Challenges Associated with Final Status Survey Implementation at a Formerly Utilized Sites Remedial Action Program (Fusrap) Site's Adjacent Properties

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ABSTRACT

Several properties located adjacent to the Linde Formerly Utilized Sites Remedial Action Program (FUSRAP) site in Tonawanda, New York were radiologically contaminated during Manhattan Engineer District (MED) era activities. These properties exhibited a combination of unique characteristics not previously encountered at the Linde Site. This included the properties being littered with building debris, a combination of metals and cesium-137 (Cs-137) commingled in the soil, thorium-230 (Th-230) being the dominant radioactive MED contaminant, and the radioactive contamination consisting of a five to seventy six centimeter thick black colored lens located at various depths below the ground surface. Because of the unique characteristics, several challenges were encountered with the characterization, implementation of the final status survey process to demonstrate compliance with the Record of Decision (ROD) [1], and subsequent remediation of these properties. Overcoming these challenges required a reevaluation of the previously developed gross gamma screening and soil core screening correlation values that ensured both the primary ROD requirements and expected residual concentrations would be met. Furthermore, modifications to the sampling, field implementation, and documentation process necessitated a revision to the Final Status Survey Plan (FSSP) to accommodate the unique conditions present at the adjacent properties.

INTRODUCTION

The Linde FUSRAP site is located in Tonawanda, New York on property now owned by Praxair, Inc. and functions as their research and development facility for specialty gases. During the early to mid-1940's portions of this property formerly owned by Linde Air Products Corporation, were used for the separation of uranium dioxide from uranium ores and for the conversion of uranium dioxide to uranium tetrafluoride. The uranium product was provided to the MED and the Atomic Energy Commission (AEC). These processing activities resulted in the radioactive contamination of various land areas with radium, uranium, and thorium. FUSRAP was initiated in 1974 to identify, investigate, and clean up or control sites throughout the United States that were part of the early atomic energy program. In 1980, the United States Department of Energy (DOE) designated the Linde site for remedial action. In 1997, the Energy and Water Development Act, Ph 105-62 was signed into law, transferring responsibility for the administration and execution of FUSRAP from the DOE to the U. S. Army Corps of Engineers

(USACE). Since 2000, the USACE and Shaw Environmental, Inc. (Shaw) have been conducting the remedial action at the Linde site in accordance with a Multi-Agency Radiation Survey and Site Implementation Manual (MARSSIM)-based final status survey plan [2]. This remedial action entails the removal of radiologically contaminated soils and implementation of the final status survey process to demonstrate compliance with the ROD. Compliance with the ROD requires removal of MED-related soils with residual radionuclide concentrations averaged over a 100 square meter area that exceeds unity for the sum of ratios (SOR) of these radionuclide concentrations to the associated concentration limits, above background, of 20,498 Bq/kg for total uranium (U_{total}), 185 Bq/kg for Ra-226 concentration limits, and 518 Bq/kg for Th-230 for surface cleanups; and 111,777 Bq/kg of U_{total}, 555 Bq/kg of Ra-226 and 1,628 Bq/kg of Th-230 for subsurface cleanups. In addition, consistent with the proposed plan released for public comment in March 1999 prior to promulgation of the amendment to 10 Code of Federal Regulation (CFR) Part 40, Appendix A, Criterion 6(6) in June 1999, USACE will remediate the Linde Site to ensure that no concentration of total uranium exceeding 22,200 Bq/kg above background will remain in the site soils [3].

Several properties located east of, and adjacent to, the Linde FUSRAP Site were identified as having potentially contaminated soil from MED activities. These properties include an active railroad line, a dining and entertainment complex, and an operating trucking transportation facility and associated buildings (Figure 1). Contamination in these areas may have originated during the delivery of uranium ores via the rail line adjacent to the Linde site, and the use of contaminated material as industrial backfill. Investigation and remediation in these areas began with the area east of the railroad tracks and progressed in an easterly and southerly direction.

