OAK RIDGE NATIONAL LABORATORY WASTE MINIMIZATION EFFORTS ASSOCIATED WITH SEVERAL SUCCESSFUL PROJECTS

J.S. Scott*, R. Boles, B. Andrie ,
Safety and Ecology Corporation
2800 Solway Rd., Knoxville, TN 37931

D. Wilson,
Bechtel Jacobs Company, LLC
P.O. Box 4699, Oak Ridge, TN 37831-7596

ABSTRACT

Waste generation, management, transportation, and disposition are challenges all face in the environmental restoration business. Over the past two years Safety and Ecology Corporation (SEC), has assisted Bechtel Jacobs Company, LLC (BJC), the Management and Integration subcontractor for the Department of Energy (DOE) Oak Ridge Operations (ORR), in cost-effectively minimizing the volume of waste that is disposed of and increasing the volume for release, reuse, and recycle. This paper will focus on the success and challenges of several projects at the Oak Ridge National Laboratory (ORNL) and one project at East Tennessee Technology Park (ETTP). SEC is one of four Remedial Action/Decontamination & Decommissioning (RADD) subcontractors selected by BJC to support site clean up goals. From the first project completed under the RADD subcontract to the most recent, the waste disposition approach has been refined and a decision process developed. This decision process will be discussed in the paper and illustrated graphically to indicate the critical elements to selecting the most appropriate waste disposition option.

This paper will focus on the following items associated with waste minimization efforts working with BJC at the Oak Ridge Reservation DOE facilities:

- Waste disposition decision process;
- Waste disposition options – recycle, reuse, salvage, and disposal;
- Technical Approach to Waste Minimization;
- BJC Waste disposition process – pre-qualification and certifications required;
- Elements of integration required for successful pre-planning – design and implementation;
- Waste disposition challenges and solutions;
- Release surveys required to disposition waste for reuse/recycle;
- Implementation strategies involving partnering of multiple subcontractors; and
- Lessons learned that will be integrated in future projects.

INTRODUCTION TO WASTE MINIMIZATION

As more and more DOE facilities transition from a production phase to a remediation and redevelopment phase, decontamination and decommissioning (D&D) activities continue to generate increasing volumes of hazardous, radioactive, and mixed wastes. Waste management activities, including generation, characterization and disposition, are a challenge all face in the environmental restoration and remediation business. As transportation, processing, and disposal rates for wastes continue to increase, exponentially in some areas, more cost-effective waste management options must be sought out. Over the past two years, Safety and Ecology Corporation (SEC) has assisted Bechtel Jacobs Company, LLC (BJC) in minimizing the volume of waste generated and disposed of during D&D activities.

As the Management and Integration Contractor for the Department of Energy (DOE) Oak Ridge Operations (ORR), BJC chose SEC as one of four subcontractors to perform Remediation Action / Decontamination and Decommissioning (RADD) activities at the three Oak Ridge facilities, Y-12, East Tennessee Technology Park (ETTP) and Oak Ridge National Laboratory (ORNL). For the past two years, SEC has been performing RADD activities for BJC, and has faced significant challenges and successes in the field of waste management. Over the course of the past two years, SEC has completed 12 RADD projects for BJC. From the first project completed to the most recent, the waste disposition approach has been refined and a decision process has been developed.

WHY MINIMIZE WASTE?

Waste minimization includes source reduction, recycling, reuse, and recovery. Waste minimization activities reduce the demand for treatment and disposal capacity resulting in less regulatory involvement and reduced costs. Waste management principles must be incorporated into environmental restoration activities to ensure the greatest environmental and financial benefits. Reasons to minimize waste include:

- To reduce treatment and/or disposal costs;
- To reduce the impacts of other hazardous, radioactive, and mixed waste requirements;
- To improve human health and the environment;
- To promote better environmental stewardship and leadership; and
- To build better community relations for the client.

Waste minimization programs must include qualitative and quantitative (where possible) reduction goals and ensure that adequate resources are available to meet these goals. Qualitative goals include the intent to identify and implement activities that eliminate or reduce the generation of waste in all phases of environmental restoration work. While often more difficult to implement, quantitative goals include commitments to measurable reductions in waste volumes generated. SEC project managers are encouraged to develop waste minimization objectives for every project, such as seeking alternative non-hazardous chemicals as substitutes for traditional cleaners and degreasers, or developing aggressive waste management strategies that decrease the volume of hazardous or mixed wastes generated by as much as 70%.

