Construction & Demolition Debris Recycling for Environmental Protection and Economic Development

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Southeast Regional Environmental Finance Center

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University of Louisville

Nancey Green Leigh
Lynn M. Patterson

Center for Environmental Policy and Management
Environmental Finance Center: Serving EPA Region 4
University of Louisville
Department of Sociology
Louisville, KY 40292
502-852-8042

http://louisville.edu/cepm
cepmefc@louisville.edu

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Foreword

Construction and demolition (C&D) waste makes up 25 percent to 45 percent of the waste that goes to our national landfills, thus contributing to the reduced life and increased environmental impacts of landfills across the country. This waste comes from the construction of new structures and the demolition of existing structures. C&D debris recycling and reuse mitigates the negative consequences of landfill destined waste and excess raw material extraction. It also serves as a vehicle to promote economic and community development. Landfill avoidance translates into saved dollars for new landfills while C&D materials provide resources for new industries. Business development, entrepreneurship, jobs and tax revenue also arise from recycling initiatives. For example, in Minnesota, manufacturing using recycled materials supported almost 9,000 jobs and generated nearly $3.5 billion in sales in 2000.[1] There is significant untapped economic development potential in a resource that is now widely regarded as waste.

This guidebook serves as a template and information resource for local governments and community groups interested in developing a comprehensive construction and demolition recycling program. The guidebook defines C&D wastes and identifies the barriers and opportunities for C&D debris recycling. It provides information for assessing existing C&D waste streams (waste stream is the term used to describe the type of waste and the stages or processes involved in handling waste from its point of origin till disposal), current trends in reuse and recycling of C&D waste, and innovations in the field regarding recycled products with resultant potential markets for recycled materials. The guidebook also reviews various interventions for local governments as they engage in promoting C&D recycling. Resources such as federal and state programs supporting C&D recycling programs, publications, and relevant associations are provided. In the tradition of best practice, this guidebook also provides specific examples of how some communities have taken these concepts and used them to promote economic development through business creation and employment generation.

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[1] Minnesota Office of Environmental Assistance. Manufacturing with Recycled Materials. http://www.moea.state.mn.us/market/index.cfm.

Disclaimer

The information in this guidebook is provided as a service to organizations seeking information about recycling construction and demolition waste. Inclusion of specific information regarding a particular organization 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.

1. Introduction

1.1. Why Recycle?

In 2001 United States residents, businesses and institutions generated more than 229 million tons of municipal solid waste (MSW).[2] This waste adversely affects the economy and the environment. Conventional methods of disposal involve landfilling. These landfills have limited capacity. As waste generation increases, new landfills must be built. Landfills are expensive to build and operate. The landfills are also highly subsidized by local governments and require significant land that then is no longer viable for wildlife habitat or residential, commercial, or recreational development. Waste negatively impacts the environment. Degradation of the natural landscape occurs through leaching from improperly lined landfills and from the extraction of resources for new materials.

To counteract the amount of waste generation, communities have instituted recycling programs across the country. Recycling has economic and environmental benefits for communities. First, recycling reduces the need for new landfills and their associated costs. Second, recycling can support industrial development as the recycled materials serve as raw materials for manufacturing and other uses. For example, recycled soda bottles are used in carpet manufacturing; steel contains 85 percent recycled content and recycled paper is milled for new paper products. By supplying raw materials to industry through the reuse of materials, recycling conserves resources by reducing the need to extract virgin resources or introduce new chemicals into the environment. By not disturbing existing natural resources and by reducing noxious manufacturing processes, recycling prevents emissions of many greenhouse gases and water pollutants. From a community and environmental preservation perspective, recycling conserves greenspace, protects habitat, and improves quality of life for residents in natural resource locations. Recycling also saves energy through avoided extraction and manufacture processes. This can be a particularly powerful strategy when one realizes that only 10 percent of all materials

Only 10% of all materials extracted are used in final products.

[2] EPA, Municipal Solid Waste in the United States: 2001 Final Report. http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm

extracted are used in final products[3]. This means that 90 percent of natural resources extracted for consumer use are disposed of as waste. From an economic perspective, such high values of unused material represent inefficiencies in the market. Missed opportunities exist where inefficiencies are present.

Table 1.1

Recycling:

- **Reduces the need for new landfills and incinerators.**
- **Supplies valuable raw materials to industry. Conserves resources.**
- **Prevents emissions of many greenhouse gases and water pollutants.**
- **Saves energy.**
- **Creates jobs.**
- **Stimulates the development of greener technologies.**

The remanufacture of recycled materials supports more than one million manufacturing jobs and more than $100 billion in revenue.

Recycling contributes to the economic base of communities. There is significant job creation and business development potential associated with recycling. Jobs in this field involve more than simple collection and separation. The remanufacture of recycled materials supports more than one million manufacturing jobs and adds more than $100 billion in revenue. As companies seek to find new uses for recycled materials, research and development of 'greener' technologies require skilled individuals and significant capital investment. A wide variety of job skills are needed to develop this industry. Thus, the more robust the recycling activity—including collection, separation, research, manufacture and resale—the more recycling can advance economic development.

In the United States, municipal solid waste recycling has become commonplace. The popular phrase *reduce, reuse, recycle* has become a household mantra with millions of households separating their plastics, paper, cans and glass and using curbside pick-up, drop-off centers, buy-back centers, and deposit/refund programs. With over 9,000 curbside programs, 12,000 recyclable drop off centers, and 480 materials recovery facilities to process materials, recycling programs have reduced waste disposal needs by approximately 28 percent. Given this level of waste reduction, can communities breathe a sigh of relief? Are their waste woes over? Have they been able to maximize the economic potential associated with recycling?

Twenty-eight percent is an impressive reduction in twenty years. However, it does not even represent a third of what could be recycled. This means there is a potential 72 percent of additional material that may be reused or recycled instead of ending up as landfill. Are there opportunities to increase the recycling rate? The US Environmental Protection Agency (USEPA) estimates that 42 percent of all paper, 40 percent of all plastic soft drink bottles, 55 percent of all aluminum

[3] William McDonough and Michael Braungart. 2002. *Cradle to Cradle*. New York: Northpoint Press.

beer and soft drink cans, 57 percent of all steel packaging, and 52 percent of all major appliances are now recycled. Certainly within these material streams, a larger percentage of recycling is possible. Further, these materials are only part of the waste stream. There are other materials that may have more impact when recycled. Construction and demolition debris materials are easily recyclable using existing infrastructure and make up larger concentrations of waste volume than cans, bottles, paper, etc.

1.2. Construction and Demolition Debris

Construction and demolition (C&D) debris is excess material produced during new construction, renovation and demolition of buildings and structures.

Construction and demolition (C&D) debris is excess material produced during new construction, renovation, and demolition of buildings and structures. This debris is made up of materials such as asphalt, brick, concrete, masonry, lumber, shingles, roofing materials, glass, plastics, aluminum, steel, architectural elements, drywall, insulation, wiring, plumbing and electrical fixtures, vinyl and aluminum siding, corrugated cardboard, soil, rocks, tree stumps and other landscaping. Standard construction and demolition operations haul and dispose these materials *en masse* to separation and transfer facilities or to permitted landfills. Some C&D facilities may separate materials on site for further processing and recycling. Others simply add the materials to the heaping piles of waste in the landfill. Of the total recorded[4] waste stream, 30-40 percent is sent to municipal landfills, 35-45 percent is sent to specialty C&D landfills, and 20 to 30 percent of C&D debris is recycled.[5]

Table 1.2

C&D Debris

Aluminum	Masonry
Architectural elements	Plastics
Asphalt	Plumbing And Electrical Fixtures
Brick	Rocks
Concrete Shingles	Roofing materials
Corrugated Cardboard	Soil
Drywall	Steel
Glass	Tree Stumps & other landscaping
Insulation Wiring	Vinyl And Aluminum Siding
Lumber	

C&D landfills are designed to accept only construction materials. There are approximately 1,900 C&D active landfills in the United States. Standards for these landfills are set by the USEPA and include location restrictions, existence

[4] Some C&D debris is not tracked as it may be sent to combustion facilities or un-permitted dumpsites.
[5] Environmental Protection Agency. 1998. Characterization of Building Related Construction and Demolition Debris in the United States.

and types of landfill liners, operating practices, groundwater monitoring closure and postclosure care, corrective action and financial assurance for environmental protection postclosure. C&D landfills do not accept hazardous waste material, including lead and asbestos. Those materials must be disposed of according to the national EPA regulations. However, state and local governments do have some control over C&D landfills. This control is usually in the form of setting tipping fees (cost per ton of disposing material in the landfills). Therefore, there is variation in tipping fees from one locale to another. As we will discuss later in the guidebook, this variability can affect the feasibility of recycling in different jurisdictions.

