

Construction and Demolition Materials Recycling

Overview

Waste material resulting from new construction, remodeling or the demolition of existing structures is for purpose of this paper referred to as construction and demolition (C&D) waste. The term C&D waste includes “building rubbish”, “demolition debris” and “construction and demolition” wastes as further defined below.

There are many definitions and material types that are considered C&D waste. Lincoln Municipal Code (LMC) 8.32 defined “**Building rubbish**” as “all discarded or unwanted material or waste material from the construction, remodeling, and repair operations on houses, commercial buildings, and other structures including, but not limited to, excavated earth, stones, brick, plaster, lumber, concrete, and waste parts occasioned by installations and repairs” and “**Demolition debris**” as “all combustible and noncombustible waste material resulting from the demolition of structures, roadways, or other paved surfaces”. Both definitions exclude “garbage, asbestos products, asphaltic products and other hazardous wastes or hazardous materials”. In the LMC these building rubbish and demolition debris materials are a subset of “refuse” and are thus subject to refuse hauler licensing and related regulations, but are exempt from the Occupation Tax provided they are “lawfully being deposited in the 48th Street public sanitary landfill”.

Nebraska Department of Environmental Quality, Title 132 regulations, define “**Construction and Demolition**” waste as “waste which results from land clearing, the demolition of buildings, roads or other structures, including, but not limited to, fill materials, wood (including painted and treated wood), land clearing debris other than lawn waste, wall coverings (including wall paper, paneling and tile), drywall, plaster, non-asbestos insulation, roofing shingles and other roof coverings, plumbing fixtures, glass, plastic, carpeting, electrical wiring, pipe and metals. Such waste shall also include the above listed types of waste that result from construction projects.” NDEQ’s definition of construction and demolition waste does not include “friable asbestos waste, special waste, liquid waste, hazardous waste and waste that contains polychlorinated biphenyl (PCB), putrescible waste, household waste, industrial solid waste, corrugated cardboard, appliances, tires, drums, and fuel tanks.”

Based on Title 132 regulation, “**Fill**” means solid waste that consists only of one or more of the following: sand, gravel, stone, soil, rock, brick, concrete rubble, asphalt rubble or similar material. C&D material used as “fill” for erosion control, erosion repair, channel stabilization, landscaping, roadbed preparation or other land improvement are exempt from NDEQ regulation and do not require regulatory reporting or disposal in a licensed facility.

Disposal sites in Nebraska that accept C&D material are required to report disposal quantities to NDEQ. C&D processing facilities in Nebraska are required to have a permit from the NDEQ, but are only required to report quantities of processed material sent to disposal (not total quantities processed or quantities diverted).

LMC defines a “Limited Landfill” as “a type of [landfill] operation approved by the Health Director in which only building rubbish and demolition debris are disposed of by plan on a specified parcel of land and operated and maintained in such a manner as to present no danger to the health and safety and welfare of human beings.” There are currently no Limited Landfills in operation in Lancaster County. LMC classifies the City’s North 48th Street Construction and Demolition Waste Landfill as a “sanitary landfill”. The site is permitted by the NDEQ as a Construction & Demolition Waste Disposal Area.

C&D wastes may be managed in wide variety of manners. It may be landfilled at either a sanitary landfill or C&D landfill [Limited Landfill]; portions of this may be used as “Fill” for the above stated purposes. Certain C&D waste may also be processed (often by grinding) to form materials suitable for replacement of sands and gravels (recycled). A portion of the material from C&D projects may also be recycled or recovered for reuse such as metals, woods and certain building materials.

The Cleaner Greener Lincoln Initiative has formed an advisory committee to discuss sustainable building standards.

Current Programs

The City provides limited education and support for C&D recycling options; the *Lincoln-Lancaster County's Official 2012 Waste Reduction & Recycling Guide* identifies limited options for managing wood waste and building materials. The City does not provide recycling or diversion facilities for C&D waste; all such facilities are provided by private and not-for-profit organizations.

The N. 48th Street Construction and Demolition Waste Landfill, 5101 North 48th Street, is located on City owned land. The North 48th Street site is approximately 450 acres in size of which 102 acres are currently permitted as a C&D waste disposal area. The City's North 48th Street Construction and Demolition Waste Landfill is located above an area where municipal solid wastes (MSW) from Lincoln and Lancaster County were disposed, starting in approximately 1956; in 1990 this site discontinued taking all wastes with the exception of demolition debris and building rubbish. These materials are used to correct grading and drainage above the historic MSW landfill area. The North 48th Street Construction and Demolition Waste Landfill has accepted an average of 70,700 tons per year of C&D waste over the last five (5) years. Lincoln's C & D Landfill operating permit has historically been more restrictive than traditional C & D Landfill operations. The City has limited the acceptance of large quantities of certain C&D and beneficial fill materials such as paper, gypsum board, rubber, plastics, shingles and asphalt. The City has also prohibited painted and treated wood. The amount of acceptable wood debris has generally been restricted to approximately 50 percent per each load. This limitation on what is accepted at Lincoln's C & D Landfill results in more construction and demolition waste being deposited at the Bluff Road Landfill.

