Optimization of Waste Disposal - 13338

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ABSTRACT

From 2009 through 2011, remediation of areas of a former fuel cycle facility used for government contract work was conducted. Remediation efforts were focused on building demolition, underground pipeline removal, contaminated soil removal and removal of contaminated sediments from portions of an on-site stream.

Prior to conducting the remediation field effort, planning and preparation for remediation (including strategic planning for waste characterization and disposal) was conducted during the design phase. During the remediation field effort, waste characterization and disposal practices were continuously reviewed and refined to optimize waste disposal practices.

This paper discusses strategic planning for waste characterization and disposal that was employed in the design phase, and continuously reviewed and refined to optimize efficiency.

INTRODUCTION

From 2009 until 2011, remediation of areas of a former fuel cycle facility used for government contract work was conducted. The work consisted of remediation of several areas of radiologically-impacted soil, decontamination and demolition (D&D) of two impacted building structures (including the slab and underlying process piping and utilities), removal of over 5,000 meters of buried waste line piping and the removal of uranium-impacted sediments from portions of an approximately 1,200 meter long stream.

Radiological contaminants consisted primarily of high enriched uranium (HEU). Other radionuclides encountered in relatively minor amounts in certain areas of the clean-up included Co-60, Cs-137, Ra-226, Th-232 and low enriched uranium (LEU). Radiological remediation was conducted under regulatory authority of the Nuclear Regulatory Commission (NRC).

While chemical contamination was generally limited to a few small areas, these chemicals were co-located in some of the same areas that required radiological remediation. Chemical contaminants included lead, cadmium, mercury, and perchloroethylene (PCE). Materials regulated under the Toxic Substances Control Act (TSCA) that were encountered and remediated included asbestos containing materials (ACM) and materials contaminated with polychlorinated biphenyl's (PCBs). The State Department of Energy and Environmental Protection (DEEP) regulations as well as the Federal United States Environmental Protection Agency's (USEPA) regulations in the Code of Federal Regulations (40CFR) governed the remediation of the non-radiological contaminants.

The following presents a discussion of strategic planning for waste characterization and disposal that was employed in the design phase, and continuously reviewed and refined to optimize efficiency.

PLANNING AND PREPARATION

Prior to conducting the remediation field effort, planning and preparation for remediation including strategic planning for waste characterization and disposal was conducted during the design phase.

Because the site was under the jurisdiction of the NRC, conduct of radiological operations required special emphasis on control and accountability of Special Nuclear Material (SNM) and adherence to specific NRC security requirements. This required the construction of a facility to store and safeguard SNM materials prior to off-site disposal at a licensed facility. This facility, named the Controlled Access Area (CAA) (Photo 1), was built to meet NRC security requirements but consideration for waste storage, handling, processing, and transport also were incorporated into the design and construction for efficiency.

Photo 1. The Controlled Access Area (CAA).

Based upon previous site remediation work, it was expected that piping and tanks would contain chemical contaminants in addition to radioactive materials. A less than 90-day RCRA storage area (LT-90) was established within the CAA to temporarily store hazardous or mixed waste generated prior to off-site disposal at a licensed facility. Additionally, a separate process area for segregating potentially mixed waste sludge from the interior of pipes and tanks was established to limit the potential for contamination of the CAA surface and protect the workers from any truck traffic during waste shipping campaigns.

Prior to conducting specific work tasks, work plans were developed for the major project remediation task items including the following:

- Interior Tank Removal
- Building Demolition
- Sub-slab Pipe and Utility Line Removal
- Pipeline Excavations
- Landfill Excavations

Each of these work plans had unique aspects that required the incorporation of special controls and monitoring requirements due to the presence or potential presence of SNM and hazardous materials. While a Job Hazard Analysis (JHA) was developed for each specific job task, safety requirements were also incorporated into the plans. This action was taken to provide a more comprehensive understanding of how the work needed to be executed, including potential hold points that may occur when specific action levels were exceeded. The work plans also identified and incorporated decontamination techniques and waste characterization, handing and disposal practices that were focused on minimizing the amounts of contaminated waste generated, and preventing the spread of residual contamination to uncontaminated materials.

The data used for developing work plans came from four principal sources:

- Site Historical Information
- Radiological Characterization Data – both former and current
- Chemical Characterization Data – both former and current
- Geophysical Surveys of Areas

The Site Historical information as described in the Historical Review Report and Historical Site Assessment Reports provided information on where materials such as drums and radiologically and chemically contaminated soils might be discovered during removal activities. Where needed, additional characterization work was performed to verify historical information or to expand upon the existing data base of information prior to implementing work activities.

