CHARACTERIZATION AND MINIMIZATION OF MIXED WASTE FROM SANDIA NATIONAL LABORATORIES CHEMICAL WASTE LANDFILL

S. G. Young
Sandia National Laboratories, New Mexico

M. N. Creech, M. M. Mitchell
GRAM, Inc.

ABSTRACT

Excavation of the 1.9-acre Chemical Waste Landfill (CWL) at Sandia National Laboratories in Albuquerque, New Mexico (SNL/NM) unearthed a number of waste streams that posed challenges in mixed waste management, characterization, and disposal. Mixed waste matrices included soil, chemicals, debris, and project-generated personal protective equipment (PPE). This paper discusses the complications associated with characterizing, managing, and disposing of mixed waste matrices.

INTRODUCTION

The CWL was excavated between 1998 and 2002 to remove buried debris and associated contaminated soil associated with trichloroethylene (TCE) contamination in the groundwater above maximum contaminant levels (MCLs) allowable by the state of New Mexico. As excavation progressed, buried debris was segregated from excavated soil. During the excavation and segregation processes, waste was screened with field radiation detection instruments as an initial characterization. Characterization of soil samples included chemical and radiological analysis. An on-site mobile laboratory was set up to analyze the soil for constituents regulated by the Environmental Protection Agency (EPA) under the Resource Conservation and Recovery Act (RCRA) and the Toxic Substances Control Act (TSCA). Samples of this soil were also analyzed for tritium and other radionuclide activity by the SNL/NM Radiological Protection Sample Diagnostic (RPSD) laboratory. Debris was swiped to determine the presence of removable and/or added radiological contamination. Approximately 1,400,000 cubic feet (ft^3), or 52,000 cubic yards (cy), of soil and debris was removed from the landfill during excavation. Approximately 2,700 ft^3, or 100 cy, of the soil and debris excavated was characterized as mixed waste.

Complications that arose from the presence of radioactive constituents in the excavated RCRA-regulated waste materials include the designation of the site as a Radioactive Materials Management Area (RMMA), the waste minimization efforts, and the complexities related to determining a disposal path based on uncertain characterization requirements. These waste management issues were addressed by forming strong teaming relationships with radiation control technicians, radiation protections engineers and health physicists, and radioactive and hazardous waste disposal specialists within SNL/NM.

RMMA DESIGNATION

Historical records kept during the operation of the landfill, indicated that radioactive materials were disposed of in the CWL, causing the Department of Energy (DOE) designation of RMMA to be applied to the landfill and all of its contents. By designating the landfill as an RMMA, additional controls were implemented in order to perform the remediation work safely. Engineering controls included additional postings around the landfill itself, designation of the site operational boundary as a controlled area, creation of Radioactive Materials Areas (RMA) within the site operational boundary and the onsite laboratory area. Additional engineering controls implemented included rigorous frisking and release requirements for all items being removed from the RMMA. Rigorous frisking requirements were also required for site personnel leaving the controlled areas of the RMMA or the RMAs. Administrative controls established included Awareness of Occupational Radiation Protection under the Price-Anderson Amendments Act (PAAA) was required for all site workers in contact with materials from the landfill; the requirement of Radiological Work Permits for specific work performed; and radiological training for all personnel performing work in the RMMA or RMAs.

Frisking Requirements

Frisking requirements at the CWL included field screening of soil and debris as the excavation process was underway. Soil excavated from the landfill was screened for radiological activity per loader bucket using a sodium iodide detector. Two methods of separating debris from soil were used during excavation. The first method used was screening with a non-mechanical table screen and manual segregation of waste matrices. The second method used was mechanical screening and using a conveyor system to assist in segregation of waste matrices. Although two methods were used throughout the excavation project, soil and debris was frisked for radiological activity before and during waste segregation. Figure 1 displays the entire process for excavation and debris segregation using mechanical methods of screening.

