The City of Boulder and Building Deconstruction

Crossroads to the Future of Waste Reduction, Resource Conservation and Architectural Preservation

Prepared for

The City of Boulder Office of Environmental Affairs

By

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I. An Overview of Building Deconstruction: 
*A National Glance with a Local Focus*

Building demolition across the country and its impact on the Municipal Solid Waste Stream

Building deconstruction and material reuse is nothing new. Humans have been salvaging their domiciles since the dawn of built shelters. Only in the last 50-60 years has machinery, such as track hoes and bulldozers, made mechanical demolition of buildings the common practice. As municipalities and other governmental jurisdictions grapple with landfill issues, greater attention is being paid to reducing the waste stream through the extraction of reusable and recyclable building materials. A house slated for demolition can now be looked at as the various components (e.g. lumber, doors, windows, cabinets, fixtures, etc.) which need to be separated at the source and put into appropriate containers for delivery to the nearest market, much like we do with household recyclables such as cans, bottles and paper.

According to a US Environmental Protection Agency (EPA) report, construction and demolition (C&D) debris is a major component of the municipal waste stream, comprising anywhere from 25%-40% of the material going to landfills across the country. Landfill fees, geography, population demographics, building activity and availability of recycling and reuse facilities will affect this rate; but it remains a significant piece of the pie. The EPA defines C&D debris as: “Waste material that is produced in the process of construction, renovation, or demolition of structures. Structures include buildings of all types (both residential and nonresidential) as well as roads and bridges. Components of C&D debris typically include concrete, asphalt, wood, metals, gypsum wallboard, and roofing. Land clearing debris, such as stumps, rock, and dirt, is also included in some state definitions of C&D debris.”

Looking at only the material in this greater C&D debris stream that is directly generated from *building construction and demolition*, the EPA reports that:

- An estimated 136 million tons of building-related C&D debris were generated in 1996. *(This is the most recent year in the report).*

- The estimated per capita generation rate in 1996 was 2.8 pounds per person per day.

- Forty-three percent of the waste (58 million tons per year) is generated from residential sources and 57 percent (78 million tons per year) is from nonresidential sources.

- Building demolitions account for 48% of the (building-related) waste stream, or 65 million tons per year; renovations account for 44 percent, or 60 million tons per
year; and 8 percent, or 11 million tons per year, is generated at construction sites.

The EPA estimates building related C&D waste to be broken down, by weight, in the following order:\(^2\)

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete and mixed rubble</td>
<td>40-50%</td>
</tr>
<tr>
<td>Wood</td>
<td>20-30%</td>
</tr>
<tr>
<td>Drywall</td>
<td>5-15%</td>
</tr>
<tr>
<td>Asphalt roofing</td>
<td>1-10%</td>
</tr>
<tr>
<td>Metals</td>
<td>1-5%</td>
</tr>
<tr>
<td>Bricks</td>
<td>1-5%</td>
</tr>
<tr>
<td>Plastics</td>
<td>1-5%</td>
</tr>
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</table>

The relatively low percentage of waste being generated from new construction can be attributed to higher efficiencies in material estimating, thanks largely to technology. Computer-Aided Design (CAD) and estimating software has greatly reduced the guesswork in the material procurement process, particularly with lumber. Recycling of materials from a new-construction site is comparatively easy because the material comes in phases, so it is already somewhat “source separated.” Lumber scrap is generated during the framing phase, with metals, sheet rock and cardboard coming later with the installation of the mechanical systems, wall coverings, interior finishes and installation of appliances and fixtures. When buildings are demolished mechanically, all these materials, along with everything else in the building, are commingled into a mess that is not easily separated or disposed of in a safe and sanitary manner. Often, demolition waste will contain lead-based paint (LBP) and asbestos containing material (ACM) that is not abated and ends up in landfills, where it can potentially leach into groundwater aquifers.

One of the primary factors inhibiting recycling and reuse in general is low landfill “tipping” fees, and nowhere in the country are they lower than in the Rocky Mountain region. The closest landfill to Boulder charges about $15/ton for disposal, whereas the fees near large municipalities along the coasts can be $75-$100/ton and more. The availability of land for siting new landfills in this region doesn’t give great hope for an overall rise in tipping fees, although many local jurisdictions are considering their own landfill diversion goals, such as the City of Boulder. Deconstruction and building material reuse and recycling can certainly be a major component in the master plan for landfill diversion in Boulder as well as other communities across the country.

The following map indicates the various levels of landfilling, recycling and waste-to-energy activity across the country by region. Tipping fees and availability of reuse and recycling facilities, along with some legislation, will strongly influence recycling rates. As the map indicates, the Rocky Mountain region does the least amount of recycling in the country.
The growth and history of the building deconstruction, material reuse and recycling industries in the United States

Although building deconstruction and material reuse is nothing new in terms of individual practice, as an industry that is linked together through national association it is little more than a decade old. In 1996 the Used Building Material Association was formed as a non-profit, membership-based trade association that has its mission being to help facilitate deconstruction and reuse throughout North America. Most of the early members were Canadian organizations; and the first offices were in Winnipeg, Manitoba, and Halifax, Nova Scotia. The offices moved to Boulder for a few years, from 2000-2002, because two local companies, ReSource/2000 and ReConnX (a deconstruction tool distributor), had members who served on the Board of Directors. During this period, membership was between 100 and 125 companies and individuals throughout North America.

Today, the Used Building Material Association is the Building Material Reuse Association (BMRA), and the number of companies, organizations and individuals involved with deconstruction, reuse and recycling, as well as peripheral activities such as tool production/distribution and value added manufacturing (e.g. flooring and furniture made from reclaimed lumber) has grown tremendously. The US Department of Agriculture’s Forest Products Lab published the Directory of Wood-Framed Building Deconstruction and Reused Building Materials Companies, which is arguably the most comprehensive listing of businesses involved in deconstruction and reuse that has been published to date. There are over 1,200 companies listed in the directory from the...
United States alone, with the most common type of company being a non-profit used building material store that offers some form of deconstruction service.

Similarly, the building material recycling industry has grown to keep pace with demand. The Construction Material Recycling Association (CMRA)\(^6\) is the primary trade association for the industry, and they have experienced significant growth in their membership as well as market development for the various materials:

- **Wood** is easily recycled by large, often mobile, grinders which produce various sized pieces for mulch, compost or other soil amendments. Smaller particles (sawdust) are used for agricultural bedding, which can then be used for composting, as well as in the production of particleboard. Nails and other metal contaminants are removed through magnets located on the machinery that processes the scrap wood. This market is driven by a growing supply of scrap pallets, lumber and land clearing debris that includes trees and stumps. Consumer demand comes from landscaping companies, farmers and ranchers, and power plants that incinerate wood-based biomass materials as “hog fuel”.

This tub-grinder is turning scrap wood into mulch, which can be used for landscaping, agricultural purposes or can be added to other “waste” materials to create compost.

- **Metal** is the most commonly recycled material in the industrialized world. Again, the feedstock is run through a system of grinders, shredders, sheerers and balers to prepare the material for remanufacture into a wide variety of products. This industry is driven on the supply side by automobile salvage and commercial demolition, as well as manufacturing waste. Metal can be removed from commingled construction and demolition waste through large, boom-operated electromagnets at C&D recycling facilities. The strongest sector of the consumer market is currently overseas, with China creating a huge demand for metal as it builds its hydroelectric infrastructure. Metal prices for ferrous (sheet and structural steel, etc) and non-ferrous (copper, brass, aluminum, etc.) materials are at record highs. So are prices for new construction materials made from metal. It is forecast that these markets will stay strong for the immediate future at least.

- **Concrete and masonry** is perhaps the most commonly recycled and reused building material in the entire world, considering its predominance in developed as well as undeveloped countries. When Londoners gathered bricks and mortar from the rubble of the blitz during World War II, they were recycling and reusing. Locally, the “World’s Largest Recycling Project” was successfully completed when
Stapleton airport was developed as part of an urban infill project. Recycled Materials Company, Inc., of Arvada, removed 6.5 million tons of concrete and asphalt hardscape for recycling. Currently, the supply for reground concrete has outpaced demand in this region. Lafarge (formerly Western Mobile) has ceased accepting concrete debris at its Valmont facility until market changes increase demand. The greatest consumer demand for reground concrete is as a sub-base for road construction. It can also be used in the manufacture of new concrete, although the amount and type of contamination is much more restrictive than in a situation where it will be used as, basically, a substitute for gravel. It should be noted, though, that using recycled concrete aggregate reduces the need to extract gravel from surface mines.

- **Gypsum board**, or sheetrock, is another major component of the C&D waste stream, with about one pound of sheetrock per square foot of building size for residential structures that use this product as interior wall and ceiling coverings. Again, this material is in greater supply as feedstock for recyclers than it is demanded by post-recycling consumers. Its primary use is as a soil amendment for crops in parts of the country where the soil is high in alkalinity due to sodium. That’s good for peanut growers along the southern coast, but not good for Coloradans. The town of Gypsum is a stark illustration of how much of this mineral is in our area’s landscape. Without being able to use it as a soil amendment, the next market for scrap sheetrock would be in the remanufacturing process. Again, the quality control specifications for remanufacturing are going to be much more stringent, with the paper facing needing removal before it can be used to make new sheetrock. Also, the storage of sheetrock scrap and debris can be problematic as it off gases hydrogen sulfide after being exposed to anaerobic bacteria, organic matter and water. Finally, painted or textured sheetrock is not recyclable as a soil amendment, which is nearly always the case for material coming out of finished structures slated for demolition.

- **Asphalt shingles** are another material that can constitute a significant portion of the C&D waste stream, particularly with older houses which may have multiple layers of shingles on their roofs. As with the other recyclable commodities, shingles would be ground into a feedstock for other uses. One of the greatest uses for recycled shingles is in hot mix asphalt and other road building and repair applications. It can also be used in the remanufacturing of shingles and as refuse derived fuel. Since asphalt is largely a petroleum product, the market for shingle recycling has greater potential in the near future than do markets for gypsum and concrete because of the higher extraction costs for oil. Unfortunately, there is no local recycling facility for asphalt shingles at this time, although there are successful programs in other parts of the country.

- **Other commodities** are being recovered from deconstruction sites and can be recycled in certain markets that are located next to the mills or factories that produced them, or if the transportation of the materials to the facility is not cost prohibitive. These materials include: ceiling tiles, vinyl siding and carpet pad.
Carpeting and insulation can be reused if they are sanitary and in good shape, and there are companies that recycle textiles and other materials from buildings; but stockpiling and transporting material that cannot get wet or will blow away in the wind creates logistical problems for these items.

