Report on
Historic Preservation and Sustainability

SUMMARY REPORT

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Department of Archeology and Historic Preservation

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ii. INTRODUCTION

In the past several years, issues surrounding climate change and sustainability have been at the forefront of national and global agendas. Reducing energy consumption and greenhouse gas emissions (GHG) is an essential part of reducing the impacts human development has had on our natural ecosystems and human health. For the building industry this is a critical time, for the amount of energy consumption and GHG emissions from buildings is staggering. In terms of raw material extraction and land use, the construction industry has the greatest impact of any sector.[1] As a result, the building industry has been advancing towards its goals of 'green' building for the past two decades in order to reduce the impact on our environment and natural resources.

The concept of sustainability has long been embedded in the practice of historic preservation. Preservation and reuse of historic buildings reduces resource and material consumption, puts less waste in landfills and consumes less energy than demolishing buildings and constructing new ones. Over the past decade, advances in high performance or "green" buildings have been numerous, but primarily have focused on new construction. As a result, the preservation and adaptability of historic and older buildings has not always been at the forefront of the 'green' movement agenda. However, preservationists have long championed stewardship of our most important built resources, and have promoted how the repair and maintenance of historic buildings can support a variety of uses for generations to come. Historic buildings, often energy efficient from inherent characteristics, can be upgraded with new technologies to maximize energy performance. Historic features, such as windows, can be repaired and restored for higher efficiency. It has been said that the greenest building already exists, as our historic buildings represent existing, durable resources that can be reused for generations. In addition to saving existing resources and historic character, historic preservation means environmental, cultural and economic benefits for Washington communities.

This study was initiated by the Washington State Department of Archeology and Historic Preservation (DAHP), and was carried out by faculty and graduate students at the University of Washington's Department of Architecture. This effort was supported by the ideas and suggestions of an advisory panel that consisted of architects, planners, historic preservationists, energy consultants and related professionals, all with the interest and experience of sustainable construction and historic preservation. The goal of the report was to disseminate information to property owners, policy makers, architects, planners, preservationists, developers and other interested parties on the critical relationship between historic preservation and sustainability. The report is intended to initiate the discussion of historic preservation as a sustainable act, and to build upon

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[1] UNEP, "Buildings and Climate Change: Status, Challenges and Opportunities.," (United Nations Environment Programme, 2007). Available at: http://www.unep.org/publications/search/pub_details_s.asp?ID=3934

current research that supports these goals. The report concludes that rather than demolishing and replacing historic buildings, it is better to reuse, repair and maintain them. It also takes on key issues of sustainable preservation, as well as suggests strategies for reducing energy consumption in historic rehabilitation projects. By reducing our resource consumption in buildings, reducing our landfill impact from new construction and demolition waste and upgrading our historic buildings to new energy efficient technologies, historic preservation in Washington State means environmental, cultural and economic benefit for our shared human and ecological future.

iii. EXECUTIVE SUMMARY

Historic Preservation and Sustainability in Washington State

HISTORIC PRESERVATION AND SUSTAINABILITY ARE NATURAL PARTNERS.

Preservation and reuse of historic buildings reduces resource and material consumption, puts less waste in landfills and consumes less energy than demolishing buildings and constructing new ones. Over the past decade, advances in high performance or "green" buildings have been numerous, but primarily have focused on new construction. As a result, the preservation and adaptability of historic and older buildings has not always been at the forefront of the 'green' movement agenda. However, this is changing. Historic buildings, often energy efficient from inherent characteristics, can be upgraded with new technologies to maximize energy performance. Historic features, such as windows can be repaired and restored for higher efficiency. In addition to saving existing resources and historic character, historic preservation means environmental, cultural and economic benefits for Washington communities.

BUILDINGS CONSUME ENORMOUS AMOUNTS OF OUR RESOURCES.

In the United States, 43% of carbon emissions and 40% of total energy use is attributed to the construction and operation of buildings[2]. The environmental impact of buildings is even more significant when we take into consideration the greenhouse gas emissions associated with manufacturing building materials and products. As a key element in sustainable development, the preservation, reuse and "greening" of existing historic buildings present excellent opportunities to reduce our nation's energy consumption and carbon emissions.

HISTORIC BUILDINGS ARE A VALUABLE, EXISTING RESOURCE.

A study conducted in 2004 by the Brookings Institution reported that if we continue with national trends of development, by 2030 we will have demolished and rebuilt nearly one-third of our entire building stock – a staggering total of 82 billion square feet.[3] The energy required to do so would power the entire state of California – 37 million people – for an entire decade. Demolishing and rebuilding takes vast amounts of energy and materials, both of which are increasingly in short supply.

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[2] United States Department of Energy, "Buildings Energy Data Book," (U.S. Department of Energy, 2008).

[3] Arthur C. Nelson, "Towards a New Metropolis: The Oppportunity to Rebuild America," (The Brookings Insitution Metropolitan Policy Program, 2004).

In addition, demolition and waste have profound adverse impacts on our landfills. Building-related construction and demolition (C&D) debris constitute about two-thirds of all non-industrial solid waste generation in the United States (US).[4] The average building demolition yields 155 pounds of waste per square foot while the average new construction project yields 3.9 pounds of waste per square foot of building area.[5] In Washington State, even with our 45% diversion rate into recycling, an estimated 1,383,998 tons of debris per year ends up in landfills, most of which comes from demolition and new construction projects. This averages an additional 2.2 pounds of garbage to our landfills per day per person in Washington.[6] When we reuse our historic buildings rather than replacing them, less debris ends up in our landfills and our environment is healthier.

PRESERVING HISTORIC BUILDINGS CONSERVES ENERGY AND RESOURCES.

Historic buildings have embodied energy in them that is lost if a building is demolished. Embodied energy is a measurement of energy used in the process of building, from the extraction of raw materials - such as harvesting trees - to the final installation of the finished material- such as framing lumber and carpentry. Embodied carbon represents the carbon emissions from the actual construction process. According to a study commissioned by the federal Advisory Council on Historic Preservation (ACHP), about 80 billion British Thermal Units (BTU) of energy are embodied in a typical 50,000 square-foot commercial building, the equivalent of about 640,000 gallons of gasoline.[7] If a building is demolished rather than reused, that expended energy and carbon is essentially wasted, and even more is expended for the demolition process and new construction.

Recent studies have successfully measured the impact of embodied energy and carbon and the implications to historic preservation. The United Nations Energy Programme estimates it takes 20 years of a typical building's 100 year operation just to offset the expenditure of its construction energy and materials.[8] Another report, focusing on the Grand Central Arcade in Seattle's Pioneer Square Historic District, concluded the embodied energy it would take to tear down the Arcade and reconstruct it to the same scale would be equal

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[4] Environmental Protection Agency, "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2008," (2008).

[5] Linda Monroe, "Diverting Construction Waste," *Buildings* 2008.

[6] Washington State Department of Ecology, "Generation, Recyling and Per Capita Data (1986-2009)," (DOE, 2009).

[7] Allen & Hamilton Booz, "Assessing the Energy Conservation Benefits of Historic Preservation: Methods and Examples," (Advisory Council on Historic Preservation, 1979).

[8] UNEP, "Buildings and Climate Change: Status, Challenges and Opportunities.."

to 730,000 gallons of gasoline.[9] While embodied energy and carbon are only part of the picture, they represent tangible measurements of the value of buildings as an existing resource and how preservation contributes to a sustainable future.

HISTORIC BUILDINGS CAN BE ENERGY EFFICIENT, TOO

Buildings accounted for 72% of total U.S. electricity consumption in 2006 and it is predicted this number will rise to 75% by 2025. Fifty one percent of that total was attributed to residential building use, while 49 % was a result of commercial building use.[10] Although historic buildings are often dismissed as inefficient energy consumers, mounting evidence reaches different conclusions. For example, data from the U.S. Department of Energy (DOE) indicates that commercial buildings constructed before 1920 actually use less energy per square foot than buildings from any other decade up until 2000 (EIA, 2003).

WHY?

Many historic buildings were designed with passive systems before the invention of electric lighting and powered heating and cooling. As a result, these buildings were designed to take advantage of natural daylight, ventilation, and solar orientation- the very characteristics that are being used as “sustainable” design attributes today. In addition, historic structures often were constructed with traditional, durable materials such as concrete, wood, glass and steel. When properly maintained these materials can have a much longer lifespan. In both residential and commercial buildings, energy consumption is dominated by space heating, venting, air conditioning (HVAC) and lighting (DOE, 2008). In historic buildings - as well as new ones - using efficient technologies can reduce greenhouse gas emissions by reducing energy use.

REPAIR, RESTORE AND MAINTAIN - *NOT REPLACE* - YOUR HISTORIC WINDOWS, DOORS, SIDING, ETC.

Historic building components, particularly windows, are mistakenly regarded as one of the major sources of energy loss in buildings. However, the DOE concludes that only an average of 10% of energy loss in the average home is caused by windows. In fact, more energy is lost through plumbing openings and un-insulated ducts than through windows.[11] While it is often said that replacing old windows with new replacement windows will save energy, there is debate as to whether doing so in historic structures is either energy efficient or cost effective over time. Rehabilitating and maintaining historic windows with appropriate energy saving techniques can be an economical and effective energy-saving solution. This repair or

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[9] Patrice Frey, "Making the Case: Historic Preservation as Sutainable Development " (National Trust for Historic Preservation, 2007).

[10] Washington State Department of Energy, "2009 Biennial Energy Report with Indicators," (Department of Energy, 2009).

[11] United States Energy Information Agency, "Emissions of Greenhouse Gases Report," (U.S. Department of Energy, 2008).

rehabilitation not only reduces the disposal of the old windows into landfills, but also reduces new window manufacturing costs and effects on the environment. New or replacement windows, in comparison, last an average of 10 to 20 years. Their materials, such as glass, vinyl and aluminum, are not biodegradable or easily recycled. In addition, PVC (vinyl) windows are considered a toxic or "red" material by green building standards.[12] Therefore, keeping historic windows is both green and healthy for occupants, as well as the environment. Best of all, historic windows can last indefinitely if properly maintained.[13]

THE SECRETARY OF INTERIOR STANDARDS FOR REHABILITATION

For decades, the U.S. Secretary of Interior's Standards for Historic Rehabilitation (Standards) have provided guidance for appropriate rehabilitation of historic buildings that allow for updates and modern amenities while protecting historic design and building fabric. But with the introduction of energy efficiency measures and green building techniques, property owners have questioned whether historic buildings can be rehabilitated according to the Standards while at the same time increasing energy efficiency and meeting green building standards. The case studies featured in this report plus a growing body of historic rehabilitation work across the nation, clearly demonstrate that the Standards and green building technologies are compatible. While some of the principles set forth in the Standards may at first seem to be in conflict, most issues can be resolved by: early consultation with a qualified preservation designer; a clear understanding of the project's design and technical issues; and familiarity with applying the Standards. The most common conflicts are installing inappropriate solar roofing materials, insulating walls without restoring original trim details, adding non-historic features for day lighting such as dormers or inappropriate skylights, and removing historic character-defining features like doors and windows for energy efficiency.[14]

The good news is that many cost-effective strategies that reduce energy consumption in historic buildings can start with small, simple changes. Once the project is completed, following up with a consistent implementation and maintenance plan is vital, since many energy saving strategies can be achieved through occupant habits and building and system maintenance.

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[12] The International Living Building Institute, "The Living Building Challenge," http://ilbi.org/.(accessed: January 12, 2011).

[13] Walter Sedovic and Jill H. Goothelf, "What Replacement Windows Can't Replace: The Real Cost of Removing Historic Windows," *Association for Preservation Technology Bulletin* 36, no. 4 (2005).

[14] National Park Service, "Energy Efficiency, Sustainability, and Green Building Practices in Historic Buildings," http://www.cr.nps.gov/tps/standards/applying-rehabilitation/successful-rehab/energy-efficiency.htm. (accessed: January 18, 2011).

TIPS FOR SUSTAINABLE HISTORIC REHABILITATION PROJECTS

- Insulate unfinished areas first, such as attics and basements, where historic fabric is less likely to be altered.
- Diagnose existing insulation and infiltration conditions with technologies such as blower tests, energy audits and infrared thermo-graphic inspections that can detect where improvements can be made.
- Evaluate existing heating, ventilation and air conditioning (HVAC) systems to ensure they are functioning properly; replace with higher efficiency units if needed. Maintain units properly for best performance. Supplement with low-energy boosters like fans, shading devices and programmable thermostats.
- Check with qualified preservation consultants to see how renewable energy sources such as ground source heat pumps, solar panels and wind turbines can be appropriately integrated into your project. Search for rebates for renewable energy sources.
- Evaluate existing lighting conditions and consult a lighting contractor if needed. Prioritize electric lighting use only when needed, and install sensors that switch on and off with occupancy. Look for ways to improve interior natural day-lighting.
- Repair and maintain historic windows (see below), light monitors and skylights wherever possible. Add new skylights only on secondary facades or screened surfaces to bring in more natural light without losing historic integrity.
- Install low-flow plumbing fixtures and install aerators in existing fixtures to reduce water use by up to 40%. Provide rain barrels at downspouts to catch runoff and use water for landscape maintenance.

TIPS FOR HISTORIC WINDOW REPAIR, MAINTENAINCE AND EFFICIENCY

- Most heat loss occurs around the windows' perimeter through infiltration rather than through the actual glass. Therefore, keep seals tight and in good repair. Also, check sealant at all window muntins.
- Keep exterior surfaces painted, including putty, with durable low VOC [volatile organic compounds] exterior grade paints.
- Add weather stripping to your windows to increase efficiency as much as 50%. To reduce heat loss, weather-strip your doors around the perimeter and in any inset glazing.

- Use exterior or interior storm windows in the winter as studies show that a window fitted with a storm window can last longer and be just as energy efficient as replacement windows.
- Check the lock on the window – the locks' most important job is ensuring that the rails and sash are held together tightly, reducing air infiltration.
- If glass in historic windows needs to be replaced, consider laminated glass. It can be installed with low-emissivity (low-E) glazing that has energy and noise reduction benefits, is easy to install, and maintains a historic finish.
- Low-E glazing reduces heat transfer through glass and can be more energy efficient than regular glazing.
- Remember, windows are only part of the picture. Therefore, it is important to follow other tips for making the entire building more efficient through insulation, weather-stripping, and installing efficient/updated heating and cooling systems.

HISTORIC PRESERVATION AND SUSTAINABILITY IN WASHINGTON STATE:

- Fosters an ethic of reuse, repair and renewal rather than consumption and waste;
- Is energy efficient and reduces our reliance on fossil fuel and non-renewable energy sources;
- Reduces construction and demolition waste going to landfills;
- Promotes an increased use of salvaged and recycled buildings and their materials;
- Encourages the purchasing and use of locally sourced products, materials and labor;
- Promotes social and cultural sustainability through the stewardship of historic resources;
- Uses on-site water efficiently through improved infrastructure and reuse;
- Improves worker and occupant health and productivity through healthier environments.

1. HISTORIC BUILDINGS AND THE CONNECTION WITH SUSTAINABILITY

Introduction

Historic preservation and sustainability are natural partners. Preservation and reuse of historic buildings reduces resource and material consumption, puts less waste in landfills and consumes less energy than demolishing buildings and constructing new ones. Over the past decade, advances in high performance or "green" buildings have been numerous, but primarily have focused on new construction. As a result, the preservation and adaptability of historic and older buildings has not always been at the forefront of the 'green' movement agenda. However, this is changing. Historic buildings, often energy efficient from inherent characteristics, can be upgraded with new technologies to maximize energy performance. Historic features, such as windows can be repaired and restored for higher efficiency. In addition to saving existing resources and historic character, historic preservation means environmental, cultural and economic benefits for Washington communities.

In the past several years, sustainable development has been at the top of agendas across national and global debates on climate change and energy efficiency. However, the term "sustainability" is often confusing and used in many contexts, and therefore has come to mean different things to different people. In terms of sustainable design, construction and operations of buildings, the most commonly cited definition of sustainability is defined by the United Nations in 1987, when the Bruntland Commission on Environment and Development wrote:

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[15]

This definition illustrates the larger goal of sustainability in how it can apply to both built and natural resources. The word *sustainability*, according to Mirriam-Websters Dictionary originates back to 1727 and means:

> 1. capable of being sustained
>
> 2 *a*: of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged <*sustainable* techniques> <*sustainable* agriculture> *b*: of or relating to a lifestyle involving the use of sustainable methods <*sustainable* society>

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[15] G. Bruntland, *Our Common Future: The World Commission on Environmental Development* (Oxford: Oxford University Press, 1987).

