Sustainable Waste Management Planning – 11181

Tammy B. Phillips** and Mona L. Johnson***
**CDM, Oak Ridge, Tennessee 37830
***Bechtel Jacobs Company, LLC, Oak Ridge, Tennessee 37830

ABSTRACT

Sustainability is fast becoming a common term used more frequently due in part to the emphasis given by the federal government through new regulations and by the example they've chosen to set. *Sustainable Waste Management Planning* is a relatively new tool to aid the project manager in attaining the ultimate in project success—*safe, quality work at a reduced cost!*

As new sustainable technologies and processes are identified, it is important that they are shared with others to promote and enhance sustainable business practices whenever and wherever possible. Even a site with the unique mission of demolition of surplus contaminated facilities and remediation of contaminated areas, both of which increase the site's generation of hazardous, radioactive, and mixed waste, can focus efforts on finding constructive ways to weave sustainability into each and every project as well as routine day to day functions. This paper shares one site's successful sustainability waste management initiatives with the goal of fostering a desire in project managers from all industries to explore creative ways to plan their waste management activities.

INTRODUCTION

Waste management is typically one of the more expensive components of a project. The key to reducing project costs is to factor sustainability into the planning phase of the project and evaluate opportunities for minimizing the volume and/or toxicity of wastes generated. Applying sound waste management principles to reduce, reuse, and recycle result in direct cost savings. Incorporating environmentally preferable purchasing into the planning phase not only promotes the purchase of products made with recycled content materials, but also can result in zero hazardous waste generation by using biobased products. These attributes have previously been associated with Pollution Prevention/Waste Minimization, but the new terminology is sustainability.

Every project manager should solicit input from stakeholders especially your Pollution Prevention or Sustainability Coordinator during the planning phase to ensure ideas from all perspectives are considered and developed. Thinking outside the box can generate new and effective ways to minimize waste and reduce project costs. Key steps in the planning phase should include:

- Evaluating planned activities and identifying potential waste streams and materials list;
- Maintaining proper standard operating procedures to ensure waste segregation and reduce potential for leaks or spills;
- Planning tasks in a manner to minimize waste generation and efficient containerization;

*Based on work performed at the East Tennessee Technology Park, managed for the U.S. Department of Energy, under contract DE-AC05-98OR22700 with Bechtel Jacobs Company LLC.

- Substituting less toxic or non-toxic chemicals or products that can reduce the amount of hazardous waste generated and potentially generate a solid waste that has less stringent management requirements.
- Exploring opportunities to reuse materials or surplus products within your company, donate usable materials to others, and search for viable markets to reuse the materials, to extend a product's lifecycle.
- Recycling potential waste materials to the maximum extent possible and save the cost of disposition. Recycling typically generates revenue. Benefits of recycling include:
  - ✓ diverting recyclables from the waste stream avoids disposal cost and saves landfill space, making new products from the recyclables conservers natural resources and energy, and purchasing products made from recovered materials completes the cycle for sustainability;
  - ✓ Designated recycled content and biobased products are typically priced similarly to non-recycled and non-biobased content products and sometimes are even less expensive;
  - ✓ Conserves natural resources such as raw materials, energy, landfill space and results in less emissions;
  - ✓ With increased use of recyclable materials, the market demands prompt vendors and retails outlets to expand their inventory of products made with recycled content;
  - ✓ Projects designed to reduce, reuse, and recycle tend to win favor with clients as well as the public; and
  - ✓ You may be helping your local community by creating jobs or helping your local municipality to meet their "waste diversion" goals.

UNITED STATES FEDERAL SUSTAINABILITY REQUIREMENTS

Managing hazardous waste from "cradle to grave" has been the motto for the past 25 years to ensure generators are accountable for the wastes they generate until final disposal. The new motto however is managing wastes from **"cradle to cradle"** where the final destination for the waste stream is the beginning of a new product. We have shifted our focus away from finding a place to bury waste and now focus on developing new ways to divert the waste stream by reducing, reusing, or recycling.

