

A NON-TRADITIONAL APPROACH TO SITE RELEASE AVOIDS SIGNIFICANT OFFSITE DISPOSAL COSTS

Barry Koh, President, and Theodore G. Adams
Vice President
B. Koh & Associates, Inc.

ABSTRACT

By using a non-traditional approach to site release the authors helped their client avoid millions of dollars of offsite disposal cost. The keys to success were a thorough characterization of the site, a unique plan for onsite disposal, and a public acceptance program that enlisted the support of the local community. A trash filled, contaminated landfill, located in a residential neighborhood, was converted to a community park. In the process, 40,000 cubic yards of uranium contaminated soils were safely entombed on the site.

INTRODUCTION

An estimated cost reduction of at least \$10 million was realized through a non-traditional approach to the remediation in Newburgh Heights, Ohio, when the NRC finally released the Bert Avenue site for unrestricted use, after nearly two decades of efforts to cleanup depleted uranium contamination. B. Koh & Associates, Inc. achieved this significant cost reduction, by avoiding the major expense of most radioactive remedial projects – offsite disposal.

The traditional approach to site release involves excavating contaminated soils until all that exceed the release criteria have been removed and sent to an offsite licensed radioactive waste disposal facility. This approach may be the traditional one, but, in our view, not necessarily the best for sites contaminated with naturally occurring radioactive materials. First and foremost, the cost of offsite disposal is so high that every effort has to be made to avoid it. Second, some of the naturally occurring isotopes can be difficult to detect in the field, especially when the contaminant is heterogeneously distributed in the waste matrix. Third, most schemes for segregating the contaminated materials are usually too difficult, too costly, and don't yield the desired result.

Faced with this very issue at the Bert Avenue remediation site: how to be sure we achieved the cleanup standard without the enormous cost of offsite disposal, we chose a different approach. Our approach requires neither careful material segregation nor offsite disposal. Instead, we constructed an onsite cell into which we disposed of 40,000 cubic yards of contaminated and potentially contaminated soil. To complete the remediation, we disposed of, offsite, another 555 cubic yards of the most highly contaminated soil. Nevertheless, we conservatively estimate the cost savings to our client were \$10,000,000.

The Bert Avenue Site is a partially filled ravine that for many years was used as an unregulated industrial solid waste landfill. It is located adjacent to a residential neighborhood of about 45 homes, some of which abut the southern boundary of the landfill. The landfill was contaminated when a nearby inorganic chemicals company inadvertently disposed of waste from a catalyst

manufacturing process involving depleted uranium (DU). Three prior attempts to decontaminate the site and release it for unrestricted use had failed. Each one was based on detecting the contamination with field instruments, then excavating the contaminated soil for offsite disposal. Unfortunately, subsequent verification surveys by the NRC revealed that extensive contamination remained.

When B. Koh & Associates, Inc., was called to develop a remediation plan for the site, our client challenged us to answer two questions. How would we avoid the earlier failures to meet the cleanup standards that had plagued our predecessors, and how much would the remediation cost? It was in answer to these questions that we developed the non-traditional approach to site release that will be described in the remainder of this paper.

THE CHALLENGE

We were first called to the Bert Avenue site when the third attempt to achieve the cleanup standards failed. A contractor, who had originally estimated that only 100 cubic yards of soil would require offsite disposal, had staged 1800 cubic yards for disposal and was unable to estimate how much more needed to be excavated. At the same time, the client's bankruptcy reorganization was stymied until a credible remediation plan and cost estimate could be developed. With this in mind, we looked for a concept that would meet the client's short run need for the bankruptcy reorganization to go forward, and his long-term need to complete the remediation at a reasonable cost.

Since the site had been under remediation for about 12 years, data had already been collected which gave some insight into the nature of the contamination. The NRC, ORISE, and the previous contractors had conducted several investigations. They showed the depleted uranium contamination to be widespread, but most heavily concentrated on the steep slope along the southern edge of the ravine. The most meaningful data was the DU concentration obtained by analyzing soil samples by gamma spectroscopy. On the other hand, the reported surface radiation readings were particularly unreliable because DU is a relatively weak beta/gamma emitter, difficult to detect and easily shielded by a thin layer of soil. We decided that to develop a remediation estimate quickly, we had no choice but to assume all of the potentially impacted soils were contaminated above the guideline value for site release. We had to imagine that we would excavate almost the entire landfill for offsite disposal.

