Green Building In The Mile High City: An Economic And Historical Analysis Of The Sustainable Landscape In Denver, Colorado

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GREEN BUILDING IN THE MILE HIGH CITY: AN ECONOMIC AND HISTORICAL
ANALYSIS OF THE SUSTAINABLE LANDSCAPE IN DENVER, COLORADO

A Thesis
Presented to
the Faculty of Natural Sciences and Mathematics
University of Denver

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

by
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The goal of this research is to provide a more in depth understanding of the green building landscape in Denver, Colorado than was previously available. The past and present of sustainable structures as well as the vernacular architecture of the region are analyzed in order to make useful projections about the future of the city and its buildings and potential planning policies. In conducting this analysis, methods utilized include case studies, histories, archival research, as well as a brief spatial analysis that outlines the extent of current green building trends in Denver. As a result of this research, it is divulged that there is a distinct difference between producing and achieving sustainability. It is seen that the vernacular traditions of the past achieved sustainability by choosing local, durable materials. An alarming trend is found in which the LEED certification process seemingly relies too heavily upon innovative technology and imported resources that produce sustainability rather than achieve it. It is hoped that through this research arises a better appreciation of vernacular architecture and traditional building elements. Ultimately this research proposes that learning from the past may be the best way to ensure the future of sustainable cities through the implementation of truly green buildings. We do not need to learn how to be sustainable, but simply remember.
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Chapter One: Introduction

Although estimates vary, the World Urbanization Prospects 2007 Revision published by the United Nations Department of Economic and Social Affairs Population Division projected that 2008 would mark the first time in history that urban and rural global populations would be equal in number. The same model anticipates that by 2050, the world’s urban residents will account for 70 percent of the overall global population (Department of Economic and Social Affairs, Population Division 2008). As a result, urban issues affect a growing portion of a growing population. Now more than ever before the relationship between the urban landscape and the people that function within demands our attention. Urban geography strives to explain these economic, social, and environmental relationships between the city and its people (Kaplan et al. 2003). It is the particular relationship between the economic and environmental that will be addressed within this thesis. With growing populations, faltering economies, and finite resources, how as an urban people do we live as such sustainably?

With a propagating urban population, the city represents itself in a rather dichotomous built form. Beloved and bemoaned, the city plays a crucial role in the past, present, and future of the global population. The city and its architecture, “constitutes our most visible past” (Brettell, 1973, ix) and exemplifies the very best of human creativity and ingenuity. “Humankind’s greatest creation has always been its cities. They represent
the ultimate handiwork of our imagination as a species, testifying to our ability to reshape
the natural environment in the most profound and lasting ways” (Kotkin 2005, xix). As
the quote suggests, cities are exemplary of the human impact on the environment we rely
so heavily upon. Visible from outer space (Kotkin 2005), there is no limit to the toll that
cities ultimately take on nature. True, cities may represent the greatest and most creative
built forms of our species, but at what cost? Cities by their very nature are
unsustainable; “sustainability means that a unit use no more than it can replace. Cities do;
therefore they are not sustainable” (Blassingame 1998, 1). But, it is not merely the
existence of the city itself that is the problem; “admittedly the root problem is the
climactic explosion in numbers of the human species” (Blassingame 1998, 3), an
observation that can be appreciated within the context of this research if not discussed in
deepth. If humankind continues to inhabit the planet at the monumental numbers
projected, a persistently increasing number of these people will be living in one urban
form or another (Blassingame 1998).

As a result, the larger the urban population, a population that does not support
itself in terms of food and other survival resources, the greater the hinterland must be in
order to sustain such a concentration of people within a small area. Indeed, urbanites
depend entirely upon the extraction of resources from the bordering hinterland; a rural
area surrounding urban centers and less densely populated with more plentiful, untouched
resources and more acreage for primary circuits of capital (Kaplan et al. 2003 ). “City
residents eat food they do not grow, buy products they do not make, use non-renewable
energy, build with material they do not produce and so on” (Blassingame 1998, 1).
Consider that it takes an estimated 9.1 acres of land (crop, pasture, wood, and other) to support one person to the high standards of the western culture (Siry 2008). By this measure, in a city of 600,000 people, roughly the current population of Denver, Colorado, it takes 5,460,000 acres of hinterland to adequately support every resident of the city and county. The vast acreage needed to support even a moderately sized city weighs heavily on the environment. The current and future viability of our populations and cities rely on the preservation and replacement of these hinterlands as they are truly the life-force of our urban centers. The sustainability of the hinterland is crucial to the success of the urban landscape. Without the proper education, economics, and mitigation these greenfields so valuable to the survival of our cities and our populations, are in peril of irreparable damage. Or worse still, vanishing all together. Staggering rates of development and environmental degradation threaten these resources as increasing acreages transform from the natural to the built environment.

Building construction dominates the demand for more natural space and resources. However, through the reuse of our buildings and the recycling of our materials we can reduce this impact and preserve the hinterland and its resources for future generations. New buildings occupy former natural habitats, often referred to as greenfields, and utilize new materials that cost dearly in the form of extraction, production, transportation, and economy. But the hinterland can be preserved and resources recycled and reused by renovating the existing building stock and already improved urban lots and as the construction industry is beginning to realize, it can be done in an economically viable way. By reusing buildings in the existing urban core and
infilling empty or abandoned downtown lots, larger acreages of hinterland can be left unscathed and unindustrialized, thus preserving land for wildlife, open space, and the agricultural stock without which the city could not be sustained.

The goal of this research is to better understand the role of historic buildings in terms of this sustainability and reuse. According to the Environmental Protection Agency (EPA), sustainability can be defined as it applies to the built environment as “the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction” (EPA Home, Green Building, Basic Information 2010).

Although further definitions of sustainability are discussed in greater depth throughout, this is the most important understanding of the term as it relates to this research. These old buildings are most often dealt with under the umbrella of historic preservation, and although preservation is what ultimately occurs from reusing these buildings, this research focuses not on restoring with historical accuracy, but rather on breathing new life into decaying buildings and neighborhoods through renovation for new uses when the original utility is no longer viable.

There exists a misconception about both historic preservation and this adaptive reuse that a renovation project of a large scale will be too expensive. Preservation projects are often seen as impractical especially when tax-payer dollars are on the line. It is falsely perceived that these types of historic projects are only viable options to the
wealthiest citizens and corporations; preservation and renovation are often seen as well
outside the realm of non-wealthy private citizens (Bluestem Interactive 2010; Bernstein
n.d.). Yet there are publications such as Donovan D. Rypkema's *The Economics of
Historic Preservation: A Community Leader's Guide* that outline in extreme detail the
actual savings gained by rescuing, reusing, and renovating the buildings of our past.
With skilled and careful planning, renovating a historic building is ultimately more cost
effective than constructing from scratch. Consider the lumber, the nails, the light
fixtures, even the land purchased on which the building sits, all these elements in an old
building have already been paid for and were done so when high quality resources cost
less. In addition, no matter what the price paid for materials used in historic buildings,
the project was paid for so distantly in the past that we can hardly consider the cost, of
say the bricks that comprise the building shell, in a calculation of renovation cost. In
terms of economics, historic preservation and adaptive reuse have an enormous head start
over new construction as the bones of the building, arguably the most expensive part, is
already bought and paid for. New construction requires the purchase of all new materials
with prices inflated to the modern market.

Historic buildings are not only more economically feasible, but they are more
sustainable as well. Carl Elefante, an architect based in Washington D.C. and frequently
referred to throughout this research, was made famous in the architectural community by
coining the phrase “the greenest building is one that is already built.” Preservationists
and green builders alike identified with this proclamation and this thesis has followed
suit. Existing buildings, those ranging from fifty to one hundred and fifty years old and
beyond, hold what many deem to be the “holy grail of the green movement” (Melaver and Mueller 2009, 168). The key to sustainability in historic buildings can be summarized within two overarching categories: embodied energy and the inherently green design utilized by the architects, developers, and builders of the past. Embodied energy will be briefly discussed in the second chapter as it is one cornerstone of sustainability in preservation, but this research will devote the bulk of its discussion to the inherently green building designs and methods most often utilized in historic buildings.

In discussing the intrinsically sustainable components of these older structures, the research naturally turns to a review of the standardization of modern green elements in new buildings and how they are identified. This is done through a concise history and explanation of the United States Green Building Council's sustainable building certification system Leadership in Energy and Environmental Design, more commonly known as LEED. LEED ultimately acts as a way of streamlining the green building process. This research however, takes issue with the LEED program’s handling of adaptively reused buildings and their certification. The existing building stock is only minimally recognized in the current LEED certification process.

This research strives to tackle the very large subject of sustainable buildings. Within this topic there are numerous and varied subtopics that might easily merit separate research endeavors and publications of their own. Therefore one of the challenges of this specific research was narrowing the wide field of related information down to only the truly pertinent. The history of green building and adaptive reuse in Denver, Colorado
pulls from two major concepts within the field of urban geography: urban sustainability and urban change. An exploration of each of these topics will take place, focusing on the basic tenants of sustainable cities and the urban form under capitalism. A history of the evolution of the urban landscape will follow. The discussion of these topics will then lead to a more in depth exploration of green building, specifically dealing with adaptive reuse and the advantages and issues surrounding renovation and demolition. Because this research is location specific, vernacular architecture will be explored, focusing both on Denver's historic vernacular as well as the apparent lack of research surrounding vernacular architecture theory in the western United States.

Considering the lack of western vernacular research, this thesis is charged with expanding and understanding this rarely discussed, yet increasingly important topic; admittedly more specific to Denver as opposed to the West in general. The West is unique in its settlement patterns as well as its resource availability and both of these aspects make it incredibly distinguishable from the prevailing themes and issues of the eastern vernacular architecture. In many ways the West is still the American Frontier, the Wild West, and instead of marginalizing its traditional urban landscape we should be learning from it. From this vernacular architecture we can gain, or regain, advances in green building; learning more from the past and relying less on current and future technology and “green gadgetry.”

To fulfill this exploration, a series of four case studies is carried out, focusing on two examples of adaptive reuse buildings and two examples of new construction projects, or newbuilds, in Denver, Colorado. Buildings analyzed in this research include the
University of Denver College of Law, the EPA Region VIII Headquarters, 4240 Architecture Inc. offices, and finally the Byron G. Rogers Courthouse. In each case study, an in depth history of the building or its lot is included. After this history, obtained largely through Sanborn Fire Insurance maps and personal interviews, the research turns then to an overview of the project’s LEED certification process including a synopsis of credits that were earned and by what means. Attention is paid to the cost per square foot as at a very basic level, this is the most simplistic and effective medium in which to compare construction prices between historic and new buildings. An overall analysis of each building and its context within the urban landscape of Denver summarizes the case study section.

Finally, observations about the past and current states of green building in Denver is summarized and from this potential projections about the future of the industry in the city are formulated. A brief spatial analysis is considered in these projects including a map of present LEED projects within the city and county as well as currently vacant buildings that could potentially be renovated and reused at some point in the future. Another brief discussion of possible policy decisions and successful mitigation practices in other communities across the country leads to the eventual conclusion of this research following the general theme in utilizing what we have learned from the green buildings of the past in order to better the buildings of our future.
Chapter Two: Background

Buildings and the Evolution of Cities in the United States

Shakespeare in his 1607 tragedy Coriolanus asked, “what is a city but the people?” This research poses the question, “what is a city but the buildings?” Obviously, without buildings there would be no urban landscape, no urban location. Buildings are made by and for the collective city and harbor all functions within the urban setting, from the financial and industrial to the cultural, artistic, and historical. As “cities are made up of real buildings and the places between them” (Ford 1994, ix) research concerning the where and why of the buildings that comprise the city fall under the umbrella of geography. However true this may be, is it seen there is “not much emphasis on buildings as places” (Ford 1994, xii) within the academic realm of urban geography. Literature in urban geography often analyzes the process of the city rather than its form, quantifying “housing but not houses, retailing but not department stores” (Ford 1994, xiii). Skyscrapers are also a common research topic, as their form and function mimics cities within cities (Ford 1994), however there is still little to be said of the individual building in its surroundings. This avoidance of extensively analyzing the architecture of urban form, contemplating buildings and building types within their larger spatial context, and realizing the relationships between urban function, place, and organization, all prevent the field of urban geography from understanding “buildings and the changing ways people use them” (Ford 1994, ix). The evolving relationship between people, cities,
and buildings becomes increasingly important when issues of population and economic, social, and environmental viability are taken into consideration. As aforementioned, with more than half of the global population residing and working in the city, how can we maintain a sustainable built landscape?

The largest and most unsustainable component of the city is the buildings within it. Buildings alone account for 48 percent of the energy consumption and consequential carbon emissions in the United States; residential structures responsible for 21 percent and commercial 17 percent. The production and maintenance of buildings, including residential, commercial, and industrial operations, account for 76 percent of all the electricity consumption in the nation. Energy and electricity use are not, however the only areas in which buildings devour resources. Nearly 13.6 percent of all the potable water in the world, about 15 trillion gallons per year, is used by buildings globally along with 40 percent or 3 billion tons of raw material (United States Green Building Council 2010). Buildings however are not only consumers of natural commodities, but producers of waste as well. According to estimates from the Environmental Protection Agency (Environmental Protection Agency 2010), “170 million tons of building-related construction and demolition debris was generated in the U.S. in 2003, with 61% coming from nonresidential and 39% from residential sources” (emphasis added). With such staggering statistics it becomes quite clear that “the way that we design and construct buildings has a profound impact on the environment” (May T. Watts Appreciation Society 2010).
According to the non-profit organization Architecture 2030, by the year 2035 three-quarters of the built environment in the US will be either new or renovated. The non-profit also figures that if we were to renovate our currently existing buildings to consume 50 percent less fossil fuel energy, this would allow new buildings to also meet the 50 percent reduction without increasing the energy demand of the construction sector (Architecture 2030 2006-2009). This is exceedingly important, as not even the most idealistic of us expect for a moment that building and development will halt all together; instead it is much more logical to reduce the existing stock's energy use to account for the inevitable growth in construction. Buildings will be constructed regardless of the environmental state and political atmosphere of the future. Preparing our existing buildings for this future now acts as the best practice in green building.

Current projections of buildings yet to be constructed in the United States are indeed staggering and most likely conservative. As of 2003 there were a recorded 65 billion square feet of commercial buildings in the U.S. By 2030, it is expected that new construction will add about 28 billion square feet, for an increase of nearly 40 percent (Nelson 2006). An increase of this size built by the conventional standards currently employed will strain economies, exhaust resources, jeopardize environmental quality, and greatly limit the levels of sustainability we are collectively hoping to achieve. The U.S. Department of Energy also notes, perhaps without the attention it deserves, that 54 billion of this existing square footage, about 84 percent of it, will be renovated by that same 2030 benchmark (qtd. in Elefante 2007). Renovating this 84 percent under sustainable guidelines will promote smarter growth, smarter energy use, and smarter, more efficient
cities overall. We have built these cities only to have let the urban core decay, wasting a vast amount of resources in which an equally large amount of money and energy has already been spent to produce and manufacture. With a calculated effort, careful planning, and perhaps most importantly patience, the heart of the city can also be the heart of its sustainability.

Nearly every American city has within it a decaying urban core. With blocks of pre-existing buildings the urban core becomes the ideal location for sustainable adaptive reuse. With careful planning and patience the central business district could not only be reused but done so under green guidelines. The historic buildings that comprise the urban core act as a prime candidate for this reuse as they not only provide a host of already processed and paid for materials but they were initially designed to be naturally energy efficient, as discussed in depth later in this research. Although addressed in a limited nature in this thesis, but of undeniable importance is the cultural value these structures represent as well. These structures provide a foundational history so important to a young nation such as the United States. Reusing historic buildings preserves a sense of place and tradition in a country that longs for a deeper history (Morley 2003).

In the introduction to her book *Historic Preservation and the Imagined West*, Judi Mattivi Morley outlines the events in American history that led to the abandonment and consequent revitalization of urban cores not only in the West, but throughout the nation. Not surprisingly, the downfall of downtown is most often and most largely attributed to a phenomenon known today as “decentralization.” Embodied by the sprawl of suburbia and edge cities, decentralization had a profound impact on the built environment and
allowed not only for the segregation of urban land-use, but for the segregation of the city’s people as well. White flight is the sound-byte terminology for the trend that was facilitated by decentralization in the 1960s of predominantly white, middle-class families abandoning the inner city and its diversity for the homogeneity and perceived safety of the suburbs that proliferated after WWII. Prior to WWII, city planners focused on the city center. The main goal of urban policy at that time was to successfully balance the center of industry and capital with its necessity for transportation, labor, and culture. The city was diverse because everyone regardless of race or ethnicity needed access to the basics of urban living that a tightly clustered city provided. This density of daily life cultivated a unique tradition. “From 1890 to 1950 vaudeville houses, cabarets, baseball fields, amusement parks, and department stores embodied a vibrant urban culture” (Morley 2003, 5), that we are only now striving to recreate. But what set this movement in motion?

Advances in transportation radically altered the urban landscape. With the advent of streetcars that radiated like spokes from the urban core, the need to live and work in the same part of town no longer existed. As those with the most disposable income and the higher tax brackets moved their families and money away from the city, urban planners followed. Catering now to the trend of decentralization, city planners sought the most effective means of facilitating movement between work and home. In promoting this daily pilgrimage from suburbia to the central business district and back again, those who did not or could not commute were largely forgotten. Intensifying in the years after WWII, the “rise of suburban shopping malls, theme parks, and sports stadiums led to the
breakdown of urban leisure” (Morley 2003, 5), demonstrating that suburbanites now had little reason other than work to ever interact with and within the city. The widening socio-economic gap then worsened as those who could not afford to move to the pristine acres of suburbia were left to deal with poverty, high crime rates, failing schools, and crumbling buildings largely due to the fact that the supporting tax base of the city now lived elsewhere. Essentially the economic process became focused within a suburban setting rather than urban. Under this new planning policy, urban space was now standardized in such a way that “failed to account for ethnic, class, or gender differences, remaking urban space to reflect the visions of generally white, middle-class, male urban planners” (Morley 2003, 5) who knew little of the communities they were shaping. This decentralization, resulting flight to suburbia, and the subsequent loss in tax base for city communities ultimately resulted in the decaying urban core that is prominent in American cities.

As the urban core deteriorated, the struggling businesses that remained in the center business district sought ways to bring the middle-class, more precisely middle-class disposable income, back to the city. City planners now turned their efforts to urban renewal, which in many cases caused more harm than good. Because a large number of suburban men already worked downtown, it was the middle-class mother-of-two whom urban policy now focused on. In an attempt to make the city more appealing to this demographic, “urban renewal designs imposed suburban-style architecture on the central business district, hoping to dispel the belief that cities were unsafe” (Morley 2003, 6), essentially charming women back into the urban environment to socialize and take care
of the family shopping. This practice destroyed many historic buildings in favor of architecturally muted styles and barren parking lots.

Specifically in Denver, the Skyline Urban Renewal project sponsored by the Denver Urban Renewal Authority (DURA), as early as 1969 began demolishing the very roots of the city in the name of progress. Auraria, one of the first sites of development in Denver was razed in 1977 and gave way to the simplistic, utilitarian buildings of the shared campuses of Colorado Community College of Denver, Metropolitan State College, and the University of Colorado at Denver. One block of the existing neighborhood was saved as the focal point of the campus; notably it was documented that the renovations on this block cost only about $20.00 per square foot while the bland, box buildings of the new campus cost about $30.00 and certainly lacked in character what the preserved block maintained (Noel n.d.). Even with this acknowledgement the 1970s and 80s were a period of large-scale destruction in downtown Denver.

But demolition was no new phenomenon to the city of Denver. Jerome Smiley in his 1901 *A History of Denver* noted at the time of his publication, that "nearly all the buildings that constituted the pioneer town have disappeared" (qtd. in Noel n.d.), although Denver was just over forty years old. Particularly in downtown, Smiley observed at a staggeringly early date that, "many of the present buildings are the third structures erected on their sites; and in some instances present buildings are of the fourth series" (qtd. in Noel n.d.). This rampant replacement comes as no surprise; at its inception Denver was a temporary town at best. The early city was a depot that served those headed elsewhere, be it into the gold-laden Rockies or back East to civilized
society. Denver sprang up over night with the discovery of gold and the promise of
fortune and like many western cities “developed haphazardly, with no cohesive
planning” (Morley 2006, 8) and certainly no time allotted to the development of a distinct
architectural vernacular. An account from Lavina Porter who arrived in Denver in 1860
with her husband and son depicts the early town as “a thriving, bustling, busy city” yet
the built landscape largely consisted of “numerous tents and numbers of crude and illy
constructed cabins, with nearly as many rum shops and low saloons as cabins” (Dorsett
1983, 28); not exactly the grand foundation of a settlement destined to become the Queen
City of the Plains. Still, the longer Denver survived past the gold bust, the clearer it
became that Denver was more than a turnstile town. As Denver became “really the only
tolerable place” to live in the Rocky Mountain Region, according to John Evans, beloved
early citizen and politician of Denver (Dorsett 1983, 27), its architecture began to
demonstrate more permanence. Following in the structural traditions more of the
Midwest and East Coast than the Southwest, Denver buildings took shape as grandiose
Victorian and Neo-Classical structures rising from the barren and brown plains. These
architectural forms gave validity to the burgeoning town; if it looked like a civilized city,
then Denver must have been a civilized city. In an ongoing attempt to always be “bigger,
better, and newer” Denver has historically favored demolition and egocentric architecture
over that of its past (qtd. in Voelz Chandler 2001, 14). Forsaking square clapboard cabins
and dirt floors for Victorian brick, endearing parking structures over a renown architect's
hyperbolic paraboloids (see Figure 1), Denver has lost much of the architectural history
specific to its western upbringing.
However, it was this era of deconstruction that acted as the impetus behind the numerous preservation movements in the city of Denver. It is unfortunate that only with a growing number of demolitions did citizens realize the potential of these old buildings, both historically and commercially. This epidemic of destruction and the city’s apparent love affair with the new did manage however, to encourage a more positive movement in Denver architecture. In the midst of the “demolition derby” in Denver specifically, but nationally as well, politicians and planners alike began to “consider old buildings as economic resources and establish historic districts to save their architectural heritage” (Morley 2006, 4). With the passing of the 1966 National Historic Preservation Act and the Tax Reform Act a decade later, there were suddenly cultural and monetary “incentives for businesses to use existing buildings” (Morley 2006, 4). As more of these historic buildings are adapted for modern uses, the conservation of historic districts follows (Morley 2006), saving the decaying urban core while also reaping the benefits of tax breaks and instilling compellingly savvy economics.
Denver, in fact, boasts one of the most successful and profitable examples of this conservation. Overseen by early preservationist Dana Crawford, the 1400 block of Larimer Street in Denver’s central business district was transformed from a raucous skid row into “the most famous street in the West” (Morley 2006, 54). After the harsh economic climate after the Great Depression, the block better known as Larimer Square (see Figure 2), suffered “bars, liquor stores, and cheap hotels replacing the upscale businesses” (Morley 2006, 44) that formerly occupied Denver’s first main street. Now bawdy and unkempt, the block was targeted by DURA for demolition in 1960s. However, in the years DURA spent seeking out funding and political approval for the “renewal” project, Crawford had been slowly rehabilitating the block business by business. Striving for a single entity in charge of acquisitions and management within the project, Crawford organized the corporation Larimer Square Inc. in August of 1964 and subsequently streamlined all matters concerning Larimer Square, including historical landmark recognition. Experiencing great economic success in the 1970s, 80s, and 90s Crawford’s foresight and dedication made possible through Larimer Square “a vision of a
great future based on an exiting, adventure-filled” Wild West past (Morley 2006, 65). Larimer Square truly shows the social and economic viability of such reuse projects. It is important though to note the environmental benefits of this success as well. During Denver’s “demolition derby” literally tons of waste and wasted materials were razed, destroyed, and sent to the landfill, yet this one fortunate block on Larimer Street was spared, preserving not only the historical context of the structures there, but the resources, energy and land spent to build them in the first place. Materials were preserved along with history. Energy was saved along with money. This exemplary project speaks to all aspects of sustainability within the city while highlighting the importance buildings and their reuse have in the urban core.

The Sustainable City

As discussed in the introduction to Wheeler and Beatley’s Sustainable Urban Development Reader; Second Edition, prior to the Industrial Revolution in the United States, the majority of the population dwelled among the resources that sustained them. A largely rural population, the pre-1790s United States was an agrarian landscape, importing a large portion of its non-agricultural goods from the United Kingdom from which the young U.S. had so recently gained its independence. As tensions between Britain and the United States became strained, peaking with the War of 1812, it soon became clear that the United States could no longer rely on its former kingdom for resources. Following the Industrial Revolution that began in the United Kingdom,
industrialization in the United States transformed the farm fields into factories and warehouses. The country's newly found sense of independence was intensified in the urban centers and was felt throughout the hinterland. The promise of jobs and steady, if not meager, wages first attracted former agronomists who abandoned the farm, uprooted their families, and joined the growing urban population. Soon however, the rural land once commonly held became privatized and landownership became increasingly centralized. The small subsistence farmer could no longer afford to live solely off the land. The benefits of the city pulled the population towards it, while rural land monopolies pushed population away. As a result urban centers quickly became dense and dirty habitats that were just as unsafe as they were unsightly.

