Challenges In Applying Sustainability Principles to the design of the Engineering School located in San Juan, Puerto Rico

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ABSTRACT

The Engineering School of Island University in San Juan, Puerto Rico has decided to complete a new classroom and lab facility on their campus in the year 2015. The facility will provide a home for innovative courses which emphasize a team approach to engineering design. The new facility will have 3 stories with a total of 10,000 square feet each. This research aims to address the challenges in implementing a sustainable design for the Engineering School of Island University new building, by following the principles of green engineering and achieving a minimum of a Silver LEED (Leadership in Energy & Environmental Design) certification.

For years, the AEC (Architect, Engineers and Contractors) industry has focused on key concerns in the creation of buildings. The first, of most importance to architects, is the design of the building. Particularly, whether the building is enjoyable to view and occupy. In addition, the structural engineers are concerned with safety and strength of the structural system to withstand all gravity and lateral loads. On the other hand, the primary focus of contractors is the actual construction of the building, i.e. how will the building be built and how much will the building cost. These are also the primary concerns of a client when the idea of constructing a building is addressed, so it is no surprise that architects, engineers and contractors focus their efforts to this end. Although they are significant, these are not the only concerns that should be addressed when planning the first stages of a construction process.

Sustainable building design is another growing concern for building owners, due to its economic, environmental and social impact. The first building with a sustainable design in Puerto Rico was the Escuela Ecológica de Culebra (School of Ecology at Culebra), built in 2006. This school generates 100% of its hot water needs with the use of a solar system. It also generates between 25% and 30% of its energy use now. Since 2006 Puerto Rico is looking for more efficient ways to implement green engineering and at the moment the U.S Green Building Council, Caribbean Chapter is providing the help and motivation to the AEC industry to achieve this.

With this in mind, this research focuses in evaluating the different factors that affect sustainability and the approach that the AEC industry is currently taking to make the right decisions during design and construction. This is important because the overall understanding of these factors will benefit the client and the users of the building over its life cycle in contrast to just considering the design-construction cost.

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1. Introduction

Puerto Rico faces multiple challenges regarding sustainable planning. Land is scarce and a highly valuable resource in this small Caribbean island. Many environmental, social and economic challenges have come about as a consequence of a history of inefficient engineering (Puerto Rico's Green Magazine, 2010). It is reasonable to argue that if current practices continue the same pattern followed during the last five decades, Puerto Rico's environment can be negatively impacted by the construction industry.

Green engineering or sustainable design is the answer to avoiding this negative impact because it involves the use of measurement and control techniques to design, develop, and improve products, technologies, and processes that result in environmental and economic benefits (www.wikipedia.com, 2011). Sustainable designs in Puerto Rico can be achieved with the commitment from the AEC industry to design, construct and operate buildings, spaces and comfortable environments; the problems of spaces that are not sustainable is not resolve by doing more, it is the opposite, we must built less and explore the ideas that create a comfortable environment (Abruña, 2007).

The Engineering School will be constructed in San Juan, Puerto Rico, following the principles of Green Building and LEED Core Concepts established by the U.S Green Building Council, Caribbean Chapter (USGBC). This implies shifting construction practice toward higher performance, lowering environmental impact, and ultimately achieving a regenerative design.

1.1 Problem Statement and Objectives

Sustainability has come to have many different meanings, but it's most important characteristic is the integration of three spheres--profits, the planet, and people. Sustainability is the natural next step in the development of the AEC industry in Puerto Rico. Unfortunately, the Sheraton Hotel of Puerto Rico is the only building in the Caribbean built and certified by LEED. This building complex fulfills all the requirements of a LEED Certified Hotel with electrical models, recycling, disposal of construction materials, and the use of local and recycled materials. The hotel also follows environmental rules involving energy consumption, quality and filtration of air, green cleaning detergents and materials, and a controlled laundry process designed to maximize the use of natural resources. By having only one LEED certified building in the Caribbean it is clear that certain barriers are preventing the Caribbean AEC industry from implementing sustainability efficiently.

Although the barriers of applying sustainability have being long recognized, many construction industries believe that cost is the real barrier that prevents green engineering to continue developing in the Caribbean (Puerto Rico's Green Magazine, 2010). Puerto Rico's AEC industry is in the stage of taking the next step to overcome the barriers and challenges to implement sustainability efficiently and it is critical that the industry understands that besides cost, imagination and design competence are key factors to achieve sustainable design.

This paper aims to accomplish a comprehensive understanding of the LEED Core Concepts and identify solutions to be able to overcome the challenges to successfully implement sustainability in Puerto Rico.

1.2 Methodology

The methodology use for this study consisted in the following steps:

1) Develop a literature review to document information that is consider to be relevant to the research.
2) Apply the LEED strategies to design of the Engineering School.
3) Identify the challenges on achieving a LEED certification and propose solutions.
4) Determine Puerto Rico's AEC industry next step to be able to implement sustainability efficiently.

2. Literature Review

2.1 U.S Green Building Council and It's Program

The USGBC is the nation's foremost coalition of leaders from every sector of the building industry working to promote buildings that are environmentally responsible, profitable, and healthful places to live and work.

Leadership in Energy & Environmental Design (LEED) was developed by USGBC; LEED is intended to provide building owners and operators a concise framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions (Wikipedia).

Puerto Rico is under the USGBC Caribbean Chapter. The Caribbean Chapter promotes that mission through its region by providing its members with the tools and knowledge necessary to become part of this rapidly expanding and continuously developing industry.

The LEED for New Construction System, which addresses the full design and construction of most commercial buildings, is divided into the following categories:

- Sustainable sites (26 possible points)
- Water Efficiency (10 possible points)
- Energy and Atmosphere (35 possible points)
- Materials and Resources (14 possible points)
- Indoor Environmental Quality (15 possible points)
- Innovation and Design (6 possible points)
- Regional Priority (4 possible points)

There are four levels of LEED certification:

- Certified: 40 – 49 points
- Silver: 50 – 59 points
- Gold: 60 – 79 points
- Platinum: 80+ points

Each Credit is allocated points based on the relative importance of the building impacts that it addresses. The result is weighted average that combines building impacts and the relative value of the impact categories. Credits that most directly address the most important environmental impacts and human benefits are given the greatest weight; the market implications of point allocation are also considered (Green Building Education Services, 2009).

Overall, the credit weights emphasize energy efficiency, renewable energy, reduced transportation demand, and water conservation, based on their direct contribution to reducing high-priority impacts, particularly greenhouse gas emissions. (USGBC, 2009).

2.2 Sustainable Sites

Creating sustainable buildings starts with proper site selection. The location of a building affects a wide range of environmental factors, including energy use, land use and preservation, erosion and storm water control, access to public transportation and many others.

