Materials & Resources

Building materials choices are important in sustainable design because of the extensive network of extraction, processing and transportation steps required to process them. Activities to create building materials pollute the air and water, destroy natural habitats and deplete natural resources. Construction and demolition wastes constitute about 40% of the total solid waste stream in the United States.

One of the most effective strategies for minimizing the environmental impacts of material use is to reuse existing buildings. Rehabilitation of existing building shells and non-shell components reduces solid waste volumes and diverts these waste volumes from landfills. It also reduces environmental impacts associated with the production and delivery of new building products. Reuse of an existing building minimizes habitat disturbance and typically requires less infrastructure such as utilities and roads. An effective way to use salvaged non-shell components in new buildings is to specify these materials in construction documents.

When new materials are used in buildings, it is important to consider different sources. Salvaged materials can substitute for new materials, save on material costs and perhaps add character to the building. Recycled content materials reuse waste products that would otherwise be deposited in landfills. The use of local materials supports the local economy and reduces the impacts of transportation. The use of rapidly renewable materials and third-party certified wood minimizes the impact of natural resource consumption to manufacture new building materials.

Over the past decade or so, an increasing number of public and private waste management operations have begun to reduce construction debris volumes by recycling and reusing these materials. Recovery and recycling activities typically involve job site separation into multiple bins or disposal areas. These activities can also take place off-site if space is not available on the project site.

Overview of LEED™ Prerequisites and Credits

MR Prerequisite 1
Storage & Collection of Recyclables

MR Credit 1
Building Reuse

MR Credit 2
Construction Waste Management

MR Credit 3
Resource Reuse

MR Credit 4
Recycled Content

MR Credit 5
Local/Regional Materials

MR Credit 6
Rapidly Renewable Materials

MR Credit 7
Certified Wood

There are 13 points available for the Materials & Resources category.

Overview

Storage & Collection of Recyclables

SS | WE | EA | **MR** | EQ | ID

Prerequisite 1

Required

Intent

Facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills.

Requirements

Provide an easily accessible area that serves the entire building and is dedicated to the separation, collection and storage of materials for recycling including (at a minimum) paper, corrugated cardboard, glass, plastics and metals.

Submittals

- ❑ Provide the LEED Letter Template, signed by the architect or owner, declaring that the area dedicated to recycling is easily accessible and accommodates the building's recycling needs.
- ❑ Provide a plan showing the area(s) dedicated to recycled material collection and storage.

Summary of Referenced Standard

There is no standard referenced for this prerequisite.

Prerequisite 1

Synergies

SS Credit 2
Urban Redevelopment

SS Credit 5
Reduced Site Disturbance

MR Credit 1
Building Reuse

EQ Prerequisite 1
Minimum IAQ Performance

EQ Credit 5
Indoor Chemical & Pollutant Source Control

Green Building Concerns

Recycling has become an integral part of U.S. culture in the past two decades. Curbside recycling is now a standard service in many urban communities. Recycling is also becoming the norm in other parts of life. For instance, office workers recycle paper, airlines recycle aluminum cans, and manufacturing facilities recycle scrap materials such as steel, plastic and wood. The majority of U.S. population is inclined to recycle as long as the process is not too inconvenient or costly. **Table 1** provides an estimate of solid waste generation for various building types. Occupant recycling rates vary by building type.

As an example of the potential for occupant recycling, the waste stream of a large federal office building was analyzed before recycling efforts were employed. The average weight of waste per employee was 2.9 pounds per day. Many of the listed materials, if not all, could be recycled instead of landfilled. The results of the study are shown in **Table 2**.

The most effective method for promoting recycling activities is to create convenient opportunities for building occupants to recycle. This includes designating adequate space for recycling activities and storage of recyclable materials.

Environmental Issues

By creating convenient recycling opportunities for building occupants, a significant portion of the solid waste stream can be diverted from landfills. Recycling of paper, metals, cardboard and plastics reduces the need to extract virgin natural resources. For example, recycling one ton of paper prevents the processing of 17 trees and saves three cubic yards of landfill space. Recycled aluminum requires only 5% of the energy required to produce virgin aluminum from bauxite, its raw material. Recycling also reduces environmental impacts of waste in landfills. Land, water and air pollution impacts can all be reduced by minimizing waste volumes sent to landfills.

Economic Issues

Recycling requires minimal initial cost and offers significant savings in reduced landfill disposal costs or tipping fees. However, recycling activities use floor space that could be used otherwise. In larger buildings, processing equipment such as can crushers and cardboard balers are effective at minimizing the space required for recycling activities.

Table 1: Solid Waste Generation Rates

Building Type	Amount of Solid Waste
Warehouses	1.5 lbs / 100 SF /day
Office Buildings	1 lb / 100 SF / day
Department Stores	3 lbs / 100 SF / day
Supermarkets	7 lbs / 100 SF / day
Restaurants	2 lbs / 100 SF / day
Drugstores	3 lbs / 100 SF / day
Cafeterias	0.5 to 0.75 lbs / meal
Clubs	1.5 lbs / meal
Hotels	2 lbs / room / day & 2 lbs / meal
Schools	6 lbs / room & 0.25 lbs / student / day
Hospitals	20 lbs / bed / day & 2 lbs / meal
Nursing Homes	4 lbs / person / day

Source: International Dynetics Corporation

Table 2: Sample Office Waste Characterization

Recyclable Material	Percentage (by volume)
High-grade paper	39.6%
Low-grade paper	20.2%
Glass	11.8%
Miscellaneous paper	7.4%
Newsprint	7.0%
Food waste	2.9%
Cardboard	2.8%
Plastic	2.6%
Metal	1.8%
Other	3.9%

Community Issues

Many communities sponsor recycling programs to encourage building owners and occupants to reduce the amount of waste being deposited in landfills. Recycling efforts return valuable resources to the production process and provide more jobs versus landfilling. Some recyclables provide revenue, although often not enough to offset the cost of collection and processing. The cumulative effects reduce dependence on virgin resources whose extraction may destroy local and distant habitat areas. Higher recycling rates also result in more stable markets for recycled materials.

Design Approach

Strategies

In the design phase, designate well-marked collection and storage areas for recyclables including office paper, newspaper, cardboard, glass, metals and plastics. Locate a central collection and storage area in the basement or on the ground level with easy access for collection vehicles. Size the collection and storage space to accommodate recyclables storage. Research local recycling efforts to find the best method of diverting recyclable materials from the waste stream.

Provide instruction to occupants and maintenance personnel on recycling procedures. Encourage activities to reduce and reuse materials before recycling in order to reduce the amount of recyclable volumes handled. For instance, building occupants can reduce the solid waste stream by using reusable bottles, bags and other containers.

The City of Seattle passed an ordinance to require minimum areas for recycling and storage of recyclables in commercial buildings. The ordinance is based on the total square footage of the building. Minimum areas for residential buildings were also specified. **Table 3** can be used as a guideline to size your recycling area. Note that LEED does not require adherence to these guidelines.

Technologies

In addition to providing sufficient and accessible space for recycling, other devices may further facilitate recycling efforts. These include, but are not limited to, cardboard balers, aluminum can crushers and recycling chutes.

Synergies and Trade-Offs

Dense urban areas typically have recycling infrastructure in place, but additional space for collection and storage may be costly. It is possible that recyclable collection and storage space could increase the building footprint in some instances. It is important to address possible indoor environmental quality (IEQ) impacts on building occupants due to recycling activities. Those activities that create odors, noise and air contaminants should be iso-

Table 3: Recycling Area Guidelines

Commercial Building Square Footage [SF]	Minimum Recycling Area [SF]
0 to 5,000	82
5,001 to 15,000	125
15,001 to 50,000	175
50,001 - 100,000	225
100,001 - 200,000	275
200,001 or more	500

lated or performed during non-occupant hours to maintain optimal IEQ.

Resources

Web Sites

Business Resource Efficiency and Waste Reduction

www.ciwmb.ca.gov/bizwaste, (916) 341-6615

A program from the California Integrated Waste Management Board to assist in office recycling and waste reduction efforts.

Earth's 911

www.1800cleanup.org, (602) 224-5444

Information and education programs on recycling as well as regional links to recyclers.

Recycling at Work

www.usmayors.org/USCM/recycle, (202) 293-7330

A program of the U.S. Conference of Mayors that provides information on workplace recycling efforts.

Waste at Work

www.informinc.org/wasteatwork, (212) 788-7900

An online document from Inform, Inc., and the Council on the Environment of New York City on strategies and case studies to reduce workplace waste generation.

Print Media

Composting and Recycling Municipal Solid Waste by Luis Diaz et al., CRC Press, 1993.

McGraw-Hill Recycling Handbook by Herb Lund, McGraw-Hill, 2000.

Definitions

Recycling is the collection, reprocessing, marketing and use of materials that were diverted or recovered from the solid waste stream.

A **Landfill** is a waste disposal site for the deposit of solid waste from human activities.

SS | WE | EA | MR | EQ | ID

Credit 1.1

Building Reuse

Maintain 75% of Existing Walls, Floors and Roof

1 point

Intent

Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements

Maintain at least 75% of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material).

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, listing the retained elements and declaring that the credit requirements have been met.

Building Reuse

1 point
in addition to
MR 1.1

Maintain 100% of Existing Walls, Floors and Roof

Intent

Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements

Maintain an additional 25% (100% total) of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material).

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, demonstrating the retained elements and declaring that the credit requirements have been met.

Building Reuse

SS | WE | EA | **MR** | EQ | ID

Credit 1.3

1 point
in addition to
MR 1.1 & 1.2

Maintain 100% of Shell/Structure and 50% of Non-Shell/Non-Structure

Intent

Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements

Maintain 100% of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material) AND at least 50% of non-shell areas (interior walls, doors, floor coverings and ceiling systems).

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, demonstrating the retained elements and declaring that the credit requirements have been met.

Summary of Referenced Standard

There is no standard referenced for these credits.

Credit 1

Credit Synergies

SS Credit 4
Alternative Transportation

SS Credit 5
Reduced Site Disturbance

SS Credit 6
Stormwater Management

SS Credit 7
Landscape & Exterior Design to Reduce Heat Islands

SS Credit 8
Light Pollution Reduction

WE Credit 1
Water Efficient Landscaping

WE Credit 2
Innovative Wastewater Treatment

WE Credit 3
Water Use Reduction

EA Prerequisite 2
Minimum Energy Performance

EA Prerequisite 3
CFC Reduction in HVAC&R Equipment

EA Credit 1
Optimize Energy Performance

EA Credit 4
Ozone Depletion

MR Prerequisite 1
Storage & Collection of Recyclables

MR Credit 2
Construction Waste Management

EQ Credit 5
Indoor Chemical & Pollutant Source Control

EQ Credit 6
Controllability of Systems

EQ Credit 8
Daylight & Views

Green Building Concerns

Many opportunities exist to rehabilitate existing buildings. Commercial real estate companies often rehabilitate old industrial buildings to take advantage of prime location, lower building costs and desirable building characteristics.