TECHNICAL APPROACH TO WASTE MINIMIZATION

To meet waste minimization goals and objectives stated in project-specific Waste Management Plans, SEC designates a Waste Engineer/Waste Minimization Coordinator (WE/WMC) throughout the course of D&D planning and execution. The WE/WMC is responsible for developing the waste minimization program, providing leadership and training for project personnel on identifying opportunities to eliminate or reduce waste generation, and for initiating a pollution prevention opportunity assessment (PPOA) during the planning stages of a project. PPOAs are included as routine aspects of environmental restoration projects and generally focus on emphasizing recycling/reuse for primary waste streams and source reduction for secondary wastes.

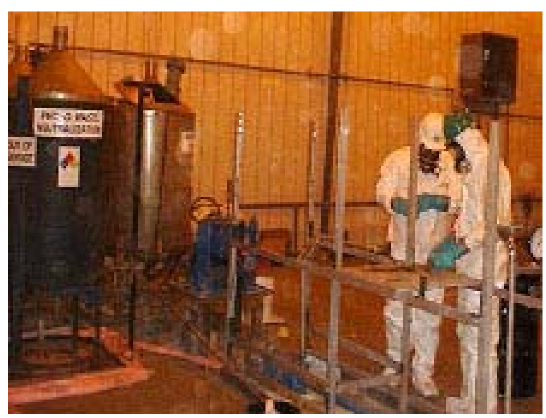

Fig. 1. SEC workers decontaminating a silver recovery unit. Decontamination of scrap metal reduced hazardous waste stream by 200% (2000)

Housekeeping:

By keeping work areas clean and equipment properly maintained, the chance of breakage or leaking is greatly reduced. Spill response plans are developed that consider cleanup methods which reduce the generation of cleanup waste. Equipment receives regular preventative maintenance to ensure efficient operation.

Material Segregation:

All materials are handled and stored to prevent commingling or cross-contamination. Great care is taken to prevent contamination spread to non-contaminated items or areas.

- SEC maintains a crib for contaminated tools and equipment to be used in contaminated areas, so new tools do not repeatedly become contaminated.
- PPE and equipment used in contaminated areas are carefully surveyed and sampled. Clean PPE and equipment are segregated from the contaminated, and disposed accordingly.
- Boundaries are established between contamination areas, buffer or reduction areas, and support areas to prevent the spread of contamination to clean areas.
- Personnel are trained on PPE donning and doffing procedures and on minimizing the spread of contamination to clean areas

Administrative changes:

Administrative criteria (such as relocating radiological boundary lines to result in less material being classified as radiological) are reviewed to determine if changes would result in reducing or eliminating the generation of wastes.

Process changes:

Changes to equipment or materials used in the process may result in less use of resources or less generation of wastes.

- Substituting non-hazardous materials for hazardous inputs will result in the reduction or elimination of hazardous waste and in the reduction of potential for worker exposure
- SEC utilizes innovative in-situ sampling technologies whenever possible. Equipment such as the XRF detector and ISOCS detector reduce the generation of sampling and analysis waste such as containers, residues, PPE, sampling tools, and decontamination equipment and effluent. Whenever possible, SEC utilizes these innovative technologies as alternates to traditional characterization methodologies
- SEC utilizes innovative decontamination methodologies such as CO2 blasting, eliminating the disposal of the blast media. All decontamination efforts are reviewed to determine the most effective and least waste-producing methodology. During decontamination, environmentally benign cleaners such as Simple Green are substituted to hazardous organic solvents whenever possible.
- SEC maintains a Hazardous Material Inventory System (HMIS) to track the possession and use of hazardous materials at each site. The HMIS includes a system of suggesting alternates to traditional hazardous materials.

Recovery/Recycling/Reuse:

Recycling and reuse is the best method for achieving minimization of the primary waste streams. SEC strives to recycle materials such as scrap metal, timber, and concrete to result in significant waste reduction and cost savings. SEC utilizes a number of waste disposition outlets that recycle non-contaminated scrap metal and timber, and reuse contaminated metal. Whenever feasible, SEC strives to decontaminate metal surfaces, allowing the material to be recycled or reused.

Volume Reduction:

Size reduction through compacting, baling and melting greatly reduces the volume of materials requiring disposal. SEC utilizes a number of waste disposition outlets that super-compact or bale compactable wastes, achieving volume reductions of 200% or more.