The amount and flow of the C&D waste stream can significantly impact local and regional fiscal conditions. As these materials make up between 25-45 percent of landfill space [6] and the construction industry continues to boom, the continued availability of space in these landfills is threatened. As capacity diminishes, communities will have to build additional landfills or export their wastes. New landfill construction costs start in the tens of millions of dollars, use millions of dollars of years to operate and require long development periods. The burden for paying for these non-revenue generating and environmentally degrading land uses falls to the taxpayer. Funds for this construction are allocated for this use in lieu of other activities. In some states, landfill permitting can take up to 10 years.

C&D materials make up between 25-45% of landfill space.

Many communities find it beneficial to have local control of their landfills, particularly for environmental protection and economic security. Exportation of waste is not a reliable long-term solution–both in terms of cost and availability as well as environmental protection. New landfills use capital funds that could be otherwise used.

Avoided landfill costs are not the only impact on local communities. The next section discusses re-evaluating perceptions of waste and the potential economic benefits from recycling C&D debris.

1.3. Waste or Misappropriated Resource?

Recycling and salvage of C&D materials can improve the bottom line for businesses and increase quality of life for people while conserving natural resources.

As discussed previously, construction and demolition excess materials can be reused in their existing form, remanufactured, or recycled and remanufactured for future use. When these materials are sent to landfills, they represent missed opportunities to maximize existing assets. C&D recycling advocates claim that recycling and salvage of these materials can improve the bottom line for businesses and increase quality of life for people and communities while conserving natural resources.

[6] Environmental Protection Agency. 1998. Characterization of Building Related Construction and Demolition Debris in the United States.

C&D recycling can be accomplished in a variety of ways. One increasingly used mode of C&D recycling is deconstruction[7]. Deconstruction, the disassembly of structures and reuse of their parts, is one method of C&D recycling. Deconstruction advocates believe there is value in salvaged materials. These materials can be sold for high dollar amounts as antiques or for pennies on the dollar to be used for lower income house repairs.

Deconstruction is the disassembly of structures and reuse of their parts.

Traditional C&D recycling methods modify materials through remanufacture. For example, older bricks may be cleaned and reused. Salvaged lumber may be re-planed into flooring or made into furniture. Copper, aluminum, and scrap iron can be melted and re-forged.

Construction and demolition waste is currently recycled at a rate of 20-30 percent. Project-based studies indicate that the potential for recycling is more than 70 percent.

Construction and demolition waste is currently recycled at a rate of 20-30 percent. Project-based studies indicate that the potential for recycling is much higher more than 70 percent[8]. While many C&D materials are suitable for recycling, there are external factors that influence the spread of C&D recycling. The value of recycled and salvaged goods in the marketplace, labor costs for removal, sorting and processing, and relative disposal costs all play a role in expanding or contracting the market for reuse and recycled goods. Recycled and salvaged goods must be price competitive and perceived to be as desirable as or even more desirable than products produced from virgin materials.

Competitive pricing is impacted by subsidies, incentives on virgin materials, and market demand. A California study[9] revealed the ingrained subsidies and incentives for continued primary virgin materials markets. Ranging from tax incentives to material extraction from public lands, virgin materials are continually subsidized. Recycled goods or secondary materials do not benefit from similar policies that could facilitate their widespread use and resultant competitive pricing. Desirability for recycled materials is a reflection of the value placed upon these goods. This desirability can be affected by industry and consumer market knowledge and acceptance. As the market grows for the recycled goods, production costs and, ultimately, the price for such goods decrease. However, hesitancy to use recycled goods on the part of building code officials, contractors, and architects is often reflected in building codes. Most codes have not been designed to accommodate the use of salvaged and recycled materials.

In a demolition field dominated by heavy machinery and constrained demolition timeframes, the process required for C&D recycling is affected by labor costs. Building deconstruction, the manual disassembly of structures and subsequent

[7] Deconstruction is used throughout this guidebook as an example of C&D recycling because it is the most basic form of recycling – reuse. Deconstruction activities are also combined with traditional recycling and some demolition for unsalvageable material.
[8] US Green Building Council. Multiple case studies. www.usgbc.org
[9] Tellus Institute. 1993. California's Incentives for Production of Virgin and Secondary Materials. Sacramento, CA. http://www.ciwmb.ca.gov/Publications/default.asp?pubid=188

reuse or recycling of their components, is one method for preparing goods for secondary use. This labor-intensive process affords maximum salvage and sorting opportunities as materials can be closely monitored and directed to their highest and best use. In some cases, deconstruction workers separate materials onsite. The sorted materials are then transported to recycling and reuse centers. Where space is limited, materials may be hauled to an off-site sorting facility where salvageable, recyclable, and unsalvageable materials are sorted and forwarded to their respective destinations. Given the increased labor needs in removing and determining mode of secondary use, labor costs are traditionally higher for deconstruction and recycling.

Tipping fees can make or break efforts to recycle.

Costs for disposal of C&D debris have the most impact on C&D recycling. Tipping fees can make or break efforts to recycle (see Figure 2). Regional and local variation in tipping fees affects the market for recycled materials. In an industry where construction profits are tight and demolition margins even tighter, when tipping fees for C&D debris are low, there is no incentive to pursue alternatives to disposal of the waste. When it is initially cheaper to send C&D debris to the landfill, rather than to a recycling facility, most contractors will choose the cost saving option.

An important concept is the first cost perspective. The way goods are valued is primarily by the initial investment. This perspective does not take into account lifecycle costs, environmental impacts, and social and human capital investments. Life cycle costs involve extraction costs, transportation costs, operating costs, and disposal costs of construction materials. These costs should all play into decision-making. However, the current economic framework does not encourage decision-makers to consider these long term and comprehensive costs.

Environmental costs associated with disposal of potentially recyclable materials include: loss of habitat when pristine land is used for new landfills or there are expansions of existing landfills; increased extraction of raw materials for new construction products; leaching from landfilled items into soil and groundwater[10]; and poor air quality from demolition activities that increase dust and noise levels. Social costs include missed opportunities for job training and employment, community involvement in reshaping local built environments, and neighborhood stability (these are discussed in more detail in the following section). In calculating current tipping fees, these costs are not incorporated and, thus, tipping fees are not reflective of the true costs for disposal of C&D debris.

Project disposal costs range from .5% to 30% of a project.

As discussed in the previous section, costs have an impact on the feasibility of C&D recycling. As project disposal costs can range from .5-30 percent of a project, construction costs savings motivate the construction and demolition industry to implement new recycle and reuse C&D materials. Helping

[10] Landfill liners are guaranteed for 50 years.

contractors to understand that using new materials and discarding scrap from them means developers pay for materials twice–first for the purchase and then again for disposal. Case studies indicate that 80 percent of building materials could be reused or recycled[11]. Communities requiring C&D waste management plans that utilize recycling can help to reduce development costs of new and rehabilitated projects. These savings can, in turn, stimulate additional development and improve the bottom line for construction firms.

Current economic and political climates value virgin materials more highly than secondary materials. This is based on the use of first costs for analysis, rather than including life cycle and social and environmental costs. For communities interested in economic development, that is "raising standards of living and improving the quality of life through a process that specifically lessens inequalities in [metropolitan] development and the [metropolitan] population's standard of living"[12], C&D recycling is a strategy to be combined with other revitalization efforts.

1.4.Economic Development and C&D Recycling

There are community-level benefits of recycling and reuse of C&D debris. Diversion of materials through recycling or salvage supports economic development and the improvement of communities. Sometimes referred to as waste-based development, recycling and reuse industries create jobs and revenue, provide small business development opportunities and job training outlets, and reduce landfill expansion needs.