Environmental Issues

Reusing the building shell and non-shell components of an existing building significantly reduces construction waste volumes leaving the project site. Reuse strategies also reduce environmental impacts associated with raw material extraction, manufacture and transportation of new or recycled materials. Building reuse minimizes habitat disturbance associated with developing on a greenfield site and typically requires less new infrastructure development for utilities and roads.

Economic Issues

Reuse of an existing structural shell depends on many factors including structural and material integrity, building code compliance, fire and safety compliance, adaptability to the new building program, possible contamination issues, and energy and environmentally efficient retrofit considerations. A critical review of all these elements is necessary to determine the advantages of reuse versus demolition.

Reuse of an existing building can reduce the first costs of building substantially. For instance, the Southern California Gas Company reused an existing building for its Energy Resource Center and estimated a savings of approximately $3.2 million, based on typical first costs for a 44,000-square-foot building. The largest savings were realized in masonry (87% savings), site work (57% savings), concrete (49% savings) and carpentry (70% savings).

Community Issues

The character of a neighborhood is often defined by existing historic buildings. Building reuse maintains the vital link between neighborhoods of the past and present. Building reuse can often shorten construction periods and reduce noise and traffic disruptions in the neighborhood.

Design Approach

Strategies

Research the potential reuse of an existing building's structural shell in the early design phase of the project and create a list of benefits and drawbacks of such a scheme. Determine if programming and space planning can be accommodated in the existing building structure. If reuse of the structural shell is not possible, consider preserving the facade, particularly in urban areas.

The building envelope has a significant impact on energy performance and operational costs over the lifetime of the building. Evaluate the building's structural integrity and skin, functional suitability, code compliance, historic and cultural significance, and adaptability. In addition, consider the environmental attributes of the building, surrounding site and structural shell. Examples of environmental attributes include solar benefits or drawbacks, transportation access, existing air quality levels, and the possibility for upgrading outdated building components such as insulation and glazing. Identify asbestos, lead-based paint and other contaminants in the building and apply required or appropriate removal or isolation measures.

Technologies

Consider upgrading outdated components with new components that can enhance energy efficiency, water efficiency and indoor environmental quality. Building systems to consider for upgrade include HVAC systems, plumbing systems, insulation and windows.

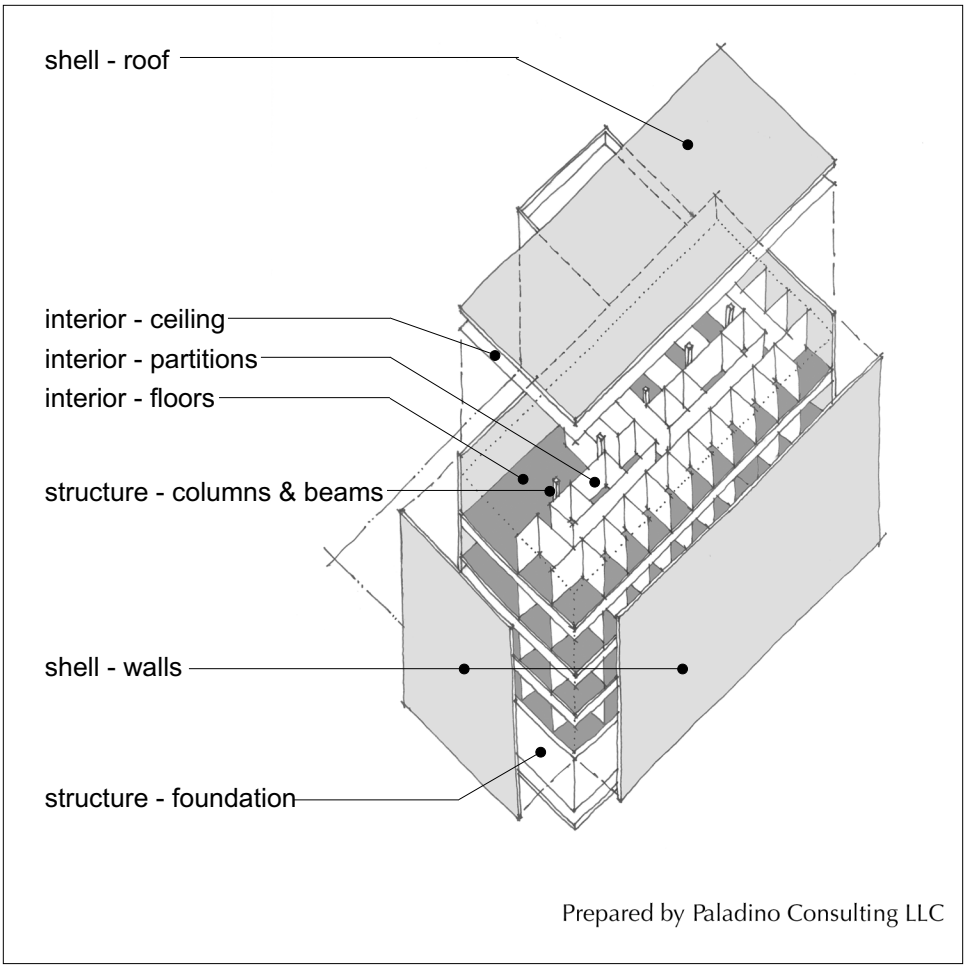

Figure 1: Example Reuse of Building

Synergies and Trade-Offs

The location of the existing building determines the neighborhood density, brownfield status and transportation options. Site amenities may or may not exist for stormwater control and site lighting. Preserved site surfaces such as roofs and parking lots may contribute to urban heat island effects. The existing plumbing and irrigation systems may not have the flexibility to allow for potable water use reduction, wastewater generation reduction, and stormwater reuse.

The energy performance of buildings is highly dependent on the building envelope and HVAC and lighting systems. For instance, an existing building with minimal insulation will tend to exhibit lower energy performance than a new building with state-of-art wall construction. The existing building orientation may preclude the use of passive solar gains or may lack shading devices to prevent unwanted solar gain and glare.

Reusing a building also reduces the amount of solid waste leaving the project site. Thus, building elements qualifying for this credit can also be applied to MR Credit 2: Construction Waste Management. If a portion of a building's structure, shell or non-shell components are reused but this effort does not meet the minimum levels as stated in this credit, apply these reuse activities to MR Credit 2.

Existing buildings may have space constraints and may not be able to provide ad-

equate space for occupant recycling activities and separation of chemical storage areas. Older buildings may contain contaminants such as asbestos and lead-based paint that can affect indoor air quality. Their systems may also contain HCFs and halons that are detrimental to the Earth's atmosphere. Daylighting and occupant control strategies may be difficult to implement in the existing building's layout.

Calculations

The following calculation methodology is used to support the credit submittals listed on the first page of this credit. In order to qualify for this point, the existing building must undergo a substantial renovation. If the project includes an addition that is greater than 50% of the existing building's square footage, it is considered a new building and is thus ineligible for the building reuse credit. In such cases, the reused building materials should be included as part of MR Credit 2.

To calculate the percentage of reused building structure, consider structural elements such as footings, slabs on grade, stem walls, columns, beams, exterior wall sections and diaphragms, as well as shell elements such as brick cladding, roofing and siding (see **Equations 1** and **2**).

Quantify structural elements in terms of cubic feet (CF) and shell elements in terms of square feet (SF). Do not include doors and similar elements. (Apply the environmental benefits of reusing these elements to MR Credit 2: Construction Waste Management.) If an item that cannot be reused for its original function is reprocessed (on or off the site) and installed for a different use, it can be counted toward MR Credit 3: Resource Reuse. Wood beams that are remilled for a similar use, for instance, would be applicable to this credit. Demolished concrete that is crushed on site for use as structural fill would also be applicable to MR Credit 3.

Once the structural and shell reuse percentages have been determined, add these two percentages together and divide by two to obtain the approximate percentage of the total building that is being reused (see **Equation 3**).

To calculate the percentage of reused non-shell building portions, consider all walls, doors, floor coverings and ceiling systems. Quantify the elements in terms of square feet and divide the reused elements by the existing total square footage of walls, doors, floor coverings and ceiling systems to obtain the percentage of reused non-shell building elements (see **Equation 4**).

Tables 1, **2** and **3** summarize an example building reuse project where both structural elements as well as non-shell (i.e., interior) elements were reused. The

Equation 1:

$$\text{Structural Reuse } [\%] = \frac{\text{Reused Elements [CF]}}{\text{Total Elements [CF]}}$$

Equation 2:

$$\text{Shell Reuse } [\%] = \frac{\text{Reused Elements [SF]}}{\text{Total Elements [SF]}}$$

Equation 3:

$$\text{Building Reuse } [\%] = \frac{(\text{Structural Reuse } [\%] + \text{Shell Reuse } [\%])}{2}$$

Equation 4:

$$\text{Non–Shell Reuse } [\%] = \frac{\text{Reused Elements [SF]}}{\text{Total Elements [SF]}}$$

spreadsheet indicates that 100% of the structure and exterior shell was reused and 56% of the non-shell interior components were reused. This qualifies for three points under this credit.

Resources

Web Sites

Sustainable Communities Network Case Studies
www.smartgrowth.org/library/typelist.asp, (202) 328-8160

Several deconstruction and reuse case studies.

Table 1: Structural Elements Reuse Example

Structural Element	Existing [CF]	Reused [CF]	Percentage Reused [%]
Foundation / Slab on Grade	11,520	11,520	100%
Columns	500	500	100%
Beams	250	250	100%
Basement Wall	500	500	100%
Floor Decks	250	250	100%
Diaphragms	1,507	1,507	100%
Roof Deck	1,507	1,507	100%
TOTALS	**16,034**	**16,034**	**100%**

Table 2: Shell Elements Reuse Example

Shell Element	Existing [SF]	Reused [SF]	Percentage Reused [%]
Roofing	1,000	1,000	100%
North Exterior Wall	8,235	8,235	100%
East Exterior Wall	6,950	6,950	100%
South Exterior Wall	8,235	8,235	100%
West Exterior Wall	6,950	6,950	100%
TOTAL	**31,370**	**31,370**	**100%**

Table 3: Interior Elements Reuse Example

Interior Element	Existing [SF]	Reused [SF]	Percentage Reused [%]
Ceilings	40,000	0	0%
Wood Flooring	40,000	40,000	100%
Other Flooring	500	250	50%
Floor Coverings	500	250	50%
Walls	500	250	50%
Wall Panels	29,600	18,800	64%
Other	29,600	18,800	64%
TOTAL	**140,700**	**78,350**	**56%**

SS | WE | EA | MR | EQ | ID

Credit 1

Print Media

Adaptive Reuse: Issues and Case Studies in Building Preservation by Richard Austin and David Woodstock, Van Nostrand Reinhold Company, 1987.

Case Study

KSBA Architects Office Building
Pittsburgh, Pennsylvania

The KSBA Architects office building is a LEED™ Certified Pilot Project located in the Lawrenceville section of Pittsburgh. The entire shell of the 1888 building was reused as well as 90% of interior millwork. New components were installed to update the interior spaces, including a raised access floor with HVAC and modular cabling, indirect lighting and ergonomics. The building now serves as a state-of-the-art information and technology headquarters for an architectural firm.