There are specialty firms, trucking companies (that provide containers and container handling services), small businesses and residents that handle C&D waste. These entities typically make decisions on how to handle waste materials based on cost, convenience, storage and handling options, regulatory requirements, material composition, and management options (recycle, fill, disposal). When materials are hauled to C&D recycling and processing facilities these materials are considered source separated and trucking operations are exempt from both licensing requirements and the Occupation Tax; they are further exempt from reporting any information regarding the type of services provided and type and quantity of material diverted/recycled. As a result, the number of firms participating or providing C&D recycling services is not known.

Some building construction contractor in the community participate in Nebraska's green building program and offer C&D material recycling and diversion as part of their services. The number of contractors or projects that have recycled C&D waste from building projects have not been tracked.

As discussed in greater detail below, the City attempts to track the recycling and diversion of C&D materials but reporting is strictly voluntary and information reported cannot be validated.

Generation and Diversion

Table 1 provides a summary of historical C&D tonnages disposed at the N. 48th Street Landfill. Quantities of C & D waste disposed will vary from year to based on economic and construction activity as well as the amount being diverted to recycling facilities. The C&D waste management business has evolved significantly since the City's 1994 solid waste plan was developed, with much greater volumes being diverted from disposal; this can be seen in the decrease in tonnages delivered to the N. 48th Street Construction and Demolition Waste Landfill. If C&D does not meet the acceptance criteria at the City's N. 48th Street Landfill it can be disposed of at the City's Bluff Road Landfill. The City does not specifically track (by waste type) the C&D waste going into the Bluff Road Landfill; this material may also arrive at the Bluff Road Landfill mixed with other waste types or via the N.48th Street small vehicle transfer station (citizen self haul of C&D materials).

Table 1 - Historical Quantities Disposed at the North 48th Street Construction and Demolition Waste Landfill (Tons)

FY	C&D Waste
00-01	61,305
01-02	88,227
02-03	78,649
03-04	98,174
04-05	76,746
05-06	86,159
06-07	75,491
07-08	89,446
08-09	53,185
09-10	59,119
10-11	76,337

A portion of the C&D waste stream generated in the Lincoln and Lancaster County may also be exported to other disposal sites in the region; the quantities exported are required to be reported (under the Occupation Tax) but are not distinguished from other waste types. C&D waste generators and demolition contractors can also haul certain waste (e.g., metals, asphalt roofing shingles, wood, concrete, and asphalt) from their project sites to various processing sites in the region that recover materials. Materials sent to these facilities are are not required to be reported to the City.

Based on processing rate information obtained by the City (shown in Table 2), it is apparent that significant quantities of potential C&D waste (e.g., concrete and asphalt) are being diverted from disposal and reused/recycled rather than landfilled. Visual observations at the City's North 48th Street Landfill suggest that opportunities remain for further recycling/diversion of C&D waste. Table 2 shows the quantities of Planning Area concrete and asphalt that have been reported as diverted from disposal since 2000.

Separate data on diverted metals from construction sources is not available, but is likely included in the reported commercial recycling tonnages. The concrete and asphalt diversion data has been relatively consistent year to year tonnage. Based on the data in Table 2, the private-sector recycling operations have diverted an average of approximately 352,000 tons per year of these materials, since 2000. Using FY 2010/2011 C&D disposal data and 2011 C&D diversion rates, the current C&D diversion rate is 75 percent.

There is at least one private firm that accepts wood waste and grinds it into landscape mulch. There are also local asphalt firms that accept asphalt roofing shingles for recycling. Both operations have disposal fees less than the Bluff Road Landfill. There are also non-profit organizations that accept donations of reusable building materials.

The composition of C&D waste can also vary significantly from project to project. While Appendix 1 provides some broad guidelines, developed by WasteCap Resource Solutions, for estimating C&D waste generation/diversion; each project will need to be evaluated individually to target project specific recyclable materials (or source reduction options).

**Table 2 –Recycled Tons of Concrete and Asphalt
(Reported by Private-Sector Processing Firms)**

Calendar Year	Clean Concrete	Asphalt	Total Tons
2000	174,524	82,876	257,400
2001	228,628	101,920	330,548
2002	272,194	100,813	373,007
2003	275,029	92,881	367,910
2004	198,732	116,020	314,752
2005	215,784	152,807	368,591
2006	315,557	101,258	416,815
2007	283,385	77,249	360,634
2008	291,514	80,863	372,377
2009	291,506	70,122	361,628
2010	263,946	77,962	341,908
2011	146,995	83,752	230,747

Program (Facility/System) Options

There are several options that the City could consider to increase C&D recycling.

- Education/Voluntary Programs (status quo)
- Regulatory requirements
- Market and Diversion Incentives
- Construction Materials Recycling and Processing Centers

As with other recycling options (residential and commercial) there is a wide array of program options that could be considered in conjunction with C&D recycling from new construction, remodeling or the demolition projects.

Increased education/behavior change will be important for any program that attempts to significantly increase the quantities of materials over what is being accomplished with existing programs.

Regulatory Requirements. These can take several forms; the most common examples may include:

- Mandatory recycling plans
- Minimum diversion requirements for demolition projects (permit condition)
- Incorporation into disaster response plans

Appendix 2 provides additional information on C&D regulations and requirements across the US. The concept of mandatory recycling plans can be used with demolition, as well as new construction or remodeling projects. Under this concept the permitting process is typically used to both obligate diversion efforts and as a means of enforcement. These are most easily used in conjunction with projects over a certain threshold of waste generation. This concept generally requires that, as part of a permit application and as a prerequisite to issuing a construction and demolition permit, a plan is submitted that identifies waste management and recycling/diversion practices that will be applicable to the project. Such projects require documentation of compliance and enforcement to be effective. Such a process will require policies to establish types of materials and degree of diversion required.