- **Trash** is almost always going to be a byproduct of building deconstruction. Even with local markets for the above materials, there will be items that are currently destined for the landfill. **Painted wood** that is not reusable (such as siding, if it’s too brittle), along with **plastic pipe** used for sewer and water are not readily recyclable. **Plate glass** from windows, mirrors and other glazings that are not reusable are also a trash item, since plate glass has a different melting temperature than container glass and cannot be recycled as such.

- **Hazardous waste** occurs at deconstruction sites in the form of **asbestos containing material** (ACM), which was used as siding, floor tiles, pipe insulation, adhesives, sheetrock binder and in other building materials up until a few decades ago. **Lead-based paint** (LBP) was also used extensively until it was banned in 1978. Both materials pose a health threat when the particulates become airborne during mechanical demolition, and ACM is supposed to be abated by licensed professionals before demolition occurs. Traditionally, the abatement process is regulated by the state environmental health department, which may not get all the information from all the building jurisdictions every time a structure is slated for demolition.

Mechanical demolition destroys reusable materials and mixes up the debris in a manner that poses air quality issues and is not conducive to recycling.

In order to best facilitate the recycling of construction and demolition or deconstruction materials, a centralized one-stop facility that is capable of receiving commingled debris would be best. These facilities exist throughout the country, particularly in areas of high population densities and limited landfill space. Unfortunately, there are no such facilities in the Denver/Boulder area. There are, however, many facilities that take scrap metal in Denver, as well as Eco-Cycle and Western Disposal (all scrap metals) and Western Aluminum Recycling (aluminum, brass and copper) in Boulder. Western Disposal also takes clean scrap lumber for processing into compost in a program subsidized by the City’s Office of Environmental Affairs. As mentioned earlier, Lafarge no longer accepts...
concrete and masonry for recycling in Boulder, but there are several companies in Denver that do.

With no centralized facility accepting commingled C&D debris, much of the material generated during mechanical demolition is taken to landfills, although most demolition contractors will recycle metal and concrete from the foundation if a facility is nearby and the tipping fees are less than those for landfilling. Single stream facilities accepting only one type of material (metal, concrete, wood, etc.) require the incoming loads to be relatively free of contaminants, which require separation of the materials at the source. Deconstruction is able to accommodate this, as materials are removed separately from the building during the deconstruction process. The only limiting factor then is having enough space on the jobsite to stage several different containers (such as roll off boxes) for the various materials.

Boulder and building deconstruction during the last decade

There has been active deconstruction occurring in Boulder over the last decade and beyond, with the biggest catalyst being ReSource 2000, which began operations accepting and selling used building materials on Earth Day (April 22) of 1996. At that time there were just a few companies doing deconstruction on a limited basis, namely Leuthold Demolition, Haul Away Recycling and Colorado Hauling. Before ReSource 2000 was available, the materials recovered from deconstruction projects were sold by the contractors directly from the site, or from their storage yards and garages. This was before the advent of eBay and craigslist, so word of mouth and newspaper ads were used to generate customers. Needless to say, the amount of material being diverted was relatively small.

Another early catalyst for deconstruction and material reuse was the City’s Office of Environmental Affairs Green Points Program, which rewards homeowners for incorporating green building practices into their projects, including deconstruction and material reuse. Boulder became one of the first cities in the country to institute such a program, which also began in 1996. Many other communities, including Aspen, have since developed similar programs based on Boulder’s success. The US Green Building Council (USGBC) has also established its LEED (Leadership in Energy and Environmental Design) program, and the Denver Home Builders Association (HBA) has its Built Green program, both of which came out in the latter part of the 1990s. Deconstruction and material reuse is typically mentioned in green building programs under waste management and resource conservation categories.

Over the course of the last decade, Boulder has seen a steady growth of interest in and practice of deconstruction and reuse. During the years between 1998 and 2002 several more contractors got involved with deconstruction, such as Kona Construction, Boulder Hauling and ReSource 2000. Several large projects brought media attention to deconstruction, particularly the Grandview Terrace project on the CU campus and the Crossroads Mall. The City of Boulder continued to support and promote deconstruction by incorporating it into their process for building removal. The Open Space and
Mountain Parks (OSMP) department has utilized deconstruction many times for removing structures from its properties in the fulfillment of its mission to return lands to their natural environment and habitat. One of the most successful such projects involved 4 large agricultural buildings (2 at 30’x180’ and 2 at 30’x300’) that had been turkey and horse barns at various times but were no longer being used. OSMP contracted with ReSource to deconstruct the buildings, which diverted over 90% of the material from the landfill, including old growth lumber and weathered corrugated sheet metal.

Another City project involved a 20-unit apartment complex just east of Eben G. Fine Park. The structure was removed because it was in the flood plain just below the canyon. An RFP was issued, ReSource 2000 had the lowest bid and was accepted, and the building was deconstructed, again diverting the vast majority of the materials from the landfill and providing them for reuse through the ReSource 2000 sales yard. At that time, there were four qualified deconstruction contractors who responded to the RFP, each of whom was capable of doing the job (ReSource, Haul Away Recycling, Colorado Hauling and Boulder Hauling). An informal survey of members of the BMRA indicated no other communities the size of Boulder with as many deconstruction contractors doing business, allowing Boulder to be the self-proclaimed city with the greatest number of deconstruction contractors on a per capita basis.

Today, the number of contractors bidding the complete deconstruction of structures is down to two, Haul Away Recycling and Colorado Hauling. ReSource performs limited, non-structural deconstruction known as “soft-stripping” where cabinets, doors, windows, fixtures, flooring and other components are reclaimed. Boulder Hauling continues to perform these services as well, on a lesser basis. Compared to the number of buildings being either completely or partially demolished; however, the number of buildings being deconstructed is relatively small, particularly in regards to whole house deconstruction.

During the years 2005 and 2006, the number of demolition permits involving entire structures was about 55 per year. The number of deconstructions performed during those years was about 12 per year. Therefore, there certainly seems to be considerable room for growth in the number of deconstructions being performed in Boulder.
II. The Deconstruction Process

The art of “delicate demolition”

Deconstruction is normally described as the construction process performed in reverse, with the intent of salvaging the maximum amount of material for reuse and recycling that is economically practical. It is referred to as unbuilding, hand-dismantling and delicate (or green) demolition. Understanding deconstruction requires a completely different mindset when looking at a structure than does mechanical demolition. With demolition, the object is to remove the structure as quickly as possible, usually to clear the site for new development. One equipment operator in a track hoe and a roll-off truck driver switching out multiple containers can make an average size house of 2,400 square feet go away in a day or two. With deconstruction, the object is to reclaim the maximum amount of material from the structure that is practical. A crew of six might take two weeks to deconstruct the same size building that took only a day or two to mechanically demolish. That’s why it’s important to inform the homeowner of the deconstruction option as early in the process as possible. Once the permit is issued for construction of the new house or other structure, the old building simply becomes something that is an impediment; and the quicker option of demolition can appear much more practical.

This 4,600 square foot Spanish-style house with concrete roof tiles was completely deconstructed, with over 90% of the material being diverted from the landfill through reuse and recycling.

Not all buildings are candidates for deconstruction, although the vast majority is at some level. When assessing a building for deconstruction, there are a few fundamental questions that must be addressed:

- Does this building have the quantity and quality of components and materials to justify deconstruction? Deconstruction will most often be considerably more expensive than mechanical demolition (often times twice as much), particularly in areas with low landfill fees. Tax-deductions can offset these additional costs if the material is donated to a 501(c)3 non-profit corporation. Labor costs are nearly
always the biggest expense for a deconstruction project, with relatively high workers compensation rates because deconstruction is classified as demolition in most insurance company indexes. The demolition industry has a high incidence of catastrophic accidents because of the dangerous nature of demolishing large structures. The deconstruction industry would better be classified along with carpenters and other homebuilding subcontractors, since the same tools and methods are used, just in reverse order.

- **Is this building safe?** This is definitely a question that needs to be answered before deconstruction begins, even if it requires a visit from a structural engineer. Buildings may often sit empty for extended periods of time before they are taken down. They can have leaky roofs and broken windows that allow the weather in, which can compromise floor systems when they get saturated with water. Buildings damaged during partial burns, or upset during severe weather are particularly dangerous. Hurricanes Katrina and Rita left tens of thousands of structures that could have yielded considerable amounts of materials and architectural antiques, but were not structurally safe for hand dismantling.

- **Will this project fit the owner’s time line and financial budget?** The decision to deconstruct or demolish is ultimately that of the building’s owner. It’s best to determine from the start if deconstruction is a viable option, given that there will be additional up-front costs and an extended time line. Not all building owner’s can benefit from a tax-deduction, particularly non-profit entities (including churches and schools), government agencies (from municipalities to the Department of Defense) and individuals who don’t have significant tax liabilities. Another deterrent to deconstruction is the unavailability of time. The building process is often a matter of waiting and waiting and waiting for drawings to be approved and construction loans to be secured; but once the permits and money are in place everything needs to happen yesterday. In jurisdictions such as Boulder’s, where demolition permits are issued separately from the new building permits, there is greater opportunity for deconstruction to get involved compared to places where both permits are issued at once.

Once these questions have been answered to the satisfaction of the owner and contractor, then the decision to deconstruct or demolish becomes clearer. Owner values and ability to pay additional up-front costs have assuredly helped deconstruction in many markets, and certainly such is the case here in Boulder. As previously mentioned, not all buildings are candidates for deconstruction; but those that don’t have something of value to yield are by far the exception and not the rule.

If deconstruction is going to be considered for the job, the contractor would next put together a bid. As mentioned earlier, labor is by far the largest line item when compiling the cost reckoning for a deconstruction job. Estimating the amount of time for each task and phase is a tricky part of putting together a bid. A thorough inspection should be done to determine the number of layers of roofing material, as well as looking at what’s behind wall, floor and ceiling coverings; although this isn’t always possible to do. A site plan also needs to be devised for container placement, which will determine how long it takes to load them with materials. Tool costs and equipment rental can be
significant for large and/or logistically challenging projects. Transportation of materials is also becoming more of a consideration with rising fuel costs. Proximity to various reuse and recycling markets compared to the proximity of a landfill can dramatically affect the cost of deconstruction versus demolition.

Roll-of containers are used for reusable and scrap wood, as well as scrap metal and trash. The concrete roof tiles were taken to a reuse facility.