Courtesy of KSBA Architects

Owner
KSBA Architects

Construction Waste Management

Divert 50% From Landfill

1 point

Intent

Divert construction, demolition and land clearing debris from landfill disposal. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites.

Requirements

Develop and implement a waste management plan, quantifying material diversion goals. Recycle and/or salvage at least 50% of construction, demolition and land clearing waste. Calculations can be done by weight or volume, but must be consistent throughout.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, tabulating the total waste material, quantities diverted and the means by which diverted, and declaring that the credit requirements have been met.

Construction Waste Management

1 point
in addition to
MR 2.1

Divert 75% From Landfill

Intent

Divert construction, demolition and land clearing debris from landfill disposal. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites.

Requirements

Develop and implement a waste management plan, quantifying material diversion goals. Recycle and/or salvage an additional 25% (75% total) of construction, demolition and land clearing waste. Calculations can be done by weight or volume, but must be consistent throughout.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, tabulating the total waste material, quantities diverted and the means by which diverted, and declaring that the credit requirements have been met.

Summary of Referenced Standard

There is no standard referenced for this credit.

Green Building Concerns

Construction and demolition (C&D) activities generate enormous quantities of solid waste. The U.S. EPA estimates that 136 million tons of C&D debris (versus 209.7 million tons of municipal solid waste) was generated in 1996—57% of it from non-residential construction, renovation and demolition activities. This equates to 2.8 pounds per capita per day.

Commercial construction generates between 2 and 2.5 pounds of solid waste per square foot, and the majority of this waste can potentially be recycled. The City of Portland, Oregon, has instituted programs to reduce solid waste generation and promote recyclable material markets. In 1993, the city was successful in diverting 47% of all construction and demolition waste from landfills. In one project, 76% of the waste from the construction of a 5,000-square-foot restaurant was diverted from landfilling (61% was recyclable or reusable wood, 11% was cardboard, and 4% was gypsum wallboard).

Recycling opportunities are expanding rapidly in many communities. Metal, vegetation, concrete and asphalt recycling opportunities have long been available and economical in most communities. Paper, corrugated cardboard, plastics and clean wood markets vary by regional and local recycling infrastructure, but are recycled in most communities. Some materials, such as gypsum wallboard, have recycling opportunities only in communities where reprocessing plants exist. The recyclability of a demolished material is often dependant on the amount of contamination attached to it. Demolished wood, for instance, is often not reusable or recyclable unless it is deconstructed and de-nailed.

A construction and demolition debris study conducted during one week in 1994 in Des Moines, Iowa is presented in **Table 1**. Data include debris from construction, renovation and demolition activities. While this example is a potential scenario, it should be noted that the composition of C&D debris is highly variable and depends on the geographic location and type of activity. Cardboard, for instance, is more prevalent during construction activities.

Environmental Issues

Recycling of construction and demolition debris reduces demand for virgin resources, and, in turn, reduces the environmental impacts associated with resource extraction, processing and, in many cases, transportation. Landfills contaminate groundwater and encroach upon valuable green space. Through effective construction waste management, it is possible to extend the lifetime of existing landfills, avoiding the need for expansion or new landfill sites.

Economic Issues

In the past, when landfill capacity was readily available and disposal fees were low, recycling or reuse of construction waste was not economically feasible. Construction materials were inexpensive compared to the cost of labor and, thus, construction jobsite managers focused on

Table 1: CDL Waste Stream Characterizations

Material	Percentage (by volume)
Concrete	28.8
Wood	20.6
Drywall	14.0
Metal	11.2
Roofing	7.7
Brick	6.2
Cardboard	3.5
Miscellaneous	8.0

Adapted from Brickner, Robert, GB&B Inc., "Identifying C&D Debris Markets." Scrap Processing, March/April 1995.

Credit Synergies

SS Credit 2
Urban Redevelopment

SS Credit 3
Brownfield Redevelopment

MR Credit 1
Building Reuse

EQ Credit 3
Construction IAQ Management Plan

worker productivity rather than materials conservation. In addition, recycling infrastructure and materials marketplaces to process and resell construction debris did not exist. In recent years, increased materials and disposal costs coupled with more stringent waste disposal regulations and decreasing landfill capacity have changed the waste management equation. Local government agencies and private organizations have partnered with the industry to support construction waste management by publishing guides, directories and other educational materials; presenting recycling information at seminars and workshops; and operating pilot projects to demonstrate the feasibility and cost-effectiveness of these activities.

Waste management plans require time and money to draft and implement but they can guide a project to achieve substantial savings throughout the construction process. Projects that recycle construction and demolition debris benefit from lower tipping fees.

As landfill tipping fees continue to escalate, the option to recycle becomes more economically attractive. As a rule of thumb, when landfill tipping fees exceed $50 per ton, recycling becomes cost-effective. Local governments sometimes inflate tipping fees artificially to encourage greater recycling efforts.

Recyclable materials have differing market values depending on the presence of local recycling facilities, reprocessing costs and the availability of virgin materials on the market. In general, it is economically beneficial to recycle metals, concrete, asphalt and cardboard—to receive revenue as well as to avoid paying a landfill tipping fee. Market values normally fluctuate from month to month. When no revenue is received for materials—often the case for scrap wood and gypsum wallboard—smaller rewards can come from possibly shorter hauling distances and avoiding landfill tipping fees.

Some materials can be reprocessed and reused on site. For instance, grinding demolished concrete for use as structural fill can provide excellent savings versus hauling debris away and purchasing gravel.

Community Issues

The conventional approach to construction waste is to remove all wastes from the site and start with a "clean slate." In recent years, construction waste strategies have dictated more thoughtful planning and scheduling of solid waste streams. Reusing existing structures and deconstructed materials on-site can reduce disruption to the community by minimizing truck traffic. Recycling supports local processing facilities, creates jobs and reduces the need for additional landfill capacity. Salvage may include the donation of materials to charitable organizations such as Habitat for Humanity.

Table 2: Construction Materials Being Recycled

Materials	
Land clearing debris	Asphalt shingles
Clean dimensional wood	Paint
Plywood, OSB, & particle board	Window glass
Concrete	Carpet & carpet pad
Asphaltic concrete	Plastic film
Concrete masonry units (CMUs)	Polystyrene
Bricks	High density polyethylene (HDPE)
Gysum wallboard	Cardboard, paper, & packaging
Rigid foam insulation	

Design Approach

Strategies

Minimize factors that contribute to waste such as over-packaging, improper storage, ordering errors, poor planning, breakage, mishandling, and contamination of construction materials. For waste volumes generated, identify and institute reuse, salvage and recycle opportunities whenever economics and logistics allow. **Table 2** is a list of materials that are being recycled in various places around the United States.

Develop and institute a construction waste management plan that identifies proposed deconstruction and salvage opportunities, on-site reprocessing and reuse opportunities, recommended recycling activities, licensed haulers and processors of recyclables, and potential markets for salvaged materials. The plan should include estimated costs associated with recycling, salvaging and reusing materials and should also address source reduction of materials use.

On the construction site, designate an area specifically for construction and demolition waste recycling. Train site workers on the proper recycling protocol and label recyclable containers effectively. Institute monthly reporting and feedback on the waste management plan to assess progress and address any problems. Post this information for all construction personnel to read. Provide signs in the native language(s) of the workers.

Synergies and Trade-Offs

Project sites in urban areas may have little or no space available for waste separation activities. Recycling areas should be chosen wisely to avoid contaminating stormwater runoff volumes and to protect stockpiled recyclable materials from the elements.

If the project is reusing a building, the materials preserved can be applied to this credit as well as to MR Credit 1. The waste management plan should address construction area housekeeping to avoid the contamination of the building and subsequent impacts on indoor air quality.

Materials included in MR Credits 3, 4, 5, 6 and 7 cannot be applied to this credit.

Calculations

The following calculation methodology is used to support the credit submittals listed on the first page of this credit. Use a spreadsheet to track the weights of construction wastes that are landfilled and the weight of construction, demolition and land clearing (CDL) wastes that are recycled. To calculate the recycling percentage, use **Equation 1**. Calculations can be done by weight or volume, but must be consistent throughout. Do not include hazardous waste and excavation soil in the calculations.

Tables 3 and **4** demonstrate waste calculations for an example project. The project recycled concrete, steel, wood, cardboard, gypsum wallboard, masonry and land clearing debris. An estimated 245.5 tons of waste were recycled while 43.7 tons were sent to the landfill. This results in a recycling rate of 85%, which qualifies for two points under this credit.

Typically, waste containers are sized by volume and these volumes are weighed at the materials recovery facility or landfill. To assist in calculations, **Table 5** provides estimates to convert waste materials from volume to weight.

Equation 1:

$$\text{Recycling Rate } [\%] = \frac{\text{Recycled Waste}}{\text{Recycled Waste} + \text{Garbage}}$$

Table 3: Recycled Materials Example

Recycled and Salvaged Materials	Weight [tons]
Concrete	138.0
Land Clearing Debris	56.2
Wood	19.6
Gypsum Wallboard	9.5
Masonry	9.4
Cardboard	7.2
Steel	3.1
Furniture	2.5
TOTAL	**245.5**

Table 4: Landfills Materials Example

Garbage	Weight [tons]
Miscellaneous Garbage	43.7
TOTAL	**43.7**

Table 5: Solid Waste Conversion Factors

Material	Density [lbs/CY]
Cardboard	100
Gypsum Wallboard	500
Mixed Waste	350
Rubble	1,400
Steel	1,000
Wood	300

Resources

Web Sites

Construction and Demolition Waste Recycling Information

www.ciwmb.ca.gov/ConDemo, (916) 341-6499

A program by the California Integrated Waste Management Board including case studies, fact sheets and links.

Construction Materials Recycling Association

www.cdrecycling.org

A nonprofit dedicated to information exchange within the North American construction waste and demolition debris processing and recycling industry.

Construction Waste Management Handbook

www.smartgrowth.org/library/articles.asp?art=15, (202) 328-8160

A report by the NAHB Research Center on residential construction waste management for a housing development in Homestead, Florida.

Contractors' Guide to Preventing Waste and Recycling

www.resourceventure.org/publications.htm, (206) 389-7304

A guidebook on waste prevention in construction from the Business and Industry Resource Venture.

Government Resources

Check with the solid waste and natural resources departments in your city or county. Many local governments provide information about regional recycling opportunities.

Recycling and Waste Management During Construction

www.metrokc.gov/procure/green/wastemgt.htm

Specification language from City of Seattle and Portland Metro projects on construction waste management.

Sustainable Building Sourcebook

www.greenbuilder.com/sourcebook/ConstructionWaste.html

A guide to construction waste management from the *Sustainable Building Sourcebook*.

U.S. EPA – Environmental Specifications for Research Triangle Park

www.epa.gov/rtp/new-bldg/environmental/specs.htm, (919) 541-0249

Waste management and other specifications.

Waste Spec: Model Specifications for Construction Waste Reduction, Reuse and Recycling

www.tjcog.dst.nc.us/cdwaste.htm, (919) 558-9343

Model specifications developed by Triangle J Council of Governments in North Carolina. Ten case studies show results of using the specifications.

