

Introduction

Construction and demolition debris (C&DD) comprise 15 to 20 percent of all the solid waste generated in Ohio.

This significant portion of the overall waste stream has not been the focus of traditional waste reduction efforts in Ohio. That focus is now changing.

The construction and demolition industry in Ohio has been relatively fortunate in the past to have some of the lowest disposal costs in the country. However, as nearby landfills fill up and close and the development of new landfills becomes more difficult and expensive, the cost of waste disposal for construction and demolition contractors will increase. Although most contractors already use materials efficiently, this rise in disposal costs will force contractors and waste haulers to consider new waste reduction and recycling alternatives to more effectively manage waste.

The purpose of this guidebook is to help construction and demolition contractors in Ohio develop and implement efficient programs to reduce the amount of waste they generate and dispose.

Acknowledgements

Many people and organizations contributed to the development of this guidebook. We would like to thank the following for their contributions.

*Carolyn Watkins, Ohio EPA, Chief, Environmental Education Fund
Nancy Moore, Ohio EPA, Office of Pollution Prevention
Diane Shew, Association of Ohio Recyclers
Irm Schubert, President, Association of Ohio Recyclers
Holly Christmann, Hamilton County Environmental Services
Solid Waste Authority of Central Ohio
Hamilton County Environmental Services
Mary Wiard, Waste Alternatives, Inc.
Dave Loewendick, S.G. Loewendick & Sons, Grove City, Ohio
Drew Lammers, King Wrecking Co., Inc., Cincinnati, Ohio
Builders Association of Greater Indianapolis
USEPA, Region 5
Illinois, DuPage County Solid Waste Department*

Disclaimer

The information in this guidebook is provided as a service to organizations seeking information about reducing and recycling construction and demolition waste. Inclusion of specific information regarding a particular company or process in this guidebook does not constitute endorsement by any of the sponsors or authors, nor does it suggest that the companies listed are in compliance with all applicable laws.

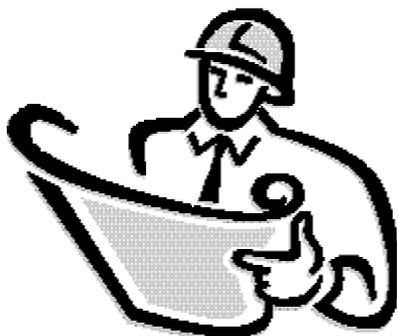
Additional Information

To obtain a copy of Ohio's Construction and Demolition Recycling Directory for C&DD recyclers in your area or if you have any questions regarding updates to this guidebook, please call the Ohio Environmental Protection Agency, Office of Pollution Prevention at 614/644-2928.

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Common Terms

Construction Waste

Materials generated from the construction of homes, residential/commercial buildings, and municipal structures.

Demolition Debris

Waste generated from the demolition of homes, buildings, commercial and municipal structures, roads, bridges, and parking lots.

C&DD

Construction waste and demolition

debris

OCC

Old corrugated cardboard.

Mixed-Material Collection and Processing

Recycling technique in which recyclable materials are taken from the job-site in a mixed load, separated at a designated facility, and sent to processors.

Source-Separation

Recycling technique in which similar materials are separated from other materials at the job-site according to categories such as

wood, metal, and concrete, and sent to processors

Time-Based Separation

Recycling technique in which the efforts to recover a particular material are focused during the period of construction in which the material is generated.

Waste Stream

The total flow of waste materials from a particular community or segment of a community, as it moves from origin to disposal.

How Can This Guidebook

Help Your Bottom Line?

Government Demolition Project

Project Description:

- Civil Defense Storage Buildings, Columbus, Ohio - era - 2nd World War
- Three 160'x1,541' buildings - 246,560 sq. ft. Total: 739,680 sq. ft.
- Site Materials consisted of: timber construction, clay tile walls and concrete slabs

Prime Demolition Contractor:

S. G. Loewendick & Sons, Grove City, Ohio

Salvage: 100 tons aluminum and 600 tons scrap steel

Reuse: 600 6"x6" timbers, 4,000 6"x12" timbers, 900 12"x12" timbers

739,680 sq.ft. concrete slab plus footings - 100% recycled
60,000 ton concrete crushed into 304 ton aggregate

9,000 ton miscellaneous clay tile walls and roof sheathing materials disposed

Total tonnage recycled: 70,600

88% of total building components
12% disposed at C&DD landfill

61,000 tons or approximately 3,500 loads diverted from waste stream

Savings: approximately \$300,000 landfill fees
Residential Demolition Project

Project Description:

- Framed and masonry apartment buildings. Kemper and Montgomery Roads, Cincinnati, Ohio
- Fifteen buildings Total: 330,000 sq. ft.
- Site Materials consisted of: brick, steel, drywall and metals

Prime Demolition Contractor:

King Wrecking, Inc., Cincinnati, Ohio

Salvage: One ton metal - \$500 saved

14,000 tons concrete - \$24,500 saved

100 tons steel - \$1,200 saved

Total tonnage recycled: 14,200

Total Savings: \$26,200



*Refer to Appendix D for additional Construction/Demolition Project

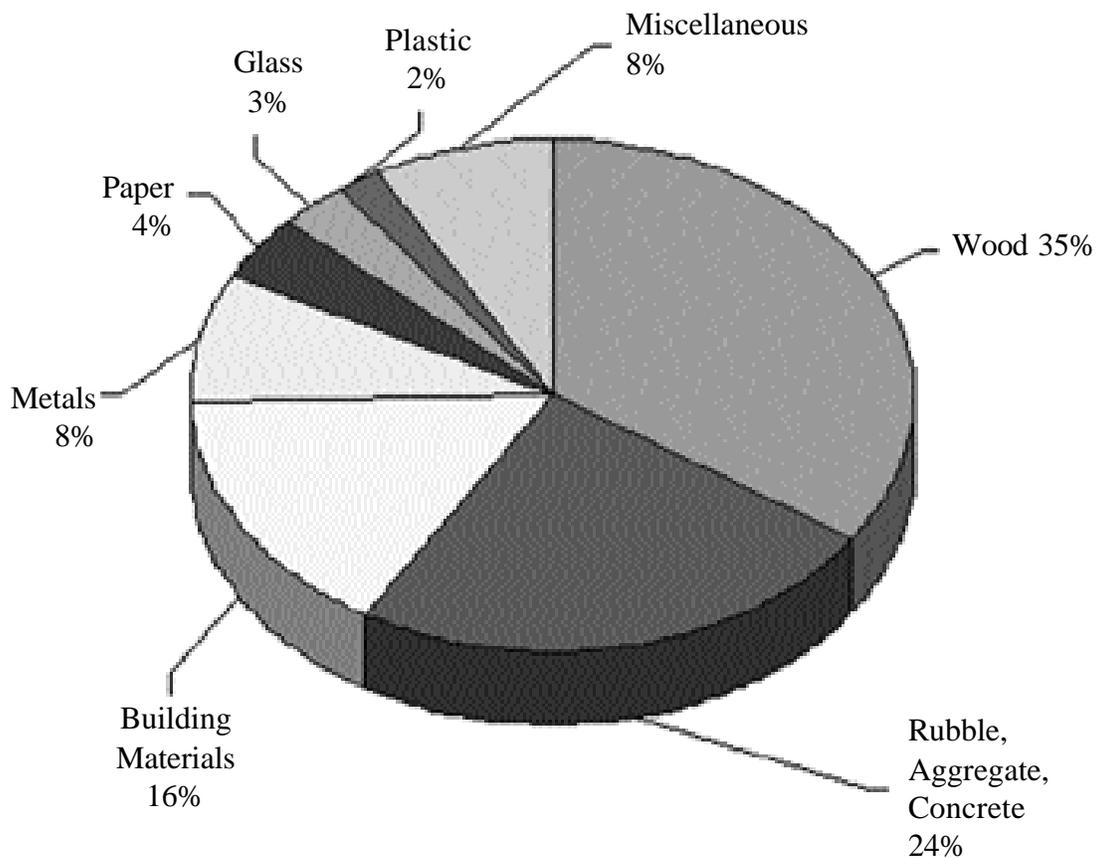
Overview of C&DD

A Few Examples

Examples of waste compositions from construction and demolition sites are presented below. These composition estimates are very general and demonstrate the types of materials that comprise C&DD. The actual waste compositions from each site can vary considerably based on the type of construction techniques used, the primary structural materials employed (e.g., wood, steel, concrete, brick), and the type of structure being built or demolished.

Although the waste components vary from site to site and from segment to segment, one thing remains consistent - many materials in construction and demolition debris are valuable and can be economically recovered from the waste.

Composition of C&DD



Source: Construction & Demolition Debris....A Primer

Overview of Waste Handling Methods

Traditionally, most waste from construction and demolition sites is placed into roll-off containers (typically 20 cubic yards in size) by the contractor or the various subcontractors on the site, and removed from the site as the containers fill up. Contractors do not often pay much attention to where the materials go when they are taken off the site.

Some waste haulers have made an effort to remove valuable materials from these waste loads and send them to processors for recycling. Such materials include concrete, steel, wood, and OCC. If a load is fairly uniform in any one of these materials, the hauler may take it directly to a recycled material processor.

However, as shown by the composition estimate on the previous page, construction waste consists of

many more materials than concrete, steel, wood, and OCC. In addition, most waste from a construction or demolition site is not uniform in any one material.

There are other approaches to recycling, such as source-separation, time-based separation, and mixed-material collection and processing, that can effectively address a wider range of recyclable materials and enhance the value of the materials. Some of these approaches require additional effort on the part of the contractor, whereas others do not.

This guidebook will help contractors evaluate each of these approaches for job sites.



Recycling Programs

- source separation
- time-based separation
- mixed-material collection and processing

Issues That Affect C&DD Recycling

The state of recycling is a mixed bag. Concrete and asphalt recycling has the most developed infrastructure because it has become common practice to recycle these materials into reusable aggregate. Recycled concrete aggregate is commonly used as base material in road projects, recycled asphalt aggregate is used in pavement for new road and parking lot construction, and both recycled aggregates are used as fill material. In addition, metal recycling from building and demolition projects is also very common. However, processing operations for other construction materials, especially demolition wood and dry-wall gypsum, are not as readily available.

There are several causes for the lack of recycling markets for some C&DD materials.

1 Waste disposal (i.e., landfill tipping fees) has been relatively inexpensive, often causing recycling to be a cost-prohibitive option for contractors.

2 Some C&DD recyclers have done a poor job of processing and marketing materials, thereby causing market prices to fluctuate

markets to deteriorate.

3 It may be difficult to cost-effectively process some C&DD materials for recycling because many of the processing operations are currently regulated in the same manner as waste transfer stations. Since the regulatory requirements for transfer stations are fairly rigorous, these facilities are often more costly to permit, build, and operate than other recycling facilities.

In addition, due to past illegal C&DD recycling operations, some local governments are now placing greater restrictions on C&DD recycling facilities to reduce the potential for site clean-ups in the future.

Recent surveys were prepared and distributed to solicit contractor attitudes toward recycling. Ninety-five percent of local contractors who respond to the surveys indicated support of recycling programs. However, many believe that most recycling programs are too costly or require too much labor to implement. In addition, many contractors indicated they lacked information about how to set up recycling programs or who was available to take the materials.

Ohio Regulations Affecting C&DD Recycling

State of Ohio

The State of Ohio's statute (ORC 3714) defines C&DD as those materials resulting from the alteration, construction, destruction, rehabilitation, or repair of any man-made physical structure, including, without limitation, houses, buildings, industrial or commercial facilities, or roadways.

The statute does not prohibit the reuse or beneficial recycling of C&DD. The statute excludes reinforced or non-reinforced concrete, asphalt, building or paving brick, or building or paving stone that is stored for a period of less than two years for recycling into a useable construction material from being defined as C&DD

Ohio adopted regulations (OAC 32745-00) does not address C&DD recycling, just disposal.

The only regulations affecting C&DD recycling would be general environmental regulations, such as, wastewater discharges, air emission...which would apply to any/all industrial activities.



What is Being Done?

Because the local residential and commercial recycling programs have become more developed over the past few years, solid waste officials are steadily turning their attention toward C&DD. The U.S. Environmental Protection Agency, Association of Ohio Recyclers, Ohio Environmental Protection Agency, Hamilton County Environmental Services and Solid Waste Authority of Central Ohio are developing new programs to promote C&DD recycling.