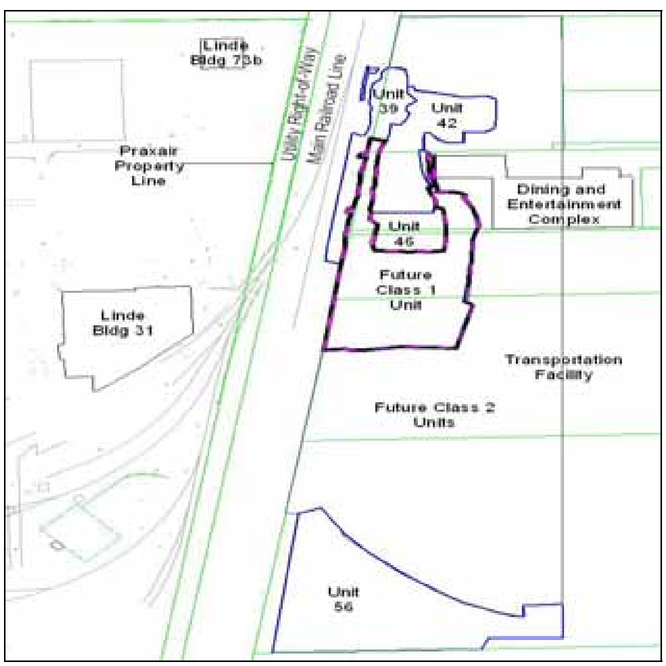

Fig. 1. LOCATIONS of main rail line, adjacent properties, and survey units

Access agreements were obtained by the USACE-Buffalo District from property owners which allow for the characterization and remediation of these properties. In addition to obtaining access agreements several activities were required to be completed prior to the commencement of any remediation efforts.

The radioactive MED contamination, soils, and overburden at these adjacent properties exhibited a combination of unique characteristics not previously encountered at the Linde Site. This included a commingling of metals and Cs-137 in the soil, the properties being littered with building debris, Th-230 being the dominant MED radioactive contaminant, and the radioactive contamination consisting of a five to seventy six centimeter thick black colored lens located at various depths below the ground surface. Because of the unique characteristics of the MED contamination, soils, and overburden in these adjacent properties several challenges were encountered with the characterization, implementation of the final status survey process to demonstrate compliance with the ROD, and subsequent remediation of these properties.

Overcoming these challenges required a re-evaluation of the previously developed gross gamma screening [4] and core screening correlation values [5], which ensured both the primary ROD requirements and expected residual concentrations, would be met. Furthermore, modifications to the sampling, field implementation, and documentation process necessitated revision to the Final Status Survey Plan to accommodate the unique conditions present at the adjacent properties.

INITIAL CHARACTERIZATION

The initial impetuses for the investigation of the adjacent properties located east of the Praxair boundary were sampling results from the Remedial Investigation (RI) [6] which indicated the potential for MED material beside the railroad tracks. Subsequent gamma walkover surveys performed beside the railroad tracks indicated elevated gamma count rates that would represent potentially elevated residual radioactive contamination. Based upon this information a data collection activity was initiated to characterize and determine the extent of the contamination. At this time access agreements that allowed for characterization did not allow any sampling within 7.6 meters of the main rail line. Split-spoon and grab soil samples were taken at locations with elevated gamma count rates and elevated RI sample points. The soil samples were sent for radiological analysis to a National Environmental Laboratory Accreditation Program (NELAP) certified laboratory, with USACE validation by the Hazardous, Toxic and Radioactive Waste (HTRW) Center of Expertise. The analytical results of the soil samples supported the results of the previous RI. Subsurface and surface radioactive contamination in excess of the ROD criteria was identified from samples taken west of the railroad tracks, and surface contamination in excess of the ROD criteria was identified from samples taken on the east side of the railroad tracks. Based on these results a Remedial Action Plan (RAP) was developed to remove MED-contaminated soils from this area [7]. The RAP did not allow for any remediation within 7.6 meters of the rail line. Any characterization of this area would be addressed in future with additional data collection requests.

