The Capitol Area East End Office Complex: A Case for Construction and Demolition Waste Diversion

December 2003

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Acknowledgments

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An Overview of Construction and Demolition Waste Management

Introduction

The mainstream construction industry has been slow to adopt integrated waste management as a business opportunity. However, increasingly construction and demolition (C&D) waste diversion (that is, salvaging and recycling) is becoming a standard business practice for many construction companies. This change is often client-driven and/or a response to local government ordinances and building permit requirements that target the C&D waste stream. Against this background, there is growing interest among building professionals for establishing best practices for C&D waste diversion programs.

This report is divided into two broad sections. The first section examines the rationale for adopting high waste diversion goals in building and construction projects, including benefits related to resource conservation, conservation of space in landfills, lower waste management costs, and enhanced neighborhood preservation. The discussion also covers procedures for implementing waste management programs, which require coordination with standard construction activities. The second section features a waste management case study of a large office complex built in a metropolitan area of California. The case study is intended to serve as a reference for building professionals. While each construction project is unique, some of the lessons learned from the case study should be transferable to other large construction projects throughout the state.

Concerning the case study project, it is noteworthy that the high C&D diversion was accomplished with relatively little adaptive reuse, deconstruction activity, or labor-intensive source separation at the construction site. Furthermore, the builder had relatively little experience in managing high-diversion waste management programs. The project's high waste diversion achievement depended on the availability of a local recycling and waste-processing infrastructure, including a recycling facility capable of sorting and processing commingled demolition debris off-site.

Public Policy in California—50 Percent Waste Diversion Mandate

In the late 1980s, California lawmakers passed groundbreaking legislation that had a mandate to divert a substantial portion of the state's municipal solid waste from landfills. This law was enacted due to awareness about the need to conserve resources, to reduce environmental degradation caused by solid waste operations, and to address a shortage of permitted landfill capacity statewide. The Integrated Waste Management Act (Assembly Bill [AB] 939, Sher, Chapter 1095, Statutes of 1989, as amended [AB 939]) requires local governments to divert 50 percent of municipal waste going to landfills by the year 2000, a goal that has not yet been fully achieved by all the state's jurisdictions.

Subsequent legislation was passed to reinforce the statewide diversion goal. AB 75 (Strom-Martin, Chapter 764, Statutes of 1999) added new provisions to the Public Resources Code (PRC), mandating that State agencies, universities, community colleges, and designated State facilities develop Integrated Waste Management Plans and divert 50 percent of their solid waste by January 1, 2004. As part of the legal requirements, large State facilities are required to submit annual reports to the California Integrated Waste Management Board (CIWMB) that documents their facility's actual solid waste diversion.

Local Government Responses to Diversion Mandate

Driven by the need to comply with State's waste diversion mandate, some local governments are targeting single-source waste streams that offer high potential to divert waste. Construction and demolition waste (C&D) is one of these "priority" solid wastes. The regulatory approaches for increasing C&D waste diversion on the local level generally include C&D waste management ordinances and building permit requirements.

One of the most compelling reasons for targeting the C&D waste stream is that it represents a significant portion of the municipal solid waste stream in many California localities. A 1999 waste characterization study, prepared by the CIWMB, determined that C&D represents about 12 percent of all municipal solid waste generated. However, C&D waste generation varies significantly from year to year due to the cyclical nature of construction activity. The quantification of the C&D waste stream is best expressed as a range due to the volatility of the generation rates. Statistically, C&D waste generation ranges between 8–20 percent of the U.S. municipal solid waste stream. However, C&D generation rate can be much higher on a local or regional basis. During the recent building boom, some California jurisdictions measured (that is, through waste characterization studies) C&D waste generation is as high as 30 percent of their municipal solid waste stream.[1]

Despite this statistic, California jurisdictions appear to be divided on the strategic value of regulating the C&D waste stream. Many local governments view the managing of this waste stream as an important element of their overall waste diversion program, while others avoid waste streams that have cyclical generation patterns. The later group is concerned that their overall municipal solid waste diversion rate would significantly decrease during years in which construction activity is below average, thus skewing the statistical norm for average years.

Decisions to target C&D wastes locally are supported by the fact that its individual waste types (cardboard, concrete, scrap wood, metal, etc.) are often served by a diverse recycling market in most urban centers. The CIWMB has recommended a C&D diversion goal between 50 to 75 percent for State construction projects that are accessible to C&D waste processors and recyclers. However, the recoverable portion of the C&D stream at any given building site will also depend on the nature of demolition and/or construction work.

For example, in the Sacramento region nearly all the concrete rubble from mass demolition activities of structures is routed to inert waste processors for crushing and recycling. Therefore the demolition of a steel-reinforced concrete parking garage would be expected to result in a high recycling rate from a mass demolition approach. On the other hand, the mass demolition of a typical "stick-built" apartment building would not necessarily yield a significant quantity of economically recoverable C&D waste materials, especially given the fact that waste volumes going to wood waste-to-energy facilities are generally in decline in California.

Local Ordinances and Permitting Requirements

Another reason some local jurisdictions are targeting C&D waste is that both its source and disposal points are relatively easy to monitor and regulate because the majority of C&D waste is disposed in the "self-haul" mode as a single source waste stream. C&D waste management goals and strategies can also be encouraged and/or mandated through the local building permit process. Since the construction industry is already subject to this local permitting process within an existing institutional framework, it is not difficult for regulators to introduce new permitting requirements for C&D waste management.

Alternatively, building permit departments may offer incentives (for example, expedited permitting, etc.) or impose disincentives to encourage builders to adopt aggressive diversion goals for construction projects and by using non-disposal C&D management strategies.

The County of Alameda, the City of San Jose, the County of Ventura, the City of Oakland, the City of Santa Monica, and the City of Sacramento are among the local jurisdictions that have adopted C&D waste recycling ordinances. For details on specific C&D ordinances, see the CIWMB Web site at www.ciwmb.ca.gov/ConDemo/.

Incentives

Local C&D waste diversion ordinances, building permit requirements, and business economics are the primary drivers for builders that elect to include high-diversion C&D waste management programs. Of course, the project-specific (internal) benefits derived from C&D waste management are distinct from the public policy justifications (that is, external and/or societal benefits) for diverting C&D wastes from landfills.

These project-specific benefits (which profit the building project's proponents) include cost avoidance of waste disposal tipping fees, reduction in waste handling costs (estimated at 2.4 hours per ton), generation of revenue from the sale of salvaged materials, and avoidance of trucking costs, especially where C&D materials are processed for reuse on-site.

Some of the most significant project-specific benefits of C&D management are non-economic in nature. For example, waste diversion efforts are often cited as mitigation measures related to environmental impacts of construction projects (California Environmental Quality Act). Deconstruction activities can also conserve historical buildings and heritage objects. As such, a project with high C&D waste diversion may be more likely to meet acceptance of planning advisory groups, which often influence key decisions integral to the local planning process.

Economics of C&D Waste Management

Unfortunately, the mainstream construction industry has been slow to view C&D waste management as a business opportunity. In fact, C&D waste management is often overlooked, even in large-scale construction projects. This oversight may occur because the decision-maker follows outdated conventional wisdom, which dictates that construction waste management is never cost-effective. In some cases, the additional work and time required for planning and coordinating a C&D waste management program may seem onerous to many contractors.

Nevertheless, more and more construction firms are finding that the decision to include C&D waste management is rewarded on their bottom line. (This is often a serendipity experience because for many firms the original motivation for including a waste management program may be compliance with a local C&D ordinance or a local permitting requirement.) The cost-effectiveness of C&D waste management is most evident once the construction company reaches the "top of the learning curve" and after the company has fully integrated waste management planning, economic analysis, and C&D waste specifications into the company's standard business procedures.

While many building projects would profit from targeted C&D waste management, the economics of managing C&D waste depends on a number of regional and project-specific factors. These variables include the following:

- General market conditions for C&D wastes.
- Access to local recycling markets.

- Types and volumes of C&D waste.
- Availability of on-site space for placing storage and/or processing waste.
- The pace of the project schedule.
- Relative haul distances to waste disposal/waste recycling facilities.
- Local landfill tipping fees.
- Ability to employ innovative or advanced waste management techniques.
- Ability to employ on-site processing of inert demolition materials for use as base and sub-base.

Project-Level Planning Considerations

A successful C&D program requires that the entire project team (that is, contractors, subcontractors, architects, waste haulers, and owners) commit to the program at an early stage. The project team should designate a C&D waste coordinator to spearhead the effort. The C&D coordinator must see that all efforts are orchestrated throughout all phases of construction and that the program is fully integrated at all management levels.

Normally the waste management procedures and requirements are discussed during the pre-bid and pre-construction kick-off meetings. Everyone on the project team must understand their respective roles and how these tasks must be coordinated to accomplish the waste management activities. Each player's responsibility needs to be clearly stated and explained. Participants should understand that they will be held accountable for failing to meet their responsibilities and contractual obligations. Recycling firms normally charge extra for processing contamination found in source-separated bins. Financial penalties are sometimes applied to subcontractors that fail to follow recycling guidelines to recover these additional costs.

Generally, the keys to successful C&D waste management are effective project planning, economic analysis, and program integration. Each step in the waste management process must be planned well in advance and coordinated with key steps in the building construction process. Table 1 on page 17 identifies most of the key decision points in the C&D waste management planning process and relates them to standard stages in the construction process.

The decision to set a C&D waste diversion goal should occur early in the project's conceptual design stage to allow for planning. The owners, the A&E firm, and other key project team members may propose targets during the preliminary cost estimating and/or programming stages. This linkage to the project's budget estimating process is appropriate because the decision to divert C&D waste has the potential to affect (hopefully improve) the project's bottom line. Sometimes the decision for establishing a high waste diversion goal supports an overarching environmental objective. For example, establishing a C&D diversion goal may help the project achieve a sustainable building rating status (for example, such as a LEED rating) or it may support mitigation of the project's environmental impacts under the California Environmental Quality Act. The decision point for this type of project-specific goal setting normally occurs very early in the project's conceptual design phase.

Economic Feasibility Study

An effective economic feasibility study for managing C&D waste (economic report) is based on an accurate waste generation study, which estimates the volume and types of waste that will be produced by scheduled demolition and construction activities. The final economic report is

normally performed when the project reaches the design development phase; however, preliminary review of waste management opportunities can occur earlier in conceptual design. This report should identify appropriate and cost-effective waste management strategies and match waste management approaches to project-specific factors. (See the Recycling vs. Disposal Economics Worksheet in Appendix A of this report, which is designed to assist the project team in evaluating C&D recycling options.)

The economic feasibility study should assess all the regional and site-specific variables discussed above. It should also consider management strategies that are best suited to each distinct phase of construction activity. For example, if the building is framed using light gauge steel studs, there may be substantial metal recycling opportunities in the framing stage of construction. The economic report should consider opportunities to reduce construction waste through source reduction and reuse. For example, can wood forming be reused for framing? Is there potential to relocate entire building structures from the construction site rather than demolish them?

Site-Specific Strategy

Each construction project presents a unique set of challenges. Often the barriers to C&D recycling can be overcome through program flexibility, ingenuity, and/or innovation. For example, space constraints at a construction site often impede source separation of recycling, due to the bin space needed to store multiple construction waste materials. In such cases, the project team may consider the option of commingling C&D wastes in a "one-bin system." However, this requires that the project is served by a materials recovery facility capable of separating the C&D waste off-site. Alternatively, they may decide to economize on space by rotating the recycling bins according to the schedule of certain construction activities or trades to recover the primary volume of segregated waste being generated by specific construction phases.