Waste characterization studies can be conducted at local level to help determine the quantities and types of C&DD materials that can be targeted for recycling. In many states, recycling pilot studies are being conducted to develop more efficient ways to collect and handle C&DD materials at the job-

site. The information from these studies helps recycling coordinators identify processors and develop specific promotional programs. This information also allows processors to get a better idea of the kinds of materials that are available. In addition, the Construction and Demolition Site Recycling Directory has been developed as a companion to this guidebook, to provide contractors with information about recycling service providers and material handlers.

Efforts are underway to revise regulations that pertain to C&DD recycling facilities. These revisions are intended to provide reputable and credible C&DD recycling businesses the ability to operate without undue permitting burdens, while still protecting the public interest.

Planning and Support

The Key to Effective Recycling

Planning

The key to an effective recycling and waste reduction program is proper planning. Proper planning involves the following steps:

1 Identify target materials that can be recovered from the job-site and salvaged or recycled

- For construction contractors, watch what is being thrown in the waste roll-off boxes. Inventory the waste components you see and note how much of each component is present in your waste containers. (See Appendix A for a form to help you do this.)

- For demolition contractors, look for materials that can be stripped out and resold or reused when you evaluate the structure and building components. Note the condition of these materials, any unique qualities they may possess, and the relative quantity of each material.

Garbage can be written into contracts to require recycling from subcontractors (see Appendix B for more information).

- From the materials you have identified, pick target materials for recycling. Target materials are those that: 1) are generated in significant quantities (at least 1-2 cubic yards per week); 2) have a good market value; and, 3) are fairly easy to sort on-site or be removed from the waste by your recycling service provider. Use the tips in the Waste Reduction and Recycling section and ask your recycling service provider to help you choose your target materials.

- For construction contractors, determine which subcontractors are generating which target materials. For example, carpenters generate mainly wood waste, whereas finish subcontractors generate packaging waste, such as OCC and polystyrene. By determining who disposes what materials, you can make each subcontractor

See the section on recycling methods to find out more about what is required for different recycling programs.

2 responsible for reducing or recycling specific target materials on the job-site.

Determine when the target materials will be generated during the construction or demolition process:

- For construction, most dimensional lumber waste will be generated during the framing stage, whereas most drywall waste will be generated later in the building phase. A recycling program can be developed to take place in stages, to correspond with the times that the specific materials are generated. (See Appendix B to find out more about recycling specifications.)

- For demolition, salvageable items will be removed from inside the building first. Next, you may recover roofing materials or siding. Finally, you may recover structural materials such as steel, concrete, brick, and wood.

3

Evaluate the economics of salvaging or recycling your target materials: (use the costs sheets in Appendix A as a guide)

- Determine if additional labor will be required by your staff and subcontractors to separate the target materials from the waste. In most cases, little or no additional labor is required if you can keep the recycling program as similar to the current waste disposal system as possible (e.g., locate recycling containers in areas where waste containers are now located, keep

Target Materials Should Be:

Generated in Significant Quantities

Have Some Value

Easy to Recover

extensive material separation to a minimum). Account for any additional labor in your costing of the program.

- Set aside time to manage the program (approximately 1-2 hours per week and 4-6 hours up front for construction, and 4-8 extra hours per project for demolition). Designate someone on your staff to promote and monitor the recycling program, educate staff and subcontractors about the program (especially in the beginning), and keep records on the amounts of materials salvaged and recycled and the costs incurred. Account for staff time in your cost estimates of the program.
- Determine the cost per month of salvaging and recycling services from service providers who accept your target materials. Look at collection services as well as drop-off centers (add in your costs for transportation if you use a drop-off center). Use the Construction and Demolition Site Recycling Directory, yellow pages, or contact your local solid waste management district to help find service providers. Shop around for the best deal.

- Estimate the disposal cost savings due to salvaging and recycling. Subtract the quantity of your target materials from your total waste to determine how much waste will remain to be disposed. Next, determine if a less frequent pick-up schedule can be arranged with your hauler or if they can place smaller roll-off containers at your site. Both of these options will save you money in disposal costs. Finally, estimate how much you will save per month.



4 Identify on-site limitations that may hinder recycling programs for your target materials. Limitations may include:

- Storage space restrictions on-site
- Language barriers with workers

Fly-Dumping is inappropriate use of dumpster. Fly-dumping in containers can be controlled by placing waste containers closer to site access points or by tarping containers when they are not in use. Signage which discourages fly-dumping may also be effective.

- Poor access from point of generation to recycling containers or area
- Material conditions that make separation of target materials difficult
- Excessive dust and noise generation
- Fly dumping

Recycling Program

Limitations

Large Projects

Although large projects have an advantage in that they create a large quantity of recyclable materials that service providers are interested in, they have a disadvantage in that there are more waste generators to manage. Large projects definitely require a designated person(s) to oversee the recycling and waste reduction programs.

Small Projects

Small projects often do not generate enough recyclable material to be cost-effective to collect. Because of this, small project contractors should reconsider either transporting recyclable materials themselves to material drop-off locations or joining together with other contractors to take material to a central location for collection by a recycling service provider. Small project contractors should work with their recycling service providers and builders' associations to set up such programs.

Commercial Construction Projects

Commercial projects, especially high-rise buildings, are often plagued by storage space restrictions and the inability to get materials to central locations for collection. To combat this, crunable containers can be used at various levels of the project and emptied into a central container on the ground. In addition, container pick-ups should be scheduled more frequently to cut down on the size of the containers required and job scheduling can be adjusted to provide extra storage space for recycling containers.

Renovation Projects

Waste from tearouts is often difficult to separate for target materials. Most target recyclable materials should be removed and either salvaged or recycled before the

5 Once existing limitations are identified, you can address them when developing your salvage and recycling program. Each of these limitations can be overcome by properly designing your program, and should not hinder your efforts. Ask your recycling service provider for tips on how to overcome the limitations you have identified.

Develop a recycling/waste reduction plan:

Take the information you have gathered about target materials, generation schedules, economics, and limitations and develop a plan for implementing a recycling/waste reduction program. This plan does not need to be elaborate, but it should be structured enough to be easily followed by those who oversee the program. More formalized plans for larger projects may

include recycling specifications. At a minimum,

A recycling/waste reduction plan is essential for getting every member of the project team on board for a new way of thinking about waste!

each plan should address the following:

- Waste reduction and reuse practices to employ (see the waste reduction and Reuse Sections);
- Target materials to salvage and recycle;
- Salvage company, used material distributor, and/or recycling service provider(s) to be used in the recycling program;
- Target material generation schedule;
- Method of recycling to be used (see the Recycling Methods sections)
- Designation of a person(s) primarily responsible for the program;
- Methods to educate workers on how to participate in the program (see the section on Program Support);
- Ways to monitor the program (see the following section); and,
- Ways to promote the program (see the following section).



