CHAPTER 14
SUSTAINABLE DESIGN AND CONSTRUCTION

The concepts of sustainability and sustainable development are described in Chapter2, Section 2.1. Briefly, "sustainable" refers to meeting the needs of the present without jeopardizing the ability of future generations to meet their own needs.[1] Sustainable design is the systematic consideration of a project's life-cycle impact on environmental and energy resources. The basic theory of sustainable design is relatively simple, however, implementation is complex. This chapter presents basic theory related to sustainable design and construction, case studies of sustainable design projects, and sources of additional information. A ski area seriously interested in implementing sustainable design should begin by reading the references mentioned in this chapter and working with organizations experienced in designing and implementing sustainable projects. The key features of sustainable design are:

1. Planning sustainable sites
2. Maximizing energy efficiency
3. Minimizing material and resource consumption
4. Enhancing indoor environmental quality
5. Safeguarding and conserving water

Example strategies for achieving these five sustainable design features are listed below.

- Increase energy and water conservation and efficiency
- Increase use of renewable energy resources
- Reduce or eliminate toxic and hazardous substances in facilities, processes, and their surrounding environments
- Improve indoor air quality and interior and exterior environments to increase human productivity and performance and to enhance human health
- Use resources and materials efficiently
- Select materials and products that minimize safety hazards and life-cycle environmental impacts (for example, local materials and lowest "embodied energy" materials)
- Increase use of materials and products with recycled content and environmentally preferred products
- Recycle and salvage construction waste and building material during construction and demolition
- Generate less harmful products during construction, operation, decommissioning, and demolition
- Implement maintenance and operational practices that reduce or eliminate harmful effects on people and the natural environment
- Reuse existing infrastructure, locate facilities near public transportation, and consider redevelopment of contaminated and out-of-repair properties
- Consider off-site impacts such as storm water discharge rates and water quality

[1] *Our Common Future*. Report by the World Commission on Environment and Development (Bruntland Commission). 1987.

- Include "low energy and low water usage" experience as a selection criteria when selecting an architectural engineering firm to design a new building
- Require architects and engineers to perform energy use simulations for building designs

A Pressing Concern

Every new building constructed without consideration of sustainability principles represents lost opportunities for the entire life of the building. The lost opportunity is staggering considering that design and construction are estimated to account for only 20 percent of a building's total life-cycle cost, yet decisions are made during the design process that commit up to 80 percent of a building's life-cycle cost. In other words, design decisions determine how a building will perform throughout its operational life from both resource consumption and waste generation perspectives, substantially impacting annual operating costs. If worker productivity costs are factored in, the ultimate costs are 2 percent for construction, 6 percent for energy and maintenance, and 92 percent for the personnel who will work in the building (see the "Sustainable Building Technical Manual" listed in Section 14.4). An added benefit of sustainable design is that it creates more comfortable working environments, which in turn increase worker productivity.

Sustainable Slopes Environmental Charter

Sustainable design is prominently acknowledged as the first principle in the Sustainable Slopes Environmental Charter (see Chapter 2 for details). Specifically, Section I, "Planning, Design, and Construction," calls for ski areas to:

1. Engage local communities, environmental groups, government agencies, and other stakeholders in up-front and continuing dialogue about sustainable development plans and their implementation.
2. Assess environmental concerns and potential restoration opportunities at local and regional levels.
3. Plan, site, and design trails, on-mountain facilities, and base area developments in a manner that respects the natural setting and avoids, to the extent practical, outstanding natural resources.

4. Emphasize nature in the built environment of the ski area.
5. Make water, energy, and material efficiency and clean energy use priorities in the design of new facilities and the upgrading of existing facilities.
6. Use high-density development or clustering to reduce sprawl, reduce the need for cars, and enhance the pedestrian environment.
7. Meet or exceed design requirements to minimize environmental impacts associated with ski area construction.

The charter offers the following options for implementing sustainability concepts:

1. Engage stakeholders collaboratively in siting of improvements and analysis of alternatives
2. Complement the local architectural styles, scale, and infrastructure to enhance the visual environment and to create a more authentic experience for guests
3. Respect the outstanding natural resources and physical "carrying capacity" of the local ecology in planning new projects
4. Use simulation or computer modeling, such as visual modeling or geographic information systems (GIS), in analyzing the effects of proposals on key natural resources and view sheds
5. Design trails that can be constructed with minimal tree removal and vegetation disturbance where feasible
6. Incorporate "green" building principles, such as using energy, water, and material efficiency techniques and sustainable building practices
7. Use long-life, low-maintenance materials in buildings
8. Include parks, open space, and native landscaping in base area developments
9. Seek opportunities for environmental enhancement and restoration
10. Maximize alternate transportation modes in and around the base area
11. Minimize road building where practical
12. Select best management practices (BMP) for construction sites with stakeholder input
13. Apply sound on-mountain construction practices pertaining to over-snow transport techniques, storm water control, and phasing of activities to minimize disturbances to natural habitats

Many examples of how ski areas are implementing sustainable design and construction practices can be found in the Environmental Charter Annual Report and the NSAA Sustainable Slopes Green Room (see Chapter 2 or www.nsaa.org).