Solid Resources Management Plan

The project team should next develop a "solid resources management plan" (management plan) based on the project's C&D economic feasibility study. This planning step normally occurs after the final design is complete, often during the development of bid documents. An effective management plan should state the specific source reduction, reuse, and recycling goals based on the viable options identified in the economic feasibility study. The management plan will identify the targeted C&D waste types, detail the staged procedures and methods for managing the wastes, and identify the C&D material recycling, processing, and disposal facilities to which C&D materials will be delivered.

Bid Specification

The next planning step is the development of the bid specification. The bid package phase of construction occurs after the working drawings are complete. The solid waste management specification is the means by which the goals of the solid resources management plan are incorporated in the bid package. This step is very critical to the whole effort because it transforms the C&D waste management goals and guidelines into enforceable requirements (contractual language) to help ensure the project's diversion goals, procedures, and specifications are followed. Construction and waste management is not mentioned in the current version of CSI Master Format, however, the specification could fit in any number of places in Division 1, including the 01100 sections or the 01500 sections.

Recordkeeping and Monitoring

Effective project planning normally includes provisions for monitoring, quality control, and feedback. As such, the designated C&D waste coordinator should monitor the actual progress of

waste management activities during construction to verify that key players are coordinating their respective activities and meeting their responsibilities. For example, an audit of the weight tickets that are available from the project's recycling and disposal facilities should validate the waste contractor's reported generation and diversion numbers. The waste volume and weight documentation should be monitored to determine if the project is on track in meeting the established diversion goal. The C&D waste coordinator should also check recycling containers for contamination and to ensure that contractors are following all the provisions outlined in the solid resources management specifications. Some projects may require "tweaking" in mid-stream to remain on course.

East End Office Complex (Blocks 171–174) Construction and Demolition Waste Management Case Study

Introduction

As previously noted, each construction project presents a unique set of challenges for incorporating a C&D waste management component, especially when the project team has established waste management goals that result in high diversion rates for C&D materials in the range of 50–75 percent. The purpose of the case study is to document the incorporation of a high diversion waste management program in a large-scale construction project. As previously noted, the case study segment of the report provides a framework for evaluating the project-level waste management planning process and the program implementation in a setting that is typical for most large, metropolitan areas in California.

The C&D case study goal is to promote education about the benefits and application of the C&D waste management. The best indicators of success are ultimately the achievement of high C&D diversion goals and demonstrated cost-effectiveness of the waste management program.

Project Overview

The Capitol Area East End Office Complex Blocks 171–174 is the larger of two related State of California design-build office building projects funded through a Public Works Board revenue bond sale of $372 million. The Capitol Area East End Complex consists of 1.47 million gross square feet of office space for use by the State departments of Education and Health Services.

Blocks 171–174 lies east and south of Capitol Park and is bounded by 15th street to the west, 17th Street to the east, L Street to the north, and N Street to the south.

The waste diversion goal for the Capitol Area East End Complex design-build projects was 75 percent for all construction and demolition materials. This aggressive waste diversion target was actually part of a broader State effort to incorporate numerous sustainable concepts related to building design, construction practices, energy performance, indoor air quality, and material specifications. The California Department of General Services (the client/ building owner) collaborated with an interagency "green team" which was formed to prepare sustainable goals and criteria that were included in the request for proposals for the design-build project. The "green team" included the California Energy Commission, the Department of Health Services, the Air Resources Board, and the California Integrated Waste Management Board.

The Blocks 171–174 project was selected as the focus of this study because it features substantial demolition work (primarily mass demolition) and limited C&D waste reduction, deconstruction, and material reuse. The project also had less space constraints compared to the smaller Block 225 project. This allowed for more source separation of C&D materials on-site—primarily asphalt, concrete, brick, and metals. Nevertheless, the majority of C&D materials are stored as commingled materials on-site and sent to an off-site materials recovery facility for separation and processing.

The site superintendent for the design-builder (Clark/Gruen) was assigned the recycling coordinator responsibility for the project. He coordinated activities between the C&D recycling contractors and the various individual trades and construction subcontractors. The recycling coordinator also monitored recycling bins for contamination. Subcontractors were made aware

that recyclers charged up to $40 per hour labor for cleaning up contamination in source-separated bins, which provided an incentive to follow recycling requirements.

This case study references the project's C&D waste reporting data, which was developed by the design-builder. The case study tracks the waste generation and diversion through September 30, 2002. Since the project was substantially 95 percent complete during the time this report was prepared, it is possible to reach general conclusions about the C&D diversion efforts. The projected waste generation for the remainder of the project is not a significant amount and should not alter the fundamental conclusions of this report.

Benefits of Waste Reduction and Reuse

The project's adaptive reuse (salvage) efforts included the relocation of an eight-unit art deco apartment and 10 mature fan palms, which were replanted at Capitol Park. These efforts signaled that the building proponents cared about the preservation of the neighborhood's unique history and architectural character. Therefore, the salvage efforts probably helped abate the local resistance and controversy that typically occurs with many large construction projects

The project's diverted C&D waste during the year 2000 represented 30 percent of the total self-haul tonnage received at Kiefer landfill during that year and 3.2 percent of the City of Sacramento's total reported diverted tonnage. The total wood component that was diverted to a biomass facility amounts to the thermal energy contained in 525 barrels of # 1 or #2 fuel oil, which averages 140,000 BTUs per gallon.

The high diversion rate achieved by the project is not just the result of conventional recycling. While the majority of the activity involved mass demolition-type work, the demolition budget afforded some limited salvaging activities. For example, an eight-unit apartment building was relocated from the building site to a nearby location within the neighborhood. The building was cut in half, raised, and transported to its new location at the southwest corner of 17th and N Streets in Sacramento.

However, the primary motivation of this operation was to conserve a historically sensitive building rather than to meet waste diversion goals. In addition, 10 historic California fan palms were dug up from the construction site and replanted in Capitol Park, which is adjacent to the project site. Again, the primary driver for the decision was not waste diversion since mature fan palms have very high economic value and represent heritage trees worthy of preservation.

Clark/Gruen incorporated waste reduction measures in the construction of the outer wall to shore below-grade excavation. As an alternative to using plywood formwork with poured-in concrete, a sprayed-on cementious material was used (shotcrete). This design approach saved 45 tons of plywood (60,000 square feet) and $60,000 in material costs. In addition, reuseable steel forms were used in the majority of the project's concrete forming operations, which greatly minimized plywood use overall.[2] Clark/Gruen also instituted a requirement to reduce product packaging, but documentation of the amount of waste material reduced is not available.

There was an effort to reduce the overall impact of demolition and construction over the project's building footprint covering four city blocks. For example, Clark/Gruen committed to salvaging existing structures, sponsoring adaptive reuse, diverting construction waste from landfills, preserving heritage trees, recycling building materials, incorporating environmentally preferable building materials, and providing storage and collection facilities for recyclable materials used by building occupants.

The project's waste management efforts conveyed a sense of civic responsibility and generated local public relations (non-monetary) benefits. For example, the project's various salvage efforts

signaled that the building proponents cared about the preservation of the neighborhood's unique history and architectural character. Therefore, the salvage efforts helped abate the local resistance and controversy that typically occurs with many large construction projects.

Waste Generation and Diversion Data

Tables 2-A, 2-B, and 2-C, starting on page 17, summarize waste generation, recycling, reuse, and disposal by material type for Blocks 171–174. The tables divide the C&D waste data into three distinct waste management phases: 1) deconstruction/reuse phase 2) mass demolition phase, and 3) construction phase. The waste conversion factors (for example, volume-to-tons) are generally based on studies that reflect average densities and moisture content of waste types. In reality, the waste conversion factors for many waste types range widely due to their variability. Some of the "yards-to-tons" conversion factors used to calculate the project's C&D numbers are taken from a 1991 solid waste characteristics study commissioned by the CIWMB.[3]

However, conversion factors for asphalt concrete, brick, and metals were determined by averaging weight and volume information taken from project weight tickets. There is no conversion factor for mixed demolition because it is not a single material type; therefore it has very high potential variability. However, the waste management consultant for the project determined an average weight per ton of mixed demolition debris based on weight tickets and on-site verification. Only a portion of the C&D material generated at the project was sent to facilities with scales that provide tonnage data. Therefore, some estimates of the weight of C&D types are based on truck types and conversion factors.

The project's reuse activities occurred early in the demolition phase of the project (March–May 2000). The project's combined diverted tonnage that was recovered for reuse (as opposed to closed-loop recycling) is 460 tons. While it does not count toward the project's C&D diversion rate, it is noteworthy that the East End Project incorporated 30,000 square feet of gray marble recovered from the historic Library and Courts Building. The recovered marble was used in the ground floor lobbies of five new buildings.

The demolition phase of the project accounted for almost 70 percent of all the C&D waste generated by weight. Asphalt concrete was by far the dominant demolition waste material generated (70 percent of all demolition material by weight) due to the removal of a large area of surface parking and two blocks of city streets. Mixed demolition and brick accounted for most of the remaining demolition waste. The demolition phase lasted about seven months, from March to September 2000.

The construction phase of the project (through September of 2002) accounted for 30 percent of the project's waste by weight and is being generated over a much longer period of time compared to the demolition phase. This phase started in about October of 2000 (last reporting quarter of 2000) and is currently ongoing. Wood waste is the dominant construction waste type for the construction phase and represented about 32 percent of all construction waste generated by weight.

Pattern of Generation

There is a pattern in the generation of construction waste that mirrors the distinct stages of construction activity. This information is useful in planning C&D waste management activities, such as predicting the capacity of recycling bins needed for storing segregated waste during specific stages of construction. Cardboard, metals, plastics, and wood were generated every reporting quarter and generally increased as the project progresses to the interior finish stages. This is a predictable generation pattern because much of the material is roll-plastic used to protect finish surfaces. Also, plastic or cardboard packaging is used to protect finish construction

materials and plastic fencing is used for safety fence and to protect landscaping. Concrete construction waste generation peaked during the second quarter of 2001 and decreased dramatically after that date. Gypsum board generated from new construction was not reported until the last quarter of 2001 and increased dramatically by the second quarter of 2001.

Environmental Benefits From High Waste Diversion

A full discussion of the many avoided environmental impacts attributable to C&D waste diversion is beyond the scope of this report. However, among the environmental benefits are conservation of embodied energy, avoidance of leachate generation (water pollution), and avoidance of landfill gas (methane)—a gas that contributes, pound-per-pound, more significantly to global warming than CO_2 gas. It is noted that gypsum board (sheetrock) can also produce a toxic gas (hydrogen sulfide gas) under some conditions in disposal sites with wetter climates or higher moisture conditions.

One of the most directly measurable and significant of these benefits is conservation of landfill space.[4] A total of 14,804 tons of C&D materials were generated during the demolition and construction activities (excluding excavated soil). The waste diverted from this project saved significant space for local landfills. The diverted tonnage (12,272 tons) is 14.5 percent of all the commercial tonnage (that is, 84,400 tons received from commercial waste haulers) sent to Kiefer landfill during the 2001–02 fiscal year.