Regulations requiring sustainable practices in purchasing have been around for many years. The Pollution Prevention Act of 1990 is the national legislation that established P2 policy. Section 6002 of the Resource Conservation and Recovery Act (RCRA) set objectives in 1994 for federal procurement agencies to develop affirmative procurement programs containing (a) a preference program for purchasing the designated items; (b) a promotion program; (c) procedures for obtaining estimates and certifications of recovered materials content and for verifying the estimates and certifications; and (d) an annual review and monitoring of the effectiveness of the program. EPA issued the Comprehensive Procurement Guideline for Products Containing Recovered Materials, 40 Code of Federal Regulations (CFR) 247to assist federal agencies in complying with Section 2006 of RCRA by designating recycled material categories for—paper and paper products, vehicular products, construction products, transportation products, park and recreation products, landscaping products, non-paper office products, and miscellaneous products. [1]

In 1998 Executive Order (EO) 13101 was issued as a means to green the government through waste prevention, recycling and Federal Acquisition. This EO first defined biobased product and established requirements for the United States Department of Agricultural (USDA) to publish designated biobased d products. This requirement ultimately was enacted in section 9002 of the Farm Security and Rural Investment Act of 2002, and biobased products were added into the federal procurement framework in

2005 by the USDA. The USDA issued final guidelines for the Federal Biobased Product Procurement Preference Program requiring all agencies to have a preferred procurement program in place by January 11, 2006. This program was to consist of: (a) a biobased product preference program; (b) a biobased product procurement promotion program; and (c) an annual review and monitoring of program effectiveness. The goal of this procurement program was to increase the Government's purchase and use of biobased products. The Secretary of Agriculture defines ***biobased products*** as "commercial or industrial products (other than food or feed) composed wholly or in significant part of biological products including renewable agricultural materials (plant, animal, and marine materials) or forestry materials". To establish a preference for the procurement of biobased products, the items must first be designated, be reasonably available, meet performance standards, and be reasonably priced—or the agency need not acquire the product(s). [2]

In 2009 Executive Order 13514 was issued as a means to demonstrate leadership by example that set sustainability goals for Federal agencies and focused on making improvements in their environmental, energy and economic performance. This order required Federal agencies to submit a 2020 greenhouse gas pollution reduction target within 90 days, and to increase energy efficiency, reduce fleet petroleum consumption, conserve water, reduce waste, support sustainable communities, and leverage Federal purchasing power to promote environmentally-responsible products and technologies. [3]

Sustainability initiatives are not only requirements for federal agencies and in government contracts, but they typically save money!

MEETING THE CHALLENGE— SUCCESSFUL SUSTAINABILITY INITIATIVES

The mission at ETTP is to demolish process and surplus buildings and remediate areas of contamination. A secondary mission is to consolidate personnel and reduce costs for operations, surveillance and maintenance. The primary mission differs from most federal facilities in that it has no active processes and minimal facility operations. Therefore, while most facilities are evaluating their processes to identify ways to generate less toxic waste streams, the focus at ETTP is demolishing contaminated buildings, which directly generates contaminated waste streams. Although the mission of site cleanup and closure at ETTP is unique, those responsible for project planning have been aggressive in their efforts to identify sustainable initiatives within each project and function. Below are some of the more interesting and successful initiatives taken to meet the sustainability challenges faced by federal agencies today.

Radio Frequency Identification Device

Radio Frequency Identification Device (RFID) technology was developed and applied for paperless onsite shipping that reduced air emissions, fuel usage, paper usage, and toner cartridge usage as well as the number of errors in the shipping information. The K-25 Project implemented a pilot program for shipping their demolition waste to the Environmental Management Waste Management Facility (EMWMF) that included more that 30,000 shipments of waste (note: a shipment is one complete cycle by the truck). The pilot project achieved their goal of eliminating twenty five minutes of idling time from each cycle as verified by the program parameters tracked on the "dashboard". Idling time occurs while waiting for hard copy shipping papers and security inspections when exiting the project. A shipping cycle starts when the truck is loaded and waiting for shipping papers, security inspections, exiting the project and driving to the landfill, dumping their waste, and returning to the project. The efficiencies noted were reduced time for inspections and waiting for shipping papers, while achieving enhanced security from the total elimination of paper shipping papers.