With this approach, we satisfied the client's objective of a firm estimate for the remediation, but unfortunately at a cost that was way out of line with his expectations, i.e., offsite disposal costs of tens of millions of dollars. We felt strongly, however, that by treating the entire site as contaminated, we could avoid the earlier failures brought on by guiding discrete excavations with hand-held instruments. Therefore, we needed a way to minimize the disposal costs. We went back to the site radiation data and were impressed by the fact that only a few of the soil samples were highly contaminated. If we could confirm that the overall contaminant concentration of the site was low, we could make a case for leaving the material at the Bert Avenue site, i.e. **onsite disposal**. We estimated that the cost for a thorough characterization of the site, filling the ravine with clean material, and capping it would be \$7.5 million. With this preliminary concept and cost estimate in hand, our client was able to complete its bankruptcy reorganization and start the final remediation of the Bert Avenue site.

INITIAL SITE CHARACTERIZATION

It was clear that we would have to provide a rigorous “pathways” analysis that showed there would be no radiological dose consequences to the public or the environment **before** we could formally propose onsite disposal of the contaminated soils. As we said earlier, there was data from the previous activities but it did not form a coherent picture of the site. Therefore, we needed to thoroughly characterize the nature and extent of the contamination, as well as the environmental setting of the site.

From the previous site investigations, we were reasonably certain that contaminated materials had been placed in the landfill at one or two locations and then spread throughout the site by subsequent operations. To locate the original disposal, we developed a program to systematically sample the landfill by advancing borings from the surface to the underlying natural material. A 20-meter by 20-meter grid pattern was selected for the initial investigation and soil samples were recovered every 2 feet as the borings were advanced. In all, there were 68 borings: the average depth was 21 feet and the maximum depth was 42 feet. Approximately 600 samples were collected and variously analyzed for uranium, thorium, radium, and chemical pollutants.

To assess the impact of the site contamination on the surrounding environment, surface water, ground water, air and vegetation samples were analyzed for radioactive and chemical contaminants. Also, air monitors and thermoluminescent dosimeters were placed at the site boundaries to determine if there was any radiation associated with the onsite contamination. No DU was detected in the air samples or vegetative samples, and radiation levels at the boundaries were consistent with the local background. The surface water and ground water samples were positive for DU but at levels substantially below NRC discharge limits.

The results of the soil sample analyses yielded much of what we had hoped for. They confirmed that while the contamination was widespread, much of it was at low concentration. As shown in Figure 1, the DU concentration in 80 percent of the samples was below the NRC guideline value for free release: 35 picocuries per gram. Notwithstanding the generally low concentration of DU, we did discover two “hot spots” on the site. The highest concentration of DU detected in the subsurface soil samples was almost 10,000 picocuries per gram. It was located more than 20 feet below the surface of the steep southern edge of the site. The surrounding samples were also found to be high in DU, indicating that this was the location of the initial disposal. The other hot spot was what appeared to be a much shallower disposal located along the western edge of the site.

The arithmetic average of all the soil samples, including those that had been reported by the previous investigators, and using all the “non-detect” results at the minimum detection concentration, was 207 picocuries per gram. This result was extremely important in that it confirmed that onsite disposal was probably a suitable remediation option for the Bert Avenue site. We based our optimism on the guidelines contained in SECY 81-576, the NRC *Branch Technical Position for the Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations*. This 1981 document, permits onsite disposal of DU provided the maximum average concentration of the DU is less than 300 picocuries per gram for insoluble material or less than 100 picocuries per gram for soluble DU. Referring to Figure 1, we observed that less than 7