The project's diverted tonnage is 31 percent of the total commercial self-haul tonnage sent to the same facility during the year 2000, the same year the project waste was generated (that is, 39,404 tons of waste received from business-related haulers at Kiefer landfill). Most C&D waste is typically disposed in the self-haul mode in California, with commercial waste haulers accounting for most of the remainder. An estimated 12,272 tons of C&D materials were conserved for recycling and/or biomass out of the project's total waste of 14,804 tons, representing an approximate 83 percent diversion rate.

The fuel value of the project's wood waste illustrates the energy conservation value of diverting wood waste to a biomass facility (11,257 cu yd). The embodied energy of wood waste is approximately 274,482 BTUs per cubic yard for a total of more than 3.09 billion BTUs of thermal energy conserved. This is the equivalent energy of 525 barrels of #1 or #2 fuel oil. This energy would have been lost if the material had been disposed in a landfill. (Kiefer landfill is the Sacramento County's largest landfill facility, which received a total of 526,800 tons of waste during fiscal year 2001–02).

Another benefit of recycling C&D materials is the avoidance of carbon loading into the atmosphere. Recycling normally reduces energy inputs in heavy industries (upstream) and results in dramatic cuts in greenhouse gas emissions ($C0_2$). For example, for each ton of steel scrap recovered in the project, there is a per-ton savings of 60 percent of the total energy input needed to produce steel from raw ore. Greenhouse gas emissions are reduced by 0.5 ton per ton of recycled steel produced compared to steel made from virgin ore.[5]

Other Benefits: LEED Points

The U.S. Green Building Council has developed a rating system for "sustainability" in design and construction known as Leadership in Energy and Environmental Design (LEED). The rating system is divided into six broad categories as follows: 1) Sustainable Sites, 2) Water Efficiency, 3) Energy and Atmosphere, 4) Materials and Resources, 5) Indoor Environmental Quality, and 6) Innovation and Design Process. The design builder is applying for LEED Silver certification for Blocks 171–174. Based on a review of LEED 2.1 for commercial buildings, the project will

earn two LEED points for demonstrating that 75 percent of their construction wastes were diverted through recycling and/or salvaging.

Other Potential Benefits: Compliance with Local Diversion Mandate

The City of Sacramento used the CIWMB's Adjustment Method to calculate its diversion rates from 1995 through 2000. This method uses the base-year generation amount (tons disposed + tons diverted) and changes in population and the economy to estimate the generation amount in each report year. The adjustment method yields an estimated report-year generation tonnage, which is then compared to an actual annual disposal tonnage reported by municipal solid waste facilities. Under this methodology, the East End Project's large diversion tonnage amount would not positively impact the city's diversion rate. In fact, in a system predicated on disposal tonnage, an increase in disposal, although a very small percentage of generation, would negatively impact the city's diversion rate. That said, the Board does allow jurisdictions to petition for disposal deductions in cases where the projects are completely out of their control.

Another diversion rate methodology that the city could choose is a generation-based calculation where diversion and disposal tonnage are tracked annually. That methodology could result in a new base year for the city. Under that scenario, both diversion and disposal could be quantified and may help a jurisdiction to increase its diversion rate.

The city is currently working to establish a new base year (2000, 2001, or 2002), which will measure diversion tonnage from throughout the city. Since the city has yet to complete this study and gain Board approval, it is difficult to know exactly how the East End Complex will impact the city's diversion rate. The city has filed an extension with CIWMB for the year 2000 in order to allow time for them to assess their diversion numbers based on this methodology.

According to City officials, the new waste diversion measurement study for the 2000 reporting year (that is, deadline for meeting the State's 50 percent diversion mandate) and for 2001 does not consider the East End Complex's C&D waste diversion. When using a generation-based calculation to establish a new base year, large increases in diversion or disposal activity associated with one-time events might be discounted, as they are not considered representative of normal diversion/disposal activity.

Based on the adjustment methodology, approximately 367,204 tons of material was diverted in 2000. The city's disposal tonnage was 452,022 tons for 2000, yielding a total estimated generation amount of 819,226 tons. Therefore, it would take roughly 8,192 tons of material to be shifted from disposal to diversion to increase the diversion 1 percent. The city's reported waste diversion for the year 2000 calculates about 1.1 points lower after deducting the project's (Blocks 171–174) C&D waste diversion for 2000.

Table 2-A indicates that the demolition phase of the project resulted in 9,108 tons of C&D materials diverted from March through September 2000—mostly asphalt concrete, mixed demolition and concrete/brick. An additional 254 tons of construction waste was diverted from October through December 2000. Therefore the total C&D diversion from the project for the year 2000 was 9,362 tons of C&D materials, excluding excavated soil.

All diversion measurement issues aside, the city can claim this type of activity as a diversion program occurring within its boundaries. Diversion programs conducted by materials generators throughout the city are essential in helping the city meet the goals of the Integrated Waste Management Act.

Economic Benefits

Comparing Costs of Waste Management Options

Most decisions in the building and construction world are driven by cost, in particular first cost over life-cycle cost. The case study offers some insights about the cost of implementing programs that set high waste diversion goals. Alternative waste management scenarios were developed to provide a basis for comparing the actual waste management cost data. The approach is to identify and compare cost indicators for each approach, including the East End Complex's (Blocks 171–174) model program. The waste management cost indicators are broken down by distinct elements, such as tipping fees, container fees, hauling costs, and waste handling/processing. This method assumes that the cost indicators would be factored into any competitive waste management bid for either demolition or construction waste activities.

Clark/Gruen (design/builder) hired two different contractors to perform the demolition and the construction waste management work. The waste management specifications required at least 75 percent diversion by weight of all C&D waste and required the contractors to document the recycling and disposal of materials (see Appendix B). Unfortunately, it is not possible to directly compare the actual contract costs of implementing the waste diversion programs to alternative bids that allow for higher disposal of C&D waste. The alternative waste management approaches were never actually bid for the project because the 75 percent diversion requirement was established early in conceptual design.

The project's separate waste management bids for demolition and construction waste do not break down into a meaningful schedule of values by waste management activities. The waste haulers charged a flat rate for each 30-yard semi end dump load of mixed demolition and green waste going across the scales. The flat rate charge includes tipping fees, labor costs, material handling, transportation charges, and bin rental.

The demolition and construction waste contractors were allowed to keep all the revenue generated from salvage activities. While Clark/Gruen did not receive the salvage revenue, it is assumed that the salvage value helped offset the costs of recycling demolition and construction waste. The waste contractors did not charge Clark/Gruen for transporting source-separated metals and brick taken to recycling facilities.

The waste management cost indicators are compared for three alternative waste management approaches: 1) the project's high waste diversion program (83 percent diversion), 2) a hypothetical 100 percent disposal scenario, and 3) a hypothetical low C&D waste diversion scenario. The study found that the most significant comparative costs are tipping fees, off-site material processing, and salvage revenue. Other cost indicators such as hauling charges, bin charges, and on-site material processing are not significantly different between the alternatives. Overall, the project's high waste diversion program cost $83,904 less than the 100 percent disposal scenario (Table 3) and $27,320 less than the more realistic low diversion scenario (Table 4). Salvage value generated for the high diversion alternative was $10,270 compared to $2,062 for the low diversion scenario and $0.00 for the 100 percent disposal alternative.

The costs of moving the apartment and the live palms were not factored into the cost comparisons because the decisions to conserve these heritage objects were not driven by economic considerations. Also the costs for moving the apartment were not paid for by the design/builder and came from separate State funding. For information purposes, the total cost of relocating the live palms was $110,000.

Tipping Fees and Disposal Surcharges

The flat rate disposal charge at L&D landfill was the baseline for factoring tipping fees to determine the theoretical cost of 100 percent waste disposal. The flat rate charge was $300 per 30-cubic yard end dump load. There was an additional $4 per truckload waste surcharge, which does not apply to the recycling facilities. The L&D landfill facility accepts most types of C&D waste materials and has competitive disposal rates (compared to Kiefer landfill). The L&D flat disposal rate has not changed since 1997.

The tipping fees and salvage revenues for two opposite waste management scenarios are listed in Table 2-C and in Table 3. These charts reveal a potential cost savings of $83,904 (tipping fees, transportation, and handling charges) for high waste diversion as compared to the 100 percent disposal alternative. The estimated cost of tipping fees for the 100 percent disposal scenario is $218,314. In contrast, the Blocks 171–174 project high diversion scenario had a net cost of $134,410.*

Tables 2 and 3 reveal the estimated costs of tipping fees between two opposite waste management approaches (that is, high diversion vs. 100 percent disposal). However, in the real world a 100 percent disposal scenario would be unlikely. Table 4 reflects a more realistic cost based on "conventional" waste management practices. This low diversion scenario (Table 4) adjusts some of the numbers shown in the 100 percent disposal scenario (Table 3). First, the segregated metals were "backed out" of the estimated total disposal costs on the basis that materials having relatively high salvage value (segregated metals) would probably not reach a landfill. By the same token, heavy inert materials (for example, concrete, asphalt concrete, etc.) are normally not disposed in solid waste facilities in the Sacramento region given that a viable inert material recycling/processing infrastructure is available in West Sacramento. Inert material recycling is generally far more cost-effective than the disposal alternative.† Brick recycling is considered a marginal recycling activity due to its labor-intensive requirements and therefore was not backed out of the disposal calculations.

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* Seventy-five semi end dump loads of mixed demolition waste (975 tons of commingled demolition waste) were sent to L&D disposal facility. The local solid waste enforcement agency sorted out permit issues at the recycling facility that received mixed demolition waste from the project. Based on the design-builder's field verification studies performed at the Florin Perkins recycling facility, about 83 percent of the mixed demolition waste was recycled. Therefore an additional 809 tons of material potentially could have been diverted from waste disposal, either through recycling processes or used for fuel at a biomass facility (that is, wood waste). This scenario would have resulted in an overall 88 percent total diversion rate and an additional $4,800 in cost savings for the project (that is, $4,800 in cost savings in comparison to the 100 percent disposal scenario).

† An exception to this "standard practice" for asphalt concrete may occur when a demolition contractor is able to locate a fill site that will accept larger pieces of inert waste material, which is often commingled with dirt, steel, and other contamination. In such cases, the demolition contractor can often eliminate much of the labor of material preparation (as well as tipping fees), such as cleaning and sizing. However, according to the project's demolition contractor, there were no available fill sites accepting unprocessed asphalt concrete, brick, and other inert materials during the demolition project.

Self-Hauling Costs

The demolition and construction waste contractors performed their own hauling (self-hauling) rather than use large commercial waste haulers. While the transportation charges were not itemized separately, the hauling requirements for the project do not indicate higher transportation costs for the high waste diversion approach compared to the alternative scenarios. Based on discussions with the waste contractors, it appears that roughly the same number of trips (30 cubic yard semi end dump loads) would have been required for transporting materials for recycling as opposed to transporting material for disposal.

Haul distances for all of the recycling and disposal sites are within about 10 miles of the building site or less. In fact, the aggregate waste processor (EBI Aggregates) is actually closer to the building site than L&D landfill, the baseline disposal facility. This should have actually reduced the hourly hauling rate slightly for the high waste diversion scenario. The mixed demolition waste, green waste, brick recycling, and most metal recycling activities were performed at a recycling facility that is about the same distance from the building site as the baseline disposal site (L&D landfill). All of the new construction waste (beginning in October 2000) is stored in the same manner as "waste" C&D materials and is sent to Florin Perkins recycling facility as mixed demolition.