This increased urbanization led to a technological boom as well. As factories prospered, the technology featured within the industrial world spread to the everyday lives of urban citizens. From streetcars to indoor plumbing, the city dweller became increasingly detached from the agrarian relationship with nature. The further this detachment progressed, the worse the toll on the environment. Air and water pollution from factories went unchecked and unregulated while deforestation occurred at a staggering rate as lumber fueled both the energy and infrastructure needed to foster the Industrial Revolution. As citizens came to live in more highly fabricated landscapes, the concern for nature dwindled with the connection people felt with the environment.

However this rampant environmental degradation did not go unnoticed for long, debatably if at all. Before the dawn of the twentieth century, citizens, writers, and planners alike began to realize the disconnect as the city grew more congested, dingy, and
dangerous. Such minds as Ebenezer Howard and Lewis Mumford bemoaned the atrocities of the city and sought a reunion with nature. The theories of these men, however, did not propose the restructuring of the existent city, rather they cried for a new urban form all together, the “garden city.” The garden city acted as a scale, balancing the population and its industry fruitfully between the city and the country. Garden cities promoted the decentralization of the urban core; a reduction in the density of the city was seen as the answer to all negative aspects of the growing urban world. While those like Howard and Mumford were among the first to realize the detriment the city could be to the natural environment, they employed within future generations of planners the ideology of sprawl.

Cities, though, already much ingrained in infrastructure and form, were not easily transformed from industrial havens to idyllic rural-urban towns. Instead the idea of garden cities quickly turned into “garden suburbs” (Wheeler and Beatley 2009, 9), and the decentralization and decay of the urban core began in earnest. In an attempt to lessen the environmental effects of the city, suburbia simply spread them out over a greater distance. The degradation of the environment was not lessened through the garden suburb, only diffused. The central problem of the city remained unsolved.

Beginning in the 1960s and 70s, with the growing polarization of the rich and poor, the increased awareness of environmental issues, and unchecked economic growth, the idea of sustainable cities was truly born. Inequalities between socio-economic groups rallied activists in favor of social equity. The worsening state of the environment, both urban and elsewhere became difficult to ignore with such treatises as Rachel Carson's
Silent Spring published in 1962. Economists slowly began to wonder if a finite planet could actually support infinite economic development simply for the sake of growth. The late twentieth century ushered in the foundational ideology behind sustainability; it was the first time that citizens on a global scale wondered what would be left for the future, if the current population continued to live as they had since the onset of industrialization.

The sustainable city is one that strives to improve the quality of life for its current and future inhabitants according to three major criteria; social sustainability, environmental sustainability, and economic sustainability. Often referred to as a “three-pillar,” (Littig and Grießler 2005; Basiago 1999) this approach recognizes that sustainability is a multi-faceted and complex idea. Balancing these three pillars, in theory, achieves sustainability both in the present and in the years to come. This concern for future generations arises from the “potentially large-scale and irreversible degradation of natural systems in the course of global economic development” (Toman 1994, 400) largely set in motion by the Industrial Revolution. Since the dawn of humanity, our species has left its mark on the natural world, always shaping it to our needs. However, in previous built forms, the environmental degradation we are experiencing was not so severe; in terms of ecology and civilization, the “problem becomes even greater if we discuss cities” (Camagni et al. 1998, 103). Discussions of the sustainable city most often and in greatest detail concern themselves with the environmental as it is often the most tangible aspect of a green built environment. The environmental sustainability of a city concerns itself with such issues as air emission, water use, solid waste management, recycling rates, land use, and overall environmental quality (Shane 2000). Recycling
programs and air quality are concrete forms of environmental aspects of urban sustainability therefore they are more easily discussed. However it takes a cultural and economic balance to maintain a “a process in which a balanced use and management of the natural environment” (Nijkamp and Perrels 1994, 4). The bulk of the conversation concerning sustainable cities does focus on the environmental aspect, however due to the importance of the social and economic, this portion of the research will review both of these lesser discussed aspects of urban sustainability in greater detail. Why does the city matter? Why does the need exist to “develop healthy urban environments” (Yohe and Morris 1999, 67)? Although cities, with their “large populations, their rapid growth and affluence, are unsustainable” (Goodland 1995, 8) and traditionally have been, this does not necessarily have to be true of the urban future. Indeed, with the right balance the city can save the world (Blassingame 1998, 4).

To begin, because the terms “green” and “sustainable” are often used interchangeably, it is of initial importance to clarify the subtle difference between the words in the context of the sustainable city. Sustainability, in this sense, refers to an overall maintenance of urban life. This includes the social, environmental, and economic aspects of the city all performing reasonably for the most equitable conditions for urbanites. Figure 3 best outlines the essentials of sustainability as referred to in this research. In terms of development,

Figure 3: Components of sustainability. Photo courtesy Johann Dréo via www.wikipedia.org.
building, and planning, sustainability refers to the practice of design and construction “that meets the needs of the present without compromising the ability of future generations to meet their own needs”(WCED 1987, 43). Green, however, refers to the specific condition of the environmental viability of both the city and its buildings. The term “green” is a common metaphor referring to any environmental association based on the idea of the color representing nature. Green tends to be associated with the trend of “going green” and is often used to associate products, organizations, political parties, or policies with environmentally sensitivity” (Presidio Graduate School n.d.). Sustainability is an overall wellness meeting the demands of social, economic, and environmental standards, whereas green focuses largely on the environmentally sustainable. True though that “development, equity, and sustainability signal a broad range of fundamental challenges” (Yohe and Morris 1999, 67) and therefore they require a more in depth discussion within this research.

**Social Sustainability**

The ideology behind social sustainability, also referred to as equity, was born from the increasing disparity seen in cities between ethnicities and socio-economic status. The larger, the denser, the more industrial the city became, the greater the political and economic injustice grew for minorities and those already in poverty. As this has occurred, “social sustainability has begun to receive political and institutional endorsement, becoming entwined with the sustainable communities agenda and the
notions of governance, social capital and corporate social responsibility” (Colantonio 2007, 2). As equity issues become increasingly important, it is necessary to recognize that “a clear theoretical concept of social sustainability is still missing” (Littig and Grießler 2005, 69). The constructs involved in measuring and analyzing aspects of social sustainability are largely abstract; how is happiness measured, for example? Is civic engagement calculated by opportunities to vote or number of public meetings attended? This uncertainty about how exactly to quantify social sustainability has led the issue to be “the least represented within public policy debates” (qtd. in Wheeler and Beatley 2009, 183). This case proves problematic as equity is so important to the well-being of a large portion of our population, yet there exists limited discourse on how to discuss, let alone distinctly define, social sustainability.

However, attempts are being made to better understand and analyze equity within the realm of sustainable cities. There are, in fact some metrics and assessment methods in development for better measuring the construct of social sustainability. Social standards, institutional sustainability, and democratic rights (Littig and Grießler 2005) are among myriad other constructs to be considered in evaluations of equity. Social sustainability is difficult to define and often changes depending on the needs and intentions of the researcher defining the phrase. Easier than a solid definition, there are widely accepted features of social sustainability that together best establish the concept. Therefore, “the broadly accepted common ingredients of social sustainability include:

- meeting basic needs;
- overcoming disadvantage attributable to personal disability;
• fostering personal responsibility, including social responsibility and regard for the needs of future generations;
• maintaining and developing the stock of social capital, in order to foster trusting, harmonious and co-operative behaviour needed to underpin civil society;
• attention to the equitable distribution of opportunities in development, in the present and in the future;
• acknowledging cultural and community diversity, and fostering tolerance; and
• empowering people to participate on mutually agreeable terms in influencing choices for development and in decision-making

...thus...the thematic areas of social sustainability [are defined] as being basic” (Colantonio 2007, 5).

Having loosely define social sustainability, Colantonio provides a chart (see Figure 4) of the measurable components of the overall construct. These components give viability and validity to an otherwise intangible measure of social wealth. However, despite a somewhat tangible methodology in measuring social sustainability, “there is paucity of tools for the implementation of this concept” (Colantonio 2007, 2).

Additionally, the urban landscape is greatly affected by issues of social sustainability and equity. As previously mentioned, there is a growing disparity between socio-economic groups within the city. This discrepancy, although echoed through such infrastructures as education, safety, and income-levels, is most visually prevalent in the buildings of the haves and have-nots. Areas of low-income and ethnic enclaves are often plagued by vacant, abandoned, and deteriorating buildings. These structures not only limit accessibility to buildings of everyday use, but also decimate the overall value of the community in terms of real estate, further propagating the decline of these areas. Social
equity in terms of urban building should translate to equal access to the buildings of necessity. Buildings should represent safe, comfortable, and convenient locations at which citizens can work, play, and live. Sustainable buildings, by providing these aspects of viability to citizens, communities, and businesses alike take on greater roles of social sustainability than is often awarded credit.

**Economic Sustainability**

Modern economic sustainability is brought into question as there are many who “question the sufficiency or even the validity of conventional economic approaches to resource and environmental problems” (Toman 1994, 399). The Industrial Revolution ushered in the use of steam power, coal, electricity, and fossil fuels; some of which are finite resources. As the global market continues to burn through such limited resources, the economy of these goods and their utility must come into question. A city’s economy “includes all services, institutions and infrastructures in the agricultural, industrial and service sectors that are used for (material) reproduction” (Littig and Grießler 2005, 71), closely interweaving the urban landscape with that of its economic system. It is this
relationship between economics and the sustainable city that warrants the following discussion on the built environment as it takes shape under capitalism.

As discussed previously, those living within the city are not those sustaining it. To better appreciate the relationship between the hinterland and the city a brief discussion of the built environment under capitalism will prove beneficial. As discussed in David Harvey’s 1983 publication *The Urban Process Under Capitalism*, there are at least three circuits of capital that function both in the hinterland and city limits that dictate the shape of the built environment; the primary, secondary, and tertiary. Understanding these circuits can assist in the understanding of the urban form and why cities are largely unsustainable in their current incarnation as previously discussed.

First, the primary circuit of capital refers to the basis of industrial production for profit; this is investment in raw materials, labor, and the means of production (qtd. in Bridge and Watson 2002). The primary circuit of capital produces the goods that will eventually create commodities; i.e. agriculture and mineral extraction. Little investment in the primary circuit of capital occurs within city limits. The primary circuit and its workers are traditionally relegated to the hinterland. Consequently, urbanites typically represent the secondary or tertiary circuits of capital rather than the primary.

The secondary circuit of capital provides aid rather than direct input to production and consumption. The investment at this circuit of capital occurs in terms of fixed capital and consumption fund assets. With fixed capital assets, secondary circuit workers provide the means of assembling these produced commodities through heavy machinery
and factories as well as the means through which the goods are in turn distributed; i.e. roads and infrastructure. Consumption fund assets invest in the actual consumption of commodities; this is circuit of consumption in which the actual product is sold to the consumer. Commodities like washing machines and lawn mowers are a part of the consumption fund in the secondary circuit of capital. The consumption fund includes not only the products themselves, but the commodities that aid in the distribution and consumption of these goods as well; such as retail locations, houses, and sidewalks, which give consumers a place to obtain and keep their purchased products as well as an avenue through which to physically transport themselves to the products themselves. Considering the consumption fund and the fixed capital assets, it can be seen that the secondary circuit of capital largely pertains to the built environment. The factories of fixed capital and the sidewalks of consumption fund assets create and bolster the built environment for consumption. Because these elements are largely immobile, and generally cannot be moved without destroying their value, the secondary circuit of capital is chiefly investment in the built landscape. The secondary circuit of capital is the city embodied and provides services rather than the raw materials of the primary circuit necessary to maintain the urban form.

The tertiary circuit of capital refers to ventures dealing with science, technology, and society. This circuit strives to enhance the productivity and cooperation of labor in the primary and secondary circuits. Technological advances in factory machinery, scientific discoveries, and public art are examples of the result of investment in the tertiary circuit of capital. The tertiary circuit is the human element; this is investment in
social welfare, conceivably the most valuable and certainly the most intangible of the circuits of capital. Frank Lloyd Wright said of the dependence between built environment and culture, a “noble life demands a noble architecture for noble uses of noble men. Lack of culture means what it has always meant: ignoble civilization and therefore imminent downfall.” Although the third circuit produces the least in terms of tangible commodities, it is what cohesively binds the producing circuits and keeps laborers and producers content.

The basic differences between the producers of each circuit of capital, in livelihood, income, even in location, steadily lead to discrepancies between the rich and the poor. “The tacit goal of economic development” through the lens of urban sustainability, “is to narrow the equity gap between the rich and poor” (Goodland 1995, 5). This notion ties in closely with issues of social sustainability, exemplifying how interconnected the three pillars of sustainability truly are. To converge on the environmental and social viability of future generations, “economic sustainability focuses on that portion of the natural resource base that provides physical inputs both renewable and exhaustible into the production process” (Goodland 1995, 2), further demonstrating the relationship between economy, environment, and equity.

Ultimately, these circuits of capital connect “local urban change with the capital accumulation process” (Wilson 1991, 403). As each circuit, beginning with the primary, achieves over-accumulation in which the excess profit spills into the next circuit inciting exaggerating profits that often fuel over-investments (Wilson 1991). Consider the affect of this over-investment on the built landscape of the city. This inflated sense of profit in
the secondary circuit of capital is marked by “periods of excess residential and commercial construction, rising building vacancies and declining real estate properties” (Wilson 1991, 403). This over-investment can only carry on so long, and as over-accumulation in the secondary circuit subsides, the urban landscape is left pocked with structures of declining value and purpose. Within these circuits of capital, “Harvey illustrated the role of finance...in determining a city’s use of space” (McDonald and Patterson 2007, 174) as well as the importance of balance and equity among the three circuits of capital. Balanced circuits minimize over-accumulation and over-investment in any one circuit of capital, thus reaching a degree of economic sustainability that can be seen in the health and utility of the urban core’s buildings.

**Environmental Sustainability**

The environmental is the most prominent aspect of sustainability. This is the easiest to define, least complicated to measure, and most popular construct of sustainable ideology that heads the current trends and practices. Environmental sustainability functions on the idea of natural capital; that our ecology provides a stock of natural resources that much like a monetary economy, yields materials of value (Costanza and Daly 1992). Resources such as trees for lumber and coal for energy make up the natural capital. In so many cases, materials of natural capital are non-renewable, making them dear in value, both economically, environmentally, and in most instances, socially as well. Ultimately, “environmental sustainability seeks to sustain global life-support systems
indefinitely” (Goodland 1995, 6). Arguably, while the importance of social and economic sustainability cannot be denied, the viability of the environment acts as an umbrella shading the other two components. Our economies are based on the exploitation and replenishment of natural resources and our social equity is based on the control and access to these resources, both ultimately depending on the environment. Indeed, because concerns of environmental viability are so widespread it is ecological issues that “must be our primary focus,” however with this in mind it becomes crucial to “conduct our assessments in full cognizance of a myriad other issues” (Yohe and Morris 1999, 68) presented by economics and equity. The unprecedented growth of post-industrial cities “emphasizes the scale of the growing human economic subsystem relative to the finite ecosystem” (Goodland 1995, 2). And this development has not stopped throughout the modern era; development has shown little side of subsiding. As there is little hope in the cessation of development all together, and to hope for such would be misguided, it would be best to instead encourage intelligent patterns of growth. Through better planning, mitigation, and most pertinently through construction we have the unique opportunity to alter our current course and act “on behalf of future generations” (Becker et al. 1999, 5). In doing so, we must ensure the buildings that comprise the sustainable city must in turn be sustainable themselves.

Environmental sustainability is extremely interrelated with both conventional and green buildings alike. As outlined in the beginning of Chapter Two, buildings consume a large amount of resources throughout their construction and maintenance. To reiterate, buildings account for 48 percent of the energy consumption and consequential carbon
emissions in the United States while the construction and maintenance of buildings, including residential, commercial, and industrial operations, account for 76 percent of all the electricity consumption nationwide. Again it is important to consider that approximately 13.6 percent of all the potable water in the world is utilized by buildings globally, while consuming 40 percent or 3 billion tons of raw material (United States Green Building Council 2010). Because buildings use such a large portion of our natural resources and emit large portions of pollutants, it is crucial to find and maintain a level of sustainability for these structures that limits the environmental degradation inherent in their construction. Without renewable and efficient building methods, we stand to irreversibly damage the resources we so desperately need to form our ever-growing, ever-changing urban landscape. Our buildings separate us from nature, yet we cannot build them without the environment so greatly impacted by their very presence. It is this very principal upon which green building is founded.

**Green Building in the United States**

Green building, also commonly referred to as sustainable or high performance building, is an overall design plan and procedure that establishes human and environmental health as the most important and integral element of any construction project. The following information is adapted from “White Paper on Sustainability; A Report on the Green Building Movement” sponsored in 2006 by the U.S. General Services Administration and the Department of Energy unless otherwise cited. Green
build seeks to minimize the negative aspects of development as provided in the following table:

<table>
<thead>
<tr>
<th>Aspects of Built Environment</th>
<th>Consumption</th>
<th>Environmental Effects</th>
<th>Ultimate Effects</th>
</tr>
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<tbody>
<tr>
<td>Siting</td>
<td>Energy</td>
<td>Waste</td>
<td>Harm to Human Health</td>
</tr>
<tr>
<td>Design</td>
<td>Water</td>
<td>Air pollution</td>
<td>Environment Degradation</td>
</tr>
<tr>
<td>Construction</td>
<td>Materials</td>
<td>Water pollution</td>
<td>Loss of Resources</td>
</tr>
<tr>
<td>Operation</td>
<td>Natural Resources</td>
<td>Indoor pollution</td>
<td></td>
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<tr>
<td>Maintenance</td>
<td></td>
<td>Heat islands</td>
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<tr>
<td>Renovation</td>
<td></td>
<td>Stormwater runoff</td>
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<tr>
<td>Deconstruction</td>
<td></td>
<td>Noise</td>
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Figure 5: Table showing negative aspects of development courtesy U.S. Environmental Protection Agency, http://www.epa.gov/greenbuilding/pubs/about.htm

Whenever possible, sustainable building strives to include recycled and renewable materials as well as reusing material from older or disused structures as well as the old or historic structures themselves. Sustainability practices also reduce overall energy and water consumption throughout the course of a construction project and then throughout the building’s life cycle using new green technologies and more energy efficient building systems.

Although viewed to be in a stage of infancy, sustainability and green building in the United States have been in practice by name since the environmental movement of the 1960s and 1970s. This movement was catalyzed by historically high oil costs and a growing awareness of environmental degradations. Some basic principles of sustainable building have been in use for millennia as local builders innately realized the benefits of such green elements as passive heating and local materials and incorporated these natural designs into their structural design. Consider the thick, insulating adobe walls and the south-facing orientation of many prehistoric and historic American Southwest structures.
and it is clear that sustainable building is by no means exclusive to the 21st century. As historically well established as sustainable building is, it has only been in the past two decades or so gaining a greater forward momentum.

It was not until the 1990s that sustainable building as a field gained a formal cohesion. The 1990s ushered in such milestones as the formation of the Energy Star Program created in 1992 by the EPA and the U.S. Department of Energy as well as the United States Green Building Council in 1993. The Clinton administration brought the term “green” into the lives of everyday Americans with the “Greening of the White House” initiative instated in 1993 in order to raise awareness and promote education.

Awareness and education, however, have not proven to be entirely effective in teaching the general public the merits of green building. Despite early efforts, the practice still has a reputation for being expensive and difficult to undertake. While some components of sustainable construction are initially more expensive, these components often pay for themselves in energy or water savings throughout the life cycle of the structure, many well within the first decade.

How then, can the public at large be convinced that green building in not only good for the environment, but for the economy as well? Why build green? Sustainable building not only has environmental and economic benefits, as the core of this research seeks to analyze and discuss, but social benefits as well, a scope that although unarguably important will only be briefly mentioned in this paper. According to the EPA, the benefits of green building are as follows:
Leadership in Energy and Environmental Design (LEED)

As sustainable building gained steam, the necessity for standardization in process, design, and materials became apparent. To fill this void, the U.S. Green Buildings Council (USGBC) was founded in 1993 by David Gottfried, Rick Fedrizzi, and Mike Italiano with a mission “to transform the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life” (U.S. Green Building Council 2010). Located in Washington D.C., the USGBC provides educational programs on sustainable design and construction for the green market, an industry projected to be worth $60 billion by 2010. The USGBC has also developed a rating system known as Leadership in Energy and Environmental Design (LEED). The LEED rating is a voluntary certification process that emphasizes sustainable site development, water

<table>
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<tr>
<th>Environmental benefits</th>
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<tbody>
<tr>
<td>- Enhance and protect biodiversity and ecosystems</td>
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<tr>
<td>- Improve air and water quality</td>
</tr>
<tr>
<td>- Reduce waste streams</td>
</tr>
<tr>
<td>- Conserve and restore natural resources</td>
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<table>
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<tr>
<th>Economic benefits</th>
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<tbody>
<tr>
<td>- Reduce operating costs</td>
</tr>
<tr>
<td>- Create, expand, and shape markets for green product and services</td>
</tr>
<tr>
<td>- Improve occupant productivity</td>
</tr>
<tr>
<td>- Optimize life-cycle economic performance</td>
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<table>
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<tr>
<th>Social benefits</th>
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</thead>
<tbody>
<tr>
<td>- Enhance occupant comfort and health</td>
</tr>
<tr>
<td>- Heighten aesthetic qualities</td>
</tr>
<tr>
<td>- Minimize strain on local infrastructure</td>
</tr>
<tr>
<td>- Improve overall quality of life</td>
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Figure 6: EPA recognized benefits of green building. Source www.epa.org.
savings, energy efficiency, materials and resource selection, and indoor environmental quality.

The LEED system, which was introduced by the USGBC in 1998, has four levels of certification that are based on points earned throughout the aforementioned categories; sustainable site development, water savings, energy efficiency, materials and resource selection, and indoor environmental quality. Prior to April 2009, the levels of certification were:

- Certified, 26-32 points
- Silver, 33-38 points
- Gold, 39-51 points
- Platinum, 52-69 points

This older point system will be referenced for the purpose of this research as the buildings explored in the included case studies were certified under these criteria. Congruent LEED certification costs were at least $450 for registration, $1,250 for design review, and $500 for construction review. The cost figured per square foot was estimated to range anywhere from $.41 to $.73 depending on the size of the building and the level of certification sought (RSMeans 2002).

Ultimately LEED offers a standardized method of conventionally defining green buildings. What was once a fairly unknown concept in design, process, and construction is now a well known, highly sought after component of modern buildings. In an interview with Ron McDaniel of the Denver Technological Center, McDaniel expressed the growing desire for LEED certified buildings. Especially in the past three to five years,
McDaniel noted that clients and would-be occupants hardly consider renting a space unless it is recognizable green (personal communication, 14 July 2009).

**Remembering Sustainability**

Although the LEED program has done much to standardize the process as well as raise awareness towards sustainability in general, green building is not enough. Sustainable building trends often focus chiefly on the production of new buildings and rely on cutting edge technologies, or green gadgets, to *produce* sustainability rather than simply *being* sustainable. LEED certification currently certifies largely for new buildings, and while the program does offer certification for existing buildings (EB), these credits deal only with small-scale renovation strictly relating to operations and building maintenance. Any large-scale renovation of an older building falls under the LEED certification for New Construction and Major Renovation. Many credits through this program are gained through technological installments or what this research will refer to as producers of sustainability, such as solar panels and energy-saving HVAC systems while neglecting to award credits for the old, inherently green components of historic buildings discussed later in the research as ways of *being* sustainable. In fact LEED for New Construction and Major Renovation only addresses building reuse in two credits with a possibility of gaining only four points; one to three possible for maintaining existing walls and floors and only one credit for maintaining interior nonstructural elements, clearly the stuff of sustainability. The historic is brushed aside, obviously not
considered as integral a part of such innovations as wastewater technologies and solar panels; yet the question still arises, do we need new to be green?

The briefly aforementioned and cited article “The Greenest Building Is…One That Is Already Built” written by Carl Elefante covers many of the issues addressed in this research and acts as a keystone publication in support of this thesis. The article states that in our efforts towards sustainable building we must realize that “our culture is drunk with the new and now. This intoxication clouds our judgment, causing us to profoundly undervalue the legacy of our forbearers” (Elefante 2007, 36), meaning we all too often ignore the buildings and technology we already have. Elefante also states that “the green building movement remains blind to its most troubling truth: We cannot build our way to sustainability” (Elefante 2007, 26), and emphasizes that we must instead conserve our way to a greener future. Elefante worries that this inebriation ultimately clouds perceptions of the future and what it will take to actually make it there with such vast numbers and overly consumptive habits. As hindsight is always said to be of clearer vision it is time to look to the past, to our buildings of antiquity with their simplistic and sustainable design to preserve not only our history, but our future as well.

Again the discussion harkens back to being sustainable versus producing sustainability. Sustainability may not be something we need to learn, but simply remember. The following is a discussion on remembering the green building techniques used by our predecessors and in utilizing that which we already have.
Adaptive Reuse

Adaptive reuse is the process of adapting old structures to be suitable for new uses and is commonly, although not always, accomplished through sustainable renovations. As a movement, adaptive reuse was born out of the 1970’s as many inner city schools that were no longer functioning due to low student enrollment were eyed, especially by city planners, for their high-density, centralized locations. Prepared to raze in favor of newbuild projects, cities were met with great opposition from the neighborhoods the old school buildings occupied as they “had an interesting character and had become such a part of the community that the idea of tearing them down just wasn’t something people would consider” (Watts 2006, 9). Adaptive reuse then gained momentum as architects and citizens put an increasing value on its sustainable nature, using existing buildings in which fewer new materials must be manufactured and transported to the building site.

