Disposal of Formerly Utilized Sites Remedial Action Program (FUSRAP) Wastes – Weighing the Options - 11536

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ABSTRACT

Waste at Formerly Utilized Sites Remedial Action Program (FUSRAP) sites are typically associated with historical processing of ore to recover uranium and thorium. These wastes are impacted with low concentrations of uranium, thorium, and their decay progeny. Depending on the process and types of materials used, this waste can be classified as low-level radioactive waste (LLRW), naturally occurring radioactive material (NORM), technically enhanced NORM (TENORM), "11(e)(2)" byproduct material, and low activity radiological waste (LARW). Traditionally, disposal options for FUSRAP waste were limited to a small number of facilities licensed by the Nuclear Regulatory Commission (NRC) or an Agreement State. When U.S. Army Corps of Engineers (USACE) began implementing the FUSRAP Program in 1997, USACE identified transportation and disposal (T&D) as a significant portion of the remedial action costs. USACE has identified Resource Conservation and Recovery Act (RCRA) Subtitle C landfills as alternative disposal options for many of these wastes streams at a significant cost savings to the program.

Primary factors weighing into disposal decisions include: (1) site location and distance to a disposal facility, (2) facilities serving the site and disposal facility (rail, truck, vessel), (3) types of waste (mixed waste, LLRW, LARW, etc.), (4) volume of the waste, (5) properties of the waste (physical characteristics, hazardous/nonhazardous characteristics, etc.), (6) appropriate permits, and/or licensees in place to accept the waste, (7) timing for state and disposal facility approval, and (8) political climate. While the first five factors listed above generally drive T&D costs, the remaining factors can be the deciding criteria for whether waste would be shipped to a facility or not (i.e., even if the pricing is desirable).

The USACE-Baltimore District along with its private industry partner is currently evaluating T&D options for wastes from a FUSRAP site in Baltimore, MD (the Site). Transportation costs are noted as being significantly higher than disposal costs. Therefore, the USACE Site Team is initially focusing on the distance to an acceptable disposal facility and volume of waste (i.e., minimizing waste that needs to be disposed based upon rigorous waste characterization and/or segregation). Alternative disposal facilities that USACE is evaluating include the use of Subtitle C RCRA landfills located closer to the Site than traditional disposal facilities. Industry experience involving disposal at Subtitle C facilities involves providing a full profile of the waste and risk assessment to determine occupational exposures of the material as received at the facility and post-disposal risks from placed wastes. Generally, approval is granted on a case- by-case basis depending on characterization information, volume, occupational exposures, post-

disposal risk, and regulatory feedback. There is the potential that not all materials would be able to meet the governing waste acceptance criteria (WAC) for a specific facility; as such, discrete populations may need to be individually managed through other disposal pathways. USACE has benefited from performing these cost-benefit analyses for traditional and non-traditional disposal options. As T&D is typically a large portion of the cost to remediate a site, savings realized by using alternative disposal facilities (versus traditional facilities) and minimizing waste to be disposed through characterization can greatly reduce overall costs to the USACE program.

INTRODUCTION

There are seven USACE districts working on FUSRAP sites in 10 states. FUSRAP was established in 1974 to identify and decontaminate sites where radioactive contamination remained from activities carried out under contract to the AEC. USACE is the lead Federal agency for investigations and remedial actions at FUSRAP sites. As required by Congress, USACE complies with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Contingency Plan (NCP) in conducting cleanup activities at FUSRAP sites. Current FUSRAP information may be found at: https://environment.uscae.army.mil/what_we_do/fusrap/. This paper will concentrate on activities at a FUSRAP site in Baltimore, MD.

The Site is an active manufacturing facility (approximately 44 hectares) located on an industrialized peninsula in Baltimore, Maryland. The facility was placed into FUSRAP in 1984 due to the presence of residual radioactivity from monazite sand processing operations conducted by the site owners in the 1950s, while under contract to the Atomic Energy Commission (AEC).