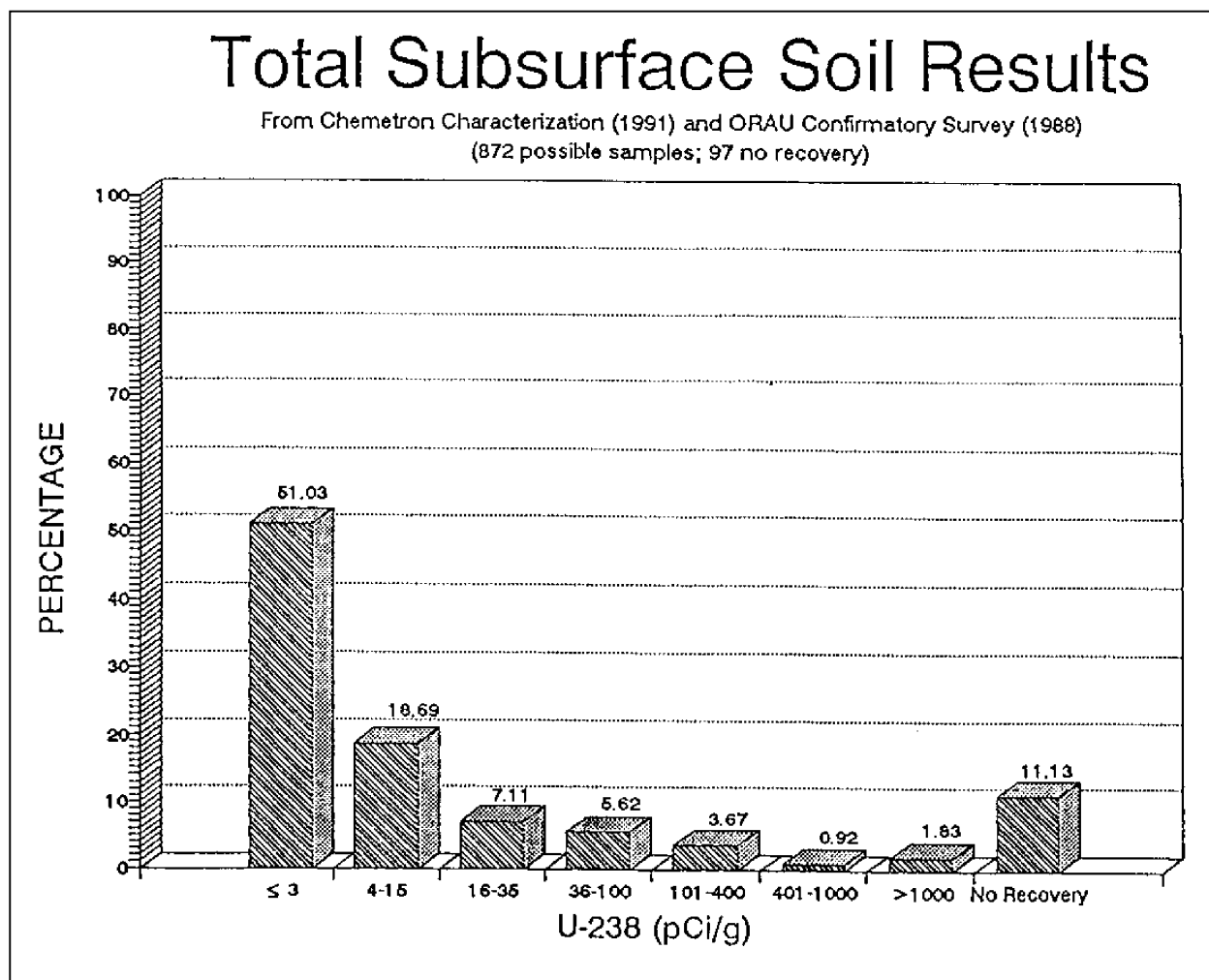


Figure 1

percent of the samples exceeded 100 picocuries per gram. Furthermore, the average concentration of all the samples was well below the upper guideline.

THE PRELIMINARY REMEDIATION PLAN

Based on these favorable results, we started to plan for onsite disposal. Three issues, crucial to the success of onsite disposal, had to be addressed immediately. First, could we accommodate all of the contaminated material onsite in a safe and stable configuration? Second, were the radiological dose consequences to the public and the environment acceptable, and third, would the residents of the area accept this type of remediation?

Using a variety of plotting and evaluation techniques, we estimated that the volume of contaminated material, whose DU concentration was potentially greater than 19 picocuries per gram, was 41,500 cubic yards. Undoubtedly, a substantial amount of this material had a

concentration less than the free release limit. Why then would we choose to dispose of it onsite? The answer lies in our overriding concern to avoid another failed remediation. During the characterization we learned that the contamination was dispersed unevenly throughout the site. As mentioned before, we had no faith in our ability to efficiently segregate the contamination, and so, we had no choice but to deal with almost all the fill material in the ravine as contaminated.

Dames and Moore, our engineering subcontractor, designed an onsite closure cell that accommodated all of the waste material. The base, sides and cover consisted of compacted clay, impervious to infiltrating surface and ground water. After placing the waste in the cell, there was still sufficient room above the closure to allow for an additional 16 feet of clean fill material to complete the ravine. The result would be a field, level with the surrounding property, completely free of contamination.