Generally to achieve LEED credits, sustainable site planning should employ an integrated-system approach that seeks to (Kubba, 2010):

- Minimize the development of open space through the selection of disturbed land, brownfields, or building retrofits.
- Consider energy implications in site selection and building orientation to take advantage of natural daylight and maximum day lighting.
- Control/prevent erosion through improved landscaping practices.
- In warm climates consider incorporating reef roof into the project as using roofing products that meet or exceed Energy Start standards.
- Consider a site with community connectivity to within walking distance of basic services. Basic services are common services that people might use regularly like banks, hospitals, church, restaurant, school, park and others.
- Incorporate transportation solutions along with site plans that acknowledge the need for bicycle parking, carpool staging and proximity to mass transit.
- Minimize habitat disturbance by limiting the site to a minimal area around the building perimeter, locate buildings adjacent to existing infrastructure and retain prime vegetation features to the extent possible.

2.3 Water Efficiency

As water becomes more of a scarce resource, the importance of developing sustainability policies based on an effective water strategy is increasing. This strategy should encompass the full spectrum of water and wastewater treatments to uncover opportunities for cost savings, reduced downtime and improved operations (General Electric, 2007).

Water conservation strategies are typically no more expensive than traditional building methods. Buildings that use water efficiently can reduce operating cost through lower water use and sewage fees. For those strategies where the cost may be higher, the payback is usually quick (Green Building Education Services, 2009).

The strategies for reducing indoor water use are (USGBC, 2009):

- Install efficient plumbing fixtures: Replace water-intensive fixtures with new low-flow fixtures. If porcelain replacement proves cost-prohibitive, install new flush valves or flow restrictors to achieve water savings.
- Use non-potable water: Strive to use the right water for the right purpose, including captured rainwater, graywater, or municipal reclaimed water flush fixtures.
- Install submeters: Meter indoor water systems and monitor the data to track consumption trends and pinpoint leaks.

The strategies for reducing outdoor water use are (USGBC, 2009):

- Choose locally adapted plants: Landscape with native and adapted plants that require less water
- Use xeriscaping: Especially in arid regions, employ xeriscape principles when designing the site landscape.
- Select efficient irrigation technologies: Drip and bubbler systems and weather based controllers can save water.

The strategies for reducing process water use are (USGBC, 2009):

- Use non-potable water: Use the right water for the right purpose. Investigate opportunities, to use captured rainwater, graywater, or municipally reclaimed water in building processes, such as cooling towers.

- Install submeters: Meter the process water systems and use the data to track consumption and identify leaks.

2.4 Energy and Atmosphere

In all the different LEED rating systems the Energy and Atmosphere category contains the most credits available. The reason for this is because of the importance of energy conservation. Increased energy use and the burning of fossil fuels are linked to global warming and air pollution. This category of sustainability specifically looks at the energy use in a building: use less energy and support the use of more environmentally friendly energy sources (Kubba, 2010).

Efforts to address energy through green building focus on four interconnect elements (USGBC, 2009):

1. Energy Demand: Saving energy begins with reducing energy demand. Green buildings and neighborhoods can reduce demand for energy by capturing natural, incident energy, such as sunlight, wind and geothermal potential, and by using integrated design processes to reduce loads.

2. Energy Efficiency: Efforts to reduce energy demand provide the foundation for efforts to use energy efficiently. This means getting the most productive work from a unit of energy often described as a measure of energy intensity. Common metric for buildings and neighborhoods include energy use per square foot and use per capita.

3. Renewable Energy: Reduced demand and increased efficiency often make it cost-effective to meet most or all of a building's energy needs from renewable sources. Renewable energy is typically understood to include solar, wind, wave, biomass, and geothermal power, plus certain forms of hydropower. Use of these energy sources avoids the myriad environmental impacts associated with the production and consumption of traditional fuels, such as coal, nuclear power, oil, and natural gas.

4. Ongoing Energy Performance: Attention to energy use does not end with the design and construction of an energy-efficient building or neighborhood. It is critical to ensure that a project functions as designed and that it sustains and improves this performance over time.

LEED recognizes and encourages operational energy performance through its requirements for building commissioning and credits for monitoring and verification.

Some strategies for addressing energy savings are (Green Building Education Services, 2009):

- Site Location: A building that can be placed in the shade of trees or another structure will remain cooler, thereby reducing the required cooling load. A building's surroundings can also help block out the wind.
- Lighting Design: Lighting is often the largest contributor to a building's energy use, so lighting design and control are critical to reducing energy consumption. To address these issues early in the design process it is important to determine what kinds of natural and artificial lighting will be used. In some climates the lighting load can be a building's greatest operating expenses.
- Monitor Consumption: Use energy monitoring and feedback systems to encourage occupants to reduce energy demand.
- Install High-Efficiency Appliances: Computers, monitors, printers, and microwaves that meet or exceed ENERGY STAR requirements will reduce plug load demands.
- Generate Onsite Renewable Energy: Install photovoltaic cells, solar hot water heaters, or building-mounted wind turbines.
- Natural ventilation: If the climate is appropriate, natural ventilation can provide fresh air and regulate indoor temperatures.

2.5 Materials and Resources

Sustainable materials are materials that reduce demands on ecosystems during their life cycle. This includes the materials' processing – such as harvesting and production – and the entire product life cycle through use and disposal. Conventional building construction and operation consumes large quantities of wood, water, metals, and energy from fossil fuels (USGBC, 2009).

A summary of the best practices for materials and resources is provided in the following list (Kubba, 2010):

- Locate in an existing building and reuse as much of the building materials as possible.
- Provide easily accessible collection and storage points for recyclable materials.

- Apply construction waste-management operations in building out a tenant space to reduce debris by recycling these materials.
- Preference should be given to materials that contain a high percentage of recycled content.
- Specify green interiors; use finishes, carpets, fabric, and other materials with low levels of volatile organic compounds (VOCs), formaldehyde, and other potentially toxic chemicals to protect indoor environmental quality and reduce the life-cycle impacts of materials.
- Use of regional materials.

2.7 Indoor Environmental Quality

The key emerging benefits of high-performance green buildings appear to be their health and productivity benefits, with paybacks that may be as much as 10 times higher than their energy savings. More and more hard evidence of the effects of good indoor air quality (IAQ) is emerging, supporting design and construction efforts that provide excellent building air quality. More recently, the range of health problems connected to buildings has shifted from air quality alone, noise, temperature, humidity, odors, and vibration (Kibert, 2007).

