Converting CCSD prototype elementary school into Leed(Tm) rated building

Jagandeep Singh

University of Nevada, Las Vegas
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- Appendix B, pages 164-333
- Appendix C, pages 335-356
- Appendix D, pages 358-425

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CONVERTING CCSD PROTOTYPE ELEMENTARY SCHOOL INTO LEED™ RATED BUILDING

by

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Bachelor of Architecture
Guru Nanak Dev University, Amritsar
1999

A thesis submitted in partial fulfillment of the requirements for the

Master of Architecture Degree
School of Architecture
College of Fine Arts

Graduate College
University of Nevada, Las Vegas
December 2006
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is approved in partial fulfillment of the requirements for the degree of

MASTER OF ARCHITECTURE

Examination Committee Chair

Dean of the Graduate College

Examination Committee Member

Examination Committee Member

Graduate College Faculty Representative
ABSTRACT

Converting CCSD Prototype Elementary School into LEED™ Rated Building

by

Jagandeep Singh

Alfredo Fernández-González, Thesis Committee Chair
Assistant Professor of Building Science
University of Nevada, Las Vegas

The study focuses on researching whether CCSD Prototype Elementary School can be turned into a Leadership in Energy and Environmental Design (LEED) building without major design modifications, to the materials and orientation of the building. The study discusses the need for a prototype building, which might not be suitable for the site. The study discusses the need of green building, the major green building rating systems in use today and the reasons for choosing LEED. LEED rating system was studied in detail and the prototype elementary school building was evaluated over the LEED criteria. Then the school building was recommended with minor changes in design and materials and the cost and the payback period for certain credits was discussed. Finally, the results showed that the CCSD prototype elementary school can be converted into LEED platinum rated building with an additional cost of 3.6 million dollars.
TABLE OF CONTENTS

ABSTRACT .............................................................................................................................................. iii
LIST OF TABLES ..................................................................................................................................... vi
LIST OF FIGURES ................................................................................................................................. vii
ACKNOWLEDGMENTS ........................................................................................................................ viii

CHAPTER 1  INTRODUCTION ............................................................................................................ 1
   Clark County School District Organization ..................................................................................... 2
   Prototype Elementary School ........................................................................................................... 3
   Energy and Buildings ........................................................................................................................ 9

CHAPTER 2  GREEN BUILDING RATING SYSTEMS ................................................................... 11
   Building Research Establishment Environmental Assessment Method .................................... 11
   Building Environment Performance Assessment Criteria ............................................................ 15
   Collaborative for High Performance Schools ................................................................................ 15
   Why LEED? ..................................................................................................................................... 18

CHAPTER 3  LEED .............................................................................................................................. 19
   LEED and Rating System ............................................................................................................... 19
   Sustainable Sites ............................................................................................................................. 25
   Water Efficiency ............................................................................................................................... 30
   Energy & Atmosphere ..................................................................................................................... 32
   Materials & Resources .................................................................................................................... 37
   Indoor Environmental Quality ........................................................................................................ 41
   Innovation & Design Process ......................................................................................................... 47

CHAPTER 4  EVALUATING CCSD PROTOTYPE SCHOOL .............................................................. 49
   Methodology .................................................................................................................................... 49
   Evaluating CCSD Prototype Elementary School to LEED ......................................................... 49

CHAPTER 5  MATERIALS AND CALCULATIONS FOR SCHOOLS ............................................. 73
   Sustainable Sites ............................................................................................................................ 73
   Water Efficiency .............................................................................................................................. 85
   Energy & Atmosphere ..................................................................................................................... 94
   Materials & Resources .................................................................................................................. 100
   Indoor Environmental Quality ...................................................................................................... 109
   Innovation & Design Process ....................................................................................................... 115

CHAPTER 6  CONCLUSIONS, AND RECOMMENDATIONS .......................................................... 117

CHAPTER 7  SUMMARY ...................................................................................................................... 122
   Key Findings .................................................................................................................................. 123
   Recommendations for future work. ............................................................................................... 123
<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>BREEAM Rating System requirements</td>
<td>13</td>
</tr>
<tr>
<td>Table 2</td>
<td>BREEAM School Points System</td>
<td>14</td>
</tr>
<tr>
<td>Table 3</td>
<td>CHPS Rating Criteria</td>
<td>17</td>
</tr>
<tr>
<td>Table 4</td>
<td>Sustainable Site Credit Breakdown</td>
<td>25</td>
</tr>
<tr>
<td>Table 5</td>
<td>Water Efficiency Credit Breakdown</td>
<td>30</td>
</tr>
<tr>
<td>Table 6</td>
<td>Energy &amp; Atmosphere Credit Breakdown</td>
<td>32</td>
</tr>
<tr>
<td>Table 7</td>
<td>Materials &amp; Resources Credit Breakdown</td>
<td>37</td>
</tr>
<tr>
<td>Table 8</td>
<td>Indoor Environmental Quality Credit Breakdown</td>
<td>42</td>
</tr>
<tr>
<td>Table 9</td>
<td>Innovation &amp; Design Credit Breakdown</td>
<td>47</td>
</tr>
<tr>
<td>Table 10</td>
<td>LEED Evaluation</td>
<td>50</td>
</tr>
<tr>
<td>Table 11</td>
<td>Design case (July)</td>
<td>86</td>
</tr>
<tr>
<td>Table 12</td>
<td>Baseline design (July)</td>
<td>86</td>
</tr>
<tr>
<td>Table 13</td>
<td>Wastewater volume for design case</td>
<td>89</td>
</tr>
<tr>
<td>Table 14</td>
<td>Wastewater volume for baseline design</td>
<td>89</td>
</tr>
<tr>
<td>Table 15</td>
<td>EPACT Fixture Rating</td>
<td>90</td>
</tr>
<tr>
<td>Table 16</td>
<td>Water use volume for design case</td>
<td>91</td>
</tr>
<tr>
<td>Table 17</td>
<td>Water use volume for baseline case</td>
<td>92</td>
</tr>
<tr>
<td>Table 18</td>
<td>Letter Template for Recycled content Materials</td>
<td>105</td>
</tr>
<tr>
<td>Table 19</td>
<td>Letter Template for Regional Materials</td>
<td>107</td>
</tr>
<tr>
<td>Table 20</td>
<td>Letter Template for Rapidly Renewable Materials</td>
<td>108</td>
</tr>
<tr>
<td>Table 21</td>
<td>Calculations for single occupancy non perimeter spaces</td>
<td>114</td>
</tr>
<tr>
<td>Table 22</td>
<td>Calculations for multi occupancy non perimeter spaces</td>
<td>114</td>
</tr>
<tr>
<td>Table 23</td>
<td>Results of LEED evaluation</td>
<td>118</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure 1  Nevada County Map.................................................................2
Figure 2  Region Map of CCSD.............................................................4
Figure 3  Typical Site Plan for prototype elementary school used by CCSD......6
Figure 4  Typical front elevation of prototype elementary school..................6
Figure 5  Floor plan for the prototype elementary school............................7
Figure 6  Bio-Aquifer storm system.......................................................80
Figure 7  Diagram of the StormTreat System..........................................82
Figure 8  Summary of Water Quality Monitoring Results of the StormTreat System...82
Figure 9  Wastewater treatment diagram................................................88
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CHAPTER 1

INTRODUCTION

The purpose of this study is to determine whether an already designed CCSD Prototype Elementary School can be converted into a Leadership in Energy and Environmental Design (LEED) rated building without any major changes to design. The need for changing the CCSD Elementary school to a LEED building is to achieve energy savings and to minimize environmental effects by the construction of the school. Since there are many elementary schools being built each year, even a small amount of saving or environmental benefits will be multifold because of the large number of schools built with the same prototype. The study will try and achieve the highest possible LEED certification for the school. The study will also calculate the additional initial cost of converting into LEED rated building.

The first chapter focuses on the use and history of Prototype Elementary schools in Clark County, Nevada. The need for the prototype schools arising from booming population growth over the last fifteen years. It will further elaborate the role of Clark County School District. Finally, the study will discuss the need and urgency for more green buildings and the reasons for choosing elementary school over other grade level schools for the study.

The second chapter focuses on the green building rating systems. The green building rating systems discussed are BREEAM, BEPAC, CHPS and LEED and the reasons for choosing LEED rating system.

The third chapter explores the United States Green Building Council (USGBC) organization, LEED rating system and its history. The sections and all credits of the LEED rating system are discussed.

The fourth chapter discusses the methodology used and evaluates different LEED sections and credits and see the requirements for completing the section and whether a particular
credit will be fulfilled or not. This chapter provides a blueprint for pursuing the credits that can be completed by the current elementary school. This chapter further evaluates the methods used to complete the credits requirements.

The fifth chapter provides the calculations, material selection information and any minor design changes that are needed for the completion of the different credits of the LEED. This chapter also provides the cost of the changes and the energy savings or environmental benefits achieved by completing a certain credit.

The sixth chapter provides conclusions and discusses the credits that are completed. The total cost of the all the design changes. Finally it discusses which credits can be dropped and which certification can still be achieved.

The seventh chapter provides a summary of the study, showing which certification is achieved. The limitations of the findings, and future research ideas.

Clark County School District Organization

Clark County School District (CCSD) is responsible for the planning, construction, maintenance and running of schools in the Clark County, Nevada (See Figure 1).

Figure 1 Nevada County Map (Clark County, Nevada)
CCSD is divided into five regions – East, Northeast, Northwest, Southeast, and Southwest (See Figure 2). Each region has its own superintendent who oversees the maintenance and operation of schools in that particular region. (CCSD Regions, 2006). CCSD mission statement is:

"Clark County School District students will have the knowledge, skills, attitudes and ethics necessary to succeed academically and will practice responsible citizenship" (CCSD Accountability Department, 2005).

In Clark County, there are 180 elementary schools, 48 middle/junior high schools and, 35 high schools (Clark County School District Directory, 2006). There are approximately four elementary schools for each middle school and there are five elementary schools per high school. This highlights the need for better designed elementary schools. The 180 elementary schools (70 year round), help educate around 150,000 students each year. Each year CCSD constructs five to six new elementary schools (Clark County School District 2006).

Prototype Elementary School

Clark County is one of the fastest growing Counties in the country. More than 5000 people move to Clark County each year (Clark County, Nevada 2006) and currently Clark County is home to 1.8 million people (Clark County, Nevada 2006). Due to the magnitude of migration to Clark County, the schools in the Las Vegas valley are overcrowded, as demonstrated by the fact that out of 180 elementary schools a total of 70 are year-round. In a year-round school, the student population is divided into four groups; with each group getting a three month break once a year at different times so as to keep the total number of students in the school under the maximum permitted by building codes and by design. In addition, some elementary schools are overcrowded. Generally elementary schools are designed for 500-700 students per the education specifications and the program of the current prototype elementary school. The Alamo Elementary School and Bell Elementary School are prime examples of the over-crowding of schools, as each has a student enrollment of over 1000 students (CCSD Accountability, 2005).
Figure 2  Region Map of CCSD (CCSD Regions, 2006)

Clark County School District
Regional Boundaries

Outlying Schools

Indian Springs
Indiant Springs ES
Indian Springs MS
Mt. Charleston
Lundy ES
Glendale
Perine ES
Logandale
Baker, Grant ES
Overton
Manzana Valley HS
Virgin Valley
Boulwer, Joseph ES
Virgin Valley HS
Blue Diamond
Blue Diamond HS
Goodsprings
Goodsprings ES
Goodsprings
Sandy Valley
Sandy Valley ES/MS

Clark County School District
Regional Boundaries
Revised 08/04

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CCSD is using portable classrooms to accommodate more enrollment of students in the schools. These portable classrooms are generally kept over the play area and thus decrease the play area available to children (Clark County School District 2006). Because of the increasing demand for more schools, and the unexpectedly high enrollment, CCSD has not been able to construct enough schools each year. CCSD has to catch up every year with the growing population. To overcome this shortage of elementary schools, in 1996 a novel concept of approaching the design and construction of new schools was adopted. The concept used is called “prototype design”. Prototype designs are generally done in a couple of variations. The first variation is to divide the school into different units (administration, recreation, classrooms with different age groups), with each unit designed separately and then placed together according to the site constraints and/or programming requirements. In the second variation, the school is designed as a single building, and then placed on the site according to the orientation and access locations, trying also to respond to other important features of the site. Therefore, the challenge in the design of the prototype school is that it should be flexible enough to accommodate different orientations or special site features where the school is to be built.

Prototype or stock plans are not new. There has been a documented use of prototype designs since the late 1920s in the State of Virginia (Task Force to Joint Committee on Educational Facilities - Public Relations Committee 2004). As much as 15 other states have used this strategy since then (Task Force to Joint Committee on Educational Facilities - Public Relations Committee 2004).

The prototype elementary school is a concept that is being used to cut cost, save time, and streamline the design and construction processes. In prototype elementary schools, the building is designed to be flexible enough to accommodate on-going changes in design and construction delivery as well as to address the concept of energy conservation (Lanuke, Dean 2005). The figures 3, 4 and 5 are typical site plan, elevation and plan of a prototype elementary school.
Figure 3  Typical Site Plan for prototype elementary school used by CCSD (Dr. C. Owen Roundy Elementary School)

Figure 4  Typical front elevation of prototype elementary school
Figure 5  
Floor plan for the prototype elementary school
Clark County School District has been using the prototype elementary school design for 11 years. The late Mr. Elton Dale Scheideman (Director of New School and Facility Planning) was a pioneer in the use of Prototype designs for Clark County (Clark County School District 2006). The first prototype elementary school designed for Clark County was built in the year 1996.

The success of the first prototype elementary school meant that more prototype schools were to follow. Currently, the CCSD uses prototype designs for all building types (i.e., Elementary Schools, Middle Schools and, High Schools). The designs have been refined and revised over a period of time and have come to complement the needs of the CCSD (Lanuke, Dean 2005).

Some of the advantages of the prototype design are cost savings, time savings, and a smooth and fast process from start to end. The cost savings are achieved by reducing the design fee for redesigning the school. Since architectural and engineering fees cost around 6-7% for the traditionally designed scenario, using the prototype reduces this fee to around 4% (Lanuke, Dean 2005). The reduction in project fees saves the school district around half million dollars per school at the current time. The fee changes with the construction cost, and the construction cost has been escalating in Clark County (Clark County School District, 2006). Time savings are achieved because only site design or minimal building design has to be done. Use of prototype elementary school also saves cost and time to the contractor by giving the same information which has been refined after the first round of schools is built. Subsequent schools typically have fewer problems in the construction drawings and reduces Request for Information (RFI) from the contractor, and since the contractor has already built the school before, he is able to work a better schedule for the school. Thus prototype elementary school makes a smooth process for construction and scheduling, while minimizes the time and cost for the conceiving to the finish of the project (Lanuke, Dean 2005).

The prototype design has its own set of drawbacks and problems. The biggest problem with prototype design is the flexibility in the design. Since the prototype school is designed without being site specific, there is not enough flexibility in the design for the site, some things have to be sacrificed when trying to fit the school building on the site. There is loss of orientation, building might have to be placed so that they are not the best option for energy savings, this can lead to
more cost in energy consumption over the period of the building and cost more than the savings reached by using the prototype elementary school. Also the use of the same type of design over a region of the size of Clark County will make the schools non-distinct, thereby reducing community pride (Lanuke, Dean 2005).