Prior to any remedial actions access agreements were obtained by the USACE-Buffalo District from adjacent property owners which allowed for remediation of these properties. Pre-remediation activities also included locating and identifying underground utilities, relocation of existing utility poles, and the installation of access roads and chain link fencing. Perimeter air monitoring stations were also set up to establish a base line for background radioactivity measurements.

After completion of all pre-remediation activities remediation began in the area west of the railroad line. During the remedial action contamination was found to extend east toward the main rail line. Therefore, access was requested by the USACE-Buffalo District, and granted, to characterize the area within 7.6 meters of the main railroad line and an additional area to the east of the main rail line.

A data collection activity was initiated to characterize these areas which included hollow stem auger sampling, grab sampling of the drilling spoils, investigative test pits, and a shallow excavation area. Hollow stem auger sampling was selected to prevent cave-in of the ballast and aid in sample recovery. Cores were counted on a TCS-405 Core Scanning system. Grab samples of the drilling spoils were collected for supplemental data and were counted on-site by gamma spectroscopy. Test pits were selected because of the large sampling area and hard fill found in this area. Grab samples were taken from the test pits and were counted on-site by gamma spectroscopy. The area east of the tracks was characterized by a shallow excavation to expedite work on the rail line right-of-way. The floor and walls of the shallow excavation soils were scanned with a 5.08 cm x 5.08 cm sodium iodide (NaI) detector, with grab samples collected at locations with count rates exceeding 18,000 counts per minute (cpm). A conservative investigation level of 18,000 cpm for gamma scanning was developed that would ensure meeting the primary ROD cleanup criteria at least at a 95% confidence level for surficial and subsurface excavation areas [4].

The results from the main railroad line data collection activity indicated that none of the grab samples from the test pits or drilling spoils exceeded the ROD criteria, and none of the core samples exhibited count rates exceeding the investigation level of 9,000 net cpm. A conservative investigation level of 9,000 net cpm was developed for the TCS-405 Core Scanning System that would ensure meeting the primary subsurface ROD cleanup criteria at least at a 95% confidence level [5]. Therefore, based on these results no further action was required beneath the main rail line. However, scanning of the floor and walls of the shallow excavation with a NaI detector revealed count rates greater than the investigation level of 18,000 gross cpm. Analytical results of soil samples from this area exhibited radionuclide concentrations exceeding the ROD criteria. Based upon this information a MARSSIM Class 1 final status survey unit (Unit 39) was created and excavation of this area proceeded. After completion of the excavation, a final status survey and sampling was performed in accordance with the FSSP [8]. The USACE then performed a quality assurance (QA) survey and review of the sample analytical results. A technical data package was then developed that documents the data generated, and chronicles the activities conducted during the final status survey process. The information contained in the technical data package support decisions relative to backfill and landowner operations, and serve as a component for the final closure report for the site.

As the excavation of Unit 39 neared completion, the owner of the property adjacent to this unit disclosed his plans for expansion of his business. In order to support the property owner's expansion plans a radiological investigation of this area was performed to ensure that this Class 2 area met the ROD criteria.

Additional information regarding the potential eastern and southern extent of the radioactive contamination was obtained by examining aerial photographs (Figure 2). These photographs revealed a dark discoloration of land extending in an easterly and southerly direction which could indicate the presence of MED material. The subsequent radiological investigation of the properties located to the east and south of Unit 39 would create challenges previously not encountered at the Linde site.

Fig. 2. AERIAL photograph of dark lens of material circa 1960

CHALLENGES AND SOLUTIONS WITH CHARACTERIZATION, IMPLEMENTATION OF THE FSSP TO DEMONSTRATE COMPLIANCE WITH THE ROD, AND SUBSEQUENT REMEDIATION OF THESE ADJACENT PROPERTIES

Characterization Challenges and Solutions

The radiological investigation necessary to support the property owner's expansion plans involved a modification of the Class 2 final status survey protocol. A modification of the existing protocol was required due to the irregular land surface, mixed hard-fill, and building demolition debris within the property area (Figure 3).