There is, however, a good amount of planning and consideration that an architect or engineer must take into account prior to starting any adaptive reuse project. A painstaking evaluation of the structure and integrity of the building must be carried out and ultimately affects the feasibility of the project, both in its design and financially (Rabun 2009). Because the economic and environmental aspects of the building and the site are not always satisfactory, it is important to admit that, “just because an old factory building is located in a great spot, doesn’t always mean the adaptive reuse project makes sense” (Watts 2006, 10).
Adaptive reuse, like any other process, has its benefits and drawbacks. The benefits are obvious and have been the focus of this research so far. The “scarcity of prime real estate and the soaring raw material costs” (Watts 2006, 9) make adaptive reuse an ideal practice in conservation. However, there are questions that must be asked of every adaptive reuse project that must be answered honestly if the project is to continue with any success. First and foremost, is the building worth saving? “Once a building goes vacant and is left unheated, deterioration starts in earnest” (Watts 2006, 10) and the structure decomposes beyond reasonable repair and renovation. Second, contamination is a major concern. The presence of hazardous materials dramatically halts the process and raises the overall costs of adaptive reuse. Elements like asbestos, lead pipes and paint, and accumulated mold if in severe enough magnitudes are enough to terminate an adaptive reuse project. Once it becomes economically infeasible to carry out adaptive reuse, the benefits are lost. The third question, does the building fit the program? Issues like zoning, parking, and building size often act as the nip in the bud for adaptive reuse projects; you cannot fit a square peg into a round hole with any amount of renovation. Another important question, as is stressed yet again, is the difference between adaptive reuse and historic preservation. Will history get in the way? “There is something unquantifiable about the historic nature of these buildings that makes them desirable for adaptive reuse” (Watts 2006, 10), but this same historic nature is often paired with laws prohibiting large amounts of change in a historical district. If there are too many prohibiting factors associated with the history of the building then it becomes a candidate for historical preservation, not adaptive reuse. And finally, possibly the farthest reaching
question, again, is it really worth it? It always boils down to the economic viability.

“Don’t let the romance of adaptive reuse cloud your judgment. Always compare the costs” (Watts 2006,10). Adaptive reuse projects are fundamentally what the planners and architects make of them, ultimately “there is no substitute for an intimate knowledge of the building and its site infrastructure. Taking the time to become familiar with the building's elements, and its condition and documenting it goes a long way to eliminating the unknown factors that typically cause delays and cost overruns during the project” (Reetz 2006, 20).

Also, adaptive reuse does not always renovate historic buildings that no longer function as they were originally intended. The reuse can also take place in modern buildings where the function demand has simply changed, for example, “a four-year old building that was originally designed to be a high-tech incubator space in Cambridge, Mass.” that is being renovated to fulfill the need for a “public safety facility” (Watts 2006, 9). Another aspect of adaptive reuse; what if the historic building is being renovated and updated but still keeps its original function? There are cases of old theaters being rehabbed and retrofitted with new, state of the art electronics and technology, but after all is said and done, the historic theater is still a theater. To many, this too, qualifies as adaptive reuse even though the building’s initial use was kept (Watts 2006). “It’s almost like buying a new car, it may not be 100 percent what you want, but you can make it work and sometimes you get a good deal” (Watts 2006, 9).

Traditionally, the most sustainable practices have included recycling, reusing, and reducing. There are many in the architectural field that propose adaptive reuse can be
thought of as a branch of green building, although not every adaptive reuse project seeks to renovate with sustainable components. This being said, however, as previously mentioned, adaptive reuse has been called the “holy grail of the sustainability movement” (Melaver and Mueller 2009, 168) as at its core, it reuses materials and buildings. Adaptive reuse as a practice also seeks to use surplus land, that is, already improved lots that are currently sitting unused or vacant as grayfields. Grayfields are areas of improved land with existing, yet abandoned buildings that require no environmental cleanup. Grayfield reclamation over the improvement of existing greenfields is also an incredibly sustainable factor as adaptive reuse (and infill projects) ultimately use old land instead of destroying what little open space some urban areas have left.

Structurally speaking, existing buildings have what is referred to as “embodied energy.” Embodied energy is the energy that has already been used in the resource acquisition, transportation, raw materials, and manufacturing of the structure. Difficult to define and compute within strict guidelines, this intangibility in no way deters from the importance embodied energy has on the sustainable building sector. To demolish or simply let existing buildings fall into decay wastes that embodied energy; demolition to a higher degree as it requires even more energy to destroy a building. Recall Elefante’s decree, the greenest building is one that is already built and this is due in large part to its embodied energy (Elefante 2007). The issue of embodied energy is hypothesized by many to be one of the most important factors in determining if adaptive reuse is more economically viable than newbuild.
Economically, adaptive reuse is the conversion of abandoned structures “into sufficiently unique economic entities that secure a potential to succeed in the futures where a reinstitution of uses similar to those of the past would be likely to fail” (Burchell and Listokin 1981, 2).

Again, the question of public support is raised. If adaptive reuse is the fundamental relic of the green movement, why are we not a society of devoted followers? Economics is always a factor, and we are forced again to realize that people have previously imagined adaptive reuse too expensive and too time consuming. Manifest Destiny, the American ideal of taming the wild frontier, also plays a part in the public’s hesitance towards adaptive reuse. We are a nation of progress and expansion; resettling territory we have already conquered seems, simply put, un-American. Low-density, sprawling residences and business parks invoke a sense of ingenuity and wealth. We build this way because we can. However as our environmental, economic, and social concerns continue to mount, this culture of consumptive progress must be reevaluated (Melaver and Mueller 2009). Adaptive reuse then, is this reevaluation. By combating resource-draining urban sprawl, reducing construction costs, and salvaging existing structures and embodied energy, adaptive reuse regardless of its sustainable renovation intention, is a truly green practice that deserves more public attention.
Demolition versus Renovation

The question of demolition versus renovation is also an integral consideration. A step below renovation, yet a step above true newbuild, demolition and its subsequent infill of the abandoned grayfield as we have seen in the adaptive reuse section above can sometimes make more sense economically and environmentally in situations in which a structure is simply too far gone to successfully rehabilitate. Embodied energy measurements can help determine if renovation or demolition is the right course of action. Factors considered should include, “the financial and energy ramifications of demolition,” “an evaluation of potential longevity and building life-cycle” and finally the “social, political, and architectural significance of the buildings” (Pfaehler 2008, ¶1) involved in the adaptive reuse project. As previously mentioned, thoroughly familiarizing yourself with the project building can save time and money. Another way of achieving this familiarization is through understanding the relationship between operating and embodied energy. Embodied energy is the “amount of labor and energy consumed in the production of a building, from the harvesting of natural resources to the fabrication and delivery of materials to the installation of these materials and products” (Pfaehler 2008, ¶4). Embodied energy is at the heart of adaptive reuse in meeting sustainability requirements and also considers the energy needed in demolition and removal of the old building components; embodied energy covers the entire life cycle of a structure. Operating energy on the other hand is more easily measurable and is simply “the energy for HVAC, lighting, equipment, and appliances” (Pfaehler 2008, ¶4).
Successful renovation is the balance of embodied and operating energy. Throughout most of modern architecture concrete, steel, and glass were the primary building materials. Earlier buildings using these materials are difficult to heat and cool, yet the demolition of these often historic structures would create a loss in the investment already embodied within the building. It would accrue vast additional costs to raze and replace the building as a whole rather than work with the sometimes already present, but inefficient materials. Finally, embodied energy can be measured by the “demolition and disposal costs of walls, roofs, windows, floors, and structural systems” (Pfaehler 2008, ¶7).

Inherently Green

Prior to 1920, construction in America relied heavily upon the locally available in terms of buildings resources, technology, and labor. This reliance on the local created “inherently energy saving” (Smith 1978, ¶4) or inherently green structures. Resources were collected regionally, from building material to physical labor. Previously limited technology dictated the form and composition of architecture in a time before technological and transportation advances allowed for labor and resources to be imported from outside the local hinterland. Transportation limitations made the shipping of materials from one place to another expensive, time-consuming, and illogical, while sheer manpower constructed our early buildings before there were hydraulic lifts and other mechanizations. If a material was unavailable, it was not used. If muscle alone could not
construct or carry, it was not built. This reliance on the regional was a huge factor in the emergence of architectural vernacular nationwide. Resources from the area were plentiful and were used in repetition. The workforce became familiar with the local materials and in turn became specialists. Masonry and other apprenticeships passed on design motifs and form became distinctive among local tradesmen. Sandstone from Coloradan quarries would have rarely reached outside the state boundaries in the architecture of the everyday, saving such a luxurious export for the ornamental and symbolic buildings of government and wealth. A publication from The Connecticut Stone and Building Industry illustrates that building materials were obtained relatively local, stating, "for foundations and ordinary work (in Chicago, Illinois) Joliet and Lemont, Illinois, limestone is used; for ornamental work the following are used: Brown sandstone from Connecticut; red sandstone from Long Meadow, Massachusetts, sandstones of all kinds from different sources in Ohio, the Lake Superior region, and, to a less degree and quite recently, from Colorado" (Day 1886, 532). Published just 28 years after the founding of Denver, resources from the region were still widely unused in other regions of the country that had their own architectural vernacular and historic traditions to pull resources from.

Limited by material and manpower, architects had to engineer ways of constructing comfortable, utilitarian buildings. Historic buildings ultimately found their stability and longevity from concepts that worked with simplistic yet effective methods and technology. Historic buildings constructed in this manner worked with the environment to optimize heating, cooling, lighting, and airflow and in doing such were
inherently sustainable. And because they were built with such attention to environment
many of them are still standing today as the existing historic building stock; much like
the case study warehouse currently occupied by 4240 Architecture (see Figure 7).

There are five elements of historic architecture that are inherently sustainable, all
of which can be found within the historic structures of Denver. These architectural
elements include operable windows, exterior window treatments, awnings, overhanging
roofs or covered porches, and brick construction. These components were not chosen
with their sustainability in mind, rather they were designed because they were cost
effective, time effective, and resulted in long-lasting, occupant-comfortable buildings.
There was no green trend or LEED credit that was being adhered to before 1920, only
practicality based on local resources and technology.

In beginning the discussion on inherently green historic practices, it is important
to first note that historic windows are notorious troublemakers in the preservation world
for one simple question; to replace or renovate? While there are many proponents for
vinyl windows over wooden, this is not a pertinent discussion in this phase of research. However, a brief overview of the issue will ensue shortly. For now, the focus then will be on wooden-framed windows, as they were the historic standard, their latent sustainable qualities once reviewed are undeniable.

Old buildings, in Denver as well as nationally, typically include five window features that are universally deemed to be sustainable. The first three features deal with the windows themselves. Double-hung windows, casement windows, and transoms act as efficient methods of natural lighting, airflow, and heating and cooling techniques. These window types are operable meaning instead of consisting of fixed, immovable panes of glass, they open to increase airflow when ventilation is needed. This is especially important considering Denver’s characteristically warm summer climate. Many historic windows are classified as storm windows that consist of one pane of immobile glass while the second is an interchangeable pane of glass for the winter months but a screen frame for the summer. This transformation with the seasons makes the most utility out of a single architectural element. Casement windows are well known for efficient airflow made possible by pivoting panes of glass. Transoms, placed over all doors in a building, manage the circulation of rising hot air throughout the interior protecting against stagnant hot air becoming trapped in one room.

Exterior window treatments common to historic buildings aid a great deal in the heating and cooling of a structure. A bare window will allow in too much sun in the summer, unnecessarily heating a building whereas the same window in the winter can allow too much exterior cold air in while also allowing for lost internal heat. With a
sufficient understanding of how shutters function, building occupants have historically used them as successful air conditioners. When closed, shutters typically shade and cool the largest source of heat gain in the summer months. During warmer seasons, shutters should be closed while the window that they cover remains open. Because shutters typically have downward sloping slats they promote air circulation, providing a cooling airflow as well as shade. During the winter months, shutters are most effective if opened when the sun directly hits the closed window, warming the interior; but closed when the window is not in sunlight. This method takes advantage of the sun for heating when available and by closing the shutters when the sunlight has passed or nightfall occurs traps the collected warmth inside the structure. This form of heating and cooling, although by no means sufficient by today’s fossil fuel powered air-conditioned comfort levels, could take much of the workload off modern HVAC systems, resulting in less energy consumed.

Finally, concerning windows, I will indulge in a brief discussion of the sustainability of wood-framed windows versus vinyl. Wood-framed windows are not immune to the elements; they age, rot, and deteriorate much faster than their fabricated polymer counterparts. Wood-frame windows do not produce as tight a seal as vinyl, so the argument is that while wood-frame windows are historically valuable, they are not insulative enough and therefore waste energy through increased heating and cooling. The other side of the argument states that while vinyl windows may save in energy costs, when one component of the window casing fails, you must replace the entire window. With a wood-framed window, if one piece rots, only the affected component is replaced.
while the rest of the material with its embodied energy remains intact. This conflict is a matter of energy cost versus embodied energy. Are the lost energy costs of the wood-framed window less than the embodied energy costs lost by replacing an entire vinyl window; casing, glass, and all? Ultimately the calculations needed to settle this dispute are complicated and in many cases are not exact; until a better evaluation method can be constructed this debate remains fruitless. At this point, perhaps it is best to focus on the historic design rather than material, allowing the form of the window to take precedence over the construction.

Moving back into less complicated components, awnings are another form of exterior historical HVAC systems (see Figure 8). Often retractable, awnings provide shade in the summer and allow for passive solar heating in the winter. In terms of

Figure 8: In the picture at left (circa 1970) it is very possible the awnings on the building in the foreground area raised to take advantage of the sun in winter (based on low level of snow on foothills in the background and leafless trees); in the picture on the right (circa 1930), the awnings on the same buildings are lowered to shade from the intense summer sun (based on lack of low-altitude snow on the foothills and foliage on trees). Photo courtesy Denver Public Library Western History and Genealogy Department.
historic commercial buildings, awnings protected potential pedestrian customers from rain, sleet, and snow in addition to a glaring summer sun.

Much in the same vein, covered or roofed porches were an integral part of many historic buildings. Porches are typically thought of as being residential, with awnings acting as the more common commercial form. Like the awning, a covered porch allowed for shade in the summer, but because of its fixed nature, did not allow for solar passive heating. However, as most porches do have open ends they provide for efficient ventilation and can sometimes protect an entire side of structure from the heat of the sun.

Although these pre-1920s structures often touted as the most historically sustainable, these buildings only represent about 6 percent of the existing commercial building stock while our post 1920s buildings constructed through the end of WWII account for nearly 11 percent of current commercial buildings. Together these buildings, built before the increasingly complex and energy intensive mechanical and electrical systems only account for 17 percent of our existing commercial stock, yet what is to be done with the often-ignored modern era of architecture constructed during the 1950s, 60s, 70s, and 80s that make up 55 percent of the commercial building stock (Elefante 2007)? This 55 percent accounts for 36 billion square feet that was made possible in part by the post-war boom both in industry and population; new technologies allowed for buildings to be constructed faster and out of foreign and cheaper materials and for a quickly booming population. But these materials were not just cheaper cost-wise, they were also cheaper in quality and they now account for more than half of the commercial building stock in the United States. True, some of the original materials used in these buildings
might not have been the most sustainable to begin with, but due to their embodied energy, a subject briefly discussed in the section to follow, materials used to replace the old could very potentially have a larger carbon footprint. Even with the shoddy construction of some of these buildings, the cost of renovation with quality materials and reuse is still more cost and energy effective than total demolition and rebuilding from scratch, although they do represent more of a challenge than the solidly built WWII structures. In further referencing Elefante, “both preservationists and green building advocates readily agree that modern-era buildings present greater challenges to both disciplines “(Elefante 2007, 4) than the pre-WWII buildings, but also that “the need to transform the modern-era building stock is an important point deserving more elaboration” (Elefante 2007, 4).

It is the potential seen in modern-era buildings that dictates the inclusion of the renovation of one such building within the case studies of this research. While the pre-WWII buildings are often seen as the “poster children” (Elefante 2007) of historic preservation and the adaptive reuse movement, they are too plentiful in our commercial landscape to simply ignore or let go to waste.

**New Preservationism**

The onset of adaptive reuse was catalyzed by a major shift in attitudes towards historic buildings. Adaptive reuse stems rather obviously from the historic preservation realm and in analyzing renovation, the historic aspect simply cannot be ignored. Historic preservation started in earnest after the Civil War “as Americans searched for ways to
heal the rift between North and South” (Morley 2006, 1). Initially early preservationists sought to save buildings that represented great moments or people in American history, for example Thomas Jefferson or the Revolutionary War, aspects of Americana that both the North and South could claim and identify with, thus minimizing “sectional differences by establishing national affiliations” (Morley 2006, 1). Due to this quest for the “quintessentially American,” (Morley 2006, 1) most objects of the everyday were overlooked as they could too closely be associated with one side of the conflict. Vernacular architecture was too Confederate, too Union, and so traditional, non-partisan architectural history flourished “from the standpoint of a few exceptional achievements...divorced from their less spectacular and often seemingly disreputable surroundings” (Carter 1997, xiii).

Traditional historic architecture studies most often dealt with a level of magnitude that alienated the common man, woman, and minority. As the early nation gained most of its historical prowess from the feats of white, European-turned-American, males, this left a large portion of the population unaccounted for in the architecture recognized as significant by the rest of the country. It was not until the 1960s that, like many social sciences, vernacular architecture began to shy away from the grandiose and specific and began to “talk more about people rather than events, about common people more than the elite” (Carter 1997, xiii). As paradigms began to shift, it was seen that artifacts of the workaday were met with a positive interest and also contributed to the American sense of place the still young nation desired. No longer was historic preservation devoted to the extraordinary, rather “the everyday and mundane found their way into the new history,
and it was a democratic approach to the past” (Carter 1997, xiii). The history of the urban landscape was now communally and appreciatively ordinary. It became a history anyone could find their place within. The brick and mortar of the past were now essentially by and for the people; an inclusive history most found to be worth saving.

This “new history” began to impact the way historic preservation was viewed by citizens of the present. Along with this democratic shift in historic preservation the sense of urgency vanished in the historical accuracy of the buildings being saved and it was through the ideology that “new preservation” was inaugurated. Historic buildings now were by and for the people and the public at large wanted to utilize their newfound property rather than admire it from afar. Thanks in full to new preservation, contemporary projects “did not make museums out of landmarks but rather fostered the conservation of historic districts through the adaption of buildings for compatible modern uses,” (Morley 2006, 5) and there adaptive reuse was born. Preservation was no longer stuffy and proper, the historic buildings of the past that had “become symbolic of the timeless stability of American ideals,” (Morley 2006, 2) were no longer for display only, but instead incorporated into the necessities of everyday life providing a solid and ample foundation on which American traditions could finally stand. Recall also that as this repurposing began to occur it was quickly realized that adaptive reuse was not only good for the people, but for the economy too. “Adaptive reuse made historic preservation profitable,” (Morley 2006, 4) ensuring that the practice of renovating structures of antiquity spoke not only to those with an appreciation for history, but to those with an appreciation for economics as well.
Just as adaptive reuse is recognized as a historically significant and economically sound phenomenon it has also been appreciated as a sustainable practice as well. Indeed, adaptive reuse and green architecture can act as the greatest allies in combatting greenhouse emissions associated with buildings in the U.S. and globally. This “sustainable preservation” (Quinn Evans Architects 2010), yet another phrase coined by Carl Elefante, could potentially have the largest impact on the greening of the building industry. In reusing and truly appreciating these historic buildings, we must learn how to purposely discuss them.

Vernacular Architecture Theory

Architectural historians realized early on that in discussing and analyzing regional vernaculars, a consolidated and theoretical approach would help legitimize and streamline their research. As with many movements in the United States, “the discovery of vernacular architecture started in the East” as a way of interpreting the pre-industrial commercial and residential building traditions of the first American colonies (Carter 1997, xiii). From colonial churches in New England to the slave quarters of the South, early American structures were largely influenced by the homeland, wherever that might have been. Immigrants to the New World from England, France, and the Netherlands, brought with them styles and ideals about what the architecture in this landscape should look like. Modified of course by available resources and interaction with other cultural ideas, these colonial structures became as unique as the new country itself.
Settlement patterns on the eastern coast were fairly consistent, growing steadily in a uniform pattern with the boundaries of the original colonies slowly pushing out against the yet explored frontier. Folklorist Henry Glassie proposed a model of dispersion and diffusion across the eastern seaboard that attempted to take historical architecture studies “away from a concern for the [building's] fabric itself toward the ideas that were the cause of the fabric's existence” (Carter 1997, 4). This model (see Figure 9) shows the movement of ideas across the eastern seaboard that influenced the vernacular of the region, and while useful for understanding the traditions and ideas supporting architecture in the east, the “diffusion model breaks down in the West precisely because there the steadily east-west moving frontier upon which the theory is based also breaks down” (Carter 1997, 4). In the East, immigrants first stopped in the major cities of Boston and New York before deciding to either remain sedentary in the city or settle further from these hubs on the outskirts of the new nation; first in places like Tennessee and Kentucky, and later on more midwestern outposts like Chicago.

Cities east of the 100th meridian, the theoretical dividing line between the East and West,
were all settled with this similar, slow and steady diffusion from the major metropolises of the East across the Appalachians.

The West, however was settled through contrasting means. Exploration west of the 100th meridian was fueled by new acquisitions, new economies, and new dreams. Certainly, “the Western story is a complicated one” (Carter 1997, xv) and settlement patterns in this region were anything but steady and gradual. Chasing visions of fortune, freedom, and sometimes being chased themselves, the early residents of the West saw themselves as anything but permanent. If resources dried up at one location, life was simply disassembled and moved up stream. This migration pattern left little time for architectural tradition to be established, however, as more sedentary habits inevitably made their way into the scattered settlements of the West, there occurred “a general reconfiguration of the place into an American place” (Carter 1997, xv).

Settlers to this new frontier brought with them, just as the colonists had done before, ideals of architecture from home. Influenced by the prominent Eastern styles, by the Spanish, and even by the indigenous population, isolation also impacted Western architecture as the settlements developed into “various subregions separated by a vast and inhospitable territory” (Carter 1997, 6). Early outpost towns such as Denver were as islands in a vast sea of dry, harsh terrain. In terms of resources, the locations that could support even a meager population were much fewer and further between than sites back East. The geography of the West, perhaps more than anything, influenced the way pioneers constructed and in turn “distinctive American architecture traditions emerged in
response to specific environmental, economic, and social conditions” (Carter 1997, 5) of this unknown frontier.

This response to the environment of course occurred in the East as well, but ultimately it is the geographical difference between the East and West that shapes the differences in vernacular architecture between the two. The vernacular of the East and even the Midwest is well studied and well understood, yet vernacular research in the West has “lagged behind” (Carter 1997, 4). Although there has been ample research conducted concerning the Mormon settlements of the Great Basin and the adobe structures of the American Southwest, little effort has been put forward to study the more mundane architecture of the West. The story of Mormon migration and the palaces of the Ancestral Puebloans conjure romantic images of the frontier; a people making their pilgrimage to freedom, another shrouded in a wonderfully dramatic and “mysterious” disappearance. These are the vernaculars of legend. Yet, with the advent of new preservationism, we must be willing to ruin the romanticism of the West, to complicate it with “suburban track houses, factories and smelters, and steel and glass office towers” (Carter 1997, xv). In order to truly understand the West, we must see the region in its reality without the thrill of the imaginary. We must become “divorced from the romantic tradition that so clearly dominates the field today” (Carter 1997, xiv).

As a result of this romanticism, Western vernacular architecture is generally lacking a methodology through which to research and clearly comprehend “the region's rich though generally overlooked architectural resources” (Carter, 1997 xiii). With vernacular architecture in the East, historians sought to typify pre-industrial architecture,
a landscape largely built by capitalism. The West was also settled through capitalistic ideology, however the frontier offered no pre-industrial example from which to define a vernacular architecture. The Eastern archetype was dominated by agriculture and population density, something also lacking in the Western frontier. Without this go-to notion of vernacular architecture, how are building traditions to be understood through previous means? There is still no conversation concerning the specific and unique instances behind the settlement patterns and resulting vernacular architecture of the West. As of 1997, “the study of vernacular architecture in the Western United States [had] barely begun,” (Carter 1997, xiv) and an in depth exploration into the modern literature shows that in over a decade, this has not changed.