To evaluate the potential radiological dose consequences of the onsite disposal, the RESRAD computer code was used to model an exposure scenario. Using the characteristics of the site, the code calculated that 5,490 years after closure, the maximally exposed individual would receive a radiation dose of 2.9 millirem per year. We now were confident that we could design and construct an onsite cell into which we could dispose of all of the contaminated material in the ravine but our preliminary efforts highlighted some areas that needed further investigation. More site-specific information was needed to support the dose evaluation and additional samples were required to determine the extent of the contamination at the hot spots. However, the most immediate need was to explain our plan to the local community and demonstrate to them why it was the best alternative.

PUBLIC ACCEPTANCE

While the NRC Branch Technical Position clearly allowed the onsite disposal contemplated by our plan, we believed that NRC approval depended on acceptance by the local community. Contrary to what is usually said about “things nuclear,” we were not alarmed by the prospect of having to face the public with our plan. Our public acceptance program had started long before we published the preliminary remediation plan. From the earliest days of our involvement at the site, we met regularly with local elected officials to bring them into the remediation process. Many of the meetings were informal, involving the village Mayor and key members of the village Council. At each meeting we stressed our willingness to conceive of a remediation that was acceptable to the residents, within the bounds of what was practical and economically achievable. Two public meetings were held: one prior to our site characterization, and one when we published the preliminary remediation plan. NRC, OHIO EPA, OHIO Department of Health and elected representatives all participated in these forums.

By the time the preliminary plan was made public, we had developed a clear, forceful argument in favor of onsite disposal. The message was: We had considered many remediation alternatives and for the following reasons onsite disposal was truly the best solution for the Bert Avenue site:

- Our plan called for transforming a swampy, trash-strewn ravine into a grass-covered field, suitable for community use. Simply removing the contaminated material would leave the ravine as is, inviting further dumping.

- Under the traditional approach, only the more highly contaminated waste would be removed from the site. The public would still be exposed to a great deal of low concentration waste that remained distributed throughout the site.
- Also, by treating the entire fill area as contaminated, we eliminated the chance of “missing” contaminated materials. Any removal action depends on a statistical sampling to confirm that guidelines are met. This does not guarantee that at some future time someone won’t encounter contamination on the site, exceeding the guideline value.
- The contaminated material would be isolated from the environment by the clay closure cell, and from the public by 16 feet of clean fill. To the local residents, it would be as if the contamination never existed.

We were gratified that the local residents were persuaded by these reasons and were willing to allow us to go to the next phase. Of course, they were also skeptical; having witnessed three earlier attempts to remediate the Bert Avenue site. While we were encouraged by the response of the local residents, we got our first inkling that the OEPA was concerned that our plan was incompatible with Ohio landfill regulations. This concern will be discussed later in the paper as it grew to be a major obstacle to implementing our plan for onsite disposal.

FINAL SITE CHARACTERIZATION

Two major issues remained after the initial site characterization and the preliminary remediation plan. The first was a need to define the groundwater regime and investigate whether the DU waste impacted it. We had assumed that since there was no local groundwater usage, there would be little interest in its quality. This was not the case as both the NRC and OEPA questioned the long-term effects of onsite disposal on groundwater. The second issue was to determine the full extent of the hot spots. This was a particular concern for the hot spot discovered deep in the south slope fill. One sample removed from this location had a DU concentration in excess of 9,000 picocuries per gram, and several surrounding samples were also highly contaminated. If this hot spot was too large, it could undermine the plan for onsite disposal.