14.1 INTEGRATING SUSTAINABLE DESIGN INTO PROJECT MANAGEMENT

Ski areas are not architectural or engineering firms, whose specialties are design and construction. By the same token, architectural and engineering firms are not ski areas, whose specialties are providing an on-snow experience and being good stewards of their mountain environment. Therefore, it is a ski area's responsibility to clearly establish environmental goals for a project that will guide the architectural and engineering work. As long as the goals have been clearly defined, most of the design work and details should be left to a trusted design team. Rather than prescribing exactly what is required for sustainable design, the strategies discussed below are recommended for incorporating sustainable design into new construction projects.

14.1.1 Design Team

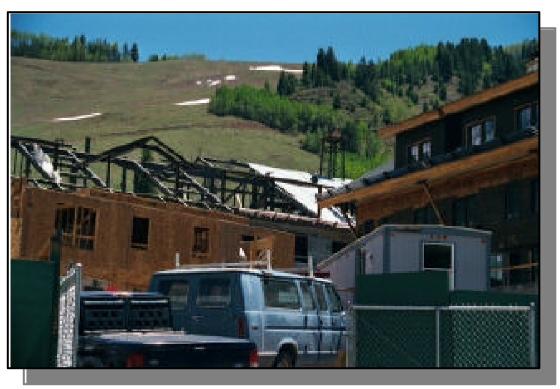
To ensure implementation of its sustainable design philosophy, a ski area should select design and related professional services on the basis of knowledge and demonstrated experience in applying sustainability concepts and principles through an integrated design approach.

> Ski resorts should seek out demonstrated contractor experience in applying sustainability concepts and principles to ski area projects through an integrated design approach.

Demonstration of such knowledge and experience should be specified in both a request for qualifications (RFQ) and request for proposals (RFP). Specifically, design teams should be asked to demonstrate the following:

- Expertise in environmentally responsible or sustainable ski area-related design
- Specific expertise in applying "integrated design" methodologies
- Experience with projects that use less heating and cooling energy than conventional standards
- Experience with projects that use less electrical and lighting energy than industry standards
- Experience with Leadership in Energy and Environmental Design (LEED™) or other green building rating systems
- Experience with projects that specifically addressed ensuring good indoor air quality through use of less toxic materials and/or better ventilation
- Experience with projects demonstrating site planning that sustains and enhances the natural environment by maximizing solar energy potential and use of natural light, maximizing the potential for natural ventilation, and minimizing off-site storm water runoff
- Experience writing specifications requiring waste management and recycling plans for construction and demolition
- Experience with life-cycle analysis techniques used to select building materials that minimize environmental impacts
- Client references for previous sustainable design work
- Experience performing energy simulations for building designs to optimize energy efficiency before construction begins

If the sustainable design expertise resides with a subcontractor rather than prime contractor, priority should be given to teams that have had success in working together on prior sustainable design projects. Moreover, priority should be given to submittals containing at least one example of a sustainable project previously designed, including an explanation of:



- Increased energy conservation and efficiency
- Increased use of renewable energy resources
- Application of daylighting strategies
- Reduction or elimination of toxic and hazardous substances
- Efficiency in resource and material use
- Selection of materials based on life-cycle environmental impacts
- Recycling of construction waste and building materials after demolition
- Metered performance and post-occupancy evaluation data to ensure that the building designed is performing as intended

There are additional ways that a ski area can include sustainability in the criteria for reviewing and scoring proposals received from design firms. This may entail assigning points to specific sustainable features, or it may entail use of the LEED™ rating system discussed in Section 14.1.3. Applicants may be required to estimate the number of LEED™ credits the completed project would qualify for and to document how the points would be obtained.

In keeping with a sustainability philosophy, ski area management should require that proposals be submitted on recycled paper with print on both sides. Although the appearance of proposals and professional presentations is important, the choice of proposal materials (paper, inks, binding materials, and so on) should reflect each team's understanding of and commitment to the sustainability principles sought in the project itself.

14.1.2 Contract Strategies

Once a design team is selected, ski area management may employ alternative contract mechanisms such as performance-based fees (PBF) to provide its design professionals with an incentive to design for sustainability and to share the risks and rewards of doing so.

Energy efficiency is a goal that all designers strive for, but achieving exceptional efficiency often requires an investment of more design time. However, conventional payment methods provide no extra award for the extra effort, nor do the designers receive any of the savings that their extra work realizes during building operations. Typically, architects and engineers get paid less per hour for putting in more time.

Under a PBF approach, a portion of the design fee is contingent upon meeting an energy performance target established in the initial agreement. This approach requires development of a base case and running of computer simulations comparing the base case to the energy efficient building design (the base case might be chosen based on local building code or the energy performance of like buildings operated by the ski area). If the building performs no better than the base, the architecture and engineering (A/E) team receives no additional fee despite having incurred the cost of performing the additional services. If the building performs at a level between the target and the base, the additional fee is prorated. If the building performs better than the target, the A/E team's compensation is proportionately greater than the value of the additional services.

14.1.3 LEED™ Certification

Building standards and certifications should be determined on a project-by-project basis. However, ski areas may consider using the LEED™ standard as a benchmark for comparing different design proposals and as a resource for investigating opportunities in sustainable design.

The LEED™ Green Building™ Rating System is a program of the U.S. Green Building Council. It is a voluntary, market-driven building rating system that evaluates energy and environmental performance from a "whole-building" perspective over a building's life-cycle. LEED™ is intended to define what constitutes a "green building."