Definitions

Construction, demolition and land clearing (CDL) debris includes waste and recyclables generated from construction, land clearing (e.g., vegetation, but not soil), renovation, and demolition or deconstruction of pre-existing structures.

Recycling is the collection, reprocessing, marketing and use of materials that were diverted or recovered from the solid waste stream.

Reuse is a strategy to return materials to active use in the same or a related capacity.

Tipping Fees are fees charged by a landfill for disposal of waste volumes. The fee is typically quoted for one ton of waste.

Case Study

The Aspen Skiing Company Sundeck Restaurant
Aspen, Colorado

The Aspen Skiing Company Sundeck Restaurant is a LEED™ Bronze Pilot Project that is located atop Aspen Mountain. The project team adopted a construction waste management plan and instituted rigorous "grass roots" construction waste management efforts that resulted in the diversion of 84% of construction waste materials from the landfill. The existing building was deconstructed, and beams, doors, fixtures, appliances, furniture and other valuable items were sold at a yard sale. Steel was segregated from the construction waste stream and recycled. Wood and gypsum wallboard were ground on-site and reused as compost. Finally, the existing foundation was processed on-site and reused as fill material. Overall, these measures significantly reduced hauling trips to the landfill and resulted in project savings of $35,000.

Courtesy of The Aspen Skiing Company

Owner
The Aspen Skiing Company

Credit 2

Resource Reuse

Credit 3.1

5%

1 point

Intent

Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources.

Requirements

Use salvaged, refurbished or reused materials, products and furnishings for at least 5% of building materials.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, declaring that the credit requirements have been met and listing each material or product used to meet the credit. Include details demonstrating that the project incorporates the required percentage of reused materials and products and showing their costs and the total cost of materials for the project.

Credit 3.2

Resource Reuse

10%

1 point
in addition to
MR 3.1

Intent

Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources.

Requirements

Use salvaged, refurbished or reused materials, products and furnishings for at least 10% of building materials.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, declaring that the credit requirements have been met and listing each material or product used to meet the credit. Include details demonstrating that the project incorporates the required percentage of reused materials and products and showing their costs and the total cost of all materials for the project.

Summary of Referenced Standard

There is no standard referenced for this credit.

Green Building Concerns

Use of salvaged and refurbished materials in new building projects extends the life of materials and can reduce overall first costs of construction materials. Use of salvaged materials can also add character to the building and can be used effectively as architectural details. Some areas of the United States, such as New England, the Pacific Northwest, and California, have well-developed markets for salvaged materials while other regions are just beginning to develop these markets.

Environmental Issues

Reuse strategies divert material from the construction waste stream, reducing the need for landfill space and the associated water and air contamination issues. Use of salvaged materials eliminates environmental impacts of producing new construction and product materials. These impacts are significant since buildings account for a large portion of our use of natural resources, including 40% of raw stone, gravel and sand, and 25% of virgin wood.

Economic Issues

Some salvaged materials are more costly than new materials due to the high cost of labor involved in recovering and refurbishing processes. However, salvaged materials are often of higher quality and more durable than available new materials. Local demolition companies may be willing to sell materials recovered from existing buildings to avoid landfill tipping fees and to generate income. In some areas, municipalities and waste management companies have established facilities to sell salvaged building material sales at landfill sites.

Sometimes salvaged materials are offered at prices that appear to be cost-effective but may include hidden costs such as the need for reprocessing, exorbitant transportation costs or liabilities associated with toxic contamination.

Conversely, certain salvaged materials may be impossible to duplicate (such as turn-of-the century lumber and casework) and may well be worth the higher cost compared to new but inferior materials.

Community Issues

By reusing locally obtained salvaged materials, local salvage businesses are supported. Also, saving landfill capacity benefits the community through lower tipping fees and fewer landfill sites overall.

Design Approach

Strategies

Develop a reuse strategy early in the schematic design phase to incorporate salvaged and refurbished building materials and set salvaged materials goals. For instance, state that a minimum of 50% of all floor surfaces will be salvaged. Identify local sources for salvaged or refurbished building materials and products. It may be helpful to create and maintain a current list of the salvage material suppliers to use on other projects.

Commonly salvaged or refurbished building materials and products include structural elements such as beams and posts, wood flooring, wood paneling, doors and frames, cabinetry and furniture, brick and other masonry products, and decorative items such as mantels, ironwork and antique light fixtures. Research all salvaged and refurbished materials for durability, performance, code compliance and environmental considerations. Do not consider items that generally should not be salvaged and reused, such as toilets (older models consume more water) and windows (older styles are less energy efficient).

When considering salvaged structural materials such as heavy timbers, it is imperative to check for structural integrity, code compliance and engineered rating to comply with building codes for structural re-

Credit 3

Credit Synergies

SS Credit 2
Urban Redevelopment

SS Credit 3
Brownfield Redevelopment

MR Credit 1
Building Reuse

MR Credit 5
Local/Regional Materials

quirements. Also investigate salvaged materials for possible contamination by lead paint, asbestos, pesticides and rot.

Synergies and Trade-Offs

The availability of salvaged materials will depend on the location of the project site. Building projects in urban areas often have many opportunities to use salvaged materials. These materials can be applied to MR Credit 5 if the materials comply with the requirements of the credit. Salvaged materials cannot be applied to MR Credits 1, 2, 4, 6 and 7.

A material salvaged during a building renovation can be applied to this credit only if it can no longer serve its original function and has been reprocessed and installed for a different use. Materials that will be reinstalled to serve in their original function must be applied to MR Credit 1.3, Building Reuse. On a project site where an existing building is being demolished or deconstructed, the material that is salvaged on-site and installed in the new building can be used to comply with this credit.

Calculations

The following calculation methodology is used to support the credit submittals listed on the first page of this credit. To calculate the percentage of salvaged materials used on a project, use the LEED Letter Template's spreadsheet to list all materials and products used on the project and their associated costs. Identify those building materials that are salvaged and use **Equation 1** to determine the salvage percentage for the project.

The salvaged or refurbished status of each material must be validated by a statement from the provider of that material, in case this credit is audited. If major mechanical, plumbing and/or electrical components are part of the salvaged materials contributing to credit compliance, then add mechanical, plumbing and/or electrical material costs in the calculation (numerator and denominator). If the cost of the salvaged or refurbished material is below market value, use replacement cost to estimate the material value. For example, if reclaimed plywood is used in the project at a cost of $15 per sheet and new plywood costs $25 per sheet, use the new cost in salvage and reuse calculations.

A sample calculation for salvaged building materials is presented in **Table 1**. Salvaged materials in this example include brick and reclaimed wood. The material costs of these items are totaled and divided by the total material cost for the project. The total materials cost figure may be derived from a default calculation (45% of total construction cost) or a tally of actual material costs. The sample project has chosen the latter. The resulting percentage of 5.68% qualifies for one point under this credit.

Resources

Web Sites

California Materials Exchange

www.ciwmb.ca.gov/CalMAX, (877) 520-9703

A program of the California Integrated Waste Management Board, this exchange allows users to exchange waste items online.

Government Resources

Check with the solid waste and natural resources departments in your city or county. Many local governments provide information about regional materials exchanges and other sources.

Equation 1:

$$\text{Salvage Rate } [\%] = \frac{\text{Salvaged Materials Cost } [\$]}{\text{Total Materials Cost } [\$]}$$

Guide to Resource-Efficient Building Elements

www.crbt.org, (406) 549-7678

The Center for Resourceful Building Technology's directory of environmentally responsible building products. This resource provides introductory discussions per topic and contact information for specific products, including salvaged materials.

Materials Exchanges on the Web

www.metrokc.gov/hazwaste/imex/exchanges.html, (206) 296-4899

A listing of materials exchanges on the Web.

Reuse Development Organization (ReDO)

www.redo.org, (317) 631-5395

A national nonprofit located in Indianapolis, Indiana, that promotes reuse as an environmentally sound, socially beneficial and economical means of managing surplus and discarded materials. See the List of ReDO Subscribers for contacts around the United States.

Salvaged Building Materials Exchange

www.greenguide.com/exchange/search.html

A searchable database of salvaged building materials.

Used Building Materials Association

www.ubma.org, (877) 221-UBMA

UBMA is a nonprofit, membership-based organization that represents companies and organizations involved in the acquisition and/or redistribution of used building materials.

Used Building Materials Exchange

www.build.recycle.net, (519) 767-2913

A free marketplace for buying and selling recyclables and salvaged materials.

Definitions

Chain-of-Custody is a tracking procedure to document the status of a product from the point of harvest or extraction to the ultimate consumer end use.

Salvaged Materials are construction materials recovered from existing buildings or construction sites and reused in other buildings. Common salvaged materials include structural beams and posts, flooring, doors, cabinetry, brick and decorative items. See the Synergies section for more LEED-related details.

Table 1: Letter Template Spreadsheet Example for Resource Reuse

Provide total construction cost for 45% default total materials value; OR Provide total materials cost (exclude labor, equipment)	$ 2,879,744	
Product Name	**Company Name**	**Product Cost**
Brick (salvaged)	Salvage Company	$ 33,700
Reclaimed Wood	Salvage Company	$ 130,000
	Sub-total salvaged or reused	**$ 163,700**
	Salvaged and reused materials as a percentage of total materials cost	**5.68%**

Case Study

Philips Eco-Enterprise Center
Minneapolis, Minnesota

The Phillips Eco-Enterprise Center is a mixed-use building that houses environmental and energy efficiency organizations, consultants and manufacturers. The building incorporates many reused building materials such as bricks, sinks, fire extinguisher cabinets, furniture, doors and windows. In addition, the structural members of the building consist of 189 reused steel joists from a demolished warehouse. Reuse of these joists saved an estimated 50 tons of steel and 110 million BTUs of energy that would have been needed for the building design. Finally, the building was designed for disassembly in the future. For example, the fire exit stair tower was designed to be disassembled, moved and reassembled. Also, the high-bay manufacturing space was designed for conversion to two floors of office space if needed by future tenants.

Owner
The Green Institute

Recycled Content

1 point

5% (post-consumer + 1/2 post-industrial)

Intent

Increase demand for building products that incorporate recycled content materials, therefore reducing impacts resulting from extraction and processing of new virgin materials.

Requirements

Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 5% of the total value of the materials in the project.

The value of the recycled content portion of a material or furnishing shall be determined by dividing the weight of recycled content in the item by the total weight of all material in the item, then multiplying the resulting percentage by the total value of the item.

Mechanical and electrical components shall not be included in this calculation. Recycled content materials shall be defined in accordance with the Federal Trade Commission document, *Guides for the Use of Environmental Marketing Claims, 16 CFR 260.7 (e)*, available at www.ftc.gov/bcp/grnrule/guides980427.htm.

Potential Technologies & Strategies

Establish a project goal for recycled content materials and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed and quantify the total percentage of recycled content materials installed.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, declaring that the credit requirements have been met and listing the recycled content products used. Include details demonstrating that the project incorporates the required percentage of recycled content materials and products and showing their cost and percentage(s) of post-consumer and/or post-industrial content, and the total cost of all materials for the project.