Contact your local builder's association, the local solid waste management district or county telephone book pages to obtain some of this information.

Program Support Keep it Concise and User-Friendly

Even if a recycling and waste reduction program is well planned, success or failure depends upon the support the program is given by those involved. Here are a few measures to properly support your recycling and waste reduction program:

- Dedicate an on-site person(s) to oversee the recycling/waste reduction program. This person(s) will be in charge of ensuring management support, promotion, labor training, and monitoring.
- Distribute the recycling/waste reduction plan to all levels of management.
- Set aside time to explain the program to all of the subcontractors at the site and instill in them that it is their responsibility to ensure that their laborers participate in the program.
- Post signs that explain which materials can go in which containers for the program. Also, post signs that suggest waste reduction methods in central areas of the site. Often, these signs must be written in several languages. Your recycling service provider or local solid waste management district may be able to help with signage.
- Periodically check the containers to ensure that the proper materials are going into them. If problems exist, find the person or people responsible and instruct them or their supervisor on how to properly participate.
- Have recycling service providers provide you with records of how much material is being removed and at what cost/savings.
- Promote success in the program (i.e., waste reduction and cost savings) to managers, subcontractors, clients, and the public (through the county or municipal solid waste district). Waste reduction and environmental stewardship make for good public relations.

Multiple signs are often required for containers approachable by several directions

Waste Reduction and Recycling Methods

New Construction & Renovation Projects

Between two and seven tons of waste materials are generated during the construction of a new single-family detached house. The cost alone of disposing this waste (\$40-\$200 per 20-cubic yard roll-off container at a C&DD landfill) often makes waste reduction and recycling programs worthwhile. This section will familiarize builders and renovators with what it takes to develop effective waste reduction and recycling programs and gives tips to incorporate at the job site.

Tips for Waste Reduction and Reuse

Design Stage

- Favor designs using standard sizes (e.g., eight-foot lengths and 24-inch o.c. stud spacing).
- Evaluate plans in relation to efficiency of materials use (e.g., move the horizontal position of windows, doors, and stairwells to coincide with modular studs).
- Review floor plans to optimize use of subflooring and sheathing.
- Specify building techniques that incorporate less materials (e.g., reduce header sizes and corner details, and use ladder

framing for intersecting walls.

Purchasing Stage

- Make sure the correct amount of materials is brought to the site (in large quantities, some materials can be specially ordered to suit custom designs).
- Work with suppliers to reduce packaging waste and overruns that come on-site.
- Ask suppliers to take back substandard, rejected items.



- Purchase good-quality, salvaged items.

On-Site

- Make all wood cuts at a central location or bring them to a central location so smaller lengths of lumber needed for cripples, lintels and blocking are readily available. Bridging, blocking and backframing lumber can also come from the cut-offs pile.
- Consider moving large unused cut-off pieces to another project site for reuse.
- Reuse appliances boxes and other corrugated containers as storage containers or as intermediate waste containers.

Waste Reduction & Reuse Methods

Waste reduction is the most economical alternative to disposal for any material type. Material reuse is one common method of waste reduction in which materials that would normally end up in the garbage are put to use on the job-site. The tips on the previous page present several ways to practice waste reduction and reuse for the waste materials you generate.

In addition to using the waste reduction and reuse

tips, you may be able to salvage materials from job-sites. Salvaging items from remodeling projects can not only save on disposal costs, but may also make money for the project. See the tips on this page for targeting materials to salvage. Once you identify salvageable items, use the Ohio Construction and Demolition Site Recycling Directory or yellow pages, or contact your county or local recycling coordinator to find reuse centers and salvage services.

Recycling Methods

Just as many types of materials can be recycled from C&DD, many methods can be employed at the job-site to recycle these materials. The most effective method depends upon the size and conditions of your job-site, and the type of construction or renovation that you are doing. As long as you put proper effort into planning your recycling program, you should be able to identify the best method to recover the target materials for recycling.

The main types of recycling methods used at construction and renovation sites are the following:

- Mixed material collection;
- Source separation; and,
- Time-based separation.



Mixed Material Collection is a method in which a recycling service provider collects target recyclable materials in a mixed load. In such a program, you are required as the waste generator to place the target recyclables together in one container and the remaining waste in another container.

The main advantages of mixed material collection are that there is no need for many separate collection containers, and there is virtually no extra labor required to separate materials. In addition, less effort is required to educate all of the workers on the site about proper participation in the program and less time is needed to monitor their performance.

Always remember that buying recycled-content building materials is an important component of recycling

One disadvantage of mixed material collection is that it costs extra money to have the recycling service provider separate the materials off-site. Furthermore, if your mixed recyclables

loads contain a large fraction of highly valuable materials (e.g., metals and OCC), you may not often realize the value of these materials. Another disadvantage of multi-material collection is that by placing materials in the same container, there is a greater likelihood that each material may become contaminated by the other materials. Thus, the value of the materials to the processors decreases with a mixed system.

Source Separation is a method in which each target recyclable material is separated from the waste stream and placed in its own container for collection by a recycling service provider(s). This method requires at least one separate container for each target material at the site.

The main advantage of a successful source separation program is that it allows you to obtain the best market value for your materials. No further separation is required by the recycling service provider, thus reducing their costs. In addition, the materials can be kept cleaner than with other recycling programs, which may

Tips

For Remodelers

Appliances: Store for reuse on project; donate or sell usable units; recycle unusable units.

Cabinets: Store reusable doors, drawers and trim for reuse on the project; donate or sell usable units; recycle unusable cabinets with wood and metal if possible.

Doors: Salvage reusable doors; recycle damaged wood and metal doors if possible.

Electrical: Give scrap wire to electrician; recycle remainder with metal.

Framing: Reuse lumber when possible; recycle remainder with wood waste.

Heating: Recycle ducts and metal trimming.

Insulation: Reuse clean scraps for chinking windows or filling around tubs.

Millwork: Remove castings and moldings for reuse; recycle unusable with wood if possible.

Paint: Use leftover as primer.

Plumbing: Remove fixtures for reuse; recycle metal and PVC, if possible.