Minimum diversion requirements for demolition (or new construction) projects would typically be a part of a mandatory (permit required) construction waste management/recycling plan concept. Such plans would establish minimum diversion requirements specific to the project. Initially this concept could be implemented with projects involving public funds. One such example is Madison, Wisconsin's ordinance requiring C&D recycling from certain new construction, remodeling and demolition projects:

- Madison, Wisconsin requires, by ordinance, (starting January 2010) that:
 - New construction projects that use concrete and steel support must recycle 70% or their construction debris by weight.
 - Remodeling projects with a value in excess of \$20,000 must recycle a specific list of materials:
 - Persons seeking a demolition permit must file a reuse and recycling plan.

(Source: <http://www.cityofmadison.com/streets/recycling/demolition/construction/Demolition.cfm>, retrieved on 09/01/2012)

As noted above, Appendix 1 provides an example of how C&D diversion quantities might be estimated. It is important to keep in mind that for such projects to be effective, especially in private development opportunities, cost effective diversion options (markets) need to be available. The challenge in recycling these materials is having contractors and their subcontractors separate the material at the job site and cost effectively transport it to recycling facilities.

Natural disasters can produce a large quantity of material that is similar in characteristics to C&D waste. Such disasters can significantly and negatively impact permitted C&D disposal sites (and MSW landfills). To avoid significant impacts, such plans should include provisions for recycling/diversion of materials such as wood, metals, asphalt shingles, vegetation, drywall (gypsum), plumbing fixtures, carpeting, electrical wiring, pipe, and other materials. This preparedness strategy would be a key asset in minimizing the quantity of waste requiring landfilling following a natural disaster.

Market and Diversion Incentives. As discussed in the paper under Recycling Incentives, there are a wide range of options that might be considered. From the standpoint of C&D recycling these options may include:

- Modify government procurement/purchasing specifications
- Require the use of recyclable materials
- Targeted programs
- Increased landfill fees
- Disposal bans

By incorporating “buy-recycled” provisions or mandatory use of recycled products in procurement and purchasing policies, it is possible to stimulate markets and create incentives to recycle. These programs are often most easily implemented in government programs and to a certain extent already exist in certain federal programs. While there are many programs in the private sector, these are typically voluntary.

As discussed in the paper on Recycling Incentives, the building specification system can also be used in new construction to dictate or provide priority to the use of recycled materials, thus helping to support markets and create market demand for certain materials. This concept is a significant cornerstone of the Green Building Council and their Leadership in Energy and Environmental Design (LEED) certification program. As a simple example, the City and County’s standard specification could be modified to include provisions to use materials such as locally produced compost in construction projects. This would create added markets for the City’s LinGro compost.

Targeted programs may involve specific facilities created by the City or private industry based on diversion policies. Examples of materials that are commonly targeted are wood (clean and pallets), aggregates (crushed concrete, asphalt, brick), or shingles. Programs that are in various states of evolution across the US also include, but are not limited to materials such as carpeting, durable goods, ceiling and floor tiles, plastics (clean film and rigid), and drywall. Most of the large volume existing programs, in or adjacent to the Planning Area, are private industry initiatives. As such, expanding diversion for these materials may involve measures (incentives) to enhance program effectiveness, participation or reduce costs. Where local or regional markets do not exist more research may be needed on how to develop, encourage or incentivize the creation of such markets. The extent of implementation details, associated with such program options, is beyond the scope of this paper. One example of such a diversion program is the carpet recycling program in Omaha, Nebraska (considered an existing market); while such a program does not currently exist in the Planning Area, it may be possible to create a program (new market) or identify options to piggyback on this existing program. Another example may be the development of a program to divert drywall (gypsum). To develop such a program would first involve establishment of markets and reasonable projection of market pricing. Gypsum (Calcium Sulfate Dihydrate) has a potential beneficial use in agriculture as a soil amendment, soil conditioner, and fertilizer. C&D derived gypsum would need to compete with other natural and readily available man-made sources (e.g., considered a waste product from air pollution control equipment from power plants). In the case of C&D derived gypsum it will be important in market development to consider that gypsum from power plants is likely already marketed for this same purpose, there is a readily available supply, and the sale price is relatively low cost.

An indirect incentive (disincentive) would be to increase landfill disposal rates to discourage disposal by making diversion options more cost effective. Raising the disposal rate may involve social and political considerations. This concept could make certain higher cost recycling options more competitive with disposal rates. One disadvantage of this concept is that the City is currently using C&D material at the N. 48th Street Landfill to correct grading and drainage above the historic MSW landfill area. By reducing the quantities of C&D material this site accepts it would have the benefit of prolonging the life of the site, but it may also require the City to purchase soil for grading and drainage purposes, as opposed to deriving revenue from accepting C&D materials and using it for the same purpose. A separate paper discusses construction and demolition site disposal capacity and capacity requirements.