Recycled Content

1 point
in addition to
MR 4.1

10% (post-consumer + 1/2 post-industrial)

Intent

Increase demand for building products that incorporate/have incorporated recycled content materials, therefore reducing the impacts resulting from extraction and processing of new virgin materials.

Requirements

Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

The value of the recycled content portion of a material or furnishing shall be determined by dividing the weight of recycled content in the item by the total weight of all material in the item, then multiplying the resulting percentage by the total value of the item.

Mechanical and electrical components shall not be included in this calculation. Recycled content materials shall be defined in accordance with the Federal Trade Commission document, *Guides for the Use of Environmental Marketing Claims, 16 CFR 260.7 (e)*, available at www.ftc.gov/bcp/grnrule/guides980427.htm.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, declaring that the credit requirements have been met and listing the recycled content products used. Include details demonstrating that the project incorporates the required percentage of recycled content materials and products and showing their cost and percentage(s) of post-consumer and/or post-industrial content, and the total cost of all materials for the project.

Summary of Referenced Standard

FTC Guides for the Use of Environmental Marketing Claims, 16 CFR 260.7 (e)

www.ftc.gov/bcp/grnrule/guides980427.htm

According to the guide: "A recycled content claim may be made only for materials that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process (pre-consumer), or after consumer use (post-consumer). To the extent the source of recycled content includes pre-consumer material, the manufacturer or advertiser must have substantiation for concluding that the pre-consumer material would otherwise have entered the solid waste stream. In asserting a recycled content claim, distinctions may be made between pre-consumer and post-consumer materials. Where such distinctions are asserted, any express or implied claim about the specific pre-consumer or post-consumer content of a product or package must be substantiated.

"It is deceptive to misrepresent, directly or by implication, that a product or package is made of recycled material, which includes recycled raw material, as well as used, reconditioned and remanufactured components. Unqualified claims of recycled content may be made if the entire product or package, excluding minor, incidental components, is made from recycled material. For products or packages that are only partially made of recycled material, a recycled claim should be adequately qualified to avoid consumer deception about the amount, by weight, of recycled content in the finished product or package. Additionally, for products that contain used, reconditioned or remanufactured components, a recycled claim should be adequately qualified to avoid consumer deception about the nature of such components. No such qualification would be necessary in cases where it would be clear to consumers from the context that a product's recycled content consists of used, reconditioned or remanufactured components."

See the FTC document for illustrative examples.

Credit 4

Credit Synergies

MR Credit 5
Local/Regional Materials

EQ Credit 4
Low-Emitting Materials

Green Building Concerns

Recycled content building products contain feedstock materials recovered from consumers or industrial waste streams. These products are beneficial to the environment because they reduce virgin material use and solid waste volumes. The number of building products containing recycled content feedstocks continues to grow every year as recycling efforts increase and the marketplace for recycled materials develops. Many commonly used products are now available with recycled content. These products include metals, concrete, masonry, acoustic tile, carpet, ceramic tile and insulation. Most recycled content products exhibit performance similar to products containing virgin materials and can be incorporated into building projects with ease.

Environmental Issues

By selecting materials with recycled content, environmental impacts associated with extracting, harvesting and manufacturing virgin materials are often reduced. The solid waste stream is also reduced by diverting recyclable materials that would otherwise be deposited in a landfill, with associated impacts to land, water and air also lessened. The total environmental benefits of material recycling are generally less than that of material reuse because of the environmental burdens associated with recyclable materials collection, transport and processing into new products. Therefore, reuse of building materials (MR Credits 1 and 3) is preferred over recycling when possible.

Economic Issues

Some recycled content products cost more than equivalent virgin products due to the expenses of research and design, innovative manufacturing equipment and new plants to produce the products, as well as the actual costs of the recycling process. As demand for recycled products in the building market continues to grow, the costs for these items will become competitive with standard products. This LEED credit favors post-consumer recycled content because there is greater need and value in stimulating the post-consumer recycling market. Some recycled products may not be as widely available as conventional products.

Design Approach

Strategies

Consider the incorporation of recycled content building materials in the early stages of project design and identify recycled content materials goals. Identify the types of materials for which recycled alternatives exist and then identify specific products.

Recycled content materials are building products that include components that have recycled content and are processed off-site. Materials from the site that are processed for reuse on the site, such as crushed brick, asphalt and concrete, are not defined as recycled content materials in this context. Instead, these materials should be applied to MR Credit 3: Resource Reuse.

Ensure that recycled content materials perform equally or better than virgin materials in terms of strength, maintenance and lifetime. Maintain or refer to lists of manufacturers and suppliers of recycled content materials, and support regionally produced recycled content products when possible to reduce the added costs of transportation.

Incorporate products into the building design that not only have recycled content but are also recyclable. Remember to research all recycled content materials for durability, performance and environmental considerations. For instance, if the recycled content product is not as durable, the benefits to the environment may be compro-

mised. Also check recycled content materials for problematic air emissions, especially with synthetic products such as plastic, rubber and polyester.

During construction, ensure that the actual materials installed are those that were specified in the contract documents. Record the percentage of post-consumer and post-industrial recycled content for the LEED Letter Template calculations.

Synergies and Trade-Offs

Recycled content products should be evaluated in terms of their potential impacts on IAQ. In some cases, chemical binders used in recycled content products or processes contain off-gassing ingredients that can have a negative impact on IAQ. These off-gassing building products could affect construction workers as well as building occupants over the lifetime of the building.

It is often possible to specify recycled content building products that are also manufactured and recovered locally. If this is the case, recycled content materials can also be applied to MR Credit 5. Recycled content materials cannot be included in calculations for MR Credits 1, 2, 3, 6 and 7.

Calculations

The following calculation methodology is used to support the credit submittals listed on the first page of this credit. To calculate the percentage of recycled content materials used on a project, use the spreadsheet in the LEED Letter Template to list all recycled content materials and products and their associated costs. For each product, identify the percentage of post-consumer and/or post-industrial recycled content by weight, and list the recycled content information source.

Mechanical and electrical systems components are not applicable to this credit (e.g., HVAC equipment, ductwork, wiring and lighting fixtures and controls). Plumbing products may be excluded. If plumbing products are included, the Letter Template's default materials cost can not be used (plumbing items must be added into the materials cost total).

Post-consumer recycled content is consumer waste that has become a raw material (feedstock) for another product. It originates from products that have served a useful purpose in the consumer market. Much of this feedstock comes from residential curbside recycling programs for aluminum, glass, plastic and paper. Other post-consumer feedstock is supplied by businesses that recycle construction and demolition debris. Post-industrial recycled content products are those that contain waste from industrial processes that has been traded through the marketplace. For instance, a composite board manufacturer may purchase (or haul away for free) sawdust from a lumber mill or waste straw from a wheat farm. This definition does not include in-house industrial scrap or trimmings, which are normally fed back into the same manufacturing process.

Most building products will only have one type of recycled content, but a few products contain both post-consumer and post-industrial recycled content. The Letter Template determines each product's recycled content values (post-consumer and post-industrial) using **Equation 1**, and calculates the total recycled content percentages using **Equation 2**. To determine point achievement, the spreadsheet uses the best one of two competing scenarios: post-consumer content value only, or post-consumer plus half of the post-industrial value.

In order to declare achievement of this credit within the Letter Templates, the project team should compile cut sheets, product literature (brochures) or other documentation that clearly indicate whether the material contains post-consumer or post-industrial recycled materials or both, and what percentages by

weight. If nothing else is available, obtain an official statement from the product manufacturer stating the recycled content percentage by weight and if the recycled content is post-consumer or post-industrial. If there is no information for steel products, assume that recycled content is 25% post-consumer. Salvaged and refurbished materials are not considered to contain recycled content, and these materials should be applied to MR Credit 3: Resource Reuse.

Table 1 presents recycled content materials calculations for a sample project. Material costs exclude installation costs (e.g., labor and equipment). The total

Table 1: Letter Template Spreadsheet Example for Recycled Content Materials

Provide total construction cost for 45% default total materials cost; OR Provide total materials cost (exclude labor, equipment)		$ 2,879,744			
Product name	**Company**	**Product Cost**	**% Post-Consumer**	**% Post-Industrial**	**Recycled content information source**
Concrete	Concrete Company	$ 22,500	100.00%	0.00%	contractor submittal
Compost	Compost Company	$ 25,000	100.00%	0.00%	common knowledge
Rebar	Rebar Manufacturing Co.	$ 86,000	65.00%	0.00%	letter from factory
Brick (new)	Masonry Manufacturing Co.	$ 28,500	0.00%	15.00%	letter from factory
Misc. Metals	various	$ 179,000	60.00%	0.00%	manufacturer's inform.
Wheatboard Panels	Wheatboard Co.	$ 93,090	0.00%	25.00%	cut sheet
Metal Siding	Siding Co.	$ 38,000	25.00%	0.00%	product brochure
Metal Roofing	Roofing Co.	$ 35,000	85.00%	0.00%	product brochure
Ceramic Tile	Tile Co.	$ 11,396	95.00%	0.00%	product brochure
Acoustical Tile	Ceiling System Co.	$ 11,000	90.00%	0.00%	cut sheet
Carpet	Carpet Co.	$ 50,000	40.00%	0.00%	product brochure
Carpet Pad	Carpet Co.	$ 3,000	0.00%	100.00%	cut sheet
Toilet Partitions	Partition Co.	$ 4,000	100.00%	0.00%	product brochure
	Product Cost Subtotal	**$** 586,486			

Total value of post-consumer content	**$ 294,776**
Total value of post-consumer content as a percentage of a total value of all materials	**10.24%**
Total value of post-industrial content	**$ 30,548**
Total value of post-industrial content as a percentage of total value of all materials	**1.06%**
Combined value of post-consumer and half of post-industrial content	**$ 310,050**
Combined value of post-consumer content plus half of post-industrial content as a percentage of total value of all materials	**10.77%**

Equation 1:

$$\text{Recycled Content Value } [\$] = \text{Material or Product Cost } [\$] \times \text{Recycled Content \%}$$

Equation 2:

$$\text{Recycled Content Rate } [\%] = \frac{\text{Recycled Content Value } [\$]}{\text{Total Materials Cost } [\$]}$$

Equation 3:

$$\text{Assembly Recycled Content} = \frac{\text{Material Weight [lbs]} \times \text{Recycled Content [\%]}}{\text{Total Weight [lbs]}}$$

materials cost figure may be derived from a default calculation (45% of total construction cost) or a tally of actual material costs. The sample project has chosen the latter. "Company" refers to the manufacturer or a manufacturer's representative. For each recycled content product, the percentage of post-consumer or post-industrial content by weight is noted. Then the recycled content value in dollars is calculated using **Equation 1**. In the example, rebar costs $86,000 and contains 65% post-consumer recycled content. This is equal to a recycled content dollar value of $55,900 ($86,000 x 65%) New bricks cost $28,500, contain 15% post-industrial content, and have a recycled content dollar value of $4275 ($28,500 x 15%)

As product data is entered, the spreadsheet sums each of the totals and uses **Equation 2** to calculate the percentages necessary for analysis and point assessment: post-consumer content value, post-industrial content value, and post-consumer content plus half of the post-industrial content. For this example, the total value of post-consumer recycled content plus half of the post-industrial content is 10.77% of the total materials cost and earns two points under this credit.