Since deconstruction is normally going to be more expensive than mechanical demolition in our market because of the low landfill tipping fees (and because deconstruction will usually have higher labor costs) having the involvement of a non-profit company that can issue a tax-donation receipt for the materials is often beneficial for the building owner. Typically, the non-profit will receive the materials for resale and issue a donation receipt. For donations that exceed $5,000.00 (five thousand dollars), an appraiser must determine the exact value amount. For values less than this amount, the homeowner can determine the value. The materials are considered a non-cash contribution to a non-profit company, which must be a 501(c)3 corporation as determined by the IRS. The homeowner will need an estimate of the value of this appraisal to be able to compare deconstruction costs to demolition. This estimation needs to come from the appraiser, acting as an independent agent, and not from the organization receiving the items if the total value declared is going to be over $5,000.00.

Bidding a job without the involvement of a non-profit company would require the contractor to figure on selling the materials on his/her own and recouping costs that way. The Internet has certainly helped facilitate this, with the architectural salvage portion of eBay being one of the fastest growing sections, and other e-tail operations popping up on craigslist and other web-based marketing sites. Retail is, however, a completely different business than deconstruction contracting, and doesn’t necessarily have great cross over in terms of employee skill sets. Most deconstruction contractors would benefit from and most likely prefer to work with a non-profit that can handle the disposition of the materials and help facilitate the tax-donation process. This would allow the contractor more time for the necessary work of overseeing current jobs and bidding all the prospective leads that will hopefully generate the next jobs.
A crane was brought in to remove large timbers, which would have been difficult to recover otherwise. The cost of the crane rental was easily compensated by the value of the timbers.

The actual disassembly of the structure is rather straightforward: the building is “unbuilt” in the reverse order in which it was constructed. First all the finish items are removed. Interior doors, cabinets, lighting and plumbing fixtures and appliances are reclaimed. Reusable floor coverings, such as wood or carpeting, might be recovered first, if there is concern for their damage during removal of the finish items. Wall or ceiling coverings, such as wainscoting or tongue and groove paneling, would be reclaimed next, along with anything else that is reusable or recyclable but doesn’t compromise the weather resistance of the building (i.e. exterior doors and windows are left intact).

At this point, crews can be split to remove the exterior roof coverings (shingles, tile, etc.) and the interior wall and ceiling coverings (sheet rock, lathe and plaster, etc.). With the exception of roof tiles made of concrete, clay or slate which can be reused, or wood shingles which can be recycled, most of the materials during this phase are currently destined for the landfill. Insulation (fiberglass, cellulose, rock wool, etc.) can be bagged for reuse if it is clean, although handling time and storage space on the job and at the reuse facility may be prohibitive. Once this phase is completed and a good clean up has taken place, the siding and roof sheathing (plywood, planking, etc.) can be removed, along with the windows and doors. Once all the insulation and mechanicals (electric, plumbing and HVAC systems) are removed, what should remain is the skeleton frame of the building. Again, this is approached in reverse order of construction with roof rafters or trusses coming off first, followed by interior, then exterior walls down to the sub floors and basement or crawl space.

Separation of wood sheathing and framing components is a matter of leverage and surgical cutting. Pry tools of all shapes and sizes are employed, along with power tools such as reciprocating saws and screw guns. A well designed job site layout will have all material moving the shortest distance to its container while being handled the least amount of times possible. Lumber, flooring, trim and other materials with protruding nails should have the nails removed on site if possible, particularly finish material that could get scratched during transportation.

What is left after another good clean up should be little or nothing more than the foundation and hardscape (driveway, garage pad, concrete patio, etc.), as well as trees
and other landscape vegetation. Most often, the deconstruction contractor will not bid this phase if the new construction requires an excavating company to dig a new foundation, since these are the folks with the equipment and expertise to do foundation removal and site clearing.

All that’s left of the house is the asphalt driveway. Over a dozen roll-off containers of materials were removed from this site. Only two went to the landfill.

**The anatomy of a deconstruction company**

A deconstruction contractor needs to form his business and seek licensing and insurance just as any other building or demolition contractor would. In Boulder, the necessary license is a Class D (Moving and Demolition) contractor’s license. This allows the deconstruction contractor to pull demolition permits from the building department, along with the homeowner and general contractor. General liability insurance is most often required in order to receive the license, and labor laws dictate that workers’ compensation is to be provided to all employees, with exceptions for certain business classifications such as sole proprietorships.

While labor will be the most costly financial liability for most deconstruction companies, it can also be its most valuable asset. A skilled and experienced deconstruction crew will have the ability to efficiently and safely dismantle most residential and low rise commercial structures in a financially viable manner, given the issuance of the bid approval and sufficient time to do the job. Previous construction experience in any of the building trades will be most helpful, along with a basic understanding of building structure in regards to how weight and stress loads are distributed through the framing and foundation. Entry level workers have easier access to developing these skills with deconstruction rather than new construction because the final product for deconstruction is an empty building plot, as opposed to the final product for new construction, which is the finished structure; therefore, the process of deconstruction is more forgiving of mistakes as skills are developed. This makes deconstruction work good training for the homebuilding industry, since deconstructionists can learn a great deal about how buildings are put together by taking them apart.

A typical deconstruction crew will consist of a lead person and four to six laborers. Two or three people can handle most tasks involving interior, non-structural components, as
well as the dismantling of the framing. It’s best to keep crew sizes as small as practical for safety’s sake, particularly when there is overhead work being performed.

Deconstruction is more about leverage than impact, more Archimedes and less Hercules. As stated earlier, the most important tools are used for prying, with little bars used for removing trim starting at 4 to 6 inches and the big bars used for trusses and framing removal going up to 4 to 6 feet in length. Other hand tools would include an equally varied selection of things to “drive” pry bars and wedges, such as hammers, mallets and sledges. Roof shovels and forks are required, as well as any specialty tools for flooring removal (wood or steel wedges) and sheathing (large double pronged forks meant to straddle framing lumber while peeling off plywood and planking). Wire and metal cutters, sockets and wrenches, screwdrivers, various pliers and a utility knife are also essential tools.

In terms of power tools, as mentioned, the reciprocating saw (aka “sawzall”) is probably the most indispensable tool for the surgical cutting of framing, fasteners (nails, screws, etc.) plumbing conduit and almost anything else holding a building together. Electric circular saws for wood and larger, gas-operated saws for masonry and metal (aka demolition saws) are useful, as well as drills and screw guns for deck, cabinet and fixture removal.

Personal safety gear would include sturdy boots with a steel shank or insert (to protect from nails sticking out of lumber), gloves, safety glasses, particle masks or respirators, and a hardhat. An electrical tester is necessary to locate hot circuits and fixtures, in the event that the electrical service hasn’t been disconnected. One-piece Tyvek™ jumpsuits are useful when removing insulation from an attic or stomping the ceiling covering free from the joists. Fall protection gear should be used on steep roofs and when working higher than 8 feet from the ground. First aid kits, fire extinguishers and wasp and hornet spray are also necessary items to have in the toolbox.

Material handling equipment from appliance and piano dollies to telescoping forklifts and cranes are often employed as back saving measures. Renting a skidsteer loader with bucket and fork attachments is often cheaper than performing many cleanup and load out tasks manually, and it’s a lot easier on the crew. Transportation of recycling and trash materials is usually done in roll-off boxes or dumping trailers, since they can be hand loaded when the back doors are opened. Reusable materials are best transported in covered trailers or box trucks to keep them protected from the weather and highway driving. Ratchet straps, stretch wrap and rope are essential for lumber and other bulky items, such as roof tile.

In addition to the unique tools for prying flooring and sheathing from sub floors and framing (e.g. customized wedges and forks); there are specialty tools for removing nails and other fasteners. A local company, ReConnX, Inc., imports pneumatic denailing guns from Asian manufacturers and is also developing other tools designed specifically for the deconstruction trade. There are also a few blacksmiths in other parts of the country who are designing and building tools to assist in deconstruction. In fact, given the incipient position of the deconstruction industry, there is great potential for entrepreneurs to improve the tools and equipment used by deconstruction
practitioners, much the same way nail guns and telescoping forklifts have helped the homebuilding industry.

The various categories of deconstruction projects

Deconstruction projects range in size and scope from a bathroom remodel prep to dismantling decommissioned military bases. In general, most projects fall into the following three categories:

- **Whole-house deconstruction** is certainly the method that is going to achieve the highest level of landfill diversion, reuse and recycling. Often times, the building site’s limited space might prevent large machinery from being able to perform mechanical demolition; or the site’s proximity to neighboring homes and businesses might create safety issues for the use of heavy equipment and the dust, noise and debris that accompanies demolition. Most often, the project is successful because the building contained enough valuable materials to offset the additional costs of deconstruction (through resale or donation); the building structure was sound; and the project fit the owner’s time line and budget.

- **Pop-tops and add-ons** are projects that are particularly opportunistic for deconstruction, since these types of projects require only partial removal of the building structure. No matter how experienced the operator is, heavy equipment is not the method of choice for removing a roof to add another story, or taking out exterior walls for an addition. These major remodeling projects have the potential to be the bread and butter for deconstruction and reuse in Boulder, particularly given the activity in the Newlands, University Hill and Martin Acres neighborhoods.

- **“Soft-strip”** is the term applied to removing non-structural elements of a building for reuse. Only items that will be reused are harvested, such as doors, windows, cabinets, flooring, plumbing and electrical fixtures and appliances, and anything else that has reuse value. Very little trash or recycling is generated during a soft strip, as the intent is to “cherry pick” only materials that will be sold for reuse. Soft-stripping is often performed as an alternative to whole-house deconstruction, with the remaining shell of the building being demolished and landfilled. This process can be detrimental to a waste diversion program with aggressive goals, such as the City of Boulder has, since the amount diverted will be considerably less than 50% of the structure, though the project will have the appearance of being a “deconstruction”. Removing only non-structural, cosmetic fixtures from a building will not dramatically reduce the amount of materials going to a landfill. Though cabinets, doors, windows, lighting, and plumbing fixtures may occupy considerable space when kept intact, their space is reduced considerably when demolished and compacted by heavy equipment. The actual landfill space saved by diverting only the items recovered in an average soft-strip will be more in the range of 10%-15% by volume (once crushed at either the site or the landfill) and less when measured by weight.
The above three categories can apply to commercial as well as residential structures, although the incidence of commercial deconstructions compared to residential is quite minuscule. There are two primary reasons for this: the materials from commercial projects have a much more limited resale market, largely commercial new construction. Few homeowners are interested in heavy, commercial doors which are usually thicker and have industrial hardware, or large pieces of fixed glass storefront glazing. Commercial structures also use metal studs for interior walls, which are recyclable but not reusable. Very few decision makers of new construction projects are willing to buy used material for their buildings, and understandably so. There is always a liability issue with anything used, and concerns are much greater for business enterprises. Just as the auto industry doesn’t put used parts in new cars, the building industry is not inclined to put used materials in new buildings.