LEED™ is a self-certifying system for rating new and existing commercial, institutional, and high-rise residential buildings. It is a feature-oriented system in which credits are awarded for satisfying different criteria. In addition, there are prerequisites that every building must meet to be certified. The table on the following page is summary of the LEED™ criteria. Note that some credits are worth more than one point. For more information about LEED™, a complete description of the system can be downloaded from www.usgbc.org.

LEED™ Scorecard

11 Points: Planning Sustainable Sites

- ❑ Credit 1 - Landscaping for Erosion Control
- ❑ Credit 2 - Reduce Heat Islands
- ❑ Credit 3 - Infill Development
- ❑ Credit 4 - Reduce Habitat Disturbance
- ❑ Credit 5 - Site Preservation/Restoration
- ❑ Credit 6 - Efficient Building Location
- ❑ Credit 7 - Alternative Transit Facilities
- ❑ Bonus Credit 1 - Alternative Fueling Facilities
- ❑ Bonus Credit 2 - Brownfield Development

11 Points: Improving Energy Efficiency

- ❑ Prerequisite 1 - Building Commissioning
- ❑ Prerequisite 2 - Energy Efficiency
- ❑ Credit 1 - Energy Efficiency (1 to 5)
- ❑ Credit 2 - Natural Ventilation, Heating, & Cooling
- ❑ Credit 3 - Waste Heat Recovery System
- ❑ Credit 4 - Renewable/Alternative Energy (1 to 3)
- ❑ Bonus Credit 5 - Measurement and Verification

12 Points: Conserving Materials and Resources

- ❑ Prerequisite 1 - Elimination of CFCs
- ❑ Prerequisite 2 - Storage/Collection of Recyclables
- ❑ Credit 1 - Existing Building Rehab. (1 or 2)
- ❑ Credit 2 - Resource Reuse (1 or 2)
- ❑ Credit 3 - Recycled Content (1 or 2)
- ❑ Credit 4 - Construction Waste Management (1 or 2)
- ❑ Credit 5 - Local Materials
- ❑ Credit 6 - Elimination of CFCs/Halons (1 or 2)
- ❑ Credit 7 - Occupant Recycling

7 Points: Enhancing Indoor Environmental Quality

- ❑ Prerequisite 1 - Elimination of asbestos
- ❑ Prerequisite 2 - Indoor Air Quality
- ❑ Prerequisite 3 - Smoking Ban
- ❑ Prerequisite 4 - Thermal Comfort
- ❑ Credit 1 - IAQ Management Plan (1 or 2)
- ❑ Credit 2 - Low VOC Materials (1 or 2)
- ❑ Credit 3 - Permanent Air Monitoring
- ❑ Credit 4 - Chemical Storage Areas
- ❑ Credit 5 - Architectural Entryways

8 Points: Safeguarding Water

- ❑ Prerequisite 1 - Water Conservation
- ❑ Prerequisite 2 - Elimination of Lead
- ❑ Credit 1 - Water-Conserving Fixtures
- ❑ Credit 2 - Water Recovery System
- ❑ Credit 3 - Water Conserving Cooling Towers
- ❑ Credit 4 - Water-Efficient Landscaping
- ❑ Credit 5 - Surface Runoff Filtration
- ❑ Credit 6 - Surface Runoff Reduction
- ❑ Bonus Credit 1 - Biological Waste Treatment
- ❑ Bonus Credit 2 - Measurement and Verification

1 Point: Improving the Design Process

- ❑ Credit 1 - LEED™ Certified Designer

50 Total Possible Points

CASE STUDY: ASPEN SKIING COMPANY (ASC) ACHIEVES LEED™ CERTIFICATION FOR THE SUNDECK

ASC worked with the U.S. Green Building Council to develop the LEED™ program. As a "LEED Pioneer," ASC provided feedback from its implementation of LEED 1.0 in the new Sundeck Restaurant and helped create LEED 2.0 (now being used around the world). In 2001, the Sundeck Restaurant became one of only eleven buildings in the world to achieve LEED certification, with a rating of Bronze. Sustainable design features of the new construction include the following:

- Landscaping plan that uses native grasses to minimize irrigation needs and eliminate irrigation entirely after the initial establishment period
- About 30 percent of the building's electricity generated from wind
- 3,700-square-foot deck outside the made of TREX, a recycled decking product

14.2 TEN KEY ASPECTS OF A SUSTAINABLE BUILDING

Ten key elements of a sustainable building include the following:

- Sustainable Site Planning and Landscape Design
- Use of Renewable Energy Resources
- High-Quality and Energy Efficient Lighting
- Energy Efficient Building Shell
- Energy Efficient HVAC System
- Environmentally Preferable Building Materials
- Water Conservation
- Recycling and Waste Management
- Construction Waste Reduction and Recycling
- Commissioning

This section briefly discusses each of elements.

14.2.1 Sustainable Site Planning and Landscape Design

Site planning is critical to the success of a sustainable building. Careful planning, building orientation, and landscaping can cut energy consumption levels and monthly utility expenses considerably. A site analysis should consider all existing features, both natural and man-made, of the site. If possible, site planning should include a topographical analysis of existing features. Emphasis should be placed on the site's relationship to the larger environment and its special features. This analysis should include natural, cultural, and aesthetic factors that affect the site. During site planning, the designer must be aware that any structure will inevitably (by virtue of its physical presence and operation) affect not only the site's ecosystem but others elsewhere. The structure's possible influence on surrounding ecosystems must be included as part of the set of design considerations. One key part of a well-designed building is that it let natural energy sources work for it. For example, for a ski area, one important consideration in site planning is the building position on the mountain to maximize solar heat gain.