Fig. 3. MIXED hard fill

The Class 2 protocol required soil coring with a split-spoon sampling rig and composite core samples being collected, scanned and analyzed. The terrain and mixed hard-fill in this area made using the split-spoon sampling rig unfeasible. This protocol was modified by excavating a series of test pits with discreet grab samples taken and analyzed on-site via gamma spectroscopy or analyzed off-site via alpha spectroscopy at a USACE-validated laboratory. The Class 2 protocol requiring a one directional surficial gross gamma walkover survey was also modified because of the unsafe terrain within the property area. The surficial gross gamma walkover survey would be obtained in a method, not necessarily in one direction, to ensure the safety of the Health Physics Technician (HPT), while maintaining adequate coverage.

During the performance of the Class 2 sampling several challenges were encountered associated with the identification of MED-contaminated soils. Th-230 was identified as the dominant isotope, and metals were commingled with the soil at this property, which resulted in reducing the gamma emissions and resultant characteristic x-ray production. Therefore, the initial high purity germanium detector gamma spectroscopy was inconclusive due to the interference of the low energy x-rays with the detection of the low energy Th-230 gamma emission. Furthermore, Cs-137 was found in excess of twice background concentrations in some areas. The high energy gamma from Cs-137 was detected when gamma scanning the soils with a 5.08 cm x 5.08 cm NaI detector for MED-contaminated soils. The influence of the Cs-137 gamma invalidated the previously developed investigation level of 18,000 gross cpm in this investigation area, which had previously been used at the Linde site.

Due to the challenges presented in this area all characterization samples were sent off-site to a USACE-validated laboratory for alpha spectroscopy analysis. The alpha spectroscopy could identify the MED-radiological contamination without the interferences associated with the on-site gamma spectroscopy. The results from the alpha spectroscopy analysis of the soil samples from the test pits revealed that that some of the samples exhibited radiological contamination in excess of the ROD criteria, with corresponding gamma count rates substantially less than 18,000 gross cpm. These alpha spectroscopy analytical results confirmed the suppositions regarding Th-230 being the dominant radioisotope, and that the investigation level of 18,000 gross cpm could not be implemented in this area. Furthermore, this area would now be investigated as a MARSSIM Class 1 survey unit (Unit 42).

Excavation Radiological Investigation Challenges and Solutions

In previous excavation activities at the Linde Site the HPT would guide the excavation of contaminated soils. This would be accomplished by using the 5.08 cm x 5.08 cm NaI detector to scan the excavated area for soils with count rates 18,000 gross cpm or greater. Soils exhibiting count rates greater than 18,000 gross cpm or greater would be excavated. Soil samples were also taken and counted on-site by gamma spectroscopy to characterize the excavation area. A daily gamma walkover linked to a Global Positioning System (GPS) was performed to track progress of the excavation. This process continued until all the contaminated soils were excavated. The USACE would then perform a quality assurance gamma walkover of the excavation area. If the excavation area passed the USACE quality assurance gamma walkover final status survey activities could progress.

Due to the unique characteristics associated with this property the investigation level of 18,000 gross cpm could not be implemented to guide the excavation process. However, elevated count rates relative to background were identified which corresponded to a visual dark lens of material (Figure 4). The analytical results from off-site alpha spectroscopy analysis revealed over 90% of soil samples taken from this dark lens of material exceeded subsurface ROD criteria. The dark lens of material varied in thickness from a few centimeters to almost a meter.

Based on this information the USACE approved a method to expedite and guide the excavation process. This method incorporated having count rates relative to background in the area of the dark lens be sufficient to support the existence of MED material in excess of subsurface ROD criteria. To support documentation of this effort daily photographic evidence of the dark lens material was taken, GPS coordinates of its location, thickness, count rate, and overlying material count rate would also be documented. Additionally, any dark lens material without elevated count rates relative to background would be sampled and sent off-site to a USACE-certified laboratory for alpha spectroscopy analysis. With USACE concurrence, excavation activities would be suspended until the analytical sample results were obtained and a determination was made if excavation activities should continue. Excavation of Unit 42 proceeded using the USACE approved method for radiological investigation in this area. The HPT guided the excavation by following the dark lens of material and corresponding elevated count rates. GPS coordinates of the lens and photographic documentation continued throughout the excavation process with sampling of soils as appropriate. Additionally, a GPS linked gamma walkover of the excavation area was performed daily to show progress of excavation activities. This methodology proved to be extremely successful and was used until the excavation reached completion. Unit 42 was now ready for final status survey and sampling.