It implies that for anything - including architecture, to be sustainable, it must be protected so the resource is not depleted nor permanently damaged. In this way, the goal of sustainability is simple: to maintain and protect our existing resources.

One way to understand sustainability today is to look at the evolution in the mid-nineteenth century when writers began evoking the power and awareness of the natural landscape and discussing a profound respect for nature. For example, American author Henry David Thoreau (1817- 1862) published his seminal book Walden in 1848. The book told of Thoreau's two-year living experiment in the woods near Walden Pond, Massachusetts, where he spent his time walking around the woods and lake, reading books and growing his own food. His intention in his manuscript was to describe a harmony that humans can only experience when living with nature, written in an increasingly industrialized world. Later in the 1960s, attention was brought upon our agricultural landscapes and the effect that humans had on them, especially in the name of progress. Silent Spring, published by Rachel Carson in 1962, focused on industrial chemicals (previously considered to be a modern miracle) that were destroying the ecosystem of plants and soils and therefore humans who lived off of these plants. While Carson focused on pesticides and insecticides like DDT that poisoned wildlife and entered the human food chain through agriculture, she also pointed out that progressive practices were harming, rather than helping, our fragile ecosystems and those dependent on it. This type of writing unveiled a critical reevaluation of our understanding of how new technologies aren't always the most beneficial or sustainable path.[16]

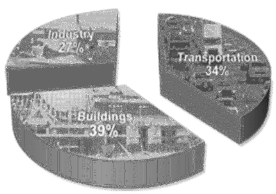
Likewise, we can consider that while new buildings and technologies can be good, old methods and ideas should also be worth preserving. In other words, if they worked well before 'new' technologies, they still do. While new construction will always be needed, the focus needs to shift to how we can fit new uses into existing resources as an alternative to building new. For the past several years the architecture and building industry has shifted most of its focus on new, higher performing structures that use less energy, more recycled material. While this is important, more emphasis must be given to the contribution existing buildings can make through historic preservation. As a practice that preservationists have been calling "sustainable" for years, historic preservation and adaptive reuse must be considered a critical component of any effort to promote green building practices, encourage environmental and cultural sustainability and counter the effects of global warming. It has been said many times that "the greenest building" is that which

[16] Kathryn Rogers Merlino, "Sustainability and the Transformative Power of Repair," *Proceedings of the Association of American Collegiate Schools of Architecture Annual Conference* (2009).

already exists.[17] Existing buildings are our single most sustainable resource in the built environment, and in many cases, may out-perform newer buildings in terms of energy consumption.[18]

1.2 IMPACTS OF BUILDINGS ON THE ENVIRONMENT

Understanding how buildings effect the environment is a critical part of moving towards a sustainable future. To begin to understand the impact our buildings make in the environment, consider that in the United States, buildings account for: 40% of all primary energy use[19], 68% of all energy use[20], 60% of all non-food / non-fuel raw materials use[21], 40% of all nonindustrial solid waste[22], 12% of potable water use[23] and 38% of all carbon dioxide emissions[24].



Total Carbon Dioxide Emissions from Energy Consumption by Sector, 2008[25]

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[17] Carl Elefante, "The Greenest Building Is...One That Is Already Built,," *Forum Journal: The Journal of the National Trust for Historic Preservation* 21, no. 4 (2007).

[18] Many older buildings were designed to take advantage of natural daylight, ventilation and solar orientation and utilize durable materials. In fact, according to a study by the US Energy Information Administration, our older commercial building stock - pre 1920 - performs at an average of 80,127 Btu/sf while new green buildings from 2003 perform at 79,703 Btu/sf. [18] These measurements illustrate how older buildings can be just as efficient as new, high performance buildings, and in fact, many of the reasons why – passive systems, climactic response design – are now being used in new 'green' building design. See section on "Historic Buildings and Energy Consumption."

[19] Ibid. This percentage is projected to rise up to 50% by the year 2030 at current rates of construction and operation,

[20] Congressional Budget Office, "Future Investment in Drinking Water and Wastewater Infrastructure," (2002); U.S. Department of Energy, "Monthly Energy Review," (Washington D.C.: U.S. Department of Energy, 2001).

[21] United States Geological Society, "Factsheet Fs-068-98 Materials Flow and Sustainability," http://pubs.usgs.gov/fs/fs-0068-98/fs-0068-98.pdf.

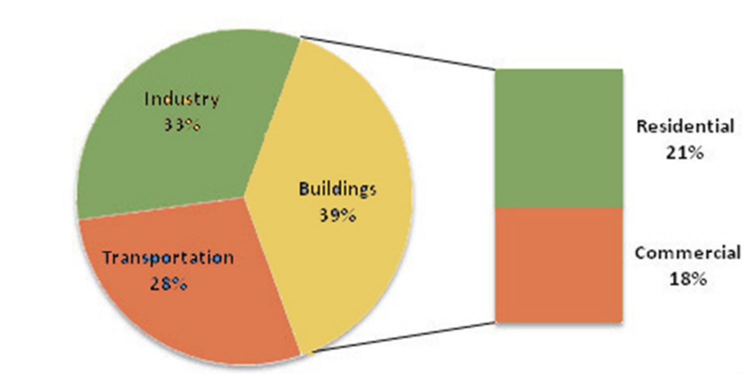
[22] Agency, "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2008."; Washington State Waste Management, "Construction and Debris Collection and Recycling," (2010).

[23] Office, "Future Investment in Drinking Water and Wastewater Infrastructure."

[24] Agency, "Emissions of Greenhouse Gases Report."

[25] Pew Center for Global Climate Change, "Pew Center for Global Climate Change Basic Facts," http://www.pewclimate.org/global-warming-basics/facts_and_figures/us_emissions/usghgemsector.cfm.

Locally, in Washington State, buildings account for 514,366 billion BTU of energy consumption annually[26], 89.5 billion tons of carbon dioxide emissions[27], 694 million gallons water/day[28] and an additional 2.2 pounds of construction & demolition waste per resident annually[29] in addition to the national of average 4.6 pounds per day.[30] At a more domestic level, the average household spends at least $2,000 a year on energy bills — over half of which goes to heating and cooling.[31] Out of the total energy consumption in an average household, 50% goes to space heating, 27% to run appliances, 19% to heat water and 4% goes to air conditioning.[32]



Building Share of US Primary Energy Consumption[33]

Commercial and residential buildings account for nearly 39% of U.S. carbon dioxide (CO2) emissions and almost 39 percent of total U.S. energy consumption.[34] Nearly all of the greenhouse (GHG) emissions from the residential and commercial sectors can be attributed to energy use in buildings.

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[26] Energy, "2009 Biennial Energy Report with Indicators."

[27] Ibid.

[28] United States Geological Survey (USGS), "Estimated Water Use in Washington, 2005," in *Scientific Investigations Report 2009–5128* (U.S. Department of the Interior, 2005).

[29] Management, "Construction and Debris Collection and Recycling."

[30] Clean Air Council, "Waste and Recyling Facts," http://www.cleanair.org/Waste/wasteFacts.html.

[31] US EPA ENERGY STAR program, http://www.energystar.gov/index.cfm?c=thermostats.pr_thermostats

[32] Changes in Energy Usage in Residential Housing Units. DOE/EIA. http://www.eia.doe.gov/emeu/recs/recs97/decade.html#totcons4

[33] Pew Center for Climate Change, "Buildings Overview: Climate Tech Book," (2010).

[34] Energy, "Buildings Energy Data Book.", Section 1.1.1., 2008.

Greenhouse gas emissions from energy use in buildings can be divided into two types: first, direct emissions from the on-site combustion of fuels for heating and cooking (domestic use on site) and second, emissions from the end-use of the electricity used to heat, cool and provide power to buildings.[35] These emissions can be reduced at a variety of levels. For example reducing use of energy on–site through more efficient appliances and lighting; improved energy efficiency of building envelopes; and reusing existing buildings to reduce energy use through demolition and new construction.
Factors effecting building-related emissions result from several building characteristics. Since buildings come in a variety of sizes, shapes, ages and construction types, there is no one singular cause. As a result, the best way to consider buildings is in a holistic way to ensure the best understanding of the causes of consumption and emissions in order to allow for the most successful rehabilitation strategies.

1.3 BUILDINGS AS ENVIRONMENTAL RESOURCES

Historic buildings are a valuable, existing resource. However, these are resources that our culture tends to disregard as a valuable commodity. A study conducted in 2004 by the Brookings Institution reported that if we continue with national development trends, by 2030 we will have demolished and rebuilt nearly one-third of our entire building stock – a staggering total of 82 billion square feet.[36] The energy required to do so would power the entire state of California – 37 million people – for an entire decade. Demolition and rebuilding takes vast amounts of energy and materials, both of which are increasingly in short supply.

Historic buildings are great repositories of embodied energy. The “embodied energy” in buildings can be described as the total energy used in the extraction, manufacturing, transportation, and construction of materials into a completed building. In this way, buildings begin their life with an energy “debt”, and the concept of embodied energy is an attempt to quantify one significant part of this debt.[37]

Embodied Energy in Buildings

Embodied energy is often considered less significant because it is already ‘expended’ and assumptions are that a new, high performing building will outperform an old one. Yet, even the most energy efficient new building cannot offset its embodied energy for many years after construction. The federal Advisory Council on Historic Preservation (ACHP), in its study of embodied energy in 1979, produced a formula that created embodied energy calculations for specific building assemblies.[38] Using this information, they calculated that

[35] Change, "Buildings Overview: Climate Tech Book.", p. 1.

[36] Nelson, "Towards a New Metropolis: The Oppportunity to Rebuild America."

[37] Jean Carroon, *Sustainable Preservation: Greening Existing Buildings* (Hoboken, New Jersey: John Wiley & Sons, Inc., 2010).

[38] Booz, "Assessing the Energy Conservation Benefits of Historic Preservation: Methods and Examples."

an average 50,000 square foot commercial building embodies approximately 80 billion BTU's (British Thermal Units, a common measurement of energy), or the equivalent of 640,000 gallons of gas – enough energy to drive a car an average of 12,000 miles a year for 1,333 years.

Using embodied energy is one useful way in a set of tools that facilitates an understanding of a building's existing worth in terms of expended and valuable resources. Embodied energy measurements can quantify the energy that was not only wasted when a historic building is torn down, but the energy it took to demolish, carry away, and build a new building in its place. While there are many tools available that measure embodied energy, one simple building calculator was released by the May T. Watts Society at www.thegreenestbuilding.org, which uses data from the 1979 ACHP study titled *Assessing the Energy Conservation Benefits of Historic Preservation: Methods and Examples*, devised to simplify building embodied energy calculations.[39]

Measuring the embodied energy can help quantify building energy value which can be translated for a better understanding in domestic terms. For example, a study of the Grand Central Arcade in Seattle's Pioneer Square calculated that to construct a new building of equivalent size would require 109 billion BTUs of energy, but preserving it would save 92 billion BTUs. This amount of energy is the same as 730,000 gallons of gasoline; the annual greenhouse gas emissions from 1,241 passenger vehicles; 6,490 metric tons of CO_2; the carbon sequestered annually by 1,384 acres of fir forests; or the greenhouse gas emissions avoided by recycling 2,185 tons of waste instead of sending it to the landfill.[40]

Embodied energy can also be understood in terms of individual material value as well as overall building value. The chart below uses data from the ACHP study to quantify material energy value, which can be useful in construction and rehabilitation projects.

[39] Ibid.; http://www.thegreenestbuilding.org.

[40] Ibid.

Embodied Energy of Materials and Construction Per Square Foot of Construction[41]	
	MBTU/sq.ft.
Residential – Single Family	700
Residential – 2-4 Family	630
Residential – Garden Apartment	650
Residential – High Rise	740
Hotel/Motel	1130
Dormitories	1430
Industrial Buildings	970
Office Buildings	1640
Warehouses	560
Garages/Service Stations	770
Stores/Restaurants	940
Religious Buildings	1260
Educational	1390
Hospital Buildings	1720
Other Nonfarm Buildings	1450
a. Amusement, Social & Rec.	1380
b. Misc. Nonresidential Bldg.	1100
c. Laboratories	2070
d. Libraries, Museums, etc.	1740

[41] The values in MBTU/sq. ft. for each building type are presented as published in the 1979 Advisory Council on Historic Preservation report, *ASSESSING the ENERGY CONSERVATION BENEFITS of HISTORIC PRESERVATION: Methods and Examples*. (ibid. This report, published in 1979, forwarded the concept of embodied energy. The calculations published are based on new buildings constructed in 1967. These figures are being used here because they are the only identified database of embodied energy information complete at this time. These figures are taken from the May T. Watts Appreciation Society sponsored Embodied Energy Calculator, located at http://www.thegreenestbuilding.org.

Embodied Carbon in Buildings

Carbon dioxide, a major component in climate change, is emitted into the atmosphere with demolition and construction of buildings. In the United States, 40% of carbon dioxide emissions are from the construction and operations of buildings; in Washington State alone the emissions amount to 35 million metric tons of carbon dioxide annually.[42] Quantifying embodied carbon is an attempt to estimate the amount of carbon emitted as a result of the building process including material extraction, fabrication, transportation and final construction. Like embodied energy, it is another quantifiable way to understand the value of expended energy and material resources that make up an existing building, and how this embodied carbon is lost and more expended with demolition.

Studies have been carried out to understand the effects of embodied carbon. In 2006, Craig Jones and Geoff Hammond's Inventory of Carbon and Energy (ICE) drew data from secondary resources, including books, conference papers and internet charts. The report compared existing, older homes to new homes and found that when embodied CO2 was considered, a new, energy efficient home took up to 35-50 years to recover embodied carbon over an existing home. The same study found that even though the perception is that new homes are more efficient, older, historic homes can be four times more carbon efficient than new ones.[43] Other recent studies have successfully measured the impact of embodied energy and carbon and the implications to historic preservation. The United Nations Energy Programme estimates it takes 20 years of a typical building's 100 year operation just to offset the expenditure of its construction energy and materials.[44] While embodied energy and carbon are only part of the picture, they represent tangible measurements of the value of buildings as an existing resource and how preservation contributes to a sustainable future.

Life Cycle Assessment in Buildings

Life Cycle Assessment (LCA) is a method that evaluates pollution, water use and carbon emissions to understand a total view of a building's impact on the environment through its lifetime. Using LCA as a tool for quantifying a building's total environmental worth can be done with certain tools. One such tool is the Canadian based Athena Ecocalculator, which uses a formula of basic assumptions and construction assemblies to assess a building's Life Cycle and in turn, to quantify buildings in terms of their global warming potential (GWP), which then can be translated into different metrics.

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[42] Department of Energy. Agency, "Emissions of Greenhouse Gases Report."

[43] Empty Homes Agency and The Building and Social Housing Foundation (BSHF), "New Tricks with Old Bricks: How Reusing Old Bricks Can Cut Carbon Emissions," ed. Empty Homes Agency (London, England: Building and Social Housing Foundation, 2008).

[44] UNEP, "Buildings and Climate Change: Status, Challenges and Opportunities.."

One case study to illustrate a LCA was performed on Building 18, the former fire station in the Sand Point Naval Air Station Historic District, now part of Seattle's Magnuson Park. Using Athena's EcoCalculator, Building 18 represents a measurement of 11,114 MMBTUs of energy, which translates to the Co2 emission equivalent of: 430 gallons of gas from a vehicle; 77,060 propane tanks from barbeques; the burning of 9.7 railcars of coal; the GHG avoided by recycling 638 tons of domestic waste by diverting them from the landfill; and the amount of carbon sequestered by either 427 tree seedlings for a decade or 3.8 acres of pine forest annually.[45] When looking at the building using embodied energy calculators, Building 18 represents the amount of embodied energy that represents an individual driving a (fuel efficient) car every day, 24 hours a day, 365 days a year, for over 200 years. If Building 18 is demolished, embodied energy equivalents are equal to 1,972,830 aluminum cans that were diligently recycled.[46] While these tools need continued refinement – and many more are published and more are being developed – they give us a basic understanding of the physical and environmental value of buildings which are otherwise difficult to measure.