WASTE DISPOSITION DECISION PROCESS

During the planning and evaluation stages of a project, SEC waste personnel assess the potential waste streams to identify disposition options. It is at this stage of project planning, that the greatest opportunity for waste minimization can be realized. The disposition decision process is depicted below in Figure 2. While seemingly straightforward, the decision-making process should be applied to each potential waste stream or waste group. The process allows planners to evaluate the disposition options, including recycle, salvage, reuse, or disposal.

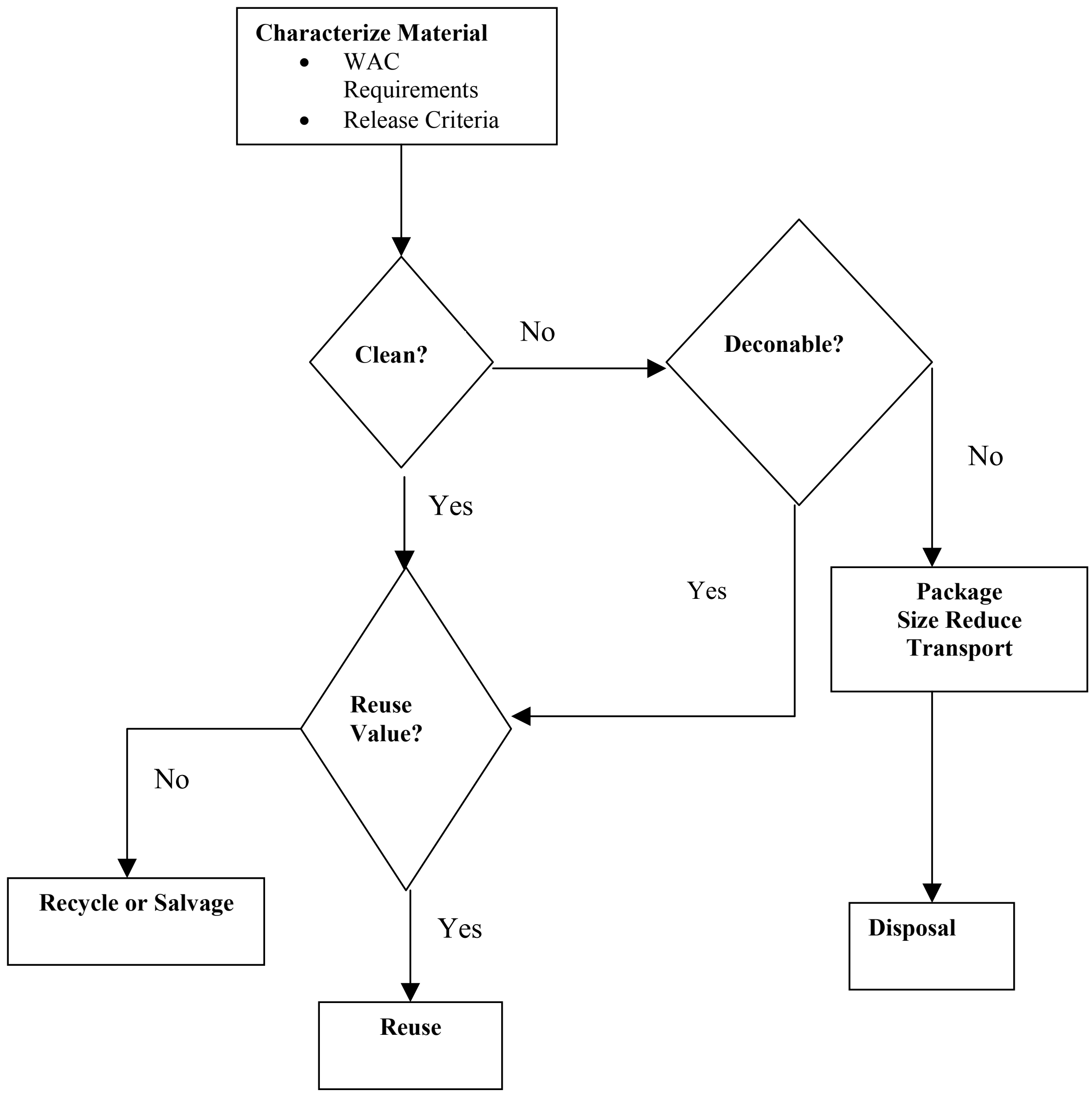

Fig. 2. Waste disposition options and decision flow diagram featuring waste minimization options.