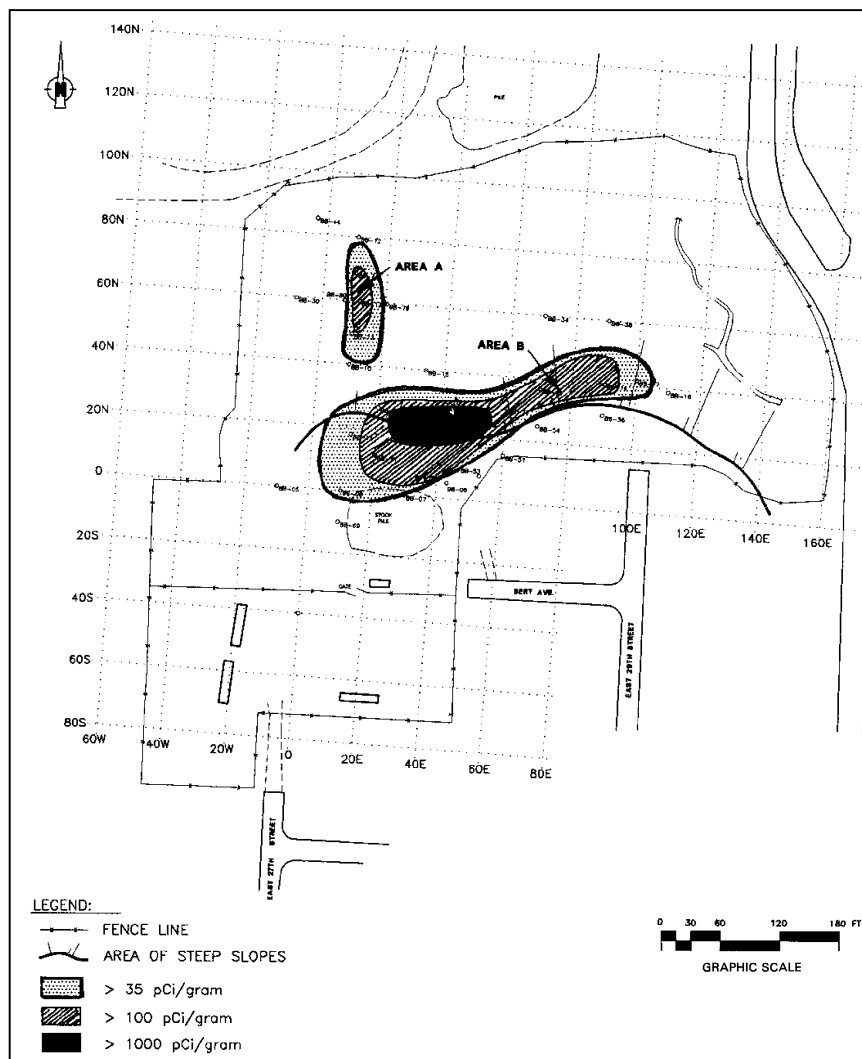


Fig. 2.

To define the geology and groundwater regime at the site, nine wells, seven well points, and four deep borings were installed. In addition, two undisturbed clay samples were removed for further testing and analysis. Subsurface soil samples were obtained at sixteen additional locations that were selected to further define the previously discovered hot spots.

The results of our investigation indicated that the site hydrogeology was well suited to onsite disposal. A confining layer of clay, at least 75 feet thick, underlies the site and groundwater discharges as seeps to the low-lying area of the site. Samples of the groundwater from the installed wells and the seeps were taken periodically, over several months. In all cases, the concentrations of radioisotopes were below the USEPA proposed drinking water standards. From these results, we concluded that there was little chance of uranium contamination of the groundwater, even with no remedial action at the site.

The subsurface soil samples from the vicinity of the hot spots revealed the true nature and extent of the contamination at the locations identified as A and B on Figure 2. The contamination at location A was fairly shallow and no sample exceeded 300 picocuries per gram. The waste at location B was discovered near the base of the steep fill area and was covered by 10 to 22 feet of less contaminated material. Within location B, three adjacent borings contained samples that ranged from 670 picocuries per gram to over 9,000 picocuries per gram. This was apparently where the waste was originally deposited.

At this point, we felt we were ready to move to the final site remediation plan.

THE SITE REMEDIATION PLAN

With regard to onsite waste disposal, NRC regulations concern mainly radiological safety. Hence, the main sections of the site remediation plan are: the guideline values for contaminant concentrations and surface contamination, the radiological controls during remediation, the post