Container Fees

While the bin rental charges were not itemized separately, the bin rental requirements do not indicate higher costs for the high diversion waste management program compared to high waste disposal alternatives. This is because nearly all the recyclable construction materials are stored on-site as commingled waste (mixed demolition) for off-site processing. The technique of commingling mixed demolition materials on-site eliminates the need to store source-separated recyclable materials on-site. Therefore no additional bins are needed for the high diversion program as compared to the other disposal alternatives. The commingled recyclable materials are removed from the building site at about the same rate as disposed materials (about two bins per day). The only significant source-separated material type reported for the project was asphalt concrete. Standard demolition practice does not normally involve bin storage of asphalt concrete during demolition activities.

On-Site Waste Handling and Processing Costs

The on-site waste handling charges were not itemized separately (for example, separation, processing, loading at the construction site). However, this activity does not indicate significantly higher labor costs for the high waste diversion scenario. The largest portion of the demolition work was mass demolition, which generally did not involve source-separation or waste processing at the construction site.

The primary exception to this rule was the source-separated asphalt concrete. Except for asphalt concrete, the majority of materials were transported off-site as mixed demolition and green waste. While asphalt concrete was by far the project's dominant C&D waste material generated, the minimal processing requirements did not result in higher costs. According to the demolition contractor, the labor for processing asphalt concrete into sized, "clean" material (that is, material acceptable at no charge at the EBI Aggregates facility) was considered standard demolition practice for inert materials in the Sacramento area. This activity involves reduction of asphalt pavement into 2 by 2-ft pieces to consolidate and balance the load.

Similarly, on-site metal processing activities do not indicate significantly higher costs for recycling. There were only about 83 tons of source-separated metals processed at the construction site, representing only about 12 percent of all the generated metal. The costs for preparing the

source-separated metals for recycling is considered to be minimal because the recycling facility classified the metal as "unprepared."

This means that metal pieces were sized larger than 4 ft by 18 in. The lack of sizing indicates that the demolition contractor probably invested relatively little time in preparing the material for recycling. Also, based on the high price paid for salvage, the metal segregated on-site appears to have been heavy gauge steel (that is, thicker than one-quarter in.) such as structural beams. This material is generally much easier to sort and handle than light-gauge steel scrap.

Off-Site Sorting, Handling, and Processing

Off-site sorting and processing activities (that is, activities needed to prepare the project's mixed demolition waste for recycling) were far more labor-intensive compared to the disposal alternative. However, the labor costs for recycling were included in the "tipping fee" for mixed demolition, which ranged from $240 to $250 per each semi end dump load (30 cubic yard capacity) received at Florin Perkins recycling facility. This tipping fee was $54 to $64 less per load than the flat rate disposal charge (tipping fee) at L&D landfill (that is, the baseline disposal alternative).

Salvage Revenue

The added labor costs for processing recyclable materials such as metals, wood, gypsum, and brick were partially offset by the recycling revenue generated. For example, an estimated 611 tons of metals were recovered from the project's mixed demolition debris at Florin Perkins recycling facility. The salvaged metals were baled at Florin Perkins and sent to Schnitzer steel for shipment to steel smelters. The estimated price paid for this salvage was $12–15 per ton.‡

Unprepared metal exceeding one-quarter-inch thick is worth substantially more than lighter-gauge metal scrap. The average salvage value paid for the segregated metal (unprepared metal source-separated at the construction site) taken to Sims Metal was $25 per net ton. The total estimated salvage value for all metals was $10,270.

Gypsum board from new construction (349 tons to date) was separated off-site and sent to a Sacramento-based agricultural facility for use as composting mix and soil amendment. Florin Perkins did not reveal any details about their gypsum board recycling program. However, the recycling of gypsum board was not a revenue generating activity for the construction waste contractor. The local gypsum board processor reports that they currently charge a tipping fee of $18 per ton for accepting this material.[6] The face paper from the wallboard is returned to the client after processing. This waste paper is sometimes used as alternative daily landfill cover.

The waste composition reports reveal that 706 tons of brick were recovered from mixed demolition materials. Clean, used brick retails for about $400 per ton in the Sacramento region ($500 per pallet weighing about 2,500 lbs). While the potential retail value of the recovered brick from the project appears to be high ($282,400), the cost of recovering and cleaning brick is considered a marginal business activity.

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‡ The estimated salvage was based on cost information provided by Schnitzer steel. Florin Perkins Recycling was not able to provide actual salvage value information. Salvage steel prices depend on sizing, average thickness, and market conditions.

Lessons Learned

- Clark/Gruen (the design-builder) was initially concerned that the high diversion requirement would be a cost burden to the project. However, this concern is no longer an issue.[7] As noted in the discussion above, there is evidence that the waste diversion program improved the project's bottom line.

- The well-developed recycling infrastructure in the Sacramento region was critical to the C&D program's success (that is, high diversion rate and lower costs). In particular, Clark/Gruen gives credit to their association with Florin Perkins Recycling, the contractor that processed the project's mixed demolition waste.[8] The contractor's experience in C&D recycling probably reduced the need for program management and oversight.

- The project's waste diversion goal of 75 percent was established without the benefit of a waste composition study and an economic feasibility study. However, it is more logical to establish the waste diversion goal after a review of the economic feasibility study and full evaluation of alternative waste management opportunities. This is because the costs of high waste diversion programs often depend on a number of regional and project-specific factors. (Normally, the economic feasibility study should be available for review early in the design development phase of the project to allow time for incorporation in the project's bid documents.) This approach would allow for maximum targeting and refinement of waste management opportunities.

- The project's solid resources management plan does not reflect the comprehensive level of planning described in the previous section. For example, the plan did not identify potential permitting problems at Florin Perkins recycling facility, which resulted in the disposal of potentially recyclable material. It does not describe the project's source reduction, reuse, and deconstruction efforts. In particular, an effective deconstruction process must include sufficient time to avoid the mass demolition scenario.

- There is some evidence that the project might have benefited from more reliance on deconstruction as opposed to mass demolition. A higher level of deconstruction was not limited by on-site space constraints and may have enhanced the project's overall diversion rate without increasing project costs. There is little evidence that the opportunity was seriously evaluated in the early planning phase of the project. According to the demolition consultant's final report, there were opportunities through deconstruction to recover large amounts of wood materials, including whole roof truss systems and reusable redwood.[9] However, architectural salvage and used building material recovery was more limited because the building landlords had already removed reusable materials, such as fixtures and hardwood flooring for use in other surrounding properties.

- The design builder used different consultants to track and report on the project's waste generation, reuse, recycling, and disposal numbers for the project's separate demolition and construction waste management phases. This may have resulted in some degradation of C&D data. For example, the waste classifications reported were sometimes inconsistent, depending on which consultant was reporting. The use of a single consultant may have eliminated this problem.

Table 1—Decision Points for C&D Project Management

Project Phase	C&D Waste Management Tasks
Feasibility study of concept	Establish C&D waste diversion goal (50–75 percent goal recommended for most projects).
Budget development/programming	Preliminary economic evaluation of C&D management opportunities.
Preliminary or schematic design	
Value engineering/design development	Commission complete C&D waste management economic feasibility study.
Working drawings	
Prepare bid package	• Develop integrated waste management plan. • Incorporate C&D specifications. • Pre-bid meetings.
Demolition	• Assign project waste coordinator. • Hold meetings with demolition contractors.
Construction	Project waste coordinator performs coordination and feedback role, including continuous monitoring and outreach to contractors and subcontractors.
Building close-out	Project waste coordinator summarizes and documents the results of C&D waste management effort as may be required to qualify for LEED rating, etc.

Table 2a—Reused Waste (Demolition Phase From March–September 2000)

Type	Percent Diverted	Yards Generated	Yards/Ton Conversion	Tons Generated	Diverted Tons	Disposed Tons
Apartment (relocated)	100%	488	0.43	210	210	0
Live palms (relocated)	100%	463	0.54	250	250	0
Asphalt/concrete	100%	4,624	1.57	7,260	7,260	0
Wood/palettes (mixed demo)	100%	<311> Included in mixed demo	0.13	<40> Included in mixed demo	<40>	0
Wood sent to FP (segregated)	100%	30	0.13	4	4	0
Green waste sent to FP (segregated)	100%	510	0.21	107	107	0
Palm tree trunks (segregated)	100%	18	0.54	10	10	
Plywood/OSB	N/A	N/A	0.39	N/A	N/A	N/A

Type	Percent Diverted	Yards Generated	Yards/Ton Conversion	Tons Generated	Diverted Tons	Disposed Tons
Cardboard (included in mixed demo)	100%	<20>	0.24	<5>	<5>	0
Metals (segregated on building site)	100%	332	0.25	83	83	0
Metal (included in mixed demo)	100%	<84>	0.25	<21>	<21>	
Carpet/pad	N/A	N/A	0.40	N/A	N/A	N/A
Paint	N/A	N/A	0.70	N/A	N/A	N/A
Gypsum board	N/A	N/A	0.20	N/A	N/A	N/A
Insulation	N/A	N/A	0.01	N/A	N/A	N/A
Plastics (included in mixed demo)	100%	<36>	0.02	<1>	<1>	0
Beverage container	N/A	N/A	N/A	N/A	N/A	N/A
Red Brick (segregated)	75%	166	1.51	251	188	63
Concrete/brick (included in mixed demo)	75%	<623>	1.51	<941>	<706>	<235>
Mixed demo to Florin Perkins Recycling	84%	2,790	0.43	1200	996	204
Mixed demo to L&D disposal	0%	2,250	0.43	967	0	967
Subtotal	**88%**	**11,671**		**10,342**	**9,108**	**1,234**

Segregated Loads:

- 484 loads of concrete and asphalt taken to EBI at zero cost.
- 11 loads segregated metal to Sims Metal at $25 per net ton paid for salvage value.
- 25 loads segregated red brick to Florin Perkins at zero cost.
- 1 load segregated wood waste taken to Florin Perkins at $150 per load; 17 loads of segregated green waste taken to Florin Perkins at $150 per load.
- 1 load of palm trunks taken to Florin Perkins at $90 per load.
- 93 loads of mixed demo waste taken to Florin Perkins recycling facility at $240 per load.
- 75 loads of mixed demo waste taken to L&D disposal site at $304 per load.
- Subtotal tipping fees: $47,910.
- Subtotal of estimated revenue from metal salvaging activities: $2,600.