Prototype schools designs have to be carefully planned and scheduled; otherwise the benefits can be overrun by the problems posed using it. By careful planning and providing the flexibility in the design of the school, the prototype can be a significant source of energy saving and cost effective measure to design and construct schools.

Energy and Buildings

Green design is not a superficial process. It is not merely adding green materials here and there. Green design requires much more pre-planning and research, with closer collaboration between design and engineering, to achieve extraordinary energy saving and environmental benefits from conventional buildings. Before 1970, the American people were not concerned about conservation and ecological effects of their activities on the environment. In fact, the American public thought that the natural resources were limitless and that nothing can damage the environment. This all changed with the Oil Embargo of 1973, when the energy crisis hit in the United States and Europe. There was immense marketplace pressure to reduce the energy demands of buildings and industries. Energy-efficient building design was in its early stages of development and the early methods of the design process were not very successful. Many buildings were nearly sealed off to prevent air infiltration and heat loss; this resulted in reduced fresh air in the buildings. This has determinable effect on the building occupants' health, especially respiratory problems. Further, the schools got rid of the windows to reduce heat loss or gain. This reduced fresh air and natural light to the classrooms. The results were reduced learning potential of kids, and even less opportunities for energy saving. There were increased number of sick days and less productive days. The electricity used in buildings account for 25% of the energy consumed by the buildings (Drummey Rosane Anderson, Inc., Architects 2004).
Energy Efficient Design

Energy Efficient Design emphasizes a combination of highly effective space conditioning equipment and controls with a tight building envelope and an efficiently designed ventilation system. With ASHRAE 90.1, the ventilation air requirement was tripled. ASHRAE 90.1 has become a standard for LEED Certification and is one of the requirements in LEED Certification (Drummey Rosane Anderson, Inc., Architects, 2004).

High-performance Design

High-performance design is an integrated design approach that emphasizes the latest technologies to achieve optimal performance. High-performance design requires thinking “outside the box” to create a facility that meets its intended uses and operations while conserving resources and minimizing energy use. Sustainable Buildings Industry Council (SBIC) has developed High Performance School Buildings (HPSB) (Drummey Rosane Anderson, Inc., Architects, 2004).

Sustainable Design

Sustainable design addresses the long-term concerns of selecting the most appropriate technologies and materials and using them in a manner that avoids depleting the earth’s resources. Sustainable design requires the designer to take into consideration material durability and sustainability, which involves not only the energy and environmental costs to replace the material, but its availability and rate of regeneration. In today’s “throwaway” society, sustainability is a shift in thinking to make decisions based on “total cost”, including health and protection of the environment, not just strict economic factors (Edwards, Brian, 1998).
CHAPTER 2

GREEN BUILDING RATING SYSTEMS

Since the idea of making buildings energy efficient and more environmentally suitable for the user was implemented, there was a need for rating the buildings. There are several Green Building Rating Systems. Some of the more popular Rating Systems are discussed below.

Building Research Establishment Environmental Assessment Method (BREEAM)

BREEAM is a green rating product based on UK Building Industry needs. Its first version was developed in 1990. Since then it has grown rapidly in the UK and the Europe. With its constant development over the time and users ranging from Government organizations to Non-departmental public bodies and from commercial developers to architects, engineers and the mangers of the building systems, it has become one of the foremost environmental assessment designing and, specifying tool for the UK market. (HEEP1, 2006)

BREEAM's success stems from its unique ability to cover a wide range of environmental issues within one assessment, and to present the results in a way that is widely understood by those involved in property procurement and management (BREEAM, 2006).

BREEAM assesses the performance of buildings in the following areas:

- Management: overall management policy, commissioning site management and procedural issues
- Energy use: operational energy and carbon dioxide (CO2) issues
- Health and well-being: indoor and external issues affecting health and well-being
- Pollution: air and water pollution issues
• Transport: transport-related CO2 and location-related factors
• Land use: greenfield and brownfield sites
• Ecology: ecological value conservation and enhancement of the site
• Materials: environmental implication of building materials, including life-cycle impacts
• Water: consumption and water efficiency

Credits are awarded in each area according to performance. A set of environmental weightings then enables the credits to be added together to produce a single overall score. The building is then rated on a scale of PASS, GOOD, VERY GOOD or EXCELLENT, and a certificate awarded that can be used for promotional purposes (BREEAM 2006).

BREEAM offers a range of benefits, from environmental to financial.
• Demonstrating compliance with environmental requirements from occupiers, planners, development agencies and developers
• Environmental improvement: in support of a wider corporate strategy or as a standalone contribution
• Occupant benefits: to create a better place for people to work and live
• Marketing: as a selling point to potential tenants or customers
• Financial: to achieve higher rental incomes and increased building efficiency
• Best practice: to provide a thorough checklist or tool for comparing buildings
• Client request: responding to the requirements of users

BREEAM has different rating systems for different building types from Offices, Homes, Industrial Units, Retail Units and Schools. These building types have different rating systems and different assessors who are more qualified to the particular type of building type.

The BREEAM School Rating is based on the points systems. To achieve a certain level of rating the school must achieve the minimum required points for that particular level. BREEAM Schools assesses new build and refurbishment school projects in line with DfES requirements.
Assessment criteria are based on environmental performance levels rather than specific design solutions, giving the design team and client maximum flexibility to select appropriate systems and innovative solutions whilst ensuring high environmental performance standards. (BREEAM, 2005).

<table>
<thead>
<tr>
<th>Rating Level</th>
<th>Minimum Points Required</th>
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<tr>
<td>PASS</td>
<td>25</td>
</tr>
<tr>
<td>GOOD</td>
<td>40</td>
</tr>
<tr>
<td>VERY GOOD</td>
<td>55</td>
</tr>
<tr>
<td>EXCELLENT</td>
<td>70</td>
</tr>
</tbody>
</table>

BREEAM assessment process is divided into six steps. The first step is when the enquiries are made and request for information is directed to BRE. Second step is assessment contract which is between assessor organization and the client. In the third step, assessors offer pre-assessment consultancy so that higher BREEAM school rating can be achieved. Fourth step is the Assessment Meeting, in which the client, the assessor and design representatives create the required information schedule. Then the final assessment is done and sent to BRE. In the fifth step, BRE invoices the client and in the final step the assessment of the records is published and certificates issued to the client (BREEAM, 2005). There are 8 sections, which include 65 credits and a maximum of 108 points can be earned on a school project (BREEAM, 2005).
<table>
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<tr>
<th>Credit Title</th>
<th>Credits</th>
<th>Maximum Points</th>
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<tr>
<td>Management Section</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Health and Wellbeing Section</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Energy Section</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Transport Section</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Water Section</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Materials and Waste Section</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>Landuse Ecology Section</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Pollution Section</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total Points</strong></td>
<td><strong>65</strong></td>
<td><strong>108</strong></td>
</tr>
</tbody>
</table>

Management Section has a total of 12 credits from which a total of 20 points can be used towards BREEAM certification.

Health and Wellbeing Section has a total of 16 credits from which a total of 19 points can be used towards BREEAM certification.

Energy Section has a total of 4 credits from which a total of 15 points can be used towards BREEAM certification.

Transport Section has a total of 4 credits from which a total of 5 points can be used towards BREEAM certification.

Water Section has a total of 5 credits from which a total of 7 points can be used towards BREEAM certification.

Materials and Waste Section has a total of 8 credits from which a total of 17 points can be used towards BREEAM certification.

Landuse and Ecology Section has a total of 9 credits from which a total of 13 points can be used towards BREEAM certification.
Pollution Section has a total of 7 credits from which a total of 12 points can be used towards BREEAM certification.

Building Environment Performance Assessment Criteria (BEPAC)

BEPAC was founded in 1987. Its aim is to improve the quality of building performance by encouraging the use and development of environmental analysis and prediction methods in building design and assessment. BEPAC is the UK affiliate of the International Building Performance Simulation Association (IBPSA). To accomplish this, BEPAC is: working towards the standardization and use of appropriate building performance analysis and prediction methods; encouraging a dialogue between users, developers and researchers in the analysis of building performance and related fields; promoting R&D and education in its fields of interest; sponsoring or co-sponsoring technical meetings, conferences and professional development seminars; promoting co-operation between members of BEPAC and collaboration with other organizations and institutions; encouraging the production of technical publications (Architecture.com – RIBA, 2001).

Collaborative for High Performance Schools (CHPS)

The Collaborative for High Performance Schools aims to increase the energy efficiency of schools in California by marketing information, services, and incentive programs directly to school districts and designers. The Collaborative's goal is to facilitate the design of high performance schools: environments that are not only energy efficient, but also healthy, comfortable, well lit, and containing the amenities needed for a quality education (CHPS 2006).

The goals of CHPS are to:

- Increase the performance of California students with better-designed and healthier facilities.
- Raise the level of awareness in California districts of the impact and advantages of high performance school design.
• Provide design professionals with better tools to facilitate effective design.
• Increase the energy and resource efficiency of California schools.
• Reduce peak electric loads (CHPS 2006).

CHPS began in November 1999, when the California Energy Commission called together Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison to discuss the best way to improve the performance of California's schools. Out of this partnership, CHPS grew to include a diverse range of government, utility, and non-profit organizations with a unifying goal to improve the quality of education for California's children. CHPS has expanded its focus beyond California, developing a national version of the manuals as well as other state-specific versions. In early 2002, CHPS incorporated as a non-profit organization, further solidifying its commitment to environmentally sound design that enhances the educational environment for all schoolchildren (CHPS 2002).

The CHPS Criteria establish the standards that define a high performance school. The system provides a convenient means of identifying a high performance school, while offering districts and designers the flexibility to create a facility that fits their budget, timeline, and educational goals. "High performance school" refers to the physical facility — the school building and its grounds. Because schools are complicated structures, high performance design covers a broad and diverse range of disciplines and choices. It is a design philosophy focused on choices that improve the learning environment and save resources. Some choices are essential and others are discretionary; it's important to keep the range of choices in perspective and focus on the key design issues. Schools are unique buildings that every day house one-fifth of the population: almost 6 million children and more than 200,000 teachers and support staff. There are few other settings in which 20 to 30 people occupy such a small space or work on such a wide a range of activities as in a school classroom. Occupant density is approximately four times as great as a typical office building (CHPS, 2006).

CHPS rating system is specifically designed for rating schools and is not applicable to other building types. CHPS rating system requires 28 points from a total of 81 points for
certification as a High performance School. The CHPS rating system is divided into six sections (The Collaborative for High Performance Schools, 2001).

<table>
<thead>
<tr>
<th>Category</th>
<th>Credits</th>
<th>Maximum Points</th>
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<tr>
<td>Site</td>
<td>5</td>
<td>14 points</td>
</tr>
<tr>
<td>Water</td>
<td>2</td>
<td>5 points</td>
</tr>
<tr>
<td>Energy</td>
<td>5</td>
<td>24 points</td>
</tr>
<tr>
<td>Materials</td>
<td>6</td>
<td>11 points</td>
</tr>
<tr>
<td>Indoor Environmental Quality</td>
<td>6</td>
<td>17 points</td>
</tr>
<tr>
<td>District Resolutions</td>
<td>6</td>
<td>10 points</td>
</tr>
</tbody>
</table>

Each Category is divided into groups. Each group has different credits and could also have a pre-requisite for getting points from those different credits. No points are awarded for pre-requisite.

Site – There are five groups in this category and deals with site related issues for achieving high performance for schools. A total of 14 points can be achieved from this category.

Water – There are two groups in this category and deals with water use reduction for achieving high performance for schools. A total of 5 points can be achieved from this category.

Energy – There are three groups in this category and deals with design of energy efficient schools. A total of 33 points can be achieved from this category.

Materials – There are two groups in this category and deals with the use of sustainable materials and environmentally safe materials. A total of 11 points can be achieved from this category.
Indoor Environmental Quality – There are four groups in this category and deals with improving the indoor environmental quality of the school. A total of 15 points can be achieved from this category.

District Resolutions – There are five groups in this category and deals with the goals of the school district. These goals are set to achieve maximum benefit for the users of the school. A total of 10 points can be achieved from this category.

Why LEED?

All the Rating Systems discussed above are great reference point from which to judge the degree of “greenness” of a proposed design. Of all the green rating systems LEED is the only system that is designed nationally for the specific needs of the United States market. BREEAM and BEPAC are designed for the United Kingdom market and are more suitable for the climate and culture of UK. While CHPS criteria is similar to the US Green Building Council’s (USGBC) LEED™ 2.0 Rating System. However, no interchangeability between the two systems is expressed or implied. A school qualifying for CHPS may contain many of the elements needed for LEED™ certification, but there is no interchangeability between the two systems. Schools qualifying for CHPS may or may not qualify for LEED and vice versa. Teams wishing to pursue a LEED™ rating do so independently (The Collaborative for High Performance Schools, 2001). CHPS is more specific to the California market and is not as stringent as LEED. With CHPS the maximum points needed for certification are 28, while LEED provides more than 4 different levels of certification. Moreover LEED is more nationally and internationally recognized, therefore, we will be using LEED to evaluate CCSD Prototype Elementary School.
CHAPTER 3

LEED

Foremost in this section will be reviewing the LEED rating system, which will include the origins and the development of LEED and its current state. Finally in the end we will be discussing about sustainable and green schools in US and some of their salient features or energy savings achieved over conventional designs for schools.

LEED and Rating System

United States Green Building Council (USGBC) is the leading national, non-profit organization on green building / sustainable design that was formed in 1993. It has a voluntary, diverse membership that operates on consensus principles. It is a developer and administrative authority of the LEED Green Building Rating System. Its purpose is to integrate, lead and educate. (USGBC)

Mission Statement – “USGBC (United States Green Building Council) is the nation’s foremost coalition of leaders from across the building industry working to promote buildings that are environmentally responsible, profitable and healthy places to live and work.” (USGBC)

Council members work together to develop LEED products and resources, the Greenbuild annual International Conference and Expo, policy guidance, and educational and marketing tools that support the adoption of sustainable building. Members also forge strategic alliances with key industry and research organizations and federal, state and local government agencies to transform the built environment.