Along with the lack of Western vernacular architectural theory, there is a perceived lack of a research model that is “flexible enough to accommodate the present as well as the past” (Carter 1997, 8). Eastern vernacular architectural theory, as aforementioned, focuses on the pre-industrial past but says little of the present. Ideology that steadfastly believes “the story is over when you get to the urban and industrial present” (Carter 1997, 8) must be reevaluated. Clearly, history, culture, economy, and environment did not cease to exist as we entered the urban era. Architectural influences have not vanished with expansion of urban populations. Ultimately, “the true West is one of both romance and reality, of refuge and opportunity, of stewardship and exploitation” (Carter 1997 xv) and the sooner vernacular architectural studies ushers this notion into the modern era, the sooner we as a society can benefit from what these old structures have to offer in terms of sustainability.
The Geographies of LEED

As green buildings become more and more prevalent in the coming years, it is crucial that we understand every aspect of their production, location, and maintenance. Because green building in its current incarnation is a fairly new phenomenon, relatively little is understood about the more specific details of the industry. Although research is limited compared to other topics, there are a growing number of scholars and professionals who are taking interest in green building as an area of analysis. Julie Cidell is one such scholar striving to better understand the spatial layout and relationships of sustainable buildings. Cidell, among others (Grubesic and O'Kelly 2002, Oppong et al 2007) admits, “although a description of the spatial distribution of a complex phenomenon like green buildings might seem overly simple, it is an important first step in analyzing such a phenomenon” (Cidell, 2009a, 204). Cidell endeavors on a purely spatial analysis concerning LEED buildings as well as LEED Accredited Professionals, (APs) stating that “if LEED standards are going to transform 'business as usual' in the building industry, it is important to know where these standards are being implemented” (Cidell 2009a, 201). Place is often overlooked in studies of green buildings, in terms of both spatial geography as well as landscape geography. While Cidell intently focuses on the purely spatial analysis of green buildings, the research conducted in this thesis chooses to further analyze the landscape geography of the industry. In other words, this research is not only concerned with the where, but also what the where has to offer in terms of resources. This research also concerns itself with
the impact these resources have had on the building styles of the region both historically and in the present; therefore this thesis does occupy in a somewhat limited fashion the cultural geography of the area as well. Ultimately, Cidell states that “geography plays a central role in determining what is possible and what is not in terms of incorporating a building into its surroundings” (Cidell 2009b, 147) and uses this statement as a means to justify the spatial analysis of green buildings. This research, however, views the commentary as a justification of vernacular architecture analysis as well, incorporating regional elements and local knowledge into the overall function and design of sustainable buildings.

Cidell finds in the analysis carried out in the aforementioned publication that LEED buildings and LEED APs do not necessarily occupy the same national geographies. Green professionals very commonly do not certify buildings within the same city or region in which they are employed. This discrepancy between the location of the APs and the buildings themselves suggests the alarming possibility that the majority of LEED projects are certified by professionals possessing little to no local knowledge concerning the landscape, climate, and culture (Cidell 2009a). Many APs, although undoubtedly qualified, do not have the regional experience to recognize and utilize the vernacular of the region in which they are certifying. This is a large topic of concern, as “studies of vernacular architecture from around the world have demonstrated how local people take into account available materials, temperature, and moisture” (Cidell 2009a, 202) as well as the building styles of their forefathers.
This lack of vernacular architecture catalyzes and legitimizes the research discussed in this paper. Historic vernacular architecture fits squarely within the realm of green architecture “because of the need to be responsive to regional and even microclimates, the importance of places in designing and maintaining green buildings is crucial” (Cidell 2009a, 203). The local is important not only to the efficiency and maintenance of these green buildings, but also to the sustainable movement itself. It is imperative to focus on localities across the nation as “green buildings exemplify the position that the local is the appropriate scale for implementing sustainability” (Cidell 2009a, 203); build it green and sustainability will follow. If the local is indeed so important to the study of green buildings, then understanding one city at a time in high resolution contributes to the overall knowledge base of the industry; something this research strives to provide.

Cidell's study finds that the geographies of green buildings “are concentrated in western cities, college towns, and state capitols” (Cidell 2009a, 212) of which Denver, Colorado is all three. Cidell also states that the centers of federal government due to the GSA LEED requirements, are “more likely to have green buildings, indicating the requirements for government buildings are making an impact on the landscape” (Cidell 2009a, 207). As Denver is often referred to as the “Washington of the West” due to its high concentration of federal offices, it stands to reason that Denver's landscape is thoroughly impacted by the green building industry. It was also found that the Rocky Mountain region has a nationally high concentration of LEED buildings (Cidell 2009a, 204), and with Denver as the unofficial capital of this part of the country, these results
further legitimize the city as a viable research area for sustainable building. Focusing then on the shared belief in the “importance of local factors” (Cidell 2009a, 213), this research strives to better understand the impact these local factors have on the way green buildings are built, rather than the where. Ultimately, this is a pertinent study as “it is a shortcoming to overlook the role of geography in green buildings” (qtd. in Cidell 2009b, 143 from Eliasson 2003).
Chapter Three: Objectives and Research

As Carter's introduction points out, there is still no explanation of the West without in part, speaking about the East. Perhaps impossible to do so, perhaps ideologically ill-equipped, what vernacular architecture theory still lacks is an explanation of its formation. Craving an autonomous theory to apply to Western architecture, it may be that we must look to our present and future to better understand and analyze the past. An in depth analysis of western U.S. settlement patterns and the resulting vernacular architecture is notably absent from the literature encountered throughout the course of this research. We have extensive theory on what caused vernacular styles in the East, many have even gone so far as to analyze the Grand Basin vernacular settled by the Mormons, the Midwest, and even the architectural heritage of the indigenous and Hispanic peoples of the Southwest, but very little exists in the form of discussion surrounding the area considered the “Last Best Place,” the “Wild West,” or the American Frontier of which Denver calls home (Carter 1997).

If the vernacular architecture of the West is hardly understood, then little chance stands of making sense of the inherently green elements of structures found within this reason. Why were buildings situated the direction they were? Why was brick so prevalent not just in the West, but Denver specifically? What part do shutters, awnings, and porches offer a large majority of the city's old commercial buildings? These are all
questions posed by adaptive reuse projects today that vernacular architecture research stands to answer. If the simplistic and sustainable building methods of those who came before us are more eloquently understood, we can better redeem the benefits of adaptive reuse with positive environmental and economic outcomes.

While this research does not undertake the task of creating a regional vernacular architecture for the West, the significance of this thesis may act as a springboard for the topic to be initiated in the future. This research has three encompassing goals: to analyze the city’s architectural history through its regional vernacular, to assess the current landscape of Denver’s green building through its design, economic value (adaptive reuse) and spatial relationships as well as its relative sustainability to other cities, and finally to project the possible landscape of Denver’s green buildings of the future in conjunction with knowledge of past and present to understand Denver’s reign as Queen City of the Plains.

Methodology

Due to the descriptive, explanatory, and exploratory nature of this research, four case studies were utilized as the major form of methodology. In reviewing Robert K. Yin's *Case Study Research; Design and Methods* it became clear that case studies were a particularly good fit for this research as green building in Denver acts certainly as a “contemporary phenomenon within some real-life context” (Yin 2003, 13). Like all methodologies, case studies must be executed with great care and patience to ensure their
validity. The case study is most often used in the following types of research listed by Yin as:

- Policy, political science, and public administration
- Community psychology and sociology
- Organizational and management studies
- City and regional planning research, such as studies of plans, neighborhoods, or public agencies

The latter bulleted point encompasses the topic of this research most closely as the study deals with building, planning and neighborhood issues not only of the present, but the past and future as well.

A case can be identified as any number of objects, groups, or as individuals themselves. Sustainable building in Denver is ideally poised to be analyzed as a case study as it is a unit of human activity embedded in the real world, can only be studied or understood in context, exists here and now and also merges in with its context so that precise boundaries are difficult to draw. Case studies are also integral when dealing with issues of the historical. Often referred to simply as “histories,” the historical accounts of the buildings included in these case studies can be considered as another methodology onto themselves. However in this research, they are more adequately used in conjunction with the case studies instead of as separate forms of analysis. Included is a chart outlining the most common methodologies used in academia (see Figure 10). Upon review of this table, it can further be seen that case studies and histories act as the most appropriate strategies for this specific research; especially considering the lack of control
over the behavioral events being analyzed in this thesis; the landscape of green buildings in Denver, Colorado.

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</tr>
<tr>
<td>Survey</td>
<td>Who, what, where, how many, how much</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Archival analysis</td>
<td>Who, what, where, how many, how much</td>
<td>No</td>
<td>Yes/No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>History</td>
<td>How, why</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Case Study</td>
<td>How, why</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

Figure 10: Table showing possible research strategies

After the in depth analysis of each building a brief summary of the findings of the case studies was compiled with special attention to the cost of each building. Following the conclusion of the case study, an analysis on the current and future state of green building was conducted. This discussion deals largely with Denver's place among other cities in the nation in terms of overall sustainability and green building. Inspired by Cidell's spatial research, a brief spatial analysis using Average Nearest Neighbor Distances of the location of LEED projects in the city and county of Denver along with Moran's I was also conducted both to map the buildings themselves and in hopes of using current locations, as well as the locations of currently vacant buildings, to act as indicators of possible future LEED or adaptive reuse projects. Finally, an economic analysis was conducted focusing on how many new buildings are thought to exist by 2030 and how much money, energy, and resources could by saved by either building green or renovating instead of turning to conventional construction methods.
Study Area

This research is conducted in the city and county of Denver, Colorado. Much care was taken in choosing the distinct boundaries of the city and county as opposed to the larger metropolitan statistical area. The Denver-Aurora Metropolitan Statistical area was discarded in favor of the higher spatial resolution of the City and County of Denver. This higher spatial resolution will include the more favorable sustainable conditions that occur within the city and county as opposed to the suburbs. The metropolitan statistical area includes many suburbs surrounding Denver, which, by their undeniable sprawl, are by definition not as sustainable as the city itself. Suburban communities are “significantly less sustainable than traditional cities, and are more harmful to the general environment” if based on nothing other than the resources wasted commuting in single occupancy vehicles over the large distances that are all too characteristic of suburbia (Blassingame 1998).

Denver is a thriving city with more than 600,000 citizens and counting. In the Mountain West region, Denver ranks second in size only to Phoenix. By 2025 it is estimated that the city and county of Denver will reach a population of 849,000; while it is projected that the surrounding Denver-Aurora Metropolitan Statistical area will have a population of about 3,958,718 by the year 2035. With a growing population and the limited resources of the American West, what shape will Denver architecture take and what role does green building play in the overall sustainability of the city? What must the
built landscape look like in order to support a population of such magnitude in a climate such as Denver’s?

Denver's climate, as will soon be discussed, plays an integral role in the way the city has been shaped in the past as well as how it will look in the future. Denver is classified as a semi-arid steppe, a climate zone characterized by about ten to twenty inches of rain annually. With over three hundred days of sunshine claimed by the Mile High City, Denver is a dry, high prairie city. The most prominent city in Colorado's Front Range, Denver is both plains and foothills, and weather patterns from blizzards to tornados are a constant reminder of the city's unique climate. The semi-arid climate includes two subcategories, the hot semi-arid and the cold semi-arid. The hot semi-arid climate includes such places as Australia and Mexico, characterized by extremely hot tropic and subtropic summers with very mild winters. Denver, however, belongs to the cold semi-arid climate group shared with many locations in China and Canada. The cold semi-arid climate is most often found in temperate zones with higher elevations. Denver, at a mile above sea level, fits within this category. Much like in hot semi-arid zones, cold semi-arid climates are characterized by soaring temperatures in the summer months. However, unlike its counterpart, cold semi-arid climate zones can often have harsh, very cold winters in which snow is both likely and prevalent. Cold semi-arid zones are also prone to drastic swings in temperature in very short time spans, unlike in hot semi-arid zones in which conditions remain relatively similar from day to day and season to season. Little precious water and high solar presence characterize Denver, and as shall be explored in the pages to come, should characterize the city's buildings as well.
Recalling the inherently green elements of historic buildings, the following tables briefly outline one, the specific building practices utilized by Denver architecturally, and two, the sustainable building practices utilized in other semi-arid steppe climates not similarly seen in Denver.

<table>
<thead>
<tr>
<th>Building Element</th>
<th>Contribution to Sustainability</th>
<th>More Common Historically or Currently</th>
</tr>
</thead>
<tbody>
<tr>
<td>brick</td>
<td>extremely insulative, slow heat transfer, locally milled</td>
<td>historically and currently</td>
</tr>
<tr>
<td>operable windows</td>
<td>indoor thermal comfort regulation, ventilation</td>
<td>more so historically in commercial buildings, although possibly becoming more prevalent currently</td>
</tr>
<tr>
<td>exterior window treatments</td>
<td>indoor thermal comfort regulation</td>
<td>historically</td>
</tr>
<tr>
<td>awnings</td>
<td>indoor thermal comfort regulation</td>
<td>historically</td>
</tr>
<tr>
<td>porches/overhanging roofs</td>
<td>indoor thermal comfort regulation</td>
<td>historically</td>
</tr>
</tbody>
</table>

Figure 11: Table demonstrating inherently green practices of buildings in Denver, CO
Inherently Green Building Practices Utilized in Other Semi-Arid Steppe Climates Not Found in Denver, Colorado

<table>
<thead>
<tr>
<th>Building Element</th>
<th>Contribution to Sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>courtyards</td>
<td>provides shade, indoor thermal comfort regulation, and ventilation throughout structure</td>
</tr>
<tr>
<td>small windows</td>
<td>minimize heat gain and loss, insulative</td>
</tr>
<tr>
<td>adobe</td>
<td>extremely insulative, slow heat transfer, a local material made from renewable resources</td>
</tr>
</tbody>
</table>

Figure 12: Table demonstrating inherently green practices of buildings in semi-arid steppe climates

The Queen City of the Plains

Denver was founded November 22, 1858 as General William Larimer staked claim to a plot of land overlooking the South Platte River and Cherry Creek. Even at its inception, Denver’s geography was crucial to its success. Set at the confluence of these two rivers, the early settlement provided easy access, not only to necessary water resources, but also to trails connecting the city to the gold rush towns of the Rocky Mountains that proliferated in the summer of 1858. Early Denver was a true outpost, with an economy based solely on providing miners with goods and services ranging from banks to gambling halls and saloons. It was this reliance on Denver and its location that fueled the decision to name the city as the territorial capitol in 1865, only four years after
the formation of the Colorado Territory itself. Soon known as the “Queen City of the Plains” for its growing population, economy, and regional importance, it was therefore no surprise that Denver was declared the capitol of the state of Colorado when it was admitted into the union on August 1, 1876.

A Cyclical Economy

Although the Pike’s Peak Gold Rush slowed and eventually came to an end in the winter of 1861, Denver continued to prosper while many smaller outposts could no longer outlive their necessity. However Denver’s growth was still largely dependent on a single commodity and transportation filled the void left by the gold rush. The Denver Pacific, Kansas Pacific and Colorado Central Railroads rolled into Denver in 1870; the city’s nationally central location made it ideal as a transportation hub for both commercial travel and industrial goods. Manufacturing soon took off in Lower Downtown, now known as LoDo, as 17th street became the industrial center of Denver. The main artery from Union Station, raw goods were unloaded easily into the surrounding warehouses of 17th, turned around as manufactured goods, and then loaded right back onto trains for dispersal across the country. The railway also made it less demanding to traverse the national interior and the novel ease of travel helped thousands make their way to Denver as mining experienced another rush with silver in the 1880’s. Denver’s third boom cycle, gold followed by rail/industry and now the silver rush, ushered in a growing population that was steadily reaching past 100,000 in 1890. By
1900 Denver was the third largest city west of Omaha behind San Francisco and Los Angeles.

Denver however, has historically been a boom and bust town and even a burgeoning population did not prevent the subsequent silver bust of 1893. Denver’s manufacturing prominence brought by the railway dwindled as manufacturing decentralized due to the 1920’s eve of mass production and consumption. Industry now needed vast amounts of space to keep up with the high demand of product and the urban manufacturing cores were abandoned in favor of the edge cities of factories.

It is partially Denver’s geographic location that makes it prone to boom and bust cycles. Proximity to the Rocky Mountains means mining is a dominant economy for Denver, but the value of the extracted ores are fickle and can change ruthlessly, leaving economic depression in its wake. The 1970’s and early 80’s energy-crisis brought on yet another boom to bust as it was realized that the Rocky Mountain region was not only traditionally mineral-rich, but also contained deposits of oil-shale; a sedimentary rock from which synthetic crude oil can be extracted. The largest deposits of oil shale in the world are found in the Green River Formation occurring in Utah, Wyoming, and more poignantly in this case, Colorado. The sickle again swung the other way in May of 1982. Low oil-prices and increased procedural expenses caused the cancellation of the Colony Shale Oil Project near Parachute, Colorado. This is turn caused the loss of 2,000 jobs and led to numerous bankruptcies and home-foreclosures in Denver. It was during this time that Denver’s urban core truly began to decay; affected by four cyclical economic depressions and nearly 50 years of central business district abandonment.
Location, Location, Location

Looking at a nighttime lights photograph of the United States (see Figure 13), the major urban centers are clearly visible and easily found. Moving west from Dallas, the lights fade in gradient to a black band that seemingly marks the boundary of westward expansion. The next brightest light after this blackout is Denver; still a western outpost nearly two centuries after the promotion of manifest destiny and go west, young man. But in a modern context, the manifestation of the frontier takes on different occupations.

The Historic Vernacular

As a precursor to discussing the case study buildings, it is important to understand the historical context in which they were built. Cities often pull from their traditional architectural styles to reconnect with more sustainable and regional building forms. Denver, however, as an 'instant city” (qtd. in Voelz Chandler 2001, 13) forwent the
vernacular foundation, skipping over the more traditional adobe of the Southwest for the grand elements of Chicago-influenced Victorian and Italiante styles. Many people mistake the classical foursquare or the craftsmen bungalow as uniquely Denver vernaculars, however these styles were prevalent across the country and simply took on regional names. This classical style revered locally as the Denver Square is also known as the Seattle Box, the Double Decker, and the Double Cube all named dependent on their specific regions. However in the search for Denver's true historic vernacular, the results can be disappointing if not eventually fascinating. “Denver style? There's no such thing, much as people try to find one” (qtd. in Voelz Chandler 2001, 18).

Instead, Denver neighborhoods act as the regional vernacular opposed to the buildings that comprise them. Therefore if an architectural tradition unique to the city must be defined, consider the sum greater than its parts. The most prominent forms of architecture in Denver, Commercial, pre WWII, the “Denver” Square, and the craftsmen bungalow, although not endemic to the region are all popular components of the city's collective neighborhoods, both residential and commercial. With tree-lined green streets born from the brown prairie, large front yards with houses set towards the back of the lot, and an infamous number of parks, Denver although not known for its architecture is known for its neighborhoods that follow in the tradition of the City Beautiful Movement.

The City Beautiful Movement began in earnest in 1893 in Chicago and soon found its way into the architectural and city planning ideologies of other major cities such as Detroit and Washington D.C. Pulling largely from the Beaux-Arts tradition taught at the École des Beaux-Arts in Paris that focused on cues taken from Imperial Roman
Architecture, Italian Renaissance, and French and Italian Baroque styles, the City Beautiful Movement sought to eradicate such urban blights as overpopulation and industrialism. While “Denver prided itself on having no tenement house district or slums” (Noel and Norgren 1987, 9), the city had its own urban issues as “city planning did not exist” (Noel and Norgren 1987, 8) within its limits.

This apparent lack of city planning was not uncommon in the nascent settlements of the western United States. The quick nature of development in the west often made for a landscape of eyesores, “crude settlement[s] of tents and sod-plugged log cabins” (Noel and Norgren 1987, 5), made of fleeting material and temporary solutions. Especially in Denver's case, no one had grandiose plans of making their fortune in the gold mines and then staying in west. Most early settlers to Denver had the idea to make their millions and move on, “few entertained visions of a new life in the Rocky Mountains or on the Great American Desert” (Dorsett 1983, prologue). This fleeting attitude towards western settlements produced “no thing of beauty” (Noel and Norgren 1987, 8), in the early Denver settlement. The City Beautiful Movement was born out of this unsightly infrastructure. For example, there existed an intense hatred for the “pitifully grotesque, gruesome, appalling” and “hideous monster” that was Chicago at the turn of the 20\textsuperscript{th} century. Consider then at this same time Denver, a fraction of Chicago's size and wealth, must have seemed far worse off. Prior to Speer delivering the City Beautiful Movement to Denver, the city was pocked with “vestiges of its ramshackle frontier origins...in the
form of tents, shacks, and makeshift housing amid the dumps lining the Cherry Creek and South Platte River” (Noel and Norgren 1987, 8).

It is of no great surprise then that as Daniel Hudson Burnham unveiled the White City at the Chicago World's Fair, Robert Walter Speer took notice. Burnham, the director of works and fair's chief architect, is credited with launching the City Beautiful Movement in the United States, “rediscovering” the classical architecture of Europe (Noel and Norgren 1987, 8). The fairgrounds, known as the White City for all its plastered facades, acted as a projection of what American cities could become. If such a transformation could occur in a “hideous monster” such as Chicago, it could successfully occur elsewhere as well. Amazed by the improvement to the marshy shores around Lake Michigan, Speer, at the time a burgeoning politician and developer, saw great potential for the city of Denver through the ideology of the City Beautiful Movement. The White City at its core “revealed to the people possibilities of social beauty, utility and harmony of which they had not even been able to dream” (Noel and Norgren 1987, 1). As Denver at this time was just a town of log cabins, haphazardly placed commercial buildings, and more drinking establishments than desirable, this sentiment struck a chord with citizens, city planners, and politicians alike and by 1900 became a dominant urban concept.

Thanks to Robert Walter Speer, who served his first term as mayor in 1904 Denver is one of the textbook examples of the City Beautiful Movement in the United States. Speer is often single-handedly credited with transforming the city from “false-fronted shacks” to “Victorian mansions” (Noel and Norgren 1987, 15) in fulfillment of his vision of Denver as “the Paris of America” (Noel and Norgren 1987, 15). Mayor from
1904 to 1912 and elected again 1916, Speer was the first Denver mayor to die while in office, suffering mid-term from pneumonia and finally perishing in 1918. Although his third term was cut short, Speer's influence on the city stretched well beyond the length of his terms and his approximately forty years in Denver.
Chapter Four: Analysis of The Modern Denver Sustainable Landscape

Economics of Sustainable Buildings

It becomes apples v. Volkswagens (Jere D. Eggleston and Bernadette Kelly, personal communication, 7 December 2009) in comparing new build and existing in terms of LEED certification. Life-cycle costs in this comparison although useful for each individual building would mean little when pitted against one another as renovation always results in lower life-cycle costs with the amount of embedded energy they innately have. Also the credits that new and existing buildings receive differ greatly from one another. So even though all buildings involved in these case studies have achieved gold certification, the means by which they have done so do not correlate to one another for a direct, concise comparison. Therefore, the best representation of the true costs of these buildings is by the simple measure of cost per square foot. Initial building costs will not be incorporated into the cost of the adaptive reuse buildings in terms of cost per square foot as they were constructed long enough ago that that cost becomes a part of the embodied energy. In other words, that money has already been spent, and it was done so long ago that it is no longer pertinent to figure that cost into the overall. This fact is the allure of adaptive reuse and renovation and what ultimately makes it a more economic practice when applicable. There are a few interpretations of cost per square foot that are important to note. Cost per square foot can mean, the cost it took to construct the entire
building, every nail, length of wire, and drywall. It can also mean the cost per usable area, meaning the space between the walls is not incorporated; this is usually calculated by the area of open floor space. The cost per square foot can also mean the cost per rentable square foot for tenants. Consider the lobby in an office building. No one business rents the lobby; it is a common area that is not figured into the tenant’s monthly rent therefore it is not calculated as a part of the rentable cost per square foot. For this research, the first meaning of cost per square foot is the most applicable, calculating the cost of the building in its entirety.

**Building Case Studies**

This element of research consisted of in-depth case studies analyzing four buildings in the city and county of Denver, Colorado. The four buildings were chosen from a cache of LEED certified buildings in the city. Buildings were selected that represent both new build and adaptive reuse projects, two projects representing each construction method. The choices were again narrowed by picking new build and adaptive reuse projects that had the same level of LEED certification to ensure that all four buildings held similar criteria for their certification in terms of cost and requirements fulfilled; to compare cost analysis on certified and platinum LEED buildings would provide a skewed perspective on respective costs of new build and adaptive reused projects. Finally, the buildings were chosen as close to the central business district as possible and therefore all were commercial properties to maintain sustainable aspects of
the city as opposed to the suburbs as aforementioned in this paper. The case study buildings ultimately decided upon are outlined in Figure 14, available Sanborn Fire Insurance maps for each building or its lot are included Appendix A.

**University of Denver College of Law**

**History**

John Evans founded the University of Denver (see Figure 15) in 1864 as the Colorado Seminary. Evans was dedicated to seeing Denver flourish and the foundation of the seminary was one of many lasting contributions the Colorado Territory’s second governor bestowed upon the city. Closed merely a few years later as a casualty of the silver bust, Colorado Seminary again opened its doors in 1880 under the new title

<table>
<thead>
<tr>
<th>PROJECT NAME</th>
<th>OWNER</th>
<th>CITY</th>
<th>LEED RATING</th>
<th>YEAR COMPLETED</th>
<th>SQUARE FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frank H. Rickeson Jr. Law Building</td>
<td>University of Denver</td>
<td>Denver</td>
<td>Gold</td>
<td>2004</td>
<td>210000</td>
</tr>
<tr>
<td>EPA Region 8 Headquarters</td>
<td>Opus Northwest, LLC</td>
<td>Denver</td>
<td>Gold</td>
<td>2007</td>
<td>257000</td>
</tr>
<tr>
<td>4240 Architecture, Inc.</td>
<td>Sprung Construction</td>
<td>Denver</td>
<td>Gold</td>
<td>1893-1903*2007</td>
<td>14200</td>
</tr>
<tr>
<td>Byron G. Rogers Courthouse</td>
<td>U.S. General Services Administration</td>
<td>Denver</td>
<td>Gold</td>
<td>1965*2006</td>
<td>247000</td>
</tr>
</tbody>
</table>

*Table outlining case study buildings*
University of Denver. The first incarnation of the university was a small building downtown amidst the questionable morality of miners, gamblers, and other untouchables of Denver’s early frontier population. Looking for a setting more conducive to higher learning, the university relocated to quiet, old potato fields donated by Rufus “Potato” Clark in 1890 that the University of Denver and surrounding neighborhoods still occupy today.