The other prohibiting factor for commercial deconstruction is the time line and budget constraints, which are often more acute for commercial projects because the project is usually larger and involves greater funding. Once business has been disrupted and construction loans are issued, the building owner is going to proceed as quickly as possible to minimize the interest paid on the loans and to get back to business as quickly as possible. Tax-deductions are almost always less for commercial projects because the IRS laws were written to favor homeowners, not commercial enterprise. For these reasons, deconstruction of commercial structures is more difficult to facilitate in terms of dismantling the entire structure, although soft-stripping is usually applicable to some degree.

The disposition of materials

The prioritized hierarchy of resource conservation is to reduce, reuse and recycle. As it applies to deconstruction, the hierarchy is reuse, recycle and refuse. Reducing resource consumption can only take place when the structure is being designed and built. Energy resources can be reduced for the building’s lifetime by designing an energy efficient structure and installing energy efficient HVAC systems and appliances. Lumber demand can be reduced by efficient designing and use of engineered wood products made from more sustainable forest products than timber harvesting. Of course, the most dramatic way to reduce resource consumption for the homebuilding industry is to not build houses larger than practically necessary, but this market seems to be driven more by demand than supply.

Reuse of building materials is a growing industry, as measured by the number of companies performing deconstruction and selling reclaimed materials compared to a decade ago. Here in Boulder, ReSource has seen its customer base and material supply grow to a point of almost bursting at the seams at their 1.2 acre sales yard on 63rd Street. They are able to divert some excess materials to their facility in Fort Collins, while that store establishes its customer base and supply lines. Elsewhere in the county, Habitat for Humanity has their ReStore in Longmont; and The ReUse People of America is operating a store in Lafayette to redistribute materials harvested from deconstruction projects. ReSource, The ReStore and The ReUse People are all 501(c) 3 non-profits that can provide tax-donation receipts for materials. There is also, as previously mentioned, growing activity on the Internet in terms of material exchanges,
companies selling architectural antiques, and listing items with eBay and craigslist. The demand for these materials seems to be growing as well, particularly for remodeling contractors and do-it-yourselfers, as well as property managers, ranchers, artists and value added manufacturers and crafts makers.

Material recycling is also taking place in Boulder, although not to the level that it once did when concrete, cinder blocks, clean brick and, occasionally, porcelain were being accepted for crushing at the LaFarge plant on Valmont east of 63rd Street. There are several concrete recycling facilities in the Denver metro area, but transportation can be time consuming and costly. Wood recycling is a success here in Boulder thanks to the partnership developed between Western Disposal and the City’s Office of Environmental Affairs. The end product of this program is bagged and bulk compost, which has a strong local demand. The wood needs to be separated from trash and other materials to be usable, however, so demolition debris can not be accepted.

Metal recycling also has facilities in the Boulder area (Eco-Cycle, Western Disposal and Western Aluminum Recycling), and the current high prices for scrap metal can make it practical to site a roll-off box from one of the larger facilities in Denver who will pay for the material. Most residential projects will not yield enough material to make this practical, but commercial projects could. Again, the material needs to be source separated and free of excess contamination, so demolition debris would not be accepted.

Aside from the reuse yards/stores and the single stream facilities for recycling wood and metal in the Boulder area, most of the rest of the deconstruction material stream is destined for the landfills located in Weld and Jefferson Counties. As noted, asphalt shingles, sheet rock and plaster are not locally recyclable, and constitute the greatest amount of “trash” by volume and weight. Painted wood, soiled or worn carpeting, glued floor coverings, and insulation constitute the remainder of materials going to the landfill from a deconstruction site. Asbestos should be abated by licensed professionals before deconstruction or demolition takes place, lead paint disturbance should be minimized on the site, and any household hazardous waste left in the building should be taken to a local facility, which Boulder has.

There are many parts of the country that have landfill prohibitions for many items, in part to encourage recycling in order to extend the life of the existing landfill, and also to prevent hazardous materials from entering landfills that might not be capable of preventing leachates from contaminating ground water. Pressure treated lumber (CCA) is one such item, because it contains arsenic. Asphalt shingles and sheet rock are prohibited from some landfills in areas where there are adequate recycling options. Without a greater number of single stream recycling options, and in the absence of a commingled C&D recycling facility, deconstruction is the best method for diverting material from the landfill through reuse and recycling.
III. The Barriers of Deconstruction and Material Reuse

Higher costs to owners

We know that deconstruction is more expensive than demolition on a bid-to-bid basis because of the labor intensity of hand dismantling compared to mechanical demolition. In the Boulder area, demolition contractors normally charge in the neighborhood of $4-$6 per square foot, while a whole-house deconstruction bid might be $8-$10 per square foot. A crew of six full-time deconstructionists on a company payroll can cost the employer about $1,000.00/day, including payroll taxes and workers compensation insurance. A typical 2,200 square foot house can take two to three weeks to completely deconstruct. Many owners suffer a slight case of sticker shock when seeing a demolition bid next to a deconstruction bid; but this isn’t a comparison of apples with apples. Only when the value of the materials is factored in, through sale or donation to a non-profit, does deconstruction compete financially with demolition. There are many instances, though, where the tax deduction can completely offset the additional cost of deconstruction and even save the owner money when factoring in the reduction in income taxes to be paid.

Even with a substantial tax deduction in the works, the cost of deconstruction is an out of pocket expense for the owner that might cause the project to go over budget in the early stages if only demolition estimates were used to determine the cost for the building removal. In addition to the higher deconstruction bid, the homeowner will most likely have to hire an appraiser, if the value of the materials exceeds $5,000.00, as it almost always will with a whole house deconstruction. Appraising the value of materials salvaged from deconstruction is very different than real estate appraisal, and has very few practitioners across the country. Deconstruction appraisals can cost $1,500.00 and more, because it is still a premium service offered by a few who are willing to explore a developing market.

Real estate appraisal takes into account that what is being appraised is a domestic shelter and has intrinsic value for being such. Properties with comparably built and located houses that have recently sold provide building appraisers of building materials some of the information they use to determine a value. There are several methods appraisers may use in determining “fair market value” (FMV). The Internal Revenue Service (IRS) defines fair market value as “the value a willing buyer will pay a willing seller if neither party is under duress.” With any appraisal method the materials from a house that has a real estate appraisal of $325,000.00 (not counting the value of the lot) will have a significantly reduced value once it has been disassembled and the reusable items donated to a non-profit. The FMV of the donation must then be applied to the homeowner’s marginal tax bracket. The result is the actual cash benefit the owner will receive when they file their Form 1040 for that year. This benefit is subtracted from the deconstruction cost to determine the actual net cost of deconstruction and this then is compared to the cost of demolition to determine which method (regardless of environmental considerations) is more economically beneficial to the owner. -
Time

We also know that deconstruction takes more time than demolition, again because of its greater labor requirements. What equipment can do in days will take a deconstruction crew weeks. That’s why it is critical for the deconstruction option to be considered from the beginning of the building planning process. If the building will be vacant prior to its removal for asbestos abatement or other reasons, it will open the door to the possibility of deconstruction being feasible. Often a property is purchased for its location and lot, and the structure is removed because it doesn’t fit the owner’s needs. In this case, there is usually ample time for deconstruction to be considered while the planning and permitting process takes place. In Boulder, demolition permits for structures built more than 50 years ago will need to be reviewed by the City’s Design Review Committee of the Landmarks Preservation Advisory Board. The decision of this group will certainly affect the disposition of the structure and needs to be determined at the outset of the planning process, if not before the property is acquired.

Awareness

Homeowner education is one of the greatest challenges for the deconstruction industry, and needs to be the task of the contractor, the non-profit (or other receiver of the goods) and government agencies responsible for landfill diversion and resource conservation goals. Just as the notion of separating cans, bottles and paper from our household trash gave impetus to the residential recycling industry, looking at the components of our buildings as something other than trash will give momentum to deconstruction.

Awareness is certainly in the top two or three reasons for limited landfill diversion. This is not the case for paper, cardboard, cans, steel, aluminum and copper. The media, state and municipality awareness campaigns, immediate cash for these items, and ease of diversion all resulted in an effective diversion effort. Such is not the case with building materials. States such as California have implemented laws forcing local governments to divert materials, but with C&D representing twenty-five to forty percent of municipal solid waste (MSW) there has not been a state sponsored – let alone local government - media/educational blitz like there was for cans, paper, cardboard, etc. Why? Probably no one knows how to do this effectively.

Are materials really usable?

Materials reuse also has its barriers. The fact that the item is used voids any manufacturer warranties, so materials are sold “as is.” With things such as doors, windows, cabinets and lumber a visual inspection should suffice; but with appliances and fixtures the rule of thumb is buyer beware. Insulated windows also pose a risk when being reused, because the seals between the panes of glass can dry up or incur a leak over time and with handling, which would allow moisture to enter and fog the window.
The only major health concern in dealing with used building materials is the presence of LBP and the potential for lead poisoning, particularly among small children. Lead is ingested into the body through the mucous membranes of the mouth, nose and eyes. Paint chips containing lead from doors, window sills or other materials can be harmful and even fatal to infants. Lead can also be held in the particulates released during sanding, sawing and stripping of wood covered with LBP, so care must be taken when working with such materials. There are relatively cheap lead indicator test kits sold at hardware stores, but it’s best to treat any material that may have been painted prior to 1978 (the year that lead paint was banned in the US) as though it contains lead. Due diligence would require that anyone selling items that may contain LBP to disclose such to the buying public. The EPA will provide stickers for suspected items and pamphlets that explain safe practices for dealing with LBP.

However, materials with LBP may still be reused without removing the paint by a method called encapsulation. Consider wood siding that is painted on one side with LBP; the board may be turned over so that the painted side is not exposed or, it may be covered with another coat of paint that does not contain lead.

**Building codes**

Although some older materials are better, stronger, and cheaper than many new materials – for instance old-growth, clear vertical grained lumber - local building codes may not allow their reuse. Many codes prohibit the use of used lumber in structural applications, used plumbing fixtures, older electric or gas fixtures or appliances. These codes vary from region-to-region, state-to-state, and municipality-to-municipality.

**Small size of businesses**

While size is not a barrier to entry, the materials actually diverted by many well meaning organizations is simply not enough to make any kind of palpable difference in landfill diversion. Contractors dedicated to performing whole house deconstructions who have been specifically trained, insured, and equipped to handle such projects will have the greatest impact on diversion of materials.