Siding: Reuse siding in good condition; recycle damaged wood and aluminum siding, if possible.

Vinyl Flooring: Reuse large sheets for concrete forming.

Windows: Remove and reuse if in good condition; recycle wood, glass and aluminum if possible.

Wood Flooring: Salvage for reuse

also reduce their costs.

The main disadvantages of source separation are that several containers must be used and additional work is often required to separate the materials and place them in their designated containers. Source-separation programs can be difficult to maintain if all the workers on the site are not properly trained as to what materials go where, and if the program is not properly monitored and supported.

Time-Based Separation is a relatively unique variation on source separation in which the recycling service provider concentrates on recovering certain target recyclable materials from the waste stream when they are most readily generated during the life of the project. For example, such a program will concentrate on recovering wood during the framing stage of construction and OCC during the finish stage of construction.

Most recycling service providers that offer time-based separation programs pick out the materials they want and actually do some pre-processing on-site (e.g., bale the OCC, grind the wood). This allows them to help you maintain flexibility in collection and storage of target recyclable materials on-site; although you are still primarily responsible for separating the target recyclable materials on the job-site.

The main advantage of time-based separation programs is that they do not require all of the separate containers required in source separation programs, yet they still recover the individual recyclable materials. This is possible because the containers for specific recyclable materials are only placed on the site when the materials are generated. Often, no containers are used at all, and the subcontractors just form piles of separate recyclable materials at the site from which the recycling service provider can collect.

The main disadvantage of time-based separation programs is that they often require more room on the site for storage of materials and processing equipment, materials and processing equipment.

To help control contamination in source-separation and time-based separation programs, replace high-sided, solid wall recycling containers with either low-sided containers or an open-mesh fenced area. These measures help workers see what is being placed in the containers or

Tips

For Choosing Recycling

Programs

Mixed Material Collection

Best for job-sites that are limited in space, job-sites that are widespread, where many subcontractors must be coordinated for a recycling program, and small sites that do not generate enough individual materials to warrant a source-separation program for each material. Achieves little or not payback for materials.

Source-Separation

Can achieve best payback for materials. Best for job-sites which have adequate space, dedicated personnel to oversee the recycling program, and enough valuable materials to make a recycling program for each material economical.

Time-Based Separation

Effective for builders in almost all conditions where enough materials are generated to make it economical. Not as effective for renovators whose waste does not vary much over the life of the project. Can achieve moderate payback for materials. Not available in all areas.

Tips

For Choosing Target

Recyclables

Wood

Clean dimensional lumber and wood pallets are the most recyclable type of wood generated from construction sites. Chemically treated wood is difficult to market because it can contaminate the process end-products. Manufactured wood products and wood shingles are not as marketable due to their adhesives. Check with your recycling service provider to see what types of wood they can take.

Metals

Aluminum, copper, and brass all have a higher market value than steel. If these metals are mixed in with steel, the market price for them becomes lower. If these materials can be separated and marketed individually, they can achieve a higher market value.

OCC

OCC is usually the most marketable material generated from construction sites. Most OCC recyclers do not accept wax coated OCC or non-paper packaging materials.

Plastic

PVC piping, vinyl siding, and polystyrene packaging may be marketed if they are clean and generated in fairly large quantities. Plastic film is difficult to market because of the many different types of plastic used to make various grades of plastic film.

Glass

Plate glass and glass from light bulbs are difficult to market. These types of glass cannot be processed with glass jars and bottles. However, plate glass can often be reused and some recycling markets exist to process the glass into fiberglass,

Demolition Projects

The demolition of one house can create as much as 50-100 tons of waste!



Demolition contractors have a greater potential than almost all other industries to reduce the amount of waste that goes to landfills. The demolition of one house can create as much as 50-100 tons of waste. Demolition of a commercial building can create thousands of tons of waste. Most often, a large majority of that waste is reusable or recyclable. Some of the reusable or recyclable materials include concrete, metals, wood, brick, architectural artifacts, and industrial process equipment. For demolition contractors who already have effective recycling and waste reduction programs, the reuse and recycling of these materials can represent 20-50 percent of their revenues.

This section presents information that may help demolition contractors develop more effective waste reduction and recycling programs and gives tips to incorporate at the job-site.

Reuse Methods

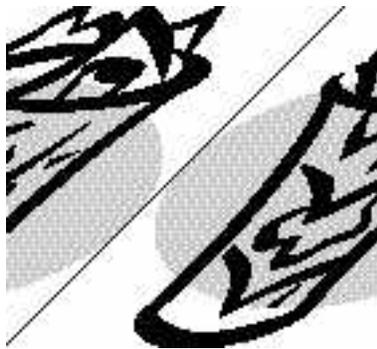
Because many valuable materials often remain in a building scheduled for demolition, there are many avenues for demolition contractors to choose from to recover and reuse these materials.

First, you can reuse certain materials for building renovation or in a new building(s) that is to be erected in the place of the demolished building. Second, you can remove salvageable materials from the building yourself and sell or provide them to material reuse centers. Finally, you can contract with an on-site salvaging company to remove the salvageable materials.

Reuse of Materials in Building Renovation is appealing because some of the decorative facets of the old building can be incorporated into the new one. This often applies to commercial buildings where decorative or historically significant structures are removed or renovated to make way for larger, more modern facilities.

When materials are reused for later construction, the demolition contractor, the owner of the site, the owner of the new building, the architects for the new building, and the construction general contractor must all work together. Salvaged materials can be purchased by the new building owner or included in the demolition contract. Reused structural materials must be included in the architectural specifications. In addition, the construction general contractor must be made familiar with these materials and their appropriate use.

Removal and Resale of Materials is a good option for any demolition project. Staff and additional laborers can be used to remove valuable materials from the building. You should be careful to ensure



that the materials are not damaged as they are removed and stored on-site. Transport materials to reuse centers or schedule reuse centers to pick up materials as soon as they are removed to minimize damage. In addition, properly number more intricate pieces, such as tile floors, ceilings, and trim work so they can be put back together later. This step will add value to the material.

Use of On-Site Salvage Services is also a good option for most demolition projects. One type of on-site salvaging service will provide its own labor force to pull the materials out. For this type of service, you should estimate the value of the materials and negotiate a price to charge the service for the materials. Another type of service opens the building for public auction of the materials. With this service, the buyers of the materials are responsible for removing them from the building. You receive the profit from the auction, and pay a fee to the auctioning company for their service.

