INNOVATIVE REGULATORY AND TECHNICAL APPROACHES FOR THE U.S. ARMY CORPS OF ENGINEERS' LINDE FUSRAP SITE REMEDIATION

J. T. Pitts, P. W. Coutts, J. Franz, IT Corporation
J. D. Boyle, U.S. Army Corps of Engineers
175 East Park Drive, Bldg. 31, Tonawanda, NY 14150

Ben C. Rogers, CHMM

ABSTRACT

The U.S. Department of Energy (USDOE) created the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1974 to identify, investigate, and cleanup or control radiological contamination at sites used by the Manhattan Engineer District (MED) and the Atomic Energy Commission (AEC) from the 1940s through the 1960s. The USDOE had identified 46 sites in the program and finished remediation at 24 of the smaller ones before the end of 1997. With the passage of the Energy and Water Resources Appropriation Act of 1998 the United States Army Corps of Engineers (USACE) was designated by Congress with responsibility to manage and execute the FUSRAP. The Linde Site located in Tonawanda, New York was operated by the MED from 1942-1946 to extract uranium from several high-grade ores. This natural uranium was subsequently enriched in U-235 elsewhere in the United States and ultimately used to produce energy or weapons. Though in the process of reviewing alternative disposal options by 1995, the USDOE had operated FUSRAP with a strategy requiring virtually all materials remediated be disposed of at only one Nuclear Regulatory Commission licensed facility. The change in management of the FUSRAP in 1997 allowed the disposal policy of low levels of radioactively contaminated materials found at the remaining sites to be reexamined. This paper presents some of the innovative regulatory and technical approaches employed at the Linde Site that are resulting in project cost savings while meeting applicable or relevant and appropriate requirements as well as fulfilling commitments made to the local community:

Characterization of Site Materials - The Linde FUSRAP site was characterized according to its physical, chemical, radiological, and legal parameters through development of a Preliminary Material Characterization Report (PMCR), an approach that was unique in the USACE-Buffalo District FUSRAP Program.

Request for Proposal (RFP) to Obtain "Best Value" - Requests for Proposals were developed for both destination handling facilities (DHFs) and transportation companies in order to obtain "best value" for USACE FUSRAP funding. Technical and pricing criteria were established, applied, and evaluated to determine the best value disposal/recycling and transportation services proposals.

Transportation of Linde Site Material - An innovative U.S. Department of Transportation (USDOT) classification approach was applied to the portion of materials shipped for uranium recovery, based upon viewing the Linde Site remediation project more as a "mining" operation than a waste-generating endeavor.

Excavation Contact Wastewater Disposal - Management of excavation contact wastewater posed a challenge when it was found to exceed both the water discharge permit levels for halogenated volatile organic compounds (VOC) and New York State Department of Environmental Conservation (NYSDEC) "action levels" for listed hazardous wastes.

Cost Savings/Conclusions - The conclusions summarize how the foregoing innovative approaches to regulatory and technical matters realized cost savings for the project, while being protective of human health and the environment, complying with Federal and State requirements, and meeting commitments to the community.

INTRODUCTION

The USDOE created the FUSRAP to identify, investigate, and cleanup or control radiological contamination at sites used by two of USDOE's predecessor agencies, the MED and the Atomic Energy Commission (AEC), from the 1940s through the 1960s. The contaminants are relatively low levels of uranium, thorium, radium, and their associated decay products. The USDOE had identified 46 sites in the program and finished remediation at 24 of the smallest ones between 1974 and 1997. Remedial action is currently planned, underway, closed out, or pending final closeout at the remaining 22 mostly larger sites (1).

With the passage of the Energy and Water Resources Appropriation Act of 1998, Public Law 105-62, beginning on the 13th of October 1997, the USACE was designated by Congress with responsibility to manage and execute the FUSRAP (2). Though in the process of reviewing alternative disposal options by 1995, the USDOE had operated the FUSRAP with a strategy requiring virtually all materials remediated be disposed of at only one Nuclear Regulatory Commission (NRC) licensed facility in the western United States. This change in management allowed a policy that tolerated more flexibility in the disposal of low levels of radioactively contaminated materials found at the remaining sites. The Linde Site is not on the National Priorities List and is being remediated under the Comprehensive Environmental Response Compensation Recovery and Liability Act (CERCLA), as are all FUSRAP sites, as mandated by Congress in 1999.

USACE recognized that limiting disposal options to only one NRC facility would not only clog the system causing delayed shipments, increased transportation/disposal costs, and capacity limitations for the entire program, but could be setting self imposed limitations since the NRC itself had determined (3) that the majority of FUSRAP materials were not regulated by them and did not require a license for disposal. This allowed other disposal options to be evaluated for potential use, and would permit competition to take place thereby lowering prices and enhancing services that are protective of human health and the environment.