14.2.2 Use of Renewable Energy Sources

Predictions of remaining supply of non-renewable energy sources vary widely, but the fossil fuel supply is finite, and fossil fuel combustion produces air pollutants and contributes to global warming. In contrast, renewable energy sources are constantly replenished and do not have the environmental consequences associated with combustion. For a ski area, the most likely renewable energy options are passive solar heating, photovoltaics, possibly geothermal sources, and wind power.

CASE STUDY: WIND POWERS THE ASC CIRQUE SKI LIFT

ASC used sustainable practices in the site planning and construction of a new ski lift above treeline (the Cirque lift); in fact, the lift was constructed without bulldozers or other mechanized ground equipment that would damage fragile alpine environment. ASC carried sustainable design principles "to the next level" by using clean, renewable, wind-generated electricity purchased from Ponnequin Wind Farm in northern Colorado to run the lift.

According to the ASC Environmental Affairs Department, because it is wind-powered, the Cirque lift provides environmental benefits equivalent to planting 17 acres of trees or not driving a car 95,000 miles . Running the lift on wind power is keeping 40,000 pounds of coal in the ground, and 82,000 pounds of carbon dioxide out of the atmosphere.

14.2.3 High Quality and Energy Efficient Lighting

Lighting is a critical aspect of both a high-quality environment and an environmentally sustainable building. There are numerous opportunities to improve the light quality while significantly reducing lighting the energy. Lighting approaches should rely primarily on well-designed daylighting systems complemented as necessary by energy efficient electric lighting systems. Daylighting and electric lighting should be designed only in the context of a whole-building design approach starting with decisions regarding the orientation and shape of the building. Well-designed daylighting provides a superior light quality, reduces energy costs, and improves the overall environment of the area. Daylighting also involves consideration of heat gain, glare, variations in light availability, and sunlight penetration into a building. A successful design must address details such as shading devices, aperture size and spacing, glazing materials and surface reflectance characteristics. Some primary strategies for designing electric lighting systems include:

- Carefully defining the required lighting
- Putting the right amount of light where it is needed, when it is needed
- Avoiding glare from the ceiling and walls
- Blending electric lighting and daylighting
- Avoiding lighting flicker and noise
- Providing good color rendition

Implementation of these strategies requires up-to-date lighting design skills and knowledge of available energy efficient lighting equipment and its performance. More information about energy efficient lighting is included in Chapter 10, Buildings.

14.2.4 Energy Efficient Building Shell

A building's shell consists of the exterior walls, roof, foundation, doors, windows, skylights, dampers, and other openings. The objectives for a well-designed building shell are to (1) minimize infiltration (both outside air leaking in and interior air leaking out), (2) reduce convective heat transfer, (3) control humidity by maintaining proper movement of water vapor in and out of the building, and (4) control or use sunlight to reduce heating ventilation and air conditioning (HVAC) loads and electric lighting needs. Strategies for meeting these objectives typically include the addition of insulation to walls, floors, and roofs; window upgrades or treatments; and shell tightening measures to reduce air infiltration and exfiltration. These strategies are especially important for a ski area building because of the extreme weather conditions during parts of the year. It is extremely costly for a building in a cold climate to have air leaks or drafts that cause heat loss.

14.2.5 Energy Efficient HVAC Systems

The sustainable design goal for HVAC systems is to meet occupant comfort needs using the most energy efficient and environmentally sensitive means possible. Although this may sound simple, the HVAC is a pivotal aspect in the design of a sustainable building because heating and cooling needs are affected by virtually every other characteristic (sustainable or nonsustainable) of the building. For example, the extent of passive solar design, natural lighting, and natural ventilation; insulation and window performance; and material selection all affect the requirements for conditioned air. Therefore, the HVAC system design is a prime example of the importance of integrated, whole-building design. Notably, if everything else is done sustainably, it should be possible to significantly downsize the HVAC system. HVAC costs are generally 20 percent of construction costs. Therefore, system downsizing represents a significant opportunity for cost savings during construction and throughout the building life. The appropriate HVAC system should therefore be selected only after the entire design team has reviewed the contributing thermal loads of all interrelated systems. Aside from ensuring proper system size, the following sustainable design goals for HVAC systems should be considered:

- Simple design
- Easy to maintain
- Minimal number of components
- Energy efficient
- Best life-cycle cost (including energy, maintenance, and replacement costs)
- Optimal air distribution configuration
- Consideration of how surfaces affect radiant comfort
- Low noise levels

14.2.6 Environmentally Preferable Building Materials

Environmentally preferable materials are those that have less impact on human health and the environment than other materials serving the same purpose. Environmentally preferable materials can help to improve indoor air quality in buildings, and are also more ecologically sensitive when analyzed over their entire life-cycle. This cradle-to-grave analysis involves tracking a material from its initial source through extraction, refinement, fabrication, treatment, transport, use, and eventual reuse or disposal. This analysis can be a complex aspect of sustainable design considering (1) the number of products claimed to be "green" and (2) the factors involved in comparing products on an environmental basis. Use of green building products requires both a prioritization scheme for comparing products and enough time to research specific products and their function, cost, and local availability. Many considerations are involved in choosing building materials, such as whether a material is natural, available locally, made from recycled material, and durable. Table 14.1 (on the following page) summarizes criteria for evaluating and choosing building products and materials.