In many cases, salvaging should be done by a third party operator prior to demolition. This limits the liability requirements on the demolition contractors

Due to liability requirements for demolition contractors, it is often not feasible to have a third-party on-site during demolition. If liability is a large concern, you may not want to contract for salvaging services. In such a case, the decision of whether or not to salvage materials from a building must be done by the owner/manager of the building. You can have your estimators provide information to the building owner/manager about salvaging options. In any case, salvage of materials prior to demolition may save you money in avoided disposal costs.

Estimators can often suggest salvaging options to owners/managers

Salvage Materials and Recyclables

Wood

Most wood in demolition waste is difficult to recycle because of coatings, paint, and other contaminants attached to it. Clean timbers from wood frame buildings and wood shingles are the best recycling candidates. However, finished wood and structural timbers are some of the most sought after materials by salvagers. In addition, this wood can be reused in new construction to preserve some of the style of the old building.

Concrete

Concrete is almost always recyclable from demolition waste (even with rebar). For large concrete structures, portable crushers can be brought on-site and concrete can be crushed into aggregate for use as backfill.

Metals

All metals are recyclable, especially if they are clean. Aluminum siding may be difficult to recycle depending on its condition. More valuable metals, such as copper, brass, and stainless steel, should be stripped out prior to demolition. Metal trimwork and ceilings have a good market value

when salvaged.

Brick

Bricks can be cleaned and salvaged. Good markets for bricks exist in the southern United States. Broken bricks can be crushed for use as aggregate.

Glass

Plate glass and glass from light bulbs are difficult to market. These types of glass cannot be processed with glass jars and bottles. However, windows and mirrors can often be salvaged.

Carpet

Carpet in good condition can be salvaged and resold. Carpet padding can be recycled.

Fixtures

Sinks, bathtubs, tiles, bath fixtures, and other fixtures can be salvaged and resold or warehoused for alter use in new construction or renovations. Broken pieces of ceramics can be recycled with rubble to form aggregate for road base and fill material.

Recycling Methods

As mentioned previously, the potential to recycle materials from demolition waste is great. However, recycling programs for demolition waste have limitations because of contamination problems inherent with these materials. The recycling methods available to demolition contractors consist of:

- mixed material collection;
- source separation; and,
- on-site processing.

Mixed Material Collection is a method in which a recycling service provider collects target recyclable materials in a mixed load. In such a program all you are required to do, as the waste generator, is segregate the target recyclables from the waste stream. You do not need to separate the target materials into each individual material

type.



Because of the contamination problems associated with demolition waste, there is virtually no market for completely mixed recyclable demolition debris materials in Ohio. However, markets do exist for some mixtures of materials, such as concrete with rebar, wood with nails, mixed metals, and miscellaneous rubble. Most of these mixtures still require a good degree of effort in separation before they become marketable.

Source Separation is a method in which each target recyclable material is separated from the waste stream and segregated for collection by a recycling service provider(s). This method requires at least one separate container or designated storage area for each target recyclable material at the site.

Estimators can often suggest salvaging options to building owners/mangers.

Because of the lack of markets for mixed recyclable demolition debris materials, source separation is usually the method of choice for demolition contractors in this area.

On-site processing is used extensively in the transportation industry for recycling roadwork debris.

Source separation can be staged to recover certain materials as they are removed from a building. This is especially true for renovation projects. For example, if walls are to be torn out, the recycling program can be set up to first collect the structural material (i.e., wood, drywall, or concrete). Once the structural components are removed, you can gear the recycling program toward collecting the piping and duct work.

On-Site Processing is a third option for large demolition projects. On-site processing is a method in which a recycling service provider brings processing equipment to the demolition site. There the materials are processed and made ready for markets.

A portable crusher can be brought on-site to crush inert materials (e.g., concrete, miscellaneous broken bricks, rock, and dirt). The crushed materials can then be used as aggregate for backfill or base materials for parking lots or driveways on the site. Alternatively, you may be able to sell or donate the crushed materials to neighboring construction sites for a similar purpose, thus saving money for both parties.

CASE study

Project Description

Tear-out of furniture and fixtures, and demolition of interior bathroom walls at a 57 unit dormitory.

Prime Contractor

Robinette Demolition, Inc., Chicago, Illinois

Waste Reduction Efforts

Robinette recycled concrete block, ceramic tile, steel piping, copper piping, and miscellaneous steel scrap from the job.

Cost Savings

Through their recycling efforts, Robinette was able to save approximately \$9,000 on the job from avoided disposal costs and the amounts paid for the recyclable materials.

Additional Waste Reduction Possibilities

It is estimated that Robinette could have saved \$875-950 in disposal costs if they could have convinced the school to salvage the wooden furniture, mirrors, sinks, and toilets torn out of the rooms.



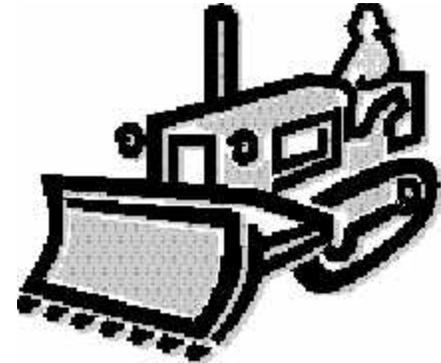
Where Does it All Go?

The Road to Being Recycled

Once you have established a recycling program at your site and are reducing the amount of waste that is being disposed, you may wonder, "Where is all of this material going?"

End Markets

End-markets are the components in the recycling process that actually drive recycling programs. Without end-markets, recyclable materials would never get processed into new products, and would end up in a landfill. Recycled-content material end-markets vary for different types of recyclable materials. The following is a list of some of the local end-markets for the materials



End markets are what drive recycling programs!

that you may be recycling at your job-site.

Wood

- wood fuel
- mulch
- bulking agents for composting
- manufactured wood products
- alternative wood fiber-based materials
(e.g., particle board, door panels

for cars, cement additives)

Concrete

- road base
- fill material
- aggregate for new ready-mix
- lime for neutralizing agent
- rip-rap for harbors

Asphalt Pavement

- asphalt patch for roads (cold mix)
- on-site processing into hot mix for

roads

- road base or fill material

OCC

- paper fiber feedstock

Metals

- reuse by salvagers
- various metal feedstocks

Glass

- reuse of windows and mirrors
- inert granular material additive
- fiberglass
- reflective beads
- asphalt

Drywall

- soil amendment (gypsum)
- cement additive (gypsum)
- new drywall (gypsum)
- paper fiber feedstock (paper)
- animal bedding (paper)

Asphalt Roofing

- asphalt patch for roads

Rubble

- aggregate for fill or road base
- construction entrance roads
- drainage bed material
- landfill cover material

Buy Recycled!