The manufacture of recycled goods increases the economic impact of recycling collection and processing fourfold

C&D recycling can be used as part of a larger industrial development effort to bring higher wage jobs to a region. Studies conducted by the Waste to Work Partnership[13] and the US Economic Information Study[14] indicate manufacturing of secondary materials increases the economic impact of recycling collection and processing fourfold. Wage rates in manufacturing are typically higher than those wages in collection or processing. The collection and processing phases do provide low skilled and entry-level workforce opportunities in the region.

[11] Why Construction Waste Management? http://oikos.com/library/waste/why.html
[12] Fitzgerald, Joan and Nancey Green Leigh. 2002. Economic Revitalization: cases and strategies for city and suburb. Thousand Oaks, CA: Sage.
[13] Waste to Work Partnership. 2002. Making Waste Work: Creating New Jobs in the Pacific Northwest Using Waste Materials.
[14] Beck, R. W. 2001. U.S. Recycling Economic Information Study. Prepared for The National Recycling Coalition.

In California, a study found the direct total sales of disposal and diversion had an economic impact of $10 billion included 85,000 jobs, an income impact of $4 billion and a value added impact of $5 billion

In California, two studies produced for the California Integrated Waste Management Board showed that diversion is a major industry in California. Diversion provides larger benefits per ton to the economy than disposal and is already comparable to disposal for total impact on statewide economy. In the one study, the direct total sales of disposal and diversion had an economic impact of $10 billion, including 85,000 jobs, an income impact of four billion dollars, and a value added impact of five billion dollars. Again the emphasis is on value-added processes for C&D recovery: "if materials are only collected and then processed but not turned into new products, then the majority of the economic benefit is lost."[15]

Depending upon the mode of recyclables collection, "green collar" jobs often involve job training for persons from distressed communities. Green collar jobs such as separation of materials, disassembly of buildings, and remanufacture of recycled materials not only require technical knowledge but also basic job skills. These jobs then provide a foundation and outlet for workforce training efforts.

For local governments, the C&D recycling activities also provide a previously untapped source of revenue through sales tax, business license fees, and property taxes. Some communities have elected to forego the revenue streams in favor of supporting local job training and business development. Using strategies similar to Enterprise Zones[16], job tax credits and other location based incentives may be used to attract C&D recycling businesses.

1.5. Leveling the Playing Field

Local government policies inherently favor the extraction of virgin materials and the discard of excess or "waste" materials.

While recycling construction and demolition debris makes sense from an environmental and economic development perspective, current economic and policy conditions thwart its full potential. These economic conditions include the under-valuation of transportation costs, raw materials extraction and subsidies to new materials retailers. For example, current transportation costs do not reflect the use and construction of roads. Mining, logging, and other raw material extraction techniques do not fully value the adverse environmental and social impacts of these activities on surrounding ecosystems and communities. Large project construction retailers often receive subsidies through tax abatement, infrastructure investment, and job training funds from local governments. Smaller, more environmentally and socially responsible firms do not receive the same incentives from governments. Thus, local government policies inherently favor the extraction of virgin materials and the discard of excess or "waste" materials.

[15] California Integrated Waste Management Board. 2003. Diversion Is Good for the Economy: Highlights from Two Independent Studies on the Economic Impacts of Diversion in California.

[16] Enterprise Zones economically distressed areas where special state and local incentives encourage business investment and promote the creation of new jobs.

Local and regional level barriers to C&D recycling exist in industry standards and acceptance, economics and market development, information, and logistics

In addition to the larger industry and policy barriers for C&D recycling, local and regional level barriers to C&D recycling exist in industry standards and acceptance, economics and market development, information, and logistics. Table 1.3 lists in detail characteristics of each type of barrier. Economic factors that thwart C&D recycling activities include increased labor and material costs and time for separating materials as opposed to traditional disposal in landfills. The need for additional information in the form of technical expertise, knowledge of recycling processes, and awareness and access to markets can affect the adoption of C&D recycling. Logistical complexity in the form of securing a trained workforce, coordinating construction schedules, meeting space requirements for sorting goods, as well as having timely availability of goods also impacts C&D recycling efforts. Combined, these barriers increase the costs of C&D recycling. Reducing these costs is the primary concern for businesses. These costs are impacted by policies and changes affecting transportation costs, identification of and access to markets, or by capital investment for facilities to process and remanufacture the materials.

Table 3.3

Industry standards and acceptance

- Absence (and lack of acceptance) of proven, performance-based specifications for recycled materials.
- Lack of testing to ensure recycled-content construction materials meet performance specifications.
- Contamination concerns
- Perception by state departments of transportation that recycled-content and reused building materials are inferior to traditional road construction materials.
- Requirements by the state for contractors doing road work to have a "letter of no objection" before using C&D materials.
- Regulations that do not differentiate construction from demolition.
- Lack of cooperation and coordination within the construction industry.

Economics and Market Development

- Low tipping fees for most, if not all, C&D materials.
- High costs for C&D collection and recovery in rural areas.
- Lack of markets for wide variety of products
- Lack of sophistication in marketing recycled-content building products.
- Highly variable waste streams which change from construction/demolition site to site.
- Lack of guaranteed supply of recovered C&D materials.

Information

- Lack of centralized information and research studies on C&D materials.
- Lack of knowledge about C&D recycling and recycled-content building products
- Lack of awareness about site-specific opportunities for C&D recovery and reuse.

Logistics

- Lack of recognition of the differences between C&D collection and recycling in urban and rural areas.
- Difficulty breaking into established markets dominated by virgin materials.
- Lack of design for recyclability in existing building products.
- Difficulty obtaining approval for deconstruction, considering timing, scheduling, and cost issues.
- Land use and zoning restrictions on C&D recovery from building sites.

Modified from Construction and Demolition (C&D) Recycling Issue Paper 2001 JTR Recycling Market Development Roundtable

There is a well-identified role for economic development participation in the advancement of C&D recycling as waste based development. Policy mechanisms to support small business, reduce waste, redefine waste, job training, and market development are all areas of potential involvement. More detail about local government involvement is available in the Government Intervention section of this guide. The remainder of this guide is dedicated to outlining opportunities for local governments to support C&D recycling as part of their larger economic development goals.

2. Assessment of Local Conditions

Before local governments embark upon creating and implementing a C&D recycling strategy, they should be knowledgeable about the existing C&D waste stream and recycling activities in their communities. In 1998, the USEPA produced a comprehensive report (http://www.epa.gov/epaoswer/hazwaste/sqg/c&d-rpt.pdf) characterizing national C&D waste streams. While this report exceeds a level of analysis that is feasible at the local level, local governments can use this information as a baseline for their own investigations and methodologies in conducting a C&D assessment. The EPA also produced a standard for measuring recycling activity. This standard (http://www.epa.gov/epaoswer/non-hw/recycle/recmeas/index.htm) provides a foundation and comparative statistics for assessing local efforts.

2.1. Existing C&D Waste Streams

Assessing a local construction and demolition waste stream can be simple or complex. The level of detail and analysis depends upon the intended policy, investment levels, and resources. For those jurisdictions interested in putting policies in place simply to support C&D recycling, a basic assessment should suffice. Jurisdictions considering a more significant investment, such as the development of facilities, should consult with a specialized firm to produce a comprehensive analysis of existing waste streams and potential markets. Results from these analyses can be used to indicate where opportunities lie for import substitution. Import substitution enables communities to produce their own goods at a competitive rate given their available resources. For C&D waste, this type of analysis can indicate where "waste" is being created. This waste can then be transformed into inputs for secondary markets.

There are three complementary data collection methods for beginning the C&D waste stream assessment. The first is to measure the difference between the amount of materials brought into a project and the amount used in the project. Waste is defined as excess material that is not used in the project and is not recycled, re-used, or salvaged. A second method for collecting data is to survey local municipal solid waste and/or C&D landfills[17] to determine the amount of C&D debris. Where landfills monitor the types of materials brought in, data may be obtained directly from landfills or transfer stations. In states such as North Carolina, its Pollution Prevention program has a mandatory reporting process for its waste stream, simplifying the data collection process for analysis. Where materials are not measured, random sampling measurements may be tracked over a period of time by the facility. A third source of data is a survey of local construction and demolition contractors. Construction companies may keep

[17] Depending upon local regulations, C&D debris may be restricted to specialized landfills or may be disposed of with common household hazardous waste.

detailed waste surveys and demolition contractors maintain records for load descriptions and quantities.