Further evaluation of the efficiencies revealed that the total idling time eliminated per each shipping cycle was twenty-five minutes and over 250,000 pieces of shipping paper work were eliminated. The summary data totals for waste generation avoidance, pollution prevention, and resource use avoidance were:

- idling time elimination results
  - 39.11 kiloliters of diesel
  - 1814.37 kilograms of nitrogen oxides (NO_x) emissions avoidance
  - 103,622.27 kilograms carbon dioxide (CO_2) emissions avoidance
- 250,000 sheets of paper use avoidance
  - $15,000 cost avoidance
  - 30 trees (12.19 meters high and 15.24–20.32 centimeters diameter) use avoided
  - 33.12 kiloliters of water use avoided
  - 18,450 megajoules of electricity use avoided
  - 34.0 kilograms of air pollution avoided

The RFID technology can be used to track types and quantities of waste in satellite accumulations areas; types and dates in 90-day areas; and types, location, dates or any permit parameter for any permitted waste storage area.

The K-25 Project pilot program proved the cycle time savings and other assumptions that saved the project $7.6M. The RFID paperless shipping process has been implemented at the Oak Ridge National Laboratory and the Y-12 National Security Complex with the assistance of the developers of the K-25 Project RFID pilot project. Other interested DOE sites are currently Savannah River and Portsmouth.

K-25 Decontamination & Demolition (D&D) Project Aluminum Modular Work Platforms

The aluminum modular work platforms (MWPs) purchased by the K-25 Project were used to access hazardous materials within the building and evaluate radiological aspects requiring removal from the building prior to demolition. The walkways created were self supporting and suspended above an elevated unsafe floor. Without the platforms, significant quantities of hazardous materials would have remained in the building, creating a situation where the hazardous materials would have become comingled with the building debris. The radiological screenings of certain components located in the building were critical for demolition to proceed. This situation would have resulted in the "needle in a hay stack" scenario while attempting to recover the materials to the extent possible after demolition.

The total dollars spent on the aluminum work platforms was ~$681K and the weight of the purchased materials was 56,982.10 kilograms. These MWPs contained approximately 80% post consumer recycled content which aligns with sustainability goals regarding the purchase of recycled products to conserve natural resources, save energy, reduce solid waste, reduce air and water pollutants, reduce greenhouse gases, and create new jobs. The MWPs recycled content exceeded the RCRA section 6002 recycled content requirements for threshold ramps and were accounted for in this category, since modular work platforms are not specifically listed as designated products. Unfortunately, the MWPs were demolished with the building because this was a radiological contaminated area and the cost of retrieving them and surveying for free release would have been cost prohibitive. The evaluation and/or removal of the hazardous and radiological materials did facilitate generation of a less hazardous building debris waste stream, but the overall cost savings is not quantifiable.

The K-25 project also purchased adjustable post shores used to reinforce existing supports and slab framework to allow access to areas of the building for abatement of hazardous materials. The project structural engineer knew the post shores could not be retrieved following use due to their location in a

radiological contaminated area of the building and therefore procured 500 used post shores instead of new ones.

K-1101 Air Plant Pre-Demolition Shutdown Energy and Fuel Conservation Initiative
The air plant was designed and placed into operation to support the gaseous diffusion plant operations that required very high volumes of air and had operated for over sixty years. The plant operated using an 895.2 kilowatt driven compressor with a power demand of 3,222 megajoules. The plant's operation and maintenance (O&M) cost were $137K/month or $164.4K annually with a deferred maintenance and refurbishment cost of $200K. DOE and project personnel evaluated options and replaced the antiquated plant with compressors that their total combined energy need was only 283.48 kilowatts. The evaluation expedited the deactivation of the facility that was targeted for D&D at ETTP. The resulting actual power use was 1018.8 megajoules and O&M cost of $17K/month or $204K/year. The summary data for energy conservation, fuel conservation, operational and maintenance cost avoidance, air emissions avoidance, and total cost savings are:

- 2203.2 megajoules/year use reduction
- 0.3 metric tons/year of coal use reduction by power company providing electricity
- $120K/month or $1.44M/year O&M and $200K deferred maintenance cost avoidance
- 4202.10 metric tons green house gas emission reduction (4192.10 metric tons and 9.98 metric tons sulfur dioxide)

K-1101/K-1201 Demolition Project Scrap Metal Recycling
Initial planning for the demolition of K-1101 and K-1201 industrial buildings included the identification of potential scrap metal that could be diverted from the demolition debris waste stream. The quantity of scrap metal industrial waste extracted for recycling was approximately 1,360,777.11 kilograms and 1911.39 cubic meters of potential waste diverted from landfill disposal. Total cost avoidance and revenues generated from the recycling was approximately $200K. A subsequent positive impact resulting from this initiative was an additional $100K in job producing revenues that were realized by the recycler and helped provide jobs for the local community.