For assemblies, the assembly recycled content should be calculated. Use **Equation 3** to determine the assembly recycled content.

Table 2 illustrates an assembly calculation for concrete containing 100% post-industrial fly ash. Fly ash constitutes 98 pounds in one ton of the example concrete mix. This results in an overall recycled content percentage of the concrete mix of 5% by weight.

Resources

Web Sites

CIWMB Recycled Content Product Database

www.ciwmb.ca.gov/rcp, (916) 341-6606

A searchable database for recycled content products, developed by the California Integrated Waste Management Board.

Government Resources

Check with the solid waste and natural resources departments in your city or county. Many local governments provide information on recyclers and recycled content product manufacturers within their region.

GreenSpec

www.greenspec.com, (802) 257-7300

Detailed listings for more than 1,500 green building products, including environmental data, manufacturer information and links to additional resources.

Table 2: Recycled Content Assembly Example

Concrete Components	Weight [lbs]	Recycled Content [%]	Percentage by Weight [%]
Water	160	--	8%
Cement	306	--	15%
Fly Ash	98	100%	5%
Coarse Aggregate	895	--	45%
Aggregate	541	--	27%
TOTAL	**2,000**		**100%**

SS | WE | EA | MR | EQ | ID

Credit 4

Guide to Resource-Efficient Building Elements

www.crbt.org, (406) 549-7678

The Center for Resourceful Building Technology's directory of environmentally responsible building products. This resource provides introductory discussions per topic and contact information for specific products.

Oikos

oikos.com

A searchable directory of resource-efficient building products and sustainable design educational resources.

U.S. EPA Comprehensive Procurement Guidelines Program

www.epa.gov/cpg/products.htm

Contains EPA information on recycled content materials with guidelines for recycled percentages. Includes a searchable database of suppliers.

Definitions

Post-Consumer recycled content is consumer waste that has become a raw material (feedstock) for another product. It originates from products that have served a useful purpose in the consumer market. Much of this feedstock comes from residential and commercial (office) recycling programs for aluminum, glass, plastic and paper. Other post-consumer feedstock is supplied by businesses that recycle construction and demolition debris.

Post-Industrial recycled content is output from a process that has not been used as part of a consumer product, that is sold, traded, or exchanged under commercial terms (including auditable transactions between profit centers within an organization) as feedstock for another industrial process, and that would otherwise be landfilled, incinerated or somehow disposed of as a waste, as defined by the Federal Trade Commission. For instance, a composite board manufacturer may purchase (or haul away for free) sawdust from a lumber mill or waste straw from a wheat farm. Wood chips would not fit this definition.

Case Study

Greater Pittsburgh Community Food Bank
Pittsburgh, Pennsylvania

The Greater Pittsburgh Community Food Bank is a LEED™ Silver Pilot Project serving local food banks in Western Pennsylvania. The building houses distribution, warehouse and processing facilities and is designed to utilize site resources and be a positive workspace for building occupants. The building contains a substantial amount of recycled content building materials. These materials were required in specifications and included the following: reinforcing steel, structural steel, metal framing, ceramic tile flooring, sheet flooring, asphalt paving, gypsum wallboard, ceiling grid and tiles, and toilet partitions. In addition, a low-permeability, cementitious (LPC) material was used as structural fill, which consisted of 95% industrial waste products such as fly ash, lime and flue gas desulfurization material.

Courtesy of Gardner + Pope Architects

Owner
Greater Pittsburgh Community Food Bank

Regional Materials

20% Manufactured Regionally

1 point

Intent

Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the regional economy and reducing the environmental impacts resulting from transportation .

Requirements

Use a minimum of 20% of building materials and products that are manufactured* regionally within a radius of 500 miles.

* Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesmen. For example, if the hardware comes from Dallas, Texas, the lumber from Vancouver, British Columbia, and the joist is assembled in Kent, Washington; then the location of the final assembly is Kent, Washington.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, declaring that the credit requirements have been met. Include calculations demonstrating that the project incorporates the required percentage of regional materials/products and showing their cost, percentage of regional components, distance from project to manufacturer, and the total cost of all materials for the project.

Regional Materials

1 point
in addition to
MR 5.1

50% Extracted Regionally

Intent

Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the regional economy and reducing the environmental impacts resulting from transportation.

Requirements

Of the regionally manufactured materials documented for MR Credit 5.1, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, declaring that the credit requirements have been met. Include calculations demonstrating that the project incorporates the required percentage of regional materials/products and showing their cost, percentage of regional components, distance from project to manufacturer, and the total cost of all materials for the project.

Summary of Referenced Standard

There is no standard referenced for this credit.

Green Building Concerns

By purchasing regionally manufactured building materials, the local economy is supported, transportation costs and environmental impacts are reduced, and dollars are retained in the region, supporting the regional economy. The availability of regionally manufactured building materials is dependent on the project location. In some areas, the majority of products needed for the project can be obtained within a 500-mile radius. In other areas, only a small portion or none of the building materials can be sourced locally. It is also important to address the source of raw materials used to manufacture building products. Raw materials for some building products are harvested or extracted far from the point of manufacture, creating air and water pollution due to transportation between point of extraction and point of manufacture.

Environmental Issues

The use of regional building materials reduces transportation activities and the accompanying pollution required to deliver the materials to the job site. Trucks, trains, ships and other vehicles deplete finite reserves of fossil fuels and generate air pollution. By selecting building materials that are produced from regional materials, transportation impacts are further reduced.

Economic Issues

Regional building materials are more cost-effective for projects due to reduced transportation costs. Also, the support of regional manufacturers and labor forces retains capital for community members and creates a more stable tax base and a healthier local economy.

Community Issues

Regional building materials are often consistent with regional design aesthetics and are sometimes more responsive to the local climate when compared with materials from other regions. The use of regional building materials supports the regional economy, helping to strengthen the local community and contribute to a high quality of life.

Design Approach

Strategies

Consider the incorporation of regional building materials early in the schematic design phase. Research regionally sourced and manufactured building materials for durability, performance and other environmental considerations. Create and maintain a current listing of regional manufacturers for future reference. Once the research of building materials is completed, specify appropriate regionally sourced and manufactured building materials in the contract documents.

Synergies & Trade-Offs

The location of the project site has a large effect on the availability of regionally sourced materials. Remote sites often require construction materials to be transported from great distances. In areas that have regional manufacturing facilities, it is advantageous to consider materials that are salvaged, that contain recycled content, that are rapidly renewable, and for wood products, those that are FSC-certified. Regional material dollar values can be applied to MR Credits 3, 4, 6 and 7 for those materials that meet the requirements of those credits. When choosing regional materials, it is also important to address volatile organic compounds (VOCs) and urea formaldehyde content as these can affect indoor air quality.

Calculations

The following calculation methodology is used to support the credit submittals listed on the first page of this credit. To calculate the percentage of regional ma-

Credit Synergies

SS Credit 1
Site Selection

MR Credit 3
Resource Reuse

MR Credit 4
Recycled Content

MR Credit 6
Rapidly Renewable Materials

MR Credit 7
Certified Wood

EQ Credit 4
Low-Emitting Materials

terials used on a project, it is helpful to use the LEED Letter Template in addition to creating a spreadsheet listing all materials used on the project and their associated costs. This spreadsheet can also be used for MR Credits 3, 4, 6 and 7. Identify those products that were manufactured within 500 miles of the project site. The Letter Template sums all regionally manufactured product costs, and divides this value by the total materials cost to obtain the regionally manufactured product percentage (see **Equation 1**).

Next, identify those regionally manufactured products that contain materials extracted, harvested or recovered within 500 miles of the project site. The Letter Template sums all regionally extracted materials costs and divides this value by the regionally manufactured products cost to obtain the regionally extracted materials percentage (see **Equation 2**).

The Letter Template spreadsheet in **Table 1** presents regional materials calculations for a sample project. Note that material costs exclude installation expenses (e.g., labor and equipment), and "company" refers to the manufacturer or a manufacturer's representative. The total materials cost figure may be derived from a default calculation (45% of total construction cost) or a tally of actual material costs. The sample project has chosen the former.

The spreadsheet will add product costs to the "manufactured" and "extracted" totals depending on the distances data that is entered. For instance, compost is both manufactured and recovered within a short distance of the project and the material cost for compost is included in both totals. Rebar is manufactured within 500 miles of the project site, but the raw materials originate from locations greater than 500 miles from the project. Therefore, the material cost for rebar is only included in the regionally manufactured products tally.

The total regionally manufactured materials cost is divided by the total materials cost to obtain a regionally manufactured percentage of 22%. The total regionally extracted materials value is divided into the total of regionally manufactured materials dollar value to obtain the regionally extracted materials percentage of 55%. This example qualifies for two points under this credit.

If audited during the LEED certification review, the location of materials manufacture and extraction, harvesting, or recovery must be verified by a product cut sheet, product literature or letter from the manufacturer.

For assemblies, or when there are multiple sources for the same material (e.g., salvaged goods), use the following guidance. If all material sources are within 500 miles, use one line item in the table and state the greatest distance of the group. Otherwise, calculate the percentages of regionally and non-regionally extracted materials by weight (as detailed in MR Credit 4) and enter as two line items. In **Table 1**, see "wallboard" for an example.

Equation 1:

$$\text{Regionally Manufactured Products Rate}\ [\%] = \frac{\text{Regionally Manufactured Products Cost}\ [\$]}{\text{Total Materials Cost}\ [\$]}$$

Equation 2:

$$\text{Regionally Extracted Materials Rate}\ [\%] = \frac{\text{Regionally Extracted Materials Cost}\ [\$]}{\text{Regionally Manufactured Products Cost}\ [\$]}$$

Resources

Check with your local chamber of commerce and regional and state economic development agencies for building materials manufacturers in your area.