Key considerations to keep in mind for tracking of C&D wastes include where to measure C&D waste in the waste stream (e.g., generation point, recycling station, landfill); and how to measure C&D waste (e.g., by volume or weight). Each of these measurement points will produce different levels of waste. As results from these data are used to develop programs, communities should be aware of the potential for under- or over-estimating waste. Studies that measure C&D debris and its potential for recycling identify three main factors that influence the characterization of C&D debris: structure type, structure size, and activity performed that create the waste. Structure type defines whether the building is residential, commercial, or institutional and what the primary building materials used in construction were (concrete, wood, steel). Structure size, in square feet or meters, will determine feasibility of ample materials to make salvage financially feasible and worthwhile. Activity performed to create the waste, such as bulldozing, implosion, wrecking ball, or selective dismantling will affect the quality of the salvageable materials. Additional factors that impact the type and quantity of C&D waste produced include size of projects, location of projects, materials used in construction, quality of debris (deconstructed or demolished materials), amount of contamination of materials (i.e. trash mixed in with recyclable material), and state regulations on definitions for C&D waste. Each of these factors can affect the amount of materials generated and diverted. If communities choose to compare their rates with other communities, they should keep these variables in mind.

Table 2.1 - C&D debris tracking variables

- How C&D wastes will be categorized? What types?
  - e.g. road C&D waste (asphalt and concrete) differs from bridge waste (concrete and steel) which differs from building waste (wood, steel, brick).
- What size and type of building will be tracked?
  - e.g. residential v. commercial, single v. multi family, office v. industrial
- What type of activity will be tracked?
  - e.g. new construction ('clean' and separated), renovation, or demolition (altered and mixed)

There are a wide variety of materials to track for C&D debris (see Table 2.2). Communities may choose to track only a portion of the total debris. In this case, the most widely recycled materials are wood, concrete, asphalt, brick, metal and glass. These materials require the most volume in landfills; therefore, communities can have the most impact focusing on a few elements.

Table 2.2 - Materials to Track

ASPHALT – paving, shingles
WALL COVERINGS – drywall (gypsum), plaster
PAINT - paint containers and waste, paint products
EARTH – dirt sand, foundry soil
PAPER - cardboard, fiberboard, paperboard, paper
WOOD - cabinets, composites, mill ends, pallets, shipping skids, crating, lumber, particle board, plywood, siding, veneer, trees: limbs, brush, stumps, and tops
ELECTRICAL - fixtures wiring
PETROLEUM PRODUCTS - brake fluid, form oil, fuel tanks, oil filters, petroleum distillates, waste oils and greases
WOOD CONTAMINANTS - adhesives and resins, laminates, paintings and coatings, preservatives, stains/varnishes, other chemical additives
INSULATION – asbestos, building, extruded polystyrene (rigid), fiberglass (bat), and roofing
PLASTICS - buckets, pipe (PVC), polyethylene sheets, Styrofoam, sheeting or bags, laminate
MISCELLANEOUS - adhesives and adhesive, cans aerosol, cans, air conditioning units, appliances ("white goods"), batteries, carpeting, caulk (tubes), ceiling tiles, driveway sealants (buckets), epoxy containers, fiberglass, fines, fireproofing products (overspray), floor tiles, furniture, garbage, glass, lacquer thinners, leather, light bulbs, fluorescent and HID, light bulbs, other, linoleum, organic material, packaging, foam, pesticide containers, rubber, sealers and sealer tubes, sheathing, silicon containers, solvent containers and waste, street sweepings, textiles, thermostat switches, tires, transformers, water treatment plant lime sludge
MASONRY AND RUBBLE – bricks, cinder blocks, concrete, mortar, porcelain, rock, stone, tile
ROOF MATERIALS - asbestos shingles, roofing, built up, roofing cement cans, excess roofing shingles, roofing tar, tar paper
METAL - aluminum (cans, ducts, siding), brass, fixtures, flashing, gutters, mercury from electrical switches, iron, lead, nails, pipe (steel, copper), sheet metal, steel (structural, banding, decking, re-rod), metal studs, wire
VINYL - siding, flooring, plumbing, doors, windows

Materials are not the sole emphasis for this guidebook. Infrastructure, market opportunities, policies and local conditions are important to the economic success of C&D recycling activities. Therefore, communities considering policy and programmatic changes to support C&D recycling should assess these as well.

2.2. Existing Recycling Infrastructure

A second component of a C&D recycling assessment is the analysis of the existing infrastructure. C&D recycling requires specialized facilities for separation and processing. Without these facilities, innovative programs that require proof of alternative means of disposal (e.g. one in San Jose, California, http://www.sjrecycles.org/business/cddd.htm), or landfills where separation of materials take place (e.g. San Jose's Zanker Landfill, http://www.z-best.com/zankerrd/index.html), are not feasible. Local governments interested in C&D recycling must therefore undertake a survey of regional infrastructure. This includes, but is not limited to, separation facilities, C&D landfills, regulations, and existing recycling programs. Distances to facilities, their fees and capacities should be a part of this information. Local regulations on banned materials, acceptable disposal sites and means, and any other policy or program that restricts

C&D disposal or reuse must be inventoried. Finally, existing recycling programs should be identified. These can be helpful in determining overall interest in recycling, potential shared facilities and infrastructure, and program components that are particularly successful. EPA's *Measuring Recycling: A Guide for State and Local Governments* walks local governments through the process of analyzing municipal solid waste recycling efforts. This approach can be modified for C&D waste recycling.

2.3. Market Demand for Materials

To best assess local conditions for C&D recycling, an understanding of the recycling market structure is necessary. For C&D specifically, local governments should have information on collectors, haulers, processors, brokers, converters, and demand for materials. Any C&D recycling activity should be documented, including deconstruction. Information about C&D recycling can be obtained through interviews with local demolition contractors, private landfill companies, brokers, for-profits and non-profits specializing in used building material resale. This analysis should be conducted at the regional level as various operators often have large territories.

2.4. Regional Factors

Understanding the composition of local waste streams requires data reflective of local conditions. To underscore this point, the National Association of Home Builders' *Report on the Feasibility of Deconstruction* highlights regional variation for C&D debris. Predominant construction materials, age of housing stock (when the house/structure was built), levels of construction and redevelopment activity, existing markets and institutional support for recycling affect the potential of C&D recycling.

Some states have put together resources detailing their regional activities and needs for C&D recycling. For example, the Illinois Department of Commerce and Economic Opportunity developed the *Illinois Construction and Demolition Site Recycling Guidebook* to guide local developers and contractors in their efforts to reduce and recycle C&D debris.

Communities should review their predominant construction materials. Linking these materials with the trends in C&D recycling products' potential uses, communities may have a better sense of the recyclability of existing materials.

3. Current Trends in Reuse and Recycling of C&D Waste

To a certain extent, the reuse and recycling of construction and demolition waste maintains a long tradition in the construction industry. For decades, asphalt has been reused in transportation projects, rubble has been used for fill, and metal has been melted down for reuse. What is changing, however, is the increase in the number and types of construction materials that can be reused and recycled. Innovative entrepreneurial activity and progressive leadership in local governments have stimulated much of this trend. The following section provides basic information on standard C&D recycling products as well as innovative measures to support additional material diversion.

Standard C&D recycling practice involves the three types of recycling. The first is the direct reuse of materials where C&D materials are salvaged in usable form. Windows, doors, bricks and hardware can be removed and reused on site or sold to a used building materials retailer. Some salvaged building materials may demand high values, such as antiques or architecturally significant components. Other salvaged materials may target remodelers and builders who are looking for inexpensive building materials. The second type of recycling involves physical alteration of the materials. For example, crushed concrete is used for granular sub-base layers in road pavement construction or drainage and excavation fill applications. Crushed brick and concrete may be used as fill on construction sites. Wood may be chipped and used as mulch or soil stabilizer during construction. A third recycling method is the remanufacture of products. In this case, salvaged wood may be re-planed as flooring or furniture. Recycled wood scraps can be used to produce composite lumber and plastic. Glass can be transformed into fiberglass or extruded into glass beads. Obviously, the more complex processes require more labor and capital. All of these activities can translate into employment and business creation opportunities for communities.