The Linde Site located in the Town of Tonawanda, New York, processed uranium ores for the Manhattan Project from 1942 to 1946. Linde was selected because of the company's experience during the 1920's and 30's in the ceramics business that involved processing uranium to manufacture the salts used to color ceramic glazes (4).

IT Corporation (IT), under the Total Environmental Restoration Contract (TERC) has been designated the Remedial Action Contractor for the Linde Site. The primary objective of the

Linde Site remediation effort is the timely and effective cleanup in accordance with alternative 2 of the approved Record of Decision (ROD)(5). Alternative 2 requires the complete excavation and decontamination, with offsite disposal, of MED-related soils and debris contaminated with residual radionuclides whose concentrations averaged over a 100 square meter area exceeds unity for the sum of the ratios of the concentrations of three of the longer lived radionuclides of the 14 member U-238 decay chain divided by respective allowable concentration limits given in Table I.:

Table I. Radionuclide Concentrations Used in Sum of the Ratios (SOR) Calculation in Linde Site ROD to Determine Excavation Areas

Radionuclide	**Average Background Levels (5)**	**Surface Limit (< 15 cm)**	**Subsurface Limit (≥ 15 cm)**
Total Uranium (U_{total})	6.5 pCi/g	554 pCi/g	3,021 pCi/g with an upper limit of 600 pCi/g*
Radium-226 (Ra-226)	1.1 pCi/g	5 pCi/g	15 pCi/g
Thorium-230 (Th-230)	1.4 pCi/g	14 pCi/g	44 pCi/g

* This means that the Total-Uranium subsurface concentration will never contribute more than approximately 0.20 to any SOR calculation that approaches unity (one) after remediation.

Crucial transportation and disposal questions needed to be answered by USACE and IT during the planning stages of the Linde Site project such as: How will remediated materials be regulated radiologically and chemically? Where will they be shipped for final custody? How will they be transported? Solutions to these and other challenges are presented in this paper.

CHARACTERIZATION OF SITE MATERIALS

The first and most important step in determining where a certain material may legally be disposed/recycled/recovered is to correctly resolve its actual physical, radiological, and chemical characteristics and how these parameters place the material within existing regulatory frameworks. The second step is to identify facilities capable of accepting guardianship of the material as described and that can do so safely, economically, and legally. Detailed agreements can then be made with these facilities on how this change in custody will be implemented.

Physical Characterization

Physically, the material was determined to be mill tailings mixed with a large percentage of soil (clay, loams, sand) and soil-like material (slag, fly-ash, backfill) as well as significant amounts of debris (concrete, rebar, pipes, etc.). Water is also a natural component and is added as needed to control dust. In addition, five buildings had to be demolished and removed. They were fully investigated and found to not contain radiological contamination above USACE accepted limits recommended in the NRC Regulatory Guide 1.86. Demolition debris from these buildings was recycled at local metal and concrete recyclers for low net cost.

Accurately estimating the quantity of physical material present, as well as the percent debris, was important because it would give the Transportation and Disposal (T & D) subcontractors an idea on how to prepare their bids. Typically, unit costs drop as quantity is increased. The initial excavated soil volume estimate made by Argonne National Labs (ANL) was that approximately

25,000 tons of excavated material would be generated for offsite disposal. This estimate did not include any debris that would be generated from building demolitions or concrete slab removal. There are many uncertainties associated with remediation project volume estimates and oftentimes contamination is found outside of predicted boundaries (6). With the benefit of previous FUSRAP experience IT made an approximation of 80-100 thousand tons in the T & D RFP's. As of January 18, 2002 nearly 92,000 tons have been shipped offsite. Current ANL estimates place the expected final total at around 120,000 tons.

A certified truck scale was installed and calibrated on the project site that measures weights using 4 significant digits with less than 0.2% error. Soil volume calculations generally possess two or less significant digits and are difficult to determine accurately, especially when soils are excavated and a "bulking factor" is used to convert in-situ volumes to ex-situ volumes. Densities of excavated materials can vary significantly from shipping container to shipping container. Small differences in volume/mass conversion factors can sometimes affect T & D costs on large projects by hundreds of thousands of dollars. Landfill operators however, generally bill customers for "as delivered" ex-situ volumes. On the other hand, transportation services contractors typically bill their services on a tonnage basis.

Given the above circumstances, IT decided that tons would be the primary unit of measure used to describe the amount of material shipped offsite. This decision also helped to resolve problems with volumes of materials varying from container to container. The maximum tonnage each type of container can legally hold is constant so that the transport vehicle doesn't exceed State or Federal Transportation laws. Licensed surveyors can determine from a topographic survey the total in-situ volume excavated from a given area.