K-27 Pre-Demolition American Recover and Reinvestment Act (ARRA) Project Reuse of Electrical Breakers and Coolant Recycling
The project team routinely looked for waste minimization and recycling opportunities. Through their excellent project planning and awareness, the K-27 Pre-Demolition ARRA Project implemented two sustainable initiatives. First, they responded to a need for unique electrical breakers by United States Enrichment Corporation (USEC) at the Paducah Gaseous Diffusion Plant. These specific electrical breakers are no longer manufactured, and are the only breakers that can be used in USEC's process which made them of significant strategic value to USEC. The K-27 project team coordinated with all interested parties, and shipped the electrical breakers to USEC for reuse. Reuse is cradle to cradle waste management. These breakers totaled 3810.18 kilograms and 18.8 cubic meters. To dispose of these electrical breakers would have required macroencapsulation treatment and disposal at a cost of $118.40/cubic feet. Transportation cost was estimated to be $12K. Summary of landfill space use avoided and cost savings to the project are as follows:

- 18.8 cubic meters of landfill space saved for waste that cannot be reused or recycled
- $12K transportation cost savings
- $78.6K treatment and disposal cost savings
- $90.6K total cost savings

Their second initiative involved recycling coolant from non-process equipment. The project routinely drained fluids from equipment and managed them until the appropriate disposition was determined. The 44.67 kiloliters of drained coolant was containerized in drums and stored until the final determination was made. The coolant would require treatment by incineration which would be disposal as well at a cost of $12.41/3.79 liters. Instead a recycle outlet was identified at a cost of $0.64/3.79 liters, and the 44.67 kiloliters of coolant was recycled. Hence, cradle to cradle management of the coolant was achieved. Summary of cost savings to the project are as follows:

- $146.4K treatment and disposal cost
- $7,552 recycle cost
- $138.8K total cost savings

Water Quality Projects Sustainability Initiatives

Project planning for the Water Quality Projects continues to make great strides implementing elements of sustainability such as waste segregation; dynamic management and characterization of drill cuttings and soils; purchasing and using environmentally preferable products; waste management controls; and recycling. Contractors use synthetic oils, biodegradable absorbents, Simple Green for cleaning, biodegradable antifreeze in equipment, and synthetic gear lube oil, The project team only allows non-hazardous commercial products to be used on their projects. Drilling activities receive close scrutiny to ensure source reduction practices for the generation of hazardous and radiological wastes. Reuse and/or recycling activities include reuse of dry drill cuttings and gravel from a completed project to a drilling location or site. Summary of activities are as follows:

- Recycling of all clean wastes (e.g. drink containers, product packaging)
- 1360.78 metric tons of gravel to be reused
- Polystyrene sheeting under every drill rig for pollution prevention/waste minimization

Surveillance and Maintenance (S&M) Organization's Reuse, Recycle, and Sustainable Acquisition

The S&M organization identified reuse needs for several surplus trailers, three forklifts, and 120 unused containers of maintenance and janitorial products rather than disposing of them. The trailers would have been disposed of in a local landfill. Two single wide and two double wide trailers were transferred to other projects for reuse which avoided disposal cost of approximately $5400. The surplus forklifts had an estimated value of $20K and not only was disposal avoided, but the receiving projects realized a cost savings. The maintenance and janitorial products were released for reuse through property sales avoiding hazardous waste treatment and disposal cost of $10K. The project also recycled the 0.03 metric tons of surplus iron filings previously used in a ground water treatment system that was shut down and had been identified for land disposal. The iron filings had an approximate value of $12K and landfill disposal cost would have been $1000. The data summary for the reuse and recycling initiatives are:

