 soil cores indicated previously unknown areas of contamination, as indicated by the red dots on Fig. 3. (Fig. 3. also shows the excavated and completed Class 1 FSS units and the Class 2 soil cores that did not indicate subsurface ROD exceedances.) The specific areas of contamination include the northwest, central, and south-central area of the site, and the area also along the northeastern site boundary. All of these areas were reclassified as Class 1 areas, requiring excavation. Three of these identified areas have been remediated: the northwest area, part of the central area, and the area along the northeast boundary. As shown in Fig. 3. , the excavations expanded into adjacent areas where there were Class 2 soil cores that had not detected contaminated soil (based on the scan results). To date, there have been about 63 Class 2 soil cores (or 4% of the total number of Class 2 soil cores) where the contamination was not detected from the gross gamma scan but they were removed during excavation, specifically, 47 cores in the northwest area of the site, 12 in the central area, and 4 in the area along the northeast boundary. The Class 2 soil cores that were excavated had not appeared to exceed the ROD criteria due in part to the heterogeneous nature of the radiological contamination and the relatively thin contaminated lens, incomplete core recoveries, and the presence of hard fill materials (e.g., building debris). In some cases, there was significant core loss or the depth of the contaminated layer was deeper than the depth of the historical RI/FS data that were collected, specifically, in the far northwest part of the site.

CONCLUSIONS

The advantage of starting the Class 2 and Class 3 sampling early in the remediation was that the results of the Class 2 core scanning and sampling were used to identify unknown contamination and define excavation boundaries (for those areas where contamination was detected at levels of concern), or to support the final status survey process (for those areas where there was no evidence of contamination at levels of concern). For sites implementing MARSSIM guidance, the final status survey sampling typically occurs after the remediation work is complete. At the Linde site, if sampling Class 2 and 3 areas would have been conducted after remediating, many additional months, if not years, would have been added to the project schedule. This would have resulted in costly reprogramming of funding, extension of contracts and reallocation of other resources. Additionally, this would have required remobilization and potentially delayed site closure, while creating further inconvenience to stakeholders such as Praxair. The Triad approach using the core scanner to scan over 1,600 Class 2 subsurface cores was advantageous in that it provided real-time measurements and was much more cost effective than sampling and analyzing subsurface core intervals. The sequencing of the data collection from various MARSSIM final status survey units reduced uncertainty and provided most of the Class 2 and Class 3 survey data prior to the completion of the remediation of the Class 1 areas.

REFERENCES

1. EPA (U.S. Environmental Protection Agency), 2000, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), EPA 402-R-97-016, Rev. 1, August
2. USACE (U.S. Army Corps of Engineers), 2000, *Record of Decision for the Linde Site Tonawanda, New York*, prepared by the U. S. Army Corps of Engineers, Buffalo District, Formerly Utilized Sites Remedial Action Program, March 2000.

Photographs courtesy of the National Resource Conservation Service.