Historical radiological data was used principally to plan for the means of removing and containerizing the demolition debris or soils. Because of the presence of enriched uranium materials and the need for strict inventory controls, a gram quantity estimate was often needed prior to removal of any materials. The site had obtained acceptance from the NRC of the methodology of removing less than 40 Becquerel per gram (Bq/g) (1,080 picocuries per gram [pCi/g]) of U-235 contaminated debris and soils into shipping containers without the need for maintaining a gram inventory. The 40 Bq/g concentration limit is based upon the Department of Transportation (DOT) fissile exempt criteria and reduced the need for inventory control for almost all operations.

The historical chemical characterization data sources were similar to that of the radiological characterization data and provided a platform for planning work activities. Additional building surveys were performed to determine potential impacts of PCBs in paint and caulking material, to identify asbestos containing building materials, and to identify universal waste materials

A geophysical survey employing a high resolution metal detector and an electromagnetic profiler was performed in areas suspected of containing drums to identify potential buried drums. These surveys proved most useful in ruling out some suspect areas, and were successful in identifying two areas of previously unidentified drums.

OPTIMIZATION OF WASTE DISPOSAL EFFORTS

The most important steps in optimizing waste disposal efforts are to minimize the amount of contaminated material that requires disposal and to properly manage contaminated material prior to disposal. In addition to the preparation process for the work plans described above, planning the sequencing of work activities played an integral role in minimizing and effectively managing contaminated material for disposal. In the following sections several phases of the remediation work are discussed, and the methods used to optimize waste disposal efforts during each phase are presented.

Soil and Debris Removal – As part of the planning process for remediation of areas of the Site where contaminated soil was historically identified, pre-excavation characterization surveys were conducted to refine the limits of soil removal. The sample density from the historical data allowed for areas of impacted soil to be delineated, but left some question as to the contiguous nature of the contamination. To minimize the amount of soil to be remediated, additional characterization survey and sampling was conducted to refine the areas exceeding remediation goals and allow for a more surgical soil removal approach to be employed.

To conduct the pre-excavation characterization surveys, historical characterization data was first evaluated and the general area requiring remediation was marked in the field. A grid system was plotted and a systematic survey was conducted in soil areas by creating and surveying the areas in grids using sodium iodide detectors.

In addition to the surveys, soil samples were collected from each grid area where an elevated count rate greater than background was identified. Where there were multiple elevated readings, the highest readings were selected for sampling as well as those that bordered the area being scanned. Soil samples were analyzed for uranium and Co-60 in an on-site laboratory using gamma spectroscopy. Data from the pre-remediation characterization effort were plotted and evaluated. The evaluation refined areas requiring remediation, thus allowing for surgical soil removal and minimizing the volume of material for disposal.

Three main types of excavation approaches were conducted during the remediation:

- Removal of soils above known pipelines where the soils were expected to be “clean” (not suspected to contain radioactive materials above cleanup levels);
- Excavation of near surface radiologically contaminated soils; and
- Excavation of areas where drums and significant amounts of debris were present in burial areas.

The excavation activities in the burial areas (Photos 2 and 3) required the institution of special controls and surveillance. Excavation work in these areas was conducted using both traditional radiological survey meters and photoionization detectors (PIDs) to check for potential volatile organic compounds. Additionally, workers were trained to visually examine the exaction areas for signs of soil staining and instructed to be aware of any odors emanating from the excavation areas. Workers were instructed to halt work and evaluate the site conditions whenever significant soil staining or odors were encountered. This allowed for material that may have been impacted by co-located radiological and chemical contamination to be segregated, sampled for chemical constituents, and managed separately from other waste streams to minimize the quantity of hazardous or mixed waste generated.

One of the soil impacted areas at the Site was a former drum burial pit. The pit contained drum carcasses that contained unknown materials, debris, trash and ash. During excavation activities in this area, whenever a drum was encountered work was halted and the following sequence employed to ensure worker safety and allow for proper characterization and management of materials for disposal:

- A visual inspection of the drum was conducted to determine if there was bulging of the drum.
- If no bulging was identified, the area soils were scanned using both radiological survey meters and a PID. A visual scan of the area was also conducted to determine if any material may have been released from the drum.
- Before moving any drums, the drums were opened and the contents sampled to evaluate the radiological and chemical contents. Approval from the Safety Manager was then required prior to removal of the drum from its location of discovery. Special precautions were taken to secure and prevent spillage of liquids if any were present from the drum.
- Finally the area was marked using stakes and the location was recorded using GPS to allow for further sample collection from the underlying soils.

Photos 2 and 3. Excavation activities in the burial area.

Drums were segregated from soil excavated from the area and the contents where characterized to determine the proper disposal methods. Soil samples were also collected from the drum grave to determine if any radiological or chemical contamination was present in the soil that would require soil excavation and disposal.