- $5,400 disposal cost avoidance of surplus trailers
- $20K estimated cost avoidance by the receiving projects
- $13K estimated cost avoidance for disposal and material value of iron filings
- $10K treatment and disposal cost avoidance for maintenance and janitorial products
- $48.4K total cost avoidance

General Maintenance Sustainability Initiatives and Fleet Garage Biobased Products Tested

In February 2009, representatives from Kelsan, a vendor that supplies janitorial products, provided a small seminar and discussed the benefits of going "green" to a select few who were intimately involved in the pollution prevention program. In April the vendor provided a training session to Building Service Workers and Ground Service Workers, discussing the benefits of "going green", explaining the chemistry of presently used products vs. "green products" and demonstrating how the products really work. In May

the vendor provided additional information and posters to be placed in the work areas where the chemicals are used. The posters provide on-the-spot information that is more easily understood than information in traditional material data safety sheets. The vendor also developed a "green catalogue" for the site identifying appropriate recycled content products and biobased meeting their regulatory designated standards.

At the present time, facility maintenance has phased out approximately 80% of the previously used janitorial products that do not meet "green" standards, by introducing such products as non-solvent cleaners with an emphasis on biobased products, and products made from recycled materials, e.g., trash can liners, toilet tissue, paper towels, and tissues. Not only do these products meet "green" standards, overall, they are less expensive than products previously purchased.

ETTP Maintenance groups are focusing on continued efforts to use "green products" and products made from recycled materials rather than focusing on cost. Janitorial cleaning supplies cost have been reduced by approximately $38,000 in a year. In addition, the utilization of motion sensing paper towel dispensers has saved slightly over $20,000.

The vehicle maintenance garage supervisor established a pilot program for substituting various products with bio-based products, e.g., cleaners, oil, transmission fluid, lubricants. The mechanics are also using cleaning rags made from recycled materials, and sweeping compound made of ground softwood and selected waxes. Traditional white pads and pigs were replaced by blue pigs and gray pads that contain more efficient absorbents that in turn, reduce waste. Based on reasonable cost, availability, and performance, nine biobased products were tested and evaluated; the following met all criteria and have replaced more toxic products once use at the garage:

- Bio-Blast™ Penetrant (Low Surface Tension)
- Bio-Soy Orange™ All-Purpose Degreaser/Cleaner
- Bio-Parts Cleaner/Degreaser™ (Soy Based)
- Bio-TC™ -W3 2-Cycle Engine Oil
- Bio-Chain & Cable™ Lubricants

The electrical maintenance group continues to purchase energy saving fluorescent lamps and electronic ballasts. They are presently pursuing the use of gloves made from recycled plastic, liner-less rubber splicing tape, and black vinyl electrical tape. They also continue to procure utility poles with low hazardous chemical content and re-use out-of-service poles for other applications to the extent possible.

Landfill Construction Sustainable Practices

Cell 5 and 6 EMWMF construction project team implemented sustainable practices by reusing materials and minimizing transportation environmental impacts such as energy savings (reduced diesel fuel use) and fewer greenhouse gas emissions. Their onsite borrow pit development and use of the qualified local soil and innovative recycling of trees removed during Cell 5 and Cell 6 construction enabled these positive impacts. Operations personnel used the soil from the borrow area at EMWMF as structural fill and general fill in construction of the berms surrounding Cells 5 and 6 which eliminated the need to purchase "fill material". This avoided purchase and delivery of 213,310.81 cubic meters of clean fill from off-site. Mulch was created from the 540 trees removed during construction of the borrow area using a very large mulching machine called "Hogzilla," and the 1682 to 1911.39 cubic meters of mulch was beneficially used to provide erosion and sediment control around the newly cleared area and the perimeter of Cells 5 and 6 during construction. The structural support of mulch reduced the amount of maintenance required for the silt fencing, and essentially eliminated any erosion and sediment run off. The benefits and

actual cost savings are not quantifiable, but the cost of purchasing the fill material alone would have been around $9/0.76 cubic meter or a total cost of $2.5M.