A current study from the National Trust for Historic Preservation's Preservation Green Lab based in Seattle is studying a LCA comparison between existing retrofitted buildings and new construction. The goal of the study is to develop four to six scenarios that explain differences in environmental impacts between new construction and building reuse in four different climate areas. These scenarios will reflect as accurately as possible the common circumstances in which buildings are demolished and replaced with new construction.[47]

1.4 ENERGY CONSUMPTION AND HISTORIC BUILDINGS

It is important to consider the physical energy value in historic buildings. Yet another critical component to sustainable preservation is operational energy. Historic buildings are often considered to be large consumers of energy compared to their higher performing, newer siblings. However, that is not necessarily the case. Data from the U.S. Department of Energy (DOE) indicates that commercial buildings constructed before 1920 actually use less energy per square foot than buildings from any other decade up until 2000.[48] Many older buildings were designed to take advantage of natural daylight, ventilation and solar orientation and utilize

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[45] http://www.athenasmi.org/tools/ecoCalculator/. From their website: The *EcoCalculator* offers architects, engineers and others access to instant LCA results for hundreds of common building assemblies. The results embedded in the *EcoCalculator* are based on detailed assessments completed with the ATHENA® *Impact Estimator for Buildings*, which in turn uses Athena's own widely-acclaimed datasets and data from the US Life Cycle Inventory Database." There are other LCA calculators used for building assessment, and more being developed.

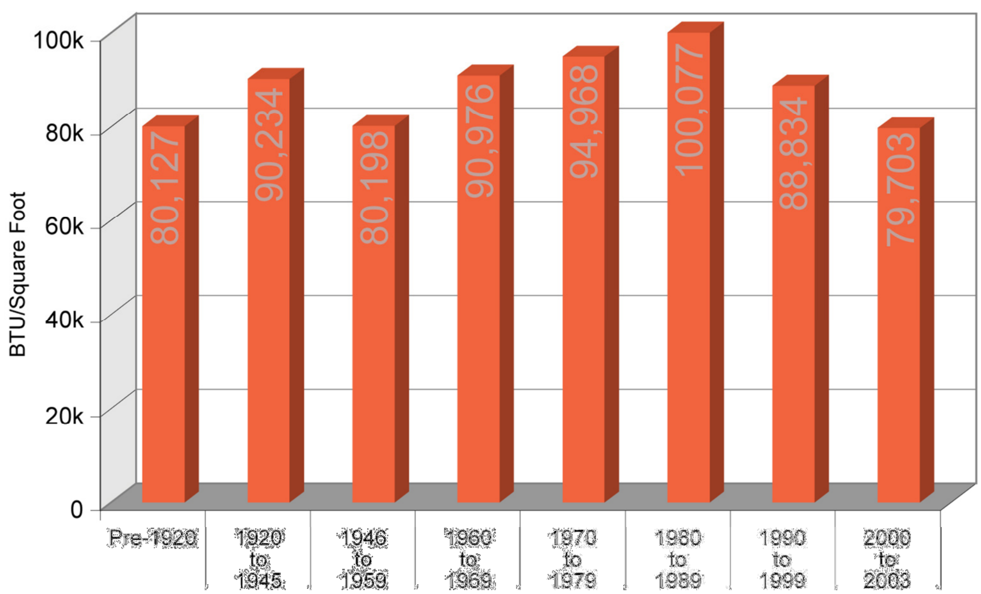
[46] http://www.epa.gov/cleanrgy/energyresources/.

[47] http://www.preservationnation.org/issues/sustainability/green-lab/research.html

[48] Energy, "2009 Biennial Energy Report with Indicators."

durable materials. They were designed before an era that relied on mechanical heating, cooling and shading devices, and utilized simple design solutions that kept human occupancy and comfort levels high. In fact, according to a study by the US Energy Information Administration, our older commercial building stock - pre 1920 - performs at an average of 80,127 Btu/sf while new green buildings from 2003 perform at 79,703 Btu/sf. [49] These measurements illustrate how older buildings can be just as efficient as new, high performance buildings, and in fact, many of the reasons why passive systems and climactic response design – are now being used in new "green" building design..

Successful greening of existing and historic buildings begins with an evaluation of the whole building system and a knowledgeable team of architects, engineers, and other experts who can guide building owners through a successful rehabilitation program. Usually, the most cost effective energy use reduction is achieved with simple moves such as efficient light bulb replacement, efficient heating and cooling systems, added insulation in walls and attics and standard repair of historic windows. While rating systems are not necessary for sustainable preservation, they can assist in the process of design, create a recognizable level of performance, and increase property values. Greening historic structures can make these buildings even more energy efficient, especially when holistic strategies are implemented in their rehabilitation.



Energy Consumption in Buildings, by decade

(Source: U.S. Department of Energy Information Agency, 2009)

[49] Energy, "Buildings Energy Data Book."

Many older buildings have inherent passive characteristics that are energy efficient. For example, electrical lighting is a major source of energy use in buildings. Yet, natural daylighting design is often seen in older buildings due to smaller footprints and well-oriented floor plans, larger windows and light wells or courtyards. Natural ventilation is another characteristic of historic buildings and one that is coming back strong as a new "green" building attribute. The ability to self-regulate climate as well as produce fresh air changes in indoor air quality is extremely important in building design. Many older, historic buildings relied on natural air movement; planning windows, doors and chimneys to circulate air through the building to cool as well as allow heat to updraft through floor vents. Low energy use fans helped spread the warm air and cool interior spaces.

Historic buildings were usually built with locally produced, indigenous materials. In today's global climate, many building pieces travel vast distances over land and sea before reaching their final destinations. While this is slowly changing, historic buildings always used locally sourced materials and ones that responded best to the local climate. The older and more historic the materials are, the more likely they were locally sourced due to transportation restrictions and cost. Green building is now turning to locally sourced "buy local" trends, of which older buildings have set the example.

Over their lifespan, historic buildings illustrate one of the best sustainable characteristics: durability and reparability. While the construction materials and assemblies contribute to this, the lower the technology of the material, the easier they are to maintain and repair; hence their durability. While the initial energy for some of these materials may be higher than newer construction assemblies, the long-term embodied energy payoff is worth the cost and length of stay through the maintenance of materials like stone, brick, concrete, steel and wood.

1.5 IMPACTS OF BUILDING DEMOLITION

Since the middle of the 20th century, the United States has led the consumption and waste pattern globally, by using 30% of the world's natural resources, even though we are just 5% of the global population. Of this 30%, 60% of the materials are attributed to construction practices. Nationally, this translates to 18% of the world's raw resources are being depleted to build buildings, roads, bridges and other types of structures considered under the "built environment" umbrella.[50] In this context, it makes sense to reuse these resources, rather than to demolish and rebuild, even in the name of higher efficiency.

[50] Society, "Factsheet Fs-068-98 Materials Flow and Sustainability."

Demolition and waste of buildings have profound adverse impacts on our landfills. A 2004 Brookings Institute study reported that by the year 2030, if we keep within current practices, we will have demolished and replaced 82 billion square feet of our current building stock in the United States.[51] Since it is estimated that there are about 300 billion square feet of space in the United States today, that means we anticipate demolishing nearly 1/3 of our building stock in the next 20-25 years, the largest component of which will be homes.[52] The implication of this trend towards demolition and new construction rather than rehabilitation is enormous. This results in nearly 62 billion tons of demolition debris. Rehabilitating existing buildings is the best means we have to reduce this trend of consumption and waste at local, national, and global levels.

Estimated Amount of Buildings in the U.S. to be demolished and rebuilt by 2030: 33% of all Building Stock. (Source: Brookings Institution, 2004. Graphic: author.)

Construction and Demolition Debris

Building-related construction and demolition (C&D) debris constitute about two-thirds of all non-industrial solid waste generation in the US.[53] The average building demolition yields 155 pounds of waste per square foot while the average new construction project yields 3.9 pounds of waste per square foot of building area.[54] In Washington State, even with our 45% diversion rate into recycling, an estimated 1,383,998 tons of debris per year ends up in landfills, most of this coming from demolition and new construction projects. This averages an additional 2.2 pounds of garbage per day per person in Washington to our landfills on top of the average 4.5 pounds of garbage per day (national average).[55] In Seattle alone, 100 cars are loaded with trash and head for a landfill each week. Of these 100 cars, at least 25 are filled with construction and demolition debris.[56]

[51] Nelson, "Towards a New Metropolis: The Oppportunity to Rebuild America."

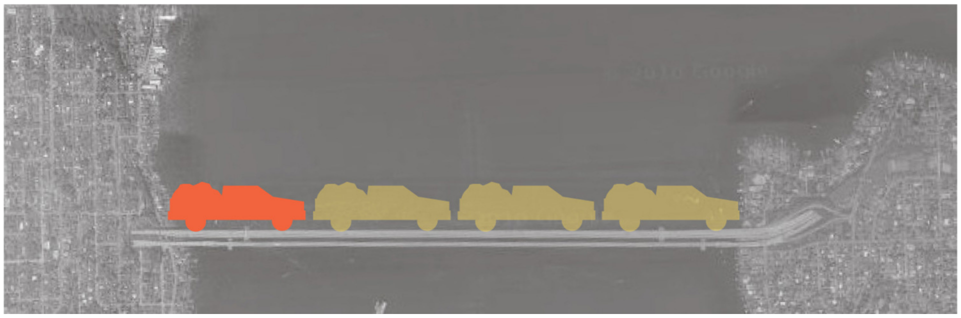
[52] Ibid; ibid.

[53] Agency, "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2008."

[54] Monroe, "Diverting Construction Waste."

[55] Ecology, "Generation, Recyling and Per Capita Data (1986-2009)."

[56] Kathy Mulady, "Where Your Seattle Trash Ends Up: And You Thought Taking out the Garbage Was a Big Chore," *The Seattle Post Intelligencer*, July 2007.



In Seattle, 25% of Waste to Landfill is Construction & Demolition (C&D) waste.

(Source: Post-Intelligencer, Dept. of Ecology; Graphic, author)

Historic preservation, by reusing existing buildings and diverting them from the waste stream, naturally reduces consumption levels of raw materials that go into a landfill. When we reuse our historic buildings rather than replacing them, less debris ends up in landfills and our environment is healthier.

Recycling materials is often suggested as a positive outcome from building demolition. However, recycling demolition waste is energy intensive and expensive. Plus many construction materials that are considered recyclable are either not fully recyclable or too cost prohibitive to recycle. In Washington State, even with a 45% diversion rate of recycling, an estimated 1,383,998 tons of C&D debris ends up in landfills.[57] In 2008, Americans generated about 250 million tons of trash and recycled and composted 83 million tons of this material, equivalent to a 33.2 percent recycling rate. On average, Americans recycled and composted 1.5 pounds of our individual waste generation of 4.5 pounds per person per day.[58] While we are advancing our recycling practices, the best practice for our environment and budget is to reduce our throwaway material into recycling or waste streams.

New construction uses new, raw resources, and in the extraction process, waste ends up in landfills. Since 1900, use of construction materials such as crushed stone, sand, and gravel has increased from about 35% to 60% (of total non-food, non-fuel) of raw materials consumed in the United States, which illustrates the rate of new raw materials being consumed. Most of this is for new construction. From this, only approximately 10% of extracted materials go into the final product of a typical building material, which means that 90% is manufactured waste and ends up in landfills.[59]

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[57] Ecology, "Generation, Recyling and Per Capita Data (1986-2009)."

[58] Agency, "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2008."

[59] William McDonough and Michael Braungart, Cradle to Cradle (New York: Northpoint Press, 2002).

Composition of C&D and Environmental Impacts

Reusing buildings and reducing demolition waste also reduces impacts from infrastructure on the site. C&D waste includes not just the debris from the construction, renovation and removal of buildings, but also the infrastructural debris – from the construction and demolition of roads, bridges and other non-building structures; as well as land-clearing debris such as rocks, vegetation, dirt and other miscellaneous materials. Since reusing buildings and historic properties does not require new roads or as much site development, it is inherently less productive of the broader types of C&D that typically are produced by construction processes.

All building-related construction debris and demolition (C&D) materials are commonly grouped as a single type of material, despite the fact that these two material streams come from different processes. Construction materials originate from construction, repair or remodeling activities. This materials stream typically consists of a variety of building products (such as concrete, roofing, gypsum wallboard, wood products, plastics, insulation, tile, and metal) as well as the packaging materials that building materials arrive in (such as cardboard and plastics). Construction materials are usually generated as a result of cutting a material down to size for installation (wood studs are notorious for this) or purchasing materials in excess of what is needed. Wood materials consists of wood scraps from dimensional lumber, siding, laminates, flooring (potentially stained), laminated beams, and moldings (potentially painted). Demolition materials are generated from the dismantling of buildings or the removal phase of remodeling. Typical constituents include concrete, wood, metal, insulation, glass, carpet, and other building materials. Debris from this process is often painted or chemically treated or is fastened to other materials, making separation difficult, and recycling near impossible.[60] Although data gaps are present from state to state, including Washington, it is clear that the three materials that stand at the top of the C&D heap are concrete (including rubble), wood and drywall [61] While some of these can be recycled, it depends on the condition, location and process of extraction.

Washington State Composition of C&D Building Materials[62]

Building Related C&D Material	Quantity Generated (million tons)	% of CD Debris Stream
Concrete Rubble	66-83	40-50%
Wood	33-49	20-30%
Gypsum Drywall	25-8	5-15%

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[60] Franklin Associates, "Characterization of Building Related Construction and Demolition Debris in the United States," (2005).

[61] Ken Sandler, "Analyzing What's Recyclable in C&D Debris," *BioCycle* 44, no. 11 (2003).

[62] Ibid.

Asphalt Roofing	16-38	1-10%
Metals	8-10	1-5%
Bricks	8-10	1-5%
Plastics	8-10	1-5%

The EPA estimates that 164 million square tons of building-related construction and demolition (C&D) debris were produced in 2003. Approximately 47 percent of this was generated through construction and renovation activities, and 52 percent was generated through demolition activities.[63] While reuse or recycling of demolition materials is often touted as an acceptable alternative when a building is destroyed, it rarely happens at substantial levels because the material quality is not of the appropriate quality for reuse or recycling. Only about 50 % of C&D wood debris is of acceptable size, quality, and condition to be considered available for recovery. Factors limiting "availability" include contamination and the commingling of wood with other nonfood building products.[64] Therefore, the best way to 'recycle' building material is to leave it on site, if possible, and maintain it over time.

The amount of waste generated in Washington State that goes to a landfill is 4.4 pounds a day, per person. If the amount of annual C&D waste is averaged with the state's population, the additional amount of landfill waste would add another 2.2 pounds a day, for a total of each Washington resident contributing 6.6 pounds a day to landfills in total.[65]

Recycling vs. Down-cycling

While recycling of demolished buildings and construction debris is a better alternative than putting into a landfill, it is rarely recycled, or put into a sustainable pattern of indefinite reuse. Recycling is usually 'down cycling'; the process of turning one product into another. However, the process so heavily changes the characteristics it is rarely able to be recycled again. Materials are reclaimed, but changed. For example, most materials, other than some metals which keep their chemical composition, lose molecular integrity during the highly energy-intensive reprocessing. One example is glass. When heated over and over it loses its workability and strength. Plastic loses flexibility, one of the most highly prized characteristics of its

[63] Ibid.

[64] David B. McKeever, "Inventories of Woody Residues and Solid Wood Waste in the United States, 2002.," ed. USDA Forest Service (USDA Forest Service, 2002).

[65] Washington State Annual Waste Per Capita to a landfill, Washington State: Washington State Population: 6,664,195 (2009); Average waste per day to a landfill, domestic garbage: 4.4lbs/day; C&D waste when averaged per Washingtonian: 2.2 lbs./day

materiality. Paper fibers degrade in quality each time they are recycled, and after a few cycles, are unusable. The better alternative is that the material is recycled in its natural state enough where it can be reused for the same or a similar application, such as salvaged materials.

C&D Material Recycling in Washington State: Down-cycling

C&D Material Recycling in Washington State: Down-cycling route[66]

Inserts	road base
cardboard/paper/plastics/metals	new products
clean wood	mulch or biomass fuel
dirt, rock and sand	ADC in landfills (daily cover)
crushed concrete	gravel or aggregate

While Washington State boasts one of the best recycling rates in the country, most of this is in the form of domestic recycling. Unfortunately, it often implies that over consumption is acceptable as long as the products are put into the recycle bin, which ignores the concept of down-cycling and limited reuse. Even so, products that are disposed in the correct recycling bin does not guarantee they will be properly reprocessed and recycled. While it is preferable to waste in landfills, it is important to note that renovations typically have more direct construction wastes per square foot than new construction, although the projects use fewer new materials for the final product. The EPA estimates that 41 percent of construction debris in 2003 came from renovations. The most environmentally appropriate way to reduce this C&D is adapting and maintaining use of buildings in their original use, even if it means for a compromise in floor plan organization or use.[67]

[66] Management, "Construction and Debris Collection and Recycling." (Accessed August 22, 2010)

[67] Carroon, *Sustainable Preservation: Greening Existing Buildings*.

