

# CHAPTER 16 SUSTAINABLE BUILDING

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## INTRODUCTION

**B**uildings are the settings for most of our lives. We live in houses and apartments. We work in offices, retail centers, hospitals, schools and factories. And we worship, play and work out in still other buildings. Because we spend so much time in buildings we often forget that they are actually made up of materials just like the packaging around the food we buy. Throughout their life cycle buildings require natural resources just like less durable goods such as electronics and clothing. In fact, the decisions we make about the buildings around us can have much greater impacts on the environment than the vast majority of the day-to-day decisions that we make about other products because buildings are so big and so long-lasting.

We tend to think that building decisions are solely made by architects, contractors and construction workers and Master Recyclers often wonder what impacts they could possibly have or why they should consider spending some of their volunteer payback talking to the public about it. Certainly it will be helpful for residents to understand better how to hire a contractor for building and remodeling so that our values are built into the places we live. But it is also important that we understand the policies that influence the make-up and design of our buildings. It is also crucial to maintain already existing buildings that have so many natural resources invested in them so as to maximize their lifespan and their efficiency.



Whether we own or we rent our homes, are decision-makers or observers in the design and maintenance of our public places, we can all play a part in influencing the policies, planning, building, purchasing, remodeling, redecorating, fixing and maintaining of our buildings.



## WHAT IS SUSTAINABLE BUILDING?

Habitat for Humanity defines sustainable, *green*, building as designing and constructing houses that are efficient and durable, that use less resources, are healthy to live in, and are affordable. This definition can be expanded to include our schools, office buildings, apartments, recreational centers and factories.

### Sustainable building can:

- Manage stormwater that runs off the building.
- Save energy.
- Utilize alternative energy.
- Include green space and food production.
- Be located near services such as retail shops, medical care, schools, jobs, and transit.
- Locate housing and service buildings away from buildings with high health impacts such as manufacturing facilities.
- Invite community gathering and expression.
- Use non-toxic materials.
- Provide safe places for children to play.



Experts in the area of sustainable building will specialize in many of the subjects above, but this chapter will focus on an area that gets less discussion. We will specifically explore the full life cycle of the materials in buildings and the environmental and social impacts of the decisions we make about those materials.

We will learn that the reduction of materials that make up our buildings can be one of the most important ways in which buildings can be sustainable. Energy efficiency decisions are currently the most important environmental decisions we can make about buildings when it comes to climate. DEQ reports that 86 percent of the total carbon emissions associated with homes are due to energy use (space and water heating, electricity consumption). However, materials production contributes the remaining 14 percent, which is still significant. As we begin to build more and more energy efficient buildings, the percentage of the energy used to make the building materials will become proportionally greater. So along with energy efficiency, the materials we choose will be important in meeting the aggressive carbon emissions reductions necessary to curb climate change.

## EMBODIED ENERGY IN BUILDINGS

More natural resources are contained in our buildings than in the products that we use day-to-day. These natural resources include building materials themselves and the energy required to process and transport those materials. Building materials include wood, iron and steel, non-ferrous metals, chemicals, natural gas and petroleum products, minerals such as cement and lime, and glass. Processing these materials requires water, oil and coal. Minimizing the need to extract these natural resources is reason enough to rethink our standard approach to building.

We don't often think about the amount of energy that is embodied in the materials that make up our buildings and the impact that embodied energy has on our climate. **Embodied energy** is the energy consumed by all of the processes associated with the production of a building, from the mining and processing of natural resources to manufacturing, transport and product delivery. Embodied energy does not include the operation and disposal of the building material, which would be considered in a life cycle approach. Embodied energy is the upstream or front-end component of the life cycle impact of a building.

Embodied energy in buildings is important because natural gas, oil and coal are widely used for energy to manufacture building materials and these fossil fuels, when burned, create carbon dioxide (CO<sub>2</sub>) emissions, a primary cause of climate change.



*Coal factory*

The amount of energy embodied in regular household materials is high. The amount of embodied energy contained in an average, 2,000-square-foot home, is 892 million BTUs, the equivalent of 7,826 gallons of gasoline, enough embodied energy to drive an SUV 5.5 times around the earth.