Buildings impact people’s lives and the health of the planet. The USGBC promotes the design, construction and operation of buildings that are environmentally responsible, profitable, and healthy places to live and work. USGBC serves its members and the community through the
development of industry standards, design practices and tools, policy advocacy, information exchange and information. (USGBC)

Council programs are:

- Committee-Based
- Member-Driven
- Consensus-Focused

Council membership has grown to over 4000 leading organizations. Membership is comprised of visionary leaders and is highly diverse group of organizations ranging from Building Product Manufacturers to State, Local and Federal Governments. The strength and diversity of the USGBC significantly enhances the resources available and the effectiveness of member efforts to improve the quality of our buildings. (USGBC)

In addition to having a centralized organization there are regional chapters of USGBC in different parts of the country which try and develop Green Building Design awareness in their region and promote the goals of LEED. Southern Nevada has USGBC Las Vegas as the regional chapter and is actively involved in promoting LEED. (USGBC Regional Chapter)

The need for the environmental and energy saving system was felt because the buildings are major source of pollutants and use a major chunk of energy. According to Department of Energy, buildings account for 49% of sulfur dioxide emissions, 25% of nitrous oxide emissions and 10% of particulate emissions which damage air quality. The buildings also use 30% of total energy used and 60% of total electricity. (USGBC)

The Leadership in Energy and Environmental Design (LEED) Green Building Rating system was developed in 1995 by USGBC after realizing the need for sustainable building industry standard. The LEED system was developed by USGBC members on a voluntary basis. The LEED system was made after reviewing the existing rating systems like Building Research Establishment Environmental Assessment Method (BREEAM) and Building Environment Performance Assessment Criteria (BEPAC) developed in United Kingdom. (USGBC)
LEED is a tool for green design to help design teams and owners determine green project goals, identify green project goals, identify green design strategies, measure and monitor progress, and document success. LEED is a predominantly performance based standard. (USGBC)

The goals of LEED System are to help the design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants. (LEED Technical Review Workshop NC-2.1)

The Benefits of LEED System in design are

- Reduce destruction of natural areas, habitats, biodiversity - By choosing a site that is already developed the impact on forests, fields and other natural areas will be greatly reduced. Construction or development near natural areas adversely affects them. (LEED Technical Review Workshop NC-2.1)

- Reduce air pollution, water pollution, and solid waste - By increasing energy efficiency the consumption can be reduced by as much as 50% without sacrificing comfort or services. Construction produces 2 to 2.5 pounds of waste per square foot. Recycling the construction waste saves a lot of resources and saves space that is needed for landfills. (LEED Technical Review Workshop NC-2.1)

- Reduce depletion of finite recourses - Using recycled materials can help save 30-40% raw materials. (LEED Technical Review Workshop NC-2.1)

- Healthier and safer indoor environments - Improving the quality of indoor environments improves health, productivity and quality of life. (LEED Technical Review Workshop NC-2.1)

- Healthier outdoor environments - Reducing the demand for large scale infrastructure will lead to community and municipal benefits and the more emphasis on mass transit systems will reduce transportation development and maintenance burden in adding to cutting back on green house effect gases. (LEED Technical Review Workshop NC-2.1)

- Personal satisfaction - Owners, contractors, designers and occupants have a sense of personal satisfaction in doing the right thing. (LEED Technical Review Workshop NC-2.1)
For each LEED rated project the economic benefits can be presented

- Reduction in Operating Costs
- Reduction in Project Costs
- Municipal Economic Advantages
- Enhance Asset Value & Profits
- Improved Productivity – Estimated to be $29-168 billion in national productivity loss due to bad indoor environment
- Reduction in absenteeism and turnover – by providing healthy workplace.
- Reduction in Liability – Improve risk management.
- Increases in retail sales with daylighting by 40%.

In the beginning the LEED System was made as a single system which encompassed all the building types. It was called LEED Version 2.0 and was launched in 2000. In 2004 with the need of change to the different sections of the building construction, USGBC released LEED – NC 2.1.

In this version, other building systems were released that were more specific to the needs of the different segments of the industry. The following systems were released in this version. (LEED Technical Review Workshop NC-2.1)

- LEED-NC (LEED for New Construction) – for building owners and design teams that address the new building design and construction or major renovation process. (LEED Technical Review Workshop NC-2.1)
- LEED-EB (LEED for Existing Buildings) – for building owners and service providers that address building orientation and on-going upgrades and performance improvements. (LEED Technical Review Workshop NC-2.1)
- LEED-CI (LEED for Commercial Interiors) – for building owners, tenants and design teams that address commercial interiors design and installation process. (LEED Technical Review Workshop NC-2.1)
• LEED-CS (LEED for Core & Shell) – For developers and design teams that address the new building design and construction process for buildings where the interiors are not part of the initial design process. (LEED Technical Review Workshop NC-2.1)

• LEED-H (LEED for Homes) – For residential building owners, developers and design teams that address the new residential building design and construction process. (LEED Technical Review Workshop NC-2.1)

• LEED-ND (LEED for Neighborhood Developments) – For residential building owners, developers and design teams that address the new residential building design and construction process. (LEED Technical Review Workshop NC-2.1)

The LEED rating system is designed to be updated to the needs and requirements of industry and environment. Therefore currently LEED – NC 2.2 is being developed. Also different building types needs guides for specific project types and requirements will vary for each building type. Therefore LEED is coming up with new Application Guides for specific building types. The following guides are under development for LEED version 2.2.

• Lodging
• Campus
• Retail
• Healthcare
• Laboratories
• Schools

LEED-NC is currently the most used LEED rating system. USGBC has come up the LEED accreditation exam which certifies the knowledge of the person to handle a LEED project. Currently, LEED Accreditation version 2.1 is using LEED-NC v2.1 for the certification. (LEED Technical Review Workshop NC-2.1)

LEED rated buildings are in 13 countries and in 50 states with over 225 million gross square foot of built area. There are approximately 1900 LEED registered projects out of which
215 certified projects. The most registered projects are in California with 306 projects. Nevada has 15 registered projects. There is a lot of interest in the international community about LEED. The first LEED project outside USA is built in India a LEED Platinum rated building. Other countries like Canada, China, Japan, Spain, Mexico, Italy are also building LEED registered projects. The LEED Certification is divided into four different levels.

- LEED Certified – 26 to 32 points
- LEED Silver – 33 to 38 points
- LEED Gold – 39 to 51 points
- LEED Platinum – 52 or more points

The maximum number of points a project can have is 69. The points are awarded in 6 different categories. Each category has a different number of credits which can be earned after that credit is implemented in the project. The following are the six categories for the LEED project:

- Sustainable Site – 1 prerequisite and 14 possible points
- Water Efficiency – 5 possible points
- Energy & Atmosphere – 3 prerequisite and 17 possible points
- Materials & Resources – 1 prerequisite and 13 possible points
- Indoor Environmental Quality – 2 prerequisite and 15 possible points
- Innovation & Design Process – 5 possible points

Total project points – 69 possible points.

Some of the sections have prerequisite, which means that the prerequisite has to be satisfied in order to get any points from that section. No point is added to the building certification for completing the prerequisite. Some sections have more than one prerequisite. All of those have to be satisfied in order to be eligible to get any point from that section. Each credit is based on design intent, which is towards achieving a green step. The credits are satisfied by completing the requirements for each credit. These are to be completed from contractor to the architect, depending upon the type of green credit being pursued. (LEED Technical Review Workshop NC-2.1)
Sustainable Sites

The first section of the LEED Rating System is called Sustainable Sites, and has 1 prerequisite and 8 Credits from which a total of 14 points can be gained for using towards the Building Rating System. A lot of points can be achieved by selecting a site which will have least impact on the environment. The breakdown of the credits is as follows:

Table 4 Sustainable Site Credit Breakdown (LEED Reference Guide NC 2.1, 2003)

<table>
<thead>
<tr>
<th>Credit</th>
<th>Title</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite 1</td>
<td>Erosion and Sedimentation Control</td>
<td></td>
</tr>
<tr>
<td>Credit 1</td>
<td>Site Selection</td>
<td>1 point</td>
</tr>
<tr>
<td>Credit 2</td>
<td>Urban Redevelopment</td>
<td>1 point</td>
</tr>
<tr>
<td>Credit 3</td>
<td>Brownfield Redevelopment</td>
<td>1 point</td>
</tr>
<tr>
<td>Credit 4</td>
<td>Alternative Transportation</td>
<td>4 points</td>
</tr>
<tr>
<td>Credit 5</td>
<td>Reduced Site Disturbance</td>
<td>2 points</td>
</tr>
<tr>
<td>Credit 6</td>
<td>Stormwater Management</td>
<td>2 points</td>
</tr>
<tr>
<td>Credit 7</td>
<td>Landscape and Exterior Design to reduce Heat Islands</td>
<td>2 points</td>
</tr>
<tr>
<td>Credit 8</td>
<td>Light Pollution Reduction</td>
<td>1 point</td>
</tr>
</tbody>
</table>

Prerequisite 1 Erosion and Sedimentation Control

Intent – Control erosion to reduce negative impacts on water and air quality. (LEED Reference Guide NC 2.1, 9)

Requirements – Design a sediment and erosion control plan, specific to the site, that conforms to United States Environmental Protection Agency (EPA) Document No. EPA 832/R-92-005 (September 1992), Storm Water Management for Construction Activities or local erosion...
and sedimentation control standards and codes, whichever is more stringent. The plan shall meet
the following objectives:

- Prevent loss of soil during construction by stormwater runoff and/or wind erosion, including
  protecting topsoil by stockpiling for reuse.
- Prevent sedimentation of storm sewer or receiving streams.
- Prevent polluting the air with dust and particulate matter.

To prevent erosion measures can be taken like Temporary Seeding, Permanent Seeding,
Mulching or the dust or soil can be trapped in Earth Dike, Silt fence, Sediment Trap, Sediment
Basin. (LEED Reference Guide NC 2.1, 9)

Credit 1 Site Selection 1 point

Intent – Avoid development of inappropriate sites and reduce the environmental impact from
the location of a building on a site. (LEED Reference Guide NC 2.1, 13)

Requirements – Do not develop buildings, roads, or parking lots on portions of sites that meet
any one of the following criteria:

- On prime farm land as defined by US Department of Agriculture
- On land where elevation is lower than 5’ above 100 year flood as defined by FEMA
- On land which provides habitat for threatened or endangered species.
- Within 100’ of any wetland
- On land that was previously public parkland.

Site selection can play an important role in the way in which the public responds to, and is
involved with, the proposed development. Channeling development away from sensitive
ecological areas in favor of previously disturbed sites can encourage public support for a project.
(LEED Reference Guide NC 2.1, 13)

Credit 2 Urban Redevelopment 1 point

Intent – Channel development to urban areas with existing infrastructure, protect greenfields
and preserve habitat and natural resources. (LEED Reference Guide NC 2.1, 19)
Requirements – Increase localized density to conform to existing or desired density goals by utilizing sites that are located within an existing minimum development density of 60,000 square feet per acre (two story downtown development). (LEED Reference Guide NC 2.1, 19)

Credit 3 Brownfield Redevelopment 1 point

Intent – Rehabilitate damaged sites where development is complicated by real or perceived environmental contamination, reducing pressure on undeveloped land. (LEED Reference Guide NC 2.1, 25)

Requirements – Develop on a site documented as contaminated OR on a site classified as a brownfield by a local, state or federal government agency. Effectively remediate site contamination. (LEED Reference Guide NC 2.1, 25)

Credit 4 Alternative Transportation 4 points

Intent – Reduce pollution and land development impacts from automobile use. (LEED Reference Guide NC 2.1, 31)

Credit 4.1 Public Transportation Access 1 point

Requirements – Locate project within 1/2 mile of a commuter rail, light rail or subway station or ¼ mile of two or more public or campus bus lines usable by building occupants. (LEED Reference Guide NC 2.1, 31)

Credit 4.2 Bicycle Storage and Changing Rooms 1 point

Requirements – For commercial or institutional buildings, provide secure bicycle storage with convenient changing/shower facilities (within 200 yards of the building) for 5% or more of regular building occupants. For residential buildings, provide covered storage facilities for securing bicycles for 15% or more of building occupants in lieu of changing/shower facilities. (LEED Reference Guide NC 2.1, 32)

Credit 4.3 Alternative Fuel Vehicles 1 point

Requirements – Provide alternative fuel vehicles for 3% of building occupants AND provide preferred parking for these vehicles, OR install alternative-fuel refueling stations for
3% of the total vehicle parking capacity of the site. Liquid or gaseous fueling facilities must be separately ventilated or located outdoors. (LEED Reference Guide NC 2.1, 33)

Credit 4.4 Parking Capacity 1 point

Requirements – Size parking capacity to meet, but not exceed, minimum local zoning requirements AND provide preferred parking for carpools or vanpools capable of serving 5% of the building occupants; OR add no new parking for rehabilitation projects AND provide preferred parking for carpools or vanpools capable of serving 5% of the building occupants. (LEED Reference Guide NC 2.1, 34)

Credit 5 Reduced Site Disturbance 2 points

Intent – Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity. (LEED Reference Guide NC 2.1, 43)

Credit 5.1 Protect and Restore Open Space 1 point

Requirements – On greenfield sites, limit site disturbance including earthwork and clearing of vegetation to 40 feet beyond the building perimeter, 5 feet beyond primary roadway curbs, walkways and main utility branch trenches, and 25 feet beyond constructed areas with permeable surfaces that require additional staging areas in order to limit compaction in the constructed area. (LEED Reference Guide NC 2.1, 43)

Credit 5.2 Development Footprint 1 point

Requirements – Reduce the development footprint to exceed the local zoning’s open space requirement for the site by 25%. For areas with no local zoning requirements, designate open space area adjacent to the building that is equal to the development footprint. (LEED Reference Guide NC 2.1, 44)

Credit 6 Stormwater Management 2 points

Intent – Limit disruption and pollution of natural water flows by managing stormwater runoff. (LEED Reference Guide NC 2.1, 49)
Credit 6.1 Rate and Quantity 1 point

Requirements – If existing imperviousness is greater than 50%, implement a stormwater management plan that results in a 25% decrease in the rate and quantity of stormwater runoff. (LEED Reference Guide NC 2.1, 49)

Credit 6.2 Treatment 1 point

Requirements – Construct site stormwater treatment systems designed to remove 80% of the average annual post-development total suspended solids (TSS) and 40% of the average annual post-development total phosphorous (TP) based on the average annual loadings from all storms less than or equal to the 2-year/24-hour storm. (LEED Reference Guide NC 2.1, 50)

Credit 7 Landscape & Exterior Design to reduce Heat Islands 2 points

Intent – Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat. (LEED Reference Guide NC 2.1, 59)

Credit 7.1 Non-Roof 1 point

Requirements – Provide shade and/or use light-colored/high-albedo materials and/or open grid pavement for at least 30% of the site’s non-roof impervious surfaces, including parking lots, walkways, plazas, etc.; OR place a minimum of 50% of parking spaces underground or covered by structured parking; OR use an open-grid pavement system for a minimum of 50% of the parking lot area. (LEED Reference Guide NC 2.1, 59)

Credit 7.2 Roof 1 point

Requirements – Use ENERGY STAR® compliant AND high emissivity roofing for a minimum of 75% of the roof surface; OR install a “green” roof for at least 50% of the roof area. Combinations of high albedo and vegetated roof can be used providing they collectively cover 75% of the roof area. (LEED Reference Guide NC 2.1, 60)
Credit 8 Light Pollution Reduction

Intent – Eliminate light trespass from the building and site, improve night sky access and reduce development impact on nocturnal environments. (LEED Reference Guide NC 2.1, 69)