Radiological Characterization

Correctly classifying this historic material radiologically was critical because classification directly impacts where and how it may be sent for disposal. When determining how these contaminated materials would be classified, the following rationale was used based on history of the site and current regulatory positions by the NRC:

> *As stated earlier, the Linde Site was utilized by the MED from 1942 to 1946 to refine and mill ores for the extraction of uranium. These MED contract activities used a three-phase process for the separation of UO_2 from uranium ores and tailings, and for conversion of UO_2 to UF_4.These processes generated substances (soil, concrete, building debris etc.) contaminated with radioactive residual by-product material from the processing of ores at the facility, which was not licensed by the NRC at the time the Uranium Mill Tailings Radiation Control Act (UMTRCA) was enacted in 1978 and thereafter. Because the AEC and successor agencies did not define and regulate 11e.(2) materials until 1978 the NRC claimed not to have jurisdiction over them (3).*

Regulatory authority shifted to the states when the NRC ruled that they do not regulate pre-1978 ore processing residuals (7). Most state radiological material disposal laws only address Low Level Waste (LLW) that is specifically defined (8). This definition does not apply to all low-activity radiological materials generated for disposal. The State of New York, an NRC-agreement state, had no regulatory framework in place to regulate Linde Site materials. Since there were no State or Federal regulations preventing the disposal of the portion of materials with slightly over background levels of radioactivity in Subtitle C or D landfills, it was determined these materials could safely and legally be disposed of in landfills within the State of New York. Health Physicists monitoring excavation activities can differentiate with handheld sodium iodide detectors the relative activity of a given portion of excavated material (9). The broad range of radionuclide activity found at the site as made known in the US DOE Remedial Investigation (RI) is summarized in the following table:

Table II. Activity Range of Key Radionuclides Found at the Linde Site

Radionuclide	**Minimum**	**Average Background (6)**	**Maximum**
Uranium-238	2.0 pCi/g	3.1 pCi/g	4500.0 pCi/g
Radium-226	0.7 pCi/g	1.1 pCi/g	813.0 pCi/g
Thorium-230	0.4 pCi/g	1.4 pCi/g	820.0 pCi/g

When the New York State Department of Conservation (NYSDEC) was made aware of a proposal to dispose of near background levels of radioactively contaminated materials generated from the Linde Site in permit allowed New York State landfills, an emergency rule was passed on July 31, 2000. A letter from the NYSDEC to USACE stated:

> *"…The effect of this amendment* (to 6 NYCRR Part 380) *is that landfills in New York State are not authorized to accept for disposal any solid waste from FUSRAP sites if that solid waste contains radioactive uranium, thorium, and their decay products at concentrations greater than normal background concentrations (10)"*.

A request to the Pennsylvania Department of Environmental Protection was made for potential disposal services in their state. This request was also rejected. With these restriction placed on the Linde Site, and without a clear definition that everyone agreed on of what exceeds radioactive "background concentrations" for both surface and volumetrically contaminated materials, it was decided that **any** potentially contaminated materials would be shipped out of the region for disposal. This decision increased the cost of the project in the short term but decreasing potential controversies and liabilities in the future.

Chemical Characterization

Ascertaining chemical contaminants and their regulatory status was the next step in the characterization process. The generator of a solid waste is responsible for making hazardous waste determinations (40 CFR 261.1(a)(2)) by either testing the waste as set forth in Subpart C of 40 CFR part 261 or applying knowledge of the hazardous characteristic(s) of the waste in light of the materials or the processes used. Manhattan Engineer District related radionuclides found commingled with chemical contamination from industrial sources were a concern at the Linde Site (5). The RI prepared by the DOE in 1993 for the "Tonawanda Sites" contained a large volume of raw scientific data including measurements of concentrations of certain contaminants of concern. Pertinent data was gleaned from the RI and summarized in tables that provided both detected contaminants and concentration ranges. The RI also described where most of the identified hazardous substances originated and what they were used for. This information coupled with RCRA hazardous waste determinations and how they would be made comprised the majority of the Preliminary Material Characterization Report (PMCR) prepared by IT and approved by USACE.

The next issue addressed was whether or not the presence of trace chemical contaminants depicted in the RI would result in the classification of an appreciable portion of the excavated materials "mixed waste"(11). Most of the chemical contaminants were ruled out as originating from a listed hazardous waste source or from MED-related activities by reading the RI and collecting historical information from former Linde employees. The only trace chemical contaminants that could not be eliminated were several halogenated solvents identified in the RI as "degreasers" (e.g., trichloroethylene, 1,1,1-trichloroethane, tetrachloroethylene, etc.). The following table presents concentrations of these 40 CFR 261.31(a) F001 contaminants of concern found in the RI and their corresponding NYSDEC Technical Administrative Guidance Memorandum (TAGM) 3028 "Action Levels":

Table III. Potential F001 Chemical Contaminants of Concern

Chlorinated "Degreasers" (VOCs)	Concentration Range at Linde (RI) (µg/kg)	Soil/Sediment Action Levels per NYSDEC TAGM 3028 (µg/kg)
Trichloroethene	BDL – 42	58,000
1,1,1-Trichloroethane	BDL – 2.3	7,000,000
Chlorobenzene	BDL – 15	1,600,000
Methylene chloride	BDL – 49	85,000
Tetrachloroethene	BDL – 6.7	12,000
Carbon tetrachloride	BDL – 1.4	4,900

BDL = Below SW-846 Method detection limits.