### TERM

**Embodied energy** : *The energy consumed by all of the processes associated with the production of a product, from the mining and processing of natural resources to manufacturing, transport and product delivery.*

### RESOURCE

*You can find more information on home remodeling and green remodeling options at the website of the National Association of Remodelers (NARI).*

## LESS IS BEST

The material that doesn't have to be extracted and manufactured is always the least environmentally costly. Below is an exploration of creative ways to think differently about how we work and live so that we can lessen the environmental impact of our buildings. These changes are big, but an increasing number of people are ready to embrace such changes not only to safeguard our environment but also to improve their quality of life. Our local governments are also including zoning and incentives programs that help remove some of the barriers to making these lifestyle changes.

### Shared space

Condominiums, town houses and apartments are all types of housing that minimize building materials by sharing common walls, courtyard space, and parking and laundry facilities. Depending on their design, multifamily homes are capable of providing a 10 to 15 percent reduction in carbon emission in comparison to equally sized single family homes. Commercial, non-profit, government and private space can also be combined to minimize materials. Getting a roommate or renting out that extra room are also effective ways to utilize existing space.

Freelancers are also embracing the shared space concept. While working from home can save money, for the sake of creativity, productivity, and sanity, many freelancers choose to rent a desk in an office or co-working space.



Space can also be shared by different types of users. Churches and restaurants will often loan or rent out their large kitchens part-time to food cart cooks. Swap n' plays where families can share toys, bring their children to play, and swap clothing can be housed in buildings with extra or seldom used space.

Such approaches can have the added benefits of creating community gathering spaces, minimizing the need for transportation, and providing easy access to services. While people generally like privacy, there is a growing sense that privacy may come at the expense of feeling more



isolated and having to spend more time earning money to pay for a private home. More and more communities are forming where people choose to live, work and play together intentionally because they see the value of protecting our planet and like the safety and satisfaction that comes from knowing the people that live around them.

## Size matters

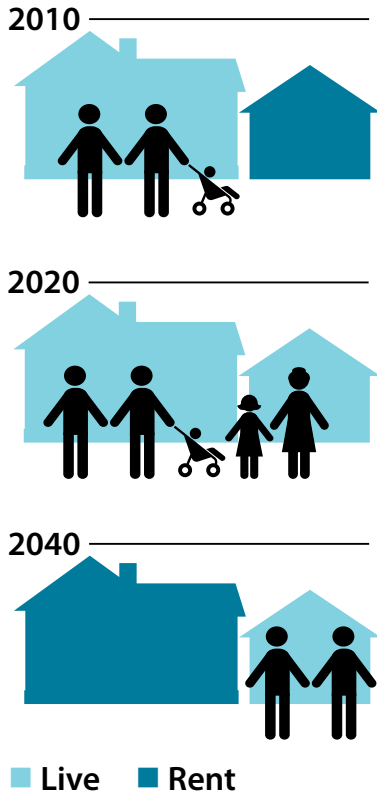
Along with sharing space, we can reduce materials by living in smaller spaces. DEQ estimates that downsizing from Oregon's average house of 2262 sq. ft. to a still reasonable 1149 sq. ft. could reduce the carbon footprint of that household by between 20 percent and 40 percent. They argue that even making a moderate change in the size of your home can be one of the most environmentally beneficial decisions that you can make.

Tiny houses are a popular new movement where people choose to live even smaller. Tiny houses are typically 100 to 400 sq. ft. While tiny houses may not be for everyone, there are lessons to be learned and applied to how we all use space. Rather than expecting their individual home to meet all of their needs, people who live in tiny houses look to shared spaces nearby for play, entertaining and gathering.

People who choose to live in smaller spaces enjoy the added benefit of freeing up their income for other priorities. As a general rule housing should not exceed 30 percent of your income. In the Portland metro area, however, in 2014 the median gross rent was 33 percent of the gross income of renters and the median for home owners was 30 percent. We are living beyond our financial means, just as we are also overdrawing natural resources from our planet. Neither of these is sustainable. People who choose to live in smaller spaces frequently mention that they enjoy the ability to meet other basic needs with the savings in rent or taxes. Some also report enjoying reducing the amount of hours they have to work to make these payments.



## ACCESSORY DWELLING UNIT



*Evolving housing over time.*

## Space that evolves with time

We often plan our personal and public buildings for the times when they will be used at their maximum capacity. Often these peak use times, however, are short and some space is then unused most of the time. We can think of our buildings as less fixed and use the space more creatively to maximize efficiency and flexibility. Accessory dwelling units and modular buildings are two examples of how we can make our buildings more flexible so that their use can evolve over time.