Always with a growing student body, the university’s landscape has been in a state of constant change. From army barracks to high performance buildings, construction at the University of Denver has been a common occurrence nearly from the ground’s inception. One notable example, as veterans returned home from WWII and sought
higher education, the university’s existing buildings could not meet the demand of the influx of so many new students. Quonset huts were erected to house students until more permanent accommodations could be built (see Figure 16). Another architectural anecdote centers on Penrose Library. In an event referred to as “Woodstock West,” DU students protested the Vietnam War and the death of four students at Kent State University. Campus legend holds these protests begged of campus planners to do away with large open areas in which students could gather en masse. Penrose Library was supposedly constructed as quickly as possible to deter students from gathering; the story accounting for the library’s hasty box design while being surrounded by red sandstone and brick structures throughout the rest of campus. The early 1990’s ushered in the most recent and ongoing construction phase at the university. Extensive planning and campaigning raised $450 million for new buildings as well as other academic pursuits. It is within this most recent phase that the Frank H. Ricketson Jr. Law building began construction.
The University of Denver College of Law was founded in 1892 and held a prominent role in the legal structure of the Rocky Mountain Region. In 2004, the college was renamed the Sturm College of Law in appreciation of the largest single donation in the school’s history given by Donald L. and Sue Sturm, the former owner of the American National Bank. Housed in at least three locations throughout the school’s history, the first law school held classes at a satellite campus located on 15th street spanning from Court to Cheyenne Place. Currently, these two blocks are home to the Sheraton Downtown Denver and the Denver Newspaper Agency. The block running from Court to Cleveland Place is now comprised solely of the Sheraton Downtown Denver that was completed in the 1960s as a Hilton, marking the first demolition of the university’s satellite campus. From Cleveland to Cheyenne Place, now the intersection of North Broadway and West Colfax Avenue, this block is dominated by the Denver Newspaper Agency. Once voted as the “worst place to have an ugly parking lot” (Denver Infill 2010, ¶1), the building occupies a longtime asphalt wasteland sitting as such for nearly two decades before the Denver Newspaper Agency bean construction in 2004.

The Sturm College of Law, then its original namesake the University of Denver College of Law, made its first move in 1982, leaving the block at Broadway and Colfax to its car-park fate. During this time, the Colorado Women’s College was experiencing financial woes and campaigned, as they had done unsuccessfully in 1976, for a merger with the University of Denver. The second attempt at joining the two institutions was a triumph and the University of Denver now managed the Colorado Women’s College campus in northeast Denver at Montview Boulevard and Quebec Street.
Meanwhile, the modern site of the Ricketson building, named for its primary financial contributor and 1919 alumni, was home to a handful of fraternity houses, girls dormitories, and a nursery school. However by the time construction started on the Ricketson building, the site had been sitting either barren or as yet another parking lot for quite some years.

Ground was broken and construction began on the new law school in 2003, striving for the same goal all new buildings on DU’s campus sought to achieve; constructing lasting buildings that would become symbols of the campus in the decades to follow. With an eye towards longevity, the university sought LEED accreditation for the new law building to promote both sustainability and the ingenuity the law school values as one of its guiding principles.

Building Process and LEED Certification

Recall that Leadership in Energy and Environmental Design certification assesses five major components of green building; sustainable sights, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and finally innovation and design. As the LEED program has evolved it has set different requirements for differing levels of certification. All projects chosen for these case studies were selected because of their gold level of certification, however it is important to note that the points required to obtain gold certification have changed with the various versions of the program. This is not a troublesome discrepancy however, as the USGBC has taken all
necessary precautions to ensure that gold certification is similar across all versions regardless of the actual number of points required, whether it be for existing or new buildings.

Under version 2 and 2.1 for New Construction, the University of Denver College of Law received 39 of the possible 69 points to obtain gold certification.

Overview and Predesign

In early June of 2007, University of Denver's current chancellor, Robert Coombe joined nearly 600 colleges nationally in signing the Presidents' Climate Commitment, stating that the “DU community is concerned with global warming and vested in sustainability...universities should play an important role in building sustainability through continued efforts to reduce greenhouse gas emissions” (qtd. in University of Denver Sustainability Council 2010). The Presidents' Climate Commitment is a call to arms among the United States' college campuses, students, presidents, and chancellors in a rush to “avert the worst impacts of global warming and to reestablish the more stable climatic conditions that have made human progress over the last 10,000 years possible.” The Ricketson Building, completed in 2005, acted as a precursor to the signing of the commitment by Coombe and certainly influenced the future of green campus buildings, such as Nagel Hall student residences completed in the fall of 2008.

Even before construction, the Ricketson Building was intended to provide a shining example of green building, not only for the University of Denver campus, but for
campuses across the nation as well. A major proponent of the Ricketson Building, environmental law professor George Pring says of the project, “Not only was building ‘green’ the right thing to do, but we hope we set a precedent among universities and colleges across the country that there is absolutely no excuse not to build ‘certified green’ from now on” (University of Denver Sturm College of Law 2010).

**Sustainable Sites**

The Ricketson Building scores fairly well in an analysis of site sustainability, with the greatest number of credits coming from transportation-related points. The University of Denver has a long tradition of being an urban school since its inception in 1864, although when it moved from downtown Denver to the potato fields in 1890, the school had to wait for the city to build to surround it. Currently, however, the College of Law's location is fairly central, about 6 miles from the central business district. In terms of transportation, the Ricketson building also ranks well as it is highly accessible by public transportation thanks to the nearby University of Denver light rail station, resting less than four blocks to the north. The University of Denver has a strong history with public
transportation.

Once referred to as “Tramway Tech,” the university enjoyed a high amount of traffic on the streetcar line that passed through the heart of the campus on Evans Ave (see Figure 17). The Ricketson Building also received points for its promotion of biking to and from the site, the building offers bicycle storage and locker rooms with showers and changing rooms for cyclists. The parking structure at Ricketson gained the project an additional two points. The first point awarded was due to the size of the lot that complied with local zoning law, provides preferred parking for carpoolers, and serves only 5 percent of the total building’s capacity supporting forms of transportation other than personal vehicles. The second point from the parking structure was awarded for the inclusion of electric vehicle recharging/refueling stations.

The Ricketson Building received a credit for storm water management treatment. This credit is awarded when a treatment system can eliminate 80 percent of post-development total suspended solids, or TSS; pollutants that find their way into storm water runoff from parking structures and other impervious surfaces. Treatment systems
must also eliminate 40 percent of post-development total phosphorus or TP. Phosphorus is typically found in fertilizer used to bolster and maintain landscaping growth after a construction project is finished. The amount of phosphorous that washes away from these sites has an often unrealized environmental impact. As the chemical makes it to waterways, it stimulates growth of algae and other aquatic plant forms and reduces the oxygen levels in the lake, stream, or river, essentially suffocating fish and other life forms dependent on a certain level of oxygen for survival. By increasing on-site filtration systems, the College of Law building removes a large amount of pollutants contributing to the disruption of natural water systems.

Architecture at the University of Denver is easily recognizable through its extensive use of copper on a growing majority of campus buildings. The copper placed on the Ricketson Building however, was not chosen just for its aesthetic appeal. The project gained a point from the copper roofing under the category of Landscape and Exterior Design to Reduce Heat Islands, Non-Roof. The most conventional way of reducing the heat island effect, which is a concentration of heat due to the impermeable, dry nature of urban settings and building lots (see Figure 18), is to top buildings with either reflective white roofs or green roofs made of living vegetation that mimics the more permeable surface of a greenfield. While a white roof was considered for the Ricketson Building, it was found that copper best fit with university's goal of constructing a building that would last for centuries. In a previous case study of the
buildings conducted by University of Denver student Sarah Showalter the copper, which is comprised of 95 percent previously used and recycled copper, is 100 percent recyclable itself and as it ages will tarnish green reducing the heat island effect to an even greater magnitude. Through Showalter's case study and also in a personal interview with Denver Technological Center vice president of development Ron McDaniel, white roofs, although billed as a green technology were typically found to have a shorter lifespan than conventional roofs (about thirty years as opposed to fifty with conventional) and are much more expensive. Therefore replacement of these sustainable roofs would be more expensive more often, detracting from the positive effects the white roof would have making other roofing options more viable. The LEED program no doubt realizes this
dilemma and therefore offers points in heat island effect reduction from non-roofing components.

Finally in the sustainable sites category, the Ricketson Building gained credit for reducing light pollution. This reduction is achieved by limiting the number and intensity of outdoor lights while still maintaining safety and by ensuring inside lights do not shine too brightly through windows and other openings at night. The light pollution credit's main goal is to ensure that light does not “leak” from the to site into surrounding areas.

*Water Efficiency*

In terms of water, the College of Law building uses an estimated 33 percent less than a building of comparable size built by conventional standards. The water conservation is achieved primarily through motion sensors on toilets and faucets and low-flow fixtures on the showers provided for cyclists as well as all faucets building-wide. The Ricketson Buildings was the first LEED project to include waterless urinals. These waterless urinals along with the sensors on the faucets save 39 percent of normal restroom water use, contributing largely to overall conservation. Xeriscaping, or the use of endemic, often drought-resistant plant species in landscaping, was also employed at this site, using recycled groundwater for 100 percent of the necessary irrigation. The total water use of the College of Law appears in the following table.
Energy and Atmosphere

LEED projects gain two points for every 10 percent optimization in energy performance gained through design and technology. The Ricketson Building gained six of its eight energy and atmosphere credits from its optimization of energy performance by 40 percent. Energy optimization, or reduction can take place through any number of components in a building, including masonry, plumbing, heating, ventilating, and air-conditioning (HVAC), and other utilities. The Ricketson Building optimized its energy use mostly though the use of innovative lighting design. First and foremost, use of outdoor light was optimized through large windows and a four-story central atrium allowing light into most classrooms and offices in the building. Working in accordance with this natural lighting, the Ricketson building uses light sensors that dim in bright sunlight as well as motion detectors that turn lights off when there is no occupancy. The advanced lighting system can be overridden by occupants if necessary, allowing a level of control that many automated systems usually withhold.

Low-emitting windows and brick used in construction of Ricketson prevent heat transfer from the building. Both materials are able to more efficiently retain thermal mass, meaning they keep warm from the sun in the winter long into the night and keep
the cool of the summer night well into the hotter days. Traditionally windows in a semi-arid steppe such as Denver should have been small to reduce the amount of energy transferred through the more penetrable glass, but with window size optimized to let in natural light, the low-emission style of windows limits the amount of energy that would be lost with conventional windows.

The well-lit and well insulation nature of the Ricketson Building results in a net savings of about $55,000 a year. A more in depth summary of the total cost spent on energy is provided in the tables below.

| Annual Purchased Energy Use for the University of Denver College of Law |
|-----------------------------|------------------|-----------------|-----------------|
| Fuel                        | Quantity         | Cost            | Cost per Square Foot |
| Electricity                 | 1,310,000 kWh    | $76,679.00      | $0.37            |
| Natural Gas                 | 15,300 therms    | $11,574.00      | $0.06            |

| Total Annual Building Energy Consumption in Cost |
|-----------------------------------------------|------------------|-----------------|
| Grand Total                                   | Cost             | Cost per Square Foot |
| Total Fuel Purchased                          | $88,253.00       | $0.42            |

The remaining points gained in energy and atmosphere were received for additional commission and green energy. Additional commission, is a five step process augmenting the primary and prerequisite commission and requires the project to:

1. Conduct a focused review of the design prior to the construction documents phase.
2. Conduct a focused review of the Construction Documents when close to completion.
3. Conduct a selective review of contractor submittals of commissioned equipment.
5. Have a contract in place for a near-warranty end or post occupancy review (New Jersey Sustainable Business Alliance n.d.). To ensure a valid review, steps 1 through 3, it is important to note, must be carried out by a designer from a firm that is not previously affiliated with the project. This ensures project integrity. The final point received in energy and atmosphere is gained from green energy, obtained by signing a two-year contract to purchase power from a renewable energy provider that meets the Center for Resource Solutions (CRS) Green-e product certification requirements. The CRS Green-e certification strives to promote the 2 percent of renewable energy resources used today in contrast with the 98 percent of electricity produced by fossil fuels and nuclear commodities. Renewable energy solutions include wind, geothermal, and solar among others. So although the College of Law did not receive points for on site-renewable energy generation such as solar panels, the Ricketson Building did receive points for purchasing wind power generated elsewhere.

*Materials and Resources*

From asphalt to window frames and wall panels, 80 percent of the materials used in the Ricketson Building contained recycled materials, gaining credit for surpassing both the 10 percent and 20 percent recycled material mark (Colorado Building Green n.d.). The project picked up two more points for using regional materials, 20 percent of which were manufactured locally with at least 50 percent of that 20 percent coming from locally harvested lumber, minerals, and other raw materials. LEED defines “local” as
any resource manufactured or harvested within a 500 mile radius; examples of this regional material include gypsum board mined from Gypsum, Colorado and the brick used as the primary construction material. Local brick is extremely easy to come by in Colorado, the region's soils are rich in clay which is a major component in brick production. As well as using recycled materials for the Ricketson Building, careful attention was paid to use 100 percent recyclable materials so that in the future as the building is renovated or demolished, all of its resources can be reused in one way or another. In addition, construction at the project was able to divert 50 percent of its waste from the landfill either by recycling or reusing excess materials, contributing carefully chosen sustainable materials to other projects across the state.

The Ricketson building lost the opportunity to seize a total of only three points from the materials and resources category by not reusing any portion of an existing structure. Recall from an earlier discussion in this research that existing buildings do have their own set of LEED credentials to achieve, but in a major renovation in which 75 percent of an existing building's shell is reused, the project then becomes eligible for the new construction guidelines. Under the new construction framework, LEED awards at most only three points for reuse of a building, a conundrum to be discussed in more detail in the following pages.
Indoor Environmental Quality

Indoor environmental standards apply not only to the safety of the building occupants, but the workers constructing the building as well. Therefore this is one of the more crucial categories in the LEED certification process of which the Ricketson gained 60 percent of the available points. By monitoring carbon monoxide and increasing ventilation effectiveness through operable windows and fans the project gained two of its nine credits within this category. Careful attention was paid in the selection of low-emitting, or low volatile organic compounds (VOC), carpet, adhesives and sealants, and composite wood. This attention was rewarded with another three points. Indoor chemical and pollutant source control is worth only one credit, yet is comprised of four steps that must be carried out. This point requires:

1. The installation of permanent entryway track-off systems (the slotted “entry-grate” just inside doors to many buildings, they trap pollutants as well as dirt and are most often constructed of recycled material)
2. That all areas with hazardous gases or chemicals exhaust directly to the outdoors
3. The replacement air-handler filters just before occupancy with super-high efficiency filters
4. The inclusion of containment drains to control hazardous liquids wherever they are used.

The project also gained two points for having in place an indoor environmental quality management plan both during construction and before occupancy that ensured adequate pollutant control, decontamination, and ventilation. The final credit in this category was achieved by complying with ASHRAE 55-2004 standards for thermal comfort acknowledging “that people who know they have control are more accepting of
and in fact prefer a wider range of temperatures, making it easier to satisfy their comfort preferences” (The Regents of the University of California 2000) promoting operable windows and personal control over thermostats.

Innovation and Design

The College of Law project received all five points possible for innovation and design, with the presence of a LEED accredited professional on the task force acting as the easiest point gained. Innovation and design points can be thought of as the extra credit of LEED certification; this is an opportunity for such components as the copper roof to gain the attention and extra points they may deserve. The Ricketson building received two such points, one for the previously mentioned copper roof and one for the success of their outdoor lighting fixtures spreading campus-wide. The project also offered sustainability education through building tours and campus awareness to gain yet another extra credit point. Finally, because the University of Denver College of Law building uses low-emitting furniture another point in innovation and design is gained. Ultimately it is these extra points that brought the Ricketson Building to the gold certification level.
**Building Context and Summary**

Regionally, the Ricketson Building fits fairly well within the semi-arid steppe climate of Denver. The building is situated facing south to take advantage of passive solar heating throughout the winter months. The project also took great care in using local building materials, like the aforementioned brick and gypsum. The use of brick from local mills is a prime example of *remembering* how to simply be sustainable. Manufactured nearby, the brick incurred low transportation costs while adding to the building's ability to retain its thermal mass. However, this research does make note of few historical building elements that might boost the overall sustainability issue of the building. Although the windows are low-emitting, they remain uncovered by shutters, the main entrances left bare to the elements without porches or awnings. Low-e windows are extremely efficient at trapping heat within the structure, but this metal-oxide treated glass does not easily let heat back out, a definite problem in the hot summer months that the use of shutters could alleviate. These components would help reduce the strain on the innovative systems maintaining a constant comfortable climate inside the Ricketson Building.
While the Ricketson Building did achieve gold certification, this research proposes that it did so largely through the creation of sustainability, rather than the presence of it. How green really is a locker room with showers for cyclists? Merely providing these amenities for occupants does not ensure they will bicycle to work and in turn consume less fossil-fuels. Ultimately these kind of points are reliant upon the occupants and not the building itself.

Also recall that without the innovation and design credits, the Ricketson Building would have been silver certified through the LEED program. Had these credits been obtained through other methods, perhaps through renewable energy and resource reuse, the gold certification would certainly sit upon a sturdier foundation. There is often discussion among critics of the LEED program that it can become too easy for projects to simply “buy” LEED credits through the inclusion of such sustainably deemed components as additional commissioning and purchasing green energy from off-site sources. While the Ricketson Building was the first gold certified LEED project in the state, it is perceived that the certification was perhaps gained through normalized, yet still important by all means, standard green practices. Save for the copper roofing, this project is business-as-usual sustainability. Any sustainable building project should be seen as a great success towards a more promising future, but this project does not greatly alter the playing field.
Environmental Protection Agency Region VIII Headquarters

Figure 19: EPA Region VIII Headquarters and LEED Facts. Photo courtesy www.buildinggreen.com.

History

The Environmental Protection Agency (see Figure 19) was founded on December 2, 1970 amidst the fairly nascent but ever-growing environmental concerns of the decade. Established in Washington, D.C., the EPA began with the overall goal to “consolidate in one agency a variety of federal research, monitoring, standard-setting and enforcement activities to ensure environmental protection” (EPA 2009). Working to ensure the health of both the human and natural environment, the EPA divides its legislation among ten specialized regions that can better react to and mitigate local issues.

The EPA building in Denver houses the headquarters of the agency for Region VIII which encompasses Colorado, North Dakota, South Dakota, Utah, Montana, and Wyoming as well as 27 sovereign tribal nations. This region “encompass[es] the heart of the American West;” (EPA 2009) once again demonstrating Denver’s prominent regional importance and validity as a study area. Region VIII, exemplified by the city of Denver,
covers much of the broad and high plains of the United States. The often harsh climate of this region puts a premium on natural resources and water demanding a more sustainable way of living and building. Construction and operation impacts were taken into the utmost of consideration when the EPA began the process of building a new headquarters, illustrating the agency’s commitment to decreasing its environmental impact.

Historically, this has been a busy block for the city of Denver. Located directly southwest of the urban anchor Union Station, the lot at 16th and Wynkoop has seen its fair share of changes over the decades. The first known improvement to the real estate is visible in an 1887 Sanborn Fire Insurance map identifying the southeast corner of the block, where the EPA Region 8 Headquarters currently lies, as the W.F. Thompson Lumber Yard. The Sanborn maps from 1890 to 1893 exemplify Denver's early love affair with demolition as this same area only three to six years later, and at the heart of the city no less, is razed and bare. The remainder of the block however at this time, was shared by the Sherman and Jewett Stoves and Ranges Warehouse along with the warehouses of J.W. Kinsey Implement Company, a mason shop, and at least one residence. From 1903-1904, the corner is occupied only by what appears to be an isolated residence building with an office front facing 16th Street. In this era beginning as early as 1903, the corner was only occupied by the residence and office front complimented by a streetcar stop across the street while the rest of the block was dedicated as a beer warehouse for the Adolph Coors Brewery and the J.P. Paulson Bank, Bar, Office, and Store Fixtures complex of showrooms and shops. In the map from 1929 to 1930, the
residence and office front are gone from the corner, replaced by the Kennicott-Patterson Warehouse Corporation. The Coors warehouse is still standing in this view, but has been left vacant at some point during the twenty-five years between the dates provided by the Sanborn maps. During these years the block begins to become less monopolized by one or two businesses, but rather it is seen that many small companies began to divvy up the block and carve out a niche for themselves in a prime central business district location. Then, sometime after 1930, the block becomes even more of an agglomeration of businesses and the advent loft residences dawns in this era. The offices that dominated the west side of the lot are now listed simply as a “loft building,” while the corner the EPA building occupies is shared by the Gates Rubber Company Shipping Warehouse and the Dixon and Company Wholesale and Paper Products warehouse. The site formerly occupied by the Coors Brewing Company is now labeled as the Post Office Terminal Annex, however at this time, the annex is occupying the northeast corner of the lot as opposed to the southeast. Not until after the 1950s did the annex occupy the more familiar southeast corner of the lot where it remained until 2005 when it was demolished in preparation for the new EPA building in February. June 19th, 2002 the Postal Annex accepted its last piece of mail after 42 years of service. Built in 1960, the same era as the Byron G. Rogers Courthouse, the exemplary modern-style building was not spared the wrecking ball as demolition began three years later.
Building Process and LEED Certification

The EPA building sought gold certification through the New Construction requirements established by the USGBC. The Region 8 headquarters were required by the EPA to achieve at least a silver rating through the LEED program and an Energy Star rating in compliance with the new law established in 2007 by the city of Denver stating that all government buildings must strive to achieve to be at least certified through the LEED program. Of course, the EPA building bettered the requirement and earned a gold certification level. This project began as a solution to the overcrowding of the headquarters' previous downtown location spread among twenty three floors and two office towers. The EPA's new headquarters at 16th and Wynkoop allows for a more efficient and consolidated workspace and also promotes more sustainable methodologies in architectural and construction practices.

Overview and Predesign

The location of the EPA building so close to Denver's first and most famous historic district, Larimer Square, the planning board worked closely with the Lower Downtown Design Review Board to ensure that elements such as paving patterns, cornice heights, and window treatments would not ultimately detour from the historical aspects of the neighborhood. As a newbuild itself, this project took great concern in dealing with a historic neighborhood both validating the neighborhood's economic and social value as well as also reiterating the profitable nature of historic preservation. Although the
existing historic building was razed in this case, extreme care was taken in creating a new building that would complement the surrounding old structures. Several designs were proposed for the building attempting to find the best thermal massing configuration of site situation, glass, and brick. However, the project experienced difficulty in site situation that all buildings in downtown Denver encounter; the original city is configured off the Platte River, giving the street grid a 45° rotation from a more traditional grid system, adopted by the city south of Speer Boulevard, that cannot effectively utilize daylighting. Ultimately, none of the proposed building plans proved to offer a truly advantageous use of daylighting, but one design in particular did meet the EPA's desire to accommodate occasional all-staff meetings, successfully seating 900 employees. This was carried out in the design plan through the use of an atrium, that while not optimal, still allows for daylighting to the fullest extent possible for the center of the building.

_Sustainable Sites_

The location of the EPA site ensures high scores in terms of sustainable site selection. Gaining 9 out of 14 points available for this category, the project faired well due to its urban location. Nestled really in the heart of the central business district, the site of the EPA building obtained a point each for site selection, development density, brownfield redevelopment, and three additional points for alternative transportation. Due to the location discussed above, the site selection point is no surprise. The high development density is also attributed to the project's central location. The point for
brownfield development is an especially important credit as the project did not break new
ground in a greenfield, but rather used already improved land on which to build.

In terms of alternative transportation, the EPA building scores quite well, gaining
three credits overall for ease of access to public transportation, bicycle storage and
changing rooms, and alternative fuel vehicles. The location of the building directly
southwest of Denver's once and future transportation hub, Union Station, provides
extremely easy access to busses, a public shuttle servicing 16th street in the center
business district, and a light rail transit system. As the light rail service expands in
Denver and the surrounding municipalities in the coming years, Union Station will
become an area of higher traffic and development, further improving the site location of
the EPA building. This project also included the ever-popular and always simple “green”
element of bicycle storage and changing rooms in an effort to promote cycling to work.
This credit, although a form of simply “buying credits” when the project location is more
remote, functions as intended in a densely urban setting such as the one occupied by the
EPA building. In a dense and mixed-use urban area, biking to work becomes simpler as
daily resources are more widely available closer to the office, limiting the necessity for a
car before, during, and after business hours. The last transportation credit was awarded to
the project for its inclusion of electric vehicle charging stations as well as an official EPA
fleet of hybrid and alternative fuel vehicles. Although electric vehicles are not widely
used at present, this credit is seen as forward-looking and anticipates a major shift in the
way vehicles are fueled. These alternative transportation methods prove highly effective
for the EPA, as two thirds of their employees regularly commute to work by alternative means. This access to alternative transportation methods was what ultimately lead the EPA to choose this site, one of five possible locations for the project.

The EPA building gained one point for stormwater management for its treatment methods. Much in the same fashion that the Ricketson building obtained this credit, the EPA building was careful to design a treatment system that successfully eliminated 80 percent of post-development TSS. Recall also that in order to gain this credit, the treatment system must also eliminate 40 percent of post-development TP. As collection is just as important as treatment in terms of stormwater management, the building's green roof also acts another method of sustainably dealing with stormwater.