BJC WASTE DISPOSITION PROCESS

Specific waste management requirements for BJC projects are delineated in the following documents and requirements:

- SPG-000000-0006, "Technical Specification for Waste Management"
- WM-A-2001, "Generator Requirements for Transferring Waste"
- BJC/OR-57, "Oak Ridge Reservation Certification Program Plan"
- DOE/OR/01-1879, "Implementation Plan for U.S. DOE Order 435.1, USDOE-ORR
- Prior to performing any work that may result in generation of wastes, subcontractors are required to prepare and submit a waste management plan (WMP) that includes information on:
    - Waste forecast (including waste type, waste stream description, quantities, planned disposition pathways, waste codes and identifiers, and special handling requirements)

- Waste generation (including identification, segregation, characterization, and packaging procedures)
- Staging requirements
- Treatment requirements
- Personnel Training requirements
- Permits and authorizations needed
- Pollution prevention

Any treatment, storage, disposal, or recycling facility (TSDRF) that accepts waste materials generated during RADD activities must be pre-qualified and certified by BJC on an annual basis. Subcontractors may choose to use a facility that is already certified, or may pursue certification and pre-qualification for a TSDRF that is not on the pre-qualified list. To qualify a TSDRF, the following criteria are used during the evaluation process:

- Permits: must verify that wastes intended for the TSDRF can be received in accordance with their existing permits.
- Certificate of Insurance: must have pollution coverage in the amount of $5 million per loss/ $ 10 million aggregate.
- Compliance History: must not have a record of non-compliance and/or unresolved violations from the appropriate EPA regional and state offices.
- EPA-Approved Off-Site CERCLA Facilities: facility must be on the EPA approved facilities list for wastes generated from a CERCLA action.
- Site Visit: a site visit may be required for certain vendors.

Any potential recycling facility that is considered must pass the evaluation criteria in order to receive waste materials from a BJC RADD project. Evaluations of the facilities must be completed prior to generation of waste material so each and every waste stream (or recycle/reuse/salvage stream) has a clear and approved disposition path prior to generation.

ELEMENTS OF INTEGRATION NEEDED FOR DESIGN AND IMPLEMENTATION

Once each potential waste stream has been evaluated through the decision process shown in Figure 2, the intended path for that waste stream should be identified. As shown in the figure, potential paths include treatment/disposition, recycle, reuse, and salvage. Once the overall path has been identified, the options within that path can be identified. For example, once salvage has been determined as the path forward for a particular material, several salvage options may be available. During the demolition of Building K-1001, SEC chose to salvage the existing furniture and fixtures in the facility. The salvaged items were donated to local churches and schools as this option provided the most advantageous benefits to SEC and to our client. Over 200 CY of material was kept out of an industrial landfill by donating the materials to local schools and churches. The workforce needed to remove, prepare and transport the salvaged items was provided by the recipient. Because K-1001 had been cleared from a radiological and hazardous material standpoint, training requirements for the workforce were minimal, allowing SEC to utilize volunteers from the churches and schools. If the workforce were required to meet stringent and extensive training requirements, another salvage option may have been more advantageous, as the use of a volunteer workforce to remove the materials may not have been as readily available. The choosing of a receiving facility is often the result of an evaluation of numerous and complex factors, and is often specific to a particular material stream.

Once the options have been evaluated and an outlet has been identified, smooth integration and arrangement with the outlet during the planning stages is essential for seamless waste management during

D&D activities. Comprehensive understanding of the acceptance criteria of the receiving facility must be incorporated into the design of project plans and activities. Client approval of the outlet during the pre-mobilization stages is an essential factor in ensuring that waste management activities progress smoothly. For example, when SEC used a volunteer workforce to remove salvageable items from Building K-1001, it was essential to identify the workforce, receive approval for each individual, and obtain the required training and badging for those individuals early in the life of the project. As material salvage activities were about to begin, the workforce was ready to go.

Similar integration and planning is necessary for other waste minimization outlets as well. Recycle facilities must go through the extensive approval and qualification process, which, if not started early in the life of a project, can delay disposition activities. Additionally, characterization of the waste material should focus on both the client's release criteria (to move material from the site) and on the vendor's acceptance criteria (to receive the material for recycle or other disposition). Release criteria may range widely depending on the final disposition of the material. By identifying disposition outlets early in the project, one can design characterization strategies to meet the acceptance and release criteria needed to get the material to the facility.