Requirements – Meet or provide lower light levels and uniformity ratios than those recommended by the Illuminating Engineering Society of North America. Design exterior lighting such that all exterior luminaries with more than 1000 initial lamp lumens are shielded and all luminaries with more than 3500 initial lamp lumens meet the Full Cutoff IESNA Classification. The maximum candela value of all interior lighting shall fall within the building and the maximum candela value of all exterior lighting shall fall within the property. Any luminaire within a distance of 2.5 times its mounting height from the property boundary shall have shielding such that no light from that luminaire crosses the property boundary. (LEED Reference Guide NC 2.1, 69)

Water Efficiency

The second section of the LEED Rating System is called Water Efficiency and has 3 Credits from which a total of 5 points can be gained for using towards the Building Rating System. The breakdown of the credits is as follows:

<table>
<thead>
<tr>
<th>Credit</th>
<th>Title</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit 1</td>
<td>Water Efficient Landscaping</td>
<td>2 points</td>
</tr>
<tr>
<td>Credit 2</td>
<td>Innovative Wastewater Technologies</td>
<td>1 point</td>
</tr>
<tr>
<td>Credit 3</td>
<td>Water Use Reduction</td>
<td>2 points</td>
</tr>
</tbody>
</table>

Credit 1  Water Efficient Landscaping  2 points

Intent – Limit or eliminate the use of potable water for landscape irrigation.
There are two points available in this credit. The first one reduces the amount of water needed for irrigation by half but if the project does not need water for irrigation then they are given another point. It promotes water conservation while using water smart landscaping. (LEED Reference Guide NC 2.1, 81)

Credit 1.1 50% Reduction 1 point

Requirements – Use high-efficiency irrigation technology OR use captured rain or recycled site water to reduce potable water consumption for irrigation by 50% over conventional means. (LEED Reference Guide NC 2.1, 81)

Credit 1.2 No Potable Use or No Irrigation 1 point

Requirements – Use only captured rain or recycled site water to eliminate all potable water use for site irrigation (except for initial watering to establish plants), OR do not install permanent landscape irrigation systems. (LEED Reference Guide NC 2.1, 82)

Credit 2 Innovative Wastewater Technologies 1 point

Intent – Reduce generation of wastewater and potable water demand, while increasing the local aquifer recharge. (LEED Reference Guide NC 2.1, 91)

Requirements – Reduce the use of municipally provided potable water for building sewage conveyance by a minimum of 50%, OR treat 100% of wastewater on site to tertiary standards. (LEED Reference Guide NC 2.1, 91)

Credit 3 Water Use Reduction 2 point

Intent – Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems. (LEED Reference Guide NC 2.1, 99)

Credit 3.1 20% Reduction 1 point

Requirements – Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992 fixture performance requirements. (LEED Reference Guide NC 2.1, 99)
Credit 3.2  30% Reduction  1 point

Requirements – Employ strategies that in aggregate use 30% less water than the water use baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992 fixture performance requirements. (LEED Reference Guide NC 2.1, 100)

Energy & Atmosphere

The third section of the LEED Rating System is called Energy & Atmosphere and has 3 prerequisite and 6 Credits from which a total of 17 points can be gained for using towards the Building Rating System. The breakdown of the credits is as follows:

Table 6  Energy & Atmosphere Credit Breakdown (LEED Reference Guide NC 2.1, 2003)

<table>
<thead>
<tr>
<th>Credit</th>
<th>Title</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite 1</td>
<td>Fundamental Building Systems Commissioning</td>
<td></td>
</tr>
<tr>
<td>Prerequisite 2</td>
<td>Minimum Energy Performance</td>
<td></td>
</tr>
<tr>
<td>Prerequisite 3</td>
<td>CFC Reduction in HVAC&amp;R Equipment</td>
<td></td>
</tr>
<tr>
<td>Credit 1</td>
<td>Optimize Energy Performance</td>
<td>1-10 points</td>
</tr>
<tr>
<td>Credit 2</td>
<td>Renewable Energy</td>
<td>3 points</td>
</tr>
<tr>
<td>Credit 3</td>
<td>Additional Commissioning</td>
<td>1 point</td>
</tr>
<tr>
<td>Credit 4</td>
<td>Ozone Depletion</td>
<td>1 point</td>
</tr>
<tr>
<td>Credit 5</td>
<td>Measurement &amp; Verification</td>
<td>1 point</td>
</tr>
<tr>
<td>Credit 6</td>
<td>Green Power</td>
<td>1 point</td>
</tr>
</tbody>
</table>

Prerequisite 1  Fundamental Building Systems Commissioning

Intent – Verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate as intended. (LEED Reference Guide NC 2.1, 111)
Requirements – Implement or have a contract in place to implement the following fundamental best practice commissioning procedures.

- Engage a commissioning team that does not include individuals directly responsible for project design or construction management.
- Review the design intent and the basis of design documentation.
- Incorporate commissioning requirements into the construction documents.
- Develop and utilize a commissioning plan.
- Verify installation, functional performance, training and operation and maintenance documentation.
- Complete a commissioning report. (LEED Reference Guide NC 2.1, 111)

Prerequisite 2 Minimum Energy Performance

Intent – Establish the minimum level of energy efficiency for the base building and systems. (LEED Reference Guide NC 2.1, 121)

Requirements – Design the building to comply with ASHRAE/IESNA Standard 90.1-1999 (without amendments) or the local energy code, whichever is more stringent. (LEED Reference Guide NC 2.1, 121)

Prerequisite 3 CFC Reduction in HVAC&R Equipment

Intent – Reduce ozone depletion. (LEED Reference Guide NC 2.1, 129)

Requirements – Zero use of CFC-based refrigerants in new base building HVAC&R systems. When reusing existing base building HVAC equipment, complete a comprehensive CFC phaseout conversion. (LEED Reference Guide NC 2.1, 129)

Credit 1 Optimize Energy Performance 1-10 points

Intent – Achieve increasing levels of energy performance above the prerequisite standard to reduce environmental impacts associated with excessive energy use. (LEED Reference Guide NC 2.1, 133)
Requirements – Reduce design energy cost compared to the energy cost budget for energy systems as regulated by ASHRAE/IESNA Standard 90.1-1999. (LEED Reference Guide NC 2.1, 133)

<table>
<thead>
<tr>
<th>New Bldgs.</th>
<th>Existing Bldgs.</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>15%</td>
<td>5%</td>
<td>1</td>
</tr>
<tr>
<td>20%</td>
<td>10%</td>
<td>2</td>
</tr>
<tr>
<td>25%</td>
<td>15%</td>
<td>3</td>
</tr>
<tr>
<td>30%</td>
<td>20%</td>
<td>4</td>
</tr>
<tr>
<td>35%</td>
<td>25%</td>
<td>5</td>
</tr>
<tr>
<td>40%</td>
<td>30%</td>
<td>6</td>
</tr>
<tr>
<td>45%</td>
<td>35%</td>
<td>7</td>
</tr>
<tr>
<td>50%</td>
<td>40%</td>
<td>8</td>
</tr>
<tr>
<td>55%</td>
<td>45%</td>
<td>9</td>
</tr>
<tr>
<td>60%</td>
<td>50%</td>
<td>10</td>
</tr>
</tbody>
</table>

Regulated energy systems include HVAC, service hot water and interior lighting. Non-regulated systems include plug loads, exterior lighting, garage ventilation and elevators. Two methods may be used to separate energy consumption for regulated systems. The energy consumption for each fuel may be prorated according to the fraction of energy used by regulated and non-regulated energy. (LEED Reference Guide NC 2.1, 133)

Credit 2 Renewable Energy 3 point

Intent – Encourage and recognize increasing levels of on-site renewable energy self-supply in order to reduce environmental impacts associated with fossil fuel energy use. (LEED Reference Guide NC 2.1, 151)

Credit 2.1 5% 1 point

Requirements – Supply at least 5% of the building’s total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems. (LEED Reference Guide NC 2.1, 151)
Credit 2.2 10% 1 point

Requirements – Supply at least 10% of the building’s total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems. (LEED Reference Guide NC 2.1, 152)

Credit 2.3 20% 1 point

Requirements – Supply at least 20% of the building’s total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems. (LEED Reference Guide NC 2.1, 153)

Credit 3 Additional Commissioning 1 point

Intent – Verify and ensure that the entire building is designed, constructed and calibrated to operate as intended. (LEED Reference Guide NC 2.1, 165)

Requirements – In addition to the Fundamental Building Commissioning prerequisite, implement or have a contract in place to implement the following additional commissioning tasks:

1. A commissioning authority independent of the design team shall conduct a review of the design prior to the construction documents phase.
2. An independent commissioning authority shall conduct a review of the construction documents near completion of the construction document development and prior to issuing the contract documents for construction.
3. An independent commissioning authority shall review the contractor submittals relative to systems being commissioned.
4. Provide the owner with a single manual that contains the information required for re-commissioning building systems.
5. Have a contract in place to review building operation with O&M staff, including a plan for resolution of outstanding commissioning-related issues within one year after construction completion date. (LEED Reference Guide NC 2.1, 165)
Credit 4  Ozone Depletion 1 point


Requirements – Install base building level HVAC and refrigeration equipment and fire suppression systems that do not contain HCFCs or Halons. (LEED Reference Guide NC 2.1, 169)

Credit 5  Measurement & Verification 1 point

Intent – Provide for the ongoing accountability and optimization of building energy and water consumption performance over time. (LEED Reference Guide NC 2.1, 173)

Requirements – Install continuous metering equipment for the following end-uses:

- Lighting systems and controls
- Constant and variable motor loads
- Variable frequency drive (VFD) operation
- Chiller efficiency at variable loads (kW/ton)
- Cooling load
- Air and water economizer and heat recovery cycles
- Air distribution static pressures and ventilation air volumes
- Boiler efficiencies
- Building-related process energy systems and equipment
- Indoor water risers and outdoor irrigation systems (LEED Reference Guide NC 2.1, 173)

Credit 6  Green Power 1 point

Intent – Encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis. (LEED Reference Guide NC 2.1, 181)

Requirements – Provide at least 50% of the building’s electricity from renewable sources by engaging in at least a two-year renewable energy contract. Renewable sources are as defined by
the Center for Resource Solutions (CRS) Green-e products certification requirements. (LEED Reference Guide NC 2.1, 181)

Materials & Resources

The fourth section of the LEED Rating System is called Materials & Resources and has 1 prerequisite and 7 Credits from which a total of 13 points can be gained for using towards the Building Rating System. The breakdown of the credits is as follows:

Table 7  Materials & Resources Credit Breakdown (LEED Reference Guide NC 2.1, 2003)

<table>
<thead>
<tr>
<th>Credit</th>
<th>Title</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite 1</td>
<td>Storage &amp; Collection of Recyclables</td>
<td></td>
</tr>
<tr>
<td>Credit 1</td>
<td>Building Reuse</td>
<td>3 points</td>
</tr>
<tr>
<td>Credit 2</td>
<td>Construction Waste Management</td>
<td>2 points</td>
</tr>
<tr>
<td>Credit 3</td>
<td>Resource Reuse</td>
<td>2 points</td>
</tr>
<tr>
<td>Credit 4</td>
<td>Recycled Content</td>
<td>2 points</td>
</tr>
<tr>
<td>Credit 5</td>
<td>Local/Regional Materials</td>
<td>2 points</td>
</tr>
<tr>
<td>Credit 6</td>
<td>Rapidly Renewable Materials</td>
<td>1 point</td>
</tr>
<tr>
<td>Credit 7</td>
<td>Certified Wood</td>
<td>1 point</td>
</tr>
</tbody>
</table>

Prerequisite 1   Storage & Collection of Recyclables

Intent – Facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills. (LEED Reference Guide NC 2.1, 187)

Requirements – Provide an easily accessible area that serves the entire building and is dedicated to the separation, collection and storage of materials for recycling including (at a
minimum) paper, corrugated cardboard, glass, plastics and metals. (LEED Reference Guide NC 2.1, 187)

Credit 1  Building Reuse 3 points

Intent – Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport. (LEED Reference Guide NC 2.1, 191)

Credit 1.1  Maintain 75% of Existing Walls, Floors and Roof 1 point

Requirements – Maintain at least 75% of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material). (LEED Reference Guide NC 2.1, 191)

Credit 1.2  Maintain 100% of Existing Walls, Floors and Roof 1 point

Requirements – Maintain an additional 25% (100% total) of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material). (LEED Reference Guide NC 2.1, 192)

Credit 1.3  Maintain 100% of Shell/Structure and 50% of Non-Shell/Non-Structure 1 point

Requirements – Maintain 100% of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material) AND at least 50% of non-shell areas (interior walls, doors, floor coverings and ceiling systems). (LEED Reference Guide NC 2.1, 193)

Credit 2  Construction Waste Management 2 points

Intent – Divert construction, demolition and land clearing debris from landfill disposal. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites. (LEED Reference Guide NC 2.1, 199)
Credit 2.1  Divert 50% from Landfill  1 point

Requirements – Develop and implement a waste management plan, quantifying material diversion goals. Recycle and/or salvage at least 50% of construction, demolition and land clearing waste. Calculations can be done by weight or volume, but must be consistent throughout. (LEED Reference Guide NC 2.1, 199)

Credit 2.2  Divert 75% from Landfill  1 point

Requirements – Develop and implement a waste management plan, quantifying material diversion goals. Recycle and/or salvage an additional 25% (75% total) of construction, demolition and land clearing waste. Calculations can be done by weight or volume, but must be consistent throughout. (LEED Reference Guide NC 2.1, 200)

Credit 3  Resource Reuse  2 point

Intent – Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources. (LEED Reference Guide NC 2.1, 207)

Credit 3.1  5%  1 point

Requirements – Use salvaged, refurbished or reused materials, products and furnishings for at least 5% of building materials. (LEED Reference Guide NC 2.1, 207)

Credit 3.2  10%  1 point

Requirements – Use salvaged, refurbished or reused materials, products and furnishings for at least 10% of building materials. (LEED Reference Guide NC 2.1, 208)

Credit 4  Recycled Content  2 point

Intent – Increase demand for building products that incorporate recycled content materials, therefore reducing impacts resulting from extraction and processing of new virgin materials. (LEED Reference Guide NC 2.1, 213)
Credit 4.1 5% (post-consumer + \( \frac{1}{2} \) post-industrial) 1 point

Requirements – Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 5% of the total value of the materials in the project. (LEED Reference Guide NC 2.1, 213)

Credit 4.2 10% (post-consumer + \( \frac{1}{2} \) post-industrial) 1 point

Requirements – Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project. (LEED Reference Guide NC 2.1, 214)

Credit 5 Local/Regional Materials 2 points

Intent – Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the regional economy and reducing the environmental impacts resulting from transportation. (LEED Reference Guide NC 2.1, 221)

Credit 5.1 20% Manufactured Regionally 1 point

Requirements – Use a minimum of 20% of building materials and products that are manufactured regionally within a radius of 500 miles. (LEED Reference Guide NC 2.1, 221)

Credit 5.2 Regional Materials 1 point

Requirements – Of the regionally manufactured materials documented for MR Credit 5.1, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site. (LEED Reference Guide NC 2.1, 222)