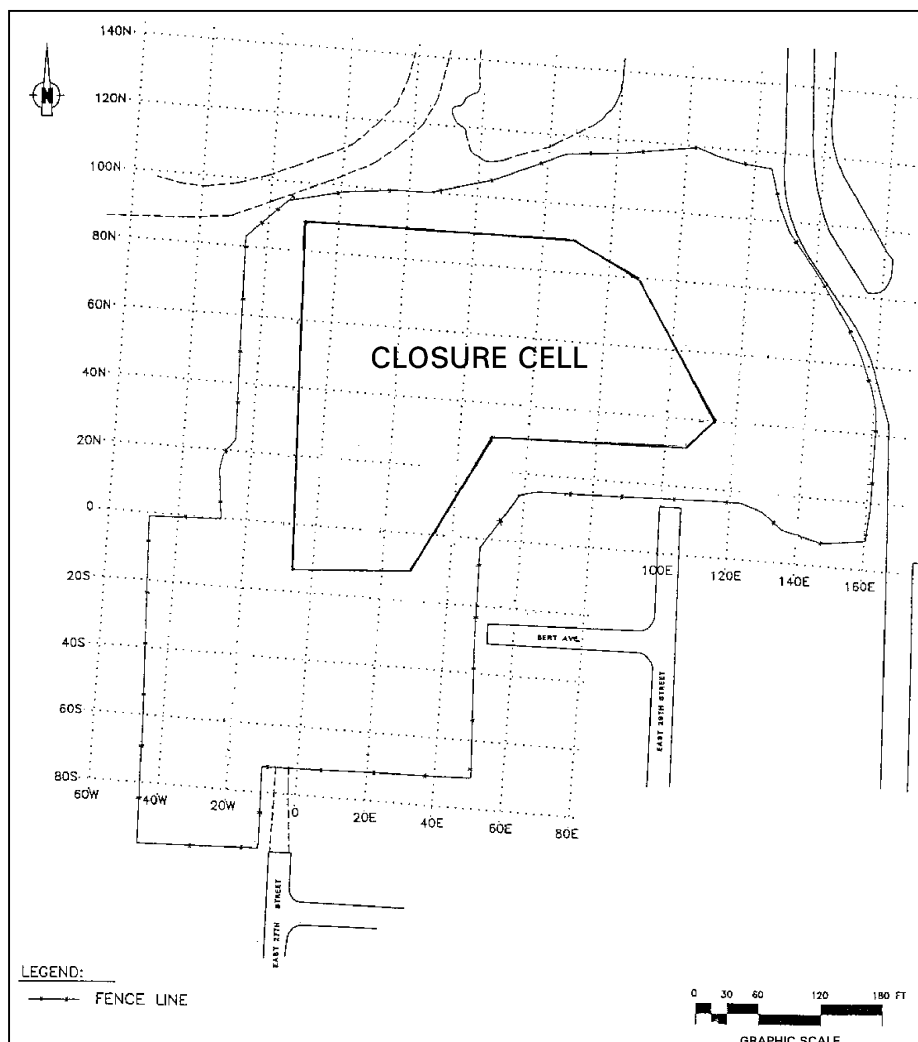


Figure 3

closure dose to the public, and the in-process and final verification surveys. Only two NRC design requirements must be satisfied: the waste is to be 10 feet above the groundwater, and there is to be at least 4 feet of clean material over the waste. B. Koh & Associates was responsible for the radiological safety portion of the plan and Dames & Moore did the detailed closure cell design.