Fig. 3. Segregation of barite shield block. Block was reused, reducing waste volume by 150% (2001)

RELEASE SURVEYS REQUIRED FOR REUSE/RECYCLE

Although reuse and recycle of waste material is often a financially attractive disposition option, RADD material slated for recycle/reuse must be sufficiently characterized to meet several important criteria, including:

- Acceptance criteria of the receiving facility;
- Release criteria of the client;
- Compliance with transportation regulations while material is in transit; and
- Environmental health and safety criteria for workers handling the material.

A number of survey and characterization strategies can be employed to meet the above criteria. In some cases, process knowledge is sufficient to adequately characterize the material. For radiologically contaminated material, a MARSSIMS-based approach is often advantageous to meet release criteria from a particular site. Other sites have additional release criteria that may be more stringent than a MARSSIMS approach. Potentially RCRA-contaminated material should be analyzed for corrosivity, flammability, reactivity and toxicity as specified in 40 CFR 261 to meet acceptance criteria of recycling facilities.

Decontamination of material has become complicated by the recent moratorium on recycling of radioactively contaminated metal from DOE facilities. RCRA contaminated metals that can be decontaminated and proven clean can be readily recycled, saving thousands of dollars in disposition costs. Radioactively contaminated metals can often be "re-used" at another DOE facility, saving disposal costs. "Re-use" provides a good alternative to recycle while the moratorium is in place.

WASTE DISPOSITION CHALLENGES AND SOLUTIONS

While waste minimization offers an array of important financial and other advantages, significant challenges can face a subcontractor dedicated to recycle, reuse, salvage, and other waste minimization activities. SEC's experience with RADD waste minimization has provided us with a pool of lessons learned regarding waste minimization challenges, some of which are presented below.

Challenge/Lessons Learned #1:

Ensure that the release criteria are clearly defined and measurable before attempting to free-release material.

Description: During performance of the Building 7934 RCRA Closure and Silvery Recovery Unit Removal, SEC dismantled a photographic solution processing unit, contaminated with a variety of RCRA metals, volatiles and semi-volatile constituents. SEC's PPOA identified decontamination of the unit and reuse of the metal as the most advantageous option. SEC planned an aggressive decontamination of the metals using high pressure heated washes and mild detergents and abrasive scrubbing to remove RCRA contaminants from the metal. The metal would then be triple rinsed and the final rinseate would be sampled for RCRA contaminants. If the final rinseate tested clean, the material could be sent to a local metal recycle facility at the old K-25 plant for eventual re-use. Although the unit never processed any radioactive material, SEC planned to perform surface scans of 100% of the metal to meet the acceptance criteria of the receiving facility.

During decontamination of the material, SEC found that the planned surface scans of the metal would not be sufficient to meet the client's release criteria and move the material from the site. Instead, because the material was located within a radiologically controlled area, SEC would have to prove that the metal had "no added radioactivity". There are no numerical criteria for "no added radioactivity"; rather, the general approach is to demonstrate by Best Available Technology (BAT) that the liquid rinseate contains no increase in radioactivity, above that in the liquid, prior to its use. Using the BAT, it was determined that if the level of radionuclides in the liquid waste was less than the minimum detectable activity (MDA) above the levels in the unused liquid, it is reasonable to conclude that the liquid waste contains no added radioactivity. The greatest difficulty arose because the laboratory was unable to achieve the MDA for the material because of the viscous nature of the rinseate. The material could not be free released, because SEC was unable to prove that the material contained no added radioactivity.

Solution: SEC was able to resample the material and obtain a sample with which the laboratory could meet the required MDAs. The re-sampling and reanalysis activities, however, added considerable cost and time to a regulatory-driven schedule for closure of the unit. While the project was able to meet its regulatory milestones, the additional release criteria caused SEC to incur further costs.

Lessons Learned: When evaluating waste minimization as a viable option, it is important to take into account not only the acceptance criteria of the receiving facility, but also the release criteria of the client and/or site. While characterization may be sufficient to meet acceptance criteria, more stringent release criteria may drive the characterization approach, introducing hidden costs and delays into waste management activities. These release criteria should be fully explained and understood before committing to waste minimization activities that will rely on the criteria. A comprehensive characterization approach must take into account acceptance criteria and release criteria.