Credit 6 Rapidly Renewable Materials 1 point

Intent – Reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials. (LEED Reference Guide NC 2.1, 227)
Requirements – Use rapidly renewable building materials and products (made from plants that are typically harvested within a ten-year cycle or shorter) for 5% of the total value of all building materials and products used in the project. (LEED Reference Guide NC 2.1, 227)

Credit 7 Certified Wood 1 point

Intent – Encourage environmentally responsible forest management. (LEED Reference Guide NC 2.1, 231)

Requirements – Use a minimum of 50% of wood-based materials and products, certified in accordance with the Forest Stewardship Council’s Principles and Criteria, for wood building components including, but not limited to, structural framing and general dimensional framing, flooring, finishes, furnishings, and non-rented temporary construction applications such as bracing, concrete form work and pedestrian barriers. (LEED Reference Guide NC 2.1, 231)

Indoor Environmental Quality

The fifth section of the LEED Rating System is called Indoor Environmental Quality and has 2 prerequisite and 8 Credits from which a total of 15 points can be gained for using towards the Building Rating System. The breakdown of the credits is as follows:
Table 8  Indoor Environmental Quality Credit Breakdown (LEED Reference Guide NC 2.1, 2003)

<table>
<thead>
<tr>
<th>Credit</th>
<th>Title</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite 1</td>
<td>Minimum IAQ Performance</td>
<td></td>
</tr>
<tr>
<td>Prerequisite 2</td>
<td>Environmental Tobacco Smoke (ETS) Control</td>
<td></td>
</tr>
<tr>
<td>Credit 1</td>
<td>Carbon Dioxide (CO2) Monitoring</td>
<td>1 point</td>
</tr>
<tr>
<td>Credit 2</td>
<td>Ventilation Effectiveness</td>
<td>1 point</td>
</tr>
<tr>
<td>Credit 3</td>
<td>Construction IAQ Management Plan</td>
<td>2 points</td>
</tr>
<tr>
<td>Credit 4</td>
<td>Low-Emitting Materials</td>
<td>4 points</td>
</tr>
<tr>
<td>Credit 5</td>
<td>Indoor Chemical &amp; Pollution Source Control</td>
<td>1 point</td>
</tr>
<tr>
<td>Credit 6</td>
<td>Controllability of Systems</td>
<td>2 points</td>
</tr>
<tr>
<td>Credit 7</td>
<td>Thermal Comfort</td>
<td>2 points</td>
</tr>
<tr>
<td>Credit 8</td>
<td>Daylight &amp; Views</td>
<td>2 points</td>
</tr>
</tbody>
</table>

Prerequisite 1  Minimum IAQ Performance

Intent – Establish minimum indoor air quality (IAQ) performance to prevent the development of indoor air quality problems in buildings, thus contributing to the comfort and wellbeing of the occupants. (LEED Reference Guide NC 2.1, 241)


Prerequisite 2  Environmental Tobacco Smoke (ETS) Control

Intent – Prevent exposure of building occupants and systems to Environmental Tobacco Smoke (ETS). (LEED Reference Guide NC 2.1, 245)
Requirements – Zero exposure of non-smokers to ETS by either prohibiting smoking in the building and locating any exterior designated smoking areas away from entries and operable windows; or providing a designated smoking room designed to effectively contain, capture and remove ETS from the building. At a minimum, the smoking room must be directly exhausted to the outdoors with no recirculation of ETS-containing air to the non-smoking area of the building, and operated at a negative pressure compared with the surrounding spaces of at least 7 PA. (LEED Reference Guide NC 2.1, 245)

Credit 1 Carbon Dioxide (CO2) Monitoring 1 point
Intent – Provide capacity for indoor air quality (IAQ) monitoring to help sustain long-term occupant comfort and well-being. (LEED Reference Guide NC 2.1, 249)
Requirements – Install a permanent carbon dioxide (CO2) monitoring system that provides feedback on space ventilation performance in a form that affords operational adjustments. (LEED Reference Guide NC 2.1, 249)

Credit 2 Ventilation Effectiveness 1 point
Intent – Provide for the effective delivery and mixing of fresh air to support the safety, comfort and well-being of building occupants. (LEED Reference Guide NC 2.1, 253)
Requirements – For mechanically ventilated buildings, design ventilation systems that result in an air change effectiveness (Eac) greater than or equal to 0.9 as determined by ASHRAE 129-1997. For naturally ventilated spaces demonstrate a distribution and laminar flow pattern that involves not less than 90% of the room or zone area in the direction of air flow for at least 95% of hours of occupancy. (LEED Reference Guide NC 2.1, 253)

Credit 3 Construction IAQ Management Plan 2 point
Intent – Prevent indoor air quality problems resulting from the construction / renovation process in order to help sustain the comfort and well-being of construction workers and building occupants. (LEED Reference Guide NC 2.1, 261)
Credit 3.1 During Construction 1 point

Requirements – Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and pre-occupancy phases of the building. (LEED Reference Guide NC 2.1, 261)

Credit 3.2 After Construction/Before Occupancy 1 point

Requirements – Develop and implement an Indoor Air Quality (IAQ) Management Plan for the pre-occupancy phase. Conduct a baseline indoor air quality testing procedure consistent with the United States Environmental Protection Agency. (LEED Reference Guide NC 2.1, 262)

Credit 4 Low-Emitting Materials 4 point

Intent – Reduce the quantity of indoor air contaminants that are odorous, potentially irritating and/or harmful to the comfort and well-being of installers and occupants. (LEED Reference Guide NC 2.1, 269)

Credit 4.1 Adhesives and Sealants 1 point

Requirements – The VOC content of adhesives and sealants used must be less than the current VOC content limits of South Coast Air Quality Management District Rule #1168, AND all sealants used as fillers must meet or exceed the requirements of the Bay Area Air Quality Management District Regulation 8, Rule 51. (LEED Reference Guide NC 2.1, 269)

Credit 4.2 Paints and Coatings 1 point

Requirements – VOC emissions from paints and coatings must not exceed the VOC and chemical component limits of Green Seal’s Standard GS-11 requirements. (LEED Reference Guide NC 2.1, 270)

Credit 4.3 Carpet 1 point

Requirements – Carpet systems must meet or exceed the requirements of the Carpet and Rug Institute’s Green Label Indoor Air Quality Test Program. (LEED Reference Guide NC 2.1, 271)
Credit 4.4 Composite Wood 1 point

Requirements – Composite wood and agrifiber products must contain no added urea-formaldehyde resins. (LEED Reference Guide NC 2.1, 272)

Credit 5 Indoor Chemical & Pollution Source Control 1 point

Intent – Avoid exposure of building occupants to potentially hazardous chemicals that adversely impact air quality. (LEED Reference Guide NC 2.1, 279)

Requirements – Design to minimize pollutant cross-contamination of regularly occupied areas: Employ permanent entryway systems (grills, grates, etc.) to capture dirt, particulates, etc. from entering the building at all high volume entryways. Provide drains plumbed for appropriate disposal of liquid waste in spaces where water and chemical concentrate mixing occurs. (LEED Reference Guide NC 2.1, 279)

Credit 6 Controllability of Systems 2 points

Intent – Provide a high level of thermal, ventilation and lighting system control by individual occupants or specific groups in multi-occupant spaces (i.e. classrooms or conference areas) to promote the productivity, comfort and well-being of building occupants. (LEED Reference Guide NC 2.1, 283)

Credit 6.1 Perimeter Spaces 1 point

Requirements – Provide at least an average of one operable window and one lighting control zone per 200 square feet for all regularly occupied areas within 15 feet of the perimeter wall. (LEED Reference Guide NC 2.1, 283)

Credit 6.2 Non-Perimeter Spaces 1 point

Requirements – Provide controls for each individual for airflow, temperature and lighting for at least 50% of the occupants in non-perimeter, regularly occupied areas. (LEED Reference Guide NC 2.1, 284)
Credit 7 \hspace{1cm} Thermal Comfort \hspace{1cm} 2 points

Intent – Provide a thermally comfortable environment that supports the productivity and wellbeing of building occupants. (LEED Reference Guide NC 2.1, 293)

Credit 7.1 \hspace{1cm} Compliance with ASHRAE 55-1992 \hspace{1cm} 1 point

Requirements – Comply with ASHRAE Standard 55-1992, Addenda 1995, for thermal comfort standards including humidity control within established ranges per climate zone. For naturally ventilated buildings, utilize the adaptive comfort temperature boundaries, using the 90% acceptability limits as defined in the Collaborative for High Performance Schools (CHPS) Best Practices Manual (LEED Reference Guide NC 2.1, 293)

Credit 7.2 \hspace{1cm} Permanent Monitoring System \hspace{1cm} 1 point

Requirements – Install a permanent temperature and humidity monitoring system configured to provide operators control over thermal comfort performance and the effectiveness of humidification and/or dehumidification systems in the building. (LEED Reference Guide NC 2.1, 294)

Credit 8 \hspace{1cm} Daylight & Views \hspace{1cm} 2 points

Intent – Provide for the building occupants a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building. (LEED Reference Guide NC 2.1, 301)

Credit 8.1 \hspace{1cm} Daylight 75% of Spaces \hspace{1cm} 1 point

Requirements – Achieve a minimum Daylight Factor of 2% (excluding all direct sunlight penetration) in 75% of all space occupied for critical visual tasks. Spaces excluded from this requirement include copy rooms, storage areas, mechanical plant rooms, laundry and other low occupancy support areas. Other exceptions for spaces where tasks would be hindered by the use of daylight will be considered on their merits. (LEED Reference Guide NC 2.1, 301)

Credit 8.2 \hspace{1cm} Views for 90% of Spaces \hspace{1cm} 1 point

Requirements – Achieve direct line of sight to vision glazing for building occupants in 90% of all regularly occupied spaces. Examples of exceptions include copy rooms, storage
areas, mechanical, laundry and other low occupancy support areas. Other exceptions will be considered on their merits. (LEED Reference Guide NC 2.1, 302)

Innovation & Design Process

To emphasize and encourage Innovation in Design and energy saving techniques this section was provided. There are a total of 5 points available in this category from 2 credits. The breakdown of the credits is as follows:


<table>
<thead>
<tr>
<th>Credit</th>
<th>Title</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit 1</td>
<td>Innovation in Design</td>
<td>4 points</td>
</tr>
<tr>
<td>Credit 2</td>
<td>LEED Accredited Professional</td>
<td>1 point</td>
</tr>
</tbody>
</table>

Credit 1  Innovation in Design  4 points

Intent – To provide design teams and projects the opportunity to be awarded points for exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System. (LEED Reference Guide NC 2.1, 313)

Requirements – [Credit 1.1 – Credit 1.4] (1 point each credit) Identify the intent of the proposed innovation credit, the proposed requirements for compliance, the proposed submittals to demonstrate compliance, and the design approach (strategies) that might be used to meet the requirements. (LEED Reference Guide NC 2.1, 313)
Credit 2  LEED Accredited Professional  1 point

Intent – To support and encourage the design integration required by a LEED Green Building project and to streamline the application and certification process. (LEED Reference Guide NC 2.1, 317)

Requirements – At least one principal participant of the project team that has successfully completed the LEED Accredited Professional exam (LEED Reference Guide NC 2.1, 317)
CHAPTER 4

EVALUATING CCSD PROTOTYPE SCHOOL

In this chapter, the methodology used for evaluating elementary school is discussed and then the focus will be on evaluating the CCSD Prototype to being made into a LEED Certified Building. This will involve going over each point in the checklist and seeing if we can get that point or not. The total points needed for a LEED™ Gold rated building are 39.

Methodology

The credit calculations for checking compliance are done in accordance with LEED requirements. The credits are evaluated to the Standard Letter Templates used for verifying compliance with the credit. Letter Templates are used primarily for standardization of the submittal process for LEED. The following software’s will be used for the calculations of the credit requirements. COMcheck is used for the checking compliance with ASHARE 90.1-1999 (COMcheck, 2006). The results will be used to complete the requirements of the Energy and Atmosphere prerequisite two (2) Minimum Energy Performance. For energy simulation eQUEST will be used. It provides results with different scenarios for the school building. These simulation results are used to for determining the appropriate number of points from Energy and Atmosphere credit one (1) Optimize Energy Performance. ECOTECT is used for daylight simulation and provides daylight factor levels. These simulation results are used to complete the requirements of Indoor Environmental Quality Credit 8.1 Daylight 75% of Spaces.

Evaluating CCSD Prototype Elementary School to LEED

To start evaluating CCSD Prototype Elementary School for LEED building we need to start evaluating each point in context to the local conditions and see which points can be achieved in this project.
Table 10 LEED Evaluation (LEED Reference Guide NC 2.1, 2003)

<table>
<thead>
<tr>
<th>Very Likely</th>
<th>Likely</th>
<th>Maybe</th>
<th>Unlikely</th>
<th>Very Unlikely</th>
<th>Credit</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Sites</td>
<td></td>
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<tr>
<td>X</td>
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<td></td>
<td></td>
<td></td>
<td>Prereq 1 Erosion &amp; Sedimentation Control</td>
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<td>Credit 1 Site Selection</td>
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<td>Credit 2 Development Density</td>
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<td>Credit 3 Brownfield Redevelopment</td>
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<td>Credit 4.1 Alternative Transportation, Public Transportation Access</td>
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<td>X</td>
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<td>Credit 4.2 Alternative Transportation, Bicycle Storage &amp; Changing Rooms</td>
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<td>Credit 4.3 Alternative Transportation, Alternative Fuel Vehicles</td>
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<td>X</td>
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<td>Credit 4.4 Alternative Transportation, Parking Capacity</td>
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<td>Credit 5.1 Reduced Site Disturbance, Protect or Restore Open Space</td>
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<td>Credit 5.2 Reduced Site Disturbance, Development Footprint</td>
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<td>Credit 6.1 Stormwater Management, Rate and Quantity</td>
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<td>Credit 6.2 Stormwater Management, Treatment</td>
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<td>X</td>
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<td>Credit 7.1 Heat Island Effect, Non-Roof</td>
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<td>Credit 7.2 Heat Island Effect, Roof</td>
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<td>Credit 8 Light Pollution Reduction</td>
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<td>Water Efficiency</td>
<td>Energy &amp; Atmosphere</td>
<td>Materials &amp; Resources</td>
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<td>Credit 1.1</td>
<td>Prereq 1</td>
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<tr>
<td></td>
<td>Water Efficient Landscaping, Reduce by 50%</td>
<td>Fundamental Building Systems</td>
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<td></td>
<td>Water Efficient Landscaping, No Potable Use or No Irrigation</td>
<td>Minimum Energy Performance</td>
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<td>X</td>
<td>Credit 2</td>
<td>Prereq 3</td>
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<tr>
<td></td>
<td>Innovative Wastewater Technologies</td>
<td>CFC Reduction in HVAC&amp;R Equipment</td>
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<tr>
<td>X</td>
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<tr>
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<td>Water Use Reduction, 20% Reduction</td>
<td>Optimize Energy Performance</td>
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<tr>
<td>X</td>
<td>Credit 3.2</td>
<td>Credit 2.1</td>
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<tr>
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<td>Renewable Energy, 5%</td>
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<td>Credit 3.3</td>
<td>Credit 2.2</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Renewable Energy, 20%</td>
<td>Renewable Energy, 10%</td>
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<tr>
<td>X</td>
<td>Credit 4</td>
<td>Credit 3</td>
<td></td>
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<tr>
<td></td>
<td>Ozone Depletion</td>
<td>Additional Commissioning</td>
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<tr>
<td>X</td>
<td>Credit 5</td>
<td>Credit 4</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Measurement &amp; Verification</td>
<td>Ozone Depletion</td>
<td></td>
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<td>Local/Regional Materials, of 20% in MRc5.1, 50% Harvested Locally</td>
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<td>Credit 7</td>
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**Indoor Environmental Quality**