An accessory dwelling unit is a really simple and old idea: having a second small dwelling right on the same property or attached to your single-family house. Planners call them ADUs (Accessory Dwelling Units), but they're also known as granny flats, in-law units, laneway houses, secondary dwelling units, and many other names. Such units are making a comeback. ADU's can include:

- An apartment over the garage.
- A tiny house in the backyard.
- A basement apartment.

Flexibility in housing makes sense for environmental, lifestyle, and financial reasons. Many people buy houses to live in for decades. But they often purchase a house to fit their family at its largest. This can leave unused space as family size changes. It is still relatively unusual to consider how the use of space can change over time.

## RESOURCE

*To learn about incentives and regulations in your city, and how to get started on building an ADU you can visit the website for Accessory Dwelling, a nonprofit group based in Portland.*

If you have a reasonably sized house, and an even more reasonably sized ADU, you've likely got a pretty green combination with flexibility as well. You could have your best friend, your mother, or your grown kid, live in the extra building. When you want to stop climbing stairs in a two-story house you can rent it out and live in your ADU. This kind of flexibility and informal support could really help as the nation's population ages. Most people want to stay in their homes as they age, but finances and design can be problematic. An ADU could help aging people meet their needs and enjoy the benefits of aging in a familiar home and community.

## RESOURCE

*To learn more about commercial options for flexible buildings consult the Bureau of Planning and Sustainability's Tenant Improvement Guide.*

Commercial buildings can also be constructed in ways that allow for change of use over time by moving from standardized permanent internal structures to modular fixtures. Retail centers and office spaces can have separators, and electrical and furniture systems that easily come apart and can be moved around to adapt to rotating tenants. Even schools are beginning to utilize this building method. Modular schools can be created to allow for additional classrooms, a library, gymnasium, or additional stories and can be modified and expanded at later dates. When enrollments shift, so can the shape and function of the school's buildings.

## REMODELING AND BUILDING CHOICES

Many green building strategies may be considered for remodeling or building a home, and many of these pertain to how materials are used. Making sustainable choices early in the process can reduce the use of resources, reduce waste generation during construction, and also eliminate future waste issues.

**Recycled-content building products** are made using materials recovered from the waste stream. The feedstock for recycled building materials can come from industrial castoffs, take-back programs, and curbside recyclables. Metro's recycled paint, UltraTouch™ insulation (made from waste denim cotton), and Shaw carpet that incorporates reclaimed plastic bottles are three examples of recycled-content building materials.

Using recycled-content materials closes the loop by turning waste into usable products, thus saving energy and natural resources, and often reducing pollution, including greenhouse gasses. However, these products are not without their challenges, such as their questionable future recyclability. For example, decking made from scrap wood and plastic waste will last longer than wood, but it's very difficult to recycle this composite material when the time comes to replace the deck. Often an even better choice is to use salvaged material. **Salvaged** material does not require the energy to process materials like recycling does and is often reuseable once again, unlike composite materials made from recycled resources.



*Salvage Works lumberyard in Portland*

### TERM

**Salvage:** *The act of rescuing materials for reuse in the original form or the resulting material.*



### Action Tips:

- When possible prioritize using salvaged materials.
- Select recycled content materials as a second best option.
- Choose durable, long-lasting products.
- Consider the future recyclability of recycled materials used.
- Ask about purchasing remnants of materials







**Designing for disassembly** facilitates the future reuse or recycling of select materials, even an entire building. For example, future harvesters will be better able to salvage lumber from today's dormer addition if headers and beams are fastened together with screws or nails, rather than the glue commonly used in modern construction.

### Action Tips:

- Reduce the variety of materials.
- Prioritize materials for ceilings, walls, floors and cabinets that have smaller components that can easily be removed, repaired or swapped out.
- Use screws instead of adhesives.
- Select materials that are durable and long lasting. Some products may look new and slick, but are made cheaply with moving parts that break easily.
- Build so that common hand tools (hammer, crow bar, etc.) can be used in disassembly.
- Leave fasteners exposed.



**Dematerialization** simply means using fewer materials. This concept applies to all stages of production, including: resource extraction, design, manufacturing, and installation. Fewer materials use fewer natural resources, consume less energy, save money, and create less future waste.