2. SUSTAINABILITY AND THE SECRETARY OF THE INTERIOR'S STANDARDS FOR HISTORIC REHABILITATION

Introduction

The U.S. Secretary of the Interior is responsible for establishing standards for all programs under departmental authority and for advising federal agencies on the preservation of historic properties listed in or eligible for listing in the National Register of Historic Places. Known as The Secretary of the Interior's Standards for the Treatment of Historic Properties (Standards), there are four treatments that pertain to the preservation of historic properties (preservation, rehabilitation, restoration and reconstruction); the Standards for rehabilitation are the most commonly used. In the Standards, "rehabilitation" is defined as: "…the act or process of making possible a compatible use for a property through repair, alterations and additions while preserving those portions or features which convey its historical, cultural, or architectural values. "[68]

The Standards are intended to assist with the maintenance and long-term preservation of historic materials and buildings. They pertain to historic buildings of all types of buildings, both interior and exterior; materials and constructions; sizes and occupancies. The Standards also pertain to the site, landscape and any additions to historic materials or buildings. To qualify for federal historic preservation tax purposes and credits, a rehabilitation project much be determined by the National Park Service on behalf of the Secretary of the Interior to be consistent with the historic character of the structure(s) and, where applicable, the district in which it is located.[69]

The Secretary of the Interior's Standards

Historic rehabilitation is defined by the U.S. Secretary of the Interior as "the process of returning a property to a state of utility, through repair or alteration, which makes possible an efficient contemporary use while preserving those portions and features of the property which are significant to its historic, architectural, and

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[68] National Park Service U.S. Department of the Interior, *The Secretary of the Interior's Standards for Rehabilitation* ed. Technical Preservation Services, Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings (2011). *The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines for Rehabilitating Historic Buildings* was produced by Anne E. Grimmer and Kay D. Weeks, first published in 1992 and reprinted in 1997. The *Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings*, which are presented in the same format, replace the chapter on "Energy Conservation" in the 1992 publication.

[69] Ibid., p. vi.

cultural values."[70] The National Park Service describes the purpose of an historic rehabilitation as follows:

> *The intent of the Standards is to assist the long-term preservation of a property's significance through the preservation of historic materials and features. The Standards pertain to historic buildings of all materials, construction types, sizes, and occupancy and encompass the exterior and interior of the buildings. They also encompass related landscape features and the building's site and environment, as well as attached, adjacent, or related new construction. To be certified for Federal tax purposes, a rehabilitation project must be determined by the Secretary to be consistent with the historic character of the structure(s), and where applicable, the district in which it is located.*
>
> *As stated in the definition, the treatment "rehabilitation" assumes that at least some repair or alteration of the historic building will be needed in order to provide for an efficient contemporary use; however, these repairs and alterations must not damage or destroy materials, features or finishes that are important in defining the building's historic character. For example, certain treatments--if improperly applied--may cause or accelerate physical deterioration of the historic building. This can include using improper repointing or exterior masonry cleaning techniques, or introducing insulation that damages historic fabric. In almost all of these situations, use of these materials and treatments will result in a project that does not meet the Standards. Similarly, exterior additions that duplicate the form, material, and detailing of the structure to the extent that they compromise the historic character of the structure will fail to meet the Standards.*[71]

While the act of preserving historic buildings is sustainable itself, the implementation of energy efficient characteristics in buildings is imperative along with appropriate historic considerations. Therefore, early planning is recommended to ensure the Standards are followed while maintaining energy performance goals. The first act should always be to carefully assess the condition of the building. While some requirements at first seem to be in conflict, most issues can be resolved with advanced consultation, understanding the issues, and familiarity using the Standards. The most common conflicts are installing inappropriate solar roofing materials, insulating walls without restoring original trim details, adding non-historic features for day lighting such as dormers or inappropriate skylights, and removing historic character-defining features like doors and windows for energy efficiency.[72]

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[70] The National Parks Service, Introduction to the Secretary of Interior Standards.

http://www.nps.gov/hps/tps/tax/rhb/stand.htm

[71] http://www.nps.gov/hps/tps/tax/rhb/stand.htm

[72] Service, "Energy Efficiency, Sustainability, and Green Building Practices in Historic Buildings." (accessed: January 18, 2011).

The good news is that many cost-effective strategies that reduce energy consumption in historic buildings can start with small, simple changes. Once the project is completed, following up with consistent implementation and maintenance plans is vital, since many energy saving strategies can be achieved through occupant habits and building and system maintenance.

The advantage of using the Standards and their guidelines, especially the publication, *Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings*, is that it helps guide professionals and individuals on the Standards and best practices for sustainable outcomes. These practices must be met in order to be eligible to receive federal preservation tax credits. Therefore, the best route is to consult a professional preservationist early in your rehabiltation project planning to avoid damage to historic fabric or incorrect installations.

The Stanards for rehabilitation are recommended to be applied to all historic properties and read as follows:

1. A property shall be used for its intended historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.
2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.
3. Each property shall be recognized as a physical record of its time, place and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings shall not be undertaken.
4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.
5. Distincive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6. Deteriorated historic features shall be reapired rather than replaced. Where the severity of deteriouration requires replacement of a distinctive feature, the new feature shall match the old in design, color, teture, and, where possible, materials. Replacement of missing features will be subtantiated by documenatry and physical evidence.
7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures shall be undertaken.
9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated

from the old and will be compatable with the historic materials, features, size, scale, and proportion, and massing to protect the integrity of the property and its environment.

10. New additions and adjacent or related new construction will be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its evironment would be unimpaired. [73]

Tax Incentives of Historic Rehabilitation

In Washington, owners of historic properties are eligible to take advantage of two tax incentive programs specifically for historic rehabilitation projects. The federal historic preservation tax incentive program, administered by the National Park Service in cooperation with the Internal Revenue Service, encourages the rehabilitation of older structures through federal tax credits. The main incentive is a 20 percent tax credit for the *substantial rehabilitation* of a certified historic structure A project is substantial when the amount spent on qualified project work is equal to or greater than the adjusted value of the building itself. To qualify, project work must be carried out in accordance with the *Secretary of the Interior's Standards for Rehabilitation* and *Guidelines for Rehabilitating Historic Buildings*. This incentive program is available to income producing properties listed in, or determined eligible for listing in, the National Register of Historic Places. To ensure your project meets both the Standards and sustainable building practices, be sure to start early in your planning and consult with qualified professionals.

The Washington Special Valuation Program is the other tax incentive program specifically tailored to encourage historic rehabilitation projects. This locally adopted property tax incentive program allows applicants to deduct the historic rehabilitation costs of a property from the new assessed value once the rehabilitation is completed. Properties eligible for this program include buildings that are either listed individually in the National Register or contribute to a National Register or locally designated historic district, or individually listed in a local register of historic places. To qualify, project work must be carried out in accordance with the Standards and Guidelines for Rehabilitating Historic Buildings. Although authorized as state law, local jurisdictions are required to adopt an ordinance in order to allow property owners to take advantage of the property tax reduction.[74]

[73] Ibid. For The Standards and more information, visit http://www.nps.gov/hps/tps/standguide/.

[74] William B. Beyes and Matt Dadswell, "The Economic Benefits of Historic Preservation," (Washington State Department of Historic Preservation, 2006). For more information on economics and preservation, see: http://www.dahp.wa.gov/economic-benefits.

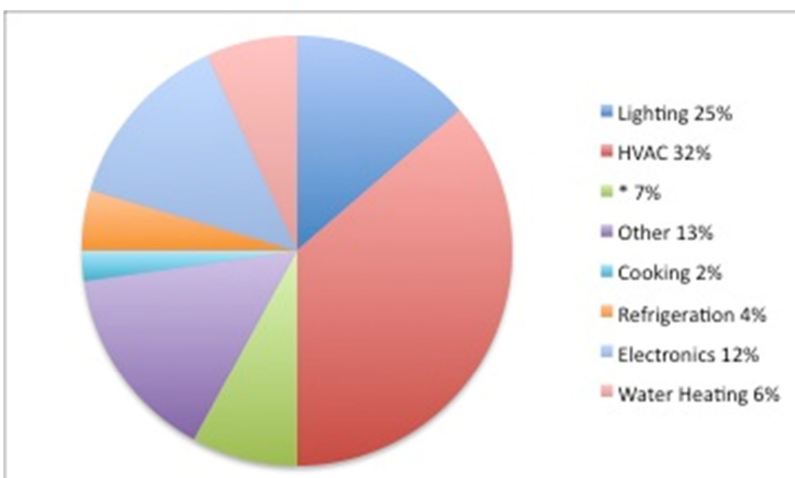
3. EVALUATION AND STRATEGIES FOR SUSTAINABLE PRESERVATION

Introduction

Moving toward sustainable goals with historic buildings requires some planning and consultation, but many changes can be done with cost-effective, simple moves. While every building project will have restraints based on building codes, property owners, location, social and financial considerations, the overall goals should be evaluation and consultation. The most effective approach is to integrate a team of knowledgeable professionals and work together on a holistic approach to the project.

Increasing End-Use Efficiency

Increasing energy end-use efficiency is usually the simplest and most cost effective. Moderating energy use can be best achieved by understanding where the greatest changes can be made for the best results, by first understanding where energy losses occur, and then testing and evaluating your building and system. In both residential and commercial buildings, most energy consumption comes from lighting and heating, ventilation and air conditioning systems. Improving the building envelope through insulation, caulking and sealing so air flow is restricted along with updated systems are the most efficient way to reduce energy use. The second largest energy consumer is electric lighting. Efficient light bulbs, sensor lights and emphasis on natural day-lighting where appropriate are simple fixes that can reduce heating loads. In both cases, an analysis and diagnosis of existing systems is critical to understand the best path for every project.



Commercial Sector Buildings Energy End Use, 2006[75]

(*7% is a result from reconciling two datasets)

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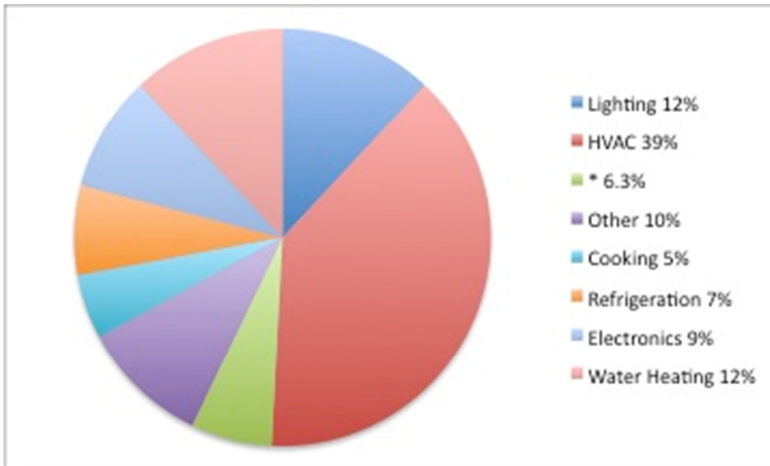
[75] Change, "Buildings Overview: Climate Tech Book."



Residential Sector Buildings Energy End Use, 2006[76]
(*6.3% is a result from reconciling two datasets)

Heating, Ventilation and Air Conditioning (HVAC)

HVAC systems are responsible for 39% of residential and 32% of commercial building energy end use in buildings. Diagnosing the building envelope through testing, adding insulation where appropriate and maintaining proper seals in doors and windows will result in better performance from heating and cooling systems. In addition, passive responses such as natural ventilation from operable windows, window shading and seasonal additions such as shutters and storm windows boost mechanical systems. Many historic buildings have these features that may have been removed over the years as part of upgrades. Adjustments to HVAC systems are most effective when sealing windows, adding insulation and other whole-building methods are implemented.

Lighting

Energy use in lighting can be reduced in two ways: reducing the amount of artificial lighting needed and using more efficient technology where artificial lighting is used. Reduction of artificial lighting is not always feasible in historic buildings due to the historic character of the building, but often some adjustments can be made. However, upgrading to more efficient light bulbs, such as changing from incandescent bulbs to fluorescent or solid-state lighting options is critical. In addition, using automatic sensors for rooms that are unoccupied can have a profound impact on the overall energy consumption from lighting.

[76] Ibid.

3.1 TIPS FOR SUSTAINABLE HISTORIC REHABILITATION PROJECTS

- Insulate unfinished areas first, such as attics and basements, where historic fabric is less likely to be altered.
- Diagnose existing insulation and infiltration conditions with technologies such as blower tests, energy audits and infrared thermo graphic inspections that can detect where improvements can be made.
- Evaluate existing heating, ventilation and air conditioning (HVAC) systems to ensure they are functioning properly; replace with higher efficiency units when needed. Maintain units properly for best performance. Supplement with low-energy boosters like fans and shading devices.
- Check with qualified consultants to see how renewable energy sources such as ground source heat pumps, solar panels and wind turbines can be appropriately integrated into the project. Search for rebates for renewable energy sources.
- Evaluate existing lighting conditions and consult a lighting contractor if needed. Prioritize electric lighting use only when needed, and install sensors that switch on and off with occupancy. Look for ways to improve interior natural day lighting.
- Repair and maintain historic windows, light monitors and skylights wherever possible. Add new skylights on secondary facades or screened surfaces to bring in more natural light without losing historic integrity.
- Install low-flow plumbing fixtures and install aerators in existing fixtures to reduce water use by up to 40% in existing buildings. Provide rain barrels at downspouts to catch runoff and use water for landscape maintenance.

Sustainable Materials for Historic Rehabilitation

Ensuring that materials used for rehabilitation are environmentally cultivated, extracted, produced or manufactured is an important component of sustainable preservation. Doing so is an important part of “green” preservation, but can be challenging to decide which is the best solution or product. Product certification is not standardized, although there are certain companies, such as EcoLogo that attempts to certify certain products.[77] While a single “list” is nearly impossible to create due to changing product lines, research and availability, some common sense is required. Products that require less energy to produce, are durable, and are easy to maintain are the best products to begin with.

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[77] EcoLogo Certified Program, "Ecologo Third-Party Cerification of Environmentally-Preferabble Products," http://www.ecologo.org/en/index.asp.

A comprehensive list might look like the following when looking for "green" products in building and rehabilitation:

- They are durable, have low maintenance, and a history of longevity (rather than experimental).
- They have been salvaged from a previous project and require little change or re-manufacturing, therefore needing little energy expenditure.
- They are made using renewable resources.
- They promote healthy indoor air quality, with no formaldehyde and low Volatile Organic Compounds (VOC's).
- No toxic substances or compounds are contained in the product or in the byproduct of their manufacturing.
- They use post-consumer waste, repurposed and/or recycled content.
- They do not contain Chlorofluorocarbons (CFCs), Hydro chlorofluorocarbons (HCFCs), or other ozone-depleting substances.
- They can be recycled after their initial use is over.
- They are produced locally or from a locally-sourced manufacturer.

While there are many green products that can be used, there are also many to be avoided. The Cascadia Regional Green Building Council, as part of the Living Building Challenge, has produced and constantly updates what they call a "Materials Red List" that names products and materials that need to be phased out and eliminated from building projects.

The Red List of Materials to Avoid in Rehabilitation

According to the Living Building Challenge, projects cannot contain any of the following materials or chemicals:[78]

Asbestos
Cadmium
Chlorinated Polyethylene and Chlorosulfinated Polyethylene
Chlorofluorocarbons (CFCs)
Chloroprene (Neoprene)

[78] Institute, "The Living Building Challenge." Cascadia has adopted a Red List of materials that the LBC believe should be phased out of production due to health/toxicity concerns. This list is currently planned to be
be updated as new science emerges.

Formaldehyde (Added)

Halogenated Flame Retardants

Hydro chlorofluorocarbons (HCFCs)

Lead (Added)

Mercury

Petrochemical Fertilizers and Pesticides

Phthalates

Polyvinyl Chloride (PVC)

Wood treatments containing Creosote, Arsenic or Pentachlorophenol

For wood products, the most respected green products are certified by the international Forestry Stewardship Council (FSC). The FSC is an independent, non-governmental, not-for-profit organization that was established to promote the responsible management of the world's forests. Founded in 1993, the organization certifies that products carrying the FCS label that come from environmentally appropriate, socially beneficial and economically viable forest management practices. As a multi-stakeholder organization, FSC applies the directive of its membership to develop forest management and chain of custody standards, deliver trademark assurance and provide accreditation services to a global network of committed businesses, organizations and communities. FSC certification provides a credible link between responsible production and consumption of forest products, enabling consumers and businesses to make purchasing decisions that benefit people and the environment as well as providing ongoing business value.[79] While FSC is nationally represented in more than 50 countries around the world, there are 167 certified businesses in Washington State that produce certified products.