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<th>Minimum IAQ Performance</th>
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<td>Environmental Tobacco Smoke (ETS) Control</td>
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<td>Carbon Dioxide (CO2) Monitoring</td>
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<td>Ventilation Effectiveness</td>
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<td>Credit 3.1</td>
<td>Construction IAQ Management Plan, During Construction</td>
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<td>Construction IAQ Management Plan, Before Occupancy</td>
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<td>Low-Emitting Materials, Adhesives &amp; Sealants</td>
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<td>Indoor Chemical &amp; Pollutant Source Control</td>
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<td>Controllability of Systems, Perimeter</td>
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<td>Controllability of Systems, Non-Perimeter</td>
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<td>Thermal Comfort, Comply with ASHRAE 55-1992</td>
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<td>Thermal Comfort, Permanent Monitoring System</td>
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<td>Credit 8.1</td>
<td>Daylight &amp; Views, Daylight 75% of Spaces</td>
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<td>Credit 8.2</td>
<td>Daylight &amp; Views, Views for 90% of Spaces</td>
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### Innovation & Design Process

| Credit 1.1 | Innovation in Design |
| Credit 1.2 | Innovation in Design |
| Credit 1.3 | Innovation in Design |
| Credit 1.4 | Innovation in Design |
| Credit 2 | LEED™ Accredited Professional |

**Sustainable Sites**

This section deals with the site and site related issues and credits can be earned from choosing the right site.
Prerequisite 1 – Erosion and Sedimentation control

This prerequisite has to be satisfied in order to get any credit from this section. To satisfy this prerequisite the civil engineer has to design a sediment and erosion control plan for the site and will show design steps to prevent loss of soil during construction, by wind and water. The plan will also prevent the sedimentation of storm water by catching the soil from runoff water by providing catch basins, temporary silt fencing and using straw-bale barriers around the sloping areas of the site to trap soil. The plan should also show steps to prevent pollution of air with dust from the site during and after construction. To earn this prerequisite credit the civil engineer or a LEED/Green Building consultant needs to sign a LEED Letter template declaring conformance in achieving minimum standards of EPA or local governing authority regulations on soil erosion, which ever is more stringent. (LEED Reference Guide NC 2.1, 9)

Credit 1 – Site Selection

One credit can easily be achieved from this credit. To fulfill the requirement of this credit the site must not be a prime farmland, elevation should be more than 5 feet above the 100 year flood elevation, land should not be habituated by endangered or threatened species, should not be within 100 feet of any water and the site acquired should not be a public parkway. In Las Vegas valley, there is not any land designated as a prime farmland. CCSD Real Property Management and Demographics generally picks up the school site which is more than 5 feet higher than the 100 year flood. Las Vegas Valley is an urban area and is not designated as habitat for endangered species. (LEED Reference Guide NC 2.1, 13)

Credit 2 – Development Density

This credit will not be applicable to the prototype elementary school. The credit requires that the development density of 60,000 square feet per acre at the project site and around the site. Since the building footprint for prototype school is 62,500 square feet and it is generally built on an 8 acre site to provide space for parking and play area for the students. The development
density ratio comes to be 7500 square feet per acre. No points will be available from this credit. (LEED Reference Guide NC 2.1, 19)

Credit 3 – Brownfield Redevelopment

This credit will be very hard to achieve and will be based on the site selection. CCSD generally picks a site that is not contaminated, so far none of the schools built have been built on a contaminated site. Therefore, this credit cannot be used towards the count for the LEED points. (LEED Reference Guide NC 2.1, 25)

Credit 4 – Alternate Transportation

A total of 4 points can be achieved from this credit. Each point is independently achieved. The primary function of this credit is to reduce pollution and impact on environment from automobile use. (LEED Reference Guide NC 2.1, 31)

4.1 Public Transportation Access

To successfully get a point from this credit, the project must be located within ½ mile of a commuter rail, subway station or ¼ mile on two or more public bus lines, usable by building occupants. This could be easily achieved. The location of the site is generally within ¼ mile of the two or more public bus lines. Therefore once point can be achieved from 4.1 credit with the selection of the site in such a way that it is connected by public bus service. Since the commuter rail or subways are not used in Las Vegas. The monorail runs along the strip (Las Vegas Boulevard) and caters to the tourists visiting Las Vegas and no schools are planned near a casino. Therefore, the distance from the computer rail cannot be used. (LEED Reference Guide NC 2.1, 31)

4.2 Bicycle Storage and Changing Rooms

To successfully complete this point, institutional buildings should provide secure bicycle storage and showers within 200 yards of the building for 5% or more of regular building occupants. Secure bicycle storage is already provided on all prototype elementary schools. By providing a shower facility for around 5 people and bicycle storage spaces of 37 (5% of 740
occupants for school (700 students and 40 adults)) one point can be earned from credit 4.2. (LEED Reference Guide NC 2.1, 32)

4.3 Alternate Fuel Vehicles

This credit will not be satisfied as it calls for either providing alternate fuel vehicles to 3% of building occupants or install alternative fuel refueling stations for 3% of the total vehicle parking capacity on the site. Since CCSD does not provide any vehicles to its staff and nor would it be installing refueling stations on school site for alternate vehicles, therefore no point will be earned from this credit. (LEED Reference Guide NC 2.1, 33)

4.4 Parking Capacity

To successfully earn one point from this credit, provide minimum number of spaces allowed by the local zoning regulations and provide preferred parking for carpools or vanpools serving 5% of the building occupants. All CCSD prototype school sites generally provide minimum parking numbers to meet the local zoning requirements. The parking number is kept to a minimum to use minimum area for parking and maximizing play area. Since the current prototype school design does not call for preferred parking for carpools or vanpools. By providing 20 spaces as preferred parking for carpools or vanpools, one point can be earned from this credit. (LEED Reference Guide NC 2.1, 34)

Credit 5 – Reduced Site Disturbance

A total of 2 points can be earned from this credit. Each point is independently achieved. The primary purpose of this credit is to conserve natural areas and restore already damaged areas. (LEED Reference Guide NC 2.1, 43)

5.1 Protect or Restore Open Space

To achieve this point, limit the site disturbance including earthwork and clearing of vegetation to 40 feet beyond the building perimeter; 5 feet beyond primary roadway curbs, walkways and main utility branch trenches and 25 feet beyond constructed areas with permeable surfaces. Or on previously developed sites, restore a minimum of 50% of the site area by replacing impervious surfaces with vegetation. This credit cannot be completed as the playarea
extends more than 40 feet and therefore will not be applicable to the credit requirements (LEED Reference Guide NC 2.1, 43)

5.2 Development Footprint

This point requires that the total open space provided should exceed the local zoning requirements for the site by 25%. The local zoning requirements for Las Vegas Valley are as follows – City of Las Vegas, Clark County, City of North Las Vegas and City of Henderson. Each of the jurisdictions has its own open space zoning requirements. The maximum total open space needed for local jurisdictions is 30% for schools. Open space could easily be increased by 25% for each school site by incorporating the play area with landscaping. The following zoning codes are used for the jurisdictions in Las Vegas. (LEED Reference Guide NC 2.1, 44)

Title 19 Zoning for City of Las Vegas
Title 30 Unified Development Code for Clark County
Title 19 Development Code (Zoning) for City of North Las Vegas
Title 17 Zoning for City of Henderson

Credit 6 – Stormwater Management

A total of 2 points can be earned from this credit. Each point is independently achieved. The primary purpose of this credit is to limit disruption and pollution of natural water bodies through stormwater runoff. (LEED Reference Guide NC 2.1, 49)

6.1 Rate and Quantity

To achieve this point, the imperviousness should be reduced by 25% if the existing imperviousness is greater than 50% of the stormwater management plan OR the imperviousness at 1.5 year post-development should be less than or equal to 1.5 year pre-development imperviousness. Clustering or concentrating development to reduce the amount of paved surfaces such as roads, parking lots and sidewalks minimizes impervious surfaces. Garden roofs or green roofs are vegetated surfaces and capture rainwater and return a portion of it back to the atmosphere via evapotranspiration. Further using pervious paving systems reduce stormwater
runoff by allowing precipitation to infiltrate the undersurface through voids in the paving materials. This point can therefore be earned. (LEED Reference Guide NC 2.1, 49)

6.2 Treatment

To earn this point, the site stormwater should be treated on site to remove 80% of annual post-development total suspended solids (TSS) and 40% of the average post-development total phosphorous (TP). Packaged stormwater treatment systems can be installed to treat stormwater volumes. (LEED Reference Guide NC 2.1, 50)

Credit 7 – Heat Island Effect

A total of 2 points can be earned from this credit. Each point is independently achieved. The primary purpose of this credit is to reduce heat island effect from the site. (LEED Reference Guide NC 2.1, 59)

7.1 Non-Roof

To achieve one point from this credit, provide shade and/or use light colored/high albedo (reflectance of 0.3) and/or open grid pavement for at least 30% of the site’s non-roof impervious surfaces. We can provide more than 30% of the impervious surfaces with high albedo light colored concrete. By providing additional landscaping 30% of the reflectance or shade can easily be achieved. (LEED Reference Guide NC 2.1, 59)

7.2 Roof

To achieve this point an ENERGY STAR® compliant roof should be used. Using a single ply roofing system with high emissivity roofing will fulfill the requirements of this credit. The use of single ply roofing in place of built-up roofing is an easy transition. (LEED Reference Guide NC 2.1, 60)
Credit 8 – Light Pollution Reduction

There is one point to be earned from this credit. The credit requires that the project meets lower light levels and uniformity ratios recommended by Illuminating Engineering of Exterior Environments. Exterior lighting and all exterior luminaries with more than 1000 initial lumens are to be shielded and all luminaries with more than 3500 initial lumens meet the Full Cutoff IESNA Classification. The lighting has been designed to shield light outside of property line. Plus the lighting is designed to be more uniform and low levels around the building. (LEED Reference Guide NC 2.1, 69)

Water Efficiency

This section deals with the water usage for the building.

Credit 1 – Water Efficient Landscaping

There are two points that can be earned from this credit. This credit is designed to reduce the use of potable water for landscaping. (LEED Reference Guide NC 2.1, 81)

1.1 50% Reduction

By using recycled water or using high efficiency irrigation technology, the consumption of potable water for irrigation by 50% over conventional means. Thus, this point can be achieved easily. (LEED Reference Guide NC 2.1, 81)

1.2 No Potable Use or No Irrigation

This point can be achieved in addition to the 1.1. To achieve this point, we only need to use captured rain or recycled site water, such that the potable water is not used for irrigation OR do not install permanent landscape irrigation system. This point can be achieved easily, by using recycled site water for the irrigation systems. (LEED Reference Guide NC 2.1, 82)

Credit 2 – Innovative Wastewater Technologies

There is one point to be earned from this credit. The complete this credit, the potable water for building sewage conveyance is to be reduced by a minimum of 50% OR treat 100% of...
waste water on site to tertiary standards. By using low flow water closets and waterless urinals,
the use of potable water for building sewage can be reduced. Composting toilets do not use any
water and are still very hygienic but it would be very difficult for elementary students to
comprehend the usage of composting toilets. Therefore, using low flow water closets will still be
able to achieve the 50% reduction for this credit point. (LEED Reference Guide NC 2.1, 91)

Credit 3 – Water Use Reduction

There are two points that can be earned from this credit. The credit is designed to
maximize water efficiency. (LEED Reference Guide NC 2.1, 99)

3.1 20% Reduction

To achieve this credit, we need to reduce the water use by 20% from the Energy Policy
Act 1992 usage. By using low flow plumbing fixtures and automatic controls at lavatories, this
point can easily be achieved. (LEED Reference Guide NC 2.1, 99)

3.2 30% Reduction

To achieve this credit, we need to reduce the water use by 30% from the Energy Policy
Act 1992 usage. This point is earned in addition to the credit 3.1 20% Reduction. By using low
flow plumbing fixtures and automatic controls at lavatories, this point can easily be achieved.
(LEED Reference Guide NC 2.1, 100)

Energy & Atmosphere

This section deals with the energy consumption of the buildings.

Prerequisite 1 – Fundamental Building Systems Commissioning

To complete the requirement of this prerequisite we need to have a commissioning team
to verify and ensure that the basic building elements and systems are installed and calibrated to
operate as intended. (LEED Reference Guide NC 2.1, 111)
Prerequisite 2 – Minimum Energy Performance

To achieve this prerequisite the building needs to be designed and built to minimum ASHRAE/IESNA Standard 90.1-1999. CCSD requires all schools to be in compliance with ASHRAE Standard 90.1-1999. Since the school is already designed to ASHRAE 90.1-1999, this prerequisite is satisfied. (LEED Reference Guide NC 2.1, 121)

Prerequisite 3 – CFC Reduction in HVAC&R Equipment

To achieve this prerequisite there should be no CFC refrigerants used in the equipment. CFC refrigerants are no longer produced in United States (since 1995) and are being phased out. No new equipment is produced which uses CFC as refrigerants and therefore no new equipment with CFC is installed or used. We are in compliance with this prerequisite. (LEED Reference Guide NC 2.1, 129)

Credit 1 – Optimize Energy Performance

There are ten points that can be earned from this credit. Points are awards based on the amount of energy cost savings from the standard energy cost savings based on ASHRAE 90.1-1999. It is based on the percentage saving achieved, if 15% saving in cost is achieved over ASHRAE 90.1-1999, one point is achieved. If 60% saving in cost is achieved over ASHRAE 90.1-1999, ten points are achieved. We will easily be able to achieve some points from this credit. (LEED Reference Guide NC 2.1, 133)

Credit 2 – Renewable Energy

There are a total of three points that can be earned from this credit. This credit promotes the achieving self dependence on energy usage.