Disposal bans are also discussed under the technical paper on Recycling Incentives. Appendix 3 is an example from Seattle, Washington, where they have begun a phased in series of disposal bans, related to C&D waste. Bans do not necessarily reduce waste generation, but

added incentives (disincentives) to encourage diversion of certain materials. Again, this presupposes the existence of processing and recovery outlets for these materials. As noted in the Appendix 3 document, effective January 2012 Seattle banned landfill disposal of concrete, brick and asphalt paving. By forecasting future bans, Seattle also provides opportunities for additional market development prior to the ban taking affect.

Construction Materials Recycling and Processing Centers. Recycling/reuse/processing centers are typically intended to give products a second life or repurpose. Examples of materials handled by recycle/reuse centers include, but are not limited to doors, windows, cabinets, electrical appliances, furniture, hardware, gently used building materials, household goods, etc. Recovery of these materials may in some instances require de-construction as opposed to demolition. Examples of such facilities include: Habitat for Humanity-ReStores and EcoStores in Lincoln. These are not-for-profits that accept and warehouse usable construction materials for resale or in program directed construction projects.

Processing facilities may be stand alone facilities or in combination with transfer stations. Some facilities only take limited types of materials (relatively clean concrete and asphalt), while others attempt to process mixed C&D wastes for recovery. Multi-material processing facilities have many challenges, including large capital costs (for buildings, material storage and processing equipment), high operating costs (for personnel and equipment), and limited markets, if they are not producing a pure enough product – all leading to tipping fees potentially higher than current C&D landfilling rates. Transfer station(s) will be examined in a separate technical paper: if transfer station(s) are considered a cost effective option for solid waste management then supplemental evaluations may be appropriate to determine the cost effectiveness of adding select materials processing capabilities, not limited to C&D wastes/recyclables.

As with other recycling programs, to be most effective a combination of the above options will likely produce the largest diversion rate.

Options Evaluation

The general issues associated with C&D recycling programs are:

- Markets for recovered material
- Material storage and handling costs
- Competition with low disposal rates
- Lack of incentives, especially for small volume projects
- Funding and cost justification for new economic incentives
- Difficulty in implementing mandatory programs (e.g., bans for inert material)

Before new programs are implemented it may be necessary to undertake a market analysis to confirm that adequate markets are available for materials targeted for recovery, especially unique materials.

Consistent with the guiding evaluation criteria developed for use in the Solid Waste Plan 2040, the C&D recycling options have been further evaluated based on the considerations shown in Table 3. Education/Voluntary programs are not included in this options analysis.

Table 3 – Options Evaluation

Evaluation Criteria	Regulatory Requirements	Market and Diversion Incentives	Construction Materials Recycling and Processing Centers
Waste Reduction/ Diversion	<p>Can contribute toward increased source reduction and recycling.</p> <p>May or may not increase market availability</p> <p>Can lead to waste exports if not done properly.</p> <p>Can preserve existing landfill space, especially as it relates to disaster response.</p>	<p>Bans, mandates, fees, and restrictions do not in and of themselves reduce the quantity of waste generation, but can be effective in directing materials away from local landfills and toward recycling programs.</p> <p>Rates and incentives/disincentives (penalties) need to be carefully considered as they can also lead to greater waste exports.</p> <p>Availability of cost effective markets and reuse options will be a key to expanding the types of C&D materials diverted.</p> <p>Bans, restriction and mandates can help create markets for diverted materials.</p>	<p>Availability of local, cost competitive recycling and processing facilities for materials not currently diverted should contribute to increased recycling, reduced exports and reduced quantities going to landfills.</p> <p>To increase facilities generally requires suitable markets. New or added facilities can not generally be implemented until viable/sustainable markets are established.</p>
Technical Requirements	<p>Existing processing facilities for concrete and asphalt diversion appear to have adequate capacity.</p> <p>The availability and stability of markets will need to be evaluated in conjunction with targeted materials.</p> <p>Can be reliable, but will require funding for mechanisms to monitor and enforce compliance, to ensure consistency.</p> <p>Programs can be constructed to be flexible, but are still based on varying forms of mandates.</p>	<p>Added processing capacity may be necessary if current local markets do not exist for diverted materials.</p> <p>Implementing preferred purchasing practices and buy-recycled can be done within the policies of local government.</p> <p>Some level of risk results from bans, restriction and mandates, unless solutions are available to deal with the affected material and enforcement is provided.</p>	<p>Existing processing facilities for concrete and asphalt diversion appear to have adequate capacity.</p> <p>Added processing capacity may be necessary if current local markets do not exist for diverted materials.</p> <p>Added facilities, through government sponsorship, will need to be evaluated against compatibility with existing privately funded programs.</p> <p>If a transfer station(s) are deemed appropriate, then further evaluation of adding processing capacity should be undertaken (not limited to C&D materials).</p>
Environmental Impact	<p>Can target materials with goal of conservation of material and energy resources.</p>	<p>Environmental benefits would need to be evaluated relative to specific option.</p> <p>A portion of the material currently disposed of is considered inert (non-toxic) and may not represent a risk to air or water resources.</p> <p>The City is using select C&D (less than 50 percent combustible) to help improve drainage and fix grading above an existing MSW landfill.</p>	<p>Can target materials with goal of conservation of material and energy resources.</p> <p>Environmental benefits would need to be evaluated relative to specific option.</p>
Economics	<p>May result in increased cost to new projects and added cost for demolition and remodeling projects for both compliance and if cost of management of recovered materials exceed cost of disposal options.</p> <p>Funding sources will be specific to the program options selected, but generally place the burden on the generator of C&D waste or new project developer.</p>	<p>New and expanded facilities will require capital expenditures. If long-term cost effectiveness is not established, funding could be a major challenge.</p> <p>Incentives can help off-set diversion program costs, but will require a funding source if the business does not generate a profit.</p> <p>Costs to residents and businesses will be specific to the program options selected, but generally place the burden on the</p>	<p>New and expanded facilities will require capital expenditures. If long-term cost effectiveness is not established, funding could be a major challenge.</p> <p>Costs to residents and businesses will be specific to the program options selected; large scale facilities may need to distribute cost to more than waste generators/users.</p> <p>All current facilities that divert C&D are funded by private and not-for-profits. City funding would likely be associated with a</p>