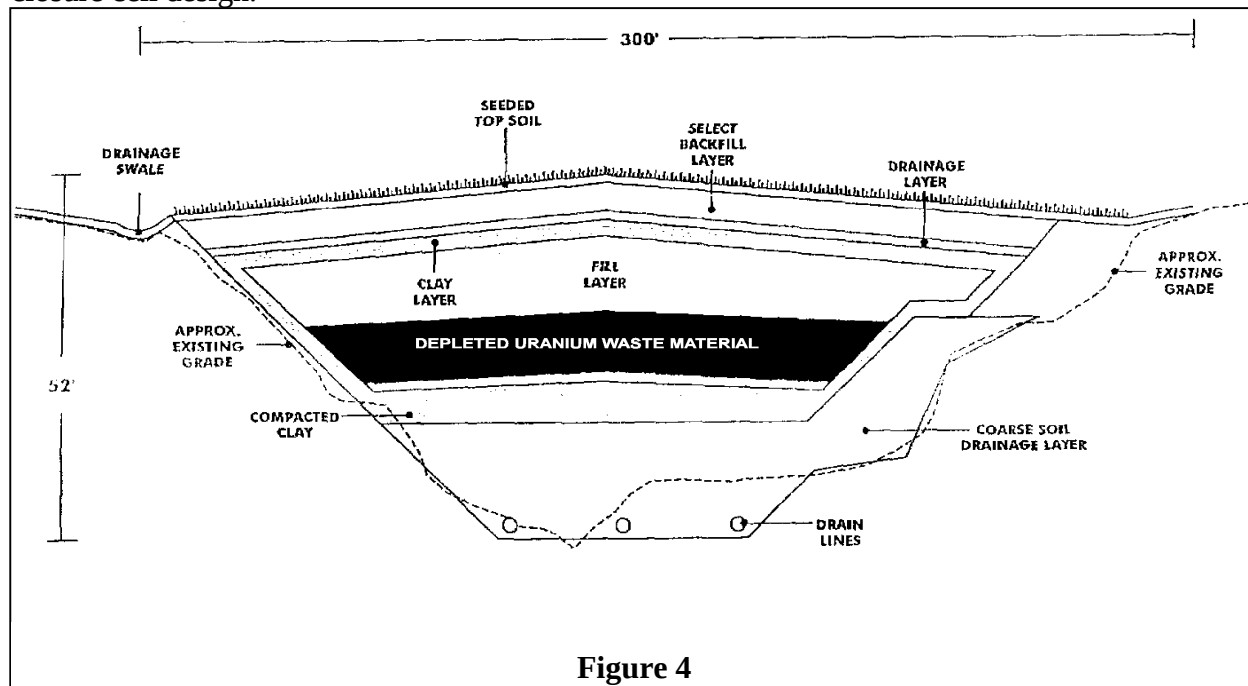


Figure 4

In order for the waste to be 10 feet above the groundwater, it would be necessary to first place 10 feet of coarse material at the bottom of the ravine. This was referred to as the ground water conveyance layer in that it elevated the waste and carried the groundwater under to cell to a drain system at the northeast corner of the site. After the waste was placed in the cell, it was covered with an impermeable system of plastic and clay, and the remainder of the ravine completed with select backfill. A plan view and cross-section of the closure cell design can be found in Figures 3 and 4.

Establishing the DU concentration guideline for onsite disposal turned out to be more complicated than originally imagined. We believed that DU and the catalyst, in which it was used, were insoluble and hence, the concentration limit of 300 picocuries per gram was applicable. The NRC countered that the catalyst manufacturing facility had converted uranium hexafluoride into uranium oxide and some of the intermediate products are soluble. Complicating the resolution of this dispute was that the NRC had not established a test or criteria to assess the solubility. Eventually, the NRC asked us to run a simulated lung fluid solubility test. This test is ordinarily applied at fuel cycle facilities for airborne contamination by fuel material. The test results indicated partial solubility in lung fluid. Using a NRC prescription, we calculated that the acceptable guideline concentration for onsite disposal was 161 picocuries per gram. Having established a concentration criterion for onsite disposal, we reviewed the results of the subsurface soil analysis and concluded that 15,000 cubic feet of waste from the hot spot at location B would have to be disposed offsite.

Once again, the RESRAD computer code was used to calculate the dose resulting from onsite disposal, except now, the simplifying assumptions used in the preliminary plan were eliminated. The NRC asked that the analysis be run for the resident farmer scenario, including use of onsite wells. In addition, a number of runs were done to simulate special conditions. For example, a case was run that considered the closure cell flooded with groundwater. Also, we analyzed the dose consequence if all of the cover was gone and the waste was exposed. Under all conditions, the dose to the public was within the range accepted by the NRC.

The in-process and final radiological surveys were also the subject of considerable discussion between the NRC and us. At the time we presented our remediation plan, the NRC had no protocol for determining compliance with guideline concentration values in large volumes of material. The existing guidance was based on soil contamination that was confined to the surface, but our waste layer was to be about 13½ feet thick. In proposing a survey plan, we were constrained by several factors. We wanted some sort of in-process control that would also serve as a final release survey. We also were concerned that too many samples would slow the construction of the cell. Finally, we wanted to minimize the amount of waste that went offsite. Since we had results from about one thousand surface and subsurface characterization samples, we used statistics to predict the results of various in-process sampling strategies. These models were presented to the NRC and eventually a protocol for in-process surveys was developed for the site. Other final surveys were identified in the remediation plan, including: release of the cell base and side walls prior to construction, post-closure release of the cell and site property, release of the site boundary, and release of adjacent properties.

Because the site was also an Ohio landfill, the NRC had included the OEPA and ODH in the review of the remediation plan. As the review progressed, it became clear that the OEPA was concerned with the compatibility of onsite disposal and Ohio solid waste landfill regulations. Initially, the OEPA viewed onsite disposal as creating a new landfill, which would require a Permit to Install (PTI). The PTI process is long and complicated. Furthermore, it has specific siting criteria that could not be fulfilled at the Bert Avenue site. As long as the OEPA required a PTI for onsite disposal, we were at a standstill. It was at this point that we called on the reservoir of trust we had built with the local community. We had been successful in gaining the resident's acceptance of our remediation plan and we asked for their support in dealings with the OEPA. The agency agreed to reconsider its position and concluded that we could approach onsite disposal as the closure of a previously unregulated landfill. In that case, we would have to comply with regulations governing excavation and ultimate closure of a landfill. While these rules presented many of their own hurdles, there were none that could not be overcome through design.