Offices/Facility Improvements
The Space Consolidation/Utilization Initiatives project eliminated 45 facility/trailer types such as mobile minis, double wide trailers, triple wide trailers, quad trailers, leased facilities. These actions resulted in 2,898,000 megajoules energy use avoidance or reduction at ETTP. Moving boxes were stored and used a minimum of three times resulting in waste generation avoidance of 3,636 boxes. More than 400 telephones were collected for reuse and/or recycle. Approximately 13 black and white and 2 color printers were returned or salvaged for a toner cost avoidance of $2025/month, and 7 copiers were reallocated instead of additional leases for a cost avoidance of $3,279/month rental fees. Other components of this initiative include the collection of office supplies, desk unit fluorescent bulbs, and furniture for reuse which results in efficiency and new product cost avoidance. The onsite reuse of furniture and office equipment resulted in a savings of approximately 24.47 cubic meters of landfill space. The metrics for energy savings, cost avoidance of purchasing or leasing and waste generation avoidance are summarized below:

- 2,898,000 megajoules energy use avoidance
- 3,636 moving boxes reused for waste generation avoidance
- >400 telephones reused or recycled for waste generation avoidance or purchasing cost avoidance
- $24,300.00 annual printer toner cartridge cost avoidance
- $39,348.00 annual copier rental cost avoidance
- office supplies, furniture, and fluorescent bulbs purchasing cost and/or waste generation avoidance

K-1035 Building Demolition Project Team Recycles Aluminum Roof Framing
The K-1035 demolition project team discovered aluminum roof framing while dismantling the roof and recognized its value. The project made the decision to remove the aluminum for recycling. The quantity of aluminum removed was 9.10 cubic meters and weighed 6985.32 kilograms. Recycling the aluminum roofing saved 9.10 cubic meters of landfill space. The cost benefits of recycling included a cost avoidance of $856 for disposal of waste, and the project received $3653.97 for the aluminum. Note that the value of recycling the material is four times greater than the cost for disposal. The total cost savings for the project was $4510.

ETTP K-1070-B Burial Ground Project Increase the Waste/Debris Disposal Rate to the EMWMF
The remedial action of the K-1070-B Burial Ground requires the majority of the 46,637.85 cubic meters of waste/debris removed from the K-1070-B Burial Ground to be sent by dump truck to the EMWMF, a local engineered and permitted landfill 12.87 kilometers away. The K-1070-B project schedule anticipated achieving a baseline waste/debris disposal rate of 19.11 cubic meters/day to meet the target project completion date of February 2010. The K-1070-B project waste/debris disposal rate averaged 100.16 cubic meters/day from November 2008 through February 2009. This reduced rate would have extended the project schedule by 13 months, at a project cost of more than $100K/month. A Six Sigma Process Improvement Project (PIP) was performed with the primary objective of increasing the disposal rate to an average of 275.24 cubic meters/day to complete the project on time.

The process improvements implemented included improving the truck waste loading technique to allow for fuller trucks thus fewer trips, eliminating unnecessary process steps by speeding up the disposal process which shortens the overall project schedule, and improving coordination with other projects to

eliminate truck idling time while waiting for shared resources to become available. There were a total of 12 individual improvements made by the project; however, only 8 required personnel re-training that were readily implemented. After implementation of the PIP improvements in March 2009, the K-1070-B project waste disposal rate increased to an average of 210.25 cubic meters/day and is projected to continue to increase. The benefits from implementation of this PIP have been to reduce the number of required truck trips, save fuel (from idling trucks), reduce CO_2 emissions, and reduce impacts to air quality. The reduced number of truck trips alone have eliminated almost 10K miles of truck driving which has resulted in the use avoidance of 6.31 kiloliters of diesel and the avoidance of 16,925.35 kilograms of CO_2 emissions. Costs avoided on the K-1070-B project from the process improvements are estimated at $1.3M.

ETTP K-1070-B Burial Ground Project Decreases the Ingress/Egress Time of Trucks Shipping Waste/Debris to the EMWMF

Shipping waste/debris from the K-1070-B Burial Ground required a routine delay due to the process of calling security to open the gate for the trucks to enter or depart from the project. This step in the process could waste significant amounts of time based on the availability of security personnel. The project team determined that they needed an automated security gate at the site entrance to alleviate this delay. After investigating the cost of a new appropriate gate, the project researched other options and located an out of service automated gate and recommend that it be moved to their project. The benefit and total cost savings are not quantifiable, but there are many positive impacts through energy savings (less diesel use), green house gas emissions reduction, and improved efficiency of trips or cycles to the landfill. By installing a used automated gate rather than buying new, this simple reuse philosophy saved the project a net $7K.