Table 2b—Waste Composition Table for Construction Phase (October 2000–September 2002)

Type	Percent Diverted	Yards Generated	Yards/Ton Conversion	Tons Generated	Diverted Tons	Disposed Tons
Asphalt/concrete	100%	0	1.57	0	0	0
Wood/palettes (included in mixed demo)	100%	10,946	0.13	1,423	1,423	0
Green waste	100%	0	0.02	0	0	
Plywood/OSB	N/A	N/A	0.39	N/A	N/A	N/A
Cardboard (included in mixed demo)	100%	1,066	0.24	256	256	0
Metals (included in mixed demo)	100%	2,360	0.25	590	590	0
Carpet/pad	N/A	N/A	0.40	N/A	N/A	N/A
Paint	N/A	N/A	0.70	N/A	N/A	N/A
Gypsum board (included in mixed demo)	100%	1,745	0.20	349	349	0
Insulation	N/A	N/A	0.01	N/A	N/A	N/A
Plastics (included in mixed demo)	100%	10,100	0.02	202	202	0
Beverage containers	N/A	N/A	0.02	N/A	N/A	N/A
Concrete/brick (included in mixed demo)	75%	304	1.51	459	344	115
Mixed demo (after sorting)		2,360	0.43	1,183	0	1,183
Subtotal	**71%**	**10,377**	**0.43**	**4,462**	**3,164**	**1,298**

Notes:

- Volume for all materials is based on averaged weight of mixed demo = 0.43 yards per ton.
- There were no segregated loads reported for construction phase.
- During the construction phase, a total of 346 loads of mixed demo waste was taken to Florin Perkins recycling facility at $250 per load.
- Subtotal of tipping fees: $86,500.
- Estimated gross revenue from metal recycling: $7,670.
- 590 tons salvaged metal times $13 per ton for unprepared scrap metal recovered at Florin Perkins and delivered baled to Schnitzer steel.

Table 2c—Waste Composition for Combined Construction and Demolition (March 2000–September 2002)

Type	Percent Diverted	Yards Generated	Yards/Ton Conversion	Tons Generated	Diverted Tons	Disposed Tons
Apartment (relocated)	100%	488	0.43	210	210	0
Live palms (relocated)	100%	463	0.54	250	250	0
Asphalt/concrete	100%	4,624	1.57	7,260	7,260	0
Wood/palettes (included in mixed demo)	100%	<11,257>	0.13	<1,463>	<1,463>	0
Wood (segregated)	100%	30	0.13	4	4	0
Green waste (segregated)	100%	510	0.02	107	107	0
Palm tree trunks (segregated)	100%	18	0.54	10	10	
Plywood/OSB	N/A	N/A	0.39	N/A	N/A	N/A
Cardboard (included in mixed demo)	100%	<1,086>	0.24	<261>	<261>	0
Metals (segregated)	100%	332	0.25	83	83	0
Metals (included in mixed demo)	100%	<2,444>	0.25	<611>	<611>	0
Carpet/pad	N/A	N/A	0.40	N/A	N/A	N/A
Paint	N/A	N/A	0.70	N/A	N/A	N/A
Gypsum board (included in mixed demo)	100%	<1,745>	0.20	<349>	<349>	0
Insulation	N/A	N/A	0.01	N/A	N/A	N/A
Plastics (included in mixed demo)	100%	<10,136>	0.02	<203>	<203>	0
Beverage containers	N/A	N/A	0.02	N/A	N/A	N/A
Concrete/brick (segregated)	75%	166	1.51	251	188	63
Concrete/brick (included in mixed demo)	75%	<927>	1.51	<1,400>	<1,050>	<350>
Mixed demo		15,417	0.43	6,629	4,160	2,469
Totals	**83%**	**22,048**		**14,804**	**12,272**	**2,532**

Notes:

- Volume numbers for mixed demo are based on 0.43 yards/tons conversion, which is the averaged weight for the project's commingled C&D materials.
- Combined tipping fees for demolition and construction programs: $134,410.
- Estimated salvage value of recycled metals: $10,270.

Table 3—Projected Cost of 100 Percent Disposal Scenario for Blocks 171–174

Type	Facility	Number of Loads	Disposal Surcharge	Total Cubic Yards	Charge by Material Type	Total Charge by Material Type	Percent Diverted From Landfill
Apartment	L&D	38	$152	488	$4,880	$5,032	0%
Asphalt/ concrete	L&D	484	$1,936	4,624	$46,240	$48,176	0%
Segregated wood	L&D	1	$4	30	$300	$304	0%
Green waste (segregated)	L&D	17	$68	510	$2,550	$2,618	0%
Palm tree Trunks	L&D	1	$4	18	$180	$184	0%
Metals (segregated)	L&D	11	$44	332	$3,332	$3,376	0%
Concrete/ brick (segregated)	L&D	25	$100	166	$1,660	$1,760	0%
Mixed demolition	L&D	516	$2,064	15,417	$154,170	$156,864	0%
Totals		**1,093**	**$4,372**	**21,585**	**$213,312**	**$218,314**	**0%**

Notes:

- Disposal surcharge: $4.00 per load.
- Charge by material type: $10 per cubic yard (flat rate).
- Mixed demo charges are based on estimated 516 loads at $304 per semi end dump load.
- Green waste charges are based on 17 loads at $154 per semi end dump load.

Table 4—Projected Cost of Conventional Waste Management Approach (High Disposal) for Blocks 171–174

Type	Facility	Number of Loads	Disposal; Surcharge	Total Cubic Yards	Charge by Material Type	Total Charge by Material Type	Percent Diverted from Landfill
AC	EBI	484	N/A	4,624	$0	$0	100%
Segregated wood	L&D	1	$4	30	$300	$304	0%
Green waste (segregated)	L&D	17	$68	510	$2,550	$2,618	0%
Palm tree Trunks	L&D	1	$4	18	$180	$184	0%
Metals (segregated)	Sims metal	11	N/A	332		<$2,062>	100%
Concrete and brick (segregated)	L&D	25	$100	166	$1,660	$1,760	0%
Mixed demolition	L&D	516	$2,064	15,417	$154,170	$156,864	0%
Totals		**1,055**	**$2,240**	**21,097**	**$158,860**	**$161,730**	

Notes:

- Disposal surcharge: $4 per load.
- Charge by material type: $10 per cubic yard (flat rate).
- Mixed demo charges are based on estimated 516 loads at $304 per semi end dump load; green waste charges are based on 17 loads at $154 per semi end dump load.
- Segregated metal estimated salvage value I =$2,062.

Appendix A:
Hard Copy of Economic Worksheet

Introduction

Would you like to recycle debris from your construction or demolition (C&D) project, but you don't know if it will save money or cost money? The economics of recycling on a project depends on many variables, including proximity of recyclers and landfills, wages, hauling costs, and the current economic value of the materials.

This worksheet. This worksheet can help you determine if recycling will save money on your project. The instructions are on page 1 and the worksheet is on pages 2 and 3.

Project size. This worksheet is most appropriate for residential and small commercial projects. A large commercial project may require a more extensive worksheet, such as the one in Minnesota's *Construction Materials Recycling Guidebook.*

Units of Measurement. This worksheet uses tons as the standard unit of measurement. You may substitute cubic yards for tons if it is used consistently throughout the worksheet.

Part A—Segregated Materials

1. Find recyclers in the project area by ordering the recyclers list *Construction and Demolition Recyclers—Processors and Receivers* (publication #431-96-017) from the CIWMB Hotline at 1-800-553-2962, or you may access the same list as a searchable database on the CIWMB Internet site at www.ciwmb.ca.gov/ConDemo/.
2. Choose a few materials that are easily separated and recycled. Don't overwhelm yourself at the beginning by trying to do it all. This worksheet has been set up to evaluate only four commonly recycled materials: wood, cardboard, concrete, and metals. If necessary, you may substitute other materials.
3. For each material, calculate the estimated labor costs (per ton), hauling costs (per ton), and tipping fees (per ton) and add together to determine the cost per ton to recycle that material if it is source-separated.

Part B—Recycling Mixed Materials

A materials recovery facility (MRF) accepts mixed debris and removes the marketable materials, usually by a combination of hand and machine sorting.

1. Determine if there is a MRF in your area that accepts C&D debris by visiting the C & D Recyclers Database at: www.ciwmb.ca.gov/ConDemo/Recyclers/
2. If there is no MRF nearby, skip Part B. If there is, calculate the estimated labor costs (per ton), hauling costs (per ton), and tipping fees (per ton) and add together to determine the cost per ton to recycle mixed debris at the MRF.

Part C—Landfill

1. Locate the landfill nearest the project that accepts C&D debris by consulting your local phone book or by contacting your Local Enforcement Agency for solid waste management.
2. Fill in the blanks for labor costs (per ton), hauling costs (per ton), and tipping fees (per ton) and add together to determine the cost per ton to dispose of mixed debris.

Part D—Comparison

To determine the most cost-effective option for each material, transfer cost information from Part A (segregated recycling), Part B (MRF recycling), and Part C (landfilling), and compare costs per ton of material.

CIWMB Contact

For questions, comments, and suggestions on this worksheet, contact Sabra Ambrose at sambrose@ciwmb.ca.gov, (916) 341-6464.

Project _____ Date _____

Prepared by _____

Part A–Segregated Materials

Wood: _____ tons

Labor: Time to separate one ton _____ hours
x Labor to separate one ton x $_____/hour = $_____

Hauling: Travel time to recycler _____ hours
x Hauling vehicle cost x $_____/hour
÷ Tons per haul ÷ _____ tons = $_____

Tipping: Recycler's tipping fee per ton $_____ = $_____

TOTAL= $.

Cardboard: _____ tons

Labor: Time to separate one ton _____ hours
x Labor to separate one ton x $_____/hour = $_____

Hauling: Travel time to recycler _____ hours
x Hauling vehicle cost x $_____/hour
÷ Tons per haul ÷ _____ tons = $_____

Tipping: Recycler's tipping fee per ton $_____ = $_____

TOTAL= $.

Concrete: _____ tons

Labor: Time to separate one ton _____ hours

x Labor to separate one ton x $_____/hour = $_____

Hauling: Travel time to recycler _____ hours

x Hauling vehicle cost x $_____/hour

÷ Tons per haul ÷ _____ tons = $_____

Tipping: Recycler's tipping fee per ton $_____ = $_____

TOTAL= $.

Metals: _____ tons

Labor: Time to separate one ton _____ hours

x Labor to separate one ton x $_____/hour = $_____

Hauling: Travel time to recycler _____ hours

x Hauling vehicle cost x $_____/hour

÷ Tons per haul ÷ _____ tons = $_____

Tipping: Recycler's tipping fee per ton $_____ = $_____

TOTAL= $.

Part B–Recycling Mixed Materials: _____ tons

Labor: Time to place one ton in bin _____ hours

x Labor to place one ton in bin x $_____/ hour= $_____

Hauling: Travel time to MRF _____ hours

x Hauling vehicle cost x $_____/ hour

÷ Tons per haul ÷ _____ tons = $_____

Tipping: MRF tipping fee per ton $_____ = $_____

TOTAL= $.

Part C–Landfill: _____ tons

Labor: Time to place one ton in bin _____ hours

x Labor to place one ton in bin x $_____/ hour= $_____

Hauling: Travel time to landfill _____ hours

x Hauling vehicle cost x $_____/ hour

÷ Tons per haul ÷ _____ tons = $_____

Tipping: Landfill tipping fee per ton $_____ = $_____

TOTAL= $.

Part D–Cost Comparison

To determine the most cost-effective option for each material, transfer cost information from Parts A, B, and C, and compare costs per ton of material.

From **Part A - Segregated**: From **Part B - MRF**: $_____

Wood per ton $_____

Cardboard per ton $_____

Concrete per ton $_____ From **Part C - Landfill**: $_____

Metals per ton $_____

Appendix B:
Waste Management Specifications

Section 01151

Solid Resources Management

Part 1 General

1.1 *Summary*

A. This Section Includes the Following: Procedures for ensuring optimal diversion of construction waste materials generated by the Work within the limits of the Construction Schedule and Contract Sum.