The EPA boasts one of the few green roofs being piloted in the city of Denver. Gaining one point for this roofing experiment, the building hopes to determine the viability of green roofs in a climate such as Denver's. At 19,200 square feet, the roof reduces heat island effect and also collects and filters stormwater. The "garden" is comprised of four-inch deep plastic trays arranged in three tiers around the terraced roof, placed on the existing roof membrane. Planted with indigenous and drought-hardy varieties, the garden at this point chiefly contains various species of *Sedum*. While plans are in place to experiment with the viability of other plant varieties, it should be noted that green roofs in areas of limited water resources are plagued with issues. In order for a green roof to be viable and sustainable, it should be able to survive on its own without intervening irrigation after a two-year period. Because Denver is located within a semi-arid steppe, water is limited and drought is common. It remains to be seen if the green
roof at the EPA will be able to survive only on the annual precipitation without further irrigation. Analysis on weighing the costs and benefits of irrigation of green roofs versus the reduction in heat island effect would be largely beneficial, however no known research endeavors could be found.

The EPA building earned one more credit within the sustainable sites category, also relating to the reduction of heat island effect, but this final credit was unrelated to the tradition green roofing system. The project obtains this point by providing at least 50 percent of its parking under a roof or underground and also by paving and landscaping with materials with a solar reflectance index, or SRI, of at least twenty nine. The SRI is the measure of a surface's ability to reject solar heat, usually measured by small rises in temperature. A black surface results in a higher rise in temperature and therefore a lower score on the SRI. A white surface however, reflects rather than absorbs heat and therefore shows less of a heat gain. The lower the heat gain, the higher the SRI (Environmental Energy Technologies Division n.d.). Using materials with high SRIs is an innovative way of reducing heat island effect without investing in a green roof, which in a clime such as Denver's, could prove to be very viable.

Water Efficiency

The EPA project gained four points overall in the category of water efficiency. Along with low-flow faucets, the project used efficient dual-flush toilets (fixtures which control the appropriate level of water flow) to save a projected 270,000 gallons of water
The use of waterless urinals contribute to the two points gained for water use reduction and the preservation of an additional 360,000 gallons annually. The other two points were granted on the basis of water efficient landscaping. The EPA building has reduced the amount of water devoted to landscaping by 50 percent through the planting of trees watered with an irrigation system that when utilized, uses less than 0.5 gallons of water per minute. In addition, the project uses no potable water in the irrigation of its street side landscaping or green roof.

<table>
<thead>
<tr>
<th>Annual Water Use for EPA Region 8 Headquarters</th>
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<tbody>
<tr>
<td>Indoor Potable Water Use</td>
</tr>
<tr>
<td>Outdoor Potable Water Use</td>
</tr>
<tr>
<td>Total Potable Water Use</td>
</tr>
<tr>
<td>Potable Water Use per Unit Area</td>
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*Energy and Atmosphere*

Overall, nine points were gained in the energy and atmosphere category of LEED certification. Five points were gained through the optimization of energy performance, one point for every 10 percent the project reduced its energy usage. The project also gained a point from the additional commissioning process outlined in the Ricketson building case study discussed above. The remaining three points were gained from innovations in ozone depletions, measurement and verification, and green power.

The ozone depletion credit is designed to encourage compliance with the Montreal Protocol adopted to reduce the rate and magnitude of ozone depletion. The Montreal Protocol on Substances that Deplete the Ozone Layer as it is called in its
entirety (United Nations Environment Programme 2009) was initially signed in 1987 and amended in 1990 and 1992. The protocol offers a set of guidelines and goals concerning the reduction of substances such as CFCs that contribute to the destruction of the ozone. In gaining this credit, the EPA building installed an HVAC system that did not contain any HCFCs or Halons, both in the cooling and fire suppressant systems. The credit gained from measurement and verification simply ensures that the EPA building monitor energy consumption over time. This requires that the project devise a plan through which to be held accountable for the energy performance optimization credits first obtained within the category. The final point within energy and atmosphere was gained through the agreement to purchase green power from renewable energy sources. In addition to these renewable energy sources, the EPA building has installed 10-kilowatt, grid-tied photovoltaics that produce a bulk of the electricity used in the headquarters. The project also makes use of the existing steam infrastructure in downtown Denver; many building in the central business district tap into this resource.

In terms of energy optimization, the EPA building sought to use both site situation and green technology to reduce its overall consumption. The building envelope is highly insulative made from R-19 and R-31 materials. “R” represents a material's R value, a measure of thermal resistance based on the ratio heat flow per unit area. Although in depth, the theory behind thermal resistance would take much more than the scope of this research to explain, the pertinent point to take away for the purpose of this application is the larger a material's R value, the more efficient insulation it provides. Insulative glazing applied to all windows also helps reduce energy use.
The EPA building is actually constructed in the shape of a “double L” with the aforementioned atrium as the center anchor. This design allows for the optimization of daylighting, although the orientation of the building itself prevents the most efficiency to be gained from natural lighting. In addition to the window glazing, the project constructed external window shades that provide extra shade and reduce the cooling demand placed on the HVAC system. In line with reducing heat gain from windows, the atrium is fitted with teflon-coated “sails” that reflect daylight from the top of the atrium where temperatures are their greatest down into the lobby of the building providing both light and heat management.

The building is also equipped with sensors to reduce energy use, some in the form of motion sensors that turn on and off lights according to occupancy, and others that detect daylight brightness and adjust the inside lights accordingly. This adaptable environment is further enhanced through air distribution vents located under the floor. Completely controllable by building occupants, these vents assist air conditioning while using less energy from the HVAC system; though the vents air is simply circulated rather than chilled.
Materials and Resources

Out of thirteen available points from the materials and resources category, the EPA building gained seven. Two of the seven credits were obtained through the management of construction waste. The project was careful to divert 75 percent of its construction waste keeping it from the landfill and either location other construction sites that could use the materials or recycling that which was unusable. To receive this credit, the contractor documented the construction waste which resulted in a monthly report. Photographs and quarterly reports were also provided to ensure the waste was being handled to certification standards.

The use of recycled content in the EPA project resulted in two additional points, specifying that at least 10 percent of the materials used were made from already recycled sources. The concrete used in construction of the project was at least 25 percent fly ash
as compared to portland cement. Fly ash has traditionally been seen as by-product of coal-fired electric power generation and is usually sent straight to the landfill as waste. However, the benefits of using fly ash in construction were realized as early as the construction of the Hoover Dam, yet only now is being realized as a sustainable construction component. When used with concrete, fly ash increases the strength and ease of pumping versus conventional concrete on its own (Toolbase Services 2001). The steel used in the building is comprised of anywhere from 80 to 100 percent recycled metal. Even something as common as the carpet contains 40 percent post-consumer materials. The break rooms in the EPA building reuse tire and cork composites in the flooring and attention was paid to the amount of recycled material used in the office furniture as well.

Although there is no explicit credit available for the use of bio-based products in a project, the EPA building used several. Many work spaces and cabinets are surfaced with wheat-board panels while the interior construction of office doors are made from rice hulls promoting insulative noise reduction. Corn cloth and recycled polyester adorn furniture panels. Finally, bamboo flooring was used in several instances throughout the project, though not in enough volume to gain a point for utilizing a rapidly renewable material.

This project gained another two points for its use of local materials, both manufactured and harvested regionally. In order to gain the point for this credit, 20 percent of all building material must have been manufactured within 500 miles of the project site. The EPA project bettered the requirement with about 50 percent of its
materials by cost having been manufactured within the local range. Additionally, the credit requires that of the 20 percent percent locally manufactured materials at least 50 percent should be harvested locally. Again the EPA exceeded this bar in that 29 percent of its overall materials if not manufactured locally, were at least extracted as such.

The final point gained from materials and resources was attributed to the use of certified wood, meaning that of the lumber used in the project, an impressive 89 percent by cost was harvested and certified to Forest Stewardship Council standards (Forest Stewardship Council United States 1996). The Forest Stewardship Council is a non-profit organization committed to sustainable forestry practices. Any Forest Stewardship Council certified lumber ensures a more sustainable harvesting and replacement method than conventionally harvested lumber.

Indoor Environmental Quality

The EPA Region 8 Headquarters building obtained six out of a possible fifteen credits in the indoor environmental quality credit. Ventilation effectiveness, worth one point, was gained through the aforementioned floor ventilation system. The building was also designated as non-smoking. Careful attention was also given to the proper ventilation of the project during and post construction, at which point the entire building was flushed to eliminate any remaining construction contaminants. The installation of carbon monoxide detectors both within the building and in the parking structure also ensures proper ventilation.
The use of low-emitting adhesives and sealants through the EPA project enhanced the indoor environmental quality for the construction workers as well as the building occupants. As observed in the Ricketson case study, this attention to the well-being of both construction worker and end occupant in another important aspect of sustainable buildings; they should promote health for all, not only the end-users. Low-emission materials were also used in the carpet and composite woods and the aforementioned bio-based products used throughout the building and accounting for another two points in the category. The use of nontoxic cleaning products as well as indoor track-off or walk-off mats to reduce indoor contaminants.

Thermal comfort components comprised the final two points earned in indoor environmental air quality. The thermal comfort of the building's occupants relies heavily upon elements already discussed within this case study. The floor ventilation system, daylighting reaching 75 percent of interior spaces, exterior window shades, and views to the outside from 90 percent of spaces within the building all promote thermal and morale comfort. Due to concerns of safety post Oklahoma City bombings and September 11 attacks, operational windows were unfortunately not an option for this building project.

Innovation and Design

Similar to the Ricketson building, the EPA project obtained all five available points for innovation and design process through the same criteria met. As previously discussed, these represent the easiest credits gained throughout the LEED process. All
buildings included in the case studies for this research have obtained the maximum amount of points possible in this category, and therefore with the exception of a few minor details, the discussion of all included case study buildings will be nearly identical in this section. Although not explicitly detailed, the EPA building no doubt gained some of these extra credit points through the use of bio-based materials and educational programs such as frequent tours of the building itself. The inclusion of recycled materials used in the furniture is also another common point that is counted in innovation and design process. This category also gained full points in the design process itself which included a materials board, a building narrative, and scale models of the project.

**Cost**

<table>
<thead>
<tr>
<th>Cost of EPA Region 8 Headquarters</th>
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<tbody>
<tr>
<td>Square Footage</td>
</tr>
<tr>
<td>Total Cost</td>
</tr>
<tr>
<td>Cost per Sq. Ft.</td>
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**Building Context and Summary**

Details of this project were complicated. The building, owned by Opus and rented out by the United States General Services Administration (GSA), had to comply with several federal regulations regarding safety and security after major matters of national defense within the past two decades. Major negotiations between the GSA and the LEED project team were tackled with one of the largest issues arising from the lack
of operable windows. Operable windows are one of the easiest and most effective ways of efficiently regulating indoor thermal comfort; this is one of the elements of historic buildings that most adds to their overall implicit sustainability. However, as concerns of terrorists attacks on government buildings can hardly be ignored, the project was forced to adhere to the GSA regulation concerning operable windows and search for the points associated with this component through other innovations.

As far as lessons learned, the project cites many. Better communication with the City and County of Denver early on in the design process as well as regional issues are listed as areas of concern encountered throughout the course of construction. More positively, the project prides itself on the care taken to promote the well-being of both its construction members and end-users, citing “employee performance, satisfaction, and health” (BuildingGreen 2008) as some of the more important goals of the project.

Among the regional concerns cited, the most bemoaned was that not all achievable points were pertinent to Denver's location as far as climate and resources were concerned. The problem surrounding the continual irrigation of the green roof was one of the major regional issues the LEED program did not adequately address. The inclusion of the green roof however, can be seen as an innovative pilot project meant to monitor and ultimately decide upon the validity of such a feature in Denver’s cold semi-arid climate.

Along with the gamble taken on the green roof, this research perceived a limited number of shortcomings pertaining to regionality. While the project did earn credit for utilizing local materials, points were also awarded for green architectural elements that were imported from other countries. In a tour taken by the author, it was cited that the
recycled carpet tiles as well as the renewable bamboo accent panels throughout the building had been imported from China. This highlights a serious issue within the green building community. Further knowledge must be gained concerning the sustainability of a product versus its point of origin. In other words, is it overall more sustainable to use quickly renewable material from a foreign location than it was to use a local, non-renewable resource that did not have to be packed, shipped, and transported to the project site? Weighing these correctly can make a difference in the true sustainability of a building, yet these concerns are not addressed within the LEED certification process. It seems almost contradictory to award points for local materials while also giving credit for renewable resources that potentially cost more in transportation energy than they save by being green. This is an issue that merits a much more in depth analysis that unfortunately cannot be tackled within the scope of this research.

Overall it appears as though the EPA building relied heavily upon ways of producing sustainability rather than being sustainable through their design. This however, is no fault of the design team itself. Restrictions concerning safety imposed by the GSA and the orientation of the city of Denver itself prevented the incorporation of some of the most significantly inherent green elements a building can integrate. While the EPA project was limited in some of its design options, there were other aspects of sustainability that the building took full advantage of the credits that were available, from daylighting to the site selection. The project, while it could not control the layout of the city, did take advantage of an infill opportunity in the heart of Denver with easy access to daily amenities and multiple modes of transportation ultimately contributing to the
revitalization and perpetuation of the urban core. The EPA Headquarters stands solidly in a historically prominent location among some of the oldest buildings in the city. As a new building the EPA project took great care to fit in with the older architecture in the area rather than be immediately recognizable as a newcomer to the block. Indeed, the brickwork surrounding the bottom of the building does give the impression that the EPA simply added on to an older existing building. This was a calculated design feature that not only helps blend the new with the old, but also provides a sense of permanence and legacy for the EPA in this region.

4240 Architecture

![4240 Architecture Inc. and LEED facts. Photo courtesy www.buildinggreen.com.](image)

History

Not every historic building housed great moments and men of our past. Since the 1970s there has been a “new preservation” that gives credence to the monuments of everyday American life. New preservation values not only the birthplaces of our
presidents but the storefronts and schoolyards of the common citizen. While new preservation is an ideology best saved for another thesis, it is important to note briefly that this newly paid attention to the more “mundane” parts of our past bestows a greater appreciation for minority groups throughout history. Through new preservation, focus is shifted from the white and wealthy male and directed towards more marginalized populations. The places of the everyday provide a glimpse into the historical, and often silenced, lives of women and minorities; giving a voice where one has rested dormant for too long. A building does not have to be a shining example of a grand architectural style, did not have to house the signing of declarations, to be effectively and creatively saved. This same concept applies to adaptive reuse projects. The brick buildings of the everyday are as worthy for reuse as any palatial marble of the ornamental. This appreciation for the everyday was also a result of Americans attempting to cure their “rootlessness” (Datel 1985, 125).

The warehouse at 3003 Larimer Street (see Figure 20) exemplifies the ideology behind new preservation, or as this research will refer to it in this instance, new reuse. One of many warehouses strung along the River North (RiNo) district, the warehouse began its utility around 1903 as the Weigele Pipe Foundry and ran from 3001-3005 Larimer Street. Until about 1903, these lots remained empty while other buildings of industry grew around them. Although no reason could be found, it is interesting that of all the lots in the surrounding blocks, these were developed 15 years after the first building rush in the district. Sometime during the next 25 years after the foundry's construction, a competitor to Weigele's business finished construction of their own
foundry directly next to the existing foundry. The Thompson Manufacturing Company first appears in a late revision to the 1903-1904 Sanborn fire insurance map for Denver. It seems from these maps that for a period the two companies coexisted, although to what degree and how favorably cannot be determined. The 1929-1930 map shows a drastic change for the Weigele Company. Whether they went out of business or were bought by the Thompson factory is not known, but in this map, the Thompson Manufacturing Company is shown to now occupy Weigele's warehouse. The Thompson Company reigned over this and its former warehouse for about 53 years from at least 1929 to 1979. Using Cole's City Directories when the Sanborn maps were exhausted, in 1980 the Thompson warehouses which now ran from 3001 to 3025 Larimer Street sat empty for the first time in nearly 80 years. Since 1981 the buildings have seen a hodgepodge of uses ranging from a medical home supply business to a media production company. A favorite former incarnation of the current 4240 Architecture employees is the U.S. Recycling Industry listed in 1997; at one time the warehouse acted as a collection and holding facility for newspapers waiting to be recycled. In 2007 renovation of the Weigele and Thompson warehouses was completed and the new tenants, the architecture firm of 4240, Inc. moved in. As if solidifying the relationship between Denver and the architectural ideology popularized by Chicago and the World's Fair, 4240 Architecture is based out of both Denver and Chicago, the firm's name representing Chicago's latitude, 42°N, as well as Denver's at 40°N. The firm used to reside at 1621 18th Street across from Union Station in the Lower Downtown (LoDo) district not far from the current site of the EPA Region 8 headquarters. In an attempt to support a sometimes struggling
community in this specific area, 4240 chose this site on Larimer Street from a few selections around town. “The history is bit of a mystery...I suppose we gave life to a soon to be forgotten, undocumented structure...” comments Michele Decker of 4240 Architecture (personal communication, 7 April 2010) perfectly summarizing the importance and impact of new reuse.

Architecturally, because of its early date of construction, the foundry is part of the pre-1920s existing building stock so favored by preservationists and renovators alike. From its brick construction to its twenty eight existing vented skylights, this building's ultimate utility lies in its workaday appeal rather than the ostentatious ornamentalism so valued in more traditionally-valued historic buildings.

Building Process and LEED Certification

Up until this point, the case studies have focused on buildings utilizing LEED certification for New Construction (NC) with identical categories and points available. The 4240 Architecture project represents one of two adaptive reuse projects and uses the LEED certification program for Commercial Interiors, CI. The CI program is appropriate for “improvements of interiors of both new and existing office spaces,” showing this credit system is not specifically designed for adaptive reuse.

However, in this case the system for CI was used by 4240 to certify their adaptive reuse project. 4240 is an architecture firm with offices in both Denver and Chicago that works nationally with a focus in green building. Although a firm cannot be designated or
certified as a “green company,” 4240 prides itself on the number of sustainable projects it undertakes as well as its innovations in green design.

Overview and Predesign

Because of 4240's commitment to green design, it was especially important to the company to create a Denver office that would showcase the expertise thriving within the firm. A strong dedication to “creating architectural, planning, and interior solutions that integrate social, technological, and esthetic concerns” (BuildingGreen 2009) through their headquarters became a priority throughout the project. The firm sought to relocate from its pre-2007 location in Lower Downtown in order to establish community, both professional and neighborhood, in the up and coming River North area of Denver's central business district. 4240 was the first professional company to establish an office in this neighborhood, a trend others are sure to soon follow.

From the very initiation of the project, the 4240 team wanted to maintain as many of the architectural elements of the foundry as possible, incorporating beam, vents, skylights and cranes into the fabric of the office space. This attentive passion towards the historical integrity is of no surprise; the firm chose this site over a few other locations based on the unique character of the building in addition to the previously mentioned potential seen in the surrounding community. 4240 not only invested in its building, the firm invested in history and the neighborhood as well. Another unique aspect of this project; the contractor owned the building and the architectural firm commissioned was
the end-user. This provided for a very open and transparent line of communication in addition to similar goals of low cost and high efficiency.

Sustainable Sites

The reused foundry building gains five out of seven possible points for sustainable sites under LEED certification for CI. Note this is half the number of available points in the same category for NC. Also noteworthy is the ability to score half and double points for some CI credits showing leniency in achievements expected of CI projects as they are often associated with office spaces occurring in larger buildings in which the project team has little ability to make decisions that affect the building as a while. 4240 gained a half-point each for non-roof heat island and light pollution reduction. The reduction in heat island effect was gained through the use of materials with a high SRI value, controlling paved surface heat gain. Light pollution was reduced by ensuring nighttime light did not “leak” past the footprint of the building.

The project's investment in occupying a dense urban location and its surrounding neighborhood gained the 4240 foundry another point under the sustainable site category. The remaining three points in this category were gained through access and support of alternative transportation. Because of the foundry's central business location, access to public transit is exceptionally easy and convenient. The ever popular inclusion of bike storage and changing rooms gave the project its second transportation related point. Finally, parking availability gained this last credit. Frequently with CI certification there
exists an already crowded parking infrastructure, however, 4240 was able to maintain its own private lot that is frequently used for employee gatherings in addition to a car park. 4240 Architecture, showing dedication to cycling beyond what has been analyzed so far, purchased and maintains a fleet of communal bicycles in addition to instating a car-pooling program among its staff to reduce the building's over CO2 emissions.

**Water Efficiency**

In LEED certification for CI the water efficiency category proves limited. With only two available points, the 4240 project only gained one. The foundry gained this point for water efficiency by reducing water use by at least 20 percent through low-flow fixtures and toilets as well as automatic sensors on faucets. The project actually bested the LEED requirements and reduced the total amount of potable water used by 25 percent, yet failed to gain the only other available point in this category by reducing water use only another 5 percent for an overall reduction of 30 percent. The architecture firm has next to no water use involved in the irrigation of landscaping and thus again conserves water in this fashion. Even if the firm had extensive exterior landscaping, there are no points offered through the CI program for best landscape irrigation practices.

<table>
<thead>
<tr>
<th>Annual water use for 4240 Architecture, Inc.</th>
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<tbody>
<tr>
<td>Indoor &amp; Total Potable Water Use</td>
</tr>
<tr>
<td>Potable Water Use per Unit Area</td>
</tr>
</tbody>
</table>
Energy and Atmosphere

Out of twelve available points, the 4240 foundry gained six credits from the energy and atmosphere category. Because of the twenty-eight skylights already in place, the project easily gained a point for optimizing energy performance by reducing lighting power by 15 percent. Another energy optimization point was gained for the HVAC system that features seven-day programmable thermostats located out of direct sunlight and easily accessible to all building occupants. Another point was gained for advanced commissioning following the same five steps outlined in LEED for NC gained both by the EPA and the College of Law buildings. The 4240 project gained two points for energy use by measurement payments and accountability which allows for the monitoring of the amount of energy actually used by the building. Through the use of metering equipment installed, the HVAC system is closely monitored to ensure efficiency standards are being met. The final energy and atmosphere credit was awarded for the project's utilization of green power for 50 percent of its electricity needs. The firm offset four years of its energy costs through wind power purchased from Renewable Choice Energy.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Quantity</th>
<th>Cost</th>
<th>Cost per Square Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>169,000 kWh</td>
<td>$12,113.00</td>
<td>$0.85</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>1,440 MMBtu</td>
<td>$10,628.00</td>
<td>$0.75</td>
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</tbody>
</table>

<table>
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<tr>
<th>Total Annual Building Energy Consumption in Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Total</td>
</tr>
<tr>
<td>Total Fuel Purchased</td>
</tr>
</tbody>
</table>
Materials and Resources

The 4240 project gained nine of fourteen available points for the materials and resources used throughout the building. Because the project wanted to keep the open floor plan of the foundry, a larger amount of resources was saved as interior walls and partitions were not constructed. This in turn saved a good deal of money while further preserving the original interior and character of the building. That being said, the project gained one point for maintaining at least 40 percent of the non-structural interior. This also saved on construction waste, 75 percent of which when actually produced was diverted from the landfill. The building was able to use about 45 percent by cost of the firm's old furniture and furnishings from the previous Lower Downtown location which gained a point for resource reuse. The project gained another point for getting 35 percent of its material manufactured locally while achieving another credit for 10 percent of the materials being extracted within 500 miles. The final point in this category came from a long term commitment on the part of 4240 as the tenant. This long term lease ensures the building will be operated as intended long enough to realize the benefits incorporated through sustainable design elements. This ties into the advanced commissioning credit as the step that ensures tenant space is designed, constructed, and calibrated based on the end-user. Changing tenants early and often after the completion of the projects would change the overall efficiency of the building. This long lease limits the chances the building will be used in ways other than initially designed for in terms of sustainability.
Indoor Environmental Quality

This is the largest category in LEED for CI certification, offering seventeen points, ten of which were achieved by the 4240 project. One point was gained for monitoring the air quality during construction, showing again the growing importance of safety and well-being for the builders involved in the project, not just the end occupants. Four credits were gathered by using low-emitting materials as often as possible; in adhesives and sealants, paints, carpets, and composite construction materials. The lights, due to the skylights and the wide range of brightness variability throughout the building as a result, were highly controllable by the occupants and thus earned one point. The same controllability was found in terms of thermal comfort, which was carefully monitored in order to gain the most efficient methods for occupant comfort such as operable windows, fans, and personal lighting. Finally, daylight was found to be penetrable to over 75 percent of the spaces thanks in large part to the frequently mentioned skylights which gained the project yet another point. At least 90 percent of the interior spaces in the 4240 foundry have outside views which in a landscape such as Denver's adds to the morale and productivity of the building occupants while also earning the project its last point in the energy and atmosphere category.

Innovation and Design

This the category of LEED for Commercial Interiors that most closely resembles that of the New Construction certification credits. Innovation and design for CI can still
be seen as the extra credit of the LEED program, with the same amount of points available. Like the previous two case studies, the 4240 foundry achieved all five available points. In addition to the industry standards of employing a LEED Accredited Professional and using nontoxic, green cleansers in housekeeping, the 4240 project gained its extra points for performing much above the levels necessary to obtain points in green power, regional materials, and transportation. The project received the baseline points for these innovations, but raised the bar either in the quality, quantity, or method through which these credits were realized.