Recycling Out-of-Use Electrical Transformers from the ETTP Site Radiological Areas

Waste management planning was implemented to identify a sustainable solution to meet the daunting challenge of recycling electrical transformers located in radiologically contaminated areas on site. The project had to prove that the transformers and their drained contents were not radiologically contaminated and that they were not contaminated with Comprehensive Environmental Response, Compensation, and Liability Act hazardous substances. Once the issue of proving that the electrical transformers were not radiologically contaminated, the transformers were sampled to prove that hazardous substances were not on or in them. The next challenge was to identify a suitable recycling company that was technically and legally permitted to accept, treat, store, and recycle the transformers. BJC evaluated the recycler's compliance status and they were approved to receive the transformers. Once these obstacles were cleared, a total of 89 of 200 transformers have been recycled to date. The recycler will recover greater than 90% (by dry-weight basis) of the transformers materials. The benefits of recycling include 18.58 cubic meters of landfill space has been saved for wastes that have no other option, reduced "hands-on" work required to be performed by project personnel, and an estimated cost avoidance of $180K in labor to dismantle, downsize, and dispose.

Waste Disposition and Liquid and Gaseous Waste Operations (LGWO) Reduce, Reuse and Recycle

Sustainable waste management planning for the CT-7800 Tent Removal and Disposition project reduced transportation and disposal cost by diverting waste from hazardous waste and solid waste disposal. Surplus materials were identified for diversion from hazardous waste to solid waste disposal, reuse, and recycle after they were characterized which resulted in significant savings. Wastes totaling 229.37 cubic meters previously thought to be hazardous waste was determined to be construction and debris waste that could go to an on-site construction and debris landfill. Approximately 252.94 cubic meters of unused spare parts was determined to be qualified for recycling, and approximately 18.35 cubic meters of

electrical equipment was identified and green-tagged (surveyed and released as no radiological concerns) to go to property sales for beneficial reuse. The total cost of disposing of this volume of waste at an off-site commercial facility would have cost approximately $200K ($140K for disposal and $60K for transportation).

Another notable initiative was the Dumpster Repackaging project that identified approximately 12.69 cubic meters of waste that was construction and debris solid waste that could go to an on-site construction and debris landfill saving approximately $11,500 in transportation and disposal cost. The LGWO project also identified clean aluminum cylinders for recycling which saved landfill space and the energy to produce the raw material. When aluminum is recycled it saves 95% of the energy required to produce aluminum from raw materials.

Total cost savings for these sustainable initiatives were $212K.

Waste Disposition Project HWMA Clean-out and Transition Reuse and Recycling

During the material clean-out of the 7600 Hazardous Waste Management Area (HWMA), the volume of waste generated was minimized in order to preserve landfill space by diverting surplus materials to reuse and recycle. The project identified approximately 611.64 cubic meters of "surplus" or unwanted materials that could be sent to a local landfill for disposal. However, the project expended the time and effort to coordinate with other projects and property sales in order to save landfill space. As a result of their efforts over 95% of these materials were transferred to other projects or property sales for reuse. The metrics for landfill space saved, surplus materials value, and cost avoidance are summarized below:

- 611.64 cubic meters of landfill space saved for waste that have no other options
- $66.5K estimated market value of surplus materials
- $68K transportation cost to send surplus materials to the landfill
- $134.5K total cost avoidance and realized return from property sales

SUMMARY

Storage and management as well as treatment and disposition of hazardous, radiological, PCB, and mixed wastes are expensive. Although less expensive, the costs associated with disposal of solid wastes is not insignificant and landfill space should be used as a last resort. Plan your waste management activities up front, be creative, and save money while being a good environmental steward.

Through the variety of projects and initiatives described above, BJC has achieved great success in reducing waste toxicity, volume, and disposal costs. The numbers detailed in Table I. below demonstrate the importance of sustainable waste management planning.