**Capital**

While all reuse and deconstruction practitioners accept the concept of sustainability, it is just as important for their organizations to be sustainable (i.e. properly capitalized). Too often, well-meaning people start businesses on a shoestring budget but they cannot sustain themselves over a long period of time to achieve an economic break even point, or to sustain themselves through the inevitable periods of contraction. Further, these small organizations often rely on grants and public subsidies to maintain their operations. In these cases, their failure has removed capital (money) from the market and consequently from others who may have used this money more prudently and achieved a sustainable diversion level of reusable materials. The capital issue then is
two-fold: first, it is a lack of proper capitalization; second it is a misplaced use of a scarce resource.

**Cyclical nature of deconstruction**

The diversion and sale of reusable building materials is tied directly to the deconstruction business – only through some type of deconstruction can good building materials be diverted from our landfills and distributed to others for reuse. Unfortunately, the deconstruction side of diversion is tied to the construction industry and its cycles. The timing of these cycles is both known and unknown.

In any region in the U.S. the known building cycle is tied to holidays and weather. Construction is at its peak during the summer months of June, July and August and in a trough from November through March, with ramp up and down periods in the spring and fall respectively. The unknown cycle is a tough one since the peaks and troughs are not predicable. While historically, construction followed what was called the business cycle of approximately five to seven years, the present building boom, while waning, is still the longest construction boom in our history. With our Federal Reserve policies of monetary constraint over inflation during the last twenty-five years, these “business cycles” have all but disappeared.

These cycles are not helpful in planning for a sustainable small business. Deconstruction crews need to be trained; and this training is almost always in the form of “on-the-job”, which necessitates a consistent flow of projects on which to train. Typically, it takes approximately sixty days of steady work flow to bring a crew member up to speed and productivity. Generally, there is not enough work to keep a full crew busy through the winter months so they usually are laid off. Most employers are not financially healthy enough to keep all crew members on the payroll. Further, few are fortunate enough to get their former employees back in the spring. Longer layoffs, due to contraction of the building industry, are even more devastating to the employer and employee alike.

Finally, these cycles also affect the resale facility that is dependent upon the flow of materials from deconstruction projects – consequently they also will feel the financial pinch during construction down-turns – although usually several months later when their inventories shrink and customers are not returning because there are no new materials to attract them. The retail facilities are in a little more precarious position since much of their costs are fixed. The deconstruction contractors’ costs are mostly variable (i.e. labor, which can be laid off.) However, the very nature of a retail establishment is that their two main costs – rent and labor – are fixed. Rent must be paid and sales people must still keep the store open.

**Dispersed markets**

The markets for reusable building materials are not fully developed for reasons beyond the scope of this report. Even in large metropolitan centers like Los Angeles, the San Francisco Bay Area, Seattle, Denver, Chicago, etc. there is not a large enough consumer
base to absorb all the materials that are truly reusable. This typically causes the local retailer to take one or more of the following courses: not accept materials that they cannot sell immediately; throw away materials which have not sold in a couple of months; ship materials to other geographic markets.

The first action causes problems with local deconstruction contractors who depend on the retailer to take materials on a consistent basis. Imagine a contractor spending the time to remove a set of hollow-core doors with their frame and hardware, putting them in a truck and delivering them to the retailer only to be told that the retailer has too many of this type of door and refuses the load. The contractor's only choice at that point is to throw them away. Not only is this a waste of the material, but think of the time, fuel, labor, equipment and money wasted when they could have been more easily discarded on the job site. This is a reality in every market.

The second action is similar to the first – time and money was spent on collecting and storing these materials only to have them thrown away. Every time a used item is handled and moved from one location to another approximately ten to twenty percent of its resale value is consumed by handling costs.

The third is, from a diversion perspective, the only viable choice. However, it is only available if the retailer knows about such markets, has the contacts to receive the materials, and the infrastructure to handle the logistics. This infrastructure has a cost component and only financially sustainable organizations can afford to use this alternative.

Management

Most small building materials reuse organizations (for profit or nonprofit) cannot afford the management talent to grow into medium-sized, well managed, sustainable companies. This problem, of course, is generally tied to lack of capitalization, discussed earlier. A review of the causes of failed companies shows that the reason for failure is inadequate management. It is not due to the lack of capital – that is only a symptom. Management requires vision, leadership, thorough knowledge of markets and supply chains, perspective, and perseverance. These are qualities that, unfortunately, are not usually found in low-margin, low-return businesses.

Low landfill fees

Low landfill or “tipping” fees are probably the first or second deterrent to anyone desiring to enter the building materials reuse business. It is axiomatic that the higher the tipping fees the higher the value of the item being discarded. Over twenty years ago, when tipping fees throughout the country were substantially less than they are now, the concrete crushing plant became an alternative to the landfill. Some day, a system of pulverization and high compaction will turn all our construction and demolition waste into lightweight, durable building blocks. This process will be difficult to develop and expensive to build; however, it - or something similar - will be developed because the economics of the future will make it a necessity. In time, owners of landfills
will come to the realization that in order to exist they must charge rates that covers all costs, including current land values, money, operating costs, and replacement costs, and that these costs cannot be carried by others but must be charged the user. Often, operators who also have a hauling component charge these very real costs to their hauling customers. Municipalities, as landfill owners, often use the general fund to cover landfill costs. The alternative to higher general taxes is user fees; and in the case of landfills, that translates to higher tipping fees.

Lack of higher income families

For the purposes of this report, there are three major benefits to having a large absolute (not relative) population of high-income families. First, they have more money to spend, as deconstruction costs more than demolition up front. Second, they tend to be better educated and more informed about the tradeoffs between disposal and reuse. Third, with a nonprofit facility, the tax donation component to deconstruction and building materials reuse is very effective.

Consider two cities in California – Sacramento and Los Angeles. Both have very low disposal fees, relative to the rest of the state. In both cities they range from $25 to $35 per ton for general C&D waste. In Sacramento, there is virtually no deconstruction and building materials salvage. In Los Angeles - or more specifically, Santa Monica, West Los Angeles, and the neighborhoods immediately adjacent to them - there is a very active deconstruction business which last year completed over thirty full, residential deconstruction projects totaling over 90,000 square feet and yielding over 1,350 tons of reusable materials.

Legacy operations

A legacy system is a procedure, business, or process that, when first implemented, seemed like the right thing to do. However, as communities grew, neighborhoods changed, new people moved in, and old procedures did not change, the legacy system did not sustain itself.

An example is Seattle, Washington. They have an existing ordinance which does not allow a demolition permit to be issued until the new project or building has been approved and a building permit issued. This ordinance was passed during WW II when housing was scarce in a city whose population was dramatically increasing due to the military and industrial build-up. In the 1990’s three used building materials facilities were opened. One was nonprofit and the other two for profit. All three of these obtained their materials from two primary sources: as local drop-off facilities for residents and contractors doing remodeling, and from their own crews doing soft-strip operations, at no cost and not requiring a permit, to save the higher value, easy to obtain, lighter weight materials before the bulldozer or track-hoe arrived on site. These organizations, with support of the city, mis characterized their soft-stripping as “deconstruction.” Later, when other companies in Seattle started charging for full deconstruction operations which salvaged up to seventy-five percent of the building for reuse, they could not get any traction since “deconstruction” in the eyes of the city and - more
importantly - homeowners, took only one or two days, required no permit, and best of all was free.

A newly passed regulation allowing for full deconstruction before a new building permit is issued has changed the dynamics in Seattle and is enabling much more material to be diverted.

Every community needs to look at their legacy systems and procedures to insure that they are not counter productive to the goal of diversion.
IV. The Benefits of Deconstruction and Material Reuse

Landfill diversion

The most obvious and often cited benefit of deconstruction and reuse is landfill diversion. This is also one of the more difficult concepts to visualize, because it is impossible to “see” something that’s diverted, unless you are at the very point of diversion. You cannot sit at a landfill and look for material that is diverted; but you can observe containers full of wood, metal and masonry going from deconstruction sites to recycling facilities, and trailers full of doors, windows, cabinets and other items going to reuse facilities. It is not difficult for deconstruction to achieve landfill diversion rates of 75% or even 90+%, as we will see in the Case Studies section of this report. Buildings with wood shingled roofs, reusable siding and interior wall covering such as knotty pine tongue and groove paneling will have the greatest opportunity for diversion; and there are plenty of these homes in the Boulder area that are coming down.

Resource conservation

This is an equally, if not more important, benefit of deconstruction, because it reduces the demand on virgin resources. Although the actual amount of lumber reclaimed from deconstruction is just a stick in the forest compared to what’s being produced by the logging industry, much of the material coming from buildings that are slated for removal is old growth, and therefore considered a premium product that’s not available in lumber stores. With remaining old growth forests protected from logging, deconstructionists are the only people with access to this previously harvested and no longer available commodity. Some old growth material, especially redwood heartwood, is sought by woodworkers who craft furniture and other value added items that feature the unique character of the wood, such as deep color and a tight, clear grain pattern, as well as nail holes and other distress marks. Beams and larger dimensional lumber can be remilled into flooring and other finished products, again showing off the richness of wood from trees that took centuries to grow.

Deconstruction also yields a large amount of wood that is not reusable but is recyclable. Wood shingles, lath boards, lumber less than 6’ in length and other scrap materials quickly fill containers once the building has been stripped down to it’s framing. Landscape vegetation is also looked at differently by the reuse industry, and is diverted through deconstruction companies by developing relationships with landscape contractors and nurseries who will often remove certain trees and bushes at no charge, and by taking cut trees, branches and shrubbery to a grinding facility.

Aside from wood products, which can comprise about half of a building’s composition, deconstruction reduces demand for the mining of mineral ore, clay and aggregate by recycling metal (ferrous and non-ferrous) and masonry (concrete, cinder block and brick). Mineral extraction takes a heavy toll on the face of our natural landscape, and is
a big industrial polluter. Diverting materials from limited disposal space to nearby facilities capable of converting this stream to a usable product makes economic and environmental sense, especially because most recycling facilities will charge less or even pay for clean materials.