The State of New York's "contained-out" policy is detailed in TAGM 3028. This guidance document sets "action levels" for listed hazardous waste constituents that if not exceeded, allow environmental media to be "contained-out" and not have to be handled under RCRA hazardous waste laws. Media that exceeds action levels is deemed to "contain" a hazardous waste so a "contained-in" determination would be made. NYSDEC regulators were informed about Linde Site chemical contaminants in the early planning stages of the project so that consensus concerning regulatory matters could be reached before remedial activities began. It was decided that using guidance set forth in TAGM 3028 would be appropriate to apply to excavated materials with trace chemical contamination.

A "Contained-Out" Sample Work Plan as required by the TAGM was written by the Linde Site Chemist and submitted first to the USACE and then the NYSDEC. It was approved and agreed that all 500-yd^3 sample results would be released immediately to NYSDEC for a contained-in/contained-out determination letter before any off-site shipments. The Linde Site Chemist examines ongoing analytical reports of F001 contaminant concentrations and then forwards them to the NYSDEC and International Uranium Corporation (IUC). As of January 18, 2002 not a single 500-yd^3 assay has exceeded NYSDEC action levels for F001 constituents. If degreaser concentrations above action levels are encountered, a hazardous waste classification will be made. The next step, identifying and obtaining approval from all parties involved to use a given disposal outlet for multi-contaminate waste, is not always easy and costs usually escalate substantially in dual regulation circumstances.

Contingency plans were prepared in the event radiological material commingled with RCRA listed hazardous waste was encountered. Before excavations began, five legacy waste drums were discovered that earlier FUSRAP subcontractors had left behind because a viable disposal outlet could not be found. One of the drums in particular was identified by analytical results to contain soil/debris contaminated with uranium, mercury (EPA hazardous waste code D009), and polychlorinated byphenyls (PCBs). PCBs with concentrations >50 ppm are regulated in the State of New York as a hazardous waste and by Federal laws under the Toxic Substances Control Act.

Since the technical term "mixed waste" was not entirely appropriate for this amalgam based on legal definitions (12), a new term was created. The acronym LAHW was formed from the term Low Activity Hazardous Waste. It was determined that RCRA land disposal restrictions could be met for LAHW drums that contained D009/PCB/radioactive debris after treatment by macroencapsulation at the U.S. Ecology of Idaho TSCA/Subtitle C landfill as per 40 CFR 268.45.

REQUEST FOR PROPOSAL (RFP) TO OBTAIN "BEST VALUE"

Although "Best Value" contracting with private and commercial companies is common in governmental projects, the Linde Site T & D work agreements were different in some respects. Transportation and disposal companies have surcharged customers for out of the ordinary occurrences during projects in the past. However, much of the success of a funded project depends on tight, accurate budgeting. Large surcharges by subcontractors for T & D services could be devastating to the project budget. To ensure that this would not happen, potential bidders were presented with relevant factual information concerning the physical, radiological, and chemical properties of the material and asked to give a single per ton rate that was all inclusive of any potential surcharges predicted by the bidder. This effort has proven successful in meeting USACE directed budget allocation rates. In addition, the T & D costs realized for the project are among the lowest currently known in the industry.

After characterization but before excavation and other operations could begin, IT/USACE needed to know where excavated materials would be shipped for disposal/recycle services. A fairly large number of facilities were considered. The goal was to increase the number of firms solicited so that the contract could be fairly competed. From research and experience it is known that there are disposal options (NRC and DOE landfills, existing 11e.(2) cells, permit allowed RCRA landfills), and recycle/recovery options (uranium mills) for materials contaminated with FUSRAP contaminants. Demolishing the onsite buildings would generate a range of materials not contaminated with MED-related radionuclides (concrete, steel, copper, fluorescent tubes, legacy chemicals, asbestos, etc.) that would be shipped to various facilities for disposal, repackaging, recovery, or recycling services. To simplify the phrase that would be used throughout the project to identify all types of facilities receiving remediated materials, the term Destination Handling Facility (DHF) was conceived.

A USACE nationwide disposal contract already exists that is operated out of the Kansas City District for radiologically contaminated materials with landfills managed by Envirocare of Utah, Waste Control Specialists of Texas, and U.S. Ecology of Idaho. There are some restrictions with this contract including:

- Potential surcharges for debris and free water content,
- Frequent sampling requirements for large relatively homogenous waste streams, and
- No limits on how long containers may stay at the disposal facility before being returned to the remediation site for refilling.