Monazite sand processing was conducted in the southwest quadrant of a five-story building (Building 23) in the active manufacturing portion of the Site. Waste materials from the processing operations, termed gangue, were disposed in the non-manufacturing portion of the Site, in the area now referred to as the Radioactive Waste Disposal Area (RWDA). USACE has conducted remedial investigations (RIs) at Building 23 and the RWDA to assess the nature and extent of radiological impact. RI results indicate that remedial response actions are necessary and appropriate for both areas. USACE completed Feasibility Studies (FS) for Building 23 (2004) and the RWDA (2008). A Record of Decision (ROD) was issued by USACE in 2005 for Building 23 to address residual radioactivity on building components and equipment and in the underlying soil. Since completion of the ROD for Building 23, USACE and the property owner voluntarily entered into a legal partnership to address the manner in which USACE and the site owner will conduct themselves during the identification and remediation of FUSRAP material at the Site. USACE is finalizing the ROD for the RWDA and expects it to be issued in early 2011. The ROD for the RWDA will address residual radioactivity in soils at the RWDA. USACE has identified T&D as a significant portion of the remedial action (RA) costs for the selected alternatives for both Building 23 and the RWDA. USACE is evaluating disposal options in accordance with USACE guidance Engineering Manuel (EM) 1110-35-1, Management Guidelines for Working with Radioactive and Mixed Waste. Cleanup at the Site is being coordinated with the Environmental Protection Agency (EPA), the Maryland Department of the Environment, and state regulators in the disposal facility state. Prior to waste disposal, USACE

will contact the respective regional EPA office to determine Off-Site Rule compliance, per 40 CFR 300.440.

HIGHLIGHTS OF THE CONTAMINATION

Building 23 and the RWDA contain residual radioactivity due to monazite sand processing/milling operations for thorium source material in the mid-1950s by the Site owner, under a license from AEC. That license is no longer in effect. The NRC has never issued a license for the Site, and there has not been a decommissioning undertaken at the Site. In addition, processing operations ceased prior to the enactment of the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 and although the processed material would be similar to 11(e)(2) byproduct material, it is not under the jurisdiction of the NRC[1]. After considerable discussion and evaluation of these factors and the lack of precedent, USACE identified the following chemical-specific applicable or relevant and appropriate requirement (ARAR) to be relevant and appropriate for Building 23 and the RWDA: 10 CFR 40 Appendix A, Criterion 6(6). This ARAR is not "applicable" to the RWDA or the Building 23 remedial action since there is no active license for the site, but the requirement is "relevant" in that the milling operations, while ongoing, were similar to operations that would occur at a thorium mill. The requirement is also "appropriate" in that it deals specifically with soil/structures, and incorporates the dose contribution from all radionuclides present at the Site into the standard.

This standard is designed to provide an acceptable level of protection to the average member of a critical group who may be exposed to radium in soil (above background concentrations) for a given scenario, and it also allows establishment of cleanup criteria for radionuclides other than radium, when present. Dose assessment calculations were performed to establish derived concentration guideline levels (DCGLs) for each radionuclide in the Thorium-232 (Th-232) and Uranium-238 (U-238) decay chains for both surface and subsurface soils. In accordance with the ARAR, a sum of the ratios calculation (also called the unity rule) is utilized with the DCGLs to assure compliance with the radium standard.

The key FUSRAP contaminants of concern in surface and subsurface soils at the RWDA and the building components in Building 23 include Th-232 and its decay progeny. Radium-226 (Ra-226) and its decay progeny may also be present; however, the Th-232 decay series also must be present at elevated levels to be classified as FUSRAP waste. Of note, other processing wastes (not related to the monazite sand processing under contract to the AEC) may have been disposed in the RWDA and surrounding areas and it may be present in wastes from Building 23. These non-FUSRAP process wastes, which may include metals (or other chemicals) and NORM, are not eligible for remediation under FUSRAP unless they are commingled with the key FUSRAP COCs or require remediation as a result of the monazite sand processing operations conducted at the Site; however, when commingled they need to be managed and disposed of in accordance with applicable regulations.