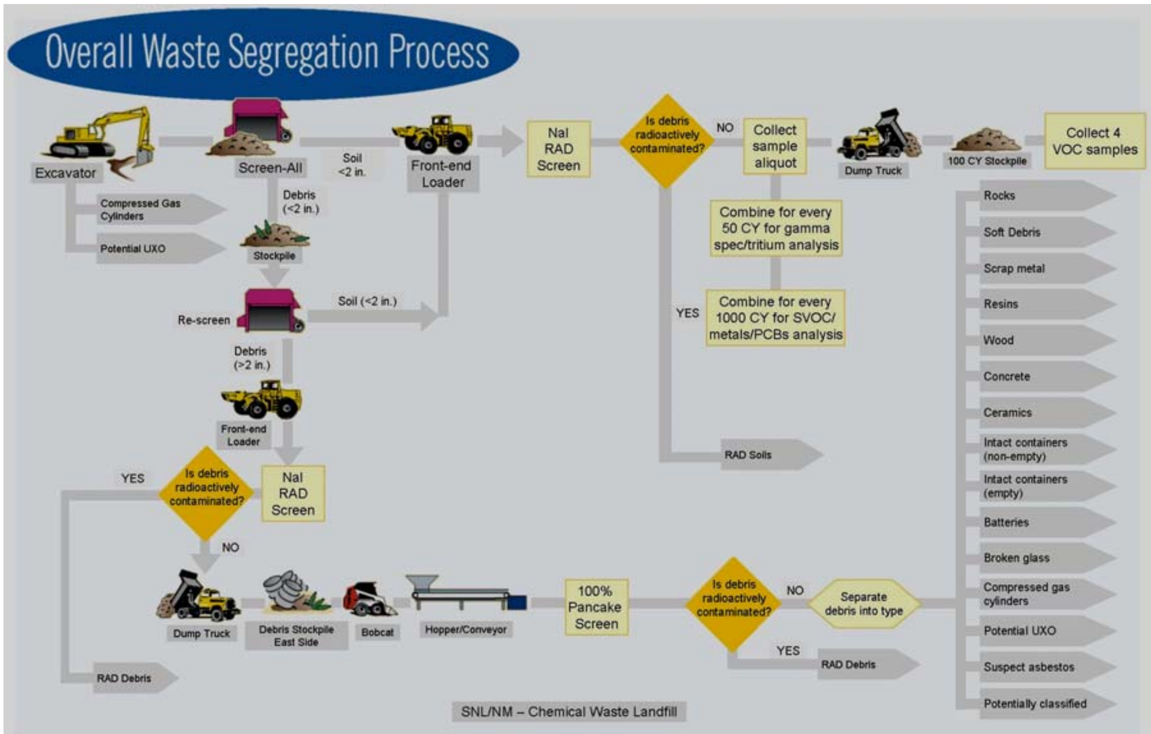

Fig. 1 Excavation and debris segregation at the CWL using mechanical methods of processing the waste.

Radiological Analysis Required For Soil

Along with field frisking requirements, soil excavated from the CWL was required to be tested for tritium and other radionuclide activity. Soil samples were taken from each 2,700 ft^3 or 100 cy excavated soil pile. Table I below displays the types of samples taken from each soil pile excavated from the CWL.

Table I. Soil samples taken from each 2,700 ft^3

Analysis	Number of Soil Samples
Tritium	2
Gamma Spectroscopy	2
Volatile Organic Compounds (VOCs)	4
RCRA Metals	1
Hexavalent Chromium and Mercury	1
Polychlorinated Biphenyls (PCBs)	1
Semi-volatile Organic Compounds (SVOCs)	1

Tritium and gamma spectroscopy samples were analyzed by SNL/NM's RPSD laboratory prior to any samples leaving the site for subsequent analysis. The majority of the chemical data was generated by the on-site mobile laboratory and SNL/NM's Environmental Restoration Chemical Laboratory (ERCL). Samples being delivered to either ERCL or an off-site laboratory required a movement survey prior to release from the site. Movement surveys were swipe samples taken from the outside of the sample jars in order to document whether radiological contamination existed on the outside of the jars. Tritium and gamma spectroscopy results were obtained prior to samples leaving the site in order to determine whether the samples were characterized as having radiological contamination for Department of Transportation (DOT) purposes and for laboratory acceptance purposes.