Evaluation Criteria	Regulatory Requirements	Market and Diversion Incentives	Construction Materials Recycling and Processing Centers
		<p>generator of C&D waste or new project developer.</p> <p>New markets for target materials may represent an economic development opportunity.</p>	<p>transfer station(s), which contained processing as a supplemental function. Transfer station(s) will be examined in a separate technical paper.</p> <p>Grants and subsidies can be used to help fund certain programs or fund new facilities, but long-term they may or may not ensure sustainable programs.</p> <p>Non-sustainable project economics represents a risk to programs success and public acceptance.</p>
Implementation Viability	<p>Will require laws/regulations/ordinance changes to implement. Social/political acceptability will be a factor in any options that attempts to change the current system and results in added costs to projects.</p> <p>Storing C&D for processing or pending distribution to markets can require relatively large area of land.</p> <p>Permitting programs would be used as part of the approval and enforcement mechanism to facilitate implementation of new programs.</p>	<p>Most programs involving incentives or bans will require laws/regulations/ordinance changes to implement, including those that use rates and fees and incentives.</p> <p>Establishing incentives/disincentives for new markets or increase diversion will need to be carefully considered to ensure they effectively achieve the desired level of recycling.</p> <p>Storing C&D for processing or pending distribution to markets can require relatively large areas of land.</p> <p>Social/political acceptability will be a factor in any options that attempts to change the current system using rates and bans.</p> <p>Changes to purchasing practices and specifications used by units of government may be easier to accomplish than large scale disposal bans on select materials.</p>	<p>Siting and constructing new large scale waste processing facilities (not limited to C&D waste) can have issues with social/political acceptance.</p> <p>Storing C&D for processing or pending distribution to markets can require relatively large areas of land.</p> <p>Some amount of permitting will be required with the construction of any new facility. This should not impede construction unless the facility is controversial or fails to comply with applicable laws.</p>

Relationship to Guiding Principles and Goals

The current C&D recycling programs are voluntary private initiatives with minimal support or involvement by Lincoln and Lancaster County. These programs currently (2011) divert an estimated 75 percent of the C&D waste generated in the Planning Area. The principle materials known to be diverted are concrete, asphalt and metals. As it relates to the Guiding Principles and Goals of the Solid Waste Plan 2040, the possibility of expanding C&D recycling is directly applicable, as further noted below.

- **Emphasize the waste management hierarchy:** Recycling is one of the most preferred waste management methods in the hierarchy (immediately after reduce and reuse) in that it places maximum emphasis on options to recover materials and recycle them into new products. Current programs are compatible with this hierarchy. To increase recycling above the status quo, additional regulations, markets, incentives or possibly facilities will be necessary.
- **Encourage public/private partnerships:** The current system of recycling involves private efforts, including trucking and recycling processing facilities provided by private and not-for-profit firms. The City provides limited education and promotional outreach. If expanded C&D recycling programs are selected for implementation it is expected that they will likely be developed with private parties providing collection and processing services. Services by non-profits, privates, and public/private are expected to continue and complement any decision to implement an expanded C&D recycling program.
- **Ensure sufficient system capacity:** System capacity for C&D recycling is believed to be adequate for materials such as concrete, asphalt and metals. Construction of additional space (facilities) may be necessary to accommodate an expanded array of recyclables collection and storage. Establishment of viable markets will be essential to expanding the array of materials diverted.
- **Engage the community:** Any expanded C&D recycling program will be necessary to engage the businesses affected by this decision. To optimize success of an expanded C&D recycling program, it will also require education (behavior change) to encourage and sustain participation.
- **Embrace sustainable principles:** Maximizing recovery of C&D materials and recycling into new products recognizes that waste is not inevitable and discarded materials are potentially valuable resources.

Summary

In FY 2010/2011 an estimated 75 percent of C&D materials were diverted, based upon the quantities of concrete and asphalt diversion (voluntarily) reported to the City. Diversion of metals from C&D waste is known to be occurring, but quantities are difficult to estimate and as such are not reflected in the C&D diversion estimates. When materials are hauled to C&D recycling and processing facilities, these materials are considered source separated and trucking operations are exempt from both licensing requirements and the Occupation Tax; they are further exempt from reporting any information regarding the type of services provided and type and quantity of material diverted/recycled. As a result, the number of firms participating or providing C&D recycling services is not known.