### Action Tips:

- Consider skipping the drywall for ceilings and walls that share other interior space and leave the main structure exposed.
- Use framing techniques that require fewer boards per wall.
- Limit the use of finishes.
- Landscape with native and hardy plants that require less maintenance, water and chemicals.
- Site, orient, and design buildings to use daylight as the primary lighting source.
- Do without ... a garage, a second bathroom, or an expanded kitchen.
- Think small; create multi-use spaces by adding creative storage and lounging options (e.g., Murphy beds, under-stair cabinets).
- Caution: Do not choose to use less material if the material can make the building more energy efficient. Insulation and finished walls are important ways to keep heated space warm.



In short, reduce, reuse, recycle is as vital a motto for building and remodeling as it is for everyday consumption.



## TAKING CARE OF WHAT WE HAVE

Practicing a little maintenance and fixing problems before they get out of control can save a lot of time and money and maximize the embodied energy in building materials by ensuring that they last as long as possible. If you rent, you can still help conserve the materials in the buildings and keep your family healthy by doing a few small maintenance tasks yourself and by informing the property owner of bigger problems early. In Oregon, you can also arrange with the owner or property manager to fix essential items yourself and dock the costs off of your rent.

### Got mold?

Moisture in or around the house can contribute to allergies or asthma and also cause structural damage in a home's walls, attic, foundation and exterior. In an average year, 22,000 gallons of rainfall will hit a 1,000 square foot roof in our region. With that amount of moisture, proper water management is essential to protect building materials. Here are a few easy ways to reduce moisture problems that everyone can do:

- **Foundations.** Ensure that landscaping drains water away from foundations. Regularly caulk areas where cement slabs sit next to the foundation. Clear debris from gutters and downspouts in the spring and fall, and replace parts that have rusted or fallen off. Make sure that downspouts drain water at least 6 feet away from a basement and 2 feet away from a slab or crawl space. Place a plastic vapor cover over dirt in a crawl space.
- **Moisture from interior sources.** Always use fans while taking a shower or in the kitchen while cooking. Ensure that the dryer vent sends moisture outside. Open windows and doors when the weather is warm and dry. Allow space between walls and furniture for ventilation. Have HVAC systems regularly serviced and repaired for proper air circulation.
- **Leaks.** Regularly check pipes to refrigerator, hot water heater, faucets and drains under sinks and laundry spigots. Look for leaks on roof, attic, behind gutters, and around windows and doors.
- **When mold appears.** Utilize fans or dehumidifiers and immediately remove carpets, drapes or furniture that has mold before the mold escalates. Professionals can also be called to clean mold.

### Tool libraries and hardware tool rentals

You don't have to have a fully equipped toolshed to maintain your house or apartment. There are currently four Tool Libraries in Portland that loan a wide variety of tools to community members free of charge. Tool libraries benefit residents by reducing the costs of maintaining and improving the places in which we live, work, and play.

#### RESOURCE

*For more on renters' rights visit Oregon's Community Alliance of Tenants (online).*



*The North Portland Tool Library, Southeast Portland Tool Library, Northeast Portland Tool Library, and Green Lents Community Library all have websites where you can find more information.*

*Many hardware stores also rent tools. From large companies such as Home Depot to smaller stores, it is worth contacting your local stores and seeing what tools they rent.*

## CONSTRUCTION AND DEMOLITION

### TERM

**Deconstruction:** *the systematic disassembly of a structure in the opposite order it was constructed to maximize salvage of material for reuse.*

Buildings in the Portland metro area traditionally get built, demolished, disposed of, and built again with little consideration of waste reduction. Waste sort studies at local construction sites reveal that, while about 90 percent of the materials used in buildings are recoverable, only 50 percent are recovered. Construction generates the third largest waste stream in Oregon.

### Construction and demolition waste in the metro region

The sources of construction and demolition (C&D) generated waste vary greatly in the Metro region. And the proportion of waste from residential, commercial, mixed use and industrial construction activity varies between rural and urban areas. However, several clear themes emerge from studies of building permit data:

- The majority of money in the region is spent on new commercial construction and commercial remodeling.
- Residential remodeling in the region is underreported due to unpermitted, bootleg activity, which is probably several times more prevalent than permitted projects.
- Little solid waste is created in civic projects like bridges and roads.