14.2.7 Water Conservation

Water is a limited natural resource that should be used efficiently indoors and out. Conserving water saves money, but the ramifications of water efficiency go far beyond lower water bills. For example, at the community level, water conservation can help to eliminate or defer the need for more dams, treatment facilities, and expensive water rights. Water treatment consumes a great deal of energy, and a large percentage of the treated water ends up being flushed down toilets and used to water landscape. Installing water-efficient appliances and fixtures and changing snowmaking practices can reduce water consumption by significant amounts. To conserve water to the greatest extent possible, the following steps should be applied to the sustainable design process:

- Minimize the amount of water required to operate inside and outside the building
- Distinguish between water needs that can be met using raw (untreated) water, and those that must be met using treated water and have separate water supplies and distribution systems
- Evaluate methods for obtaining the required raw water supply using on-site resources such as streams or ponds

TABLE 14.1 GREEN BUILDING PRODUCT AND MATERIAL CRITERIA

Environmental Factor	Criterion
Energy efficiency	• Energy efficient production methods • Use of renewable energy sources
Resource responsibility	• Minimal need for other materials • Low maintenance • Durability • Efficient use of material • Recycled content • Recyclable
Social and public health	• Avoidance of harmful chemicals in production • Minimal off-gassing • Avoidance of harmful chemicals in use, disposal, and reuse
Economics and functionality	• Initial cost • Cost savings and payback period • Availability • Performance
Supplier or manufacturer	• Local supplier • Local economic benefits • Suppliers with in-house environmental programs

14.2.8 Recycling and Waste Management

A sustainable design building should be designed to foster sustainable practices within the building. For example, one requirement for each LEED™-certified sustainable building (see Section 14.1.3) is that the building be designed for storage and collection of recyclables. Although many ski areas have recycling programs in place, there is usually room for improvement—for example, expansion to include additional materials or to make current recycling efforts more efficient and less labor-intensive. The sustainable design process should include examination of current recycling practices at the ski area, and development of provisions for continuing and improving upon these practices in new buildings. Also, collection systems for recyclables should be designed to minimize labor costs. For example, chute systems that drop recyclables to central collection areas may save money.

14.2.9 Construction Waste Reduction and Recycling

Using construction methods that minimize waste generation is critical, as it is estimated that construction-related waste accounts for about 25 percent of the total landfill waste in the US. Yet many construction materials can be recycled, including glass, aluminum, carpet, steel, brick, and gypsum. Fifty to 80 percent of construction and demolition (C&D) waste is potentially reusable or recyclable, depending on the type of project being performed and local markets for waste materials.

Strategies for applying sustainability principles to construction practices include:

- Use of waste reduction techniques during construction
- Reuse of construction waste material on the construction site
- Salvaging C&D waste material from the construction site for resale or reuse by others
- Returning unused construction material to vendors for credit
- Recycling C&D waste for remanufacture into new products

CASE STUDY: ASC RECYCLES A RESTAURANT AND LODGE

ASC was faced with the challenged of removing a pre-existing restaurant building from the site designated for a new restaurant; the site lay at an elevation of 11,300 feet on Aspen Mountain. Instead of demolishing and removing the old structure in a conventional manner, ASC first salvaged materials such as structural wood, doors, and plywood for sale and reuse; ASC then ground the remaining wood and sheetrock. It cost $93,400 to deconstruct the old restaurant, where as a conventional demolition project would have cost $135,000. Most of the savings were gained by grinding wood waste into pulp, which was used as compost at the local landfill. Grinding the wood reduced its volume by a factor of five, resulting in a 500 percent decrease in truck trips to the local landfill, and saving time and money while decreasing pollution. The landfill waived the disposal fee of $21.50/yd^3 because the landfill resells chipped wood and sheetrock as compost.

A total of 1,340 cubic yards (yd^3) of demolition material was produced during the project. Figure 14-1 shows the breakdown of these materials. Figure 14-2 shows the breakdown of the waste disposal costs.