2.1 5%

To achieve one point from this credit, one needs to supply at least 5% of the total energy use through on site renewable energy generation system. Use of solar panels can easily help achieve one point from this credit. (LEED Reference Guide NC 2.1, 151)
2.2 10%

To achieve one point from this credit, one needs to supply at least 10% of the total energy use through on site renewable energy generation system. This point is in addition to point from 2.1 5% credit. Use of solar panels can easily help achieve one point from this credit. (LEED Reference Guide NC 2.1, 152)

2.3 20%

To achieve one point from this credit, one needs to supply at least 20% of the total energy use through on site renewable energy generation system. This point is in addition to points from 2.1 5% credit and 2.2 10% credit. Use of solar panels can easily help achieve one point from this credit. (LEED Reference Guide NC 2.1, 153)

Credit 3 – Additional Commissioning

There is one point that can be achieved from this credit. The purpose of this credit is to provide commissioning for the entire building. The commissioning in the prerequisite is for energy systems. This additional commissioning is for the entire building. By hiring the commissioning team for the entire building, it costs only a little more but provides high returns in terms of cost saving achieved from energy usage. (LEED Reference Guide NC 2.1, 165)

Credit 4 – Ozone Protection

There is one point that can be achieved from this credit. To achieve this credit we will need to use refrigeration equipment and fire suppression systems that do not contain any HCFC’s and Halons. Even though some of the high potential ozone depletion HCFC’s are being phased out since 2003, it will take till 2030 to complete the phasing out of HCFC’s. By using non HCFC’s and Halons equipment one point from this credit can be achieved. (LEED Reference Guide NC 2.1, 169)
Credit 5 – Measurement and Verification

There is one point that can be achieved from this credit. To achieve this point we need to install continuous metering equipment for the energy usage systems like lighting system and controls, constant and variable motor loads, variable frequency drive operation, chiller efficiency at variable loads, cooling load, air and water economizer and heat recovery cycles, air distribution static pressures and ventilation air volumes, boiler efficiencies, building related process energy systems and equipment and, indoor water risers and outdoor irrigation systems. The LEED point will not be achieved for engineering calculation using spot or short term measurements, computer simulations, and/or historical data. But the LEED point can be achieved for analysis of utility meter data using techniques from simple comparison to multivariate regression analysis. Or calibrated energy simulation and modeling; calibrating with hourly or monthly utility billing data and/or end-use metering. This point can be achieved easily by constant monitoring. (LEED Reference Guide NC 2.1, 173)

Credit 6 – Green Power

There is one point that can be achieved from this credit. To achieve this credit at least 50% of the building’s electricity needs to be from renewable sources by at least a two-year renewable energy contact. Nevada Power provides power to the Southern Nevada and Nevada Power purchases about 235 megawatts of electricity from Hoover Dam, the historic federal hydroelectric project along the Colorado River. Of the electricity produced at company-owned power plants, about 37 percent is from natural gas and oil-fired generating units and 63 percent is from the coal-fired generating units (Nevada Power energy). Since hydroelectric electricity is considered as a renewable energy and the signing of the contract between Nevada Power and CCSD for providing 50% of its electricity from hydroelectric project will be able to earn one point from this credit (LEED Reference Guide NC 2.1, 181). This credit will be subjected to the energy consumption by the building and the number of schools being added by CCSD.
Materials & Resources

This section deals with the usage of new or recyclable materials for the building construction.

Prerequisite 1 – Storage & Collection of Recyclables

To complete this prerequisite we need to provide an easily accessible area that serves the entire building and should be dedicated to the separation, collection and storage of materials for recycling. We are already providing a separate building (service building) which will include trash area and can also be used for storage and sorting of materials for recycling. Therefore, this prerequisite will be completed (LEED Reference Guide NC 2.1, 187).

Credit 1 – Building Reuse

Even though there are three points that can be earned from this credit, but we might not be able to complete this credit. Sometimes CCSD does a replacement school, but they are not as frequent as the new schools. Therefore, no points can be achieved from this credit (LEED Reference Guide NC 2.1, 191).

Credit 2 – Construction Waste Management

There are two points that can be achieved from this credit. The purpose of this credit is to stop the waste generated from construction process from going to landfills and to be reused or recycled.

2.1 Divert 50% from Landfill

To achieve one point from this credit, we need to develop and implement a waste management plan for diverting 50% of construction waste from landfill to recycling. For commercial construction, there is 2 to 2.5 pounds of solid waster per square foot of construction. Lot of this construction waste is recyclable like concrete, wood, drywall, metal, roofing, brick and cardboard and can easily be recycled. This credit could be completed. (LEED Reference Guide NC 2.1, 199)
2.2 **Divert 75% from Landfill**

The point from this credit is in addition to the 2.1 Divert 50% from Landfill. To achieve this point from this credit, there needs to be a waste management plan for diverting 75% of construction waste from landfill to recycling. (LEED Reference Guide NC 2.1, 200)

Credit 3 – **Resource Reuse**

There are two points that can be achieved from this credit. The purpose of this is to reuse building materials and products.

3.1 **5%**

To achieve one point from this credit, we need to use salvaged, refurbished or reused materials, products and furnishings for at least 5% of building materials. Some materials like reclaimed door and frames, beams or posts or refurbished materials can be used for achieving this point. (LEED Reference Guide NC 2.1, 207)

3.2 **10%**

To achieve one point from this credit, we need to use salvaged, refurbished or reused materials, products and furnishings for at least 10% of building materials. This point is in addition to the one earned in credit 3.1 5%. The availability of reused or refurbished materials will define whether this point can be achieved or not. (LEED Reference Guide NC 2.1, 208)

Credit 4 – **Recycled Content**

There are two points that can be achieved from this credit. The purpose of this is to use building products that have high content of recycled materials.

4.1 **5% (post-consumer + ½ post-industrial)**

To achieve one point from this credit, we need to use products that have more than 5% recycled materials in them from post consumer plus one half the post industrial content. By using ceramic tile and carpets with high recycled content we will be able to achieve this point. (LEED Reference Guide NC 2.1, 213)
4.2 10% (post-consumer + ½ post-industrial)

To achieve one point from this credit, we need to use products that have more than 10% recycled materials in them from post consumer plus one half the post industrial content. This point is in addition to the one earned from credit 3.1 5% (post-consumer + ½ post-industrial). By using materials with high recycled content one point can be achieved from this credit (LEED Reference Guide NC 2.1, 214)

Credit 5 – Regional Materials

There are two points that can be achieved from this credit. The purpose of this is to use building materials and products that are either manufactured or extracted locally.

5.1 20% Manufactured Regionally

To achieve one point from this credit, we need to use a minimum of 20% of building materials and products that are manufactured within a radius of 500 miles. Since we have concrete and CMU plants within 500 miles, we will be able to achieve this point. (LEED Reference Guide NC 2.1, 221)

5.2 50% Extracted Regionally

The point earned from this credit is in addition to the point earned in 5.1 20% Manufactured Locally. To achieve one point from this credit, the school needs to use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site. (LEED Reference Guide NC 2.1, 222)

Credit 6 – Rapidly Renewable Materials

One point can be achieved from this credit. To achieve this point the school needs to have rapidly renewable materials and products for 5% of the total value of all building products and materials used in the project. By using wheatgrass cabinetry and high content cotton/wool carpet which have less than 10 year growth cycle, we may be able to complete the requirements of the credit. (LEED Reference Guide NC 2.1, 227)
Credit 7 – Certified Wood

One point can be achieved from this credit. To achieve this point we need to use a minimum of 50% of wood based materials and products that is certified in accordance with Forest Stewardship Council's criteria. By using certified wood in more than 50% of the construction needs we will be able to earn one point from this credit. (LEED Reference Guide NC 2.1, 231)

Indoor Environmental Quality

This section deals with the more with the indoor air and environment of the building interior.

Prerequisite 1 – Minimum IAQ Performance

To be in compliance with this prerequisite we need to meet the minimum requirement of ASHRAE 62-1999. This section defines the ventilation rate and make up of air inlets away from sources which contaminate the air quality. The school will be provided with minimum ventilation rate and all air inlets are planned away from the contamination sources. (LEED Reference Guide NC 2.1, 241)

Prerequisite 2 – Environmental Tobacco Smoke (ETS) Control

To be in compliance we need to prohibit smoking in the building and locate any exterior designated smoking areas away from entries and operable windows. CCSD has a no smoking policy on the CCSD School properties. Therefore, the project will be in compliance with this prerequisite. (LEED Reference Guide NC 2.1, 245).

Credit 1 – Carbon Dioxide (CO₂) Monitoring

There is one point that can be achieved from this credit. To achieve this credit we need to install a permanent carbon dioxide monitoring system that provides feedback on space ventilation performance. Automatic ventilation control will be installed for all HVAC systems serving large
number of spaces. The project will be able to achieve one point from this credit. (LEED Reference Guide NC 2.1, 249)

Credit 2 – Ventilation Effectiveness

There is one point that can be achieved from this credit. Since the elementary school is mechanically ventilated, we need to design the ventilation systems that provides air change effectiveness greater than or equal to 0.9 as determined by ASHRAE 129-1997. (LEED Reference Guide NC 2.1, 253)

Credit 3 – Construction IAQ Management Plan

There are two points that can be earned from this credit. This credit deals with the indoor air quality during and after construction.

3.1 During Construction

To achieve this point we need to comply with a number of issues. During construction the general contractor need to meet the recommended design approaches of Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ guideline for Occupied Buildings under Construction. Stored on-site or installed absorptive materials must be protected from moisture damage. Since no air handlers will be used during construction, there is no need to comply with the criteria for air filtration. Replace all filtration media prior to occupancy. (LEED Reference Guide NC 2.1, 261)

3.2 After Construction/Before Occupancy

To achieve one point from this credit we need to develop and implement an IAQ plan for the preoccupancy phase. After construction ends, flushing a minimum for two weeks 100% outside air with Minimum Efficiency Reporting Value 13 filtration media. After flush out, replace all the filtration media. (LEED Reference Guide NC 2.1, 262)
Credit 4 – Low-Emitting Materials

There are four points that can be earned from this credit. This credit deals with reducing the harmful contaminants emitted from materials used.

4.1 Adhesives and Sealants

To achieve one point from this credit, there is a need to use adhesives and sealants with VOC content less than the VOC content limits of South Coast Air Quality Management District (SCAQMD) (LEED Reference Guide NC 2.1, 269)

4.2 Paints and Coatings

To achieve one point from this credit, there is a need to use paints and coatings with VOC emissions less than VOC limits of Green Seal's Standard GS-11 requirement. (LEED Reference Guide NC 2.1, 270)

4.3 Carpet

To achieve one point from this credit, there is a need to use carpets that meet the requirements of the Carpet and Rug Institute's Green Label Indoor Air Quality Test Program. (LEED Reference Guide NC 2.1, 271)

4.4 Composite Wood

To achieve one point from this credit, the composite wood and agrifiber products that are used should not contain any urea-formaldehyde resins. (LEED Reference Guide NC 2.1, 272)

Credit 5 – Indoor Chemical & Pollutant Source Control

There is one point that can be earned from this credit. To achieve this credit, three things need to be satisfied. There need to be permanent entryway systems to capture dust particles from entering the building. There is a need to separate the housekeeping area by providing deck to deck partitions with separate exhaust at a minimum rate of 0.50 cubic feet per minute per square foot. Drains need to be plumbed for appropriate disposal of liquid waste in spaces where water and chemical concentrate mixing occurs. (LEED Reference Guide NC 2.1, 279)
Credit 6 – Controllability of Systems

There are two points that can be earned from this credit. This credit deals with control for thermal, ventilation and lighting systems.

6.1 Perimeter Spaces

To achieve one point from this credit, there needs to be on average one operable window and one lighting control zone per 200 square feet for all regularly occupied areas within 15 feet of the perimeter wall (LEED Reference Guide NC 2.1, 283). Operable windows cannot be provided on the outside perimeter of the school, due to student safety and security issues. Therefore, no point can be earned from this credit.

6.2 Non-Perimeter Spaces

To achieve one point from this credit, there should be controls for each air flow, temperature and lighting for 50% of the non-perimeter occupants. Each classroom has at least one or two thermal zones (depending on size), controlled by separate controls installed in the same room. Lighting is also controlled individually for each classroom, with motion controlled sensors to provide energy savings. Therefore it is possible to earn one point from this credit. (LEED Reference Guide NC 2.1, 284)

Credit 7 – Thermal Comfort

There are two points that can be earned from this credit. This credit deals with thermally comfortable environment for occupants.

7.1 Compliance with ASHRAE 55-1992

To earn one point from this credit we need to comply with ASHRAE 55-1992, for thermal comfort. To achieve this point the HVAC system needs to be designed to achieve the temperature range as defined in ASHARE 55-1992. Therefore, it is possible to achieve one point from this credit. (LEED Reference Guide NC 2.1, 293)
7.2 **Permanent Monitoring System**

The point earned from this credit is in addition to the point earned in 7.1 Compliance with AHSRAE 55-1992. To be in compliance with this credit, we need to install a permanent temperature and humidity monitoring system configured to provide operators control. Thus it is possible to earn one point from this credit. (LEED Reference Guide NC 2.1, 294)

Credit 8 - **Daylight and Views**

There are two points that can be earned from this credit.

8.1 **Daylight 75% of Spaces**

To achieve this point we need to achieve a daylight factor of 2% in 75% of all space occupied. Daylight factor is the ratio of exterior illumination to interior illumination and is expressed as a percentage. Therefore, it is possible to achieve one point from this credit. (LEED Reference Guide NC 2.1, 301)

8.2 **Views for 90% of Spaces**

To achieve this point we need to achieve direct line of sight to vision glazing for building occupants in 90% of all space occupied. Since more than 25% areas do not have direct line of sight to the glazing, it may not be possible to achieve one point from this credit. (LEED Reference Guide NC 2.1, 302)

**Innovation & Design Process**

This section deals with the new technologies and new strategies applied to design to promote sustainability.

Credit 1 – **Innovation in Design**

There are four points that can be earned from this credit. To achieve this we need to identify the intent of the innovation credit and propose requirements for compliance. We might be able to earn one point from this credit by proposing innovative performance in Green Building...
categories not already addressed in the LEED system or by outperforming on the required credits standards. (LEED Reference Guide NC 2.1, 313)

Credit 2 – LEED™ Accredited Professional

There is one point to be earned from this credit. We need to have a one LEED accredited professional on the design team to earn the credit. (LEED Reference Guide NC 2.1, 317)
CHAPTER 5

MATERIALS AND CALCULATIONS FOR SCHOOLS

In this chapter, we will provide the required calculations, that will be used for achieving the LEED Credit. We will also explore the use of green materials to achieve more environmentally conscious design and an energy saving school.

Sustainable Sites

Prerequisite 1 - Erosion and Sedimentation control

There are quite a few ways of achieving erosion and sedimentation control. Sedimentation basins (allow for settling of sediment from stormwater volumes), drop inlets, and seeding and mulching can be used to achieve appropriate erosion and sedimentation control. The appropriate measures are chosen by the civil engineer in collaboration with the architect and the landscape architect to achieve the best results for a particular site. These issues vary from site to site and are also dependent on the soil type. To achieve erosion control, we could use the following products.