Fig. 4. DARK lens of material in the excavation

Challenges and Solutions for Implementation of the FSSP

Challenges to accomplish final status sampling in the excavation area occurred because of incessant rainfall and the natural low topography in the excavation area. These conditions made sampling extremely difficult, to impossible, because the excavation area was underwater or constantly muddy. This challenge was overcome by continuous dewatering efforts and dry weather conditions which lasted long enough to dry out the bottom of the excavation and allow for sampling activities.

Furthermore, the technical challenges associated when excavating this area were also encountered when surveying this Final Status Survey Unit. Cs-137 in excess of twice background concentrations was detected in the northern portions of the unit and Th-230 was determined to be the remediation driver. Metal commingled in the soils in this unit, reducing gamma emissions and resultant characteristic x-ray production, resulted in poor resolution involving the use of a NaI detector with a ratemeter. Also, initial high purity germanium detector gamma spectroscopy proved to be inconclusive because of the low energy characteristic x-ray production.

The sampling performed in the southern portion of this unit identified radiological contamination in excess of subsurface ROD criteria. The majority of the corresponding field gamma count rates for these samples were determined to be substantially less than 18,000 gross cpm, the gross gamma investigation level that provides a 95% confidence of meeting the surface ROD criteria [4]. Therefore, there was no correlation between the final gamma walkover of the unit and the investigation level that could verify the unit met subsurface ROD criteria.

To overcome these challenges a significant number of bias samples were taken on the perimeter benches of the excavation. These samples were analyzed at a USACE-validated off-site laboratory by alpha spectrometry. Entire perimeter benches were excavated if analytical results revealed radiological contamination in excess of subsurface ROD criteria. Additionally, the floor of this unit appears to be natural red clay that is just below the 1940’s elevation for this property. This additional information, along with the final status survey sampling results, would be presented in a Technical Data Package for Unit 42.

Following approval by the USACE, the Final Status Survey Technical Data Package for Unit 42 documented the successful remediation of this unit to meet the requirements and expectations of the ROD. It was, therefore, determined that Unit 42 did not require additional remediation.

The property was restored to pre-remediation grade and function, and was subsequently backfilled with USACE approved backfill material in accordance with the Linde Site Restoration Plan [9].

The methods and approach elucidated above were subsequently used for the successful implementation of the Final Status Survey process for another MARSSIM Class 1 final status survey unit (Unit 46) and a MARSSIM Class 2 final status survey unit (Unit 56) at these adjacent properties (Figure 1).

CONCLUSIONS

The impetus for investigation of the adjacent properties began with a review of the initial RI [6]. This review led to the USACE-Buffalo District obtaining access agreements with property owners to investigate their properties. After obtaining access agreements utilities were relocated and infrastructure was installed. The unique combination of radioactive and overburden characteristics associated with the adjacent properties presented characterization challenges not previously encountered at the Linde Site. Data collection activities required the modification of plans and procedures with subsequent interpretation of analytical results. The sample analytical results necessitated a modification to the excavation process previously used at the Linde Site. Gross gamma correlation values could not be used to guide the excavation. Instead, a dark lens of material guided the excavation process. After completion of the excavation the location and topography of the adjacent properties, along with inclement weather conditions also presented challenges with implementing the final status survey process.

Meeting the challenges and developing and implementing innovative solutions required the combined efforts and cooperation of the USACE-Buffalo District and Shaw Environmental & Infrastructure, Inc. The collaboration of a multi-disciplinary team of professional and craft personnel completed the team effort required for the successful remediation effort. Several adjacent properties still require remediation and the same combination of effort and cooperation will be required to meet the challenges ahead.

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