With this in mind, IT set out to write a Request for Proposal (RFP) with the goal of obtaining best value for disposal/recycle services. This would be accomplished by:

- Expanding the number of solicited DHFs;
- Reducing or eliminating opportunities for DHFs to surcharge material as delivered (debris, free water, etc.);
- Requesting that "free release" decontamination services of shipping containers not be surcharged;
- Reducing the amount of redundant sampling for characterization; and
- Placing emphasis on value added services that could be offered by potential DHFs. These value added services included in the technical evaluation portion of the RFP added extra points to DHF proposals that demonstrated:
    - Low regulatory violations rate;
    - Onsite rail siding;
    - Quick turnaround times for shipping containers with monetary incentive; and
    - Flexible delivery rates.

When the main parameters of site operations were chosen an RFP could be written that would describe the Scope of Work and other contract provisions so that a relatively simple pricing structure could be applied. The Disposal/Recycling Services RFP was released first so that the transportation services RFP could be written next with only viable DHFs listed for transportation logistics consideration. The transportation services RFP contained a technical evaluation portion similar to the Disposal/Recycling services RFP that added points to proposals that demonstrated:

- Low regulatory violations rate;
- At least five positive references for similar type work;
- Experience in safely transporting USDOT Class 7 materials;
- High maximum shipping rates through proposed transload site; and
- Low cycle times for shipping containers from origin back to origin.

Best value scores were calculated from DHF bidders and added to the best value score obtained from the winning transportation subcontractor. Totals for each possible combination were compared and the two overall best value choices were made and submitted to USACE for review. Lower activity non-USDOT Class 7 materials would be shipped to WCS in Andrews, TX (generally < 2,000 pCi/g average estimated total activity). Higher activity USDOT Class 7 materials would be shipped to International Uranium Corporation (IUC) located in Blanding, UT for uranium recovery (generally > 2,000 pCi/g)(13).

Securing two DHFs with different but complementary capabilities and acceptance criteria has proven to be beneficial to the project in several ways. Materials that cannot be disposed of at IUC or in the states of New York or Pennsylvania that contain very low activity soils, debris, used PPE, and potential LAHW can be shipped to WCS of Texas relatively economically. Soils and debris with activity higher than what is acceptable at WCS can be shipped to IUC as uranium ore. On average IUC receives approximately 80% of project IMCs and WCS about 20%.

TRANSPORTATION OF LINDE SITE MATERIAL

Transportation of radioactive residuals from the Linde Site to designated DHFs involved planning the logistics, equipment requirements, obtaining a subcontractor and formulating shipping papers based on USACE needs and applicable United States Department of Transportation (USDOT) regulations. Major points of some of these decisions include that:

- The mode of transportation would include rail because it is the safest mode of ground transportation (14) and costs per ton can be held to a minimum.
- Intermodal containers on flatcars would be utilized instead of gondola railcars in order to lessen potential airborne contamination and ease excavation, staging, packaging, and loading operations.
- Transportation/DHF subcontractors would be required to provide the capability and flexibility to ship/receive up to 24 intermodal containers (IMCs)/day.
- Cable trucks would be used for staging and transporting loaded IMCs around the Linde Site.
- USDOT "Strong Tight Containers" (or Packages) would be required to have a backup closure capability (flappers) to ensure no spillage of contents anytime during transport.

For Class 7 shipments to IUC an "Exclusive Use Agreement" (EUA) was written and signed by representatives from USACE, IT, IUC, and MHFLS. This exclusive use agreement includes detailed, specific instructions on how shipping containers are to be handled during the entire loop from the Linde Site to the DHF and back for reloading. The EUA outlines quality control (QC) measures to be taken at each stage of the journey and actions to be taken by designated personnel. Specific emergency contact numbers, regulatory citations, Bill of Lading (BOL) distribution, and tracking documentation are also outlined in this document.

An excellent example of innovative transportation regulatory interpretation for USDOT Class 7 material shipped to IUC utilized throughout the USACE Tonawanda FUSRAP projects involves the 49 CFR 173.427(a)(6)(v) exemption for placarding of uranium or thorium ores. This exemption reads:

> *"Except for shipments of unconcentrated uranium or thorium ores, the transport vehicle must be placarded in accordance with subpart F of part 172 of this subchapter."*

The NRC defines ore as:

> *"A natural or native matter that may be mined and treated for the extraction of any of its constituents or **any other matter from which source material is extracted in a licensed uranium or thorium mill**".*

There is a Memorandum of Understanding (MOU) between the NRC and the USDOT that was published in the *Federal Register* on July 2, 1979. This agreement states that the USDOT governs the transportation of radioactive materials and the NRC regulates the receipt, possession, use, and transfer of licensed radioactive materials. The NRC has determined that Linde Site material qualifies as "alternate feed material" (ore) under IUC's license amendment. Furthermore, Linde Site material is described under USDOT regulations as LSA-I Class 7 radioactive material and is defined in 49 CFR 173.403 as (LSA-I)(1)(i):