1. Assembly Bill 939, California Solid Waste Management Act, requires that localities throughout the state develop source reduction, re-use, recycling, and composting programs, to reduce the tonnage of solid waste disposed in landfills 50% by the year 2000. Construction waste materials generated by the Work are targeted to achieve these diversion rates.

2. The Work of this Subcontract shall provide for a minimum of 75% by weight of the solid resources generated in the Work to be diverted from landfill disposal through a combination of re-use and recycling activities.

3. This section includes requirements for submittal of Subcontractor's Solid Resources Management Plan prior to the commencement of the Work and Subcontractor's quantitative reports for construction waste materials generated by the Subcontractor as a condition of approval of progress payments submitted to the General Contractor.

1.2 *Definitions*

A. Class III Landfill: A landfill that accepts non-hazardous resources such as household, commercial, and industrial waste, resulting from construction, remodeling, repair, and demolition operations. A Class III landfill must have a solid waste facilities permit from the California Integrated Waste Management Board (CIWMB) and is regulated by the Enforcement Agency (EA).

B. Construction and Demolition Debris: Building materials and solid waste resulting from construction, remodeling, repair, cleanup, or demolition operations that are not hazardous as defined in California Code of Regulations, Title 22, Section 66261.3 et seq. This term includes, but is not limited to, asphalt concrete, Portland cement concrete, brick, lumber, gypsum wallboard, cardboard and other associated packaging, roofing material, ceramic tile, carpeting, plastic pipe, and steel. The debris may be commingled with rock, soil, tree stumps, and other vegetative matter resulting from land clearing and landscaping for construction or land development projects.

C. C&D Recycling Center. A facility that receives only C&D material that has been separated for reuse prior to receipt, in which the residual (disposed) amount of waste in the material is less than 10% of the amount separated for reuse by weight.

D. Disposal. Final deposition of construction and demolition or inert debris into land, including stockpiling onto land of construction and demolition debris that has not been sorted for further processing or resale, if such stockpiling is for a period of time greater than 30 days; and construction and demolition debris that has been sorted for further processing or resale, if such stockpiling is for a period of time greater than one year, or stockpiling onto land of inert debris that is for a period of time greater than one year.

E. Enforcement Agency (EA). Enforcement agency as defined in Public Resources Code 40130.

F. Inert Disposal Facility or Inert Waste Landfill: A disposal facility that accepts only inert waste such as soil and rock, fully cured asphalt paving, uncontaminated concrete (including

fiberglass or steel reinforcing rods embedded in the concrete), brick, glass, and ceramics, for land disposal.

G. Mixed Debris: Loads that include commingled recyclable and non-recyclable materials generated at the construction site.

H. Mixed Debris Recycling Facility: A processing facility that accepts loads of commingled construction and demolition debris for the purpose of recovering re-usable and recyclable materials and disposing the non-recyclable residual materials.

I. Recycling: The process of sorting, cleansing, treating and reconstituting materials for the purpose of using the altered form in the manufacture of a new product. Recycling does not include burning, incinerating or thermally destroying solid waste.

J. Reuse. The use, in the same or similar form as it was produced, of a material which might otherwise be discarded.

K. Separated for Reuse. Materials, including commingled recyclables, that have been separated or kept separate from the solid waste stream for the purpose of additional sorting or processing those materials for reuse or recycling in order to return them to the economic mainstream in the form of raw material for new, reused, or reconstituted products which meet the quality standards necessary to be used in the marketplace, and includes materials that have been "source separated".

L. Solid Waste: Refer to Public Resources Code Section 40191.

M. Source-Separated: Materials, including commingled recyclables, that have been separated or kept separate from the solid waste stream at the point of generation, for the purpose of additional sorting or processing of those materials for reuse or recycling in order to return them to the economic mainstream in the form of raw materials for new, reused, or reconstituted products which meet the quality standards necessary to be used in the marketplace.

N. Waste Hauler: A company that possesses a valid permit from the Sacramento Regional County Solid Waste Authority to collect and transport solid wastes from individuals or businesses for the purpose of recycling or disposal in Sacramento.

1.3 *Submittals*

A. Subcontractor's Solid Resources Management Plan

1. Review Contract Documents and estimate the types and quantities of materials under the Work that are anticipated to be feasible for on-site processing, source separation for re-use or recycling. Indicate the procedures that will be implemented in this program to effect jobsite source separation, such as, identifying a convenient location where dumpsters would be located, putting signage to identify materials to be placed in dumpsters, etc.

2. Refer to Section 01151C or access the CIWMB website at www.ciwmb.ca.gov for a list of local reuse and recycling organizations and companies.

3. Prior to commencing the Work, submit Subcontractor's Solid Resources Management Plan. Submit in format provided herein as Section 01151A. Solid Resources Management Plan must include, but not be limited to the following:

a. Subcontractor and project identification information;

b. Procedures to be used;

c. Materials to be re-used and recycled;

d. Estimated quantities of materials;

e. Names and locations of re-use and recycling facilities/sites;

f. Tonnage calculations that demonstrate that Subcontractor will re-use and recycle a minimum 75% by weight of the construction waste materials generated in the Work.

4. Subcontractor's Solid Resources Management Plan must be approved by the Design Builder prior to the Start of Work.

5. Subcontractor's Solid Resources Management Plan will not otherwise relieve the Subcontractor of responsibility for adequate and continuing control of pollutants and other environmental protection measures.

B. Subcontractor's Reuse, Recycling, and Disposal Report

1. Submit Subcontractor's Reuse, Recycling, and Disposal Report on the form provided herein (Section 01151B) with each application for progress payment. Failure to submit the form and its supporting documentation will render the application for progress payment incomplete and delay progress payments. If applicable, include manifests, weight tickets, receipts, and invoices specifically identifying the Project for re-used and recycled materials:

a. On-site crushing of asphalt and concrete for use off-site.

b. Reuse of building materials or salvageable items.

c. Source separated recycling facilities.

d. Mixed debris recycling facilities.

e. Recycling of material, including soils, as landfill alternative daily cover.

f. Delivery of soils or mixed inerts to an inert landfill or other use.

g. Disposal of soils or other materials at a landfill or transfer station.

h. Other (describe).

C. Subcontractor's Reuse, Recycling, and Disposal Report must quantify all materials generated in the Work, disposed in Class III Landfills, or diverted from disposal through recycling. Indicate zero (0) if there is no quantity to report for a type of material. As indicated on the form:

1. Report disposal or recycling either in tons or in cubic yards: if scales are available at disposal or recycling facility, report in tons; otherwise, report in cubic yards. Report in units for salvage items when no tonnage or cubic yard measurement is feasible.

2. Indicate locations to which materials are delivered for reuse, salvage, recycling, accepted as daily cover, inert backfill, or disposal in landfills or transfer stations.

3. Provide legible copies of weigh tickets, receipts, or invoices that specifically identify the project generating the material. Said documents must be from recyclers and/or disposal site operators that can legally accept the materials for the purpose of re-use, recycling, or disposal.

a. Indicate project title, project number, progress payment number, name of the company completing the Subcontractor's Report and compiling backup documentation, the printed name,

signature, and daytime phone number of the person completing the form, the beginning and ending dates of the period covered on the Subcontractor's Report, and the date that the Subcontractor's Report is completed.

Part 2 Products

(Not used.)

Part 3 Execution

3.1 *Salvage, Re-Use, Recycling And Procedures*

A. Identify re-use, salvage, and recycling facilities: Refer to Section 01151C, or access the CIWMB website at www.ciwmb.ca.gov for a list of local organizations and companies.

B. Develop and implement procedures to re-use, salvage, and recycle new construction and excavation materials, based on the Contract Documents, the Subcontractor's Solid Resources Management Plan, estimated quantities of available materials, and availability of recycling facilities. Procedures may include on-site recycling, source separated recycling, and/or mixed debris recycling efforts.

1. Identify materials that are feasible for salvage, determine requirements for site storage, and transportation of materials to a salvage facility.

2. Source separate new construction, excavation and demolition materials including, but not limited to the following types:

a. Asphalt.

b. Concrete, concrete block, slump stone (decorative concrete block), and rocks.

c. Green materials (i.e. tree trimmings and land clearing debris).

d. Metal (ferrous and non-ferrous).

e. Red Clay Brick.

f. Soils.

g. Wood.

h. Other new materials, as appropriate, such as wood and corrugated cardboard.

3. Develop and implement a program to transport loads of mixed (commingled) new construction materials that cannot be feasibly source separated to a mixed materials recycling facility.

3.2 *Disposal Operations And Waste Hauling*

A. Legally transport and dispose of materials that cannot be delivered to a source separated or mixed recycling facility to a transfer station or disposal facility that can legally accept the materials for the purpose of disposal.

B. Use a permitted waste hauler or Subcontractor's trucking services and personnel. To confirm valid permitted status of waste haulers, contact the Sacramento Regional County Solid Waste Authority, Pat Quinn, (916) 875-7082.

C. Become familiar with the conditions for acceptance of new construction, excavation and demolition materials at recycling facilities, prior to delivering materials.

D. Deliver to facilities that can legally accept new construction, excavation and demolition materials for purpose of re-use, recycling, composting, or disposal.

E. Do not burn, bury or otherwise dispose of solid waste on the project job-site.

3.3 *Re-Use And Donation Options*

A. Implement a re-use program to the greatest extent feasible. Options may include:

1. California Materials Exchange (CAL-MAX) Program is sponsored by the California Integrated Waste Management Board. CAL-MAX is a free service provided by the California Integrated Waste Management Board, designed to help businesses find markets for materials that traditionally would be discarded. The premise of the CAL-MAX Program is that material discarded by one business may be a resource for another business. To obtain a current Materials Listings Catalog, call CAL-MAX/California Integrated Waste Management Board at 1-877-520-9703 or send an email to CalMAX@ciwmb.ca.gov. The CALMAX Catalog is available through the Internet Site at www.ciwmb/ca.gov/Calmax/.

2. Other re-use organizations or activities including those identified in Section 01151C.

3.4 *Revenue*

A. Revenues or other savings obtained from recycled, re-used, or salvaged materials shall accrue to Subcontractor unless otherwise noted in the Contract Documents.