At this point in the discussion of benefits derived from deconstruction and reuse should be a consideration for the embodied energy contained in the materials throughout the building. US Bureau of the Census data indicates that the typical home built in the US in 1950 averaged 1,000 square feet or less. Fast forward to the year 2000 and the typical home now averages 2,265 square feet, more than a 100% increase in house size accompanied by a decrease in the average number of household members. With an average of 1.5 million housing starts since 1996, not only is housing a key element in the nation’s economy, it is also an enormous consumer of materials and resources. The National Association of Home Builders (NAHB) June 2001 study entitled *Housing: Facts, Figures and Trends*, defines some of the primary materials used to build a 2,082 square foot home as follows:

- 13,837 board feet of framing lumber
- 11,550 square feet of sheathing
- 3,011 square feet of exterior siding material
- 3,061 square feet of insulation
- 5,550 square feet of interior wall material
- 2,117 square feet of interior ceiling material
- 2,841 square feet of roof material
- 2,082 square feet of flooring material
- 226 linear feet of ducting
- 16.92 tons of concrete
- 18 windows

The homebuilding industry also consumes tremendous amounts of energy; around 30% of the nation’s total energy output is used for homebuilding, including oil for asphalt shingles and gypsum for sheet rock in addition to wood, metals and aggregate. Loggers and miners burn huge quantities of diesel fuel and belch out clouds of exhaust pollutants in the forest and field, as do the trucks transporting timber and ore to the mills. These processing facilities in turn consume vast amounts of electricity and water to refine these materials into products, which are then transported to manufacturers (steel factories, sheet rock and concrete plants) or end users (lumber stores and aggregate yards). The embodied energy of these materials also includes all the human labor that went into turning trees and earth into the sticks and stones of homebuilding. Air pollution, road degradation, and energy consumption all contribute to the embodied energy costs of building materials, which aren’t necessarily reflected in the shelf price of the items but are passed along to future generations who will have to deal with the effects of fewer natural resources, dirtier air and water, and more expensive energy costs.
There are agencies attempting to determine how best to measure the actual kilowatt hours of electricity, number of trees, gallons of water, and barrels of oil consumed by the homebuilding industry, as well as the amount of air and water pollution created and the tolls to our transportation system from our highways to logging and mining roads. This is a monumental undertaking that is still in development. However, embodied energy is becoming an important part of the discussion regarding the carbon footprint that industries leave, and helps us to see how to look at an old board with new light.

**Architectural preservation**

The history of architecture is a reflection of the changes and developments in human culture; and one doesn’t need to travel into the distant past to find a diverse collection of styles and sizes of houses. From Victorian cottages and craftsman bungalows to art deco and ranch; from miner’s cabins to today’s McMansions; and from old farm buildings to schools, businesses and military bases, much of our culture is expressed through our architecture and the materials and fashions of the time. Hand craftsmanship has been replaced by mass production in many cases, such as cabinet making and ornamental molding. Solid wood has been succeeded by particle board, and rosettes and plinth blocks are much less common than finger jointed door and window trim.

When homeowners elect to remodel an older building, they often find it difficult to source authentic materials, such as horizontal panel doors and hardware, divided glass double hung windows, antique plumbing and electrical fixtures and full dimension lumber. Deconstruction and reuse puts these period items back into the building loop at (normally) affordable prices. It isn’t unusual for some materials to be purchased by neighbors who have a similar house, possibly constructed by the same builder, directly from the deconstruction site during the project. Certain artifacts and materials will often be saved for inclusion in the new construction, to bridge the architecture from the past to the present and future.

As noted earlier, all buildings in Boulder more that 50 years old need to be considered by the Design Review Committee of the Landmarks Preservation Advisory Board before a demolition permit will be issued. This includes many houses and structures in Downtown, Mapleton Hill, Newlands, University Hill and even Martin Acres neighborhoods. With Boulder approaching being “built out” in terms of available, empty building lots, older houses in these neighborhoods are coming under greater pressure for remodeling and removal as new owners opt for larger floor plans and modern amenities. Preserving the architectural legacy of these buildings, if only in pieces, is another benefit of deconstruction and reuse, passed on through the corbels, columns, pedestal sinks, claw foot tubs, steel cabinets and other artifacts from antiques to the shabby-chic. Even the burnt orange and avocado green bathroom fixtures of the 70’s are finding new homes in today’s “retro” design, confirming the adages that one person’s trash is another person’s treasure, and everything old is new again.
Job creation

With automation, robotics, and customer-service websites eliminating jobs and sometimes entire business operations, it’s refreshing to find some industries that add to the labor pool, if only in a slight fashion. Deconstruction and reuse do this. Whereas mechanical demolition takes a few people a few days to dispose of a house, deconstruction will employ a half dozen workers for a couple of weeks to do the same task. The materials generated from deconstruction will add further employment to the sales staff at the reuse stores and the laborers and equipment operators at the recycling facilities. Materials going to landfills are quickly buried without considerable labor effort – most often just one person in the scale house, a few people directing traffic, and a few equipment operators running over the refuse with huge compactor bulldozers.

Aside from providing jobs, deconstruction provides valuable skills training for the building trades. Learning how to use basic hand and power tools, as well as seeing how structures are put together, is a natural step for getting into the homebuilding and remodeling industry. As mentioned earlier, deconstruction is also much more forgiving of mistakes than new construction, since the end product is an empty building lot and not a finished home. Providing this entry level work is becoming more of an important occupational service, as industrial arts and similar programs are dropping out of secondary school curricula, with dollars going more toward information technology courses and computers and less toward wood shop and tools.

Larger projects, such as military base redevelopments, have been successful candidates for AmeriCorps volunteers (the equivalent of the Peace Corps for domestic service). Salvage operations following Hurricanes Katrina and Rita, limited though they were, also provided work for AmeriCorps and other volunteer organizations, such as Habitat for Humanity. Non-profit recycling and reuse facilities are also able to accommodate people who have gotten into trouble with the law and have to perform community service, or who are incarcerated and provide labor through work release or inmate worker services. These alternative sentencing programs provide cheap, valuable labor for pulling nails from lumber and other general labor activities, and allow the participants an opportunity to make a positive contribution to their community. Although this might provide good training for those involved in the alternative sentencing programs, it does not constitute a formal training program for deconstruction workers. The BMRA recently offered an 8 hour training course for deconstruction at its national conference in May, 2007. Other organizations have offered deconstruction training utilizing classroom and hands on field training. Normally, these are grant funded, one-time events. There is not currently a training program offering continual class and field work for deconstruction, although such a program is under development and near completion in California. This program is designed to train members of the California Conservation Corps, which consists of young men and women between the ages of 18-22 who are not part of any court ordered restitution program, but are simply looking for job skills.
**Small business development**

In addition to simply creating and providing jobs, deconstruction and reuse operations provide business development potential for entrepreneurs and small business owners. Most deconstruction contractors are private businesses that have formed as either sole proprietorships, partnerships, or limited liability companies (LLC). These are relatively easy business structures to establish, and don’t require the paperwork and personnel of corporations, such as articles of incorporation, bylaws, board members, and shareholders. An LLC can be created online with the Secretary of State in a matter of minutes for very little money. Sole proprietorships and partnerships are a little more involved in terms of organizational procedures, but are still accessible to the general population. Reuse facilities are often formed as 501(c) 3 non-profit companies, so they can offer tax-deductions for donated goods. This process can take anywhere from several months to more than one year.

There are also peripheral businesses that benefit from deconstruction and reuse. Value added furniture and craft making, which utilizes the unique character and stability of materials and items reclaimed through deconstruction, is one such cottage industry. Wood that has been nailed in place as joists, rafters and other framing members has had the chance to cure, which means the inherent moisture in the wood has had time to release without allowing the board to warp. Modern lumber, which is often speed grown on tree farms, is much more prone to twisting and cupping, even after being kiln dried. Old growth lumber will also be much more structural to begin with, as the growth rings will be much closer together because the tree grew slowly. This tight grain pattern and the absence of knots (from the branchless trunk of taller trees) give woodcrafters a premium stock from which to make their furniture, flooring, and millwork. Others like the saw marks of old, rough-cut lumber or the knotty-pine appearance of wall paneling for their creations. Older, larger trees also have a higher percentage of heartwood (the center) to sapwood (just under the bark), which is much more dense and colorful, allowing for the creation of beautiful, unique pieces.

Toolmakers and distributors are also responding to the demands of the deconstruction industry. There are numerous blacksmiths and metal fabricators across the country who is trying to develop product lines for custom pry tools, wedges, and material handling equipment specifically for deconstruction. Locally, a company called ReConnX is importing pneumatic denailing tools from various Asian manufacturers for sale here in the US. These tools have proven themselves to be invaluable for any organization that deals with reclaimed lumber and other wood components, such as flooring, siding, sheathing and T&G paneling. Similar to a nail gun that shoots nails into boards, the denailing gun fires a pin out of its barrel that shoots nails out of boards. This dramatically reduces the stress of prying nails and the incidence of repetitive motion injury, like carpal tunnel syndrome. ReConnX has sold hundreds of its nail guns throughout the country and is developing other tools for nail and screw removal.
Entrepreneurs aren’t the only people who benefit from the opportunities of deconstruction and reuse. Existing companies performing demolition, remodeling or new construction can add a deconstruction component to their scope of services without much difficulty. The license requirements would not demand any additional effort for these contractors, only the acquisition of some tools, labor, and a change of perspective from “getting rid” of a building to harvesting it for its resources.

**Affordable housing benefits**

Boulder has a great deal of allure for a lot of people, particularly because of its natural beauty, its proximity to the mountains and open spaces and the recreational activities they afford, its progressive culture, and because the community is protected from sprawl by virtue of the greenbelt of preserved land surrounding much of the city. It is also one of the more expensive places to live in the county.

Many of the people who provide the basic services of washing dishes, building houses, maintaining lawns and landscapes and other general labor work can’t afford to live in Boulder and must find residence in the outlying communities and commute to Boulder, which contributes to traffic congestion and pollution. Off-campus student housing and other rental properties are in need of continuous repair and improvements, as are starter houses purchased by first time homeowners. Purchasing used building materials at prices that are 50% or less of retail allows property managers and homeowners the ability to build more with less money. Affordable building materials contribute to affordable housing, and often enable working class people the opportunity to improve their dwellings with renovations and additions that wouldn’t be possible otherwise.

**Green building program credits**

The practice of “green building” is relatively new, with its emphasis being to increase the energy efficiency and indoor air quality of buildings while utilizing materials and systems that conserve natural resources. There are national and local initiatives that strive to reward efforts to incorporate green building methods into commercial and residential construction. Arguably, the most prominent such agenda at the national level is the USGBC LEED program, which provides credits in the following categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality and Innovation in Design. Depending upon how many credits are garnered, the building can achieve a rating of: Certified, Silver, Gold or Platinum (in ascending order). Under the Materials and Resources category, credits are given for building reuse, construction waste management, materials reuse and recycled content (of new materials) as well as other practices. The USGBC’s first Greenbuild conference was held in Austin, Texas, in 2002 and had over 4,000 attendees. Their most recent national conference, held in Denver in November of 2006, had nearly 14,000 attendees from all 50 states and 25 countries. Deconstruction and reuse of salvaged materials has been addressed in sessions in each of the conferences, with over 300 people attending the Denver presentation, filling the room to capacity and having to turn others away.
Locally, Boulder’s Green Points program has rewarded builders for sustainable building practices including deconstruction, reuse and recycling for over 10 years. This program awards points in ten different categories, the first of which is Construction/Demolition/Use of Recycled Materials. These guidelines reward builders for submitting a deconstruction plan, recycling debris, using reclaimed lumber, donating materials to a reuse facility, and using materials that have recycled content. Contractors and homeowners are required to take classes to become certified. When the program began in 1996, there were but a handful of certified contractors who had successfully completed the training. Today, there are dozens.