> *"Ores containing only naturally occurring radionuclides (e.g. uranium and thorium) and uranium or thorium concentrates of such ores".*

The commonly used exception from marking and labeling for bulk domestic Class 7 exclusive use shipments found in 49 CFR 173.427(a)(6)(vi) is also employed. A copy of the BOL with USDOT information such as the proper shipping name, North American Emergency Response Guide 162, current estimated average specific activity (pCi/g), estimated total activity for package, detailed EUA, and signed shippers statement, all on one sheet of paper, is attached to each IMC before leaving the Linde Site for IUC in Blanding, UT.

Texas Hazardous Waste Manifests required by the Texas Department of Environmental Quality are filled out and attached to WCS shipping containers. These manifests state that Federal or State regulations do not regulate this NORM material as a hazardous material or waste. To avoid confusion WCS and IUC containers are differentiated in two different ways that make them easily distinguishable at a distance. The USACE mandated non-DOT marking sticker that is required on all bulk shipments is yellow on IUC containers and purple on WCS containers. Weight stickers required by the Occupational Safety and Health Act (OSHA) in 29 CFR are white on IUC containers and multi-colored on WCS containers.

The Linde Site is capable of shipping IMCs of USDOT Class 7 material to IUC without individually sampling each and every container. This is because of interpreting what LSA radiological material is as defined in USDOT regulation. This definition found in 49 CFR 173.403 describes how LSA material's activity per package may be determined by estimating the average specific activity. The definition does not specify any minimum sampling frequency. Total estimated average specific activity per gram for each IUC and WCS shipping container is calculated from project cumulative 500-yd^3 radiological assays of U-238, Ra-226, and Th-230.

These specific activities are then used to calculate the total average activity of the uranium decay chain in its entirety. Health physicists also perform pre-shipment surface scans of all Linde Site shipping containers for radiological dose levels as required by 49 CFR 173. None have exceeded the 0.5 mrem/hour limit for the LSA-I USDOT subcategory.

EXCAVATION CONTACT WASTEWATER DISPOSAL

Nearly all excavation activities must deal in some way with accumulated water disposal. Options considered included offsite disposal by truck and onsite discharge to the existing sewer system and treatment at the Town of Tonawanda Wastewater Treatment Facility (TTWTF). The TTWTF was contacted and discharge limits on target compounds were provided. When these limits were compared to site excavation waters it was found that they would probably be met without filtration. IT/USACE decided that filtration using high flow rate 5 and 10-micron bag-type filters would be prudent because sediments would be prevented from accumulating in pipes and sumps that might then require remediation. Acceptable permit discharge levels of radionuclides of concern found in New York State surface water permit discharge limits and Linde Site levels after filtration are given in the following table:

Table IV. Radionuclide Levels Permitted in Surface Water Discharges in New York State vs. Filtered Linde Site Wastewater

Radionuclide	**Permit Level**	**Initial Linde Site Filtered Wastewater Results**
Radium-226	600 pCi/L	2 pCi/L
Thorium-230	1,000 pCi/L	1 pCi/L
Uranium-238	3,000 pCi/L	130 pCi/L

A TTWTF industrial sewer connection permit is required before discharging any contact wastewater. While the permit was being developed, it was planned to ship accumulated contact wastewater offsite so that excavations would not be impeded. Even though local treatment facilities stated that the wastewater easily would meet their permit requirements, the NYSDEC declared that any contact wastewater transported from the site would be required to meet New York State radioactive material licensing regulations because of an emergency rule that had been proposed earlier (15). This rule was designed by NYSDEC to regulate pre-UMTRCA mill tailings that the NRC has declared not regulated (16). For this reason as well as cost considerations, wastewater was not shipped by truck to any local treatment plants.

Two large storage tanks were brought onsite to capture filtered water for the pilot study. Filtered water was sequestered until analytical results were received and confirmed to meet discharge limits set by the Public Owned Treatment Works (POTW). After pilot testing was established to be successful and operation plans were submitted to USACE and the TTWTF, the filter/discharge system was set up for operation.

The TTWTF permit requires that wastewater must be sampled for chemical and radiological constituents at a rate of every 100,000 gallons. After the second sampling event it was discovered that the concentration of several volatile halogenated hydrocarbons exceeded permit levels. These contaminants highest detected concentrations in excavation contact water and NYSDEC surface water discharge levels are given in Table V. below:

Table V. Linde Site Contact Wastewater VOC Contaminants

Constituent:	**Highest Levels Detected (Influent) μg/L ≅ ppb**	**Regulatory Levels [a,b] μg/L ≅ ppb**
1,1-Dichloroethene	4	0.7
1,1-Dichloroethane	12	5
Cis-1, 2- Dichloroethene	200	5
1,1,1-Trichloroethane	350	5
Trichloroethene	430	5
Tetrachloroethene	220	0.7
Vinyl chloride	57	0.3

[a] - Discharge permit stipulates that twice these levels are not to be exceeded. Values shown are identical to TAGM 3028 action levels for groundwater.