Table 1: Letter Template Spreadsheet Example for Regional Materials

Provide total construction cost			**$ 6,582,471**		
for 45% default total materials cost; OR			**$ 2,962,112**		
Provide total materials cost (exclude labor, equipment)					
Product name	**Company**	**Product Cost**	**Distance between project & manufacturer (in miles)**	**Distance between project & extraction site (in miles)**	**Regional content information source**
Reclaimed Concrete	Concrete Company	$ 22,500	9	31	Letter from manufacturer
Planting	Nursery Company	$ 35,066	42	42	Cut sheet
Compost	Compost Co.	$ 25,000	20	40	Cut sheet
Rebar	Supply Co.	$ 86,000	317	644	Letter from manufacturer
Brick (salvaged)	Salvage Co.	$ 33,700	39	58	Cut sheet
Brick (new)	Masonry Co.	$ 28,500	216	229	Letter from manufacturer
Misc. Metals	various	$ 58,700	439	?	Letters from manufacturers
Reclaimed Wood	Salvage Co.	$ 130,000	54	172	Cut sheet and letter
Millwork	Millwork Co.	$ 85,590	31	?	Cut sheets
Struct. Insulated Panels	SIP Co.	$ 80,500	500	497	Letter from manufacturer
Wallboard (gypsum)	Wallboard Co.	$ 60,000	294	566	Product literature
Wallboard (paper facing)	Wallboard Co.	$ 540	294	269	Letter from manufacturer
Toilet Partitions	Partition Co.	$ 4,000	311	427	Letter from manufacturer
	Product Cost Subtotal	**$** 650,096			

Total value of regionally manufactured products	**$ 650,096**
Value of regionally manufactured products as a percentage of the value of all materials	**21.95%**
Total value of regionally extracted products	**$ 359,806**
Value of regionally extracted materials as a percentage of regionally manufactured products	**55.35%**

Case Study

Monsanto Company Life Sciences Incubator
St Louis, Missouri

The Monsanto Company Life Sciences Incubator building is a LEED™ Silver Pilot Project housing research facilities committed to finding solutions to growing global needs for food and health. The design team specified regionally manufactured and sourced materials in the building where possible. Regional materials included cast-in-place and structural concrete, brick, structural and ornamental steel, structural and non-structural lumber, synthetic marble countertops, casework and millwork, insulation, door systems, gypsum wallboard, tack panels, signage, blinds, and toilet partitions. Overall, almost two-thirds of the materials for the project were sourced within 500 miles of the project site.

Courtesy of Monsanto Company

Owner
Monsanto Company

Rapidly Renewable Materials

SS | WE | EA | **MR** | EQ | ID

Credit 6

1 point

Intent

Reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials.

Requirements

Use rapidly renewable building materials and products (made from plants that are typically harvested within a ten-year cycle or shorter) for 5% of the total value of all building materials and products used in the project.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, declaring that the credit requirements have been met. Include calculations demonstrating that the project incorporates the required percentage of rapidly renewable products. Show their cost and percentage of rapidly renewable components, and the total cost of all materials for the project.

Summary of Referenced Standard

There is no standard referenced for this credit.

Credit 6

Credit Synergies

MR Credit 5
Local/Regional Materials

MR Credit 7
Certified Wood

EQ Credit 4
Low-Emitting Materials

Green Building Concerns

Many conventional building materials require large inputs of land, natural resources, capital and time. Conversely, rapidly renewable materials generally require less of these inputs and are therefore likely to be more environmentally friendly. Rapidly renewable resources are those materials that substantially replenish themselves faster than traditional extraction demand (i.e., planted and harvested in less than a 10-year cycle). Examples of such building materials include (but are not limited to) the materials listed in **Table 1**.

Environmental Issues

Rapidly renewable resources sometimes provide the opportunity to displace raw materials that have greater environmental impacts. Common examples include composite panels that are made from agricultural fiber such as wheat, substituting for composite wood panels. Irresponsible forestry practices cause ecosystem and habitat destruction, soil erosion, and stream sedimentation. Rapidly renewable crops require significantly less land—often due to higher density and shorter growing cycles—to produce the same amount of end product, and are often by-products that are otherwise considered waste.

Table 1: Rapidly Renewable Materials

Examples of Rapidly Renewable Materials
Bamboo flooring
Cotton batt insulation
Linoleum flooring
Sunflower seed board
Wheatgrass cabinetry
Wool carpet

Bio-based plastics (e.g., from corn starch) and other rapidly renewable resources are beginning to provide alternatives to some petroleum-based plastics.

Economic Issues

Because rapidly renewable resources may be harvested more quickly, they require less land to produce the same quantity of material, which equates to lower land costs. Rapidly renewable materials tend to give a faster payback on investment for manufacturers. Some rapidly renewable materials are new to the marketplace and are subsequently more expensive than their conventional counterparts. As demand for rapidly renewable materials increases, they will become more cost-competitive with conventional materials.

Community Issues

The land saved from the production requirements of rapidly renewable resources may be used for a variety of other uses, including open space and other agricultural products. Rapidly renewable materials create a more consistent harvesting cycle that can sustain a community instead of clearcutting and then abandoning the forest, as well as the workers, for decades.

Design Approach

Strategies

Research rapidly renewable materials for flooring, cabinetry, wood products and other project applications. Specify these materials in contract documents and create a current list of rapidly renewable products for future reference.

Equation 1:

$$\text{Rapidly Renewable Material Portion} \ [\%] = \frac{\text{Rapidly Renewable Material Cost [\$]}}{\text{Total Materials Cost [\$]}}$$

Synergies and Trade-Offs

Because many products made from rapidly renewable resources are relatively new, their long-term performance characteristics may be unknown. For example, the performance and stability of bamboo flooring has improved in recent years through the use of laminated layers of the material. Therefore it is important to evaluate a product's performance history prior to specifying.

Rapidly renewable materials costs can also be applied to MR Credits 5 and 7 if the materials meet the credit requirements. Some products made from rapidly renewable materials contain adhesives that may off-gas contaminants and have a negative impact on indoor air quality.

Calculations

The following calculation methodology is used to support the credit submittals listed on the first page of this credit. To calculate the percentage of rapidly renewable materials used on a project, it is helpful to use the LEED Letter Template in addition to creating a spreadsheet listing all materials used on the project and their associated costs. Identify those products that are considered to be rapidly renewable. Sum all rapidly renewable material costs and divide this value by the total materials cost to obtain the rapidly renewable material percentage (see **Equation 1**). **For assemblies,** calculate the percentage of rapidly renewable materials by weight (as detailed in MR Credit 4).

Table 2 presents rapidly renewable materials calculations for a sample project. The total materials cost figure may be derived from a default calculation (45% of total construction cost) or a tally of actual material costs. The sample project has chosen the former. Material costs exclude installation expenses (e.g., labor and equipment). "Company" refers to the manufacturer or a manufacturer's representative. The costs for these materials are totaled and divided by the total material cost to obtain the rapidly renewable material percentage of 7%, which qualifies for one point under this credit.

If audited during the LEED certification review, cut sheets, product literature or a letter from the manufacturer must be submitted to confirm that the reported materials are manufactured with rapidly renewable resources.

Table 2: Letter Template Spreadsheet Example for Rapidly Renewable Materials

Total construction cost		**$**	**6,399,431**		
for 45% default total materials cost; OR		**$**	**2,879,744**		
Provide total materials cost (exclude labor, equipment)					
Product name	**Company**		**Product Cost**	**% Renewable**	**Rapidly renewable content information source**
Miscellaneous finish carpentry	Milling Company	$	21,380	100%	Letter
Wheatboard panels	Wheatboard Company	$	93,090	100%	Product literature
Linoleum	Linoleum Company	$	18,500	100%	Cut sheet
Bamboo flooring	Flooring Company	$	70,345	100%	Cut sheet
	Product Cost Subtotal	$	203,315		
			Total value of rapidly renewable products		**$ 203,315**
			Rapidly renewable building materials as a percentage of total materials cost		**7.06%**

Resources

Web Sites

Environmental Building News

www.buildinggreen.com/products/bamboo.html, (802) 257-7300

An article in *Environmental Building News* on bamboo flooring, including a listing of bamboo flooring suppliers.

Environmental Design + Construction

www.edcmag.com (search for *Highlights of Environmental Flooring*)

An *Environmental Design & Construction* article providing information on bamboo flooring, linoleum and wool carpeting.

GreenSpec

www.greenspec.com, (802) 257-7300

Detailed listings for more than 1,500 green building products, including environmental data, manufacturer information, and links to additional resources.

Guide to Resource-Efficient Building Elements

www.crbt.org, (406) 549-7678

The Center for Resourceful Building Technology's directory of environmentally responsible building products. This resource provides introductory discussions per topic and contact information for specific products.

Oikos

oikos.com

A searchable directory of resource-efficient building products and sustainable design educational resources.

Case Study

The Solar Living Center
Hopland, California

The Solar Living Center is a retail facility, learning center and demonstration building for the Real Goods Trading Center. The materials selection process emphasized those materials that were high in recycled content and low in embodied energy. Two rapidly renewable materials were chosen based on these criteria: straw-bale walls and pressed strawboard. The north and west walls of the building were constructed with straw-bales, a local agricultural waste product that is routinely burned. The exterior and interior wall surfaces are covered with a cement and soil combination to protect the straw from moisture and to provide structural rigidity. The straw-bale walls have thermal insulating benefits as well as excellent sound insulation characteristics. In addition, pressed strawboard panels were installed between structural elements to serve as a sound absorber, insulator and radiant barrier.

Courtesy of Real Goods Trading Corporation

Owner
Real Goods Trading Corporation

Certified Wood

SS | WE | EA | MR | EQ | ID

Credit 7

1 point

Intent

Encourage environmentally responsible forest management.

Requirements

Use a minimum of 50% of wood-based materials and products, certified in accordance with the Forest Stewardship Council's Principles and Criteria, for wood building components including, but not limited to, structural framing and general dimensional framing, flooring, finishes, furnishings, and non-rented temporary construction applications such as bracing, concrete form work and pedestrian barriers.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or responsible party, declaring that the credit requirements have been met and listing the FSC-certified materials and products used. Include calculations demonstrating that the project incorporates the required percentage of FSC-certified materials/products and their cost together with the total cost of all materials for the project. For each material/product used to meet these requirements, provide the vendor's or manufacturer's Forest Stewardship Council chain-of-custody certificate number.

Summary of Referenced Standard

Forest Stewardship Council's Principles and Criteria

www.fscus.org, (877) 372-5646

Certification is a "seal of approval" awarded to forest managers who adopt environmentally and socially responsible forest management practices, and to companies that manufacture and sell products made from certified wood. This seal enables consumers, including architects and specifiers, to identify and procure wood products from well-managed sources and thereby use their purchasing power to influence and reward improved forest management activities around the world.

LEED accepts certification according to the comprehensive system established by the internationally recognized Forest Stewardship Council (FSC). FSC was created in 1993 to establish international forest management standards (known as the FSC Principles and Criteria) to assure that forestry practices are environmentally responsible, socially beneficial and economically viable. These Principles and Criteria have been established to ensure the long-term health and productivity of forests for timber production, wildlife habitat, clean air and water supplies, climate stabilization, spiritual renewal, and social benefit, such as lasting community employment derived from stable forestry operations. These global Principles and Criteria are translated into meaningful standards at a local level through region-specific standards setting processes.

FSC also accredits and monitors certification organizations. These "certifiers" are independent, third-party auditors that are qualified to annually evaluate compliance with FSC standards on the ground and to award certifications. There are two types of certification.

- **Forest Management Certification** is awarded to responsible forest managers after their operations successfully complete audits of forestry practices and plans.
- **Chain of Custody Certification** is awarded after companies that process, manufacture and/or sell products made of certified wood successfully complete audits to ensure proper use of the FSC name and logo, segregation of certified and non-certified materials in manufacturing and distribution systems, and observation of other relevant FSC rules (e.g., meeting minimum requirements for FSC fiber content in assembled and composite wood products).

The majority of FSC certification audits performed in North America are conducted by SmartWood and Scientific Certification Systems (SCS), which are based in the United States. A more limited number are performed by SGS, which is based in Europe.