Another local organization that is helping to promote green building practices, including deconstruction and reuse, is the Boulder Green Building Guild (BGBG). It, too, has seen substantial growth in its short history. Having started in 2004 with only a few visionary participants, it currently boasts a membership of over 200, with attending a Green Points class being a requirement for membership.
V. Case Studies

Now that we have examined deconstruction and material reuse from a national and local perspective, it is time to take a look at the diversion results of actual jobs. The following projects were performed in the Boulder area from 2005-2007 by Haul Away Recycling, dba Deconstruction Services. They illustrate one soft-strip/demolition and five complete deconstructions. For the purpose of this analysis, the recycling of concrete and masonry rubble was not included, as this material is most often recycled whether the structure is demolished or deconstructed, so long as there are recycling facilities within the market area.

Disposition of Materials from Residential Deconstruction Projects in Boulder

Case 1: 5400 Baseline Road – soft-stripped and then demolished 2,000 square foot wood framed house and garage
Ranch style with three layers of asphalt shingles
Materials reused: Cabinets (0.5 tons); Doors/Windows (3 tons)
Materials recycled: None
Materials disposed: Commingled debris of the demolished structure (54.49 tons)

Case 2: 1 Neher Lane – full deconstruction
3,555 square foot wood framed house and garage
Two story with asphalt shingles
Built circa 1948-1952. Deconstructed in March 2006
Materials reused: Lumber (13.5 tons); Cabinets (1 ton); Doors/Windows (2.25 tons)
Materials recycled: Wood (6 tons); Metal (5 tons)
Materials disposed: Roofing/Tar Paper (3.97 tons); Painted Wood (5.54 tons); Drywall/Plaster (5.15 tons); Insulation (2.84 tons); Trash on Site (1.16 tons)
Case 3: **3787 Spring Valley Road** – full deconstruction
- 3,950 square foot wood framed house and garage
- Two stories with trusses and wood shingles
- Built in 1969. Deconstructed in August 2005
- Materials reused: Lumber (13.5 tons); Plywood (3 tons); Trusses (6 tons); Cabinets (0.5 tons); Doors/Windows (2.7 tons); Appliances (0.1 tons)
- Materials recycled: Wood (13.5 tons); Metal (1.37 tons)
- Materials disposed: Tar Paper (2 tons); Painted Wood (2.55 tons); Drywall (8.76 tons); Insulation (0.87 tons)

Case 4: **3901 Pleasant Ridge** – full deconstruction
- 3,224 square foot wood framed house and garage
- Two story with asphalt shingles
- Built circa late 1960s. Deconstructed in September 2005
- Materials reused: Lumber (8.25 tons); Plywood (2.25 tons); Cabinets (0.5 tons)
- Doors/Windows (2.25 tons); Appliances (0.2 tons)
- Materials recycled: Wood (4.5 tons); Metal (2 tons)
- Materials disposed: Roofing (4.41 tons); Painted Wood (2.85 tons); Drywall (11.25 tons); Insulation (2.35 tons)

Case 5: **319 Foxtail Court** – full deconstruction
- 5,300 square foot wood framed house and garage with an 800 square foot deck
- Three story split-level with asphalt shingles
- Materials reused: Lumber (23.25 tons); Plywood (1.5 tons); Cabinets (2 tons); Doors/Windows (4.5 tons); Insulation (0.186 tons); Appliances (2 tons); Landscaping Stone (99.5 tons)
- Materials recycled: Wood (10.47 tons); Metal (5.31 tons); Carpet/Pad (1.28 tons)
- Materials Disposed: Roofing/Tar Paper (7.1 tons); Painted Wood (9.46 tons); Drywall (12.98 tons); Insulation (3.87 tons); Trash on Site (0.29 tons)

Case 6: **13555 Cherryvale Road** – full deconstruction
- 6,000 square foot log house plus garage
- Two story with wood shingles
- Materials reused: Lumber (22 tons); Plywood (7.5 tons); Cabinets (1.25 tons); Doors/Windows (6 tons); Insulation (0.62 tons); Appliances (1 ton); Stone (20 tons); Logs/Landscape Timbers (34 tons)
- Materials recycled: Wood (16.65 tons); Metal (9 tons); Carpet Pad (0.35 tons)
- Materials Disposed: Tar paper (2.02 tons); Painted Wood (12.6 tons); Drywall (15.2 tons); Insulation (2.54 tons); Carpet (1.3 tons)
Demolition permit analysis for 2005 and 2006

Boulder’s Planning and Development Services Department reviews and approves demolition permits for projects within city limits. An analysis of the permits for the years 2005 and 2006 reveals what is happening and where in regards to residential and non residential demolition. The projects are categorized in the following manner:

**Type of Structure:** Residential or Non-residential.

**Building Use:** Single Family Detached Dwelling, Multifamily Dwelling, Mobile Home, Garage, Shed or Outbuilding (for residential structures). Non residential structures include Commercial/Retail, Office, Motel/Hotel/Bed and Breakfast, Amusement/Recreational, Medical and Dental Clinics, Restaurants, Manufacturing, Warehousing, Hospital/Institutional, Research & Development, Financial Institution and Government Uses.

**Type of Demolition:** Entire Structure (including relocation of structure), Partial Structure and Structural Interior Only. (For the purpose of this analysis, Partial Structure and Structural Interior Only are lumped together, as these would both apply to preparation for remodeling).

**Total Area to be Demolished in Square Feet** is also listed for each project, although the information was often missing for non residential partial/interior demolition projects.

The following table gives a breakdown of how the demolition permits are distributed among these categories for the two years, as well as averages of square feet involved.
The greatest opportunity for deconstruction and material reuse would apply to the residential sector, for reasons given earlier. Of these, about 80% of the permits are for entire structure and partial/interior demolitions of single family dwellings. The size and incidence of these projects are relatively close in numbers, with the total square footage of projects being:

**Entire Structure:** 70,785 total square feet (2005)  
                           64,240 total square feet (2006)

**Partial/Interior:** 59,163 total square feet (2005)  
                           67,824 total square feet (2006)

The National Association of Homebuilders (NAHB) Research Center estimates that new construction of the average home generates about 4.0 pounds of waste per square foot for new construction. It is further estimated that each square foot of conditioned space
in the finished structure contains between 30 and 40 pounds of building materials. At this rate, the amount of material generated from the demolition of these structures would break down as follows:

**2005:** 129,948 total square feet. Equivalent to 1,949.22 to 2,598.96 tons of waste generated from entire structure and partial/interior demolitions of single family dwellings.

**2006:** 132,064 total square feet. Equivalent to 1,980.96 to 2,641.28 tons of waste generated from entire structure and partial/interior demolitions of single family dwellings.

To put this in greater perspective, if *all* this material was taken to a landfill, it would amount to the following, given a five day work week on an annual basis:

**2005:** 7.5 to 10 tons per day (roughly the equivalent of one roll off container).

**2006:** 7.6 to 10.2 tons per day (again, roughly one roll off container of material).

If we look at *all* the material from *all* of the demolition projects (residential as well as non residential), the numbers would be as follows:

**2005:** 21.3 to 28.4 tons per day (less than three roll off containers of material).

**2006:** 38.3 to 51.1 tons per day (four to five roll off containers of material).

Again, to put this in perspective, the material we’re looking at in this analysis would be commingled demolition debris, which would require separating into its constituent elements before it could be recycled or reused. The non residential demolition numbers may skew this analysis because the materials from these commercial projects would not be as homogeneous as that coming from residential structures. A home in Martin Acres and a home on Mapleton Hill are much more similar in their makeup than non residential demolition projects, which would include anything from a restaurant retrofit to the demolition of Crossroads Mall. Even the most sophisticated and expensive recycling systems in use today would only be able to recover a portion of this total stream for recycling, and very little for reuse, if mechanical demolition was employed, because the material would be contaminated in the process (non-recyclable material would be intermixed with recyclable material as it is crushed by the heavy equipment of demolition.) The consequences of this will be discussed in the following Recommendations section.
VI. Recommendations

State mandates

Lobby state legislature

Some of the most successful recycling and reuse programs exist in states that have legislative mandates for landfill diversion. California enacted Assembly Bill 939 in 1996 which requires municipalities to achieve a 50% landfill diversion goal, and also helped establish the California Integrated Waste Management Board (CIWMB) to help fund and oversee various reuse and recycling operations.

Therefore, the primary recommendation would be to encourage state legislators to require all landfills operate on a life-cycle cost basis. This means that every operator in determining their costs must include the current value of land (reassessed annually), all general operating costs, the amortized costs of closing the landfill, real estate taxes (imputed if government owned), and a fund to cover the costs of citing and opening a new landfill. The key here is to value all the costs of operating a landfill and not have it subsidized by a hauling operation if owned by a waste hauler or the general fund if operated by a government.

As an alternative, since the legislature has not been too receptive in the past, compute these costs and add them to the building permit.

Local mandates

Deconstruction bond

Several cities have recently enacted reuse/recycling bonds. For instance, the city of Atherton, California, has a one dollar per square foot bond which is posted before the permit is issued. Verification of the square footage (including outbuildings, porches, breezeways, etc.) must also be presented with the bond. In order to receive the bond back, the owner or contractor must present weight certificates showing that at least sixty percent of the structure was diverted from the landfill.

Another city revised its fifty percent diversion to be after an allowance for the concrete and hardscape. In this manner, they have eliminated just the recycling of concrete to comply with their original fifty percent rule. In the average house, fifty percent of the weight is in the concrete and asphalt and the balance in the actual structure.

Fast-track of projects

Many years ago, Austin, Texas, implemented a fast-track system of plan approval and permitting if there was a reuse/recycling plan attached to the submission documents.
After the project was completed the results had to be turned in to obtain the occupancy permit. If the results were equal to or better than the plan, then the occupancy permit was issued. If they weren’t, then a substantial fine was imposed and had to be paid before the occupancy permit could be obtained; and the contractor was not allowed to submit on a fast-track basis again for two years.