Cost

<table>
<thead>
<tr>
<th>Cost of 4240 Architecture, Inc. Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square Footage</td>
</tr>
<tr>
<td>Total Cost</td>
</tr>
<tr>
<td>Cost per Sq. Ft.</td>
</tr>
</tbody>
</table>

Building Context and Summary

This was an intriguing case study as it is so very clearly an adaptive reuse project yet it seemingly struggled to make the most of a LEED certification program that does not fully appreciate or address the issues specific to the renovation a reuse project entails. The architecture firm took great care in preserving the original and unique features of the foundry building yet only received one point for reusing the building itself. Adaptive reuse, referred to previously in the research as the holy grail of green building, should be
worth more than one point in a sustainable building certification system. It is chiefly due to this shortcoming that this research finds the LEED certification program ill-equipped to adequately approve and certify adaptive reuse projects. The 4240 project was also distinctive in its attention to promoting social sustainability as well as environmental.

The investment 4240 made in the emerging River North neighborhood will act as a testimonial to other businesses, the more flourishing this commercial district can become, the more residents the community will attract, and as a result this neighborhood stands to experience an intense period of revitalization within the next decade if not years. This attention to the non-economic and environmental side of sustainability should perhaps be worth more than the one credit gained through LEED for CI, however social constructs as reviewed previously, become difficult to quantify and are therefore absent from any form of standardization.

In terms of what this project means to the city of Denver, the foundry shows that its former occupants need not be unsinkable to warrant the protection and preservation of the building inhabited. The 4240 foundry building represents the most mundane of Denver's historic buildings yet also demonstrates the inherent utility these workaday structures can still provide for the city and its citizens. The foundry is also indicative of Denver’s contribution to the new preservationism that respects all old buildings regardless of their conventional historic importance. Although it is representative of a new movement in historic preservation, this building is also an archetypal traditional preservation case, belonging to the stock of buildings often seen as the paragons of the adaptive reuse movement. Constructed prior to the 1920s the foundry represents the type
of building that most preservationists are passionate about. With locally milled brick and ventilation skylights now so important to the building’s daylighting, the foundry is exemplary of the historical architectural elements that were inherently green; then designed out of common sense and necessity, now appreciated for efficiency and sustainability. The next and final case study, however, acts as a foil to this poster child and offers another effective take on the adaptive reuse project.

**Byron G. Rogers Courthouse**

![Figure 21: Byron G. Rogers Courthouse and LEED Facts. Photo courtesy www.archrecord.construction.com.](image)

**History**

After WWII, the United States sought to decrease its coastal vulnerability and bolster response times in matters of national security. Denver's nationally central location made it appealing to this heightened sense of threat from the outside world. So far into the interior of the country, Denver is protected in terms of surrounding landmass
which provides an infrastructural stronghold; an enemy cannot destroy that which it cannot reach. Following this logic, a mass migration of federal offices, departments, and personnel made their way to Denver in the 1950s, the impact of which is still seen and thriving today. Denver, possessing yet another nickname, has been referred to as the “Washington of the West,” as it has the country's second largest concentration of federal employees and offices outside of Washington D.C. Itself. It was this inward federal migration that catalyzed the 1962 groundbreaking of the Byron G. Rogers (see Figure 21) courthouse at 19th and Stout Street, one of many buildings on this and surrounding blocks of the Denver federal complex that houses the U.S. District Court and the U.S. Court of Appeals for the Tenth Circuit. Due to this large influx of positions and consequential employees, the existing building was quickly outgrown in this era.

Fulfilling the need to accommodate a growing federal sector, the GSA sought the firms of James Sudler Associates and Fisher and Davis to design a formalistic and modern masterpiece.

A style typified by the United Nations Complex in New York City, the lead project architects from James Sudler Associates created a building that typifies the Formalist sub-style of Modern architecture known for its flat rooflines and columnar supports that instill visions of symmetry, quality, and artistry to its beholders. Pulling inspiration from the older structures of the 1931 United States Custom House and the 1916 Byron R. White Courthouse and former main post office, the Byron G. Rogers Courthouse pays little other homage to its historical surroundings.
As early as 1887, the block now occupied by the Byron G. Rogers Courthouse was completely built up with residential structures. Such an early date shows this block was one of the very earliest areas of occupation within the city of Denver. Just north across Stout street from the first Denver High School and Public Library, this neighborhood is also just a few blocks shy from being considered part of Denver's first suburb Curtis Park, further showing its early prominence within the city. From 1890 to 1893, the block remained fairly unchanged from the 1887 view. The same row houses facing 19th street on the corner of Stout still stood in 1893 just as they had 1893 just six years prior. Only a few blocks away along Curtis Street, the only non-residential structures belonged to a carriage company and a horse stable. From 1903-1904, the block remained a largely residential area, the row houses on the corner of 19th and Stout are again still present. A former residential structure on the block at this time however began offering “Lodgings” and the transformation of the neighborhood slowly began. A plumbing office now occupies space next to the row houses and the stable on Curtis evolved partially into a sign painting shop as well as additional lodgings for transients and travelers alike. The surrounding blocks mirror this change from purely residential to combined commercial. Bike shops and awning factories slowly began to emerge during this time. The shift seen in the landscape of the neighborhood from 1928 to 1930 is incredibly drastic. The block at 19th and Stout is now more heavily commercial than residential, although the row houses on the corner remain among the few scattered dwellings still standing. The block is occupied during this time by a filling station, a
parking lot, multiple garages, the Carpenter's Union Lodge, and a few other various offices. The plumber's shop next to the row house transforms into a car wash for the adjacent fill station at this time as well. The metamorphosis of this block is indicative of the nation-wide shift to the personal car. A once exclusively residential area supported by a streetcar line became step by step a block largely dominated by car-oriented structures. A Sanborn map from 1929 to 1951 shows this shift in even greater contrast to the past as the block is now completely swallowed up by parking lots and garages. Two residential holdouts remain until construction begins on the courthouse in 1962, the steadfast corner row houses and the original holder of the 1929 Stout Street address, a two story family dwelling absolutely engulfed by asphalt and automobiles. Although the courthouse replaced the previous structures of this very historic area of Denver, the replacement itself can be considered a part of the neighborhood's history as well. Constructed after WWII when building materials and methods became more about quick quantity than traditional quality, the case study of the Byron G. Rogers Courthouse is an analysis of how to reuse the less than ideal existing building.

Building Process and LEED Certification

Nearly a fatality of the wrecking ball, the possible cultural heritage of the Byron G. Rogers Courthouse was questioned just in time to save the building. Completed in 1965 in the Formalist tradition, many Denverites saw and still see the building as a modern eyesore devoid of character and historical value. However, it was recognized at a
crucial point in discussions concerning the future of the building that noteworthy events have played out within the walls of the courthouse such as the trial of the Oklahoma City bombings perpetrator, Timothy McVeigh.

Architecturally, the courthouse is quite noteworthy. The complex is actually comprised of three components, a low-lying courthouse, an 18-story office tower, and a landscaped courtyard tying the two structures together. In 1999 when the General Services Administration, GSA, first began alternations to the complex it was realized that not much was known about the building and its character-defining style. The initial renovations were intended to answer a growing list of security concerns, and much like with the EPA building, the renovations carried out on the building were required to adhere to strict security guidelines instated by the GSA. To better understand the impact of these security guidelines on this potentially historically significant building, the GSA commissioned a study to analyze the architectural context of the courthouse. Published in 2003, the results of this commission were entitled “Growth, Efficiency, and Modernism: GSA Buildings of the 1950s, 60s, and 70s;” for it was not just the Denver courthouse that had presented itself as a void of knowledge to the GSA. Across the country federal buildings constructed after WWII were up for either demolition or renovation and the government as well as civilians needed a better knowledge base for discussing these structures. Adorned with works of local public art, the Byron G. Rogers Courthouse although not yet fifty years old, offers an important glimpse into Denver's past and in doing so was worth renovating. It should be noted that this adaptive reuse project is not typical. The building has simply undergone a revitalization, but its same
utility has remained in tact. Also, the building's young age makes it a different type of adaptive reuse project than most expect to see.

Overview and Predesign

Like the EPA building, the Byron G. Rogers Courthouse had to balance its LEED certification goals with its need to uphold standards of GSA security. In addition to these stipulations, the courthouse was also a pilot participant in the pre 2004 LEED for Existing Buildings or EB program. In fact, the Byron G. Rogers Courthouse became the first GSA-owned gold certified project under the new LEED category. Because the original integrity of the building was to be preserved, most of the renovation that took place during this project occurred indoors. Cherry-stained maple details and black granite finishes contrasted with white gypsum walls for a “tuxedo” effect which was a vast improvement over the drab 1960s existing fixtures. The public art installed in the complex was an existing feature the project sought to maintain; the art projects are so valued to the building that the GSA allotted $50,000 out of the original construction budget for the installations and feature multiple pieces from the Denver sculptor William Joseph and Edgar Britton. The public art tradition was carried into the present by a piece commissioned through Jim Campbell. Ultimately is it of great interest to analyze the procedure of this certification as it represents one of the first projects to achieve their credits under the EB program.
Sustainable Sites

The Byron G. Rogers Courthouse is located within the central business district of Denver. High density, mixed-use, and access to alternative modes of transportation all contribute to the general sustainability of the site. Very little demolition took place during this project and so the reuse of the existing structures was very nearly extensive. These factors contributed to three out of the possible sixteen points for sustainable sites, with one point gained for site selection and two points gained for urban redevelopment, although this project was again not the traditional redevelopment undertaking. Two more points were gained for the location's aforementioned access to public transportation and bicycle friendly design meaning of course bicycle storage and facilities for commuters were provided. Because most of the renovation on this project took place within the structures of the complex there was very little disturbance in terms of the native and landscaped vegetation cover, adding two points to the courthouse's scorecard. Finally, the last two of the eleven points scored total in the sustainable sites category were awarded for the already developed and therefore green site as well as the the overall plan that used the existing exterior and minimized the introduction of new chemicals into the site.

Water Efficiency

This category can provide limited options for existing buildings as often the existing water infrastructure can be difficult to replace while still reusing the old system.
In this case, it must be calculated what has the greater benefit, a new water infrastructure or the embodied energy saved in keeping the old. Through the typical use of low-flow fixtures and faucet sensors, the courthouse appears to have little conflict in this area and gained two points for reducing water usage by 20 percent. However, due to the large amount of landscaped courtyard, the project did not gain any credit for water efficient landscaping which ultimately allows an opportunity for additional water usage reductions. Note that the information contained in tables for the previous case studies in water efficiency and energy and atmosphere were not available for this project.

Energy and Atmosphere

Existing Buildings can gain up to twenty two points in the category of energy and atmosphere, the most of any LEED program discussed within these case studies. Often with existing buildings there is little the project team can alter about the exterior of the structure so more points must be offered in areas the team can control. Out of a ten possible points for overall energy reduction, the courthouse gained eight points for optimizing energy performance by 40 percent. This was done through a comprehensive building operation plan that dictated the workings of the HVAC system. Lighting controls also contributed to the achievement of this point. Commissioning and maintenance accounted for three of the total fifteen points gained in this category. Continuous monitoring and modification of the indoor atmosphere in addition to standing maintenance contracts and comprehensive preventative maintenance programs ensured
these points for the Byron G. Rogers Courthouse. A point for additional ozone protection was gained by ensuring the HVAC system did not emit HCFCs or Halon into the atmosphere. The project gained two points for measurement and verification which is yet another way of monitoring the efficiency of the building and providing the tenant with means to self-measure and report based on occupancy needs. Finally, the courthouse gained its last energy and atmosphere point from offsetting its energy use through green power credits.

Materials and Resources

Of ten possible points in this category, the courthouse received only two credits, one for recycled content and one for certified wood. In order to gain credit for recycled content the project had to ensure that at least 10 percent of the total cost of materials used throughout the course of the project was recycled. Another point would have been gained had the courthouse managed to use 20 percent recycled content. The point gained for certified wood was granted for the use at least 50 percent by cost of wood products were FSC Certified.

Indoor Environmental Quality

Another large category as far as EB certification goes, indoor environmental quality offers a maximum of eighteen possible points, ten of which were achieved by the Byron G. Rogers Courthouse project. One credit was gained for simply monitoring
carbon dioxide levels within the building. Just as seen in the other case studies scenarios, another point was gained for rightly ensuring proper indoor environmental quality not just for the end users but the construction works throughout the entirety of the project as well. The courthouse received a staggering six credits for green housekeeping, a point each for entryway systems, mixing areas, high volume copying, low-impact cleaning and housekeeping, low environmental impact disposable products and finally initiating a low environmental pest control policy. In LEED certification for NC, these six credits were generally rolled into one point under innovation and design. The impact of having separated the credit into seven parts will be discussed briefly in the conclusion of this case study. Another point was gained for the permanent monitoring system designed to keep a watchful eye on the thermal comfort of the building, yet no credit was gained for actually establishing thermal comfort itself. The last point in this category was gained through the implementation of contemporary indoor air quality practices instated by ASHRAE 62-1999 which deals with adequate levels of sound transmission and acoustics with the goal of reducing background noises from HVAC systems that could potentially disrupt proceedings within the courthouse.

**Innovation and Design Process**

The Byron G. Rogers Courthouse is the only case study project explored that does not score all five of the points available through innovation and design. The first point was gained for using low-emitting materials such as adhesives, sealants, paints, and
carpeting; this time credits that were usually worth up to five points in LEED NC are consolidated into one innovation point. The same action has been applied to the single point gained for the encouragement of public transportation use. The courthouse project does gain a point for using the building as part of an education program like the other buildings analyzed through the case studies but does not receive a point for the credit simply titled “innovation.” The loss of this point stems from the some of the GSA guidelines that ultimately limited the creativity in which teams could approach the project. Finally, the last innovation point was gained for employing a LEED Accredited Professional to assist in the design and certification process.

Cost

<table>
<thead>
<tr>
<th>Cost of Byron G. Rogers Courthouse</th>
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</thead>
<tbody>
<tr>
<td>Square Footage</td>
</tr>
<tr>
<td>Total Cost</td>
</tr>
<tr>
<td>Cost per Sq. Ft.</td>
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Building Context and Summary

Ultimately this project created most of its sustainability through extensive monitoring. More than half of the points gained by the Byron G. Rogers Courthouse were a result of commissioning and reporting projects set in place to assure the efficiency of the green technologies utilized in the project. The LEED certification process for EB leaves much to be desire in the way of simply being sustainable as many of the points
come from procedural processes and paperwork. Certification though this program relies
much too heavily on green housekeeping and on measurement systems intended to ensure
efficiency. In actuality, these credits provide “low-hanging fruit” in terms of easily
obtainable points. The critique of monitoring processes and green housekeeping is that
these elements have no impact on the actual construction and architecture of the building.
How a building is cleaned does not make the structure itself green. Certainly, these are
sustainable practices that are carried out within the property, but they have little to do
with the buildings itself. Vernacularly speaking, this adaptive reuse project takes
virtually no cues from the environment around it, both ecologically and architecturally,
which can be attributed to the original design of the building rather than a lack of
innovation from the project team. This is an example perhaps of why post WWII
buildings are not more highly regarded for preservation and adaptive reuse; it was not
that the project team did not search out ways of incorporating the climate and vernacular
elements into the structure, but rather they simply worked the best they could with what
the building had to offer. Certainly when the courthouse and the 4240 foundry are
compared the benefits of pre-1920s construction have a greater impact on the overall
sustainability of the building. The 4240 project started out with an inherently sustainable
shell using local materials a regional design in which green components could be easily
incorporated and efficiently function. The courthouse on the other hand, was made
during an era in the United States in which synthetic materials were valued over the
natural; for example, the use of gypsum wallboard over brick. The courthouse was also
constructed without consideration of the local climate or site situation, which seemingly
by chance happens to face south, but offers few windows to take advantage of solar passive heating during the winter months. This project differs from the foundry on a fundamental level as the courthouse was simply not built with regional efficiency in mind, but rather built when cost and time efficiencies were more highly valued. Post WWII construction was geared towards quick and widespread development, and the courthouse as a product of the 1960s exemplifies this era.

Certainly the most sustainable aspect of this project was the basic reuse of an existing building. The renovation alone of this project automatically makes it more environmentally savvy than demolishing the building all together. Still many of the additional “green” elements of the building appear too dependent upon documentation and self-reporting; components of green building that really have little to do with high performance and sustainable design. In all due respect, the courthouse project was a pilot program, an experiment in LEED certification for Existing Buildings, and perhaps this building stock is not the most lucrative canvas on which to practice adaptive reuse. All leniency aside, the fact remains that in terms of sustainable performance and certification, the Byron G. Rogers Courthouse is the least impressive of the four case studies.
Chapter Five: Discussion

Case Studies Summary

Ultimately it is seen that green buildings in Denver are quite sufficient in creating sustainability, but struggle with retaining and reusing lessons learned from historic buildings. The two new construction projects rely heavily upon energy-saving appliances and efficient technologies to achieve LEED certification. While certainly a step in the right direction this accomplishes little in achieving high levels of true sustainability. This research uncovers an unnerving trend in the LEED certification process that promotes ways of creating green rather than actually achieving some level of sustainability. It is important to make this point clear as it is a central finding of the analysis of green buildings in Denver, Colorado. To further illustrate, many LEED points available are easily obtainable not through the act of the greening the building itself but rather through including such elements as bike storage, showers for cyclists, access to public transit, furniture made from recycled material, systems that monitor the efficiency of the building, and nontoxic and environmentally friendly cleaning products. While these are all worthwhile components that contribute to more sustainable practices, they have little impact on the sustainability of the building itself. In reality, how green is a building that uses non-renewable resources and all new materials built upon a former nature habitat miles from the nearest bus line that gains its largest component of sustainability from the
use of nontoxic cleaners? Builders must be held more accountable for the sustainability of the building, not the practices that take place inside. It is in this way the current LEED certification process endorses creating sustainability rather than achieving it.

The University of Denver College of Law, or Ricketson building, exemplified a modest balance between new construction and traditional architecture. This building did heavily utilize such methods of creating sustainability, such as the project favorite of bike storage and showers, but it also included the extensive use of brick and careful attention paid the site situation to best take advantage of daylighting throughout the building. The points gained by the Ricketson building seemed the most diverse with credits earned evenly across the board from stormwater management to indoor thermal comfort. The project also had a level of innovation not perceived in the other case studies. The use of copper in the project, although originally intended to match the existing buildings on campus, ended up as a unique way of minimizing the heat island effect. As the copper ages and turns green it becomes less reflective than conventional roofing material and therefore contributes less to heat gains typically seen in urban areas. Overall, the Ricketson building presents itself as an ideal new construction project if adaptive reuse is not a viable option.

The EPA Region VIII Headquarters also presented itself as a model of green building. This project however, was bound by certain safety restrictions set in place by the GSA. These restrictions inhibited some of the historic methods of achieving sustainability, most notably the use of operable windows in aiding thermal comfort and total building ventilation. This project also realized the importance that site situation can
play in efficiently heating and lighting a building, but ultimately could not take full advantage of their knowledge of solar benefits as the grid of downtown Denver is at such an angle as to prevent solar optimization. This being the case the EPA project was still sure to make the best out of what daylight they could harness regardless of the orientation of the building. The care taken to design the building as a part of the history and character of the surrounding area stands out in this project. Although there is no ecological sustainability achieved in constructing this building to be a part of its architectural environment, this aspect of the EPA project does contribute to the overall social sustainability and sense of tradition in Denver’s central business district.

Despite some shortcomings, overall the Byron G. Rogers Courthouse, constructed in the 1960s outside of the “golden era” for historic preservation, was a forerunner for its participation in the pilot certification process for existing buildings. Though the project was, as aforementioned, perhaps the least impressively green project analyzed, it should receive credit where it’s due for taking a risk on a new LEED certification process. The project no doubt anticipated the issues encountered in testing a new procedure, yet continued anyway. The courthouse used this certification because the project did not take on major renovations, but focused on efficiency and indoor renovations instead.

Obviously, the reuse of the warehouse now occupied by 4240 Architecture uses the highest degree of historically green elements since it is a completely adaptively reused building originally built before 1920. Although the warehouse likewise used many green gadgets to achieve its certification, this is the only project to take full advantage of the already existing brick, skylights, and architectural features of the
originally purposed building. It is of no surprise then that this was also the cheapest project per square foot. Every element and design component of the original building was an exercise in economy.

### Comparative Costs

<table>
<thead>
<tr>
<th></th>
<th>University of Denver College of Law</th>
<th>EPA Region VIII Headquarters</th>
<th>4240 Architecture, Inc.</th>
<th>Byron G. Rogers Courthouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square Footage</td>
<td>237863 sq. ft.</td>
<td>257000 sq. ft.</td>
<td>14200 sq. ft.</td>
<td>248000 sq. ft.</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$65,000,000</td>
<td>$90,000,000</td>
<td>$1,349,000</td>
<td>$45,000,000</td>
</tr>
<tr>
<td>Cost per Sq. Ft.</td>
<td>About $273 per square foot</td>
<td>About $350 per square foot</td>
<td>About $95 per square foot</td>
<td>About $181 per square foot</td>
</tr>
</tbody>
</table>

*Figure 22: Table showing comparative costs of the four case study buildings*

In the previous case study sections, cost was only addressed in the form of a brief table. This section compiles all the cost information pertaining to each case study and through this consolidation facilitates further analysis and comparison. The first noticeable feature of the table above shows the buildings chosen, with the exception of 4240 Architecture, were of relatively similar sizes. Ranging from about 230,000 to roughly 260,000 square feet, the comparable area of each project makes for a more meaningful cost analysis in terms of price per square foot. Although the 4240 foundry is a great deal smaller than the other three buildings, the price per square foot measure will still provide an accurate point of comparison between all four case study buildings.
The total cost of each project acts more as a reference than as a tool for analysis; again looking at 4240 Architecture, it is no wonder this project was the cheapest as it had the least area to renovate or construct. It is for this reason that the cost analysis is based on price per square foot as it normalizes the size of each building and ensures the validity of comparison between the projects. The cost data provided does not include such goods as furnishings or elements installed by the end user, the numbers given account purely for the construction costs. The cost does not account for LEED certification fees either. The following is an overview of the cost of each project as it relates to the other case study buildings.

Most notably, the 4240 Architecture, Inc. adaptive reuse of an old foundry building has the cheapest price tag among the other projects explored for this research. True, this is the smallest building, but as explained above, the price per square foot accounts for the discrepancies in project size. At about $95 US dollars, the 4240 foundry exemplifies the notion that adaptive reuse projects are not only environmentally friendly, but also economically viable as well. This is a logical conclusion as the foundry project kept so much of the original structure and design elements that not many new materials and resources were needed to renovate the warehouse and give it a new life. The quality in which the foundry was built allowed the building to survive nearly a century until its current use as an office space for the architectural firm. This analysis confirms the standing recognition that pre-1920s buildings are ideal for historic preservation and adaptive reuse alike; thanks in large part to the longevity and durability of the historic construction materials.
In direct comparison then to the 4240 Architecture project, consider next the Byron G. Rogers Courthouse. As previously explored in depth, this post WWII building proved to be a challenge in terms of combining elements of historically green building methods and modernly certifiable sustainable practices. And while still a good deal cheaper to renovate that it was to construct either of the two new buildings explored in this research, the courthouse cost nearly double that of its fellow adaptive reuse project. At about $181 US dollars per square foot, the courthouse proved to be the second most economical buildings while also being the second largest. The relationship between large size and relatively low cost in this project helps again to validate that prices are simply not higher because a building is larger. The price tag as well as the size of the courthouse does indeed further substantiate the economic viability of adaptive reuse projects. The two new projects explored have comparable areas, yet are at least $90 more expensive per square foot.

Take for example the University of Denver College of Law building. At 237,863 square feet the building cost nearly $273 US dollars per square foot and started construction from a clean slate. Built on land that was previously occupied by parking lots and dormitories, the Ricketson building was innovative in its site situation, technologies, and even employed some historic building methods in its new construction allowing it to work with its environment instead of against it. But these design innovations could not be built upon an existing shell. The materials that were reused or recycled in this project did not come from former incarnations of the building itself but from other construction projects and sources. The second most expensive project of the
group, the law building enforces the results found in the adaptive reuse projects. Starting
a building from the ground-up costs more than renovation.

The same result was again found in an analysis of the EPA Region VIII
Headquarters project. The 257,000 square foot building was the largest area of any of the
projects researched and cost $350 US dollars per square foot, awarding the highest price
tag to this building. It can be conceptualized that the project cost so much more than the
others because of the strict safety precautions enforced by the GSA that dictated many of
the design elements. The same presumption could also be made about the Byron G.
Rogers Courthouse as it was held to these same GSA standards, although this research
could not completely validate this idea, which might act as an avenue for further analysis
at a later date. Also because the EPA is charged with the protection of the environment it
is also feasible that the project went above and beyond in terms of purchasing sustainable
materials, which often have higher up-front costs, although if this were truly the case it
seems as though a higher level of LEED certification might have been achieved.
However, this research confidently finds that again the new construction project proved
to be more expensive than those that were reused. In fact renovation of both the 4240
foundry and the Byron G. Rogers Courthouse combined were cheaper than the EPA
building or the law building individually.