Washington State Businesses with FSC Certified Products:[80]

Adpro Litho, Inc.		Mason County Forest Products
Alexandria West Alexandria Moulding Inc.		Matheus Lumber Company Inc.
Alliance Door Products, LLC		McFarland Cascade
Allied Building Products, Edmonds		McGregor Door & Hardware
AllpakTrojan		McKillican International, Inc.
Allweather Wood LLC		Metropolitan Hardwood Floors, Inc.

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80 Forestry Stewardship Council, National Database, update 2011. For database and other information:

http://www.fscus.org/certified_companies/index.php?num=*&state=WA&letter=&order=Organization+Name&type=companie

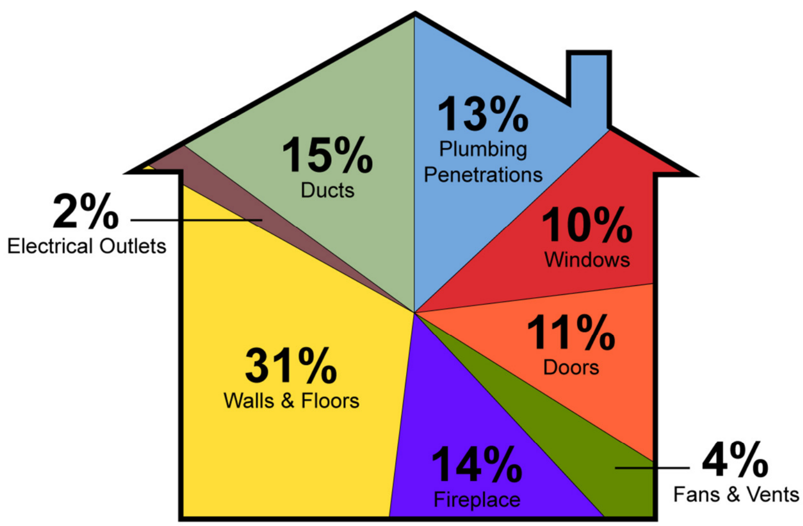
Alpha Graphics - US297		Moulding & Millwork Manufacturing Group / Ferndale
AM Hardware Co., Inc.		Mt. Baker Products, Inc. dba Mt. Baker Plywood
Architectural Woods, Inc.		National Envelope
Arclin Surfaces - Tacoma		Nippon Paper Industries USA Co. Ltd.
Bamboo Hardwoods		Northwest Label/Design, Inc.
Belco Forest Products		Northwest Millwork & Door Co., Inc.
Bellingham Millwork Supply Co.		Northwest Millwork, Inc.
Benson Industries, LLC		Northwood Cabinets, Inc.
Boise Cascade Building Material Distribution		OI Forest Products, Inc.
Boise Cascade Building Material Distribution		Olympic Panel Products, LLC
Boise Cascade Building Material Distribution		Olympus Press, Inc.
Boise Cascade Building Material Distribution		OrePac
Brazier Lumber Co., Inc.		Pac Paper Inc.
Builders Alliance Corporation, LLC		Pacific Lumber & Shipping, LLC
C-K Graphics Inc.		Pacific Lumber & Shipping, LLC
Cabinet Tech, LLC		Pacific Lumber & Shipping, LLC
Cahan Wood Products, Ltd.		Pacific Rim Tonewoods
Calvert Glulams		Pacific Source, Inc.
Capitol City Press		Pacific Western Lumber
Cascade Hardwood, LLC		Paneltech International, LLC
Cascade Print Media		ParaTimber Works LTD
CCS Digital, Inc.		Parr Lumber Company
Cenveo Inc.		Pearson Millwork, Inc.
City of Seattle Cedar River and South Fork Tolt River Municipal Watersheds		Pinnacle Lumber and Plywood
Color Press		Port Townsend Paper Corporation
ColorGraphics (a Cenveo Company)		Price & Visser Millwork, Inc.
Columbia Vista Corp		Print Management Corporation
Combat Sports Group Inc./ Sales & Marketing		KML Corporation
Compton Lumber & Hardware		Print NW
Consolidated Press Printing Company, Inc.		Printery Communications
Consortium of Papers		PrintWest, Inc.

Continental Hardwood Co. (Kent and Portland), a division of Johnson International Industries, Inc.		ProBuild
Contract Hardware, Inc. (Bothell, WA)		ProBuild - Auburn
Custom Source Woodworking, Inc.		ProBuild - Kennewick
DCG West, dba McCallum Print Group and Mailhandlers		ProBuild - Olympia
DCGWest, dba McCallum Print Group and Mailhandlers		ProBuild - Spokane
Dearborn Lumber Co., Inc. dba Alki Lumber Co.		ProBuild - Yakima
Duluth Timber Company, Inc.		Rainier Plywood, dba Rainier Richlite
Dunn Lumber Company		Rainier Veneer Inc.
E. B. Bradley Co. / West Coast Laminating		Read Products, Inc.
E. Roko Distributors-Kent, Washington		ReBinder
East Teak Fine Hardwoods, Inc.		
Ecohaus		Roof Truss Supply / RTS Lumber Co.
Ecohaus - Seattle		Rose City Printing & Packaging
Edensaw Woods, Ltd.		Seattle Warehouse
Edwin Enterprises Inc. dba Defiance Forest Products		Silver Star Cabinets, Inc.
Evergreen Construction Specialties, Incorporated		Sonderen Packaging
Fasson Roll North America		Sonoco Sumner Mill
Forestry Branch, Fort Lewis Military Installation		South Everson Lumber Inc.
Fritch Forest Products, Inc.		Specialty Forest Products, Inc.
Gascoigne Lumber Company		Spicers Paper - Kent
Genothen Holdings, LLC		Swifty Printing & Digital Imaging, Inc.
Gray Lumber Company		Synsor Corporation
Grays Harbor Paper L.P.		Telepress, Inc.
Hancock Natural Resource Group McCloud Tree Farm		Teragren LLC
Hardwoods Specialty Products LP		The Cronin Company
HASEGAWA INTERNATIONAL LTD.		The Cronin Company
Higuera Hardwood, LLC		The Cronin Company
Hillprint, Inc. dba Printco		The Magellan Group Ltd.
idX Corporation		Typesetter Corporation d.b.a. Printex Press
Inside		Unisource Worldwide, Inc.

Interior Construction Specialties, Inc.		Unisource Worldwide, Inc.
Interior Environments		University Publishing at Washington State University
International Forest Products Limited - Site		Vancouver Door Co. Inc.
K&H Printers		W. W. Wells Millwork LLC
K/P Corporation		Wapato Converting
Kaye-Smith		Washington Alder, LLC
Kimberly-Clark Corporation		Washington Architectural Hardware
Louis and Company - Seattle		Washington Hardwoods
Lacey Door and Millwork		Washington State Department of Printing
Larson-Juhl - Seattle, WA		West Coast Laminating, LLC
Lawton Printing, Inc.		West Coast Paper
Litho Craft, Inc.		West Coast Paper - Spokane
Livingston Printing, Inc. dba Windward Communications Group		West Coast Paper - Sumner
Lynden Door Inc.		Weyerhaeuser NR Company, South America Sales & Marketing
		Whale Bay Woods, LLC
		Wright Business Forms Inc. dba Wright Business Graphics
		Xerox Corporation - Seattle, WA
		Yadon Construction Specialties, Inc.

3.2 HISTORIC WINDOWS

Historic windows are significant architectural features of a building, and once removed and discarded, they are lost forever. Unfortunately, historic windows are commonly considered to be one of the major sources of energy losses in buildings. However, recent studies increasingly show that old windows are not necessarily the energy drain that many people believe them to be. The U.S. Department of Energy (DOE) reports that only 10% of energy loss in the average home is caused by windows; more energy is lost through plumbing openings and un-insulated ducts than through windows.[81] While it is common to hear that replacing old windows with new replacement windows will save energy, there is debate whether doing so in historic structures is either energy efficient or cost effective over time. The proper repair and maintenance, historic windows can be as energy efficient as new replacements and can last indefinitely whereas replacement windows are found to last an average of 10-20 years.[82]



Heat Loss through an Average Home.

(Source: Buildings Energy Data Book, U.S. DOE, 2009. Graphic by author)

In 2009, the U.S. government created a federal tax credit on the purchase price of new windows up to $1500 for homeowners if new, qualified, Energy Star windows that met requirements were installed. Unfortunately, this led to the assumption that new windows were desirable over existing windows in rehabilitation and existing projects. Ongoing studies and research contribute to an ever-growing

[81] Energy, "Buildings Energy Data Book."

[82] Goothelf, "What Replacement Windows Can't Replace: The Real Cost of Removing Historic Windows."

body of articles, studies and guidelines that document and demonstrate how existing windows can be repaired to reduce the transfer of air and come close to matching the performance of new windows. Repairing, sealing and maintaining historic windows in combination with additional strategies such as shading, storm windows, glazing films, shutters and insulated curtains, can improve the thermal quality.

Other studies compare the energy efficiency of historic windows with double-glazed windows. One study in Vermont made a side-by-side comparison with historic, single pane windows next to double paned insulated units. This study concluded little difference in thermal performance.[83]

In 2003, a Berkeley storm window research compared infiltration rates of a low-e storm and historic window to a low-E replacement window. One significant conclusion was "the addition of low-e storm windows to the prime window provided performance very similar to that of the replacement window."[84]

At the Massachusetts Institute of Technology, a 2009 study of the windows and facades of the buildings known as the "Main Group" identified heat loss as the primary source of energy consumption, although the expectations had been that cooling loads would dominate. An initial assumption began that a double window, which would slow or prevent solar loads from entering the building, offered the best solution actually proved incorrect because solar gains through a window in winter can offset the heating loads.[85]

Other studies have looked at the environmental impacts of window construction, in order to assist in choices for windows that must be replaced if needed. One study in 2007 conducted in Australia evaluated windows with Life Cycle Assessment tools consistently found that aluminum clad wood windows had the lowest environmental impact, followed closely by wood windows. The highest

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[83] Andrew Shapiro Brad James, Steve Flanders and David Hemenway, "Testing the Energy Performance of Wood Windows in Cold Climates: A Report to the State of Vermont Division of Historic Preservation Agency of Commerce and Community Development," (National Center for Preservation Technology and Training, 1996).

[84] J. H. Klems, "Measured Winter Performance of Storm Windows," (Berkeley, California: Lawence Berkeley National Laboratory, 2003). Available at: *www.parks.ca.gov/.../berkeley%20storm%20window%20research.pdf.*

[85] Carroon, *Sustainable Preservation: Greening Existing Buildings*. Carroon references an unpublished study in March 2009 for the MIT Department of Facilities with a team of investigators led by Transsolar Energietechnick GMBH, Simpson Gumpertz, Energysmiths, Building Conservation Associates and Daniel O'Connell's Sons.

impact was polyvinyl chloride (PCV) windows and aluminum windows. Aluminum clad wood windows had less of an impact as they were cladding a softer variety of wood, and therefore had more flexibility in origin and less miles travelled, which affected the outcome.[86]

In addition, studies show that economics also play a role in historic window performance. One study illustrated that it can take up to 240 years to recoup enough money in energy savings to pay back the cost of installing replacement windows. In summary, both in energy and economics, it pays to repair rather than replace. [87]

TIPS FOR HISTORIC WINDOW REPAIR, MAINTENAINCE AND EFFICIENCY

- Most heat loss occurs around the windows' perimeter through infiltration rather than through the actual glass. Therefore, keep seals tight and in good repair. Also, check sealant at all window muntins.
- Keep exterior surfaces painted, including putty, with durable low VOC [volatile organic compounds] exterior grade paints.
- Add weather-stripping to your windows to increase efficiency as much as 50%. To reduce heat loss, weather-strip your doors around the perimeter and in any inset glazing.
- Use exterior or interior storm windows in the winter, as studies show that a window fitted with a storm window can be just as energy efficient as the more expensive replacement window – and last longer.
- Check the lock on the window – the locks' most important job is ensuring that the rails and sash are held together tightly, reducing air infiltration.
- If glass in historic windows needs to be replaced, consider laminated glass. It can be installed with low-e glazing that has energy and noise reduction benefits, is easy to install and maintains a historic finish. Low-e, or low-emissivity, glazing reduces heat transfer through glass, and can be more energy efficient than regular glazing.
- Remember, windows are only part of the picture, so follow other tips for making the entire building more efficient through insulation, weather-stripping and efficient, updated heating and cooling systems.

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[86] Ibid; Australian Government Forest and Wood Products Research and Development Corporation, "Comparitive Service Life Assessment of Window Systems," (2008).

[87] Carol Krause, "Old Homes Can Be Green," *Herald Times Online*, August 29, 2009.

- Repair or reopen historically operable windows if possible. These add to natural ventilation and better indoor air quality.
- Historic steel windows can be retrofitted with more efficient caulking or sealants, and often with storm windows for better thermo-efficiency.
- Glazing can be retrofitted with new, Low-e (low-emissivity) glass when needed in damaged historic glass.
- When replacement windows are absolutely necessary, replace with locally sourced products that are efficient, recyclable and repairable.

For more information about the repair and maintenance of historic windows, see the resource bibliography at the end of this report, and also visit the Department of Archeology and Historic Preservation website.[88]

[88] Washington State Department of Archeology and Historic Preservation, "Windows Preservation Guidance," http://www.dahp.wa.gov/window-preservation-guidance; ibid.

3.3 WATER AND SITE STRATEGIES FOR REHABILITATION PROJECTS

Experts conclude that it will be water that will be the most desired and needed resource in the future, therefore managing its use and reuse is critical. Water conservation and on-site management are some of the most important strategies in all development projects, and can easily be incorporated into historic preservation. Sustainable water use is sustainable historic preservation. Similar to embodied energy and carbon of buildings, water is also being measured as having embodied qualities. Embodied water is a term used to describe the water load of any given product or service. The *Pharos Materials Database* defines it as "the quantity of water used directly or indirectly during the production of a product from cradle to gate."[89] It is similar to the notion of embodied energy or embodied carbon, for one source cites a common example of embodied water: on average it takes 39,090 gallons of water to make one new car.[90]

Water and Building Use Statistics

- Building occupants use 13 percent of the total water consumed in the United States per day. Of that total, 25.6 percent is used by commercial building occupants, and 74.4 percent by homeowners (1995).[91]
- Between 1950 and 2000, the U.S. population nearly doubled. However, in that same period, public demand for water more than tripled. Americans now use an average of 100 gallons of water each day—enough to fill 1,600 drinking glasses.[92]
- Faucets account for more than fifteen percent of indoor household water use—more than 1 trillion gallons of water across the United States each year. Showering accounts for approximately 17 percent of residential indoor water use in the United States—more than 1.2 trillion gallons of water consumed each year. A leaky faucet wastes gallons of water in a short period of time. A leaky toilet can waste 200 gallons per day.[93]
- Of the 26 billion gallons of water consumed daily in the United States, approximately 7.8 billion gallons, or 30 percent, is devoted to outdoor uses. The majority of this is used for landscaping.[94]

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[89] Pharos, Embodied Water: http://www.pharoslens.net/framework/definitions/id/7

[90] Carroon, *Sustainable Preservation: Greening Existing Buildings*.

[91] (USGS), "Estimated Water Use in Washington, 2005."

[92] Environmental Protection Agency, "Watersense, Why Water Efficiency?,"

http://www.epa.gov/watersense/water/why.htm. .

[93] US EPA, WaterSense program: http://www.epa.gov/watersense/kids/fixleak.htm

[94] US EPA, WaterSense program: http://www.epa.gov/WaterSense/docs/water-efficient_landscaping_508.pdf

- The typical suburban lawn consumes 10,000 gallons of water above and beyond rainwater each year. [95]
- Currently, about eight percent of U.S. energy demand goes to treating, pumping, and heating water and is equal to enough electricity to power more than 5 million homes for an entire year. Water heating accounts for 19 percent of home energy use and 13 percent of the average utility bill. [96]

The major cities of the Puget Sound Lowlands, such as Seattle, Tacoma and Olympia, receive an average of 42 inches of rain a year, much of which overflows directly into Puget Sound before or after being treated at a wastewater treatment plant. [97] Better on-site stormwater management in and around historic buildings is a non-intrusive and easy sustainable strategy for reducing polluted runoff. Low-Impact Development (LID) [98] techniques offer excellent guidelines for sustainably managing stormwater on-site. Porous or pervious pavement, vegetated swales or rain gardens can drain and infiltrate rainwater on-site and regulate off-site water. Green roofs and walls in acceptable areas can help reduce the urban heat-island effect and absorb rainwater on-site. Barrels or cisterns can slow down peak water flow during heavy rain seasons and be harvested to use on site for non-potable water uses such as flushing toilets or watering plants and gardens. Water saving fixtures reduces overall water use in a building and are easily replaced in historic buildings as a low cost measure.