Strategies for maintaining indoor air quality are (USGBC, 2009):

- Protecting the Site during Construction: IAQ issues begin with the construction process. Prior to construction, contractors and project team members should incorporate and IAQ management into both bid and construction documents.
- Prohibit Smoking: Institute a no-smoking policy in the building and around building entrances, operable windows, and air intakes.
- Ensure Adequate Ventilation: Appropriately size and operate ventilation systems to supply ample outside air to the occupants.
- Monitor Carbon Dioxide: Install monitors and integrate them with a ventilation system that regulates the supply of air based on occupant demand.
- Conduct a Flush-Out: Before occupancy, flush out indoor airborne contaminants by thoroughly exhausting old air and replacing it with outdoor air.
- Install High-Efficiency air filters. Use filter with high MERV (Minimum Efficiency Reporting Value) ratings in the ventilation equipment.

- Use Integrated Pest Management: A coordinated program of nonchemical strategies, such as monitoring and baiting, can reduce the use of pesticides and other potentially toxic contaminants.

Strategies for improving thermal comfort, lighting, and acoustics in indoor environments are (USGBC, 2009):

- Use of Daylight: Design the building to provide ample access to natural daylight and views for the occupants. Service areas, equipment rooms, closets, and locker rooms should be located in the building core, and regularly occupied spaces placed around the perimeter of the building.
- Install Operable Windows: If possible, provide windows that can be opened to the outside.
- Give Occupants Temperature Control: In mechanically ventilated buildings, provide thermostats that allow occupants to adjust the air flow to their immediate environment.
- Give Occupants Lighting Control: Provide occupants with adjustable lighting controls so that they can match lighting levels to their task.
- Conduct Occupant Surveys: Use valid survey protocols to assess occupant's satisfaction with the indoor environment. Make operational changes based on the feedback.

2.8 Innovation and Design

Innovation in design or innovation in operations for existing buildings is a flexible category used to award points for performance and creativity. The category is flexible because the points in this section are not necessarily earmarked for specific items completed or designed. Exceptional performance strategies surpass the requirements of existing LEED credits and substantially exceed the performance-based standards for energy, waste, or waste management (Kiber, 2007).

LEED has recognized the following kinds of exceptional performance (USGBC, 2009):

- Doubling density requirements for sustainable sites credits.
- Significantly reducing indoor water use beyond the LEED requirement of 40%.
- Significantly diverting construction waste beyond the requirement of 75%.
- Providing more daylight than the 75% requirement.
- Use of the building as educational tool for green engineering.

- Document and evaluate the buildings performance before it becomes LEED certified and then document performance during and after the changeover.

2.9 Regional Priority

The concept of Regional Priority Credits (RPCs) was introduced in the LEED 2009 rating systems to incentivize the achievement of credits that address geographically specific environmental priorities. RPCs are not new LEED credits, but instead are existing credits that USGBC chapters and regional councils have designated as being particularly important for their areas. The incentive is to achieve the credits is in the form of a bonus point. If an RPC is earned, then a bonus point is awarded to the project's total points. Each specific area is referenced by ZIP code. A project may earn up to four bonus points as a result of earning RPCs, with one bonus point earned per RPC. (www.USGBC.org)

3. Application and Challenges Encountered

3.1 Project Description

The Engineering School is going to be located in San Juan, Puerto Rico, it is going to be constructed in 2015. The facility will provide a home for innovative courses which emphasize a team approach to engineering design. The new facility will have 3 stories with a total area of 30,000 square-feet. The school is going to be composed of faculty offices, administration offices, student offices, auditorium, Instructional Labs, high technology classrooms and others. The owners are requiring the project team to achieve a minimum of Silver LEED Certification. There is also a limited budget of $7,500,000.

3.2 Selecting a Sustainable Site

Puerto Rico is located in the northeastern Caribbean Sea, east of the Dominican Republic and west of the Virgin Islands. San Juan is the capital of Puerto Rico and its most populous municipality. As of the 2000 census, it has a population of 658,304 making it the 42nd-largest city under the jurisdiction of the United States. The Engineering school is going to be located in the University's Rio Piedras campus located in San Juan.

Figure 2. San Juan is located along the north-eastern coast of Puerto Rico. It lies south of the Atlantic Ocean; north of Caguas and Trujillo Alto; east of and Guaynabo; and west of Carolina. The city occupies an area of 76.93 square miles (Google Maps).

LEED prefers project teams to pick or manage sites in ways that benefit the environment and the people using the facilities. The following list explains the issues encountered by applying the LEED strategies and some of its solutions:

1. <u>Community Connectivity</u>.

Connecting the Engineering school to the community is one the important challenges to be addressed. For example, sites without access to public transportation start at a disadvantage and may require additional attention to transportation impacts. By allowing people to walk from the project to other basic services, the building is encouraging its occupants to a more sustainable environment.

The selection of a building site is generally the purview of the building owner, but to be able overcome this challenge, the input from all members of the project team is needed. The way to earn this credit in the LEED certification is by studying the site and locating the project around basic services (Train station, pharmacies, school, recreation parks, and others) while providing pedestrian access within half a mile. Figure 3 shows the location of the construction site and how it can integrate to different services around it. The building is also going to facilitate the use of bicycles by the occupants by providing secure bicycle storage within 200 yards of the building.

Figure 3. Construction Site (Google Maps).

2. <u>Protecting and Restoring Habitat</u>

Buildings have traditionally been seen as having adverse impacts on the environment. In fact, the whole concept of environmental impact assessment often presumes that development has a net negative impact. Our project site is located in a very green area as show in Figure 4. It is critical to pay attention to the negative impact that our project can have by causing destruction of the ecosystem, disturbance of wildlife, loss of plants and trees that absorb CO_2.

The approach to obtain this credit in this project will be to minimize the impact of the construction process on natural systems by requiring the contractor's minimal site disturbance, this can be done by reducing the size of the development footprint, maximizing the area that is undisturbed, limiting the amount of vegetation to be cleared and by keeping the ecologically site features that help maintain the natural landscape.