Challenge/Lessons Learned #2:

When wastes slated for one disposal facility are sent to another facility, because waste minimization activities are employed, it is important that differences in the acceptance criteria of the facilities are understood early in the planning stages.

Description: During performance of the Building 7503 Recovery Project, SEC was tasked with removing and disposing of over 100 tons of high density block shielding. Historical information indicated that the shield blocks were radioactively contaminated. Based on this information, SEC managed the material as radioactive and instituted a contract with a radioactive waste disposal facility. Blocks were packaged for transport to the radioactive waste disposal facility. As SEC was removing the shield blocks, it was noted that the vast majority of the blocks were non-contaminated. Based on these observations, SEC was able to perform a MARSSIM-based survey of the material and free-release the blocks as "clean". Free-releasing the blocks as clean and disposing of them in a local industrial landfill would save the client hundreds of thousands of dollars in transportation and disposal costs.

As SEC instituted a contract with the industrial landfill, it became apparent that the packaging and physical properties of the blocks, including their size, density, and weight may make disposition at the landfill difficult. Rather than repackaging the blocks, SEC chose to pursue a special case waste permit with the landfill to allow acceptance of the material "as is". SEC expected the special case waste permitting process to take several weeks; however the process took over 3 months and caused considerable delays in the waste management portion of the project schedule. Although the special waste permit was granted and the material was disposed at a local industrial landfill, the permitting process caused considerable delays.

Lessons Learned: Waste minimization activities performed in the field can prove to be extremely cost-effective. However, when those activities change the anticipated disposal outlets for a particular waste stream, the long-reaching effects of those changes should be considered at an early stage of the project. These changes may not be readily apparent, but should be sought out. Subtle differences in acceptance criteria can dramatically affect packaging, size-reduction and handling requirements for waste streams. Waste that was sized and packaged for a particular disposal outlet may not be acceptable to a different outlet. Ideally, characterization of waste streams should be performed before wastes are generated, so packaging and handling requirements can be specified based on characterization results. Again, proper planning at the earliest stages of a project is essential to meet aggressive schedules and budgets.

WASTE MINIMIZATION SUCCESSES ON RADD PROJECTS

Despite occasional waste minimization challenges that are common to all field projects, SEC has been able to save hundreds of thousands of dollars by implementing waste minimization strategies during RADD activities. By implementing minimization strategies such as source reduction, recycling, reuse, or salvage, SEC has reduced the volume of radioactive, hazardous and/or mixed RADD waste disposed by over 1,000 cubic yards within the last 2 years. Specific examples of waste minimization successes on RADD projects are detailed below in Table I.

TABLE I. RECENT RADD PROJECTS HAVE FEATURED EXTENSIVE USE OF WASTE MINIMIZATION ACTIVITIES TO PROVIDE DRAMATIC RESULTS.

RADD SITE/INSTALLATION	WASTE MINIMIZATION STRATEGY	RESULT
Building 3019B LOG Duct Characterization	Use of the ISOCS system to perform radiological characterization of the laboratory off-gas duct system. The ISOCS greatly reduced the need for intrusive sampling and eliminated wastes associated with intrusive sampling.	• The generation of radioactive secondary waste was reduced by > 10 CY • The possibility of contaminating tools and equipment was eliminated by not performing intrusive sampling
Building 7503 Recovery	Original scope of work called for 200 CY of radioactive waste disposal. SEC found over 107 CY of wastes in the building labeled as radioactive, slated for disposal. SEC performed innovative characterization and management techniques to maximize recycle and reuse as alternatives to disposal.	• Only 27 CY of waste was disposed as radioactive. • Approximately 100 CY of waste was released and disposed of as clean. • SEC saved 80 CY of material from disposal by recycling and reusing. • Resulted in a savings of over $200, 000 to our client.
Building 7934 RCRA Equipment Removal and RCRA Closure	SEC performed extensive decontamination of an abandoned silver recovery unit, contaminated with RCRA metals. The recovery unit was slated for disposal as hazardous waste	• Hazardous waste stream volume was reduced by over 200% • Over 10CY of clean scrap metal .was recycled
Building K-1001 Demolition	Prior to demolition of the facility, All salvageable and recyclable materials from the building.	• Salvage of over 200 CY of office furniture and materials • Recycle of over 200 lead batteries • Recycle of over 3800 mercury bulbs
Building 7602 Recovery	Radioactive waste material removed during the decommissioning was compacted, baled or melted for reuse.	• Waste processing resulted in a volume reduction of over 98%
Joyner Scrap Yard	Radioactive waste material removed during the remediation was compacted, baled or melted for reuse.	• Waste processing resulted in a volume reduction of over 40%
GAAT Stabilization	As the 150,000 gallon below ground tanks were stabilized with grout, all above ground support and process piping, risers, pumps, off-gas systems and appurtances were grouted in place within the tanks, providing a cost, effective, stable form of disposition.	• Waste volume requiring disposition was reduced by over 400% • Cost avoidance was > $200,000
KAFad Demolition	Radiologically contaminated concrete building foundations and footers were scabbled to remove contamination. The clean concrete was then surveyed and recycled.	• Over 500 CY of concrete was recycled. • Radioactive waste volume was reduced by over 150%.