Underground Pipe Removal - The project included the removal of over 3,000 linear meters of buried piping that was used to convey waste streams that contained both radiological and chemical compounds. Piping materials included concrete encased ductile iron, clay tile, and polyvinyl chloride (PVC). The piping also contained sludge that had accumulated at various locations within the piping. Due to the presence of both chemical and radiological materials in the historic waste streams, the possibility for generation of mixed waste during remediation was considered. In an effort to ensure worker safety, characterize piping materials and materials within the piping, and optimize the disposal of these waste streams, the following process was employed during buried piping and manhole removal:

- The area excavated around the pipe or manhole was examined for soil staining, cracks in the pipe, and evidence of leakage (visual and/or olfactory).
- Prior to opening the pipe for sampling, a PID and combustible gas meter reading were obtained from inside the pipe. If penetration into the pipe was needed for sampling, non-sparking tools were used to create a small sample port in the pipe.
- For piping suspected of containing significant quantities of uranium, once the piper was determined to be safe for segmentation radiological samples were collected approximately every twelve linear feet of pipe.
- Any water in the pipe (if present) was removed and stored in a temporary holding tank for analysis, treatment (if needed), and disposal.
- Visual inspection of the interior of the pipe was conducted to determine if water or elemental mercury was present. If no water was present a mercury vapor detector was used to evaluate the presence of mercury within the pipe.
- Piping materials that did not contain any sludge material and had a U-235 concentration less than 40 Bq/g were placed directly into a waste container. Piping materials that contained sludge or had a U-235 concentration greater than 40 Bq/g were moved into the CAA for optimization of waste disposal that included the following:
  - Removal and characterization of sludge
  - Mixing of pipe materials with sufficient low level radioactive soils or debris to reduce the overall shipping concentration to less than 40/Bq/g.

In addition to segregating the contaminated piping and its contents as described in the process above, additional segregation of piping components was conducted to reduce the amount of material requiring disposal as “mixed waste”. The collars used to seal the joints in the pipe were sampled and analyzed to determine whether or not they contained concentrations of lead that classified them as a “mixed waste”. In order to optimize waste disposal and minimize the disposal costs, the pipe collars were removed from pipe segments and segregated for disposal as a mixed waste. This allowed for the remainder of the pipe to be disposed of as either construction debris or radiologically contaminated waste based on radiological characterization sampling results. Photos 4 and 5 depict photos of pipe characterization activities.


Photos 4 and 5. Characterization of buried piping.

Removal of Interior Tanks – One of the tasks associated with this project included the characterization, removal, and disposal of four 20 cubic meter (m^3) and ten 7.5 m^3 contaminated storage tanks that were housed inside of a water treatment building. Characterization of the tanks identified that the tanks and contents were contaminated with both chemical and radiological contamination, and that the paint on the exterior of the tanks contained PCBs. During the planning process discussions with the disposal facility identified the most cost effective way of shipping the tanks was to ship them intact with no size reduction to optimize use of the shipping container. Negotiations with the waste disposal facility allowed the project to realize a reduction in the project cost by eliminating the size reduction labor and equipment costs.

Additional cost savings were realized by keeping the tanks intact since any size reduction activities conducted on the tanks would have required supplied air and special engineered ventilation to support worker safety during size reduction.

Prior to shipping the tanks, additional activities were conducted to optimize waste disposal efforts (Photos 6 and 7). These activities included removal and cleaning of debris and sludge from the interior of the tanks to prevent the entire tank and its contents from being disposed of as “mixed waste”. Removal and cleaning of the interior of the tanks was more easily controlled by maintaining the tank as a unit and simply removing the end cap to allow ease of access for cleaning and debris/sludge removal. Debris and sludge removed from the tank was characterized and disposed based on characterization sampling results. Removal and cleaning of debris and sludge from the interior of the tanks resulted in the tanks being disposed of as a radiologically impacted material but not a “mixed waste”.

Photos 6 and 7. Preparing tanks for shipment.

Concrete Materials – Another waste optimization technique employed included reducing to the extent practical the amount of radiologically impacted concrete that required disposal. The project requirements included the off-site disposal of all concrete materials encountered above four feet below ground surface, and off-site disposal of all radiologically impacted concrete regardless of the depth. In an effort to control project costs, minimizing the amount of concrete disposed of as radiologically impacted waste was identified as having a high potential for cost savings.

To optimize the disposal of concrete waste streams, concrete materials were fully characterized to identify the location, level of contamination, and depth of penetration of contamination into the concrete surface. Horizontal and vertical concrete building surfaces, as well as the concrete piping and manholes were characterized. Based on the characterization data an evaluation was conducted to determine if decontamination of the concrete was practical and cost effective. Where characterization data showed that contamination was localized or limited in depth of penetration, decontamination techniques such as scabbling or surgical removal were employed to minimize the amount of material requiring disposal as radiologically impacted.