### Deconstruction

**Deconstruction** is the systematic disassembly of a structure in the opposite order it was constructed to maximize salvage of material for reuse. Deconstruction is most often done by hand with machinery only being used to lower walls or load materials. The method of mechanically demolishing buildings, and then attempting to pull out materials for recycling, often results in damaged and mixed up materials, to the point where materials must be used for very low environmental benefits like burning for fuel. Deconstruction, on the other hand, results in whole pieces of building materials that are predominantly intact and can be reused in other sites.



Credit: Lovett Deconstruction

### There are many benefits to deconstruction:

- The deconstruction of a 2,000 sq. ft. home can yield 6,000 board feet of lumber, enough for the construction of 660 sq. ft. of affordable housing. This amount of salvaged lumber is equivalent to 33 mature trees, or the yearly output of 10 acres (that's 7 football fields) of planted pine.
- Deconstruction supports six to eight jobs for every one job associated with traditional mechanized demolition.
- Salvaging reusable material supports the local economy, creates viable local enterprises, and offers an affordable option for residents and businesses to acquire quality used building materials such as old-growth lumber.
- Deconstruction offers greater carbon benefits by preserving the embodied energy of existing building materials and avoiding the creation of greenhouse gases associated with landfilling waste.
- When salvaged building materials are donated to a non-profit such as the Rebuilding Center, there is a tax deduction for the materials if they are donated.
- Deconstruction companies and non-profits often have competitive bids against companies that use conventional demolition methods because they pay less landfilling fees and receive money from the sale of salvaged materials.



Credit: Lovett Deconstruction



### First deconstruction law in the country

Antique glass doorknobs, wood framing from long-gone old growth forests, basket weave bathroom tiles, and inlaid hardwood floors are all beloved touches in old homes. Instead of stripping our forests and land for natural resources to decorate and build our new homes, we can harvest materials at local reuse centers like the ReReBuilding Center and Habitat for Humanity ReStore.

Recognizing the value and benefits of salvaging building materials for reuse, Portland City Council approved in July 2016 the first ordinance of its kind in the country that required development to fully deconstruct homes built in or before 1916 instead of demolishing them. In 2020, the ordinance was expanded to 1940 or earlier, resulting in approximately over 100 deconstructions or about two-thirds of house demolition permits. These houses are taken apart by hand, allowing materials to be separated for reuse and recycling while creating pathways to deconstruction careers. The Bureau of Planning and Sustainability also created incentives to use deconstruction and developed training for workers and contractors who want to learn this trade.

*“Our goal is to preserve neighborhood character and affordability by discouraging demolitions, but when buildings do come down, that work should still serve the public good. Taking apart buildings in a way that allows for salvaging valuable materials for reuse benefits our community, economy, and environment.”*

— Charlie Hales, Mayor  
City of Portland, 2013-16

### RESOURCE

To find contractors, learn about trainings, and find incentives you can visit the City of Portland, Bureau of Planning and Sustainability’s webpages, **Explore Deconstruction.**

## Present C&D waste practices

Successful waste reduction planning for construction and demolition requires a good understanding of present practices. This section looks at what kinds of C&D activity takes place in the metro region, what materials are generated, and how the materials are usually disposed of.

### Building materials in the waste stream

Over 250,000 tons of C&D materials are generated each year in the region. These are primarily wood, metal, corrugated cardboard, concrete, drywall and roofing. Some new materials and composites are difficult to recycle, but they're a small part of the dry waste stream. Pure loads of concrete, asphalt, and dirt are not counted as part of the solid waste system tonnage, as they would eclipse the quantity of solid waste in the system many times over.

Typically, the generation of individual materials follows a predictable schedule (for example, all drywall scrap is generated in the two days after the drywall is installed).

The quantities of the six C&D material types are also very consistent and predictable. Such predictability in types, timing, and amounts of materials could facilitate source separation for recycling.

The demolition phase of any construction project is usually where more than 60 percent of C&D debris is generated. This makes demolition activity a huge opportunity for recycling and reuse. Renovation and remodeling comprise the next largest debris-generating activity, making this yet another area with great potential for waste prevention and reduction.

### Hauling

The building industry presently relies on three primary methods for hauling C&D debris: drop boxes, self-haul, and a cleanup contractor. Many builders use a combination of these options, depending on the materials being used and the phase of the project.