Table 3.1 - Uses for C&D Recycled Materials

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

Concrete - roadbase, fill material, aggregate for new ready-mix, lime for a neutralizing agent, rip-rap for harbors (large pieces)
Asphalt (including roofing) - asphalt patch for roads (cold-mix) pavement, on-site processing into hot-mix for roads, roadbase or fill material
Metals - reuse by salvagers, various metal feedstocks
Glass - reuse of windows and mirrors, inert granular material additive, fiberglass, reflective beads, glasphalt
Drywall - soil amendment (gypsum), cement additive (gypsum), new drywall (gypsum),
Paper - paper fiber, feedstock (paper), and animal bedding (paper)
Rubble - aggregate for fill or roadbase, construction entrance roads, drainage bed material, landfill cover material

While C&D recycling is increasing, certain limitations affect its ability to reach full potential. The industry suffers logistically from insufficient capacity at the front and back ends of C&D debris processing. On the construction and demolition site, space, cost, timing and training may impede separation of materials. When materials are not sorted, they require special facilities for separation and process. These facilities are not widely accessible in many markets. To develop these facilities, investors desire certain market conditions. Without dependable markets, investors are hesitant to invest the significant capital that is required to fund these projects.

Innovators use government support and entrepreneurship to use excess C&D material rather than categorizing it as waste and casting it off to the landfill

Market underdevelopment also plays a role in the infancy stage of C&D recycling processing. Immature markets and restricted perceptions of accepted uses limit the recyclability of wood waste and materials other than concrete, brick, asphalt and metals. These markets require support and a climate that fosters entrepreneurship and environmental protection (see 4. Government Intervention). C&D recycling associated businesses demonstrate that innovators are using government support and private entrepreneurship to use excess C&D material rather than categorizing it as waste and casting it off to the landfill. This section highlights a small sample of potential uses and programs developed by public and private entities. It is intended to provide creative fodder for communities' own C&D recycling needs and simultaneously stimulate business development.

3. 1. Innovation in Recycled Products and Markets

Beyond traditional recycling methods, there are innumerable innovative programs and processes underway across the U.S. These programs take the less popular recycled materials (not already standard recycling material) and produce innovative products. For example, asphalt shingles can be mixed with hot-mix asphalt offering a savings of 5 percent (70 cents) per ton of asphalt. To support asphalt shingle recycling in New Hampshire, the Northeast Resource Recovery Association helped to form a co-operative business to increase the supply and processing of asphalt shingles. The co-operative provides a pickup and drop off service where they will pick up the shingle and leave an equal amount of recycled aggregate material for roadway use.

Scrap drywall can be ground and used in cement. Industry standard experts are working to increase the accepted formulation to allow up to 5 percent ground limestone (drywall) in its product. Drywall has also been used as a soil amendment both onsite and distributed for sale.

Recycling and reusing secondary materials are not limited to small businesses. Armstrong World Industries has developed a Ceiling Recycling Program that allows building owners to recycle old ceiling tiles rather than sending them to the landfill. Armstrong picks up the old ceiling tiles and ships them to its plant, where they will be used as raw materials in the manufacture of new acoustical ceilings.

A truly innovative feature of this program is that neither the old nor the new replacement ceilings tiles need to be Armstrong products to qualify for the program.

Used carpet continues to be a landfill problem. The material is bulky and does not degrade over time. The Carpet and Recovery Effort (CARE) program supports a wide variety of products made from recycled carpet. In Crestview, Florida, the city uses a product similar to hay bales to prevent sediment runoff from construction sites. This product, GeoHay, is made from recycled carpet fibers. Using funds from the Florida Department of Environmental Protection, a GeoHay manufacturing plant opened in Crestview. This plant increased the market for recyclable carpets and provided jobs and economic development opportunities in the region.

Non-profit organizations that cater to the resale of used building materials are springing up around the country. Organizations such as The Reuse People (http://www.trp.org/), The Loading Dock (http://www.loadingdock.org/httpdocs/index.html), the Boston Building Materials ReUse Center (http://www.bostonbmrc.org/bostonbmrc/), and Habitat for Humanity ReStore (http://www.habitat.org/env/restores.html) offer retail outlets to increase the market for used building materials.

Demonstration projects serve to inform markets and ostensibly increase market demand for recycled and reused building materials. Similar to other state programs, the Wisconsin Department of Natural Resources Waste Reduction and Recycling Demonstration Grant Program funds innovative projects which serve as the springboard and catalyst for additional C&D recycling activities. These demonstration projects range from documentary films to collection, separation, and processing methods. The funds may also be used to support testing of new technologies incorporating C&D debris material.

As the market for recycled and salvaged C&D materials grows, the variety of innovative products and programs increases. The aforementioned examples are only a sampling of the many products and programs designed to support innovation in this field. Local governments can facilitate this innovation via their support of this emerging industry. The following section details various forms of intervention for local governments.

4. Government Intervention

To create a level playing field for construction and demolition debris recycling, there are three avenues for government intervention. The first is regulation. Regulations restrict activities to achieve desired behaviors. The second is incentive-based market support. Incentives foster an economic climate that

supports and nurtures environmental stewardship and economic development. The third option is a combination of regulation and incentive based market support. This most common approach has proven to be the most effective means of policy intervention. This section will investigate the merits of both regulation and use of incentives, as well as how local governments can embrace strategies to encourage C&D recycling for economic development.

4.1. Government Regulation to Support C&D Recycling

Regulation creates limits for activities that are undesirable and holds all projects and companies subject to the same standards.

Regulation creates limits for activities that are undesirable. The benefit to regulation as a policy intervention is that all projects and companies are subject to the same standards. Where regulation is able to reduce uncertainties in supply and demand, it can create more stable market conditions. Regulation also eliminates advantages of firms that would ordinarily not be required to comply. There are drawbacks to regulation, however. Regulation is often associated with limited flexibility with which to achieve compliance and therefore can stifle innovative methods. Regulations can be costly if enforced alone without mechanisms to support the regulation. Without supportive programs, regulation can increase costs and slow market development of the industry.

Regulation for C&D waste disposal may take the form of a ban, tax, or process requirement

Government regulation is manifested in a variety of ways. Regulation for C&D waste disposal may take the form of a ban, tax, or process requirement. These three regulatory tools are detailed below. In each example, regulation is the primary tool. However, local governments recognize the need for supplemental and supportive policies. These secondary tools are also presented.

Bans disallow the disposal of a particular type of waste. For example, hazardous waste is banned from municipal solid waste and construction and demolition waste landfills. These materials require special treatments and facilities. Banning materials also requires consideration for what will happen to materials and where they will be disposed.

Massachusetts uses regulation to reduce waste. The Massachusetts *Beyond 2000 Solid Waste Master Plan* targets a C&D waste reduction goal of 88 percent by 2010. To accomplish this, the Department of Environmental Protection proposes a ban on the disposal of unprocessed C&D waste by the end of 2003. Previous regulatory action banned lead acid batteries, leaf and yard debris, bottles, cans, paper, white goods, tires, and cathode-ray tubes (CRTs) at Massachusetts' solid waste transfer stations. The new ban on C&D waste would include asphalt, brick, concrete and wood. Methods for diversion in Massachusetts include recycling, reuse, and marketing woodchips to wood fired power generators. As for stimulating economic growth, a positive result of this regulation has one company considering locating a wood power generating plant in New Bedford, Massachusetts.

By increasing the cost of the undesirable behavior, businesses will likely choose the more desirable behavior.

The Massachusetts Department of Environment and Protection (DEP) realizes it must support regulation with services. Under the auspices of the DEP, the Solid Waste Advisory Committee sponsors a C&D debris sub-committee with four work groups. These work groups include Source Separation, Market Development, Processing, and Policy. The workgroups independently research how their area might further support the regulatory requirements.

Taxes are a second method of regulation used to foster changes in industry practice. As discussed in the Leveling the Playing Field section of this guide, the barriers to C&D recycling center on economics, knowledge and logistics. Taxes on undesirable behavior can foment change. By increasing the cost of the undesirable behavior, businesses will likely choose the more desirable behavior. True transactions costs in building materials are often not calculated. Instead, government subsidies act as incentives that unwittingly provide for the continued extraction and use of virgin materials. A program to resolve this incongruity would be to levy taxes on virgin materials.