END OF SECTION

Section 01151A

Subcontractor's Solid Resources Management Plan

(To be Submitted and Approved Prior to Commencement of Work)

Project Title: CAPITOL AREA EAST END COMPLEX

Project No.: 105171

Subcontractor's Name:

Street Address:

City, State, Zip:

Phone: Fax:

Date Submitted: Prepared By:

These are the procedures to be used for re-using, salvaging, or recycling materials. Indicate the procedures (by number), types of materials, and estimated quantities that will be recycled or disposed in the sections below:

Source separation of materials and separately hauling to recyclers
Hauling mixed recyclables to a mixed debris recycling facility
Other (describe):

I. Re-Use/Salvage/Recycling Of Materials

Type of Material	Number of Procedure to Be Used (as above)	Facility to be Used/Location	Estimated Quantities (whenever available)		
			Tons	Cubic Yards	Units
Example: Concrete	1	ABC Recyclers, Sacramento	120		
Asphalt/Concrete					
Corrugated Cardboard					
Soils (clean)					
Wood/Green					
Scrap Metal					
Salvage Items (describe):					
Other (describe):					
Misc. Construction debris					

II. Disposal Of Materials				
Type of Material	**Facility to be Used/Location**	**Estimated Quantities (whenever available)**		
		Tons	**Cubic Yards**	**Units**
Example: Misc. Construction Debris	XYZ Disposal Sacramento	60		
Asphalt/Concrete				
Gypsum Board				
Soils (clean)				
Wood/Green				
Scrap Metal				
Other i.e., Cardboard, Paint) Please Describe:				
Misc. Construction Debris				
01151-A **Subcontractor's Solid Resources Recycling Plan** **Landfill Diversion Rate Calculation**				
Number of Tons to be Re-used and Recycled	Example: 10,000 tons	TONS		
Number of Tons to be Disposed	Example: 2,500 tons	TONS		
Total Tons Generated	Example: 12,5000 tons	TONS		
Landfill Diversion Rate (Recycled Tons/Generated Tons = Diversion Rate)	Example: 10,000/12,500 = 80%	%		

END OF SECTION

SECTION 01151B

Subcontractor's Reuse, Recycling and Disposal Report

(Submit with Each Progress Payment)

Project Title: CAPITOL AREA EAST END COMPLEX

Project No.: 105171

Subcontractor's Name:

Street Address:

City, State, Zip:

Phone: Fax:

Date Submitted: Prepared By:

These are types of recycling or disposal activities for material generated in your project. Indicate the type of recycling or disposal activity (by number), types of materials, and quantities recycled or disposed in the sections below:

1. Recycling of source separated materials at a recycling facility.
2. Recycling of mixed debris.
3. Recycling of material as landfill alternative daily cover.
4. Reuse of building materials and salvageable items.
5. Delivery of soils or mixed inerts to an inert landfill or other fill use.
6. Disposal at a landfill or transfer station.
7. Other (please describe):

Type of Material

A = Asphalt C = Concrete

M = Metals S = Soils

I = Mixed Inerts D = Mixed Construction Debris

R = Salvage/Re-use W = Wood

O = Other (Describe)

Type of Material (Put letter of material as above)	**Type of Activity to be Used** (Put number as above)	**Facility to be Used/Location** (Where materials are taken for disposal, recycling, other)	**Total Truck Loads This Month** (For the facility listed)	**Total Quantities** (All loads this month) (If Scales are available, report tons. Attach legible copies of weight tickets, receipts, or invoices that specifically identify the project generating materials. For salvage items, list quantity and approximate weight.)		
				Tons	Cubic Yards	Other documen-tation
Example: C	1	ABC Recyclers, Sacramento	5		120	
Example: R	5	Building Resources, Sacramento				10 windows (40 lbs each)

Section 01151C: Subcontractor's Reference List: a Partial List of Deconstruction, Reuse, and Recycling Organizations and Facilities

Contact the companies listed below in advance to arrange for recycling services that may include deconstruction, reuse, or recycling. Depending on the type of materials and quantities, companies may be available to process materials (such as concrete, asphalt, red clay brick, and wood) on-site and transport off-site for further processing and marketing. Other companies may have sites to which Contractor may deliver materials for recycling.

This partial list of companies is provided for the Subcontractor's convenience and information only. The Subcontractor shall verify the services provided and materials accepted by each company and shall not rely on the information provided in this list. The information was compiled from information provided by the California Integrated Waste Management Board, the City of Sacramento, and other sources. Additional recycling facilities may exist. In addition to this list, access the CIWMB Web site at www.ciwmb.ca.gov/ for a list of local reuse and recycling organizations and companies.

Contact	***Services Provided/Materials Accepted:***
Deconstruction & Reuse Companies	
B&E Salvage 10401 Gerber Road, Sacramento (916) 423-1040	Salvage/Used Building Materials
Beyond Waste 3262 Wilder Road, Santa Rosa (707) 792-2555 Contact: Pavitra Crimmel	Deconstruction services, used building material salvage, dismantling, and hand-wrecking
Blue Collar Supply 4871 Florin Perkins Rd., Sacramento (916) 383-1442	Salvage/Used Building Materials
Doors & Moore Surplus 1409 Del Paso Road, Sacramento (916) 920-2533	Salvage/Used Building Materials
P&P Building Wrecking, Inc. 8589 Florin Road, Sacramento (916) 383-6198	Salvage/Used Building Materials
The ReUse People 1119 Heritage Road, San Diego (619) 427-0430 Contact: Ted Reiff	Deconstruction services, used building material salvage, dismantling, and hand-wrecking
Surplus Lumber Sales 4018 Taylor Road, Loomis (916) 652-5826	Used lumber sales outlet
Wood Bros. Doors & Moldings 550 No. 16th St., Sacramento (916) 442-0716	Salvage/Used Building Materials
Concrete and Asphalt Recyclers	
California Concrete Crushing & Recycling 5980 Outfall Circle, Sacramento (916) 387-5050	Concrete and asphalt crushing for road base

Harbor Sand and Gravel 28th St. & The American River, Sacramento (916) 442-9089	Concrete and asphalt crushing for road base
Raisch Products 99 Pullman Way, San Jose (408) 227-9222 Contact: John Armando	On-Site Crushing
Scrap Metal Recyclers	
A-1 Metals 2655 Elkhorn Blvd, Rio Linda (916) 991-5808	Scrap Metal, Glass, Plastic
Atlas Recycling 30 Arden Way, Sacramento (916) 929-7331	Scrap Metal
Schnitzer Steel-Sacramento 12000 Folsom Rd., Sacramento (916) 927-8153	Scrap Metal
Simsmetal America 130 No. 12th Street, Sacramento (916) 444-3380	Scrap Metal
Red Clay Brick	
Brening's Rock and Supply 6325 Auburn Blvd., Citrus Heights (916) 723-1717	Used Red Clay Brick
The Brick Yard-Used Brick 8988 Elder Creek Road, Sacramento (916) 381-8012	Used Red Clay Brick
Rustic Brick Manufacturing Co., Inc. 3150 Power Inn Rd., Sacramento (916) 452-8114	Used Red Clay Brick
Wood and Green Materials	
City of Sacramento Compost Facility 2028 28th St. (28th & A), Sacramento (916) 264-7561 Contact Gary Van Dorst	Accepts wood and green materials for compost and soil amendment.
Continental Capital Wood Technology 8109 Watt Ave., #293, Antelope (916) 348-0127	Used wood
Phil Lionudakis Site located on Maheu St., Sacramento (916) 381-8191 (Cell) (209) 5838-8150 (Office)	Accepts wood and green materials for compost and soil amendment.
Tenneco 4545 Auburn Blvd., Sacramento (916) 381-3240	Used wood

Mixed Construction Debris	
Note: Recycling rates and end-uses for recovered materials at the following facilities may vary greatly. It is important for the Contractor to verify with facility operators the types of materials recovered, end-products, and recycling percentages for materials delivered to these sites.	
Atlas Disposal 3000 Power Inn Road, Sacramento (916) 737-0100 Contact: Robert Vanekoven	Recovers metal, wood, and cardboard from mixed debris loads for recycling.
Florin-Perkins Transfer Station/Sacramento 4201 Florin Perkins Rd., Sacramento (916) 383-2660 Contact: Ken Whitmire	Recovers concrete, drywall, and wood from mixed debris loads for recycling.
Kiefer Landfill 9700 Goethe Road, Suite C, Sacramento (916) 363-9390	Recovers asphalt, concrete, brick, appliances, flooring, glass, drywall, metal, paint, and wood from mixed debris loads for recycling.
L&D Landfill 8635 Fruitridge Road, Sacramento (916) 737-8640 Contact: Wayne Schindler	Recovers cardboard, green materials, scrap metal; wood; concrete, and asphalt from mixed debris loads for recycling.
Other Materials	
A&J Floor Technical Services 8950 Osage Ave., Sacramento (916) 386-8095	Carpet padding
Cal Waste Recovery 8642 Elder Creek Rd., Sacramento (916) 387-8425	Glass and wood
Strategic Materials 5850 88th St., Sacramento (916) 388-1076	Glass
Sunshine Padding & Foam Recycling 1645 Parkway Blvd. #B, Sacramento (916) 383-5213	Foam insulation, carpet padding
Soils	
Harbor Sand and Gravel 28th St. & The American River, Sacramento (916) 442-9089	Clean, non-contaminated soils without concrete, asphalt, rebar or other debris.
RMC Pacific Materials 3145 Kilgore Road Rancho Cordova, CA 95670 (916) 635-4614	Clean, non-contaminated soils without concrete, asphalt, rebar or other debris. An account with the company is required before materials can be accepted.

Granite Construction Contact Scott Wilcott (916) 564-8844	Clean, non-contaminated soils without concrete, asphalt, rebar or other debris. Contact Scott Wilcott to provide an estimate of the number of cubic yards of materials that would be delivered.

Appendix C:
Waste Management Plan

American Demolition Inc.

Demolition Materials Management Plan

Capitol Area East End Complex/State of California

Project Number 105717

Site assessment and estimated quantities of materials was preformed on June 1, 2000. On Site processing and separation of materials is as follows:

1. Concrete
2. Asphalt
3. Wood
4. Mixed Wood
5. Metals
6. Green Waste/Tree limbs and trunks

On site processing and separation of materials that cannot be recycled, and which will be landfilled are as follows:

1. Stucco
2. Plaster
3. Welded wire mesh
4. Mixed demolition debris
5. Ceiling tiles
6. Carpet
7. Drywall

Procedures to be used to process and separate materials are as follows:

A) Track loader to be utilized to demolish and stockpile concrete.

B) Track loader to be utilized to load trucks for disposal of concrete at recycling facility.

C) Track loader to be utilized to demolish and stockpile asphalt.

D) Track loader to be utilized to load trucks for disposal of asphalt at recycling facility.

E) Loader and excavator will be used to process and stockpile clean wood materials.

F) Loader to be used to load wood materials in trucks, and hauled to recycling facility for conversion to compost and by products.

G) Loader and excavator will be used to demolish and stockpile non-recyclable materials.

H) Loader will be used to load trucks with non-recyclable materials for hauling and disposal at landfill.

I) Loader and excavator will used to separate and process metals for recycling.

J) Loader will be used to load trucks for hauling of metals to recycling center.

All recycled concrete and asphalt will be processed into crushed aggregate base material. Tree limbs and trunks are milled and used for lumber. Below are listed for convenience the primary disposal and recycling sites which will be utilized on the project.

The tonnage recycled, and the facilities, which will be utilized on this project, are as follows:

Concrete and asphalt / 12,904 tons

EBI Aggregates, 1201 South River Road West Sacramento Calif

Riverside Aggregate, Port of Sacramento Calif.

Demolition Debris / 249 tons

Florin-Perkins Landfill, Inc, 4201 Florin Perkins Road Sacramento Calif.

Red Clay Brick / 683 tons

Florin-Perkins Landfill, Inc, 4201 Florin Perkins Road Sacramento Calif.

Recyclable metals / 45 tons

(See attached form 0220C for list of recycling facilities)

Tree trunks and limbs / 525 tons

Harbor sand and gravel (Calif. Hardwood Producers) 200 28th Street Sacramento Calif.

Total project tonnage: 16,647

Total tonnage recycled: 1,3474

Total percentage recycled: 76.5%

See attached form 02220A for estimated quantities of materials.

See attached form 02220C for a list of organizations and facilities to be used during the project. American Demolition / Concrete Cutting Inc., Reserves the right to use any or all of the listed facilities. In addition, other facilities, which may not be listed, could be utilized. American will get prior approval from Clark Construction for other site not listed.