[1] NRC has characterized this type of material as "residual radioactive material resulting from the processing of ores before the enactment of UMTRCA".

EVALUATING THE DISPOSAL OPTIONS

Primary factors weighing into disposal decisions include: (1) site location and distance to a disposal facility, (2) facilities serving the site and disposal facility (rail, truck, vessel), (3) types of waste (mixed waste, LLRW, LARW, etc.), (4) volume of the waste, (5) properties of the waste (physical characteristics, hazardous/nonhazardous characteristics, etc.), (6) appropriate permits, and/or licensees in place to accept the waste, (7) timing for state and disposal facility approval, and (8) political climate. While the first five factors listed above generally drive T&D costs, the three remaining factors can be the deciding criteria for whether waste would be shipped to a facility or not (i.e., even if the pricing is desirable).

Site Location and Site/Facility Infrastructure

Many FUSRAP sites, including this Site, are located on the east coast and require transport of material by a combination of rail and/or highway thousands of miles to disposal facilities in the west. Identifying the infrastructure capabilities supporting each disposal facility as well as the RA Site (rail, truck, or vessel) are important factors in determining overall T&D costs for a RA. Factors driving costs associated with transport include distance between a site and facility, number of times the materials require handling, type of shipping container, ownership of shipping containers, demurrage or downtime resulting from transport delays, and accidents or incidents involving waste being transported. Sites and disposal facilities with full or partial rail access may possess an initial advantage (over trucking), as shipping by rail maximizes the volume which can be shipped per event and is typically cheaper (kilometer per kilometer basis). However, if rail access points for loading and unloading necessitates double handling of material or over the road transport for the initial and/or final leg to disposal, potential advantages or savings may be diminished. Some flexibility may be gained in using lined intermodal containers (or roll-offs) as opposed to direct loading of gondola cars. Principle rail transport methods for intermodal containers (or roll-offs) include the use of articulating bulk commodity rail cars rated for up to 154,200 kilograms (340,000 pounds) allowing for a greater shipping volume per event and substantial savings when transporting material from the east coast to the west. Conversely, use of lined gondola cars although easier to load may require additional costs to offload at a selected facility. Disposal to a more local disposal facility may include the use of covered end dump trailers, standard dump trucks, and/or roll-off containers transported by truck depending on the material being disposed (i.e. either no-activity [meets surface criteria] or reduced NORM concentration material as approved). Transport by truck may amount to increased savings over rail when transporting wastes locally or in certain other scenarios where double handling, demurrage costs, or other factors makes rail cost prohibitive.

The Site has access to rail sidings and the site is in close proximity to major highways. Identified disposal facilities are accessible by both rail and truck routes. Cost effective use of rail access at the site requires either the use of lined intermodal containers (or roll-offs) or soft-sided containers (such as Nautilus Bags) as siding locations do not permit cost effective use of direct loading techniques for either Building 23 or the RWDA. Facility operations may also reduce open access to rail lines and limit available loading times. Another alternative would be the use of trucks or flat-beds, which may allow flexibility in loading, shipping, reduction in handling, and alignment with proposed disposal facilities existing infrastructure.

Type, Volume, and Properties of the Waste

As mentioned previously, both Building 23 and the RWDA contain residual activity due to monazite sand processing/milling operations for thorium source material in the mid-1950s by the Site owner, under a license from AEC.

Building 23

For Building 23 the volume of material to be disposed, based on investigations conducted to date, includes approximately 376 cubic meters (CM)(492 cubic yards)(CY) of building components, dust, and equipment/tanks from Building 23. Scanning, segregation, and chemical testing (including TCLP testing) completed as an initial component of the RA allowed profiles of several waste streams to be developed in advance of disposal.