The City derives some benefit from the C&D materials currently disposed of at the N. 48th Street Construction and Demolition Waste Landfill because such materials are beneficially used to

correct grading and drainage above the historic MSW landfill area. By reducing the quantities of C&D material this site accepts it would have the benefit of prolonging the life of the site, but it may also require the City to purchase soil for grading and drainage purposes, as opposed to deriving revenue from accepting C&D materials and using it for the same purposes.

There are many program options available, all of which are essentially consistent with the Solid Waste Plan 2040 guiding principles and the waste management hierarchy. With any new or expanded program, markets for the recycled C&D materials will be a key factor in determining that such a diversion program is viable and sustainable. If the Solid Waste Plan 2040 incorporates expanded C&D waste recycling systems, facilities or programs, the City will need to evaluate minimum program requirements, and how to fund, implement and enforce such programs.

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Appendices

APPENDIX 1

How to Estimate Quantities of Construction or Demolition Debris Your Project will Generate

Calculating Quantities of C&D Debris

Step 1. Estimate Total Quantity of Debris

After you have determined what materials will be in your waste stream and produced a preliminary list of materials that may be targeted for reuse or recycling (see Construction Waste Management Plan Form ANALYSIS OF ESTIMATED CONSTRUCTION OR DEMOLITION WASTE TO BE GENERATED) it is time to estimate how much construction or demolition debris your project will produce.

If you have records of weights and volumes from past projects your company has done, these will be the most accurate. If not, here are some calculations to get you started. After you have documented a few projects, you will be able to get much closer estimates. However, these calculations should be useful in the beginning to determine appropriateness of recycling a variety of materials and to calculate projected hauling costs.

Method #1 (Construction only)

Use Project Estimates. Research quantities of materials ordered for your project. Determine a waste factor (typically between 5 – 10%) and calculate the waste from each material in that manner. Make sure to include packaging in estimates.

Method #2

Utilize EPA Estimates.¹

Commercial (Non-residential) Construction Debris. Nonresidential building vary in C&D debris generated. US EPA uses an average generation of 3.89 pounds per square foot.

Commercial (Non-residential) Demolition Debris. Assuming an average building size of 13,300 square feet for buildings built between 1920 and 1969, EPA used 155 pounds per square foot for nonresidential buildings. A 13,300 square foot warehouse, for example, would produce 2,061,500 pounds of construction and demolition debris or 103,075 tons when demolished.

Residential Construction Debris. Types of houses, building practices and regulations vary widely. EPA used an average of 4.38 pounds per square foot of floor space for their estimates. Therefore, a 1,200 square foot house would result in 5,256 pounds of or 2.62 tons of construction debris.

Residential Demolition Debris. Assuming an average of 1,600 square feet for single-family houses and 1,000 square feet for multifamily houses, EPA used 61 pounds per square foot for single family and 115 pounds

¹ Franklin & Associates. "Characterization of Building-Related Construction and Demolition Debris in the United States" 6/15/1998. Order number EPA530-R-98-010

per square foot for multifamily houses. Consequently, a single-family house of 1,600 square feet, when brought down, would result in 97,600 pounds of demolition debris, or 4.88 tons.

Method #3

Utilize WasteCap Resource Solutions and National Association of Home Builders Estimates

Commercial Construction Debris. Based on several WasteCap Resource Solutions projects, the average generation rate it has found is 5.44 pounds per square foot of commercial construction debris. These projects tend to be large buildings with large quantities of heavy materials -- concrete and metal in particular.

Residential Construction Debris. The National Association of Home Builders estimates four pounds per square foot of construction and the following waste from a 2,000 square foot home

Step 2. Calculate the percentage, by weight, of different materials anticipated in the waste stream. Use project estimates or the estimates below.

Commercial Construction Debris

Material	Estimated % (by weight) *
Trash	25%
Cans & Bottles	.5%
Cardboard	10%
Concrete/masonry	18%
Drywall	12%
Metal	11%
Wood	24%
Reuse/Other	0%
Total	100%

* Edit to suit your project. Estimates are from WasteCap's Commercial Construction projects.

Commercial Demolition Debris:

Sample composition of demolition debris (19 nonresidential projects in the Pacific Northwest)²

Material	% (by weight)
Trash	9%
Asphalt	2%
Brick	1%
Concrete	66%
Scrap Iron	5%
Roofing	1%
Wood	16%
Total	100%

² Ibid. Figure 9. Page 2-18. Order number EPA 530-R-98-010.

Residential Construction Debris (from National Association of Home Builders):

Material	Weight (Pounds)	Estimated % (by weight)	Volume (Cubic Yards)
Solid Sawn Material	1,600	20%	6
Engineered Wood	1,400	18%	5
Drywall	2,000	25%	5
Cardboard	600	8%	20
Metals	150	2%	1
Vinyl	150	2%	1
Masonry	1,000	13%	.71
Containers – paint, caulks, etc.	50	1%	-
Other	1,050	13%	11
Total	8,000	100%	49.71

Residential Demolition Debris (Note: numbers based on landfill data, not on data from demolition sites, so any material from residential demolition which was recycled (e.g. concrete) is not included) ³

Material	% (by weight)
Trash	19%
Asphalt shingles	29%
Brick	4%
Cardboard	2%
Drywall	6%
Ferrous metals	3%
Plastic	3%
Wood	34%
Total	100%

Step 3. Calculate projected weight and volume of the different materials. Utilize project estimates or use the conversion numbers below. Haulers can be very helpful with these calculations. They may have conversion estimates of quantity to weight which may be more accurate to your project. Work with your hauler(s).