Radiological Analysis Required For Unknown Chemicals

Along with field frisking requirements, intact containers of unknown chemical product excavated from the CWL were required to be tested for added tritium, gross alpha, gross beta and other radionuclide activity. Tritium, gross alpha, and gross beta were analyzed by taking a swipe sample of the inside of the container. This method of sampling adequately characterized the unknown chemical for rad. Once the rad waste characterization was completed, Hazard Categorization (HazCat) was performed on the unknown chemical product. During the HazCat process, the unknown chemical was put through a number of tests to determine the hazard classification. Hazard classifications seen in chemicals excavated from the CWL included inert products, oxidizers, organics, flammables, caustics, and various others. Once the hazard classification was determined, additional testing was performed to produce qualitative data that was used to determine suspected compounds in the unknown chemical.

Once a number of chemicals with the same hazard classification were identified, they were packaged into secondary containment, either a 20-gallon tote or 5-gallon bucket. The unknown chemical containers and the secondary containment (tote or bucket) were swiped for movement. Once the movement survey was completed and no external radiological contamination was observed, the entire tote or bucket was analyzed through gamma spectroscopy. This method of analysis was called Q^2 because multiple containers were analyzed to determine one set of results.

Radiological Analysis Required For Debris

During the field screening process, debris was swiped for movement or release. Once the movement or release survey results were received, the debris was then sorted by matrix type. Types of debris excavated from the CWL included wood, ferrous metal, non-ferrous metal, plastic, paper, and concrete. The majority of the debris excavated from the CWL did not have radiological contamination above critical levels. The debris that was determined to have radiological contamination was segregated and will be discussed in the next section of this paper.

WASTE MINIMIZATION

All matrices of waste, with the exception of intact chemical containers, went through a waste minimization process. The processes were tailored to each matrix type. Waste minimization processes utilized at the CWL are detailed in the following sections.

Waste Minimization for Soil

Two methods of waste minimization for soil with radiological contamination were used during the remediation of the CWL, dependent on the contaminant of concern. Soil excavated from the

CWL had three different criteria that were used to determine disposal pathways for the soil. Initially, the background level of 420 pCi/L was used to determine whether soil was contaminated with tritium for off-site disposal. For disposal in the engineered, geo-membrane lined landfill at SNL/NM's Corrective Active Management Unit (CAMU), the soil had to have a tritium activity of below 20,000 pCi/L. Finally, to be disposed of as backfill material into the CWL, the action level for tritium activity was 150,000 pCi/L. Any soil with tritium activity above 150,000 pCi/L required regulatory approval prior to using it as backfill material. For soil with tritium as the primary radiological contaminant of concern, the 2,700 ft^3 soil piles were each separated into eight equal sub-piles. The eight sub-piles were then labeled and sampled for tritium. Figure 2 displays an example of this method of segregation and sampling. Once the tritium results were available, the segments were then managed accordingly. The majority of the soil that underwent additional segregation and tritium sampling was allowed to go to the CAMU for treatment and final disposal. A small portion of the soil was allowed to go back into the CWL excavation as replaceable soil. An even smaller portion of the soil was drummed as containing radiological contamination. By processing the soil in this manner, off-site disposal costs were avoided for approximately 15,120 ft^3 (560 cy); therefore, this effort was considered a successful method of waste minimization.

Soil piles that were found to contain above background radionuclide activity, other than tritium, above background were thinly spread out on the ground. Field technicians then walked over the piles with a NaI detector in an attempt to find hotspots of activity. The result of this process was that particles of rad were so finely dispersed that segregation was not possible. Although this effort did not have the intended effect, it was important to attempt waste minimization alternatives in order to verify that all possible waste minimization tools were explored. In fact, depleted uranium nuggets have been successfully removed from other SNL/NM soils by manual and mechanical methods.

Once soil was characterized as mixed waste, it was then packaged into DOT certified and inspected drums. SNL/NM's Radiological and Mixed Waste Management Facility (RMWMF) staff provided inspection services for the drums. During the packaging process, aliquots were taken from each drum set. A drum set was determined based on the original identification number of the soil. Each drum set was sampled for off-site analysis. The number of samples per drum set was determined based on the cubed root of the number of drums per drum set. Off-site analysis included:

- Tritium
- Gross alpha and Gross beta
- Toxic Characteristic Leaching Properties (TCLP) for heavy metals
- VOCs
- SVOCs
- PCBs

Fig. 2 Segmenting and sampling soil piles for tritium as a waste minimization effort

Based on the result from the off-site analysis, the drum sets were categorized by treatability groups. The results determined that the majority of the drum sets would be sent to an approved off-site facility for soil stabilization due to heavy metal contamination. Based on Universal Treatment Standards (UTS), at least two of the drums sets were determined to need no treatment.