Radiological screening of open floor surfaces for alpha and beta activity was conducted using a surface contamination monitor (SCM), which is a cart mounted gas flow position sensitive proportional counter integrated with a survey information management system. Building 23 was cleared of all material allowing for 100 % screening of the floor surfaces. The SCM recorded approximately 1.9 million surface measurement for both alpha and beta activity.

The analytical data from representative samples do not definitively identify the source of the contaminants; however, they do support the assumption that the source was the waste products. The extraction of thorium would be expected to produce a waste with elevated levels of daughter products. Those daughter products have a relatively short half-life (for example, the half-life of radium-228 (Ra-228), which is the daughter of Th-232, is 5.75 years). Thus, the waste product would reach secular equilibrium in approximately 40 years. It has been over 40 years since this waste product was created in Building 23. Data gathered through Site investigations show the radiological contamination in Building 23 to be in, or close to, secular equilibrium.

In an attempt to convert the surface results to criteria for an unimportant quantity of source material, the surface-to-mass ratio (σ) and measured radiological activity of the concrete floors was evaluated. The methodology utilized in the calculation and the concrete density assumed were consistent with guidance and assumptions provided in NUREG 1640, "Radiological Assessments for Clearance of Materials from Nuclear Facilities" (June 2003). Using the maximum gross alpha activity and conservatively assuming that each alpha decay is associated with the decay of ^{232}Th; the maximum volumetric activity of the concrete waste was determined to be 0.593 Becquerels per gram (Bq/g) (16.03 picoCuries per gram) alpha which allows for disposal as exempt waste.

Available data suggests that a single small tank (estimated 2080 liters) (550 gallon) has the potential to be characterized as LLRW requiring an alternate disposal option. Asbestos, suspect polychlorinated biphenyl (PCB), lead-based paint, and possibly other unknowns are present which require consideration during the disposal process.

RWDA

For the RWDA, the FS indicates that the volume of soil that will be excavated and segregated is approximately 46,514 CM (60,834 CY). Based on the anticipated segregation efficiency, it is estimated that approximately 32,560 CM (42,584 CY) of soil will be disposed at an appropriate offsite facility permitted or licensed to accept the waste stream. Additional scanning, segregation, and testing (including TCLP testing) as part of the RA will be required to profile the waste in advance of disposal.

Permits and/or Licenses

If the waste materials are LARW and meet available exemptions for federal and state regulations, the waste material may be eligible for consideration at a RCRA Subtitle C facility. Specific exemptions are listed in both state and federal regulations and some that typically fit the materials generated from FUSRAP sites are identified as an unimportant quantity of source material "thorium and/or uranium which is by weight less than one-twentieth of one percent (0.05%)". Other approvals are available, at both the state and federal levels, and typically involve specific approval of proposed disposals based on risk/dose considerations. If the material does not meet any of the exemptions and/or alternative disposal approaches, it is usually defined as LLRW.

When wastes are defined as LLRW, consideration must be given to the LRRW Compacts. Each compact has specific requirements for import/export of waste and out-of-compact disposal facilities will require a letter from the compact authorizing export of the waste. For each waste stream, the characterization of the materials must meet the WAC of the accepting facilities permits/license. All disposal actions from a CERCLA site must also comply with the requirements of the CERCLA Off-Site Rule as outlined in 40 CFR 300.440. This process adds an additional level of review to the specific waste stream, the facilities' licenses and/or permits, as well as a review of any relevant release/violations from the treatment, storage, and/or disposal facility.

Based on characterization results, much of the Building 23 and RWDA waste material appears to be eligible for disposal at a RCRA Subtitle C facility. As such, USACE is investigating alternative disposal facilities to assess whether the Site waste would be accepted.