Recycling Conversions	Trash	Cans & Bottles	Cardboard	Concrete	Drywall	Metal	Wood
Average pounds per cubic yard	350	50	100	1400	500	1,000	300
Average tons per cubic yard	0.175	0.025	0.050	0.700	0.25	.50	0.150
Average cubic yards per ton	5.71	40	20	1.43	4	2	6.66

³ Camp Dresser & McKee Inc. "Quantity and Composition Study of Construction and Demolition Debris in Wisconsin" Prepared for the Wisconsin Recycling Market Development Board. February 1998. Table 3-3.

Step 4. Use These Calculations:

- To help you decide what to and not to recycle
- In Your Construction Waste Management Plan
- To provide to potential haulers for more accurate bids
- To compare hauling proposals (see “Hauling RFP”)
- To calculate the projected cost of recycling vs. not recycling (see “Hauling RFP”)

APPENDIX 2

NERC | Northeast Recycling Council

Celebrating 25 Years of Uniting the Ten Northeast States for Environmentally Sound Materials Management

SUMMARY OF U.S. STATE AND MUNICIPAL C&D REGULATIONS AND REQUIREMENTS

In the U.S., the solid waste management hierarchy places source reduction, reuse, and recycling as the highest priorities. This is applicable to residential and business-generated materials. It is also applicable to construction and demolition materials (C&D). More and more state and municipal regulations and requirements are mandating the recycling of C&D.

C&D materials are generated in new construction, remodeling, deconstruction and demolition. Common components of new construction in the U.S. include: wood; concrete/masonry; wallboard; metal; corrugated cardboard; bottles and cans; and trash. Demolition debris includes: concrete; wood; trash; scrap iron; asphalt; brick; and roofing. Many of these materials can be recycled and made into new products— clean, untreated wood can be made into new wood products (i.e., furniture, and wood chips and mulch for landscaping purposes); gypsum wallboard can be ground into a gypsum powder that is then manufactured into new plasterboard or applied as a soil amendment; and asphalt shingles can be recycled into cold patch, new shingles, or hot mix asphalt.

In 2011, the Northeast Recycling Council (NERC) completed the [Disposal Bans & Mandatory Recycling in the United States](http://www.nerc.org/documents/disposal_bans_mandatory_recycling_united_states.pdf) (http://www.nerc.org/documents/disposal_bans_mandatory_recycling_united_states.pdf)—a summary of state recycling regulations and material disposal bans in the U.S. Of the 49 states and District of Columbia (DC) reported in this study, 13 (28%) have some form of C&D material disposal ban or recycling requirement. Following are some of the highlights:

- Sixteen C&D materials are either banned from disposal or are required to be recycled in the reporting states.
- Six states ban the disposal of friable asbestos, which is commonly found in acoustic ceilings and tiles, many types of plasters, wallboard, joint compound or "mud" and thermal insulation for water heaters and pipes made before 1978.
- Five states ban the disposal of wallboard.
- Ten states require corrugated cardboard to be recycled, and one state bans its disposal.
- Seven states ban the disposal of mercury containing devices found in thermostats and in other devices.
- Seven states require glass containers to be recycled, and four states ban its disposal.

Table 1 below provides a summary of the information provided by the states.

C&D Material	States												
	CT	DC	MA	ME	NH	NJ	ND	PA	RI	SD	VA	WV	WI
Asbestos (friable)	B	B					B	B			B	B	
Asphalt Shingles & Pavement		B	B									B	
Brick		B	B									B	
C&D Wood		B	B									B	
C&D Metal	R	B	B		B		R	B	R			B	
Concrete		B	B									B	
Corrugated Cardboard	R	R	R	B	R	R		R	R	R	R		R
Glass (containers)	R	R	B	R	R	R		B	R	B	R		B
Land Clearing Debris												B	B
Metal (containers)	R	R	B			R		R	R		R		B/R
Mercury Containing Devices		B	B	B			B		B			B	B
Paint	B	B										B	B
Plastic (containers)		R	B			R		B/R	R	B			B/R
Scrap Metal	R					R	R	R	R				
Wallboard		B	B		B	B						B	
Wood (clean)	B		B						R				

NOTE: Glass, plastic, and metal containers are part of the waste generated by workers at C&D job sites.

Further research into municipal C&D recycling ordinances revealed that many regional state and federal agencies, as well as municipalities, do not maintain records about how C&D is handled at the municipal level. Instead, they track the promotion of C&D diversion at the state level, the kinds of C&D data tracking the states conduct (whether it is through voluntary methods or required by rule), and the licensing and permitting process for solid waste facilities and activities relating to the handling of C&D.¹

Iowa offers a [model C&D recycling ordinance](http://www.iowadnr.gov/portals/idnr/uploads/waste/cndord_demorecycling.pdf) (www.iowadnr.gov/portals/idnr/uploads/waste/cndord_demorecycling.pdf).