The best approach for these issues is to plan ahead and perhaps hire an arborist to do a survey and then build around the trees that can be saved. It takes more time and will probably cost more, but replacing a 50 year old 100–ft. tree with a year old ft. tall sapling isn't quite a fair trade

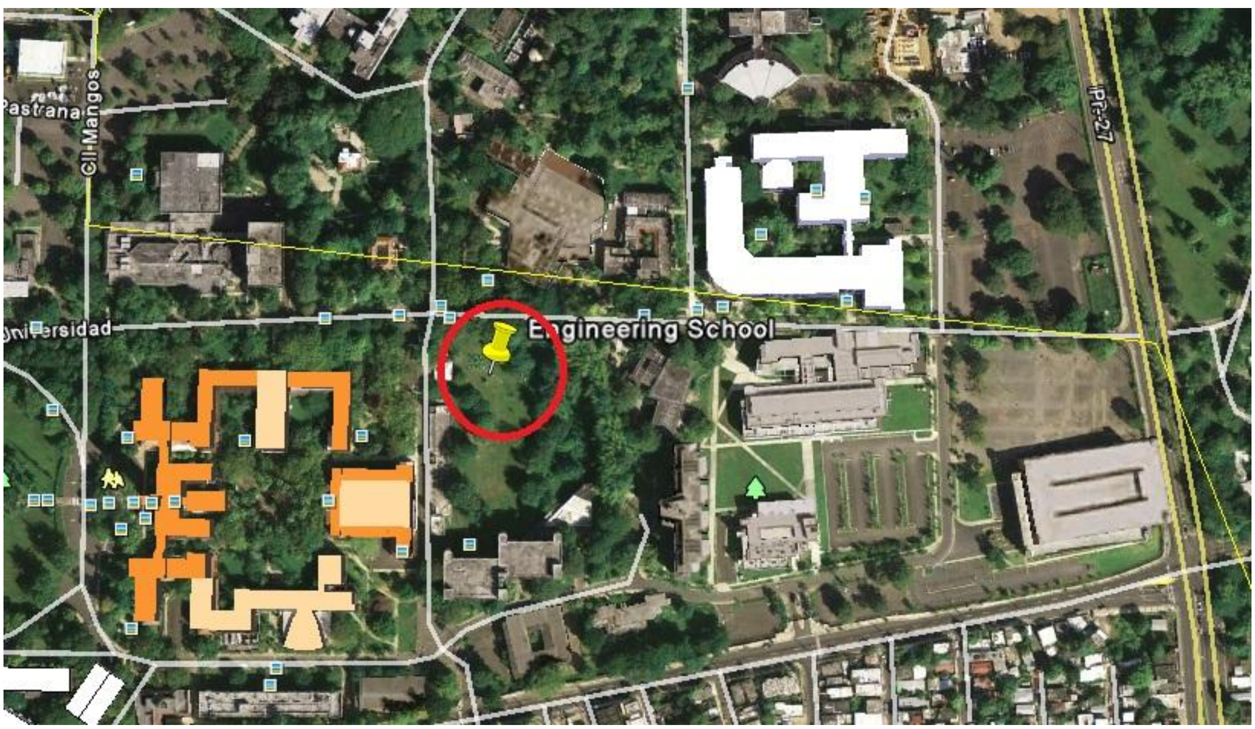

Figure 4. Location of the project showing vegetation (Google Earth).

3. Uncontrolled Storm water

Puerto Rico is one of the countries that experiences a very long and catastrophic hurricane season. Precipitation is part of the natural hydrologic cycle, but uncontrolled storm water is a major problem. Impervious materials prevent the percolation and infiltration of storm water runoff, which then rushes off the site, causing soil erosion and sedimentation in local waterways. This runoff can also carry harmful chemicals into the water system, deteriorating surface water quality and harming aquatic life and recreation opportunities in receiving water.

To be able to reduce the quantity and quality of storm water runoff in this project limiting the number of impervious surfaces, reusing storm water or adopting some low – impact strategies are the answer.

For the purpose of minimizing impervious areas, we are going to have to increase the area of permeable surfaces, such as vegetated roofs, porous pavement, and grid pavers. Storm water can be used for irrigation or inside the building, for example, to flush toilets.

3.3 Process of Saving Water

Of the various resources needed for the built environment, water is the most critical. Puerto Rico's booming population has caused competition for water to become more intense and thus the corresponding water problems have increased in number of complexity.

Puerto Rico's Green Magazine (2010) indicated that using large volumes of water increases maintenance and life-cycle costs for building operations and also increases consumers' costs for additional municipal supply and treatment facilities. Conversely, buildings that use water efficiently can reduce cost through lower fees, less sewage volume, reductions in energy and chemical use, and lower capacity charges and limits for the city of San Juan, Puerto Rico.

LEED encourages project teams the use of strategies and technologies that reduce the amount of potable water consumed in buildings. The following list explains the issues encountered by applying the LEED strategies and some of its solutions:

1. Reducing Indoor Potable Water Consumption

Indoor water use refers to the water that occupied buildings typically need to operate on a day-to-day basis, like, water for closets, urinals, lavatories, showers and kitchen.

The approach implemented on this project to save water will be the usage of alternative water sources for non-potable application and installing building components, such as water-efficient fixtures, flow restrictors on existing fixtures, electronic controls, composting toilet systems, and waterless urinals. Lowering potable water use for toilets, showerhead and faucets, and other fixtures can reduce the total amount withdrawn from natural water bodies.

The total reduction of potable water in the building will have to be around 30 percent. To be able to calculate this reduction, the mechanical/electrical/plumbing (MEP) engineer is going to provide calculations to demonstrate the reduction compare to a baseline similar project.

2. Wastewater Technologies

The water used to flush a toilet doesn't need to be as clean as the water you drink from a faucet, yet the clean and treated water is what flows through 99% of our toilets. Recycled graywater from showers and bathtubs can be used for flushing toilets. Such a system could provide an estimated 30% reduction in water use for the average household, while on a commercial scale; the savings are even more.

Wastewater treatment systems and water recovery systems require initial capital investment in addition to regular maintenance over the building's lifetime. The project team is going to face the challenge of balancing these costs with the anticipated savings in water and sewer bills. Another challenge with wastewater technologies is that additional energy is needed for on-site treatment and pumping.

The feasibility of implementing wastewater reuse and treatment strategies is going to depend on the project's final size and location. This project does not have the necessary scale and land to support on-site wastewater treatment, because it is on located in the heart of San Juan and space is limited.

3.4 Efficient Use of Energy

The recommendations by the USGBC applicable to this research include: insulating the building to resist cooling losses, making use of shaded areas for cooling, establishing energy performance targets for the community and individual residences, and incorporating feedback systems for energy monitoring that will motivate residents. The following list explains the issues encountered by applying the LEED strategies and some of its solutions:

1. Reduce Demand for Energy

The project is going to look to reduce demand for energy by capturing natural, incident energy such as sunlight, wind, and geothermal potential, and by using integrated design processes to reduce loads. The approach to overcome this challenge will be mainly in, sizing the building appropriately and design the building incorporating passive strategies, like mass and daylight, to reduce the demand lighting and cooling.

Because of Puerto Rico's location in the tropics, the cooling of a facility is common. In San Juan, the use of air conditioners is widespread. Most wall-mounted air conditioners are designed to cool single rooms. The energy required to cool a room depends on the square footage; air conditioners are manufactured over a range of power ratings that correspond to different sized rooms. ENERGY STAR, a sector of the U.S. Department of Energy, demonstrates the correlation between square footage and power required for such an application. To be recognized as an ENERGY STAR air conditioner, the unit must be 7% more efficient than the average (www.energystar.gov, 2009). Updating the efficiency of major household energy consumers, such as an air conditioning unit, is a particularly viable means of reducing total household energy use (see Table 1).