A landfill tax or increase in "tipping fee" raises the cost of disposal. Rationally, contractors seeking to minimize cost would find other methods for disposal or locate a market for the waste (i.e., recycling or resale). There are some unintended consequences with taxing disposal. Some contractors may transport waste to untaxed jurisdictions or participate in illegal dumping. These infractions can be minimized when there is regional consensus for waste recycling goals and enforcement against illegal dumping.

Tax revenues can finance specific programs or municipal general funds.

Revenues from taxes can be useful to local governments. Tax revenues can finance specific programs or municipal general funds. In some cases, revenues are earmarked to offset taxpayer burden for new landfills. In other cases, the taxes are used to fund recycling and reuse programs. Over 16 states have disposal surcharges on tipping fees that fund recycling programs (see Table 4.1). For example, revenues from the Alameda County Waste Management Authority fund recycling education and grant programs. Alternatively, taxes from disposal can be used in support of general government programs. Pennsylvania uses its landfill taxes to support curbside recycling programs, municipality general funds, and the Environmental Stewardship fund.

Table 4.1 Disposal Surcharges to Support Recycling[18]

State	SW Disposal Surcharge/Ton	Use of Funds
AZ	$0.25	Recycling program & grants
CA	$1.34	
GA	$0.50 $1.00 local government host	Some recycling projects Hazardous waste management

[18] Table provided courtesy of the North Carolina Recycling Business Assistance Center. Information compiled by S.C. Recycling Market Development Advisory Council and obtained from states through EPA JTR list serve and survey by N.C. Division of Pollution Prevention and Environmental Assistance.

	fee	
HI	$0.35	Solid waste program
IA	6.5% of tonnage fee	Waste exchange Grants recycling/solid waste
IL	$0.95	50% - Recycling 50% - LF management
IN	$0.50	50% - RMD 50% - Recycling grants for government
KS	$1.00	
MI	Assessed by some counties	
MN	$2.00 (C&D) .60/cu. yd. (industrial)	
MO	$1.80 St. Louis County has an additional 5% gate fee	Waste reduction & recycling
MS	$1.00	50% LF management 15% HHW 35% P2 grants/loans
NE	$1.25	Solid waste reduction Grant/tires
OK	$1.50	Waste management division
OR	$1.24	$.21 Compliance $.09 Recycling act $.81 Domestic solid waste fee $.13 Orphan site fee
PA	$2.00	Recycling grants Market development
SD	$1.00	Solid waste clean – up
TN	$0.80	Solid waste reduction Grants & administration
TX	$1.25	Solid waste program General fund
VT	$6.00	State waste management program
WI	$.30	Recycling
WV	$8.75	LF management closure Solid waste program & grants Recycling program & grants

Another type of taxation rewards those contractors that recycle construction and demolition waste and penalizes those who do not recycle. A system of deposit and refund charges the contractor of each demolition/construction project a certain deposit amount. When the loads are taken to the landfill and proof is shown that a portion of the original demolished materials was recycled or reused, the contractor receives a refund. Deposit and refund programs are perhaps the most successful as they discourage illegal dumping that is associated with a simple disposal tax. This system provides reduced fees for waste minimization.

San Jose, California, instituted a Construction and Demolition Debris Diversion (CDDD) Program to reduce C&D waste disposal. For this program, any renovation, demolition, or construction permitted project falls under the purview

of the program. Materials can be reused or donated, taken to a CDDD-Certified Facility for recovery/recycling, or a combination of the two.

The third method of regulation is process requirement. In 1989, California passed the Integrated Waste Management Act that directed the state's cities and counties to divert 50 percent of their waste streams by 2000. While there was no direct ban on materials in this case, each jurisdiction must develop a solid waste management disposal plan. According to the California Integrated Waste Management Board (CIWMB), the statewide diversion rate is now approximately 48 percent (2002).

Local ordinances that require C&D recycling are becoming more common in areas plagued by excessive C&D waste and limited landfill capacity. The CIWMB provides sample ordinances for communities to consider adopting. With this type of regulation, local governments can mandate C&D recycling. It is advisable, however, to combine regulations with supportive programs to ensure the highest level of program success.

4.2. Incentives and Resources

Incentives provide developers, builders and demolition contractors with a bottom-line rationale that reduces or eliminates traditional market-based barriers.

As an alternative or complement to regulation, local governments can support C&D recycling in the forms of incentives and resources. Incentives provide developers, builders, and demolition contractors with a bottom-line rationale that reduces or eliminates traditional market-based barriers. Market support programs can be useful for promoting C&D recycling market activity. Common market support strategies include rebate programs, market identification and product marketing, below-market rate interest loans and grants, and technical assistance. These strategies and examples of their implementation are discussed in more detail below.

Rebate programs or discounts for secondary (recycled or reused) materials make those goods more economically attractive. In California, haulers are eligible for rebates on tipping fees provided they take materials to approved waste facilities for sorting and recycling. The City of Oakland offers a $10 per ton rebate on C&D waste that is recycled, while the Midwestern Group for Recycling has suggested a sales tax rebate on new carpeting when old carpet is recycled.

Market identification reduces market friction and facilitates market exchanges. Local governments use clearinghouses to identify industry level buyers and sellers of C&D materials through economic development networks, or at-large markets by listing recycled content products on materials exchange websites and other industry publications. These clearinghouses may be as sophisticated as web pages or as simple as pamphlets in the planning and zoning department. Obviously, more widely accessible information will breed more activity. Clearinghouse materials would include general information on C&D recycling, lists of C&D

contractors, C&D recycling and salvage operators, non-profit donation sources, referrals for technical expertise of networked individuals and firms.

Knowledge of existing markets, access to these goods, and networking within these communities are crucial to the success of C&D projects. C&D recycling facilities must market their goods. One method for marketing these goods is an online materials exchange. Material exchanges are online clearinghouses for goods and services that are available for sale or trade. The majority of materials exchanges involve building materials, either salvaged or excess. Online exchanges provide either cataloguing or real time inventories of C&D excess materials. Interested parties can log on to the exchange to find materials or to advertise their interest in purchase. While material exchanges do not provide long-term supply guarantees, they do allow for short term exchanges and the development of more extensive networking. Many state pollution prevention offices have created web-based materials exchanges to facilitate this process. USEPA provides a list of state materials exchanges.

As part of a larger economic development strategy, materials exchanges can provide the base information for developing an eco-industrial park. In eco-industrial parks, firms use each other's waste material as raw material inputs. It is possible to link firms together in mutually beneficial relationships through the identification of existing waste strategies and exploration of ways to minimize ecological impact for the firms involved.

Grants or low to no-interest loans are a traditional economic development mechanism to support developing and expanding businesses. Conventionally used to fund start-up costs or capital acquisitions, these financial assistance programs enable (mostly) small businesses or non-profit organizations to begin or expand operations. A Wisconsin program funds pilot or demonstration projects that demonstrate waste reduction and recycling. In Florida, the Recycling Loan Program provides loans and grants to small businesses in the recycling industry. The Alameda County Waste Management Authority operates a series of loan and grant programs, including the revolving loan fund and mini-grant program designed to support C&D recycling based organizations.

Recognizing the inability of regulation to work alone, the Massachusetts DEP developed incentive programs to assist C&D projects financially. These programs include the Recycling Industries Reimbursement Credit grants that can be used to leverage other funds, the Recycling Loan Fund, and technical assistance grants to municipalities. The California Integrated Waste Management Board developed Recycling Market Development Zones, similar to Enterprise Zones. Originally, these zones were not designed specifically for job creation; however, combined with the USEPA Jobs through Recycling Program, they were able to take full advantage of federal resources.

Procedurally, local governments can reduce transaction costs by offering expedited permitting and site assistance or even changing their own procurement requirements to incorporate recycling. In the Oakland/Berkeley Recycling Market Development Zone, expedited permitting, referral of qualified job applicants, low-interest loans, site location assistance, and employee training are employed to encourage behavior through market signals.

Technical assistance may be provided in the form of standards or access to expertise. Government initiatives that support C&D recycling often involve the green building movement. Green building standards, such as those used in the national commercial certification program Leadership in Energy and Environmental Design (LEED), or in residential green building programs such as the Alameda Green Building Guidelines[19], include waste minimization during construction and remodeling. These initiatives engage a broader spectrum of participants and improve the educational component of C&D recycling.