FIGURE 14-1 SUNDECK RESTAURANT DEMOLITION WASTE GENERATION

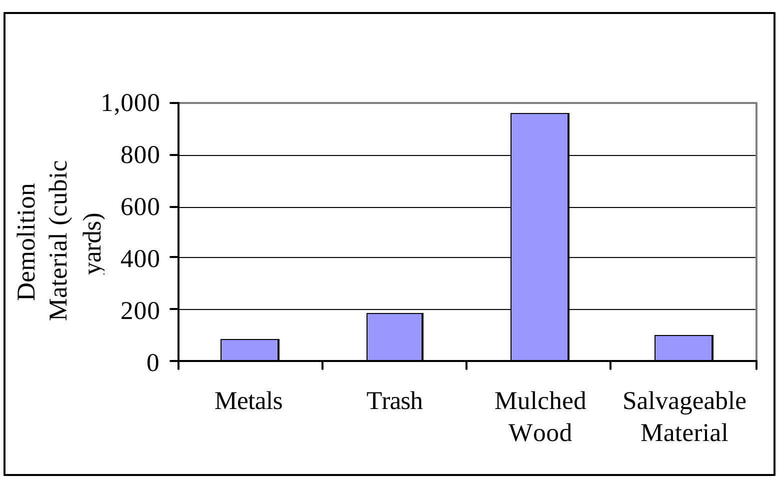
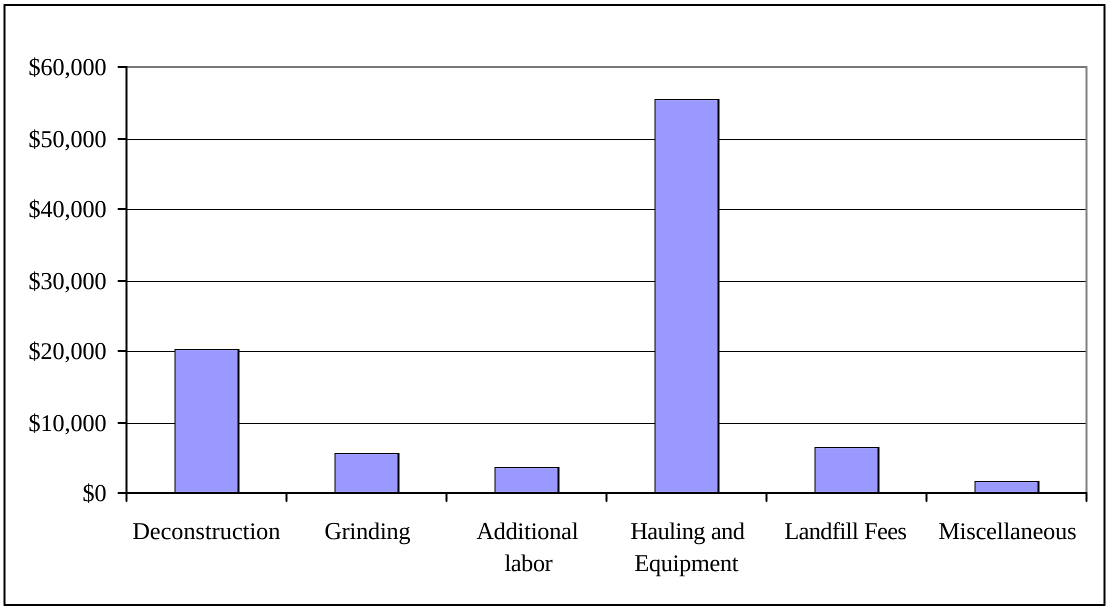


FIGURE 14-2 SUNDECK RESTAURANT DEMOLITION WASTE DISPOSAL COSTS

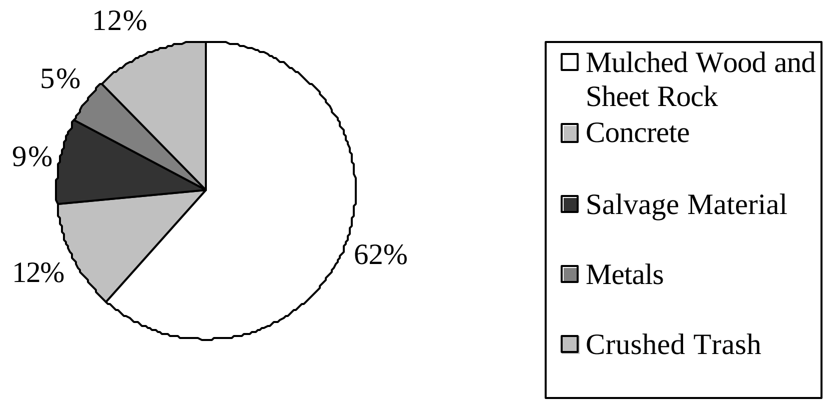


ASC also deconstructed and recycled the Snowmass Lodge and Club. Alpine Demolition in Arvada, Colorado, implemented the deconstruction process at the Snowmass Lodge and Club. Overall, the project phases included (1) furniture and appliance sales, (2) employee give-aways, (3) deconstruction, (4) segregation, (5) on-site grinding (5:1 reduction of wood waste), (6) composting and landfill, and (7) reuse. As a result of the project, the following items were salvaged for reuse or recycling.

- 649 yd^3 of building materials for reuse
- 400 yd^3 of rock and fill reused as fill on site
- 60 yd^3 of steel and wood
- 610 yd^3 of salvageable materials
- 210 yd^3 of concrete crushed and used as fill on site
- 3,200 pounds of copper pipe
- 800 pounds of aluminum pipe
- 380 yd^3 of miscellaneous steel
- 3 yd^3 of wire
- 10 yd^3 of miscellaneous material
- 45 yd^3 of wood beams and 15 yd^3 of steel beams