Stormwater and Wastewater

Managing stormwater and wastewater on-site and in buildings is a major part of sustainable development, including the sustainable development of historic properties.

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[95] Ibid.

[96] US EPA, Office of Water: www.epa.gov/water/water_efficiency.html

[97] The National Climatic Data Center's "Climate of Washington" (http://cdo.ncdc.noaa.gov/climatenormals/clim60/states/Clim_WA_01.pdf): "Puget Sound-Lowlands…Annual precipitation ranges from 32 to 37 inches from the Canadian Border to Seattle, and then gradually increases to 47 inches in the vicinity of Centralia."

[98] The Puget Sound Partnership and Washington State University have put together an excellent guide on LID strategies called "Low Impact Development: Technical Guidance Manual for Puget Sound," which is available online here: http://www.psparchives.com/our_work/stormwater/lid.htm

The Puget Sound Partnership has identified stormwater runoff as the biggest cause of water pollution in Puget Sound.[99] As the *News Tribune* reported in May 2010: "Each year, researchers say, an estimated 14 million pounds of oil and grease, heavy metals, bacteria, flame retardants, pesticides and fertilizers wash into Puget Sound from roads, parking lots and suburban lawns. The contaminants have deadly effects on marine life, from the smallest organisms to clams, oysters, and salmon." [100]

In addition to sustainably managing stormwater, developing urban sites and buildings to sustainably manage wastewater is important. Generally wastewater, or sewage, is a combination of potable water and non-potable stormwater, graywater and blackwater. From a building use perspective wastewater is primarily generated from using sinks, showers, dishwashers and laundry machines, and toilets. Commonly, potable water is piped in to a building, used and contaminated with soaps, detergents or organic matter, and then piped out in to the sewers to make its way to a treatment plant for screening, cleaning and discharge.

In addition, urban stormwater events (large storms when street systems can't dispose of the water run off fast enough) are forced to use combined sewer outputs (CSO) that exacerbate stormwater runoff issues and create direct wastewater discharges. During heavy rains sewers that convey both stormwater and wastewater (aka combined sewers) can overflow. Instead of overflowing onto streets or into homes, overflows are built into the system to directly discharge all the extra water. The result is that increased amounts of raw sewage and polluted stormwater get discharged into local water bodies during heavy rain.

TIPS FOR SUSTAINABLE WATER MANAGEMENT IN HISTORIC BUILDINGS

There are many ways to reduce stormwater runoff and wastewater runoff and disposal by sustainably developing buildings and building sites. The intention behind many of the suggested solutions list below is to recognize and utilize water as an asset rather than treat it as a liability. Additionally, many of the design strategies suggested propose the use of natural systems instead of mechanical systems for managing stormwater, which of course often have many other sustainable benefits embedded in their design besides sustainable water management.

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[99] *Stormwater & Low Impact Development*. Puget Sound Partnership. Web. 17 Oct. 2009. <http://www.psp.wa.gov/stormwater.php>.

[100] http://www.thenewstribune.com/2010/05/02/1170993/saving-the-sound-from-water.html

Stormwater

The best way to mitigate the negative impacts of stormwater is to reduce its flow into municipal sewers. Low-Impact Development (LID)[101] techniques offer excellent guidelines for sustainably managing stormwater on-site. Here are some of the strategies that could be applied to historic properties:

Porous or Pervious Pavement – allows water to infiltrate into the ground, which recharges the water table and slows down runoff. Porous surfaces can decrease or eliminate the need for detention basins. Porous pavement is available in many different forms, from pervious concrete to prefabricated pavers, and can be implemented on both large and small areas of a site. Porous pavement could be used to replace older impervious surfaces on a site to make it more water-friendly while also respecting the original design of the site.

Vegetated Swales or Rain Gardens – allows water to infiltrate into the ground, and prevents runoff during heavy rains by catching the water in depressed, vegetated basins and slowing it down. Additionally, swales and rain gardens remove many pollutants from polluted stormwater through natural filtration processes (also known as "bio-filtration" and "bio-retention"). Swales and rain gardens could be added to a historic site or incorporated into a new landscape plan. In addition to their stormwater management capabilities, they provide valuable habitat services and are commonly considered an amenity for a property.

Soil Amendments[102] – restores on-site soil from compaction from construction in order to increase water absorption and retention on-site, as well as to reduce need for pesticides, fertilizers and irrigation, which lowers toxic runoff and water use requirements. Soil amendments are specially designed for each site and could be easily applied to any historic property.

Green Roofs – can reduce runoff by absorbing rainwater on a roof surface; absorption rates are dependent on soil depths and intensity of rainfall. According to the Center for Neighborhood

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[101] The Puget Sound Partnership and Washington State University have put together an excellent guide on LID strategies called "Low Impact Development: Technical Guidance Manual for Puget Sound," which is available online here: http://www.psparchives.com/our_work/stormwater/lid.htm

[102] For more on soil amendments see pages 90-97 of the "Low Impact Development: Technical Guidance Manual for Puget Sound" (http://www.psparchives.com/publications/our_work/stormwater/lid/LID_manual2005.pdf)

Technology in Chicago, runoff can be absorbed by between 15 and 90 percent.[103] The soil depth and intensity of a green roof design would probably be somewhat dictated by the structural capacity of an existing historic building. "Extensive" green roofs are thinner and lighter than "Intensive" green roofs.[104] Green roofs can be combined with a rain water harvesting system by directing unabsorbed runoff into a rain barrel or cistern. A green roof could be an unobtrusive addition to a historic building that could assist with stormwater management.

Green Walls or Living Walls – can dispose of captured stormwater through evapotranspiration when designed in conjunction with a larger water catchment and harvesting system. A green wall is a vertical vegetated surface that can be applied to the interior or exterior of a building. Because a green wall has a rather strong visual presence, it may be challenging to apply to a historic building that has strict design protections.

Rain Barrels or Cisterns – slows down peak water flow during heavy rain by catching and storing rainwater. This water could then also be harvested and used on-site for irrigation needs or other non-potable uses where allowed. A rain barrel or cistern would be a relatively easy component to add on to a historic site or building, but its design and placement would have to be carefully considered. Implementing LID techniques to remove or lower the amount of stormwater that enters municipal sewers are beneficial at reducing both stormwater overflows and CSOs.

Wastewater

The best way to mitigate the negative impacts of wastewater, from both untreated and treated discharges, is to reduce its flow into municipal sewers and to recognize and use different kinds of water appropriately. For example, potable water does not need to be used to flush toilets – why make the cleanest water perform the dirtiest function? Rather, captured rainwater or treated graywater can be used in flush toilets; or further still: composting toilets can be used and water removed altogether. Here are some strategies for sustainably managing wastewater that could be applied to historic properties:

Composting Toilets – reduces overall water use in a building and removes blackwater from wastewater stream. There may be legal or maintenance barriers to installing composting toilets in some areas. Check your local regulations.

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[103] Green Roofs: http://greenvalues.cnt.org/green-infrastructure

[104] See http://www.greenroofs.com/Greenroofs101/faqs.htm for more facts about green roofs.

Water Saving Fixtures – reduces overall water use in a building. Fixtures are a very easy thing to replace in historic buildings and include sink faucets, shower heads and low-flow toilets. Water efficient appliances, such as dishwashers and laundry machines, can additionally significantly cut down on water use.

Graywater System – reduces overall water use in a building and cleans graywater for reuse; creates a sustainable on-site water cycle; requires on-site water treatment. Graywater, which can include collected stormwater, can be collected, treated, and reused for all non-potable water needs. Some common uses for treated graywater include irrigation, toilet flushing, and use in a cooling tower. Depending on the level of treatment performed by the system, the water source, and local regulations, treated graywater could also potentially be used for non-drinking water needs like laundry.

Rainwater Harvesting – reduces overall water use in a building and, where allowed, prevents potable rainwater from becoming wastewater; creates a sustainable on-site water cycle; requires on-site water treatment. Rainwater can be collected, treated and use for potable water needs. The technology currently but legal barriers currently prevent actual activation of these systems in the state of Washington. Additionally, rainwater harvesting system could be integrated with a graywater system to cycle back any potable water that goes down the drain after use, thereby closing the water use cycle with perpetual treatment and reuse.

On-Site Water Treatment – can eliminate or reduce the amount of wastewater that needs to be sent to a central treatment facility; creates a sustainable on-site water cycle; can integrate with a larger graywater reuse system/strategy. On-site treatment systems can vary from compact, mechanical systems inside buildings, to larger, natural-mechanical systems, such as Living Machines or Eco-Machines™, [105] that work indoors and out. The correct on-site treatment system for any given historic property would depend on the system requirements, the area available for installation, and whether or not the system could be visible.

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[105] Eco-Machines™ are a type of Living Machine system trademarked by Dr. John Todd (http://toddecological.com/) .

4. GREEN BUILDING RATING SYSTEMS IN WASHINGTON STATE

"Green" building rating systems function as tools for decision making in historic rehabilitation projects. They encourage education in new systems, and assist with goal setting for design and construction teams on projects. While not all rating systems are designed with rehabilitation in mind, they do help with setting up a framework for projects and opening up discussion for possibilities and solutions for sustainable projects. While there are the market leaders in rating systems, there are often smaller, more regional systems that can be taken advantage of. Both types can help promote projects as "green" as well as assist on the long term understanding and maintenance of critical performance issues.

Washington State has many national and local programs for green ratings, including: Leadership in Energy and Environmental Design (LEED™), The Living Building Challenge, Built Green, Earth Advantage Institute, Evergreen Sustainable Development Standards for Affordable Housing, National Green Building Standard and The Washington Sustainable Schools Protocol. LEED™ is currently recognized as the leader in rating programs, with several hundred certified buildings in Washington state. Of State government-funded projects, 25% of the LEED™ rated buildings were significant historic rehabilitation projects.

State-Mandated Green Building Certification Programs

During the 2005 legislative session, the Washington State Legislature passed the country's first law requiring that all new buildings and renovation projects that receive state funding be built to one of three green building standards (Chapter 39.35D RCW High-performance Public Buildings). Projects that receive funds from the capital budget must achieve the LEED Silver standard. All K-12 schools that receive funding from the Office of the Superintendent of Public Instruction must be built either to the Washington Sustainable Schools Protocol (WSSP) or LEED Silver standard. Finally, projects that receive funding from the Department of Commerce Housing Trust Fund must comply with the Evergreen Standard for Affordable Housing. Check if your historic rehabilitation project comes within the purview of these state-mandated requirements.

Evergreen Sustainable Development Standards for Affordable Housing[106]

The Evergreen Sustainable Development Standards (ESDS) were developed to promote sustainable building practices in affordable housing projects in Washington state, and are based on Enterprise Community Partners' Green Communities™ program. The criteria promote public health, energy

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[106] http://www.commerce.wa.gov/site/1027/default.aspx

conservation, and reduction in long term operational costs. ESDS believe that "Green building practices improve the economics of managing affordable housing while enhancing quality of life for residents" and that locating affordable housing near urban amenities such as transit will create walkable, livable communities and decrease "sprawl-related transportation impacts". Complying with ESDS criteria is mandatory for an affordable housing project to qualify for Housing Trust Fund grants or loans in Washington state. ESDS contains eight sections including: Integrated Design Process, Site Location and Neighborhood Fabric, Site Improvements, Water Conservation, Energy Efficiency, Materials Beneficial to the Environment, Healthy Living Environment and Operations & Maintenance. Fulfillment of the criteria requires complying with mandatory requirements within each section and earning at least 40 points for rehabilitation projects. Sections specifically dealing with reuse projects include: 5-2, 5-8, 5-14, 5-15, 5-16, 7-16, 7-17, 7-22, and Appendix B.

Leadership in Energy and Environmental Design (LEED™)[107]

Leadership in Energy and Environmental Design (LEED) is an internationally recognized green building certification system developed and administered by the United States Green Building Council (USGBC). The USGBC began certifying buildings using the LEED rating system in 1998, and to date has certified more than 14,000 projects throughout the US and 30 countries around the world. The most current version of LEED, v 3.0, covers projects at all scales through one of seven different rating systems including: Homes, Neighborhood Development, Commercial Interiors, Core & Shell, New Construction (NC), Schools & Healthcare and Existing Buildings: Operations and Maintenance. LEED offers four levels of certification: Certified (40-49 points), Silver (50-59 points), Gold (60-79 points) and Platinum (80 or more points). Certification is dependent first on meeting a mandatory number of required prerequisites. The level of certification is then based on a project's total accumulation of up to 100 points (plus 10 bonus points for innovation) in five different areas of focus. The five areas are: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources and Indoor Environmental Quality.

The number of points possible in each area differs slightly among the seven rating systems, but all systems are most heavily weighted in the Sustainable Sites and Energy & Atmosphere categories which combined, account for over 60% of the available points. To date, the LEED rating system does not consider post-occupancy building performance in the certification process, but instead relies only on computer modeling and prescriptive guidelines during the design phase of projects as a way of dealing with projects' energy conservation. Clients wishing to adaptively reuse existing (and

[107] http://www.usgbc.org/

possibly historic) projects will most likely apply under the LEED NC system, which also covers major renovations. These projects face a steep challenge, as there are only 4 available points for use of existing structures, under the Materials and Resources section.

The Washington Sustainable Schools Protocol[108]

The Washington Sustainable Schools Protocol is one of two ways (the other being LEED for Schools) to comply with the State's green building requirements for public schools (K-12). Compliance requires meeting one or more perquisites in each of five areas including: two for Site (16 points possible), one for Water (6 points possible), one for Materials (17 points possible), two for Energy (20 points possible) and four for Interior Environmental Quality (21 points possible) and accumulating at least 38 of the possible 86 points available (eight extra credit points are available, of which a maximum of four can be used. Also, at least four points from the Energy section must be used). The Protocol contains no information or guidelines for school renovation.

OTHER GREEN BUILDING CERTIFICATION PROGRAMS

Living Building Challenge[109]

The Living Building Challenge (LBC) was issued in 2006 by the Cascade Green Building Council. In 2009, the International Living Building Institute (ILBI) was formed to administer the LBC, and has recently certified its first three projects. The current version of the LBC, v 2.0, contains seven petals: Site, Water, Energy, Health, Materials, Equity and Beauty, which combined encompass a total of 20 imperatives. To achieve Living Building status, a building must demonstrate that it has met all 20 imperatives through a full year of occupation and undergo a third party audit. The ILBI has recently certified the first three buildings as meeting the LBC. They include: Washington University's Tyson Living Learning Center in Eureka, Missouri; The Omega Center for Sustainable Living in Rhinebeck, New York; and Eco-Sense, a home in Victoria, BC (Eco-Sense has gained "Petal Recognition" status for meeting four of the six petals of the LBC v 1.0). There are currently over 70 more projects working towards achieving Living Building Status.

NAHBGREEN - National Green Building Program[110]

The National Association of Home Builders focuses on single and multi-family residential projects in the United States, and has certified more than 115,000 homes in various green building programs

[108] http://www.ecy.wa.gov/programs/swfa/greenbuilding/law.html

[109] https://ilbi.org/lbc

[110] http://www.nahbgreen.org/

between 1995 and 2008. NAHB and The International Code Council partnered in 2008 to establish a national standard for "green homes". ICC 700-2008 National Green Building Standard™ defines green building for new construction and remodel projects while attempting to provide the flexibility to allow "regionally appropriate best green strategies". Homes follow prescriptive code based sets of criteria and can achieve ratings of Bronze, Silver, Gold or Emerald after independent certification from the NAHB Research Center.

Built Green[111]

Formed in 1996, Built Green Washington is a non-profit organization that represents eleven regional Built Green programs throughout the state, serving 30 of Washington's 39 counties. Built Green programs throughout the state each set their own requirements for certification, and vary in project type from only dealing with single family new construction to also covering multi-family residential and residential remodel projects. Regardless of the requirements for certification, all Built Green projects must be verified by third-party organizations prior to certification. All Built Green certified projects demonstrate achievement in the following areas of environmental responsibility: "Preserving natural processes through responsible site and water management"; "Lowering operating costs through energy-efficient equipment and systems"; "Reducing toxins and pollutants for a healthier indoor environment"; and "Minimizing waste by careful materials selection and jobsite recycling". Certification levels range from one to five stars based on the total number of standards meet by each project.