NERC identified C&D recycling ordinances in 128 municipalities; 118 in California (25% of all municipalities in the state), 2 in Connecticut, 2 in Florida, 2 in Illinois, 1 in Missouri, 12 in North Carolina, and 1 in Washington. Tables 2 and 3 lists of communities per state. Table 4 lists the C&D materials commonly included in municipal recycling ordinances.

Alameda	Coachella	Huntington	Piedmont	Santa Clara
Albany	Colma	Indian Wells	Pleasant Hill	Santa Clarita
Aliso Viejo	Contra Costa	La Canada Flintridge	Pleasanton	Santa Fe Springs
Antioch	Cotati	La Mesa	Pomona	Santa Monica
Apple Valley	Dana Point	Livermore	Port Hueneme	Santa Rosa
Arroyo Grande	Duarte	Lynwood	Portola Valley	Santee
Artesia	Dublin	Manhattan Beach	Rancho Cucamonga	Sierra Madre
Asheboro	East Palo Alto	Marin	Rancho Mirage	Signal Hill
Atherton	El Centro	Menlo Park	Rancho Santa	South El Monte
Baldwin Park	El Dorado	Mission Viejo	Redlands	South Gate
Bellflower	Emeryville	Monrovia	Redondo Beach	South Lake Tahoe
Berkeley	Fairfield	Monterey Park	Sacramento	Stockton
Brawley	Forest City	Moraga	San Buenaventura	Tulare
Brea	Foster City	Morro Bay	San Carlos	Tustin
Brentwood	Freemont	Needles	San Clemente	Union City
Brisbane	Fresno	Newark	San Diego	Vallejo
Burlingame	Gardena	Norwalk	San Francisco	Vista
Butte	Glendora	Oakland	San Gabriel	Walnut Creek
Calaveras	Half Moon Bay	Ontario	San Jose	Willits
Calexico	Hawaiian Gardens	Orinda	San Juan Capistrano	Winters
Camarillo	Hawthorne	Oro Loma	San Leandro	Woodland
Castro Valley	Hayward	Palo Alto	San Louis Obispo	Woodside
Chula Vista	Hidden Hills	Pasadena	San Marino	
Clayton	Highland	Pico Rivera	San Mateo	

¹ E.g., New Jersey regulates the facilities able to accept C&D. Municipalities' involvement with C&D is limited to the issuance of a building or demolition permit.

Table 3. Municipalities with C&D Material Recycling Ordinances in Other States					
Connecticut	Florida	Illinois	Missouri	North Carolina	Washington
Bridgeport	Lee	Chicago	Kansas City	Asheboro	Seattle
New Haven	Sarasota	Northbrook		Chapel Hill	
				Cramerton	
				Efland	
				Four Oaks	
				Glen Lennox	
				Hillsborough	
				Mount Olive	
				Pinehurst	
				Randleman	
				Smithfield	
				Stanley	

Table 4. Common C&D Materials Included in Municipal Recycling Ordinances	
Aluminum	Pallets
Asphalt	Paper
Brick	Pipe
Buckets	Plastic
Cardboard	Roof Tile
Carpet & Carpet Padding	Steel
Concrete	Shingles
Land Clearing Debris	Wallboard
Lumber	Wood

APPENDIX 3

Seattle C&D

Required Recycling of C&D Materials

Around 61% of construction and demolition (C&D) waste was recycled from Seattle projects in 2010. Seattle Public Utilities is proposing a goal of 70% recycling for construction waste by 2020. In order to reach that goal, SPU is proposing a series of landfill disposal bans on readily recyclable C&D materials and certifying processing facilities that meet the City's new recycling requirements.

Effective January 2012

No Landfill Disposal of Concrete, Bricks and Asphalt Paving

Ordinance #123553 prohibits the disposal of recyclable concrete, bricks and asphalt paving from landfill disposal effective **January 1, 2012**. Such material should not be put in garbage containers or dumpsters, intermodal boxes or delivered to transfer stations for disposal. These materials already have a very high recycling rate and facilities that accept them and other C&D materials for recycling can be found at the following link [Seattle-King County Construction Recycling Directory](#).

Exceptions: This disposal ban does not apply to these materials that are painted, have hazardous contents, are difficult to separate from other attached materials such as wood or are present in only very small quantities.

2012 will be a year of education regarding this new disposal ban. Enforcement actions with potential penalties will not take place until 2013.



Other Proposed Disposal Bans on C&D Materials

SPU is proposing to ban the disposal of these additional C&D materials:

- **Metal** (2013)
- **Cardboard** (2013)
- **Carpet** (2013)
- **Plastic Film Wrap** (2013)
- **New Construction Gypsum Scrap** (2013)
- **Clean Wood** (2014)
- **Tear-Off Asphalt Shingles** (2014)

All disposal bans are applicable to:

- Construction, Demolition and Remodeling Contractors
- Self-Haul Customers to Private Transfer Stations
- Self-Haul Customers to Public Transfer Stations
- Third Party Haulers
- Processing Facilities

For more information on these proposed disposal bans, other new C&D programs which are being proposed and stakeholder involvement and input please visit the SPU webpage for the Solid Waste Plan at www.seattle.gov/util/SolidWastePlan

This webpage will be updated with new recycling requirement information as it becomes available.