Figure 4, below graphically depicts the waste volumes before and after waste minimization strategies were implemented for three of the projects described above. Each of the projects showed a marked decrease in total volume of waste disposed as well as volume of radioactive and/or hazardous waste disposed.

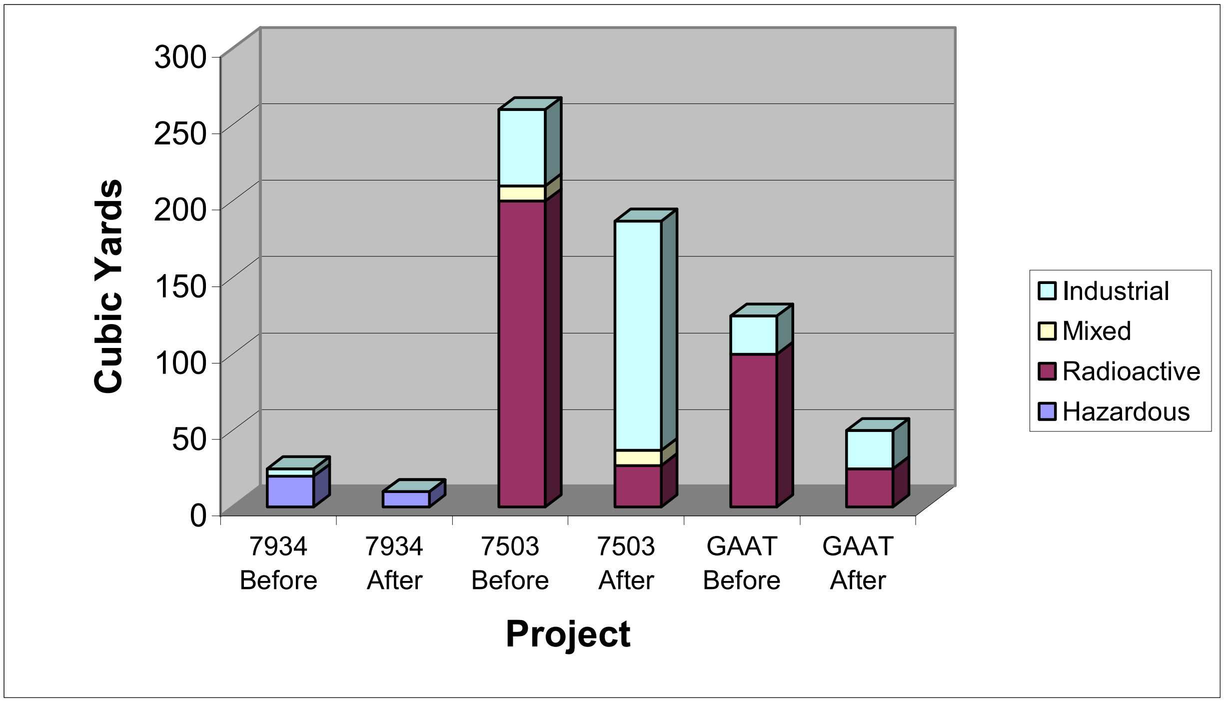

Fig. 4. Reductions in hazardous, radioactive and total waste volumes result after waste minimization activities are implemented.

Waste minimization is an integral part of any remediation strategy that SEC and BJC develop. Effective environmental restoration depends on the reduction of the quantity and toxicity of hazardous and radioactive waste. SEC has assisted BJC and proven the effectiveness of the team at taking waste minimization strategies from the planning table into the field, resulting in significant reductions in waste volumes and toxicity.