**Coupling of demolition permits**

This is almost the reverse of the Seattle problem mentioned above. Allow a deconstruction (not soft-strip) permit to be issued before the final permit is issued for the new building. Otherwise, the contractor cannot get a demolition permit until the final permitting processing is complete. This will eliminate the argument that deconstruction takes much longer than demolition.

**C&D tax**

Attach a ten dollar surcharge on every ton of C&D that goes to a landfill. This will require the cooperation of the landfill operator. At the rate of ten dollars per ton, there is enough money generated to cover the operator’s costs of collection.

**Subsidies**

Encourage other organizations (for profit and nonprofit) to enter the market through the offer of rent subsidies. Presently, there exists a virtual monopoly on reuse facilities and this has created inefficiencies in diversion, minimized diversion, and created lost opportunities for more creative solutions.

**Local incentives**

**Adjust Green Points**

While the Green Points program has served Boulder well over the past years, there are some elements which actually hinder reuse, energy conservation, and diversion.

First, abide by the philosophy of reduce, reuse and recycle. Then the most points should be given to projects which incorporate a large percentage of reused materials in the new structure which are salvaged from the old. Second, lesser points need to be awarded for materials which are going to a reuse center (for profit or nonprofit). Finally, the smallest number of points needs to be given to materials which are recycled. Each level needs to have a minimum percentage. For example using 10% or more of the materials from the old structure in the new one would be awarded 15 points. Sending 50% or more of the materials from the old structure to a reuse facility would earn 10 points – materials reused in the new project would count towards this 50%. Recycling over 10% would earn 5 points. In the first case, this would be verified by inspection, the second and third cases by weight receipts. In all cases the percentage is calculated on weight.
Next, awarding points to an owner or contractor for simply soft-stripping prior to demolition is a negative incentive. One could send their windows and doors to a reuse facility thereby earning points and then discard the balance of the entire structure. This method would encourage demolition not deconstruction. There must be a minimum for reuse and recycling otherwise the process is a sham.

**Program development**

**Deconstruction flyers**

Recently, Seattle placed a deconstruction (not soft-strip) flyer in the envelope containing the application information. This flyer discussed the advantages of deconstruction and listed the three companies doing deconstruction in the city.

**Demonstration deconstruction**

Conduct a city sponsored deconstruction and encourage at least one manager from every licensed general contractor to attend and even participate. While we have not heard of this being implemented by any city, we have deconstructed a house in record time using all volunteers. A 1,000 square foot house can be deconstructed in one week if organized properly. The advantage is that all contractors will immediately see the benefit and have fun doing it.

**Require attendance at a deconstruction workshop**

This would be a two-day workshop consisting of one day of classroom training and the second day of on-the-job training. This will include showing the removal and disconnection of cabinets, doors, windows, electrical and plumbing fixtures, salvaging hardwood flooring, and the removal, denailing, sorting and banding of structural lumber.

**Infrastructure**

In order to achieve the level of landfill diversion of C&D materials that the city of Boulder has challenged itself to do, there will need to be some sort of facility for receiving and processing recyclable masonry, wood, and metal in a cost-effective manor for both contractors and the City. Simply diverting reusable materials to local non-profit facilities will not suffice. Since there are limited locations for concrete recycling in the Boulder area, most of this material needs to be transported to neighboring counties. Even with rising diesel fuel costs, this can still be cost-beneficial for large loads (i.e. dump-truck or roll-off containers which can carry 10-20 tons at a time) because there are facilities in western Weld county that will accept clean (source separated) concrete and masonry for a fraction of landfill tipping fees. However, the closest facility to the landfill is not open year around, and is not necessarily beneficial to contractors and homeowners who are removing smaller amounts of concrete (less than 10 tons). Unloading cabinets, doors, and windows from a pick-up truck and trailer
and receiving a tax-donation receipt is one thing; but hauling concrete rubble in the same vehicular arrangement and trying to hand unload it is quite another.

Bulk recyclable materials need to be transported in a method that allows for mechanical dumping at a facility that has the space, equipment, and market partnerships to handle large amounts of clean material at once. Before Eco-Cycle moved into the Boulder County Recycling Facility on 63rd street - which has a concrete tipping floor, dedicated loading equipment, and larger containers - the amount of metal recycling that occurred at their drop off facility was minuscule compared to what it is now. Similarly, before Western Disposal (in partnership with the city of Boulder) began receiving wood waste at it’s facility - which also has the tipping space, equipment, and containers to handle large quantities, as well as a local processing facility and end markets for the material - there was little if any wood recycling in Boulder. Finally, when La Farge (Western Mobile) stopped accepting concrete and masonry at its aggregate facility on Valmont, the amount of material going to the landfill certainly increased.

Dedicated C&D recycling facilities do exist in most of the larger metropolitan markets in the country. However, none exist in Colorado. Denver would certainly be the first place for this to occur, since it is the largest metropolitan area. There are many facilities in the Denver metro area that will take either source separated wood, metal, or masonry, but none that will take this material if it is commingled, as it would be if it came from a demolition project. Boulder certainly shouldn’t expect that it could cost-effectively operate a commingled C&D facility, regardless of incentives or mandates. There simply isn’t enough material being generated on a daily basis to justify the millions of dollars of capital equipment, acres of land, and environmental noise and dust pollution associated with this type of facility.

However, there may be opportunities to collect these three streams (wood, metal, and masonry) at a single location and then bring in mobile equipment to crush, grind, and transload material on an “as need” basis, similar to how Christmas trees and other yard waste have been collected in the past. Western Disposal has indicated for several years that they would be interested in siting a source separated facility that could accept these items at their satellite facility across from the power plant on 63rd street, where they are currently processing the wood waste received at their transfer station. Eco-Cycle has also entertained the hope to address parts of the C&D waste stream if and when they move to a joint location with ReSource on the Brickyard site. Boulder County has also recently started to press for deconstruction and material reuse and recycling, and could certainly assist in establishing a drop-off facility for C&D recyclables. The best opportunities lie in the potential partnerships and cooperation between all of these entities: nonprofit recycling/reuse facilities, for-profit hauling/processing companies, city, and county government agencies.

Lastly, we need to look to the future, and develop markets for the material. Nothing is reusable if nobody wants to reuse it; and there’s no sense in recycling something, if there’s no market for the end product. If current building codes require windows to have a certain energy efficiency in order to be installed in new construction and remodeling projects, then there is little sense in harvesting those windows that don’t meet these
requirements. The market for windows that won’t pass local building codes would only be with people who aren’t following those codes. There’s little environmental benefit to having a homeowner save money on purchasing windows and then waste it (and more) on energy usage. The same can be said for plumbing fixtures (i.e. toilets) that use excessive amounts of water, or heating appliances that use excessive amounts of natural gas.

The same rationale applies to recyclable materials, which normally have much higher processing costs, because of the capital equipment necessary, and lower end-product payback, because material has been downgraded to “feedstock” (scrap metal), soil amendment (scrap wood), or gravel-substitute (concrete and masonry debris) applications. If there was money to be made recycling concrete, La Farge would most likely still be doing so. In order for this to happen, something on the scale of the Colorado Department of Transportation would have to require that a certain percentage, let’s say 10%, of all new road base in highway construction would have to be post-consumer recycled material. When President Clinton mandated that all federal government agencies use office paper with a certain percentage of post-consumer content, the market for recycling such paper became more profitable and more stable.

The markets for scrap metal are stronger than ever before and have good prospects for the near future because of overseas demand. Certainly, this product could be viewed as the money maker for a source-separated, C&D recycling facility, although haulers would probably want to be paid for larger loads, or they might end up hauling this material to another facility. There isn’t a tremendous amount of scrap metal that would come out of a residential deconstruction – mostly HVAC material and non-reusable appliances. Structural steel beams can be reused if they aren’t damaged in their removal, and fetch a good price on the resale market. Precious metals (such as copper wiring and plumbing conduit) can be easily recovered during deconstruction, and can contribute thousands of dollars to the deconstruction contractor or homeowner.

The demand for products made from scrap wood also has a strong future, though with less financial benefit than metal. Wood mulch is being used for residential landscaping as a moisture retainer for tree bases as well as in xeriscapes. Mulch can also be applied to exposed soil from construction and road building applications to stabilize soil on slopes, and in areas that have been affected by wildfire. If mixed with other “waste products” it can be turned into compost, which certainly has a strong market as a top soil alternative for local gardening and agricultural uses. If buried under soil, as it would be in a landfill, wood does not decompose and only takes up space. If ground-up and spread on top of soil, in almost any application, the wood fibers break down and turn clay and other hard ground into something more beneficial for growing plants and retaining moisture.

Regarding future markets, asphalt shingles are being recycled in other parts of the country, and it’s just a matter of time until there will be companies here in the Denver metro area doing the same. Since asphalt shingles and other roofing material are derived largely from petroleum, oil prices will drive this market. Ground shingles and roll-roofing can be ground up, have the nails removed magnetically, and used in hot-mix for road repairs as well as new road construction. Again, having an entity such as
the Department of Transportation require a certain percentage of post-consumer recycled content would certainly kick-start this market. To a lesser extent, city and county governments could propose similar requirements for their projects.

Sheetrock (gypsum board) and carpet recycling are the fringe markets that could still be developed if the economics are favorable. Waste-not-Recycling is currently mixing unpainted sheet rock scraps from new construction into a stream of waste material from production hog farming to create a soil amendment product as well as other applications. However, most uses for recycling sheet rock won’t accept painted material, so the opportunities for diverting sheet rock are greater in the new construction market than in deconstruction. Carpet recycling also has its hurdles locally, because there are no textile mills in this part of the country accepting used carpet, and not all carpet is sought for recycling.

There exists a fertile environment in the Boulder area for considerably greater diversion of C&D materials. The next steps would certainly need to involve identifying a champion and players in siting and staffing a facility which could handle potentially large amounts of source separated material streams, and find end markets for the product. Local legislation regarding deconstruction/new construction material reuse and recycling, along with cooperative arrangements with local non-profit, for profit, and government agencies provide the greatest opportunity for success by offering cost-competitive, comprehensive solutions finding new uses for old waste items. Doing all this in a part of the country where landfill fees are cheaper than elsewhere presents the greatest challenge.
1 Characterization of Building-Related Construction and Demolition Debris in the United States; United States Environmental Protection Agency; EPA530-R-98-010; June 1998.
2 Analyzing What’s Recyclable in C&D Debris; Ken Sandler (EPA); BioCycle; November 2003; Vol. 44; Iss. 11; p. 51.
3 The State of Garbage in America; BioCycle; April 2006; Vol. 47; Iss. 4; p. 26.
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