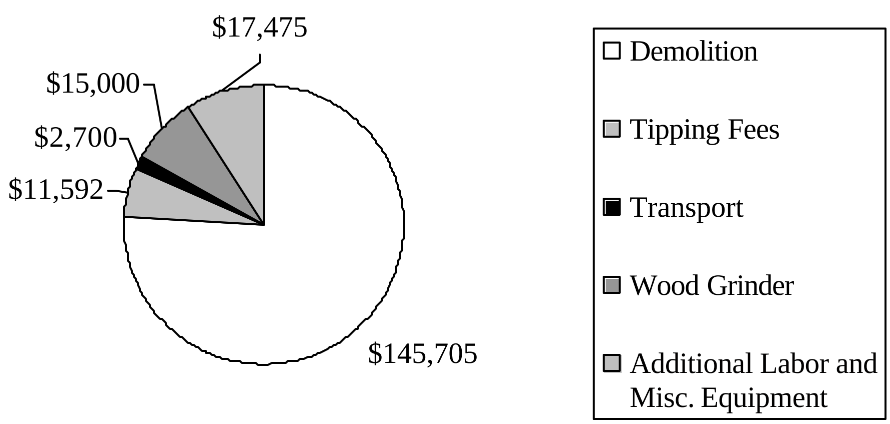
ASC held a salvage sale where the public was offered a chance to buy deconstructed materials. This sale diverted an estimated 610 yd^3 of material from being hauled to the landfill. About 6,810 yd^3 of demolition debris was generated during deconstruction. A breakdown of the demolition waste is shown in Figure 14-3.

FIGURE 14-3 ASC LODGE AND CLUB DEMOLITION DEBRIS



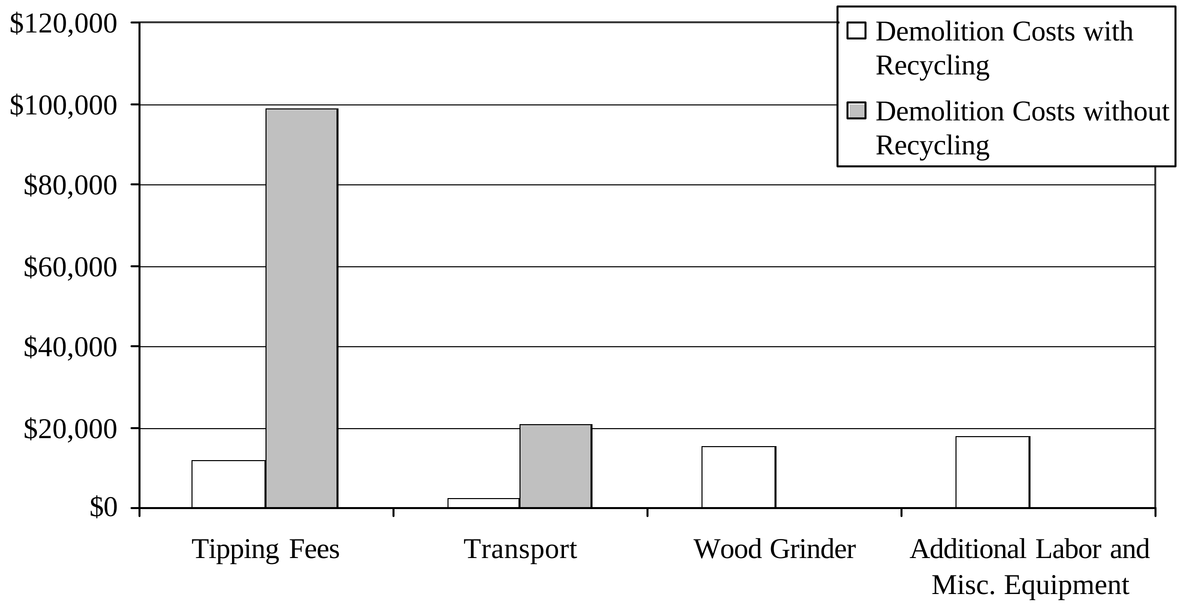
An estimated 6,000 yd^3 (88 percent) of material was diverted from the landfill for recycling. ASC paid $11,592 to dispose of the items not diverted. If all 6,810 yd^3 of debris had been taken to the landfill without recycling, it would have cost almost $94,000. Figure 14-4 represents the costs Snowmass Mountain incurred for deconstruction and recycling:

FIGURE 14-4 ASC LODGE AND CLUB DESTRUCTION AND RECYCLING COSTS



With or without recycling, the cost for the Lodge and Club demolition would have been $145,705. However, the overall savings realized from deconstructing and recycling the building materials was $72,787. Figure 14-5 shows the comparison of costs between demolition with and without recycling. Revenue was generated through (1) furniture sales (of interior furnishings, curtains, etc) that brought in $58,000 and (2) a salvage sale, during which 610 yd^3, windows, beams, and doors sold for a total of $10,500.

FIGURE 14-5 ASC LODGE AND CLUB DEMOLITION COST COMPARISON



14.2.10 Commissioning

Commissioning is defined as "documented confirmation that building systems function in compliance with criteria set forth in the project documents to satisfy the owner's operational needs." This definition is based on the critical understanding that the owner must have some means of verifying that functional needs are rigorously addressed during building design, construction, and acceptance.

Commissioning can be thought of as the step that bridges the gap between a sustainable design building on paper and the fully functional, energy efficient, sustainable building in practice. Essentially, commissioning verifies that building systems perform as intended so that the anticipated benefits of sustainable design become a reality. It also provides a communication conduit from the design team to the staff charged with day-to-day operation of the building. Commissioning is a required component of LEED™ certification (see Section 14.1.3).

14.4 ADDITIONAL INFORMATION SOURCES

The following table contains a list of more extensive resources relate to sustainable design and construction.