[b] - An analysis of background concentrations of halogenated VOCs in city supplied chlorinated water used for dust control revealed that regulatory levels for chloroform, bromo-dichloromethane, and methylene chloride were exceeded.

The NYSDEC requested that USACE declare the contact wastewater a hazardous waste stream based on the fact that the concentrations of several chlorinated VOCs exceeded TAGM 3028 levels for groundwater. The NYSDEC asserted that because VOC levels exceeded discharge levels in the permit regulated under State laws similar to the Federal Clean Water Act (CWA), they should also be regulated under New York State RCRA laws.

This was a situation where one waste stream could potentially be regulated under two different sets of regulations. IT's position was that the wastewater did indeed exceed discharge levels under the State CWA regulations, but that State hazardous waste laws need not be invoked. IT requested that NYSDEC reconsider the applicability of the spent solvent wastewater exemption found in 6 NYCRR 371.1(d)(1)(ii)('d') to the Linde Site circumstances. The exemptions found in this part were designed with the intention of keeping the RCRA "mixture rule" from making large volume wastewater streams hazardous wastes simply because they contain very low concentrations of certain listed constituents. NYSDEC granted the proposed exemption and the wastewater was not declared a hazardous waste.

The next challenge was to find a way to reduce contaminant levels so that the water could be discharged under the existing permit. Several systems were considered to remove the halocarbons from the wastewater, and after assessing available options it was decided that the best remedy would be the use of a six-tray air-stripper. A computer model was run and then a pilot study was carried out similar to the earlier one for filtration, and it too was successful in meeting treatment goals. VOCs were reduced to levels below allowable discharge permit limits given in Table V. No permitting is required for the air stripper treatment system because the Linde Site is exempt under the CERCLA, however requirements in New York State laws for air discharge are being met. As of January 18, 2002 nearly 2.2 million gallons have been successfully discharged using the filtration, air-stripper operation.

COST SAVINGS

The Linde Site has realized significant cost savings by using the following approaches:

- Appropriate characterization of radiological material as pre-1978 11e.(2) byproduct material and not LLW. This allowed the elimination of NRC 540, 541, and 542 manifesting forms for each container shipped to WCS.
- Shipment sampling costs were reduced approximately 30 times less than what would be expected if each individual container were sampled.
- Substantial savings in preparing Class 7 shipments by eliminating the requirement of placarding by use of the USDOT ore exemption for an environmental remediation project.
- PPE transportation and disposal costs are at about 5-10% of industry standard. This was accomplished by requiring per ton prices be given in the RFP instead of volume rates for a low-density material stream.
- Exemption of wastewater treatment operations from RCRA regulations eliminates potential liabilities as well as operational difficulties.
- Excavation contact wastewater treatment/disposal costs are about 340 times less than offsite disposal costs would be.
- Making use of the NYSDEC "contained-out" policy has avoided an estimated $4 million dollars thus far in disposal costs.
- As of January 2002, the Linde Site has shipped over 71,000 tons of USDOT Class 7 material to IUC and about 22,000 tons of non-USDOT regulated material to WCS. Total project dollars divided by total tons shipped equals a per ton rate at nearly half of what other projects report (16).
- In the spring of 1995 FUSRAP Waste Management personnel contacted active and dormant uranium mills throughout the country to see if they would be willing to accept large amounts of soils contaminated with relatively small amounts of naturally occurring radionuclides for disposal in their existing 11e.(2) cells or for feedstock in uranium recovery. International Uranium Corporation accepted the challenge and provided a cost effective alternative. It is difficult to directly compare current unit disposal costs of today with previous contracts because they included delivery caveats and surcharges that were not easy to predict during the course of a project. If base rates are compared however, with the lowest cost USACE contract of 1995 and surcharges, minimums, annual increases, etc. are ignored it can be demonstrated that unit charges for FUSRAP remediated materials have decreased at least 240%.
- Waste Management FUSRAP employees also contacted RCRA Subtitle C landfills in 1995 and found a small number that carried permits allowing them to accept low activity Naturally Occurring Radioactive Material (NORM). Several of these facilities were willing to accept FUSRAP NORM. This increased competition and potential landfill space. Disposal prices have fallen significantly for environmental media contaminated with small amounts of naturally occurring radioactivity. Some traditional waste disposal costs saving techniques (e.g., material compaction, separation of scanned PPE, "soil washing", etc.) have been made non-cost effective.