To encourage C&D waste reduction, a successful education program must include source separation strategies for use with all three hauling methods. Contractors' hauling choices will determine whether separating recyclables on site is possible, or whether separation will have to happen at a Materials Recovery Facility that serves C&D customers.

- **Drop box.** About half of the region's C&D tonnage is hauled in drop boxes, which are hard to move, bulky, and incur daily rental fees. Drop box hauling tends to be used during the demolition phase, which produces the bulk of material and can be done fairly quickly. Contractors usually mix all debris in one drop box.

One way to source separate with this hauling method is to use a box for each material. However, there are many challenges that make this



option unfavorable to contractors. Larger projects may still have limited space for multiple boxes. Small projects often only generate enough debris to fill one box. Multiple containers for source separating in these conditions usually cost more than one large container where debris is mixed.

- **Self haul.** The second most utilized method is self hauling. Contractors use everything from a pickup or trailer load to a 20-yard dump truck. Source separation is usually much easier with this hauling technique as materials can each be hauled directly to the proper recycler.
- **Clean-up contractor.** This specialized service provider comes to the job site several times over the life of the project to collect, sort and haul off debris. Contractors usually pay more for this service, but it takes waste management off of their list of things to do and makes a sub-contractor responsible for the entire task. Clean-up contractors work best on new single-family residential developments of five houses or more.



## Disposal

Mixed dry waste (also known as limited-use) facilities accept loads of mixed paper, wood, metal, and glass for processing. They do not accept food or other organic waste. Some accept both source-separated recyclables and mixed dry waste. Mixed C&D trash is sorted for recycling by these facilities. On average, 25 to 30 percent of mixed dry waste loads are recovered for recycling at dry waste facilities.

In the metro region, the Enhanced Dry Waste Recovery Program (EDWRP) requires that all mixed dry waste be delivered to a Metro-authorized dirty MRF that will separate the waste into marketable components and that dirty MRFs must ensure that their processing residual contains no more than 15 percent of wood, metal and cardboard. Portland has additional requirements. For all building projects within the city where the total job cost (including both demolition and construction phases) exceeds \$50,000, the general contractor shall ensure that 75 percent of the construction waste produced on the job site is recycled.



Metro placed a suspension on the EDWRP requirements for wood recycling because of the closure of the WestRock paper mill in Newberg that used to burn 85% of the region's urban wood as boiler fuel. WestRock's closure means that painted and treated wood generated in the Metro region is now being disposed of. Two other, smaller paper mills in Washington continue to accept clean and unpainted/untreated wood from the Metro region as boiler fuel to produce steam and electricity.

As part of an effort to move wood waste up the waste hierarchy, Metro began a multi-phase project in 2014 to identify and develop Metro area alternative end-markets for wood waste. Likely first steps will include an increased focus on recovery of reusable wood pieces at Metro Transfer Stations.

To ensure the safety of customers and the public, Metro requires paperwork for all loads of construction, remodeling or demolition waste for materials that may contain asbestos. Loads of construction, remodeling and demolition debris brought to Metro transfer stations is thoroughly screened for materials that may contain asbestos. Find information about how to identify asbestos and protect yourself, your family and neighbors from it on the Department of Environmental Quality's website.

Construction projects will find that most facilities that traditionally take wood waste or construction and demolition materials will either refuse the material or require proof that it does not contain asbestos. Visit Metro's Find a Recycler (online) to get the latest information about what is accepted in your area.



Metro's programs, tools, and resources for the construction and demolition (C&D) sector build on 30 years of research, demonstration projects, infrastructure grants, education programs, and partnership work with the building industry and workforce development organizations. Current programs include:

### **Metro Construction Industry Partnership Project**

Metro partners with the region's construction industry associations and green building associations to encourage source separated recycling and building material salvage practices. This ongoing outreach effort has media, retail, and public project components all designed to support C&D waste reduction. (Surveys have shown that builders now look to Metro as a trusted source of information about recycling and that they are consistently using Metro's Toolkit and other resources to make decisions about waste and recycling.)

### **Metro Find a Recycler**

The on line Metro Find a Recycler includes providers of reused building materials, deconstruction services and construction debris recycling options. This resource is updated daily and lists over 100 recycling and reuse facilities that accept C&D materials.