RESOURCE	DESCRIPTION
The Sustainable Building Technical Manual Department of Energy (DOE) Center of Excellence for Sustainable Development 1617 Cole Boulevard, Golden, CO 80401; available for free download from www.sustainable.doe.gov/articles/ptipub.shtml	A manual for designing, operating, and maintaining environmentally friendly buildings; over 300 pages of detailed suggestions written by more than 24 leading experts; designed to synthesize the large volume of information available on green buildings; very comprehensive

RESOURCE	DESCRIPTION
The Sustainable Building Sourcebook www.greenbuilder.com/sourcebook,	Created by the Austin Green Builder Program; 400-page document is being converted to html format for direct download. Contains sections on water, energy, building materials, and waste
Environmental Building News www.ebuild.com	Monthly newsletter and web site for environmentally sustainable design and construction
Center for Resourceful Building Technology (CRBT) Guide to Resource Efficient Building Elements P.O. Box 100, Missoula, MT 59806	Detailed guide to resource-efficient material selection and construction methods; covers foundations and block walls, framing, panel systems, sheathing and wallboard, roofing, siding and exterior trim, insulation, windows and doors, interior finishes, floor coverings, salvaged materials, landscaping, job site recycling, and indigenous building; for each topic covered, an overview is provided followed by a list of vendors and contact information.
AIA Environmental Resource Guide American Institute of Architects (AIA) Order Department 9 Jay Gould Court, P.O. Box 753 Waldorf, MD 20604 (800) 365-ARCH (800) 678-7102 (facsimile)	A 600-page, 3-ring binder containing information for design professionals or incorporating environmental criteria into design decisions; well-formatted with easy access to both in-depth product details and at-a-glance reference charts; contains project reports of case studies, application reports comparing material performance and environmental concerns within product categories, and materials reports detailing life-cycle impacts of 20 categories of building materials.
AIA Colorado www.aiacolorado.org	Sustainable design database for Colorado and the Western Mountain Region compiled by the AIA Committee on the Environment
Waste Spec Triangle J Council of Governments P.O. Box 12276 Research Triangle Park, NC 27709 (919) 549-0551	A 114-page binder providing architects and engineers with background information and model specification language regarding waste reduction, reuse, and recycling before and during construction and demolition; contains specifications tailored to all 16 divisions of the Construction Specifications Institute (CSI) format; includes a sample waste management plan for construction contractors; comes with a disc containing model specifications in a generic format that can be cut and pasted into standard specifications
Green Spec Kalin Associates, 154 Wells Avenue Newton Centre, MA 02159 (617) 964-5477	A database of green products and practices organized by CSI Master format; includes the pros and cons of existing products and methodologies and the green alternatives; supplies specification language; costs: $125

RESOURCE	DESCRIPTION
Resources for Environmental Design Index (REDI) http://oikos.com/index.html iris@oikos.com	A free database listing over 1,800 companies providing green products and services; can be searched by CSI division or company name; web version located at is updated weekly; three times a year, all companies listed in the database are contacted for current information.
NPS Sustainable Design and Construction Database www.nps.gov/dsc/dsgncnstr/ Bob Lopenske, Denver Service Center 12795 W. Alameda Parkway P.O. Box 25287 Denver, CO, 80225-0287 (303) 969-5406	Sustainable design portion of the database lists over 1,000 products that can be searched by manufacturing plant location, CSI division, or product type; products are rated in terms of 14 environmental factors; the construction portion of the database contains information and resources for construction site recycling; database is available on four diskettes from the National Park Service or can be downloaded directly from the Internet
Green Developments Book and CD ROM www.RMI.org	A textbook and accompanying CD ROM for developers, architects, and engineers; describes green development principles and practices and presents over 100 case studies of green buildings around the world; each case study includes a description of green features, cost savings, and impacts; searchable database based on keywords, locations, building types (commercial, industrial, residential, and so on), and other attributes; contains technical briefs on various technologies as well as background information on the basics of green design; new accompanying CD ROM with 200 case studies will be available in January 2002
Sustainable Buildings Industry Council www.sbicouncil.org/	Distributor of Energy 10 software, which has user-friendly, comprehensive energy usage simulations for buildings of less than 10,000 square feet.
Building Life Cycle Cost (BLCC) Software www.eren.doe.gov *(*download requires technical assistance and analytical software tools)	Provides an economic analysis of proposed capital investments that are expected to reduce long-term operating costs of buildings or building systems; up to 99 alternative designs can be evaluated simultaneously to determine which has the lowest life-cycle cost; several economic measures, including internal rate of return and payback period, can be computed for each alternative; complies with American Society for Testing and Materials (ASTM) standards related to building economics and National Institute of Standards and Technology (NIST) Handbook 135, Life Cycle Costing Manual for FEMP

RESOURCE	DESCRIPTION
Building Sustainable Resorts: Guidelines for Environmentally Sustainable Design and Construction of Aspen Skiing Company Buildings Auden Schendler (970) 923-8628 aschendler@aspensnowmass.com	To guide contractors, architects, and staff, ASC has published a booklet called "Building Sustainable Resorts: Guidelines for Environmentally Sustainable Design and Construction of ASC Buildings."
Build for the Future Kathy Dale, (303) 692-2976 kjdale@smtpgate.dphe.state.co.us	Colorado Department of Public Health and Environment's bound report provides statewide resources for sustainable building practices; include vendor contact information.