As local governments struggle with potential interventions to support and encourage C&D recycling, Massachusetts and California have put forth programmatic suggestions for local governments to consider (Table 4.2 and Table 4.3). These recommendations address the four fundamental barriers to widespread adoption and implementation of C&D recycling. Essentially, the programs would address: promotion, education, and technical assistance, planning requirements, reporting requirements, diversion requirements, deconstruction requirements, pre-processing requirements, pre-approved sites, economic tools, and market development.

Table 4.2

Massachusetts Action Plan to Promote C&D Waste Minimization

- Promote C&D source reduction
- Promote building materials exchanges
- Promote existing loan and grant programs
- Promote new end-use markets for processed C&D materials;
- Work with the design and construction industry to promote better design for recycling and source separation of recyclables through technical assistance and education;
- Assist the waste industry and municipalities who are seeking to expand or site new C&D processing facilities;
- Allow C&D residuals to be used to close inactive unlined landfills.
- Establish a preference for C&D and other residuals disposal facilities
- Implement pilots for job site separation of C&D for public projects and residential homebuilding;
- Explore changes to permitting requirements
- Encourage local building permits to provide incentives to contractors to recycle the materials they use;
- Explore additional specifications for the reuse of salvaged material, use of materials with recycled content, and use of appropriate C&D recyclables on state projects.

[19] There are dozens of regional and national green building guidelines across the country. Alameda is used as one example that is highly integrated with a C&D recycling program.

Table 4.3

The California Integrated Waste Management Board suggested incentives to promote C&D recycling

• Promote buy recycled by local and state government and private industry • Promote government procurement of recycled products • Provide general information on composting reuse and collection • Promote compost/mulch • Better report waste stream data • Identify contaminants and determine how to overcome or eliminate them in collection • Develop marketing information database • Create industry advisory task forces • Set up pilot projects to research the use of secondary material to replace virgin material • Publicize uses of materials	Information interventions
• Provide alternative use information • Provide education and advertisement • Consumer rebates • Consider low interest loans for equipment and projects. • Consider purchasing incentives/tax credits • Minimize or eliminate barriers to use of secondary materials • Consider bonds for small business development • Provide collection incentives • Assist in formation of niche markets • Market secondary materials as commodities, not waste • Develop ways of reduction transportation costs • Equalize incentives • Lower production costs	Economic interventions
• Determine optimal sorting strategies • Invest in and promote new technology and equipment design • Develop quality standards for goods • Provide training • Simplify permitting processes and develop one stop shop • Support Solid Waste Program at Triangle J Council of Governments	Logistical interventions

There is one market mechanism that makes C&D recycling and deconstruction truly competitive. This mechanism is available nationally and is present within the US Tax Code. Donation of building materials (including those salvaged through demolition) to a non-profit organization constitutes a charitable donation. This donation can then be applied to personal or commercial federal taxes. Current law suggests that the value of the building materials should be used for valuing the donation; however, a recent US Tax Court settlement valued the donation as the whole structure as built, instead of the market value of each of the salvageable building materials. Individuals or companies desiring to make a charitable contribution should seek advice from a tax professional.

5. Conclusion

Construction and demolition waste recycling is a growing industry that can satisfy economic, environmental, and social objectives. Diverting C&D debris from landfills and reselling, remanufacturing, or recycling the material can create jobs and business opportunities, reduce environmental degradation, and provide low-income residents with job skills. In some cases, C&D recycling emerges out of legislative necessity. In others, innovation for community development stimulates C&D recycling activities. In still others, entrepreneurship supports recycling and salvage efforts.

This guidebook presents the various resources local governments have at their disposal to explore and expand this field in their own communities. From workforce training to policies that require diversion of resources from landfills, there are many possible options to facilitate growth of this industry. We encourage you to use this guide to explore the possibilities C&D recycling has for your economic development goals.

The Best Practices Appendix introduces three best practice cases where C&D recycling is active in communities. The economic development benefits are highlighted, as are the policies that enable these programs to exist.

6. Glossary

Construction and demolition (C&D) debris is excess material produced during new construction, renovation and demolition of buildings and structures.

Davis Bacon wage requirement is the payment of prevailing wage rates (which are determined by the U.S. Department of Labor) to all laborers and mechanics on Federal construction projects in excess of $2,000.

Green building is the standard for construction that minimizes impact of the built environment on the natural and social landscape.

Deconstruction is the disassembly of structures and reuse of their parts.

Eco-industrial park is a community of manufacturing and service businesses located together on a common property using each others' wastes as materials for production.

Municipal solid waste is more commonly known as trash or garbage—it consists of everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries.

Secondary resources are products created using recycled materials.

Tipping Fee is the price per ton of landfill-destined waste.

Virgin resources are resources using raw materials which have not been used before.

Waste-based development is based on productivity that adds value to waste materials by reusing, remanufacturing, or recycling materials we traditionally think of as useless waste into new processes or products.

7.Appendix: Resources

The following section lists online resources for local governments and communities to obtain more information on a particular topic. The sites were verified at the time the Guide was written; however, we cannot guarantee their current status.

7.1. Industry Associations

The **Construction Materials Recycling Association** provides information on issues and technology facing the industry including a listing of available literature on relevant topics; promotes the acceptance and use of recycled construction materials including concrete, asphalt, wood, and gypsum; represents the industry at trade shows and other industry functions related to C&D recycling in order to raise the visibility of C&D recycling: http://www.cdrecycling.org/wholeframe.htm.

The **Used Building Material Association (UBMA)** represents companies and organizations involved in the acquisition and/or redistribution of used building materials: http://www.ubma.org/.

The **National Association of Demolition Contractors (NADC)** represents contractors that manage demolition debris, including disposal and recycling: http://www.demolitionassociation.com/site/index.html.

The **Associated General Contractors (AGC)**, http://www.agc.org/index.ww, supports recycling by its members. The association produced a brochure that provides examples of outstanding recycling projects carried out by AGC members, along with facts and statistics pertaining to the reclamation of asphalt, concrete, steel, and wood: http://www.agc.org/content/public/pdf/Environmental_Info/recycle_brochure.pdf.

The **Northeast Recycling Council** is a ten-member non-profit organization that serves as a forum for cooperative research, collaborative action, and networking on regulatory, market and business development issues that link recycling and economic development: http://www.nerc.org/.

The **Mid-Atlantic Consortium of Recycling and Economic Development Officials (MACREDO)** is six-member regional organization seeking to identify, promote, and implement projects and programs that enhance recycling and economic development opportunities on a regional basis: http://www.libertynet.org/macredo/.

National Association of Home Builders' *Report on the Feasibility of Deconstruction*: http://www.huduser.org/publications/destech/deconstruct.html.

Northeast Resource Recovery Association: http://www.recyclewithus.org/.

The **Carpet and Recovery Effort (CARE)**: http://www.carpetrecovery.org/market/index.asp.

National commercial certification program: **Leadership in Energy and Environmental Design (LEED)**: http://www.usgbc.org/LEED/LEED_main.asp.

7.2. Government Agencies and Organizations

Alameda County Waste Management Authority's recycling education and grant programs: http://www.stopwaste.org/.
Alameda's revolving loan fund: http://www.stopwaste.org/fsfunding.html.
Alameda's mini-grant program: http://www.stopwaste.org/fsfunding.html.
Alameda's green building: http://www.stopwaste.org/nhguide.html.

California's Recycling Market Development Zones: http://www.ciwmb.ca.gov/RMDZ/.
Oakland/Berkeley: http://www.ciwmb.ca.gov/RMDZ/OaklandBerk/Default.asp.

The **Environmental Protection Agency (EPA) Office of Solid Waste (OSW)** website, http://www.epa.gov/osw/, has many helpful resources. A select number of these links/publications are listed below. This listing is by no means exhaustive. We recommend readers go the **OSW recycling** webpage at http://www.epa.gov/epaoswer/osw/recycle.htm for updated information and new publications. The C&D Debris portion of the EPA OSW webpage includes a variety of links to resources by program and commodity.

The **Institute for Local Self Reliance** is a non-profit organization specializing in "waste to wealth" creation: http://www.ilsr.org/.

The **University of Florida's Center for Construction and the Environment** specializes in research on sustainable construction, construction and demolition waste recycling and deconstruction: http://www.cce.ufl.edu/.

Florida's Department of Environmental Protection's grant program: http://www.floridadep.org/waste/categories/recycling/pages/grants.htm.