Earth Advantage Institute[112]

The Earth Advantage Institute (EAI) is a nonprofit organization focusing primarily on new residential and small commercial (less than 70,000 square feet) green building projects in Oregon State. EAI's mission is to "create an immediate, practical and cost-effective path to sustainability and reduction of carbon in the built environment". In addition to third party certification of projects, EAI offers numerous other services to individuals and organizations pursuing green building projects including help with sustainable financing, Energy Score report cards to help compare green buildings and classes and workshops surrounding various issues of sustainability in the built environment. The Earth Advantage Commercial program for small commercial spaces is in the pilot stages, with its first project nearing the certification process, and the second in the middle of construction after breaking

[111] http://www.builtgreen.net/

[112] http://www.earthadvantage.org/

ground last summer. The cities of Portland and Eugene are considering including EAI certification in their green building codes as an alternative to LEED certification for public projects.

EAI certifies buildings based on five areas: energy efficiency (buildings must comply with Northwest Energy Star), limited impact to site, healthy buildings, safe and durable materials and reduction in water consumption. Certification requires two third party inspections during construction (one at the conclusion of rough-in and the second at the conclusion of construction) as well as performance testing. Projects are certified at either the Silver, Gold or Platinum level.

5. RECOMMENDATIONS FOR NEXT STEPS TO ADVANCE SUSTAINABILITY AND HISTORIC PRESERVATION

The role of historic preservation in sustainability strategies and reducing carbon emissions is rapidly changing. A growing body of research and the completion of green historic rehabilitation projects keeps the topic one of expanding interest and lively debate. However, much remains to be done by the rest of us to make sure that existing buildings and communities, both urban and rural, are fully utilized to reach sustainability goals as well as enriching quality of life. Following is a discussion of various issues surrounding the discussion as well as recommended approaches for research and implementation.

Preservation and Sustainable Neighborhoods

In recent years, land has been developed in the United States at a rate nearly triple the rate of population growth. The average American uses five times more land than 40 years ago, and every year, 1 million acres of farmland is given over to new development in the United States.[113] The carbon impact of this trend can be seen not only in the new buildings constructed over vacant land, but in the vehicle miles travelled that are used commuting out to sprawling areas; those who live in the sprawling areas travel 20-40% more than those who live in denser urban areas. Many historic neighborhoods and communities were developed before dominance of the automobile and by nature have a more compact urban landscape. Revitalization of these historic neighborhoods supports a reduction of vehicle miles travelled to places of work, shopping, and schools by maintaining activity near transit lines, bike trails, and promoting alternative transportation modes. In Washington, transportation accounts for nearly half (47%) of the total greenhouse gas emissions, including emissions from cars, trucks, planes, and ships. According to the U.S. Census Bureau, the statewide drive-alone rate has decreased from 73.9 percent in 1990 to 73.3 percent in 2000. Preserving historic neighborhoods can help reduce this rate even further.[114]

The use of historic preservation as a tool to promote compact, sustainable communities can be seen in many places in Washington, such as those that use the National Trust for Historic Preservation's Main Street approach to development. At the neighborhood and street level, these walkable neighborhoods are critical pieces of the sustainability puzzle. However, as cities move towards higher density, historic neighborhoods are being lost at an increasing rate. Often maximizing lot coverage or economic needs, new buildings built for higher neighborhood density lack a sense of pedestrian quality, historic character and sense of place. Reconciling the desire to retain older buildings, neighborhood character including old and new development must be stitched into the future of our cities through historic preservation at both a building and neighborhood level as well as at the policy level of the many jurisdictions that have authority over our built environment.

Policy and Code Changes for Historic and Existing Buildings

Historic buildings present complex energy challenges that need individual, careful evaluation. Current energy codes often prescribe solutions that do not fit the framework of historic buildings, and often result in an unintended financial or energy solution that is not always successful and often cost prohibitive. If the goal is for aggressive energy savings in existing buildings, a review of alternative paths of energy code modeling is needed to evaluate a better outcome for energy performance.

Making New Connections

New partnerships and collaborations need to be established between historic preservation groups; policy makers; green designers, planners, builders; and government officials. While many institutions are investigating energy performance in historic structures, more collaboration is needed for transparent information sharing and most effective measures to be implemented. This is critical to create more efficient, cost effective and successful sustainable historic rehabilitation projects.

Education and Research

Education needs to be increased across all fields on how historic preservation and sustainable rehabilitation can be incorporated successfully in all projects, not just a few.

Window Performance Studies

Windows are often at the top of historic building debates. Historic window performance needs more research so that informed choices of repairing, retrofitting, and ultimately as a last choice, replacement can be made. In addition, more knowledge of passive additions (such as storm windows and interior/exterior shading) to historic windows needs to be available.

Advisory Committee End Goals for Washington State Sustainable Historic Preservation:

- Foster a culture of reuse, repair and renewal rather than consumption and waste;
- Promote sustainability through the stewardship of historic resources;
- Is energy efficient and reduces our reliance fossil fuel and non-renewable energy sources;
- Reduce construction and demolition (C&D) waste going to landfills;
- Promote increased use of salvaged and recycled materials;
- Use locally-made products and materials;
- Improve worker and occupant health and productivity;
- Increase employment opportunities by promoting labor intensive preservation projects, skills, and trades;

- Reduce vehicle miles traveled by conserving historic community centers and walkable neighborhoods;
- Use on-site water efficiently through improved infrastructure and recycling;
- Reduce stormwater runoff into streams, rivers, lakes and Puget Sound by ecologically treating water on-site before it enters into municipal systems.

7. SELECTED CASE STUDIES IN WASHINGTON STATE

The following case studies were compiled by UW graduate students in the Department of Architecture and represent a variety of historic rehabilitation projects in Washington State.

Case Study: King Street Station, Seattle

Built: 1906

Rehabilitation: ongoing as funding allows

Architect: ZGF Architects

Contractor: Sellen Construction

Historic Registry: National Register 4/13/1973, Pioneer Square Historic District

Other Registry: LEED Silver expected

Photo Credit: Author

Sustainable Design Strategies:

The restoration of King Street Station revives the building's original grandeur through a number of sustainable strategies. Natural ventilation and lighting are restored by the removal of a tile ceiling in the waiting room and restoring access to clerestory windows. The clerestory windows will be controlled mechanically based on ventilation needs. Other spaces in the building that are regularly occupied will have more controlled systems installed. The upper level spaces will be left to future tenants to finish, but guidelines and mechanical systems will be installed that meet energy efficiency standards. Insulation has been also added to the masonry walls to reduce the temperature swing in the space.

A ground source heat system takes advantage of the ground's constant temperature to heat and cool the building. Radiators and high efficiency unit ventilators will efficiently distribute the heat. The mechanical room is strategically located as a potential location for a streetcar electrical substation, allowing its heat to be captured and used for the building. A district strategy for water collection is also being considered. King Street Station would collect more water than it can reuse for itself, and this system would allow other buildings to use the excess.

Historic materials are being reused wherever possible, with replacements being sustainably sourced. During excavation, granite that matches the existing granite was uncovered and will be used in the restoration. Original windows are being repaired and reused. Aluminum replacement windows are being removed, recycled, and replaced with new wood frame windows that replicate the original windows. The original glass will be reused where possible, and replacements will be uncoated insulated glass. In several areas of the building, historic features exist underneath elements that had been added over the years. A grand staircase is being uncovered and its marble, granite, brick, and brass handrails will be reused. In the waiting area, the original ornate ceiling has been uncovered and will be restored.

In addition to energy and material sustainability, there will be improvements to the building's social sustainability. On the north side of the building, a former parking lot will be turned into a public plaza, reintegrating the building with pedestrian activity.

Energy:

- ground-source heat technology for heating and cooling
- space for eco-district utilities and ability to reuse heat from a streetcar substation
- space for future smart grid equipment
- daylight improved by removal of drop ceiling and exposure of clerestory windows
- cross-ventilation restored by removal of drop ceiling and exposure of clerestory
- clerestory windows controlled mechanically based on ventilation needs
- wall and roof insulation improved
- insulated glass used for new glazing
- high-efficiency unit ventilators
- guidelines and systems to match energy efficiency standards for unfinished spaces

Materials:

- 60,000 square feet of existing building reused
- original windows repaired and original glazing reused where possible
- granite found during excavation used to match historic granite
- staircase made of marble, granite, brick, and brass handrails uncovered and reused
- original ornate ceiling restored above the removed suspended tile ceiling in lobby
- historic canopies lining the west side of the building removed and replaced
- seismic upgrades enhance the longevity of the building
- replacement materials to match old, sourced within the United States

Water and Site:

- district roof water collection with neighboring properties (potentially)
- excess water from King Street Station used by other properties

Private Residence, Walla Walla

Built: 1917

Rehabilitation: 2009

Architect: Strata Architects

Contractor: Barber Construction

Historic Registry: Walla Walla Register of Historic Places, 2009

Other Registry: 4-Star rating King/Snohomish County Built Green®

Back of the house with expansion, courtesy of Sandra Cannon

Sustainable Design Strategy:

The primary goals of the renovation were to "preserve, protect, prepare." The homeowner works for the U.S. Department of Energy and has served on Walla Walla's historic preservation commission. Her home shows that homes can be sustainable while maintaining historic character.

Energy consumption was reduced by improving air-tightness of the building envelope. Blower door testing helped to determine placement of insulation. For a five-star Built Green rating, a higher R-value of wall insulation was needed. This was not done because the existing walls would need to be torn out to do so. Improvements included attic insulation, floor and wall insulation, weather stripping, and ceiling fans. New wood windows were installed to meet energy requirements, and old windows were reused in the unconditioned basement stairwell. The wood frames were not thick enough for insulated glass, and storm windows were installed instead.

The heat source was changed from a finite to renewable source. A ground source heat system provides heat to the main level of the house. Radiators and radiant flooring systems replaced a forced air system. By using a formula from the Oregon Geothermal Institute, the load capacity for the system was calculated to be 2 tons, rather than 4 tons by standard formulas. The installed heat pump has a capacity of 3 tons, chosen as the most up to date product available not containing freon.

Existing vegetation was protected during construction. Plants were moved to safe areas and 100-year old trees were fenced off. New vegetation is drought resistant and pervious materials reduce storm water run-off. A gray water system is in place, but initiation is on hold until an environmental cistern system is found. Other energy saving features include WaterSense labeled water faucets, dual flush, low-flow toilets, 18 ENERGY STAR qualified lighting fixtures, and wiring for future photovoltaic (PV) panels on the garage.

Reused materials include doors, flooring, lumber, siding, and nails. Old concrete and 3-gallon toilets were used as fill for a new patio. New materials containing recycled content include fly ash concrete, carpet pad, insulation, paint, roofing, and tile. Construction waste was either donated (bathroom sinks with cabinets, carpet and pad, gutters) or recycled (cardboard, metal, plastics, roofing, and unusable lumber).

Indoor air quality was emphasized as early as the contract, which stated that there be no formaldehyde, volatile organic compounds (VOC), or vinyl. New carpet was all-wool carpet with jute backing. Interior paint was commercial grade recycled with low (17 grams/liter) VOC's, and the exterior paint was commercial grade with low (20-51 grams/liter) VOC's.

Energy:

- 18 ENERGY STAR qualified lighting fixtures
- calculated energy load reduced from 4 tons to 2 tons
- ground source heat system installed
- finite energy source changed to renewable source
- radiators and radiant heat in floors improve heat delivery
- increased air-tightness of building envelope
- insulation added to attic space
- insulation improved in floors and walls
- storm windows enhance energy performance
- garage (steep south facing sun) pre-wired for future PV panels

Materials:

- 97% construction waste diverted from landfill
- existing vegetation, including 100 year-old trees, preserved
- reused doors, flooring, lumber, and siding
- concrete and toilets used as fill for new patio and ramp
- reused non-code compliant windows for unconditioned basement stairwell
- recycled cardboard, metal, plastics, roofing, and unusable lumber
- donated bathroom sinks with cabinets, carpet and pad, gutters, and other such items
- recycled-content products were carpet pad, insulation, paint, roofing, and tile

Water:

- runoff reduced by pervious materials
- less water demand with drought resistant new plants
- gray water system-equipped for the future
- WaterSense labeled water faucets
- low-flow and dual flush toilets

Finishes:

- only low or no VOC content materials and finishes used
- interior and exterior paint with low VOC content
- no formaldehyde or vinyl used
- wool carpet installed with jute backing

Back of the house before expansion, courtesy of Sandra Cannon

Current Photos:

Installation of ground source heat system, courtesy of Sandra Cannon

Installation of cellulose insulation, courtesy of Sandra Cannon

Materials reuse stations, courtesy of Sandra Cannon

Nails pulled from siding and both materials reused, courtesy of Sandra Cannon

Concrete to be crushed and reused as fill for new patio, courtesy of Sandra Cannon

Martin Woldson Theater at the Fox, Spokane

Built: 1931

Rehabilitation: 2007

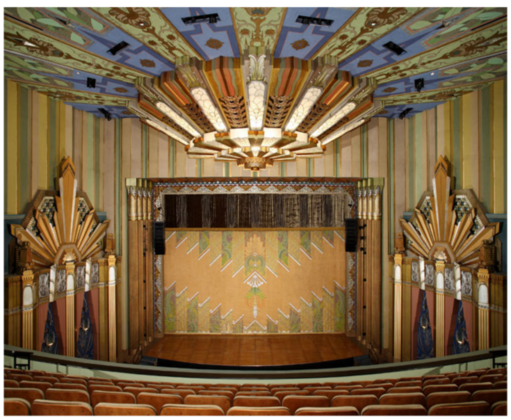
Architect: NAC | Architecture, Spokane

Contractor: Walker Construction Company

Historic Registry: National Register 11/30/2001, Spokane Register of Historic Places 12/10/2001

New Market Tax Credits, Historic Tax Credit

Honors: Valerie Sivinski Award for Outstanding Achievement in Historic Rehabilitation (2008)



Fox Theater interior. Photo courtesy of NAC|Architecture, Spokane

Sustainable Design Strategy

The Fox Theater project involved the acquisition and rehabilitation of a historic Art Deco style theater located in downtown Spokane. The Fox Theater has been a significant Spokane landmark since it opened in 1931 and was in constant operation as a movie palace and performance facility until 2000, when it was threatened by demolition. Broad-based community support saved the Fox from the wrecking ball and the nonprofit Spokane Symphony spearheaded fund-raising and rehabilitation work. Upon completion, the Fox (renamed the Martin Woldson Theater at the Fox in honor of a local benefactor) assumed its new role as home to the Spokane Symphony as well as a mid-sized venue for a variety of performing arts, entertainment, business and private events.

The major design problem was transforming a 1931 movie theater into a multi-use performing arts facility while preserving the original art deco architecture and murals that were featured on almost every wall and ceiling surface. Any changes that were made had to be in accord with the *U.S. Secretary of the Interior's Standards for Rehabilitation* in order to qualify for federal historic preservation tax credits.

All of the changes occurred while allowing the preservation and restoration of the Fox's original murals, lighting, and other art deco details. In some cases this meant existing murals had to be stripped of non-original paint to expose the original artistry, and then re-painted by art restorers. Historical light fixtures were kept, cleaned and restored, while missing fixtures were recreated to match the originals. For example, the well-known glass sunburst in the auditorium and the lay light in the lobby ceiling were restored to original condition. The construction took advantage of local artists, employing them to recreate missing, broken or non-original panes.

Throughout the restoration process, most elements were refurbished and reused, consistent with historical restoration requirements and significantly reduced potential waste. In addition, insulation was added to the roof and exterior walls where possible to increase the efficiency of the building. Single-glazed windows were replaced by new insulated windows with thermal breaks and custom frames that matched the profile of the original windows. A new mechanical system was also installed. The energy efficient system combined with the upgrades to the exterior envelope, significantly improved the performance of the building. Ultimately, an Art Deco treasure has been saved and restored, and the Fox Theater has become a catalyst for additional rehabilitation projects in downtown Spokane that sets an example for sustainable building methods applied to restoration projects.

Energy:

- new high-efficiency mechanical system installed to increase energy performance
- single-pane windows replaced with custom, insulated windows with thermal breaks
- new insulation added in roof and exterior walls to increase efficiency

Materials:

- reuse of existing building shell and core
- restoration of existing finishes and materials reduces use and waste

The Cobb Building, Seattle

Built: construction began in 1909, completed in 1910

Rehabilitation: 2006

Architect: Howell and Stokes (1909), GGLO (2006)

Contractor: Lease Crutcher Lewis (2006 GC)

Historic Registry: National Register of Historic Places, Washington Heritage Register, Historic Tax Credits

Other Registry: LEED Silver (NC 2.0/2.1)

The Cobb Building after 2006 rehabilitation (photo: GGLO)

Sustainable Design Strategy

Like many historic rehabilitations in Washington, a seismic upgrade and structural reinforcement was vital and required for the building. However, beyond seismic upgrades, the Cobb's design reflects the architect's and owner's pursuit of LEED certification. Many sustainable features were easily incorporated into the renovation without compromise to the building's character-defining features. However, some existing conditions posed a challenge to sustainability goals. Project architect GGLO's integrated approach to the design process for this rehabilitation began with an interdisciplinary team of architects, interior designers, and landscape architects that aimed at both historic preservation and sustainable goals.