In one of the building structures removed during the project, 9,300 square meters of building floor slab was characterized and only 30-percent of the surface area was radiologically impacted. Decontamination of the radiologically impacted areas via concrete shot-blasting and scabbling resulted in less than 30 cubic meters of concrete requiring disposal as radiologically impacted material. The remainder was disposed of as construction debris at a much lower cost.

During removal of the 33 manhole structures associated with over 350 linear meters of piping associated with the project, concrete characterization efforts resulted in only the manhole inverts being disposed of as radiologically impacted waste and resulted in an estimated 550 cubic meters of concrete from the manholes being disposed of as construction debris at a much lower cost.

Intentional Mixing - Intentionally mixing waste was proposed in order to meet waste acceptance criteria at off-Site radiological disposal facilities and optimize the waste disposal process for the project. The disposal facility waste acceptance criteria for enriched uranium (>10%) has an upper limit of 44 Bq/g (1,190 pCi/g) of U-235. The NRC has indicated that this is an acceptable practice as described in Commission Paper SECY-04-0035, "Result of the License Termination Rule Analysis of the Use of Intentional Mixing of Contaminated Soil" (NRC, 2004). This process used at the Site followed the guidance provided by the NRC in NUREG-1757 Volume 1 Revision 2, Section 15.13 (NRC, 2006). As defined in 10 CFR 61.55 "Waste Classification for Near Surface Disposal, since uranium is not listed in Table 1 or 2 of 10 CFR 61.55, it is classified as "Class A" waste. In addition, the waste classification for uranium does not change with enrichment, so depleted, natural or enriched uranium are all Class A waste. Therefore intentional mixing of uranium wastes did not change waste classification since it will always be Class A waste.

Intentional mixing of waste was anticipated for the following scenarios during waste management and disposal for this project: mixing soil or soil-like materials, mixing soil or soil-like materials containing small debris, or mixing large debris with soil or soil-like materials. The waste streams were not homogenous with respect to uranium concentrations and the intent of intentional mixing was not to achieve homogeneity. Intentional mixing was conducted to the level necessary in order to meet the waste acceptance criteria (WAC) for off-site disposal. Intentional mixing of soil or soil-like material was conducted using the simplest approach possible. In this regard, material that was intentionally mixed was not significantly different than other wastes generated during decommissioning operations at the Site.

Intentional mixing of waste with residual SNM was an effective solution to ensure that waste materials met WAC for off-site disposal and reduced potential schedule delays during decommissioning activities at the Site.

Building Structures and Systems – As part of the project several building structures and associated systems (e.g., heating, ventilation, and air conditioning [HVAC] systems) that were potentially impacted by radiological materials from past operations with radioactive materials were demolished. Prior to demolition characterization surveys and sampling was conducted on building surfaces and systems. The results of the characterization work showed that, in most cases, contamination was fixed on walls, steel beams, and concrete but in isolated locations within the buildings.

In areas where fixed contamination was identified, volumetric sampling was then conducted for waste characterization and quantification. In contaminated sections of the buildings a fixative was applied to the contaminated surfaces and then controlled demolition was conducted. The controlled demolition included sizing of building materials and systems for efficient packaging into waste containers for disposal. More heavily contaminated building structures and systems (HVAC systems and piping) were grouped into batches for quantification and loading into intermodals.

CONCLUSIONS

This project employed several techniques to optimize waste disposal practices associated with remediation of areas of a former fuel cycle facility. Strategic upfront project planning allowed for numerous types of waste streams (soil, piping, tanks, building materials, concrete, and sludge) to be identified, and provided several opportunities for waste disposal optimization techniques to be employed.

Optimization strategies were focused on characterizing contamination prior to conducting activities that generated waste for disposal so that an understanding of the levels of contamination and the make-up of the waste streams could be considered in identifying and implementing waste disposal optimization practices. Waste disposal optimization practices that proved to be cost-effective and efficient, and were utilized during the project included:

- Surgical soil removal;
- Segregation of different types of waste streams;
- Proper management and handing of waste streams;
- Effective characterization of waste streams;
- Utilizing decontamination methods when applicable and cost effective;
- Sizing of material prior to disposal when applicable and cost effective; and
- Understanding and utilizing practices allowable under regulations to manage waste streams.

REFERENCES

NRC, 2004. NUREG-1757, Volume 1 Revision 2,"Consolidated Decommissioning Guidance, Decommissioning Process for Materials Licensees". U.S. Nuclear Regulatory Commission March 2004.

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