Green Building Concerns

Wood has the potential to be a truly sustainable resource because it is renewable, biodegradable, non-toxic, energy efficient and recyclable. Too often, however, wood is linked to the degradation or destruction of ecologically important forest ecosystems, such as old-growth forests. Thus, responsible forestry practices aim to minimize or eliminate these problems. Responsible forestry meets the long-term forest product needs of humans while maintaining the function and biodiversity of forested landscapes. The primary goal is to restore, enhance and sustain a full range of forest values while producing a perpetual yield of quality forest products.

Environmental Issues

The negative environmental impacts of irresponsible forest practices can include destruction of forests, loss of wildlife habitat, soil erosion and stream sedimentation, water and air pollution, and waste generation. The FSC standard incorporates many criteria that contribute to the long-term health and integrity of forest ecosystems. From an environmental perspective, the elements of responsible FSC-certified forestry include sustainable timber harvesting (i.e., not removing more timber volume than replaces itself over the cutting interval or rotation), preserving wildlife habitat and biodiversity, maintaining soil and water quality, minimizing the use of harmful chemicals, and conserving high conservation value forests (e.g., endangered and old-growth forests).

Economic Issues

World trade in forest products has increased dramatically in the last 30 years, from $47 billion in 1970 to $139 billion in 1998. As more developing countries embrace world forest product markets and their growing economies encourage domestic consumption, the protection of forests will become a critical issue.

Currently, the costs of FSC-certified wood products are equal to or higher than conventional wood products, and availability varies by region. The price of FSC-certified wood products is expected to be more competitive with conventional wood products in future years as the world's forest resources are depleted and the forest industry embraces more widespread adoption of sustainable business principles.

Community Issues

Irresponsible logging practices can have negative social impacts. Thus, the socioeconomic and political components to FSC certification include respecting indigenous people's rights, adhering to all applicable laws and treaties, and involving forest workers and forest-dependent communities as stakeholders in, and beneficiaries of, responsible forest management. Through the encouragement of responsible forest practices, local timber economies are stabilized and forestland is preserved for future generations.

Design Approach

Strategies

Establish a project goal in which at least 50% of the dollar value of wood-based materials shall be FSC certified. Identify all major areas of wood usage in your project to determine the types of products needed (e.g., wooden doors and windows, interior millwork and casework, framing lumber, trim and structural panels, form ply and bracing, etc.).

Using the contacts and materials listed in the Resources section below, research the availability of the wood species and products that you wish to use to ensure that they are available from FSC-certified sources.

Credit Synergies

MR Credit 5
Local/Regional Materials

MR Credit 6
Rapidly Renewable Materials

EQ Credit 4
Low-Emitting Materials

Research and specify quality grades that are most readily available from well-managed forests. Using lower grades of wood can dramatically reduce pressure on forests, which produce only limited quantities of top-grade timber (e.g., Architectural Woodwork Institute [AWI] Grades 2 or 3 for lumber or veneer rather than Grade 1, Select & Better rather than First And Second [FAS] for hardwood lumber graded to National Hardwood Lumber Association [NHLA] rules, or 2 and Better rather than Select Structural for softwood lumber graded to Western Wood Product Association [WWPA] rules). As an example, the typical yield of FAS-grade lumber in a deciduous forest is 5% - 20% of all hardwood lumber cut depending on many variables, i.e. thickness, length, etc. In structural applications, specify the lowest grade that will meet the project's performance and engineering requirements. In interior finishes and other exposed surfaces, consider specifying "character" grades that highlight the uniqueness of wood as a natural material.

At the earliest possible opportunity, make contact with, and develop for your bidders, a list of local vendors, suppliers and manufacturers that are certified for FSC chain-of-custody. Also, encourage project bidders to contact certified vendors as early as possible to establish product availability and pricing. As the availability of certain certified wood products may vary over the life of a project, consider having the owner pre-purchase, store and supply particular items to the contractor ("Furnished by the Owner, Installed by the Contractor," or FOIC).

Specify in contract documents that wood products shall come from forests that are certified as well-managed according to the rules of the FSC. Wherever possible, employ a line-item strategy based on current availability of specific products rather than a blanket approach. As evidence of compliance with your specification and to document your use of certified wood for LEED, require that project contractors and subcontractors submit vendor (supplier) invoices containing vendor's chain-of-custody certification numbers and identifying each certified product on a line-item basis.

Synergies and Trade-Offs

Some FSC-certified wood products may not be locally available. Certified wood products can be applied to MR Credits 5 and 6 if these products comply with requirements for those credits. Like their non-certified counterparts, some FSC-certified products contain adhesives and chemicals that have off-gassing characteristics that may affect indoor air quality, and may conflict with eligibility for IEQ Credit 4.4 (urea formaldehyde)

Calculations

The following calculation methodology is used to support the credit submittals listed on the first page of this credit. To calculate the percentage of certified wood products used on a project, use the spreadsheet in the LEED Letter Template listing all materials used on the project and their associated costs. First, identify all wood-based materials and product costs on the project, not including installation expenses (e.g., labor and equipment). Exclude salvaged and refurbished materials as well as the value of the post-consumer recycled wood fiber portion of any product. These exclusions ensure that applicants seeking the certified wood credit are not penalized for using non-virgin wood.

For assemblies, calculate cost percentage of the FSC-certified wood versus the to-

Equation 1:

$$\text{Certified Wood Material Portion } [\%] = \frac{\text{FSC Certified Wood Products Cost } [\$]}{\text{Total New Wood Based Products Cost } [\$]}$$

tal material cost for the product, then multiply that percentage by the total product price to get the cost value of the certified wood portion (to evenly distribute labor and other production costs). If the product itself has been FSC-certified, then the entire cost of the product is to be used.

The Letter Template calculates the total materials value of the wood-based products. Next, identify percentages (by weight, as detailed in MR Credit 4) of those wood-based products that are FSC-certified. All FSC-certified wood material costs are summed and then divided by the total value of wood-based products to obtain the certified wood products percentage (see **Equation 1**).

The example in **Table 1** presents certified wood calculations for a sample project. The total materials cost figure may be derived from a default calculation (45% of total construction cost) or a tally of actual material costs. The sample project has chosen the former. Material costs exclude installation costs (e.g., labor and equipment). This example qualifies for one point under this credit because more than 50% of new wood-based products are FSC-certified.

Keep copies of vendor invoices for each product used to meet these requirements in case of a LEED certification audit. Per Forest Stewardship Council rules, each invoice should include the vendor's chain-of-custody certificate number and should also identify certified products on an item-by-item basis. A "vendor" is defined as a company that furnishes wood products to project contractors or subcontractors for on-site installation. For example, a company that manufactures but does not install interior casework would be considered a vendor for the purposes of this definition, but an architectural woodworker that fabricates and installs interior case-

Table 1: Letter Template Spreadsheet Example for Certified Wood

Provide total construction cost	**$**	**19,881,455**
for 45% default total materials cost; OR	**$**	**8,946,655**
Provide total materials cost (exclude labor, equipment)		
Total cost of all wood-based products	**$**	**709,026**
Cost of Wood-based products as percentage of all materials		**7.93%**

Wood product	Vendor	Product Cost	Certified Wood %	Forest Stewardship Council chain-of-custody certificate number
Rough carpentry	Supply Company	$ 85,629	46%	SW-COC-013
Millwork, casework	Supply Company	$ 160,423	77%	SCS-COC-00067
Miscellaneous	various	$ 31,557	0%	n/a
Roof Structure	Supply Company	$ 175,309	89%	SCS-COC-00094
Doors, frames	Supply Company	$ 141,100	70%	SW-COC-675
Finish carpentry – elevator interior	Supply Company	$ 5,469	55%	SCS-COC-00067
Furniture	Office Furniture Company	$ 73,775	71%	SCS-COC-00122
Workstations	Office Furniture Company	$ 35,764	61%	SCS-COC-00122
	Product Cost Subtotal	**$** 709,026		

Total value of FSC-certified wood products	**$ 494,914**
Value of FSC-certified wood products as a percentage of the value of all wood-based building materials	**69.80%**

work on a custom, project-by-project basis would not. In the case of the woodworker, the vendor would be the company that supplies his or her raw materials, such as veneer, plywood and lumber.

Resources

Web Sites

Certified Wood & Paper Association

www.cwpa.info, (503) 224-2205

A nonprofit business association that promotes environmentally and socially responsible forest products, it provides a free service to help architects who seek to specify FSC-certified wood, research product availability and identify potential vendors.

Forest Certification Resource Center

www.certifiedwood.org, (503) 224-2205

Contains a searchable database of FSC products and a variety of resources, including comparative information on forest certification systems.

Forest Stewardship Council

www.fscus.org, (877) 372-5646

The FSC promotes responsible forest management globally by certifying forest products that meet the rigorous forest management standard. The organization brings industry, environmentalists, and community groups together to promote practical solutions that meet its diverse stakeholders' needs. The organization was founded in 1993 by environmental groups, the timber industry, foresters, indigenous peoples and community groups from 25 countries.

GreenSpec

www.greenspec.com, (802) 257-7300

Detailed listings for more than 1,500 green building products, including environmental data, manufacturer information and links to additional resources.

Scientific Certification Systems

www.scs1.com/forestry.shtml, (802) 434-5491

Scientific Certification System's Forest Conservation Program is a third-party certifier that is accredited to conduct forest management and chain-of-custody audits in the United States and internationally according to the rules of the FSC.

Smartwood

www.smartwood.org, (802) 434-5491

SmartWood is a third-party certifier that is accredited to conduct forest management and chain-of-custody audits in the United States and globally according to the rules of the FSC. It is a nonprofit program of the Rainforest Alliance and is based in the United States.

Print Media

Sustainable Forestry: Philosophy, Science, and Economics by Chris Maser, CRC Press, 1994.

The Business of Sustainable Forestry: Strategies for an Industry in Transition by Michael B. Jenkins and Emily T. Smith, Island Press, 1999.

Definitions

Chain-of-Custody is a document that tracks the movement of a wood product from the forest to a vendor and is used to verify compliance with FSC guidelines. A "vendor" is defined as the company that supplies wood products to project contractors or subcontractors for on-site installation.

Sustainable Forestry is the practice of managing forest resources to meet the long-term forest product needs of humans while maintaining the biodiversity of forested landscapes. The primary goal is to restore, enhance and sustain a full range of forest values—economic, social and ecological.

Case Study

Bicentennial Hall Science Building
Middlebury, Vermont

The Bicentennial Hall Science Building at Middlebury College is a campus building that houses laboratories, classrooms, offices and a library. Over 125,000 board feet of FSC-certified wood was specified and installed for interior millwork. Wood species chosen were native to Vermont and included hard and soft maple, beech, yellow birch, red oak, black cherry, poplar, basswood and ash. These species were used for paneling, base molding, wainscoting, picture rails, chair rails and balcony railings. The cost of FSC-certified wood products on the project was estimated to be 3% greater than conventional wood products.

Courtesy of Middlebury College

Owner
Middlebury College

Credit 7