Waste Minimization for Unknown Chemicals

Due to the nature of working with unknown chemicals, a formal process for waste minimization was never instituted for waste matrix. Best management practices were used such as not bulking chemicals; therefore, more difficult to dispose of chemical mixtures were not created during packaging and disposal efforts. The on-site mobile laboratory was demobilized during the fourth year of the project. After the laboratory was demobilized, the remaining chemicals needing characterization prior to disposal were sent to an off-site laboratory. A number of the chemicals remaining at that point were of such small volumes that the entire excavated chemical product was consumed in analysis. Approximately 13% of the total unknown chemicals excavated from the CWL were completely consumed in analysis in this manner. Therefore, the number of containers disposed was less than the number excavated.

SNL/NM's RMWMF maintains the capability of treating the unknown chemicals that have a rad component at their facility. The majority of the mixed waste chemicals were treated at the

RMWMF with neutralization and/or solidification technologies, reducing the cost of disposal for SNL/NM.

Waste Minimization for Debris

The majority of the waste minimization for the debris excavated from the CWL was completed during the segregation process. Any debris that might have radiological contamination based on either field frisking or swipe sampling was set aside and managed as such. Once enough swipe sample results were taken, and the debris was determined by SNL/NM not to have radiological contamination, it was segregated into specific matrices. The debris set aside as hazardous waste and shredded and/or packaged for disposal. Metal that was too large to shred, along with project-generated metal, was sent to a RCRA-certified metal recycling facility. This saved money because SNL/NM was paid for the metal recycled.

By working with SNL/NM's RMWMF staff, management of the mixed waste debris excavated from the CWL was condensed into two different processes. The analytical data from the mixed waste soils was used to determine the chemical characteristics of the mixed waste debris. The mixed waste debris was sorted based on treatability groups. Two treatability groups were excavated from the CWL, organic-compactable and inorganic, non-compactable. The mixed waste organic-compactable debris was parceled and numbered. A random number generator determined which parcels were sampled for radiological analysis. Sampling included cutting samples of the debris material and packaging it for analysis. Prior to off-site analysis, the samples were sent to SNL/NM's RPSD laboratory for gamma spectroscopy. Following the gamma spectroscopy analysis, the debris samples were sent to an off-site laboratory for tritium, gross alpha, and gross beta analysis.

Paired swipe samples were taken from the mixed waste inorganic, non-compactable debris was swiped in 100 cm^3 increments, depending on the size of the metal. Both sets of samples were sent to the SNL/NM's RPSD laboratory. The first set of swipe samples were analyzed for gamma spectroscopy. The second set of swipe samples were analyzed for tritium, gross alpha, and gross beta.

Each secondary container in which the two debris matrices were packaged also underwent analysis with a portable gamma spectrometer. This analysis allowed the waste management facility, SNL/NM's RMWMF, to analyze the activity of the debris as a whole.

DISPOSAL PATHWAYS

Once the waste minimization techniques were applied, finding the appropriate pathways for disposal for mixed waste excavated from the CWL was relatively simple, in that all of the mixed waste soil and debris was disposed of at one facility. By having a facility that could treat the excavated unknown chemicals with radiological activity on-site, disposal costs were minimized. While working in tandem with the SNL/NM RMWMF team, checks and balances were created during the process of managing the mixed waste that ensured that appropriate characterization was performed for disposal. Since the SNL/NM RMWMF team provided input during the writing of the sampling and analysis plans for both the mixed waste soils and the mixed waste debris, guidelines and regulations imposed by the disposal facility were taken into consideration from outset of characterization.

CONCLUSION

The excavation of the CWL included many unknowns. With unknown waste streams, the process of characterization and disposal can be time consuming and difficult. By integrating various stakeholders at SNL/NM into the planning and implementation process, the system was simplified. Problems were identified on a real-time basis; therefore, easy to overcome. By implementing waste minimization techniques where possible, cost savings were realized. The teaming atmosphere greatly increased the success of realizing the goal of site closure of the CWL site.

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