Table 1: Square Footage and Required Air Conditioner Capacity (Source: Energystar.gov, 2009).

Area To Be Cooled (square feet)	Capacity Needed (BTUs per hour)
100 to 150	5,000
150 to 250	6,000
250 to 300	7,000
300 to 350	8,000
350 to 400	9,000
400 to 450	10,000
450 to 550	12,000
550 to 700	14,000
700 to 1,000	18,000
1,000 to 1,200	21,000
1,200 to 1,400	23,000
1,400 to 1,500	24,000
1,500 to 2,000	30,000
2,000 to 2,500	34,000

Air Conditioning Chart.JPG

Make any adjustments for the following circumstances:

- If the room is heavily shaded, reduce capacity by 10 percent.
- If the room is very sunny, increase capacity by 10 percent.
- If more than two people regularly occupy the room, add 600 BTUs for each additional person.
- If the unit is used in a kitchen, increase capacity by 4,000 BTUs.
- Consider where you install the unit. If you are mounting an air conditioner near the corner of a room, look for a unit that can send the airflow in the right direction.

Other strategies that are going to implemented are

- Performance of the building envelope, this will be done by using an appropriate amount of insulation in the walls and roof and install high performance glazing to minimize unwanted heat gain.
- Lighting design: Energy is used both to power the lights and provide additional cooling to compensate for the added heat generated by lights. To address these issues for this project it is important to determine what kinds of natural and artificial lighting will used.
- Occupancy sensors: Most of the time when students leave a classroom they leave everything turned on; occupancy sensors ensure that lights are turned off when occupants leave. Occupancy sensors can also be tied into other parts of the building to adjust cooling systems when occupants are not present, further reducing energy use.

2. <u>Improving Energy Efficiency</u>

Due to the expenses in Puerto Rico associated with fossil fuel electricity generation, it is important for this project to increase energy efficiency. To be able to overcome this challenge the following strategies are going to be implemented:

- Managing the site of the building and passive design strategies: As address in the previous challenge the proper orientation of the building, selection of materials, and location of windows can allow the building to stay cool. The use of natural resources for the design is going to help in reducing the requirement of additional energy.
- Installing high-performance mechanical systems: Energy efficiency and occupant comfort go hand in hand. Employees who can easily control their surrounding temperatures with an air system will likely be more productive, this can decrease the cost of the mechanical systems and there will be overall energy savings.
- High efficiency appliances: Computers, monitors, printers and microwaves that meet or exceed Energy Start requirements will be used in this project to be able to reduce plug load demands.

3. <u>Alternative Energy Forms:</u>

Because it is impossible to “run off” of renewable energy, using it is much more sustainable and environmentally beneficial than fossil fuels. The ecological impact to the project is also significantly less than fossil fuels. The cost of systems to use renewable energy are usually a significant investment, but over the life cycle of the building, the cost are significantly less than using power supplied by fossil fuels. The strategy to use renewable energy in the project will be following:

- Cool roof: Since Puerto Rico’s weather is warm during the entire year, highly emissive roof products can help reduce the cooling load on the building by releasing the remaining heat absorbed from the sun.
- Photovoltaic Panels: These panels are semiconductor devices that convert sunlight into electricity. These panels are not going to be used because of its costs and reputation to not be really efficient in Puerto Rico.

4. <u>Ongoing Energy Performance:</u>

Monitoring and verification provide the basis for tracking energy performance with the goal of identifying and resolving any problems that may arise over time. Just because the project is complete, attention to energy use has to be finished as well. Some of the strategies to prevent this from happening are:

- Maintenance: A preventive maintenance program will be developed to keep the building in optimal condition.
- Incentive for Occupants: The use of energy efficiently will be promoted to occupants.
- Provide Staff training: Facility managers must have the appropriate training to keep the building performance in optimal condition over time.
- Document: Keeping track of records of energy consumption will help us prove energy savings.

3.5 Selection of Materials and Resources

One of the most difficult and challenging task that a construction project team faces is the selection of building materials and products for a high-performance green building project. During the life cycle of a material, its extraction, processing, transportation, use, and disposal can have negative health and environmental consequences, polluting water and air, destroying native habitats and depleting natural resources. This project is going to implement environmentally responsible procurement policies to significantly reduce these impacts.

The following list explains the steps to be implemented to overcome the challenges encountered by applying the LEED strategies and some of its solutions:

1. <u>Construction Waste Management:</u>

Before construction begins, a construction waste management plan is going to be developed with the purpose of identifying potential waste streams. The contractor is going to take responsibility for enforcing the plan throughout the construction process; this plan is going to aim to achieve the following:

- A minimum of 50% Recycled and Salvage of construction Materials. This includes concrete, wood, Wallboard (eco-rock), Steel, Cardboard. During construction there will be an area designated for recycling.
- The construction waste management includes a commingled and sorted off-site because the site does not have enough room for sorting materials.
- It is going to outline the responsibilities of each subcontractor to recycle lunch waste in a separate, smaller container, to prevent contaminating the construction waste.
- The construction office is going to be instructed to sort paper, plastic, cans, and bottles within the office.
- Reuse between 5% - 10% of the materials found off-site such as concrete.
- We are going to use recycle materials found off site as: Steel, glass, plastic.

2. <u>Regional Materials:</u>

Regionally harvested, processed, and manufactured products reduce transportation cost by avoiding overseas shipping costs, long rail transport, or long distant trucking cost. Reducing transportation costs reduces the energy needs for that transportation. To comply with the LEED requirements the project is going to do the following:

- The project is going to use at least 70% of our building materials within the 500 miles radius from our site. This includes concrete, wood, wallboards, plastic, ducts, etc. These materials are going to be provided by Velazquez Industries which is located within a distance of 30 miles from our site.

3.6 Providing Stimulating and Comfortable Environments

In today's construction, with the struggle to build cost-effective buildings, it is easy to forget that the ultimate success or failure of a project can rests on its indoor environmental quality (IEQ). Healthy, comfortable employees are invariably more satisfied and productive. Unfortunately, this simple, compelling truth is often lost, for it is simpler to focus on the first-cost of a project than it is to determine the value of increased user productivity and health. This facility will be constructed with an appreciation of the importance of providing high-quality, interior environments for all users.

The following list explains the issues encountered by applying the LEED strategies and some of its solutions:

1. Increasing Ventilation:

Some spaces are going to be ventilated naturally by opening windows and doors, not all of them are going to be naturally ventilated because of Puerto Rico's hot humid air that is present throughout the entire year, because of this the building is going to use both natural and mechanical ventilation. By increasing the quantity of outdoor air the quality of indoor air will increase. Providing more fresh air is a key factor in reducing contaminants indoor.