In order for recycling to work, contractors must make an effort to purchase products that contain recovered material (i.e., support the end-markets in this area). If the recycled-content materials are not purchased, the markets will diminish and there will be fewer outlets for the materials that you recycle at your job-site.

Several good references exist to help you find recycled-content building materials. A partial list of



There are several good references available to help you find recycled-content building materials!

Environmental Building News

these references is provided here:

*Environmental Building News
122 Birge St., Suite 301
Brattleboro, VT 05301
Ph: (802) 257-7300
info@ebuild.com
Website: www.ebuild.com*

*Website: www.recyclingdata.com
Iris Communications, Inc.
P.O. Box 5920
Eugene, OR 97405-0911
Ph. (800) 346-0104
Website: www.oikos.com*

Buy Recycled Guidebook for the Commercial Construction Industry

*National Recycling Coalition, Inc.
1727 King Street, Suite 105
Alexandria, VA 22314-2720
Ph: (703) 683-9025*

Official Recycled Product Guide (RPG)

*Website: www.nrc-recycle.org
American Recycling Markets, Inc.
P.O. Box 577
Ogdensburg, NY 13669
Ph: (800) 267-0707*

Guide to Resource Efficient Building Elements

*Center for Resourceful
Building Technology
P.O. Box 100
Missoula, MT 59806
Ph: (406) 549-7678*

Green Spec

*Website: www.crbt.org
Alameda County Recycling Board
777 Davis Street
Suite 200
San Leandro, CA 94577
Ph: (510) 639-2498
Website: www.stopwaste.org*

Appendix A

Recycling Economics

This appendix features a recycling economics worksheet designed to help you assess the costs associated with a recycling program. The first section of this worksheet will help you detail the quantity and composition of materials found in your job-site's waste stream. The second portion will allow you to evaluate the costs associated with recycling programs for the target materials. To estimate the volume of each material generated on-site and the volume of the entire waste stream, complete the tables below. For construction activities, these tables should be completed at least three different times during the building phase (i.e., at the beginning, in the middle, and toward the end). Construction waste varies over time, therefore the accuracy of your

Recyclable Material Volumes

Material Type	Percentage of Waste (by Volume)	Average Size of Waste Containers* (cubic yards)	Number of Containers On-Site	Number of Container Pulls per Month	Volume of Material Generated per Month
Wood	%				cy
Drywall	%				cy
Steel	%				cy
Other Metals	%				cy
OCC	%				cy
Roofing Materials	%	X	X	X	= cy
Concrete	%				cy
Asphalt	%				cy
PVC Plastics	%				cy
Glass	%				cy
Carpet Waste	%				cy

* For demolition jobs, estimate based on the number of containers generated per job.

Total _____

Total Waste Volume

Size of Waste Containers Cubic Yards	Number of Waste Containers	Number of Container Pulls Per Month	Total Volume of Waste Generated per Month
Total Waste	X	X	=

Estimate Costs Associated with Recycling Programs

To estimate the costs associated with recycling programs for each of your target recyclable materials, complete the tables below.

- | | | |
|--|--|---|
| <p>1 Calculate current disposal costs</p> <p>2 Determine the additional labor costs for recycling your target materials.</p> <p>3 Determine the cost to have your recyclables collected from the</p> | <p>4 site or transported to a drop-off center.</p> <p>5 Determine the revenue gained from your recyclables</p> <p>Calculate the savings you may achieve in avoided disposal costs.</p> | <p>Net Cost/Benefit</p> <p>3-4+5= cost or savings of recycling programs for each target material.</p> |
|--|--|---|

Total Waste Disposal Cost

Number of Waste Containers	Number of Container Pulls per Month	Cost per Container Pull	Total Cost per Month for Disposal
X	X	\$	= \$

Additional Labor Costs

	Number of Hours per month	Average Labor Rate (\$/hr)	Cost Per Month
Additional Labor for Sorting	X	\$	= \$
Additional Labor for Transportation	X	\$	= \$
Monitoring and Education	X	\$	= \$

Service Fee/Material Revenue

Material Type	Service Fee + Transport Costs (\$/mo.)	Material Revenue (\$/Mo.)	Percentage of Waste (by volume)	Total Labor Costs (\$/Mo.)	Waste Disposal Costs (\$/Mo.)	Waste Diversion Savings	Net Cost/Benefit (3-4-6)
Wood	\$	\$	%			\$	\$
Drywal	1\$	\$	%			\$	\$
Steel	\$	\$	%			\$	\$
Othe Metals	\$	\$	%			\$	\$
OCC	\$	\$	%			\$	\$
Roofing Materials	\$	\$	%	X \$	X\$	= \$	\$
Concrete	\$	\$	%	X \$	X\$	= \$	\$
Asphalt	\$	\$	%			\$	\$
PVC Plastics	\$	\$	%			\$	\$
Glass	\$	\$	%			\$	\$
Carpet Waste	\$	\$	%			\$	\$
	3	4		2	1 Total	\$	3 \$

Appendix B

Waste Reduction & Recycling Specifications

In order to encourage waste reduction and recycling practices, engineers and architects can develop pertinent language to include in their specifications. Recycling and waste reduction specifications communicate to prospective bidders that the project will not involve the traditional waste management practices of the past. Language can be used to address: 1) waste reduction techniques to use during specific phases of construction; 2) material reuse techniques to employ for specific operations; 3) salvage of specific components; 4) return of unused portions of materials to vendors; and, 5) recycling programs for specific materials. Bidders may also be asked to develop a waste management plan and a cost estimate.

Several advantages are associated with waste reduction and recycling specifications. For bidders, these specifications can eliminate concerns that they may be at a competitive disadvantage if they choose to recycle or practice other waste reduction techniques at the job. The specs can be developed so that the contractor makes a waste management plan and cost estimate for recycling after being selected as the builder on the project. In this manner, it is up to the owner to choose whether to go ahead with the plan if it is more costly, and the cost burden does not fall on the contractor.