Cost data can be difficult to access, so breakdowns and itemized lists of
expenditures were not made available for the purposes of this analysis. This research
dealt with two buildings associated with the federal government, further decreasing the
availability of detailed cost reports. In general a more itemized approach in a cost
analysis would provide a much clearer picture of the true economy of green buildings, with particular attention to the viability of adaptive reuse projects versus those of new construction. However, in working with the available data, a fairly clear picture of the cost of the buildings researched is presented. As stated above, both adaptive reuse projects analyzed combined cost less than either of the new construction projects. Anecdotally, this means specific to this study of four individual buildings in Denver, Colorado that with adaptive reuse projects you can renovate two existing structures for the price of constructing one new building from scratch. The cost data provided confirmed this as the adaptive reuse projects studied cost an average of 55.7 percent less than the newly constructed buildings as calculated from the table provided above.

Overall, it should be noted that there are certain challenges presented by any cost analysis attempt. Specifically with buildings, the growing interest in cost, specifically life cycle cost analysis, “may be attributed to a related and growing interest in ‘green’ building technologies that rely in part on the durability and sustainability of building materials to minimize environmental impacts” (Hoff 2007, 5). Popular and meaningful as life cycle cost analyses are, in their attempt to put a price tag on a building from cradle to grave so to speak, they are exceedingly difficult to quantify. While “many building professionals are increasingly interested in learning about the life cycle costs of key building components, few tools currently exist to help them compare the almost unlimited choices of competing building materials” (Hoff 2007, 5). Simply stated, life cycle cost analyses are overwhelming in their complexity and variability, making the utilization of such means of analysis somewhat unreliable and certainly beyond the scope
of this research. Consider also the intangible components often included in a life cycle cost analysis, “for example, a historic water meadow worth $25,000, or is it worth $500,000 because of its environmental importance? What is the value of stress-free travel to work in the morning?” (MindTools 2010, ¶5). These factors no doubt contribute to the overall cost of a building, yet are in many ways impossible to accurately quantify. So, while in figuring the true cost of these four buildings components such as maintenance, transport costs, and the true cost of the impact on the environment would help reveal the actual economic and environmental costs of each project, these variables prove too complex to consider within the context of this research. It is due to this complexity and uncertainty that simpler form of cost analysis was chosen in terms of total cost per square foot.

Ultimately, as discussed previously in the adaptive reuse section of Chapter Two, adaptive reuse projects, although found to be more cost effective in this research, are not always the most viable economic and environmental options. Recall that an evaluation of the building and its integrity must be performed and the outcome of such an evaluations ultimately affects the feasibility of the project, both in its design and financially (Rabun 2009). If it is determined an adaptive reuse project will be too expensive, or will simply not meet the needs of the project is is crucial to again realize that “just because an old factory building is located in a great spot, doesn’t always mean the adaptive reuse project makes sense” (Watts 2006, 10). The strongest argument for adaptive reuse comes from the aforementioned “scarcity of prime real estate and the soaring raw material costs” (Watts 2006, 9), but when the cost of the renovation project becomes greater than
the cost of a new building project, the economic benefit of adaptive reuse is lost. It is important to realize the economic feasibility of adaptive reuse projects while avoiding the romanticism of renovating a historic building (Watts 2006). Again, the question is raised, if adaptive reuse is the cost-effective cornerstone of the green movement, why is it not more prevalent in the building sector? Perception play a large part in the viability of these renovation projects, often if something seems too costly, that reputation can be difficult to dispel (Bluestem Interactive 2010).

**Denver: Once and Future**

Having extensively looked at the past of four green buildings in Denver, the research will now use the information gathered from the case studies as well as other outside resources to summarize the current state of sustainable buildings in the city. The location of the buildings themselves as well as their sustainability goals will be discussed. Then, based on the location of both LEED certified buildings as well as the location of currently vacant structures, some exploration concerning the potential for reuse in these vacant locales will be undertaken. In this respect, an economic analysis will show the potential economic and energy savings gained in renovating the vacant buildings under sustainable guidelines. Finally, this research will briefly discuss green building practices in other cities in terms of certification, process, and policy as well as what Denver can learn from these cities; taking great care to also outline Denver's successes.
Denver Today

Ranking cities on their varying levels of sustainability became increasingly popular in the last decade. Quantifying such aspects as air quality, recycling, and transportation, these city rankings motivate citizens and city officials to improve their green efforts while also acting as promotors of the cities in an attempt to attract new businesses and residents. There are a number of organizations that compile these lists on a regular basis, whether it be every year or two to five years. In 2008, Sustain Lane, one of three of the more well known and trustworthy rankings discussed in this research, places Denver as the 11th most sustainable city in the United States. What is especially interesting in terms of this ranking, considered every two years, is the inclusion of the category “Green (LEED) Buildings” in which Denver is ranked 5th, pinpointing the city as one of the more ideal locations in which to study sustainable buildings. Sustain Lane considers this ranking to indicate that Denver is “leading” the green building movement in the United States. Also intriguing, as far as location within the nation goes, Denver is the highest sustainably ranked inland city; those in the top ten are all coastal. Another ranking, this time performed by the United States Environmental Protection Agency, ranks Denver 4th in the nation for energy efficient buildings, saving $29.6 million in energy costs with 136 Energy Star Buildings. The Energy Star designation is awarded by the EPA to “commercial buildings that rank among the top 25 percent in energy efficiency compared with similar structures” (Woody 2010, ¶2). Released March of 2010, this most recent ranking places only Los Angeles, Washington D.C., and San Francisco
ahead of Denver in terms of efficient buildings. Demonstrating yet again that Denver proves an intriguing location in which to study sustainable, high performance buildings. The final ranking report discussed in this research comes from the Natural Resources Defense Council. The NRDC ranking is certainly the most in depth as it measures the most constructs with widest breadth in categories. Considering such factors as standard of living, green space, environmental standards and participation, as well as green building, Denver ranks 9th overall for large cities over 250,000. In terms of green building, however, the NRDC awards Denver its lowest ranking out of the three explored reports included in this research, with 14th place. Although still in the top fifteen, which is often associated with some bragging-rights, Denver most likely loses points in this ranking because of the incredible amount of suburban sprawl that faces the city. The NRDC ranking assigns points based on number of LEED certified projects within the city, the number of Energy Star labeled buildings, as well as extra points for LEED buildings that obtain platinum certification, a level that only one of the forty six certified buildings in Denver achieves. The NRDC also awarded points for local and regional green building programs not widely known. Overall, Denver consistently ranks within the top fifteen large cities in terms of general sustainability and more specifically in green building. In terms of location, Denver ranks as the most sustainable inland city, second only in the NRDC green building ranking to Austin, Texas, which at just under four hours driving time and about 200 miles from the Gulf of Mexico, while not coastal, is not incredibly land-locked either.
These rankings divulge Denver as a key urban competitor among the major United States cities such as Chicago, Los Angeles, and New York. These reports also highlight Denver's importance within the middle of the country; while there are more dominant cities along the coast in terms of population, global importance, and sustainability, Denver still acts as the frontier outpost it was settled as over 150 years ago. It is the anchor of the American interior. No other southwestern, midwestern, or mountain west city successfully competes with Denver's sustainable innovations and certainly not its green building industry. If doubt existed as to Denver's worth as an area of research with particular attention to its green building, that uncertainty must ultimately be reconsidered and dissolved after reviewing these sustainability rankings.

**Spatial Analysis of LEED Buildings in Denver**

A cursory glance at the map of Denver LEED certified projects shows the buildings clustered around the central business district (*see Figure 23*). A spatial analysis (Average Nearest Neighbor Distance and Moran's I) conducted in ArcGIS however concluded that statistically, that LEED projects are dispersed, not clustered and there is less than a 1 percent chance that this spatial pattern is result of randomness. This appears counter-intuitive. Visually, it is easily seen that there are many more LEED certified and registered projects in the central business district than anywhere else within the city. This result is gained from the outliers that occur as locations in the Denver Technological Center, a secondary business district about 15 miles southeast of downtown Denver.
Only a portion of the area considered the Denver Technological Center is actually within the boundaries for the city and county of Denver, so LEED projects within this area were not included in this research. Had they been considered it is quite possible that two clusters of LEED projects would have been observed. Although no spatial analysis was carried out concerning what factors explained the location of the projects, visually, we can again see that population and business density will most likely be the key variable in explaining LEED project location. Buildings are certified where there is the population and capital to support the project in terms of money and patronage. While this outcome should come as no surprise, the spatial analysis was helpful in gaining a better understanding of the green building landscape within city boundaries.

Another cursory spatial analysis was conducted, mapping the location of vacant buildings. The city and county of Denver keeps a frequently updated document of vacant
buildings reported and monitored. In this instance, there is statistical evidence to support that which can be gathered from a visual analysis of the location of these vacant structures. These vacancies appear to be clustered and indeed there is less than a 1 percent chance that the building locations take this spatial pattern by chance or randomness. Again, although a statistical analysis was not preformed in order to define predicting variables of this spatial pattern, visually and with some knowledge of Denver neighborhoods some conclusions can be intuitively made.

The highest concentrations (see Figure 24) of vacant buildings occur in the neighborhoods of Sun Valley, Five Points, and Montbello. Informally, these neighborhoods are seen as the “rough” part of town; the presence of housing projects, poverty, and high crime rates is responsible for the attitudes Denverites have towards

Figure 24: Overview of study area, gray dots represent all vacant buildings
these communities. Sadly, then it is not surprising to see clusters of vacant buildings within these areas in which the chance to buy, repair, and renovate these buildings is limited by income and the socio-economic standings of local residents. But these neighborhoods' greatest blight could be their single greatest asset. With ninety six vacant buildings across Denver and clustered in these struggling neighborhoods the opportunity to renovate and adaptively reuse the vacancies to bolster community and local economy alike becomes something not to be ignored. The renovation of these buildings has the potential to help the community create a better sense of place, a safer neighborhood, and a more economically viable local landscape. Careful to distinguish between neighborhood revitalization and gentrification, two large subjects which merit theses of their own, not just the reuse, but the sustainable reuse of these empty buildings could have a profound and lasting effect on the neighborhoods so pocked by decrepit and trespassed buildings.

Next, consider the cost of the sustainable reuse of these vacant buildings. Recall as of January 2010, there were 96 vacant buildings throughout the city and county of Denver, again, most of them clustered within neighborhoods commonly afflicted by high poverty and crime rates. The cost of green building is admittedly more expensive initially, but the bulk of this extra cost comes from the increased time spent planning and designing rather than from the materials themselves (Kats 2003). This extra cost however, is dramatically less than is often perceived and the “average premium for these green buildings is slightly less than 2% (or $3-5/ ft²)” (Northbridge Environmental Management Consultants 2003). This 2 percent upfront premium however, results in an
overall life cycle savings of 20 percent of the total construction cost. Stated otherwise, in the long run, building green is like applying a 20 percent off coupon to the overall cost of a building while only using 2 percent of that overall cost to receive the coupon in the first place. All things considered, this citation determines that green building saves 18 percent in terms of construction cost over the entire life cycle of the building. Up until this point, this conversation has only made the distinction between non-sustainable buildings and conventional green. Consider then the drop in cost when adaptive reuse is entered into the equation. This thesis has shown from its exploration of conventional green building and adaptive reuse that, at least in this situation, specific to Denver, Colorado, that sustainable building through adaptive reuse is more cost effective. Recall that in terms of price per square foot, the adaptive reuse case study buildings cost 55.7 percent less than the conventional newbuild sustainable buildings. Therefore in analyzing these vacant buildings it becomes clear that tearing them down to build anew would cost more, more than the additional 18 percent cost from conventional to conventional green, than it would take to renovate or adaptively reuse these vacant buildings to green standards.

These cost predictions are hypothetical at best and it should be realized that calculating building cost is not an easy or precise thing to do. In reality there are many factors to consider and some should be regarded as having more impact than others; this is all dependent on region, material, and overall environment. The goal of this research was not to provide absolute numbers in terms of costs and savings, but rather to invoke intelligent thinking towards the potential costs and savings of green construction in only one location. Through this research and others, it can be reasonably concluded that
conventional newbuilds cost more than sustainable conventional, and newbuilds cost more than adaptively reused sustainable buildings. Reused historic buildings renovated to LEED standards are the most cost effective and sustainable methods of green building in Denver, Colorado.

**Adaptive Reuse in Policy**

So then, if adaptive reuse acts as the true cornerstone of the green building movement, where is its place in policy? Something so beneficial must surely be used when and wherever possible. However an analysis of the planning policy results in a limited number of municipalities with any sort of legislation in place that actually addresses adaptive reuse. Among the few included in the list, a brief overview will be provided for Los Angeles, California, Tyler, Texas, and the state of New Jersey in an attempt to demonstrate that policy can effectively and successfully address adaptive reuse through policy.

Los Angeles has perhaps the most well-known mitigation practices towards adaptive reuse. A subdivision of the city's municipal code that has been in effect since December of 2001, the policy goals are to “reduce vacant space as well as preserve Downtown's architectural and cultural past,” while also encouraging “the development of a live/work and residential community downtown” (Los Angeles Planning and Zoning Code 2001). Legislation of this type is designed to create a more mixed-use central urban area, promoting a “24-hour city” in which all aspects of daily life can be carried out
within a fairly dense and small area. This policy is seen as a move towards the 
revitalization of Los Angeles' downtown to improve the economic and cultural quality of 
the central business district. The policy instated by the city also realizes the importance 
that mixed-use urban areas have in terms of transportation. These areas of high density 
promote reduced vehicle trips and better air quality as citizens are more inclined to take 
public transportation, bike, or simply walk. Investing in adaptive reuse is investing in the 
overall well-being of a city. Specifically, Los Angeles's regulation can be applied to 
buildings constructed before July 1, 1974 as well as structures designated by the National 
Historic Register of Historic Places, the California Register of Historical Resources, and 
the City of Los Angeles List of Historic-Cultural Monuments. Building projects fall 
under the legislation of the adaptive reuse policy if they were built after July 1, 1974 only 
if they have been vacant for five years or if the zoning administrator “finds that the 
building is no longer economically viable as an exclusively commercial or industrial 
building.” In terms of action, the main goal of the legislation is to introduce more 
housing units into what is largely a commercial area. Los Angeles hopes that in turning 
either a portion or all of an existing commercial structure into residential units that the 
goal of the 24-hour city will be achieved. Incentives are offered that promote the ease of 
adaptive reuse projects, allowing for certain procedural steps and forms to be foregone if 
a contractor chooses repurposing over a newbuild.

The city of Tyler, Texas although hardly on the national radar for innovation in 
sustainability, implemented in 2007 its comprehensive city planning model called Tyler 
21 (City of Tyler 2007). This policy in conjunction with Main Street Tyler seeks to
revitalize and reinterpret the “best parts of its past” states Beverly Abell, director of the main street organization. Tyler has turned its focus to the reuse of its older buildings, again realizing the economic and social benefits of renovating, especially in the case of a small town main street. The success of the program has been overwhelming in managing and successfully placing a population that doubled from 1950 to 2006 without forsaking the utility of Tyler's central business district. Much like the policy in place in Los Angeles, Tyler 21 cited mixed-use and higher density as a large component of revitalization in their downtown. Also reminiscent of Los Angeles's protocol, the city of Tyler is striving to provide more housing units in the urban center for its growing population, expected to increase another 35 percent by 2030. Tyler's policy does indeed appear to be working as since the inception of the legislation, some $130 million has been reinvested in the city, particularly in the main street district. The town's success was noted early on in the course of the policy, one of its central business district's renovation projects received the award for best adaptive reuse project within the entire state of Texas. The program has become so successful that in March of 2010, Tyler adopted the International Existing Building Code into its municipal planning policy. The International Existing Building Code or the IEBC, is “intended as a fair and reasonable approach to the enhancement of public safety within existing buildings within gaining full compliance as required for new construction” (International Code Council 2007, 8) Again, as seen in the example from Los Angeles, different standards and codes applied to adaptive reuse projects act as yet another incentive towards choosing a project of its type. The end result of these incentives impacts the large number of older and historic
buildings downtown, ensuring the “reuse of the buildings will be less cost-prohibitive” (AdaptiveReuse.info 2004) while also instilling public safety throughout the course of the revitalization of the main street. Adopting an international code is a grand gesture on the part of any city showing true commitment to global sustainability as well as concern at the local level.

Finally, this research will focus on the example set by the entire state of New Jersey that not only addresses adaptive reuse, but abandoned properties as well. This example coincides with the point made above about the potential for reusing vacant buildings in the city of Denver. The inclusion of this policy attempts to show that if it can be successfully carried out statewide in New Jersey, there is a strong chance it can be a positive form of mitigation for just one municipality such as Denver. Enacted in 2004, the Abandoned Properties Rehabilitation Act addresses the prevalence of vacant buildings throughout the state despite it being one of the wealthiest in the nation (Mallach 2005). Cited as “both a problem and an opportunity,” the Housing and Community Development Network of New Jersey realized that adaptive reuse can be a powerful solution not only for urban areas, but for rural and suburban as well. The act sets standards for redevelopment, renovation, and revitalization acknowledging “the potential value for residential and other uses” of vacant buildings, stating they “should be preserved rather than demolished” (AdaptiveReuse.info 2004, ¶1). This policy, used in congruence with New Jersey's Historic Property Reinvestment and Smart Housing Incentive Acts promotes the dense areas of mixed-use so familiar from Tyler and Los Angeles. Again, by providing guidelines, regulations, and incentives, the Abandoned Properties
Rehabilitation Act promotes adaptive reuse through methods that could work nationally as well as locally.

While none of the policies were discussed in painstaking detail, the ideology behind each was fairly simple. Adaptive reuse reinvests time and money into the urban areas that need it most while ensuring various options for housing, employment, and daily activities. None of the legislation discussed is incredibly groundbreaking in theory, but the innovation comes in the form of the existence of mitigation itself. In recognizing the importance of reusing our historic buildings, these locations have used the past to build a better foundation for their future. There is no one aspect of any adaptive reuse policy in existence that cannot be retrofitted for the specific needs of Denver. Through Green Print Denver, the city and county has a comprehensive green building plan for the future, however adaptive reuse is hardly mentioned and no plan exists to fully explore this method as a means of sustaining the economy, the culture, and the environment of the Queen City of the Plains. From the Colorado Historical Society to Colorado Preservation, Inc., there exists minimal transparent communication between these historic preservation proponents and Green Print Denver. The best policy for Denver would be to initiate an active discussion between the planning and preservation communities. The goals of each camp are truly not so different from one another that they cannot work together in order to provide Denver with a meaningful policy towards adaptive reuse and its contributions to sustainable building.
Chapter Six: Conclusions

A synopsis of this research proves difficult to succinctly summarize. The general breadth of the topic translates into many questions and not nearly as many answers. Overall the goal of this thesis was to provide a general portrait of green building in Denver, Colorado using the past and present to formulate ideas about the future landscape of the city with particular attention to the urban core. While no statements of finality can be made as a result of this study, intriguing and worthwhile observations and analyses were made that provide a solid foundation upon which others can construct further research in the quest for providing more concrete results. Ultimately, green building is a still burgeoning research topic that many find difficult to even define, let alone analyze. The tangible effects of sustainable building on economics, society, and the environment have yet to be substantiated beyond disputable constructs and the task of doing such fell outside the realm and scope of this research.

However, in believing that it is truly the parts that comprise the whole, understanding one city's green building landscape, with its unique climate and vernacular, can help explain the national sustainable industry at large. This location specific approach highlights vernacular architecture or a region's traditional methods of accounting for environmental factors through architectural elements. Arguably, vernacular architecture acts really as the first form of sustainable building; constructed
with regional materials, by and for local citizens. This research surprisingly uncovered a major shortcoming in the study of vernacular architecture. The eastern United States is well-studied and well-understood in terms of its architectural traditions, but the history of buildings in the West have barely begun. This research focuses not only on understanding Denver's sustainable building landscape, but also suggests the necessity for a more adequate vernacular architecture theory for the common structure in the West. Unfortunately, the scope of this thesis is unable to propose such a theory but rather calls attention to the issue and poses the topic for the further research it so aptly deserves.

This research also scrutinizes the LEED certification programs utilized by the four case study buildings analyzed. While each building was able to craft some form of innovative green design, there were many credits awarded to each project that either overly-praised a process or a technology while other truly sustainable elements were under-appreciated or ignored all together. While there is a certification process specifically for Existing Buildings, this research found that many of the credits available through this system did not fully appreciate the true sustainability inherent in these older buildings. LEED for Existing Buildings seemingly focuses on monitoring and green housekeeping, while overlooking some of the greatest green tenets of adaptive reuse. Credit for embodied energy saved is absent and points available for keeping the building and its original integrity intact are minimal. If the LEED program is looking to encourage the renovation of existing buildings, the United States Green Building Council must make the heart of adaptive reuse, the reuse, more important.
In another critique of the LEED system, the process does not largely consider regional attributes in the certification. In April of 2009 the USGBC did release a new set of Regional Priority Credits to be allocated as bonus points dependent on a project's ZIP code. These credits, however are not newly formulated points and act only as extensions of previously available points. For example, these credits simply award extra points for water efficiency in a drought prone area, however they fail to address true regional aspects of sustainability such as the viability of green roofs in the Denver area. The Regional Priority Credits, instead of acting as an add-on, should be incorporated into the very fabric of the certification process. Instead of tempting Denver buildings with a point for a green roof that could very potentially fail, why not replace that credit with something better suited for the city, such as situating the building to take full advantage of passive solar heating from Denver's nearly three hundred days of sunshine. Better yet, why not prioritize xeriscaping over irrigating a green roof? The Regional Priority Credits are a positive step in the realization that geography impacts buildings, but leave much to be desired. True regional credits will ultimately appreciate and incorporate the vernacular architecture of the past to eventually create an efficient tradition for the future.

Beyond what this research posed for the future, observations about the past and present derived from this analysis do prove fruitful. In looking at the vernacular architecture of the city it became clear that as a result of the unique circumstances surrounding the foundation of Denver, a traditional building style can be difficult, if at all possible, to define. However, such historical elements as brick, locally mined and manufactured goods, as well as operable windows that are found across the nation are
prevalent in Denver and therefore become a part of the city’s vernacular. It was found that although these inherently green architectural components are not unique to this city, they are important to the future of green building in this location.

Further projections about the future of Denver’s sustainable built landscape were made based on maps of current and in progress locations of LEED certified buildings, showing where the projects are most common in the city and county. A brief analysis concerning currently vacant buildings also took place within this research presenting these empty structures as potential adaptive reuse projects in the future. This discussion naturally led to the investigation of current adaptive reuse policies enacted in other locations around the United States. This portion of the research was conducted in hopes of providing the city of Denver with valid and successful models of incorporating adaptive reuse into urban planning legislation with the intent of promoting such policies in Denver as well.

In conclusion, the goal of this research was to gain a clear understanding of the green building landscape in Denver, Colorado. A focus was placed on the past and present of sustainable structures in an attempt to make useful projections about the future of the city and its buildings. This was certainly achieved and unexpected developments were uncovered in the process. Most poignantly discovered was the difference between creating and being, or achieving sustainability. The vernacular buildings of the past, both in Denver and nationwide, achieved sustainability by simply being green thanks in large part to the use of local resources and durable materials. However, in an alarming trend encouraged and rewarded by the LEED certification process, modern green buildings
largely rely on innovative technology and imported, albeit often renewable resources, that create sustainability rather than achieve it. A critique of this trend is presented and a better appreciation of regional vernacular and traditional building elements are suggested as a solution to an unmistakable problem within the green building industry. Ultimately this research proposes that learning from the past may be the best way to ensure the future of sustainable cities through the implementation of truly green buildings.
Works Cited


Figure A1: Downtown location of College of Law in a 1903-1904 Sanborn map; at this point no structure existed at the corner of 15th and Cleveland and the lot is labeled simply “Ruins.” Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A2: Downtown location of College of Law in a 1929-1930 Sanborn map; the corner at 15th and Cleveland is now infilled and labeled the “University of Denver Law Dept.” Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A3: Downtown location of College of Law in a 1929-1951 Sanborn map; the corner at 15th and Cleveland is still labeled as the "University of Denver." Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A4: Current location of College of Law in a 1929-1951 Sanborn map prior to construction; the corner of Evans and York show residences. Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A5: Current location of College of Law in a 1929-1950 Sanborn map prior to construction; the corner of Evans and York show residences and dormitories; at this point the College of Law is still downtown. Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A6: 1887 corner of 16th and Wynkoop where the EPA building now stands; this view shows the lot occupied by the W.F. Thompson Lumber Yard. Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A7: 1890 corner of 16th and Wynkoop where there EPA building now stands; this view shows an empty lot and train tracks. Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A8: 1903 corner of 16th and Wynkoop where there EPA building now stands; this view shows the lot occupied by a building, possibly an office, labeled only as “Lime.” Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A9. 1929 corner of 16th and Wynkoop where the EPA building now stands; this view shows the lot occupied by the Kennicott Patterson Warehouse. Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A10: 1890 corner of Larimer and 30th where there 4240 building now stands; this view shows the lot occupied by the Weigele Steel Foundry. Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A11: 1929 corner of Larimer and 30th where there 4240 building now stands; this view shows the lot occupied by the Thompson Manufacturing Company. Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A12: 1887 corner of 19th and Stout where the Byron G. Rogers Courthouse building now stands; this view shows the lot occupied by the dwellings across the street from Denver High School. Map courtesy Denver Public Library Western History and Genealogy Department.
Figure A13: 1929-1950 view of the corner of 19th and Stout where the Byron G. Rogers Courthouse building now stands, notice how the block once dominated by residences is now largely parking lots. Map courtesy Denver Public Library Western History and Genealogy Department.