CONCLUSIONS

The Linde FUSRAP Site is an excellent example of how low levels of naturally occurring radionuclides can be economically remediated, transported, and permanently disposed or recycled in the United States even with the complex political and public perception problems associated with such operations. Most of the FUSRAP sites became contaminated in the 1940s and it has taken until now for the larger ones to finally be able to be cleaned up to safe standards for public use. Remedial efforts were delayed due to the fact there were no viable disposal facilities that were acceptable to all concerned. Careful planning and innovative approaches by the Linde Site Contractor afforded the public protection while providing "best value" and lowest price to the government.

REFERENCES

1) FUSRAP Report to Congress, USACE, September 30, 1997.
2) White Paper, FUSRAP Waste Disposal Alternatives, July 7, 1998.
3) Fonner Letter, 3/2/98 – and subsequent NRC director's decision, accession number M003777111, December 14, 2000.
4) Remedial Investigation (RI) Report for the Tonawanda Sites, DOE, February 1993.
5) Record of Decision for the Linde Site, USACE, March 2000.
6) Soil Characterization at the Linde FUSRAP Site and the Impact on Soil Volume Estimates –J. Boyle, T. Kenna, R. Pilon, US Army Corps of Engineers, 2002.
7) Problems Associated with Disposal of Pre-AEA Byproduct Material, Philip V. Egidi, ORNL, 2000.
8) Low-Level Waste (LLW) – is defined in the Low-Level Waste Policy Act of 1985 as (A) radioactive material that is not classified as high-level waste, spent nuclear fuel, or byproduct material (as defined in Section 11e.(2) of the Atomic Energy Act of 1954 (42 U.S.C. 2014(e)(2)), and (B) the Nuclear Regulatory Commission, consistent with existing law and in accordance with paragraph (A), classifies as low-level radioactive waste.
9) Correlation of Radiological Scan Measurements with Discrete Soil Samples for the Linde Site, IT Corporation, May 2001.
10) NYSDEC letter from Stephen Hammond to George Brooks of USACE, August 7, 2000.
11) http://www.dawnwatch.org/45.html
12) The term "mixed waste" is broadly used to describe any discarded or abandoned materials contaminated with radionuclides above background concentrations and RCRA hazardous waste. Most Federal and State "mixed waste" laws are designed to only address the subset that includes LLRW commingled with RCRA hazardous waste.
13) Remediation and Recycling of Linde FUSRAP Materials – P.W. Coutts, IT Corporation; M.R. Rehmann, International Uranium Corporation (USA), 2002.
14) U.S. Department of Transportation Bureau of Transportation Statistics, 1991-1997.
15) Emergency Rule to Regulate FUSRAP Materials for Land Disposal, NYSDEC, July, 2000.
16) Program Achievements in the Formerly Utilized Sites Remedial Action Program-K. R. Huston, P.E., USACE, 2001.

ACRONYMS

AEA............. Atomic Energy Act
AEC............. Atomic Energy Commission
BOL............. Bill of Lading
CERCLA...... Comprehensive Environmental Response Compensation Recovery and Liability Act
CFR............. Code of Federal Regulations
CWA............ Clean Water Act
DHF............. Destination Handling Facility
EUA............. Exclusive Use Agreement
FUSRAP....... Formerly Utilized Sites Remedial Action Program
IMCs............ Intermodal Containers
IT.................. IT Corporation
IUC.............. International Uranium Corporation
LAHW.......... Low Activity Hazardous Waste
LLW............ Low Level Waste
LSA............. Low Specific Activity
MED............ Manhattan Engineer District
MHFLS......... Molly Hills Farm Logistical Solutions
NORM.......... Naturally Occurring Radioactive Materials
NRC............. Nuclear Regulatory Commission
NYCRR........ New York Code of Rules and Regulations
NYSDEC...... New York State Department of Environmental Conservation
ORNL........... Oak Ridge National Laboratory
OSHA........... Occupational Safety and Health Act
PCB............. Polychlorinated Biphenyl
pCi/g............ picoCuries/gram
PMCR........... Preliminary Material Characterization Report
POTW........... Publicly Owned Treatment Works
ppb................ part per billion
PPE............... Personal Protective Equipment
RCRA........... Resource Conservation and Recovery Act
RFP............... Request for Proposal
RI.................. Remedial Investigation
ROD............. Record of Decision
SOR.............. Sum of Ratios
SW................ Solid Waste
T & D............ Transportation and Disposal
TAGM.......... Technical Administrative Guidance Memorandum
TERC............ Total Environmental Remediation Contract
TSC............... Transportation Subcontractor
TTWTF......... Town of Tonawanda Wastewater Treatment Facility
UMTRCA..... Uranium Mill Tailings Radiation Control Act
USACE......... United States Army Corp of Engineers
USDOE......... United States Department of Energy
USDOT......... United States Department of Transportation
VOC............. Volatile Organic Compound
WCS............. Waste Control Specialists