Another advantage of waste reduction and recycling

specifications is that they clearly identify what types of measures are to be instituted at the job-site. This helps eliminate any confusion about which materials are target recyclables and which waste reduction techniques are to be employed. If pertinent language is tailored to all 16 divisions of the CSI format system for specifications, subcontractors would realize that they are required to be involved in the designated waste reduction and recycling programs along with the general contractor.

When developing language within the specifications that addresses waste reduction and recycling, specifiers should be conscious of a few key concerns:

- Additional reporting requirements usually constitute additional costs;
- Adequate markets must exist for materials targeted for recycling;
- Conditions vary on each project so language must be customized to fit the project;
- Adequate time must be set aside for discussions with bidders if specifications require them to submit recycling alternatives; and,

Available Publications

- All specifications must be in compliance with local and state waste management regulations (e.g., some recyclable or salvageable components may have handling and disposal restrictions).

The following publications are available to help in the development of waste reduction and recycling specifications:

Waste Spec, Model Specifications for Construction Waste Reduction, Reuse, and Recycling
Triangle J Council of Governments
P.O. Box 12276
Research Triangle Park, NC 27709
Ph: (919) 558-9343
Website: www.tjcog.dist.nc/cdwaste.html#wastespec

Assistance Education Clearinghouse
520 Lafayette Rd. North, 2nd Floor
St. Paul, MN 55155-4100
Ph: (800) 877-6300
Website: www.moea.state.mn.us

Green Spec
Alameda County Waste Management Authority
777 Davis St., Suite 200
San Leandro, CA 94577
Ph: (510) 614-1699
Website: www.stopwaste.org

Bid and Contract Specifications for the King County Regional Justice Center Project
King County Solid Waste Division

Sample Specifications for Recycling Programs

Section 01031 Waste Management/Recycling Alternatives

Part 1 - General

SUMMARY ALTERNATE BIDS

A. It is intended that references in the Bid Forms to "Waste Management/Recycling Alternate Bid" shall refer directly to this Section. Information included is provided for the use of the bidders in completing their Bid Proposals and will not be repeated on the Bid Forms.

SCHEDULE OF ALTERNATES

A. For each Waste Management/Recycling Alternate proposed, describe the recommended method for proper disposal of materials to be recycled or disposed of included in the Waste Management/ Recycling Alternate.

B. For each Waste Management/Recycling Alternate proposed, provide a waste management plan with the bid.

C. For each Waste Management /Recycling Alternate proposed, describe waste management requirements. Requirements for performance, appearance, workmanship, and materials not modified under the Alternate Bids shall conform to Drawings and Specifications, except as exceeded by Code.

PART 2 - PRODUCTS Not Used.

PART 3 - EXECUTION Not Used.

(excerpted from Waste Spec, Triangle J Council of Governments, 1995)

Appendix C

References & Information Sources

Source for this guidebook is Illinois, Construction and Demolition Site Recycling Guidebook, 1997, Illinois Department of Commerce and Community Affairs.

The following is a list of references that have been used to create this guidebook and can be consulted if you have further questions about waste reduction and recycling programs for C&DD.

400 Yesler Way, Room 600
Seattle, WA 98104
Ph: (206) 296-4407

Website: www.metrokc.gov/dnr/swd

Cosper, S.D., W.H. Hallenbeck, and G.R. Brenniman, January 1993, Construction and Demolition Waste, University of Illinois at Chicago, Public Service Report, OSWM-12.

Donnelly, Chris, February/March 1995, "Construction waste," *Fine Homebuilding*, pp. 70-75.

Innovative Waste Management, March 1993, Construction Materials Recycling Guidebook, Metropolitan Council of the Twin Cities Area, Minnesota.

McGregor, M., H. Washburn, and D. Palermini, July 1993, Characterization of Construction Site

Waste, METRO Solid Waste Department, Portland, Oregon.

METRO Portland, June 1994, Construction Site Recycling, guidebook.

Metro Waste Authority, Des Moines, Iowa, 1995, Construction and Demolition Guide Book.

National Association of Home Builders Research Center, April 1995, Residential Construction Waste: From Disposal to Management, interim document.

REIC Consulting Ltd., 1991, Making a Molehill Out of a Mountain II, Greater Toronto Home Builders Association.

Solid Waste Management Association of North America, October 1993 Construction Waste and

Appendix D

Construction/Demolition Project

Residential Construction Project

Demolition Debris Recycling... A Primer, GR-REC 300.

100%

100%

Yost, E. and E. Lund, Residential Construction Waste Management - A Builder's Field Guide, National Association of Home Builders Research Center.

*Based on waste assessments conducted by the NAGB Research Center in 1995.

Project Description:

Five custom builders and one production builder agreed to participate in a pilot project.

Technical Feasibility:

Grinder through put:

Approximately 10 cubic yards per hour for wood and slightly higher for drywall and cardboard.

Volume reduction:

Wood volume was reduced approximately 50 percent, drywall approximately 60 percent.

Particle size:

80 percent of the processed wood was less than 2 inches in size, remaining 20 percent ranging up to 6 inches. Gypsum wallboard essentially processed into dust.

- Job site grinding using a portable shredder to process the clean wood, drywall, and cardboard components of the waste stream.

- Study conducted in Indianapolis in 1998 to evaluate the feasibility of processing and managing certain waste materials on a new construction site. The primary use for the processed material was intended to be the construction site on which the debris was generated. The pilot intended to determine the feasibility of using the material on-site, thereby eliminating transportation.

Economic Feasibility:

Cost of grinding service for production and custom builders estimated at: \$780/house

Cost of grinding service for production builders only estimated at: \$660/house

Cost of conventional landfilling with roll-off trucks and dumpster estimated at: \$840/house*

* Savings largely due to avoided disposal costs.

Project Management:

Builders Association of Greater Indianapolis (BAGI)

Estimated annual machine cost of the grinder (based on 1,000 hours of operation) is \$17.00 per hour, excluding labor costs. The cost for routine maintenance and fuel (per 1,000 hours of operation) is estimated at \$3,578.00.

Current Waste Disposal:

It is estimated that residential construction generates roughly 4 tons of waste per house.

The residential construction waste stream*

Material

Weight	Volume	Wood
42%	24%	Drywall
26%	11%	Cardboard
4%	38%	Other
28%	27%	Total

Overall economic feasibility:

The grinding service was more than cost-competitive with conventional landfilling given the project conditions: moderately high tipping fees, modest labor rates and low transportation costs.