Table I. Sustainability Metrics for BJC Waste Management Planning

Project/Function	Landfill Space Saved	Quantity Reused/ Recycled	Pollution Avoided	Energy/ Fuel Saved	Cost Savings (dollars)
Radio Frequency Identification Device	-	-	250,000 sheets paper; 30 trees; 1814 kg NO_x; 103,622 kg CO_2; 34 kg air pollution; 33 kL of water use	39 kL diesel; 18,450 MJ;	$7.6M

Project/Function	Landfill Space Saved	Quantity Reused/ Recycled	Pollution Avoided	Energy/ Fuel Saved	Cost Savings (dollars)
K-25 D&D Project Aluminum Modular Work Platforms	-	56,982 kg aluminum (80%) platforms; 500 used post shores	-	-	-
K-1101 Air Plant Pre-Demolition Shutdown Energy and Fuel Conservation Initiative	-	-	4202 metric tons ghg emissions	2203 MJ/yr; 0.3 metric ton/yr coal;	$200K + $1.44M/yr
K-1101/K-1201 Demolition Project Scrap Metal Recycling	1911.39 m^3	1,360,777 kg	-	-	$200K; $100K
K-27 Pre-Demolition ARRA Project Reuse of Electrical Breakers and Coolant Recycling	18.8 m^3	3810 kg used electrical breakers; 44.67 kL coolant	Air emission from incineration of 44.67 kL coolant	-	$90.6K; $138.8K
Water Quality Projects Sustainability Initiatives	-	1361 metric tons gravel	-	-	-
S&M Organization's Reuse, Recycle, and Sustainable Acquisition	-	Surplus trailers, 3 forklifts; 120 unused products; 0.03 metric tons spent iron filings	-	-	$48.4K
General Maintenance Sustainability Initiatives and Fleet Garage Biobased Products Tested	-	-	Phased out 80% of cleaning products not "green"; implemented	-	$38K $20K
Landfill Construction Sustainable Practices	1911 m^3	213,311 m^3	Trees cleared converted to 1911 m^3 mulch	-	$2.5M
Offices/Facility Improvements	24.47 m^3	3,636 boxes reused several times; 400 telephones; 15 printers; 7 copiers;	-	2,898,000 MJ	$24.3K/yr; $39.3K/yr
K-1035 Building Demolition Project Team Recycles Aluminum Roof Framing	9.10 m^3	6985 kg			$4,510

Project/Function	Landfill Space Saved	Quantity Reused/ Recycled	Pollution Avoided	Energy/ Fuel Saved	Cost Savings (dollars)
ETTP K-1070-B Burial Ground Project Increase the Waste/Debris Disposal Rate to the EMWMF	-	-	16,925 kg CO_2 emissions	6.31 kL diesel	$1.3M
ETTP K-1070-B Burial Ground Project Decreases the Ingress/Egress Time of Trucks Shipping Waste/Debris to the EMWMF	-	Reused automated gate	Reduced diesel fuel use, air emissions	-	$7K
Recycling Out-of-Use Electrical Transformers	18.58 m^3	89 transformers	-	-	$180K
Waste Disposition and LGWO Reduce, Reuse and Recycle	253 m^3; 18.35 m^3	253 m^3 of spare parts; 18.35 m^3 electrical equipment; Aluminum cylinders	229 m^3 hazardous waste downgraded to C&D waste	-	$212K
Waste Disposition Project HWMA Clean-out and Transition Reuse and Recycling	612 m^3	612 m^3 surplus materials	-	-	$134.5K

- data unavailable/not applicable
kg kilograms
kL kiloliters
MJ megajoules
M million
ghg green house gas
K thousand
yr year
m^3 cubic meter
C&D construction and demolition

REFERENCES

1 Code of Federal Regulations (CFR). 1995. Title 40, Protection of Environment, Chapter 1 Environmental Protection Agency; Subchapter I, Solid Wastes, Part 247—Comprehensive Procurement Guideline for Products Containing Recovered Materials. May 1.

2 CFR. 2005. Title 7, Agriculture, Chapter XXIX Office of Energy Policy and New Uses, Department of Agriculture; Subchapter I, Administrative Regulations, Part 2902—Guidelines for Designating Biobased Products for Federal Procurement. January 11.

3 EPA. 2009. Federal Leadership in Environmental, Energy, and Economic Performance, Executive Order 13514, October 8.