2. Implementing a Construction IAQ Management Plan:

The goal of this plan is to improve indoor quality problems resulted from construction. The parties responsible for implementing this plan will be the Facility Manager, General Contractor and Owner. The plan is going to follow these steps:

- HVAC protection – When possible, HVAC system should be shut down during construction.
- Low emitting paints, adhesives, sealants, and carpets must be used when feasible.
- Housekeeping: Services must utilize best practices for minimizing IAQ problems, such as dust suppression, cleaning frequency, cleaning efficiency, and water and spill cleanup, protection of on-site or installed absorptive and porous material.
- Building flush out: After construction ends and all interior finishes have been installed, new filtrated media must comply with the procedure listed within the LEED rating system.
- Prohibit smoking inside the building and within 25 ft of building entrances once the building is enclosed.

3. Providing Adequate Comfort:

In addition to air quality, the comfort of the occupant plays an integral role in successful IEQ. Some of the strategies to be implemented on this project are:

- Allowing natural Light into spaces. In addition, there's going to be Lightning system controls for all learning spaces including classrooms, instructional abs to enable adjustments that meet occupants needs and preferences.
- Providing views for occupants. We are providing windows to throughout the building to have occupants a sight to the outdoor environment.
- Individual controls for cooling. Air Condition systems will have control in different spaces to adjust to occupant's preferences.

3.7 Exploring Innovative Green Building Strategies

This LEED category is flexible because the points in this section are not necessarily earmarked for specific items to completed or designed but the project is going to look to achieve exemplary performance in the following:

- Increasing the use of alternative transportation by having bicycle parking spots.
- Reducing the heat island effect by having a vegetated roof.
- Relocating/transplanting trees on site.
- Use of the building to educate Puerto Rico with sustainability.

3.8 Credits for Regional Priority

Our project has a 00925 ZIP Code; table 2 shows the credits that can achieve by having this Zip Code.

Table 2. Credits available to earn for school projects in Puerto Rico and U.S Virgin Islands.

Zip Code	Credits to Earn					
00841	SSc2	SSc5.1	SSc6.1	SSc8	WEc2	MRc2 (75%)
00850	SSc1	SSc6.2	WEc2	EAc1 (22%/18%)	MRc2 (75%)	IEQc8.1
00851	SSc1	SSc6.2	WEc2	EAc1 (22%/18%)	MRc2 (75%)	IEQc8.1
00952	SSc2	SSc6.1	SSc8	WEc2	EAc1 (20%/16%)	MRc1 (95%)
00953	SSc2	SSc6.1	SSc8	WEc2	EAc1 (20%/16%)	MRc1 (95%)

00956	SSc2	SSc6.1	SSc8	WEc2	EAc1 (20%/16%)	MRc1 (95%)
00957	SSc2	SSc6.1	SSc8	WEc2	EAc1 (20%/16%)	MRc1 (95%)
00959	SSc2	SSc6.1	SSc8	WEc2	EAc1 (20%/16%)	MRc1 (95%)

Since our Zip code is not listed in table 2 then we have to use the closest Zip code which is 00952. The extra credits that the project can achieve are the following:

1) SSc2: This credit corresponds to density development and community connectivity which is in the sustainable site category.
2) SSc6: This credit corresponds to Storm water Quality Control, which can be achieved by reducing imperviousness of the building and by using vegetative roofs.
3) SSc8: This extra point corresponds to reducing light pollution. This credit is going to be applied to interior lighting.
4) WEc2: This extra point corresponds to implementing innovative wastewater technologies, which can be gained by reducing potable water used for sewage conveyance by at least 50 percent.
5) EAC1 (20%/16%): This credit corresponds to improving energy performance by 20%, which is going to be achieved by implementing the strategies described in the energy and atmosphere category.
6) MRc1 (95%): This credit corresponds to Materials and resources, which can be achieved by reusing materials by 75% percent. At the moment the project is not aiming to reuse materials from a previous building.

3.9 Impact of Applying LEED Strategies on the Budget

The owners of this project have let us that there is a limited budget of $7.5 M for construction with fees. In today's construction, having a LEED certified building adds between 6% and 18% to construction costs. More than half of these costs are for "greening:" investments in alternative systems, practices, and materials that earn points under the LEED system and go beyond standard practices. The remaining costs fall outside of the range of construction cost, they include incremental costs for design, documenting compliance, and verifying compliance through the commissioning process.

Commissioning is a prerequisite of the LEED process. Commissioning involves an outside team of individuals that is not part of the design and construction team. Their primary area of responsibility is to ensure compliance of “fundamental building elements and systems” with the LEED guidelines. LEED also awards an extra point for additional commissioning. This requirement comes at a significant cost. Various sources estimate commissioning costs to be in the range of 0.5 percent to three percent of construction costs. R.S. Means estimates commissioning costs for project located in Puerto Rico to be between 0.5 percent and 0.75 percent of construction costs.

The following table shows the cost of LEED certification on each stage of construction and the benefits that can be obtained.

Table 3. LEED Expenditures: Who Profits? (Source, USGCBC)

Cost Elements	Percentage of Construction Costs	Paid To:
Soft Costs		
Design	0.4% to 0.6%	Architect, consulting engineers, LEED consultant or coordinator
Commissioning	0.5% to 1.5%	Commissioning agent, LEED consultant or coordinator
Documentation and Fees	0.5% to 0.9%	Architect, consulting engineers, LEED consultant or coordinator Fees paid to USGBC for administration
Energy Modeling	0.1%	Consulting engineers, LEED consultant or coordinator
Subtotal	**1.5% to 3.1%**	
Greening Costs		
Premium over traditional construction costs to meet selected LEED criteria	3% to 8%	Contractors, subcontractors, material suppliers
Total	**4.5% to 11%**	

As this research has described, obtaining LEED certification triggers many different costs. In table 4, I have categorized the costs according to the types of benefits that would result for this project. While these costs do not yield any direct benefits they represent the price that must be paid to get into the LEED system and to fulfill its requirements.