Sustainability goals sought to maximize the efficiency of the building envelope to improve comfort while reducing energy use. The historic significance of the terra cotta exterior and window sashing precluded re-glazing the windows with higher performance glass or adding exterior insulation to the walls. The compromise was to apply a removable low-e film to the existing glass in order to improve thermal performance and comply with the Washington State Energy code. Along the same line of conservation, the units were heated and cooled using a "hybrid" heat pump system that saves about 5% a year over a water source heat pump. Further, all carpet, adhesives, sealants, and paint are low VOC. Carpet was limited to the corridors, with hard surface flooring throughout the units.

Architectural efforts maximized rental square footage while providing seismic reinforcement and maximizing daylighting through the use of existing windows. Units range from studios to two bedroom apartments, and all offer light and open floor plans with high ceilings and movable barn doors

Energy:

- low-E film was applied to original windows to increase efficiency
- hybrid heat-pump system for heating and cooling uses rejected heat to preheat domestic hot water

Materials:

- Reuse of existing building, including existing windows, exterior brick and terra cotta
- Diverted at 95% of construction waste from landfills through recycling and reuse
- Recycled materials used included metals, wallboard, insulation, acoustical ceiling panels and concrete

Water:

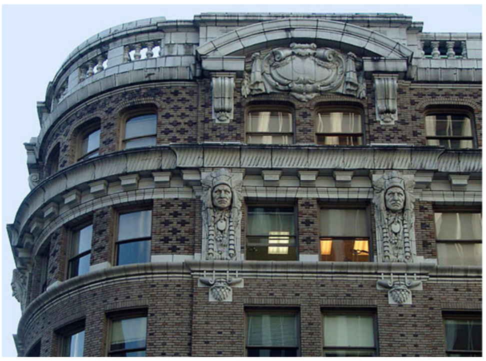
- Rooftops were converted into garden space, reducing runoff by 38%
- Reduced water usage by 30% and sewage by 40% using dual flush toilets, lavatory fixtures and Energy Star appliances

Finishes:

- Low VOC/emitting finished used for paints, carpets and adhesives

Health and Comfort:

- User-controlled conditioning systems
- Daylighting and views for 90% of spaces



The rehabilitated Cobb Building, detail (photo: by GGLO)

The Cobb Building after 2006 rehabilitation (photo by GGLO)

Cobb Building, interior. Photograph by GGLO

Cherry Parkes Building, Tacoma

Built: 1890-1904

Rehabilitation: 2004

Architect: McGranahan Architects with BOLA Architecture + Planning

Contractor: Lease Crutcher Lewis

Historic Registry: Contributing buildings in the Union Depot-Warehouse Historic District, National Register of Historic Places

Certification: LEED Silver

Renovated Cherry Parkes Building, photo from University of Washington, Tacoma

Sustainable Design Strategy

Virtually all state-funded construction projects in Washington must meet minimum standards to achieve USGBC LEED-Silver certification. Yet, prior to the renovation of Cherry Parkes in 2004, the University of Washington, Tacoma (UW-T) established a commitment to environmental stewardship, setting their goals above and beyond this compliance. The University committed to being a positive force in environmental issues, not just in research, but in facility and resource management as well. Selection by UW-T of the Union Depot-Warehouse Historic District as the setting for this branch campus clearly demonstrates this commitment.

The UW-T Phase 2B capital project comprised five former warehouse buildings. The Cherry Parkes Building and the nearby Mattress Building renovation involved the adaptive re-use and complete modernization of 135,000 square feet of building area. Cherry Parkes combined three formerly independent buildings into one with space for classrooms, broadcast studio, technology center, and faculty offices.

The University was committed to appropriately weaving an educational facility within an existing urban commercial context. The cross fertilization has benefited the surrounding neighborhood and the campus. This was the first LEED Silver certified project for the University of Washington as well as the city of Tacoma and incorporates an educational tour of key sustainable building elements and systems.

Energy:

- energy efficient lighting design used in conjunction with natural daylighting
- high performance glazing in windows to increase envelope efficiency
- daylighting was used to offset lighting use

Materials:

- reused existing buildings and brownfield for development
- 82% of existing exterior walls and structural party walls were successfully reused
- existing timbers were salvaged, milled and repurposed as stair treads & hand rails
- existing cast iron pilasters were conserved and restored
- 78% of construction debris was diverted from landfills through recycling & salvage
- all 456 historic windows were salvaged, refurbished and reused by local businesses

Water:

- new plumbing fixtures are ultra-low flow for water use reduction

Finishes:

- building materials & finishes were selected based on recycled content & proximity
- low emitting finishes include paint and carpet throughout

Other:

- spaces were programmed to maximize natural daylight availability
- mechanical ducts and piping were upgraded to improve thermal comfort and ventilation
- operable windows for occupant comfort

Rehabilitated Cherry Parkes Building, BOLA Architecture + Planning

Fire Station No. 9 (Design Source, Incorporated), Spokane

Built: 1930

Rehabilitation: 1992-1993

Architect: Arthur Crowley (1930), Design Source, Inc. (designer, 1992)

Contractor: 1930 building by fire fighters

Historic Registry: contributing building in the Ninth Avenue Historic District National Register of Historic Places and Spokane Register of Historic Places

Other Registry: Innovation in Green Building - Spokane SMART Business Recognition Program

Rehabilitated Fire Station No 9, photograph by Design Source, Inc.

Sustainable Design Strategy

Historic Fire Station No. 9 was rehabilitated by new owners, Design Source, Inc., prior to the LEED rating system, but sustainability was still a goal in the project. Design Source, a Spokane architecture and design firm, takes pride in the fact that they are located in a dense residential neighborhood within walking distance of many businesses and public transportation. Interiors were retained or reused, such as doors and windows, interior walls, floors and finishes. Low VOC paints and coatings were used, and space planning considers window placement for maximum occupant comfort. High efficiency lighting is used and less efficient lighting is controlled to complement natural day lighting of the large window openings.

In order to retain the existing windows, historically appropriate storm windows were custom made for each of the 29 openings to achieve better energy efficiency and preserve the embodied energy of what existed; all windows were retained.

Surplus wood trim found in the basement was fashioned into display rails for the conference room, and existing surplus doors were modified to add glass to showcase the call board relocated to the hose tower. The hose tower was modified to gain useable space on both floors. However, the large wooden brackets and names carved into the walls have been retained and preserved. All wood trim, brass stair nosing, and one of the two brass fire poles were all retained. The second pole is stored in the basement. Storage racks in the basement once used to store barrels of fire-fighting chemicals were modified for storage of project files. In lieu of conventional broadloom carpet installation, double stick mesh carpet was used so as not to damage the original hardwood floors on the second floor. Wood floors were exposed and refinished to lengthen usable life span.

Energy:

- storm windows custom manufactured to retain existing windows and increase envelope efficiency
- high efficiency lighting and task light complement daylighting to decrease overall energy use

Materials:

- repointed and restored all exterior materials
- repaired and restored all historic windows
- interior walls, floors and finishes were reused; existing and salvaged materials include storage lockers, trim that was repurposed into railing

Finishes:

- low VOC/emitting finished paints and coatings, and carpets

Other:

- user-controlled conditioning systems
- daylighting and views throughout

Fern Hill Elementary School, Tacoma

Built: 1911

Rehabilitation: 2006

Architect: BLRB Architects

Contractor: Babbit Neuman Construction Company

Fern Hill Elementary School. Courtesy of the Tacoma School District,

Sustainable Design Strategy:

Fern Hill puts historic preservation in a "green" context. The school was designed to comply with the recently adopted State of Washington Sustainable Schools Protocol for High Performance Schools. Sustainable features include water conservation by way of rainwater harvesting and the use of rain gardens for storm water management. Daylighting is maximized, and all electric lighting is controlled by occupancy sensors and photo-cell controls. The design called for the reuse of existing building materials and the selection of many building materials with high recycle content. All interior finishes were carefully selected to be non-toxic with low- or no-VOC content. (BLRB Architects website)

Fern Hill Elementary School was designed to meet standards adopted by the State of Washington's Sustainable Schools Protocol. When the school district announced plans to tear down the building, a community-led effort convinced the administration to change its course. Architecture firm BLRB was charged with designing a facility that met educational program goals, while celebrating the school's long history and honoring long-running ties to the community.

With strong public support for preservation, it was clear the architect would need to turn to the community for the project to reach its fullest potential. The design process included extensive and formal community outreach, the key to delineating the goals of sustainability and preservation.

The design called for re-using and upgrading the historic, three story building and adding new construction to house the changing needs for a contemporary elementary school. A new bell tower on the main building provides visibility for the historic bell, an element of the Fern Hill School since 1888. A new school entrance leads into the "Heritage Hall", a display space celebrating school and community history. Thus, the team was able to capitalize on the goal of preserving history for the community and meet sustainability guidelines as outlined by the state.

Energy:

- daylight and views provided by existing large classroom windows
- daylight in all occupied areas with switched zones to reduce use of artificial lighting
- 2-pipe fan coil system and a computerized energy management system boost HVAC system efficiency

Materials:

- over 27,000 square feet of the existing building retained
- overall footprint reduced by a two-story addition that replaced the demolished wing
- salvaged and reused truss and framing timbers, brick, hardwood flooring, stone parapet copings, door casings, chalkboards with wood trim
- recycled content in structural steel, concrete, GWB, carpet, masonry, roofing, woodwork
- carpet removed, remade at a carpet factory, and reinstalled as new
- lumber, flooring, cabinetry, plumbing and light fixtures, lockers, chalkboards, playground equipment were salvaged and stocked into local second-hand stores
- all interior finishes are non-toxic, low- or no-VOC

Water:

- raingarden provides natural stormwater treatment
- decreased impervious area reduces stormwater runoff
- drought-resistant, native landscaping eliminates the need for irrigation system
- roof-top cistern collects rainwater for education and demonstration garden

Mattress Factory Building, Tacoma

Built: 1912

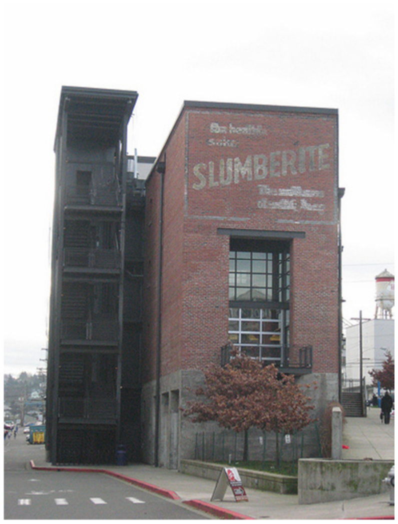
Rehabilitation: 2004

Architect: Miller|Hull Partnership

Contractor: Lease Crutcher Lewis

Historic Registry: Contributing building Union Depot Warehouse Historic District, National Register of Historic Places

Other Registry: LEED Silver



Mattress Building after rehabilitation

Sustainable Design Strategy:

The rehabilitation of the building had to address common issues associated with reuse: seismic reinforcing, energy upgrades, and hazardous materials abatement including arsenic and lead, and contaminates due to the industrial past of the neighborhood. The building was re-roofed and insulated, including some new aluminum-clad insulated windows to replace the existing wood ones that were deteriorated and not considered historically significant. Windows that were in good shape were saved. The building is located within and contributing to a designated historic district. As a result, the rehabilitation was subject to review by the Tacoma Landmarks Commission.

The masonry character of the building was exposed where possible at the internal partition wall, and furred out on the exterior walls for added insulation for greater energy performance. The existing structure was also revealed where possible, mostly on the exterior of the building. A few new interventions (exterior stair, north wall opening, and clerestory) were designed to highlight and distinguish themselves from the historic building fabric.

Energy:

- new skylight between the two buildings brings light in along the masonry partition wall
- clerestory added at the south end
- operable windows
- exterior walls furred to add insulation
- energy upgrades

Materials:

- reused existing building
- 78% construction waste recycled (whole complex)
- $1+ million in existing materials salvaged and refurbished, including brick, wood beams and columns, and historic windows (whole complex)
- sustainable-minded materials selection, wheatboard
- exterior facades restored to preserve character

City Hall Rehabilitation and Expansion, Port Townsend

Built: 1892

Rehabilitation: 2006

Architect: ARC Architects

Contractor: Dawson Construction

Historic Registry: National Register of Historic Places 05/14/1971, Port Townsend Historic District 05/17/1976, Port Townsend National Historic Landmark 05/05/1977

Port Townsend City Hall viewed from Madison and Water Streets, Kelly Laleman.

Sustainable Design Strategy:

The rehabilitation of the Port Townsend City Hall displays the city's pride in preserving its 19th century government center, while wanting to incorporate forward thinking green building strategies. The new City Hall Annex is strategically designed to buttress the existing building, providing seismic reinforcement with minimal impact to the historic building. In the original building, less historically significant spaces were utilized as office spaces, which minimized the footprint of the annex.

Ninety-five percent of construction waste was diverted from the landfill. Of new materials, 65% were regionally manufactured and 40% were regionally extracted. Two roof beams were replaced with stronger beams, and those beams were reused for stairs and benches in the new annex. In addition to reusing wood, 58% percent of new wood was FSC certified. Many other materials contained recycled content, including rebar, brick, structural steel, insulation, wood doors, tile and carpet.

Heat loss was reduced by adding insulation to the interior of the masonry walls, improving roof insulation, re-sealing and re-puttying windows, and refurbishing storm windows. Heat gain was reduced by a highly reflective roof surface and interior roller shades. A high efficiency boiler and radiator system replaced a duct system that had been installed. Water consumption was reduced by 38% by using low-flow fixtures and planting native and drought-resistant plants. Electrical demand was reduced by motion sensors, and the annex roof is equipped to hold PV panels. Wind power has also been utilized as a renewable energy source.

Individual thermal comfort is achieved by having at least one operable window and one lighting control zone provided per 200 square feet of perimeter space. Daylight is provided to 82% of regularly occupied space. Timed gauges allow building occupants to regulate non-perimeter airflow, and adjustable radiators create various thermal zones. Indoor air quality was addressed by using several low VOC finishes and copy rooms having independent exhaust systems.

Energy:

- original windows re-sealed to be more energy efficient
- reflective roof reduces heat gain
- annex roof built to hold PV panels in the future
- wind-power energy from Renewable Choice Energy
- motion sensors for lighting control
- insulation placed along exterior masonry walls
- roof insulation improved
- boiler and radiator system re-introduced
- high efficiency boilers installed
- roller shades control sun
- 82% of regularly occupied space provided with daylighting
- 92% of occupants have view through windows to the outdoors
- independent exhaust for copying and printing rooms
- radiators adjust individually to create different thermal zones
- timed gauges allow regulation of non-perimeter airflow
- at least 1 operable window and lighting control zone per 200 square feet of perimeter
- no CFCs in base building HVAC&R systems
- non-CFC-based refrigerants in all fire suppression systems

- no HCFCs or Halons in base building HVAC, refrigeration and fire suppression equipment

Materials:

- 95% of construction waste recycled
- 58% of wood based building materials considered FSC certified
- plywood, Douglas Fir lumber, and finish wood all met FSC certification
- 23% of materials were recycled-content products
- rebar, brick, structural steel, insulation, wood doors, tile, and carpet contained recycled content
- 65% of materials were regionally manufactured
- 40% of materials were regionally extracted
- gravel, concrete, steel, lumber, plywood, and paint obtained within 500 mile radius
- size of the annex addition minimized by using existing non-historic spaces for offices
- annex designed to reinforce the existing building as a seismic upgrade
- existing brick re-pointed on both interior and exterior
- existing windows resealed and re-puttied
- storm windows refurbished and reused
- two beams removed from roof structure reused for stairs and benches in annex
- low VOC content weatherproofing sealant, silicone, paints, coatings and carpet

Water:

- 38% reduction in water consumption
- native and drought-resistant plants reduce irrigation
- parking lot runoff drains to a rain garden
- low flow fixtures
- dual flush toilets and waterless urinals
- motion-activated faucets and other low-flow fixtures

Original windows maintained, Kelly Laleman.

Seismic bracing at Annex entry ties to the historic structure, Kelly Laleman.

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