The **U.S. Department of Housing and Urban Development** has supported sustainable construction practices, including deconstruction with its HOPE VI program: http://www.huduser.org/.

Jobs Through Recycling (JTR) is an EPA program that brings together the economic development and recycling communities through networking and information sharing: http://www.epa.gov/jtr/index.htm. Through JTR, EPA supports projects designed to enhance business development, technical assistance, and financing efforts for recycling-related industries.

Wisconsin's funding program for pilot projects: http://www.dnr.state.wi.us/org/caer/cfa/Ef/recycle/.

The **Massachusetts Beyond 2000 Solid Waste Master Plan**: http://www.mass.gov/dep/bwp/dswm/mplan/swmp.doc.

7.3. Publications and Research

C&D Recycler offers news and industry updates for the construction and demolition waste industry: http://www.cdrecycler.com/.

The **Waste Wise Update, Building for the Future**, discusses green building and construction & demolition debris reduction: http://www.epa.gov/wastewise/pubs/wwupda16.pdf.

The *Illinois Construction and Demolition Site Recycling Guidebook* outlines how to develop a C&D recycling program for that region. This excellent resource provides step by step guidance on putting together a program: http://ec.dupageco.org/solidwaste/pdf/!dupageg.pdf.

Among many resources provided by the **California Integrated Waste Management Board,** the *C&D Recycling Plans and Policies: A model for local government recycling and waste reduction* presents the tools and strategies necessary for implementation. A case study of Hawthorne California is included: http://www.ciwmb.ca.gov/Publications/LocalAsst/31001014.pdf.

Portland, Oregon's *Metro Construction Industry Recycling Toolkit*, http://www.metro-region.org/library_docs/recycling/toolkit.pdf, is a guidebook for architects, designers, specification writers, developers, property owners, property managers and construction project managers interested in construction and demolition (C&D) debris salvage and recycling. An online database of salvage and recycling operations is available for use in conjunction with this guidebook.

The Decision-Makers Guide to Solid Waste Management, http://www.epa.gov/epaoswer/non-hw/muncpl/dmg2/chapter6.pdf, provides detailed

information to help communities implement integrated municipal solid waste management programs. The guide covers key technical, legal, economic, political, and social issues that must be addressed to develop effective waste management programs. Additional information is provided for collection & transfer, source reduction, recycling, composting, combustion, and land disposal of solid waste.

INFORM offers a *Community Waste Prevention* toolkit that outlines how to implement a waste prevention program through data collection, government action, and market identification: http://www.informinc.org/cwp_00.php.

The *Clean Washington Center* provides information and services to develop markets, technologies, and beneficial end uses for recycled materials. The Clean Washington Center (CWC) managed and documented over 90 projects validating recycling technologies or recycled content products, and has developed *Best Practices In Recycling* for several recyclable commodities.

This collection of case studies, *Building Savings: Strategies for Waste Reduction of Debris from Buildings*, reports projects that have successfully reduced large amounts of C&D debris: http://www.epa.gov/epaoswer/non-hw/muncpl/pubs/combined.pdf.

The *U.S. Recycling Economic Information* (REI) *Study*, http://www.epa.gov/jtr/econ/rei-rw/rei-rw.htm, is a national study that demonstrates the importance of recycling and reuse to the U.S. economy. The study calculated direct economic impacts, indirect economic impacts, and tax revenues.

The *Benefits of Regional Recycling Markets: an Alameda County Study* discusses in detail the outcomes of a **Jobs Through Recycling** project: http://www.ciwmb.ca.gov/publications/markets/41203022.doc.

The **U.S. Environmental Protection Agency (EPA)** developed a voluntary, standard methodology for measuring recycling rates: *Measuring Recycling: A Guide for State and Local Governments*: http://www.epa.gov/epaoswer/non-hw/recycle/recmeas/index.htm.

The Characterization of Building-Related Construction and Demolition Debris in the United States report analyzes the quantity and composition of the C&D materials as well as waste management practices for this waste stream: http://www.epa.gov/epaoswer/hazwaste/sqg/c&d-rpt.pdf.

North Carolina's markets assessment characterizes the state's waste stream and recycling rate. The document provides a good overview of a complete and thorough analysis: http://www.p2pays.org/ref/02/0162203.pdf.

The South Central Iowa Construction Waste Management study illustrates how a waste stream analysis is conducted for a particular project: http://www.sciswa.org/Waste%20study2.pdf.

The Residential Construction Waste Management: A Builder's Field Guide provides detailed information about ways builders can reduce, reuse, and recycle jobsite waste: http://oikos.com/library/waste/order.html.

The **National Association of Demolition Contractors** published *Demolition Industry Promotes C&D Recycling* supporting the development of a federal C&D recycling policy:
http://www.demolitionassociation.com/site/pdf/C&D%20Recycling%20Report.pdf.

Triangle J Council of Governments produced *WasteSpec: Model Specifications for Construction Waste Reduction, Reuse, and Recycling*, a detailed guidance document for developers: http://www.tjcog.dst.nc.us/cdwaste.htm. Triangle J Council of Governments has been working to develop markets for recycled materials since 1990.

7.4. Financing

The **National Recycling Coalition**'s *Government and Community-Based Sources and Strategies for Financing Recycling Enterprises* report discusses how traditional and innovative strategies can be used to support recycling activity: http://www.nrc-recycle.org/resources/Financing/ilsrfn.pdf.

Wisconsin offers **Waste Reduction & Recycling Demonstration Grants** to support the implementation of innovative waste reduction, reuse and recycling projects on a pilot or demonstration scale: http://www.dnr.state.wi.us/org/caer/cfa/Ef/recycle/.

Florida offers an array of programs supporting recycling that include a **Recycling Business Assistance Center and Recycling Loan program, Innovative Recycling/Waste Reduction Grants, and Recycling/Education Grants**:
http://www.floridadep.org/waste/categories/recycling/pages/grants.htm.

San Jose, California's Construction and Demolition Debris Diversion (CDDD) Program: http://www.sjrecycles.org/business/cddd.htm.

7.5. Databases

The **Construction Waste Management Database** is a searchable database of C&D recyclers across the U.S., created by **the General Services Administration, National Institute of Standards and Technology, EPA** and other partners:
http://www.wbdg.org/ccbref/cwm.php.

Materials and waste exchanges are markets for buying and selling reusable and recyclable commodities. Some are physical warehouses that advertise available commodities through printed catalogs, while others are simply web sites that connect buyers and sellers. Exchanges also vary in terms of area of service and the types of commodities

exchanged. The **EPA** website lists a number of international/national and state specific materials exchanges: http://www.epa.gov/jtr/comm/exchstat.htm.

7.6. Deconstruction Resources

A Guide to Deconstruction, http://www.hud.gov/deconstr.pdf, and *A Report on the Feasibility of Deconstruction*, http://www.huduser.org/publications/destech/deconstruct.html, are **US Housing and Urban Development** publications that focus on barriers and opportunities for deconstruction as part of a construction and demolition recycling strategy.

Deconstruction - Building Disassembly and Material Salvage: The Riverdale Case Study is a report detailing a 2000 square foot deconstruction project in **Maryland**: http://www.smartgrowth.org/pdf/deconstruction.pdf.

Deconstruction: Salvaging Yesterday's Buildings for Tomorrow's Sustainable Communities provides an overview of deconstruction as a component of C&D recycling: http://www.ilsr.org/pubs/pubswtow.html. The report highlights local policies and programs that support deconstruction.

The **Smart Growth Network** is a coalition of organizations, including EPA, fostering sustainable community development: http://www.smartgrowth.org/Default.asp?res=800. Among the many topics covered on this website are C&D debris and other aspects of the environmental impact of buildings.

Produced by the **National Association of Home Builders Research Center**, the *Deconstruction: Building Disassembly and Material Salvage* brochure provides an overview of the economic and environmental benefits of deconstruction: http://www.epa.gov/epaoswer/non-hw/debris/pubs/decon_br.pdf.

The **Institute for Local Self-Reliance (ILSR)**, http://www.ilsr.org/, has a **Building Deconstruction** web page, http://www.ilsr.org/recycling/decon/builddecon.html, including publications and information on its deconstruction projects.

The **Reuse Development Organization (ReDO)** is a nonprofit organization promoting reuse of numerous materials, including building products: http://www.redo.org/.

7.7. Other Resources

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