See attached form 02220A for tonnage calculations, recycled versus non-recycled.

The anticipated revenue from the sale of salvaged materials is approximately $3,500.00

Landfill tipping fees, which will be saved from the recycling of asphalt and concrete approximately $28,000.00

Landfill tipping fees, which will be saved from recycling of trees, is approximately $6,720.00

Please note, the dollar amounts listed above are for data analyses only and all savings from recycling has been calculated into the original bid amount.

The only subcontractors who will directly handle recyclable materials, will be Kemper Tree Service of Roseville Calif. They will be performing tree demolition and will be recycling the trunks and limbs.

See below for a copy of the "subcontractor's reuse, recycling and disposal report." This report will be attached to the monthly invoice, along with the schedule of values.

SECTION 02220A
SUBCONTRACTOR'S DEMOLITION MATERIALS MANAGEMENT PLAN
(To Be Submitted and Approved Prior to Commencement of Work)

Project Title: CAPITOL AREA EAST END COMPLEX
Project No.: 105171

Subcontractor's Name: American Demolition / Concrete Cutting
Street Address: 2337 American Ave.
City, State, Zip: Hayward, Calif. 94545
Phone: 510-264-1890 Fax: 510-264-1898

Date Submitted: June 2, 2000 Prepared By: Lawrence Grauman

These are the procedures to be used for re-using, salvaging, or recycling materials. Indicate the procedures (by number), types of materials, and estimated quantities that will be recycled or disposed in the sections below:

1. Deconstruction (i.e. hand-wrecking) to recover salvageable materials
2. On-Site concrete and asphalt crushing for use off-site
3. Source separation of materials and separately hauling to recyclers
4. Hauling mixed recyclables to a mixed debris recycling facility
5. Other (describe):

I. Re-Use/Salvage/Recycling Of Materials

Type of Material	Number of Procedure to Be Used (as above)	Facility to be Used/Location	Estimated Quantities (whenever available)		
			Tons	Cubic Yards	Units
Concrete	3	EBI Aggregates	9738	6086	NA
Asphalt/Concrete	3	EBI Aggregates	3166	1978	NA
Corrugated Cardboard					
Soils (clean)					
Wood/Green	3	Calif. Hardwood	525	NA	NA
Scrap Metal	3	See form 0220c	45	NA	NA
Salvage Items (Describe):	None	None	NA	NA	NA
Other (Describe):					
Misc. Demolition Debris					

II. Disposal Of Materials				
Project Title: CAPITOL AREA EAST END COMPLEX Project No.: 105171				
Type of Material	**Facility to be Used/Location**	**Estimated Quantities (whenever available)**		
		Tons	**Cubic Yards**	**Units**
Misc. Demolition Debris	Florin-Perkins	2490	2988	Misc. demo-lition debris
Asphalt/Concrete	NA	NA	NA	NA
Gypsum Board	NA	NA	NA	NA
Soils (clean)	NA	NA	NA	NA
Wood/Green	NA	NA	NA	NA
Scrap Metal	NA	NA	NA	NA
Other (i.e., Cardboard, Paint) Please Describe:	Brick/ Florin Perkins	683	621	NA
Misc. Demolition Debris				
Section 02220A SUBCONTRACTOR'S DEMOLITION MATERIALS RECYCLING PLAN LANDFILL DIVERSION RATE CALCULATION				
Number of Tons to be Re-Used and Recycled	See pages 1 and 2	1374 tons		
Number of Tons to be Disposed	See pages 1 and 2	3173 tons		
Total Tons Generated		16647 tons		
Landfill Diversion Rate (Recycled Tons/Generated Tons = Diversion Rate)		76.5 %		

Section 02220C: Subcontractor's Reference List: A Partial List Of Deconstruction, Reuse, and Recycling Organizations and Facilities

Contact the companies listed below in advance to arrange for recycling services that may include deconstruction, reuse, or recycling. Depending on the type of materials and quantities, companies may be available to process materials (such as concrete, asphalt, red clay brick, and wood) on-site and transport off-site for further processing and marketing. Other companies may have sites to which Contractor may deliver materials for recycling.

This partial list of companies is provided for the Subcontractor's convenience and information only. The Subcontractor shall verify the services provided and materials accepted by each company and shall not rely on the information provided in this list.

This list was compiled from information provided by the California Integrated Waste Management Board, the City of Sacramento, and other sources. Additional recycling facilities may exist. In addition to this list, access the CIWMB Web site at www.ciwmb.ca.gov/ for a list of local reuse and recycling organizations and companies.

Contact	***Services Provided/Materials Accepted:***
Deconstruction & Reuse Companies	
B&E Salvage 10401 Gerber Road, Sacramento (916) 423-1040	Salvage/Used Building Materials
Beyond Waste 3262 Wilder Road, Santa Rosa (707) 792-2555 Contact: Pavitra Crimmel	Deconstruction services, used building material salvage, dismantling, and hand-wrecking
Blue Collar Supply 4871 Florin Perkins Rd., Sacramento (916) 383-1442	Salvage/Used Building Materials
Doors & Moore Surplus 1409 Del Paso Road, Sacramento (916) 920-2533	Salvage/Used Building Materials
P&P Building Wrecking, Inc. 8589 Florin Road, Sacramento (916) 383-6198	Salvage/Used Building Materials
The ReUse People 1119 Heritage Road, San Diego (619) 427-0430 Contact: Ted Reiff	Deconstruction services, used building material salvage, dismantling, and hand-wrecking
Surplus Lumber Sales 4018 Taylor Road, Loomis (916) 652-5826	Used lumber sales outlet
Wood Bros. Doors & Moldings 550 No. 16th St., Sacramento (916) 442-0716	Salvage/Used Building Materials
Concrete and Asphalt Recyclers	
California Concrete Crushing & Recycling 5980 Outfall Circle, Sacramento (916) 387-5050	Concrete and asphalt crushing for road base

Harbor Sand and Gravel 28th St. & The American River, Sacramento (916) 442-9089	Concrete and asphalt crushing for road base
Raisch Products 99 Pullman Way, San Jose (408) 227-9222 Contact: John Armando	On-Site Crushing
Scrap Metal Recyclers	
A-1 Metals 2655 Elkhorn Blvd, Rio Linda (916) 991-5808	Scrap Metal, Glass, Plastic
Atlas Recycling 30 Arden Way, Sacramento (916) 929-7331	Scrap Metal
Schnitzer Steel-Sacramento 12000 Folsom Rd., Sacramento (916) 927-8153	Scrap Metal
Simsmetal America 130 No. 12th Street, Sacramento (916) 444-3380	Scrap Metal
Red Clay Brick	
Brening's Rock and Supply 6325 Auburn Blvd., Citrus Heights (916) 723-1717	Used Red Clay Brick
The Brick Yard-Used Brick 8988 Elder Creek Road, Sacramento (916) 381-8012	Used Red Clay Brick
Rustic Brick Manufacturing Co., Inc. 3150 Power Inn Rd., Sacramento (916) 452-8114	Used Red Clay Brick
Wood and Green Materials	
City of Sacramento Compost Facility 2028 28th St. (28th & A), Sacramento (916) 264-7561 Contact Gary Van Dorst	Accepts wood and green materials for compost and soil amendment.
Continental Capital Wood Technology 8109 Watt Ave., #293, Antelope (916) 348-0127	Used wood
Phil Lionudakis Site located on Maheu St., Sacramento (916) 381-8191 (Cell) (209) 5838-8150 (Office)	Accepts wood and green materials for compost and soil amendment.
Tenneco 4545 Auburn Blvd., Sacramento (916) 381-3240	Used wood

Mixed Construction Debris	
Note: Recycling rates and end-uses for recovered materials at the following facilities may vary greatly. It is important for the Contractor to verify with facility operators the types of materials recovered, end-products, and recycling percentages for materials delivered to these sites.	
Atlas Disposal 3000 Power Inn Road, Sacramento (916) 737-0100 Contact: Robert Vanekoven	Recovers metal, wood, and cardboard from mixed debris loads for recycling.
Florin-Perkins Transfer Station/Sacramento 4201 Florin Perkins Rd., Sacramento (916) 383-2660 Contact: Ken Whitmire	Recovers concrete, drywall, and wood from mixed debris loads for recycling.
Kiefer Landfill 9700 Goethe Road, Suite C, Sacramento (916) 363-9390	Recovers asphalt, concrete, brick, appliances, flooring, glass, drywall, metal, paint, and wood from mixed debris loads for recycling.
L&D Landfill 8635 Fruitridge Road, Sacramento (916) 737-8640 Contact: Wayne Schindler	Recovers cardboard, green materials, scrap metal; wood; concrete, and asphalt from mixed debris loads for recycling.
Other Materials	
A&J Floor Technical Services 8950 Osage Ave., Sacramento (916) 386-8095	Carpet padding
Cal Waste Recovery 8642 Elder Creek Rd., Sacramento (916) 387-8425	Glass and wood
Strategic Materials 5850 88th St., Sacramento (916) 388-1076	Glass
Sunshine Padding & Foam Recycling 1645 Parkway Blvd. #B, Sacramento (916) 383-5213	Foam insulation, carpet padding
Soils	
Harbor Sand and Gravel 28th St. & The American River, Sacramento (916) 442-9089	Clean, non-contaminated soils without concrete, asphalt, rebar or other debris.
RMC Pacific Materials 3145 Kilgore Road Rancho Cordova, CA 95670 (916) 635-4614	Clean, non-contaminated soils without concrete, asphalt, rebar or other debris. An account with the company is required before materials can be accepted.
Granite Construction Contact Scott Wilcott (916) 564-8844	Clean, non-contaminated soils without concrete, asphalt, rebar or other debris. Contact Scott Wilcott to provide an estimate of the number of cubic yards of materials that would be delivered.

Bibliography

Conversion Factors for Individual Material Types. CalRecovery Incorporated, December 1991, pp. 15–21.

Lewis, Michael, Jeffrey Vandall, and Neil Seldman. "Economic and Environmental Impacts of Construction and Demolition Recycling," Institute for Local Self-Reliance, January 1995, section VII.

Strategies for Waste Reduction of Construction and Demolition Debris from Buildings. U.S. Environmental Protection Agency, June 2000, p. 1.

Tchobanoglous, George. *Integrated Solid Waste Management: Engineering Principles and Management Issues*, New York: McGraw-Hill, 1993, p. 138, table 6–3.

Endnotes

1 Tchobanoglous, George, *Integrated Solid Waste Management: Engineering Principles and Management Issues*, 1993, p. 138, table 6-3.

2 Communication with Kelly Ingalls of KMI Associates, May 19, 2003.

3 *Conversion Factors for Individual Material Types*, CalRecovery Incorporated, December 1991, pp. 15–21.

4 *Strategies for Waste Reduction of Construction and Demolition Debris from Buildings*, U.S. Environmental Protection Agency, June 2000, p. 1.

5 Lewis, Michael, Jeffrey Vandall, and Neil Seldman, Institute for Local Self-Reliance, "Economic and Environmental Impacts of Construction and Demolition Recycling," January 1995, section VII.

6 Communication with Al Lopez, Lopez Agricultural Services, February 27, 2003.

7 Communication with Tom Crane, Clark/Gruen Design Build, Inc., December 14, 2002.

8 Ibid., December 14, 2002.

9 Project Memorandum from KMI Associates to Gruen Associates Architects, March 28, 2001.