THE FINAL APPROVALS

Once the OEPA established its criteria, we were faced with two separate approval actions. The NRC remediation plan was primarily concerned with radiological safety, and the OEPA closure plan focused on the design and construction details of the closure cell. Dames & Moore had to rework the original design to make it compatible with Ohio landfill closure requirements. Specifications and drawings were prepared to describe the details of the cell construction and were submitted to the OEPA for review and approval. As a result of this review, a number of significant changes had to be made to the original design, delaying the remediation. The OEPA

was particularly concerned with demonstrating the permeability of the clay liner, the stability of the south slope of the ravine during excavation, the long-term stability of the east slope of the waste cell, and post-closure groundwater monitoring. In response, we agreed that we would construct clay test pads prior to placing clay. The permeability of these pads turned out to be a major issue during the cell construction. Also, the OEPA had an extremely conservative point-of-view regarding slope stability, and Dames & Moore submitted several excavation plans before reaching agreement with the regulators. At one point, we had to return to the site and extract soil samples to confirm the material properties that were used in the stability analysis. The requirement for post-closure groundwater monitoring was, of course, unique to the Ohio regulations since the NRC concept of "free release," assumes the site can be used without any further oversight. With our client's permission, we reluctantly agreed to install a network of monitoring wells for post-closure sampling, and final approval of the site closure plan was granted by the OEPA.

We still needed NRC approval of our site remediation plan before we could start onsite work. This action was delayed as we tried to reach agreement on the sampling protocol for demonstrating compliance with the concentration guidelines. Eventually, we reached a compromise with the NRC and a license amendment approving the remediation plan was issued. After six and one-half years we had all the regulatory approvals needed to implement onsite disposal at the Bert Avenue site.

CELL CONSTRUCTION

Construction of the closure cell and completion of the landfill extended over two construction seasons. Only one major delay was encountered. It occurred when the OEPA rejected the results of the clay permeability test. Considerable review and reanalysis of the data failed to establish the suitability of the clay and we were compelled to construct a second and third test pad. Unfortunately, the decision to construct the third pad was made just as winter was setting in, so we had to postpone the test until the next season.

Other unique and interesting challenges confronted us as we tried to comply with regulations from two separate agencies: the NRC and the OEPA. How we addressed these issues will be the subject of a separate paper. However, one point should be made in the context of our present discussion. We devoted almost two years and \$1.5 million to characterize the Bert Avenue site. The length and cost of this approach begs the question as to whether it was necessary. Some of our answer will be found in the conclusion but in the context of the cell construction, the response is a resounding "yes." Our greatest fear was that the radiological conditions of the site might be different from what we predicted, which could have one of two unfortunate outcomes. Either we would be forced to dispose of much more material offsite and negate the cost savings envisioned for onsite disposal or, we would find the contamination so low that a closure cell was unnecessary. Neither happened. The amount, concentration and location of the contaminated materials were as we expected. Per the remediation plan, 15,000 cubic feet of material, with DU concentration greater than 161 picocuries per gram, were shipped offsite. An additional 400 cubic feet of miscellaneous contaminated material encountered during the excavation were disposed of offsite at the conclusion of the project.

CONCLUSION

On November 5, 1998, the NRC released the Bert Avenue site for unrestricted use. The local community is looking forward to using the land as a recreation area in the spring of 1999. Clearly, onsite disposal has met the needs of our client, the host community and the regulators. Millions of dollars of disposal costs were avoided by taking a non-traditional approach to site release. By foregoing the traditional approach of guiding excavation with field instruments, we were able to construct a structured remedial program. We went step by step from concept, to characterization, to remedial plan, and finally, to site cleanup. At each step, we reinforced the three principles on which the program rested: safety, public acceptance and economy

We demonstrated safety in the following manner:

- Extensive site characterization to gain a thorough understanding of the nature and extent of the contamination,
- Geostatistical and radiological analyses proving that onsite disposal would be within regulatory limits and protective of human health, and
- State authorized and industry accepted landfill closure design.

We achieved public acceptance by:

- Candidly explaining our plans,
- Respecting the community's needs,
- Relying on the community's common sense when explaining remedial options, and
- Encouraging participation by local political leadership.

The economy is evident in that we avoided offsite disposal of 30,000 cubic yards of contaminated material. Furthermore, we were able to predict remedial costs almost from the outset, enabling the client to more carefully control expenditures.