Table 4. Categories of Costs and Benefits for Green Buildings

Types of Cost	**Types of Benefits**	**Issues**
Designing	None	. Process likely to focus on "easiest" points rather than "best" points from environmental perspective.
Commissioning	None	The additional level of oversight on design, installation, and operation of building systems is going to increase the overall cost of the project.
Documentation & Fees	**None**	A very rigid documentation process is needed from early on the design process and fees have to be paid to the USGBC for administration.
Greening (Improving Building & System Efficiencies)	Tangible economic benefits through reduced operating and maintenance costs. Also potential benefits from improved working conditions and productivity.	Investments would be justified if payback time is short and if building owner is in a position to be compensated for his investment. These potential benefits dominate benefit/cost analyses of greening, but proof that LEED certification will improve worker attendance and productivity is anecdotal at best

Greening (Reducing Environmental Impacts)	Non-market benefits(reduced runoff, more reuse and recycled material) accruing to society at large.	There is no market value on these "externalities" so it is difficult to justify investment. Failure of market to value these may justify government intervention to promote these investments (e.g., tax credits). Puerto Rico is currently on track to apply tax credits for green project at the end of 2011.

Overall the cost of the project of the project was $ 6.1M (Construction Cost) with applying LEED strategies so the project was able to stay under budget. As stated before the owners are looking for a minimum of a Silver LEED Certification while staying under budget. Early on the design process the estimators were able to determine the cost of the building while performing a square foot estimate and then proceed to perform the actual estimate while applying LEED strategies; table 5 shows the differences between both estimates.

Table 5: Cost Differences by Applying LEED Strategies

System	Square Foot Estimate	LEED Estimate	Justification for Increase
Substructure	$525,000	$569,918.11	The increase was due to the total excavation not because of LEED Strategies.
Superstructure	$650,000	$774,630.42	A Post-tension concrete system was implemented for less impact on the environment.
Exterior Enclosure	$535,000	$791,168.45	The use of passive design strategies, especially windows to allow natural light.

Interiors	$430,000	$615,938.05	The use of environmentally friendly finishes like vinyl flooring.
Mechanical	$1,200,000	$1,608,748.46	High Efficiency Mechanical Systems.
Electrical	$650,450	$750,000.00	The use of occupancy sensors to reduce energy use.
Plumbing	$250,000	$345,000.00	Water Efficiency Fixtures.
Site Work	500,000	$655,000.00	Waste Management Plan and protection of the habitat.
Construction Cost	$4,740,450	$6,110,403.49	25% Increase

By applying LEED strategies we can see from table 5: there's a 25% increase in the total construction costs. This is not a final estimate of the project so this cost can certainly change for different systems, but it really helps the owner understand the challenges in applying sustainability in Puerto Rico when the current increases on a project's cost in the US are around 18%. Since the project has a limited budget of $7.5 M and the owner is really focus on increasing the life cycle of the building; achieving a LEED certification is recommended but it really the depends on the payback time specially once benefits (tax credits) for implementing sustainability start being implemented with a lot of strength in Puerto Rico.

3.10 Building's Energy Performance

In order to be able to achieve adequate energy efficiency, it is important for the MEP to create multiple solutions to fit and coordinate with other disciplines, especially architecture and structure.

In order to reduce energy use, passive design strategies were considered before the design of any HVAC systems. Reducing heat and humidity inside the building were seen as priorities. In order to reduce heat, design collaborations were made with the architect to include certain features in the building. Cool roofs and green roofs were integrated into both architectural designs. To reduce heat gain through windows, shading all over the façade was included in the architectural design as well. Vertical shading was used for the east and west sides and horizontal shading for the north and south sides of the building. The architect also took natural ventilation into consideration when designing the floor plan.

Possible energy sources were considered in designing the cooling system. It was determined that the HVAC system could be hooked up to chillers located close to the projects site. This would greatly save space and cost for the HVAC system. Heat loads were approximate using ASHRAE standards and the building floor plans. Internal heat loads included lighting, plugs, and occupants. External heat loads included solar radiation through windows, conduction through windows, and conduction through façade. Ventilation requirements were based on the larger of rate based on building area or rate based on number of occupants. A 30% increase was added for LEED points. Based on the heat loads, ventilation requirements, and indoor air quality goals, approximate duct sizes were calculated for each design.

At this moment the energy consumption of the building stands at is 551440 kW at the moment. This calculation was done with the use of Ecotech, and by comparing this project to others to baseline similar projects in Puerto Rico

3.11 Future Application of Photovoltaic Panels

At the end 2011, there's a possibility of being able to count on a state rebate for the construction costs of PV Panels. Puerto Rico supports the introduction of solar systems for power generation and they are planning to support these systems in an extensive program. Up to now Puerto Rico is producing its energy requirement with fossil fuels, which originates from the mainland and is responsible for a relatively high energy price.

There are different incentive steps, which are financially limited. Up to 50% of the system would be supported but max 200.000$ of building Costs. At present the break-even point of our system is reached after 8 years; table 6 shows the calculations for the payback in 8 years.

The dimension and the efficiency of our area have changed fundamentally. We are now using 3000 ft^2. The PV system is also installed above the atrium and serves as natural shading. At the same time the efficiency of the single panels has been raised. This project needs approx. 200.000 kWh annually according to the ecotec analysis. We are able to cover 45% of our power requirement by our system (90.000kWh).

Table 6. PV Panels Payback ($ US Dollars)

Year	0	1	2	3	4	5	6	7	8
Initial Cost	**-285000**								
Interest		-8550	-7621.31	-6609.88	-5520.04	-4347.29	-3086.93	-1734	-283.281
Insurance		-5415	-5523.3	-5633.77	-5746.44	-5861.37	-5978.6	-6098.17	-6220.13
O&M costs		-2907	-2965.14	-3024.44	-3084.93	-3146.63	-3209.56	-3273.75	-3339.23
Energy Savings		35985.6	36705.31	37439.42	38188.21	38951.97	39731.01	40525.63	41336.14
Energy Loss of PV Panels		-539.784	-367.053	-374.394	-381.882	-389.52	-397.31	-405.256	-413.361
Income State Rebate	114000								
Net Operation Income	-171000	-152426	-132198	-110401	-86945.8	-61738.7	-34680.1	-5665.62	25414.52

3.12 Benchmark Process

This project can be compare with the Sheraton Hotel located in Puerto Rico in order to determine its overall success relating to its LEED Certification. The Sheraton Hotel achieved a Platinum certification, while staying under budget and on schedule. Unfortunately the access to data from the Sheraton hotel is very limited so it is difficult to be able to provide a benchmark process for the project, but this can certainly be done with the commissioning process and LEED supervision of providing feedback to the project team success towards achieving the certification. Commissioning is use to ensure compliance of “fundamental building elements and systems” with the LEED guidelines.

3.13 Why or Why not LEED for this Project

Based on our current scope and budget, we think that we could realistically seek a minimum of a LEED Gold certification for the project. From our analysis, it appears that many of the “hard cost” expenses that might be necessary to gain LEED points are for things that we will be doing no matter what. For example, we will be installing the kind of high-efficiency HVAC system that is needed to pick up points for improved energy performance. We also plan to commission our new building systems to insure that they are working together and functioning properly.