Timing of Facility Acceptance/Political Climate

The last two factors are the most difficult to define and can pose the most risk to schedule and costs if delays are realized. To minimize these risks, USACE communicates with each disposal facility and their regulator on a frequent basis. The communications focus on lessons learned from previous disposal activities and how to apply past experiences to available processes to make the disposal of FUSRAP wastes more efficient. Each specific waste stream poses different challenges for each potential disposal facility. USACE technical and management teams frequently meet to share the lessons learned from disposal of materials from FUSRAP as well as other environmental restoration programs. The sharing of these lessons assists each team in

minimizing the risks from the disposal of materials from their site while maximizing the cost avoidance to the programs.

EVALUATING THE DISPOSAL OPTIONS FOR THE SITE

For the Building 23 RA, characterization, demolition and decontamination (D&D), and Final Status Survey (FSS) activities will be coordinated to achieve an integrated process that minimizes risk to workers and the environment, minimizes generation of waste, streamlines technical processes, and reduces costs. Whenever practical, characterization activities will be conducted in advance of remediation to identify areas requiring D&D and/or special waste packaging.

Additional sampling for characterization has led to more defined waste profiling which can be used to take advantage of alternative disposal options. Based upon the anticipated activity of the majority of the project's pending remediation waste, USACE has determined that the best disposition mode for the Site waste is bulk packaging for direct landfill disposal at an approved disposal facility. However, all waste generated may not meet the governing WAC at a single disposal facility, and such discrete populations will be managed appropriately. USACE has identified RCRA Subtitle C landfills as alternative disposal options for many of the wastes streams generated from the site at a significant cost savings.

During the RA, the RA contractor will initially segregate the waste based on the level of radioactivity present as well as other hazardous constituents. The waste will then be prepared for transportation to ensure that all materials shipped meet the designated disposal facility WAC. Materials destined for the same disposal facility, will be placed in packages to maximize the payloads based on both volume and weight capacity for the selected packaging.

Radiologically-contaminated solid wastes generated and characterized during site remediation will be transported to a Subtitle C (non LLRW) disposal facility in IP-1/IP-2 soft-sided Nautilus Bags, additionally packaged in IP-1 rail gondola liners and hauled by railcar. In the event that the segregated materials exceed the WAC for that facility, the material may be shipped to a different facility licensed to receive LLRW after appropriate communications, profiling and approvals.

USACE has typically disposed of exempt and LLRW wastes in three approved locations in the west but has interest in disposing wastes at more local facilities.

For disposal of FUSRAP material in a RCRA Subtitle C landfill, the host state requires USACE to "certify" the waste stream, i.e., to provide a signed statement specifically addressing the characteristics of the volume of waste to be disposed within the state. A key element of the certification is that the material to be disposed of is exempt from licensing. In addition the state requires the Subtitle C landfill to submit a dose assessment to determine the maximum activity concentrations of each of the constituent waste radionuclides that can be placed within the landfill. The dose assessment and certification are part of the landfills application to the state to gain approval for the disposal of the FUSRAP material. The approval process must be factored into the schedule or disposal may be delayed.

SUMMARY

As T&D is typically a large portion of the cost to remediate a site, savings realized by using alternative disposal facilities (versus traditional facilities) and minimizing waste to be disposed through characterization can greatly reduce overall costs to the USACE program. Evaluating waste disposal options requires the review of numerous factors. These factors are different for each site depending on the site location, facilities serving the site, volumes and types of waste, and approval from the accepting disposal facilities regulator.

Currently, USACE and its industry partner are completing the remediation of Building 23 to address residual contamination in building materials. USACE and its industry partner have benefited from working together and performing cost-benefit analyses for traditional versus non-traditional disposal options using the factors described above. The cooperative analysis has set a firm foundation for achieving successful remedial action and site closure using a "forward thinking" approach which combines additional characterization, segregation and the use of nontraditional but acceptable disposal options. The collaborative effort led to the development of a disposal plan which is acceptable to the site owner, the regulators, and the public, thus allowing USACE to move this project forward successfully in the FUSRAP program.

REFERENCES

U.S. Army Corps of Engineers, Department of the Army, EM 1110-35-1, Engineering and Design - Management Guidelines for Working with Radioactive and Mixed Waste (2005).