Our architects, engineers and contractors would be requiring an additional of $50,000 to $100,000 to achieve LEED certification in order to track, document and report to the USGBC as part of the formal certification of the project.

I wonder if this a good use of funds? Or would we be better off putting this money into additional building improvements, such as a highly-efficient cooling system? What is the big difference between the certifications, does one level of a certification have a better environmental impact than the other?

There’s a lot on uncertainty when it comes down to the feasibility of achieving a LEED certification, this is mainly due to the fact that just because a project has a LEED Certification doesn’t not mean that it’s going to be sustainable throughout the life of the project. My recommendation to the owners is that because they are looking for energy efficiency buildings is to implement LEED strategies but while keeping the project under budget.

3.14 LEED Checklist

The LEED Checklist used for this project was the 2009 version for New Construction and Major Renovation. Table 3 summaries the results on the six categories applied to this project:

Table 5. Summary of LEED Checklist

Credit	Possible Points	Points Awarded
Sustainable Site	26	23
Water Efficiency	10	7
Energy and Atmosphere	35	18
Materials and Resources	14	8
Indoor Environmental Quality	15	14
Innovative and Design Process	6	4
Regional Priority	4	4
Gold Certification		78

At this moment by filling out the LEED checklist the project would obtain a Gold certification. This can certainly improve this by putting more emphasis in the Energy and Atmosphere credits, which can be done by optimizing our energy performance and developing on site renewable energy, the only problem is that by developing more efficient energy the project would be going over budget.

4. Conclusions & Recommendations

In terms of the construction of this project, one of the most important steps in determining the importance of a LEED Certification is the Cost/Benefits analysis, by being able to determine the cost/benefits for the Engineering School it was clear that a LEED certification was possible and different benefits would be available for the owners. There is something very important to point out and that is that LEED Certifications benefits are materialize after a certain period of time; the social, environmental and economy benefits become available once a payback for the owner has been reached. Also the benefits obtain from a LEED certification depend on the encouragement of the government and allowing different incentives to be available for the construction industry.

Puerto Rico’s currently energy use is based only on fossil fuels, so the introduction of sustainability and green engineering is something that can really give an advantage to projects in order to be more energy efficient. This does not mean that projects have to follow a LEED Certification, but they should continue to follow a “green” design thinking in order achieve its benefits.

After applying LEED strategies to the design of the Engineering School and identifying different challenges that Puerto Rico faces in terms of achieving sustainability; the future of sustainability in this Caribbean island is uncertain and many different outcomes can be hypothesized, and certainly not all the challenges can be cover in detail in this research. But in order to start overcoming these challenges, the research concluded that certain changes must take place in Puerto Rico:

- Education: All the professionals in the industry need to be educated and trained in the need, process, and approaches for creating high-performance green buildings.

- Incentives: Government needs to develop more financial incentives for high-performance construction. It was only in 2010 when the current Puerto Rico governor Luis Fortuño started a program with incentives established for green buildings.

- Construction Process: By having the entire AEC teams involved early in a construction process, the environmental impact of the project can be greatly reduce.

- Planning With the Triple Bottom Line: The use of triple bottom line in design and construction, this is done by clearly defining and balancing the economic, environmental and social benefits in the early stages of the project.

- Changing the mindset of the owners: Owners focus on buildings that have minimal construction cost and that are designed just to accomplish their functions with little or no attention given to the environmental impact.

Further research can be conducted by trying to determine why construction project owners are not fully pursing the goal of achieving a LEED certification. This could be done by further investigating the use of the triple bottom line in the design and construction stages of a project.

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7. Appendix

Table 6. LEED Checklist

LEED 2009 for New Construction and Major Renovation

Project Checklist

Project Name

Date

Y	N	?			
23	3		**Sustainable Sites**		Possible Points: 26
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
5			Credit 2	Development Density and Community Connectivity	5
	1		Credit 3	Brownfield Redevelopment	1
6			Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
3			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
2			Credit 4.4	Alternative Transportation—Parking Capacity	2
1			Credit 5.1	Site Development—Protect or Restore Habitat	1
1			Credit 5.2	Site Development—Maximize Open Space	1
	1		Credit 6.1	Stormwater Design—Quantity Control	1
1			Credit 6.2	Stormwater Design—Quality Control	1
	1		Credit 7.1	Heat Island Effect—Non-roof	1
1			Credit 7.2	Heat Island Effect—Roof	1
1			Credit 8	Light Pollution Reduction	1
7			**Water Efficiency**		Possible Points: 10
Y			Prereq 1	Water Use Reduction—20% Reduction	
2			Credit 1	Water Efficient Landscaping	2 to 4
2			Credit 2	Innovative Wastewater Technologies	2
3			Credit 3	Water Use Reduction	2 to 4
18		4	**Energy and Atmosphere**		Possible Points: 35
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
10			Credit 1	Optimize Energy Performance	1 to 19
4			Credit 2	On-Site Renewable Energy	1 to 7
2			Credit 3	Enhanced Commissioning	2
		2	Credit 4	Enhanced Refrigerant Management	2
2			Credit 5	Measurement and Verification	3
		2	Credit 6	Green Power	2
8	5		**Materials and Resources**		Possible Points: 14
Y			Prereq 1	Storage and Collection of Recyclables	
	3		Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
	1		Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
2			Credit 2	Construction Waste Management	1 to 2
2			Credit 3	Materials Reuse	1 to 2
			Materials and Resources, Continued		
1			Credit 4	Recycled Content	1 to 2
2			Credit 5	Regional Materials	1 to 2
1			Credit 6	Rapidly Renewable Materials	1
	1		Credit 7	Certified Wood	1
14	1		**Indoor Environmental Quality**		Possible Points: 15
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
1			Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
	1		Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
1			Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
1			Credit 7.2	Thermal Comfort—Verification	1
1			Credit 8.1	Daylight and Views—Daylight	1
1			Credit 8.2	Daylight and Views—Views	1
4			**Innovation and Design Process**		Possible Points: 6
1			Credit 1.1	Alternative Transportation	1
1			Credit 1.2	Heat Island Effec - Roof	1
1			Credit 1.3	Relocating Trees on Site	1
1			Credit 1.4	Use of Building for Educaton	1
			Credit 1.5	Innovation in Design: Specific Title	1
			Credit 2	LEED Accredited Professional	1
4			**Regional Priority Credits**		Possible Points: 4
1			Credit 1.1	Development Density and Community Connectivity	1
1			Credit 1.2	Stormwater Design - Quality Control	1
1			Credit 1.3	Light Pollution Reduction	1
1			Credit 1.4	Improve Energy Perfomance	1
78	9	4	**Total**		Possible Points: 110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110