Sediment Logs – Excelsior Sediment Control Device:

Curlex Sediment Logs® use excelsior fibers to reduce hydraulic energy and filter sediment-laden runoff. Water filters through (not underneath) the diameter of the porous, interlocked fiber log matrix. As it does, velocity is naturally reduced and sediment is collected on the upstream side of the excelsior fiber log. Sediment Logs can be installed over bare soil and/or biodegradable and permanent erosion control blankets, on steep slopes as a wattle, around drains for inlet protection, or around jobsites for perimeter control. (Sediment Logs, 2006)

Material Characteristics - Sediment Logs are versatile excelsior logs comprised of an outside containment fabric and filled with unique Curlex fibers. Curlex fibers are made of Great Lakes
Aspen excelsior fibers. The fibers are curled with soft interlocking barbs and 80% will be six inches in length or longer. The outside, open weave containment fabric is degradable, thus Sediment Logs will degrade in place if not removed. Sediment Logs are porous, allowing water to pass through the excelsior matrix, progressively slowing velocity and filtering sediment as it passes through the log diameter. Sediment Logs are extremely flexible and contour to the terrain to maintain intimate contact with the subgrade. They are lightweight, require no trenching, no weed seeds, no disposal hassles and, are re-usable and hold their shape. Sediment Logs come from 6" -20" diameter with lengths varying from 10'- 25' (Sediment Logs, 2006)

**Typical Applications** - Energy dissipation and Sediment Control Device in:

- Ditch bottoms, swales, and waterways
- Over bare soils and/or temporary and turf reinforcement blankets
- Drop structures and let down structures
- 360 degree protection around catch basins and drop inlet structures
- Curb & drainage outlets
- Project ingress and egress termination points
- As wattles on steep slopes (Sediment Logs, 2006)

**SiltTRAP**

SiltTRAP captures sediment before it washes away, the excelsior fibers in SiltTRAP filter soil from the runoff. SiltTrap fibers are 100% biodegradable.

Curlex SiltTRAP fibers expand when wet creating a “clinging” effect to the soil, making the blanket become twice as thick, thereby adding additional protection during heavy rain. The same fibers then slowly release the absorbed moisture back to the soil creating a hygroscopic action that nurtures seeds and promotes revegetation. See appendix for additional information on SiltTRAP (Sediment Logs, 2006).
Silt Fence Fabrics

When attached to posts and properly trenched into the soil, Geotex® silt fence fabrics will contain overland flow and screen soil particles from storm water runoff, allowing for efficient drainage and preventing environmental damage to adjacent areas. Geotex’s superior ultraviolet (UV) resistance and tensile strength make sure that the silt fence fabrics continuously perform throughout the entire life of the project. (SI Geosystems 2006). See Appendix for product brochures and technical data on silt fence fabrics.

For dust control, water will be used to keep the dust down during the construction period. This is an additional requirement by the local jurisdiction, Clark County in Southern Nevada. This dust control reduces erosion and is an additional step for achieving this prerequisite (CCSD Air Quality, 2006).

Erosion control mats are used to protect soil from rain and wind erosion and to support establishment of sustainable vegetation. For areas at berms or slopes, the soil is more sustainable to erosion from water runoff, to prevent soil erosion we will be using erosion control blankets. One such product is Rolanka’s Bio D-Mat 90 (Bio D-Mat 90, 2006). Another product is Curlex blankets, which are made from softly barbed, interlocking, curled, Aspen excelsior fibers (Sediment Logs, 2006). See Appendix for product brochure.

Credit 1 – Site Selection

All aspects of site selection and other requirements are under the scope of CCSD Real Property Management and will be completed by them.

Credit 4 – Alternative Transportation

We will be earning 3 points out of 4 from this credit.

4.1 Public Transportation Access

By choosing the school site to be within ¼ mile of two public bus lines, we will be able to achieve this credit. The transit map of the CAT bus route is in the appendix (CAT System Map, 2006).
4.2 Bicycle Storage and Changing Rooms

The school is already designed to have a bike rack. Since the bike rack is next to the Service Yard, adding changing room and showers next to the Service Yard. The Service Yard is located less than 20 yards away from the building, thus the changing room and showers will be within 200 yards as required by LEED credit (LEED Reference Guide NC 2.1, 32).

Equation 1 (LEED Reference Guide NC 2.1, 39):
Full Time Equivalent (FTE) = Worker Hours / 8
FTE = [700 (students) X 6 + 40 (faculty) X 8] / 8 = 565

Equation 2 (LEED Reference Guide NC 2.1, 39):
Secure Bicycle Spaces = FTE Building Occupants X 5%
Secure Bicycle Spaces = 565 X 5% = 29 Spaces.

Equation 3 (LEED Reference Guide NC 2.1, 39):
Showering Facilities = Bicycling Spaces / 8
Showering Facilities = 29 / 8 = 4 Showers.

In each school, CCSD is requiring at least 50 secure bicycle spaces, with 7' high chainlink fence, enclosing the bike rack area. By adding 10 more secure bicycling spaces, and total of 8 showers, another credit can be earned in Innovation and Design, as we would have gone over and beyond the requirement of LEED (LEED Reference Guide NC 2.1, 39). The space required for showers and locker area will be 400 sq. ft.

Cost of showers and locker room addition = $160,000 (1250 X 128) (RSMeans 2006, 748)
4.4 Parking Capacity

CCSD builds schools in different jurisdictions, like Clark County, City of Henderson, City of North Las Vegas, City of Las Vegas with each adopting separate zoning regulations and therefore has different parking requirements. We also need to provide preferred parking for carpool spaces. The carpool spaces will be calculated with Equation 5 (LEED Reference Guide NC 2.1, 32):

Required Number of Carpool Spaces = FTE Building Occupants X 5% / 2

Carpool Spaces for each school = 565 X 5% / 2 = 15 spaces.

Clark County parking space requirements for elementary school are:
1: classroom, + 4: 1,000 sq. ft. of office (Clark County UDC, 2006).
There are 42 classrooms and 5600 sq. ft. of office space.
Clark County parking spaces = 1X42 + 4X (5600/1000) = 66 spaces.

City of Las Vegas parking space requirements for elementary school are:
Two spaces for each classroom, plus twenty spaces for administrative staff (Las Vegas Ch. 19.10, 2006).
City of Las Vegas parking spaces = 2X42+20 = 104 spaces.

City of Henderson parking space requirements for elementary school are:
1 per teacher/employee + drop-off spaces per Sec. 19.10.1.N.6.c. (COH development code, 2006).
City of Henderson parking spaces = 1X40 = 40 spaces.

City of North Las Vegas parking space requirements for elementary school are:

a) Minimum of 55 spaces, or

b) One and one-half spaces for each classroom, library, lecture hall and cafeterias, plus
c) One space per each three fixed seats in the main area of public assembly, designed to be utilized by the public (non student assembly) (CNLV Zoning, 2006)

City of North Las Vegas parking spaces = 1.5 x 45 + 0 = 68 spaces.

Credit 5 – Reduced Site Disturbance

There is one point to be earned from this credit.

5.2 Development Footprint

With different jurisdictions and separate zoning regulations, like Clark County, City of Henderson, City of North Las Vegas, City of Las Vegas has different open space zoning requirements.

Clark County requires a front setback of 15’, side and rear setbacks to be 10’ (Clark County UDC, 2006). To earn this credit we will need to increase the open area requirement by 25%. To achieve this we will have to provide a front setback of 18.75’ (15’ + 15 x 25%), side and rear setbacks of 12.5’ (10’ + 10 x 25%) from the property line.

The City of Las Vegas requires a front setback of 20’, side and rear setbacks to be 15’ (Las Vegas Ch. 19.10, 2006). To earn this credit we will need to increase the open area requirement by 25%. To achieve this we will have to provide a front setback of 25’ (20’ + 20 x 25%), side and rear setbacks of 18.75’ (15’ + 15 x 25%) from the property line.

The City of Henderson requires a front setback of 25’, side and rear setbacks to be 10’ (COH development code, 2006). To earn this credit we will need to increase the open area requirement by 25%. To achieve this we will have to provide a front setback of 31.25’ (25’ + 25 x 25%), side and rear setbacks of 12.5’ (10’ + 10 x 25%) from the property line.

The City of North Las Vegas requires a setback of 25’ front setback and 15’ for side and rear setbacks from the property line (CNLV Zoning, 2006). To earn this credit we need to increase the open area requirement by 25%. To achieve this we will have to provide a front setback of 31.25’ (50’ + 50 x 25%) and a rear and side setback of 18.75’ from the
property line. The only drawback of this would be the loss of the usable property for play area for students.

Credit 6 – Stormwater Management

There are two points to be earned from this credit.

6.1 Rate and Quantity

This credit requires a lot of work from the civil engineer and is very much dependent on the site and the soil type at the site for the discharge rate of storm water. Most of the sites chosen for an elementary school are virgin sites in Las Vegas. Therefore, the imperviousness of the site is never over 50%. To achieve a point from this credit we will have to make the post-development 1.5 year, 24 hour discharge rate to be less than pre-development 1.5 year, 24 hour discharge rate. Harvesting rainwater runoff from the roof to be later used for irrigation will significantly reduce the storm water discharge from the roof. A Filtering Roofwasher is installed between the downspout and cistern to remove dirt and debris from water collected from a roof. Larger debris is collected by screens in "leaf catcher" compartments. The first water to be collected, which washes off dirt and debris that has accumulated on the roof surface between rains, is held in a "quiet chamber" and drains away slowly through a "weep-hole." Use of the Filtering Roofwasher can greatly improve the quality of cistern water and significantly increase the time between cistern cleanings. The unit is constructed of a replaceable filter element, heavy-duty fiberglass, stainless steel, and PVC. See appendix for more information on the product (Filtering Roofwashers, 2006). Rainwater Harvesting provides complete rainwater harvesting system. See appendix for more information on their products (Rainwater Harvesting, 2006).

To further lessen the discharge rate, using porous pavers in place of asphalt concrete at parking lot and at concrete pavement will reduce the amount of discharge rate significantly. The Bio-Aquifer Storm System (BASS) from Advanced Pavement Technology is an engineered permeable paving system which provides post-construction
runoff rates that are the same or better than preconstruction, without the use of detention ponds. The system includes subsurface drainage/detention layers of rocks and aggregate to a minimum depth of 18", topped with concrete porous pavers. The system permits exceptionally heavy vehicle traffic and is not affected by extreme thermal conditions. Further, a Bio-Aquifer storm system is a more efficient storm water management method, improving the quality of storm water run-off as it is returned to a ground water source. The coefficient of runoff for permeable pavements at dead flat has been proven to be .15, where asphalt is .98 using the rational method. (Pavement System, 2006)

Figure 6  Bio-Aquifer storm system (Pavement System, 2006)

6.2  Treatment

To achieve this credit we will need to remove suspended solids and total phosphorous from the storm water. To achieve this, we will be using StormTreat. StormTreat System is sized based upon the water quality design storm, the area of
impervious surface, the amount of water processed during the storm and the available storage volume of preliminary detention. Stormwater passes through six sedimentation chambers and a constructed wetland prior to infiltrating into backfilling of 3 to 5 mm washed stone. Generally, 1 to 2 units per acre of impervious surface are required to meet standards (StormTreat System, 2006).

STORMTREAT SYSTEM incorporates effective pre-treatment by directing stormwater through STORMTREAT'S unique, multi-stage, total suspended solids (TSS) removal system prior to infiltration. This includes 1) a grit-filter bag to trap the larger floatables which may find their way past the catch basin preceding the STS unit, 2) a series of sedimentation chambers fitted with "skimmers" (which significantly enhance the settling efficiency of particulates by continually drawing from just below the surface of the water, and "decanting" it to the next chamber, and 3) a gravel filter which serves as a substrate for a constructed wetland. Larger-diameter particulates are trapped inside the sedimentation chambers and smaller (silt and clay-sized) particles are filtered in the gravel wetland substrate. The smaller particles are predominantly organic in composition and therefore can be decomposed in the wetland soils by bacteria which reside within the wetland plant root zone. Treated stormwater may then be infiltrated into the 3/4-inch stone used for backfill in the excavation around and under the STORMTREAT tanks. This stone is highly permeable and serves to transmit the treated water downward until it encounters the parent soils. During peak flow periods, the infiltration rate may exceed the permeability of the parent soils and the stone backfill area serves as a temporary storage reservoir. As this area fills with water, a substantially larger leaching surface is encountered by the treated stormwater. The cost of a one typical StormTreat unit is $8,000. A total of 1 unit per acre is required for the site (StormTreat System, 2006).
Figure 10, Diagram of the StormTreat System (StormTreat System, 2006)

New Design Modification Now Provides 7000 gallons of Storage & Treatment

Figure 11, Summary of Water Quality Monitoring Results of the StormTreat System (StormTreat System, 2006)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Percentage Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecal Coliform</td>
<td>97%</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>99%</td>
</tr>
<tr>
<td>Chemical Oxygen Demand</td>
<td>82%</td>
</tr>
<tr>
<td>Total Dissolved Nitrogen</td>
<td>77%</td>
</tr>
<tr>
<td>Total Petroleum Hydrocarbon</td>
<td>90%</td>
</tr>
<tr>
<td>Lead</td>
<td>77%</td>
</tr>
<tr>
<td>Chromium</td>
<td>98%</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>90%</td>
</tr>
<tr>
<td>Zinc</td>
<td>90%</td>
</tr>
</tbody>
</table>
Credit 7 – **Heat Island Effect**

There are two points to be earned from this credit.

### 7.1 Non-Roof

Using the Bio-Aquifer Storm System (BASS) from Advanced Pavement Technology in SS 6.1, another point in this credit can be earned (Pavement System, 2006). Bio-Aquifer Storm pavers, have an open grid pavement and using it on more than 60% of the total site paving. In addition to using open grid pavement, there are landscaping requirements at parking lot, set forth by Clark County. The use of landscaping further provides shade to the paving. Since, it is only required on an area of 30% for achieving this credit. Another additional point can be earned in last section, for going over and beyond the requirements of this credit (LEED Reference Guide NC 2.1, 59).

The ecological paving system being used is replacing asphalt and concrete. The total area being covered by pavers is approximately 217,000 sq.ft. The cost of the pavers is $7.50/sq.ft. (Pavement System, 2006).

**Total cost of the using pavers = $1,627,500 (217,000 X 7.50)**

**Conventional cost using concrete and asphalt = $ 655,783 (458,983 + 196,800)**

**Additional cost of using ecological paving system = $ 971,717 (1,627,500 – 655,783)**

### 7.2 Roof

The school prototype is currently using a built-up roofing system, which includes 3-4 layers of hot bitumen applied over insulation. The color of the roof is generally black and it has very low reflectiveness and very low emissivity. The roofing system is not at all suitable for a climate like Southern Nevada, where cooling is required for almost 8 months of the year. The using of single ply roofing system like Sarnafil can help achieve this credit. Sarnafil has a high emissivity of 83% and will be used for 50,000 sq.ft. of built up roof area. While the rest 16,684 sq.ft of roof area will be kept the same standing seam
metal roof. See the appendix for additional information (Sarnafil, 2006). Single ply roofing is cheaper than built-up roofing both in cost material and installation.

Built-up Bituminous Roofing per 100 sq. ft. (RSMeans 2006, 223)

Total Bare Cost = Material Cost + Labor Cost + Equipment Cost

Total Bare Cost = $123.00 + $80.00 + $16.85 = $219.85

Total Cost Including Overhead and Profit = $290.00

Single Ply Roofing per 100 sq. ft. (RSMeans 2006, 224)

Total Bare Cost = Material Cost + Labor Cost + Equipment Cost

Total Bare Cost = $111.00 + $42.50 + $5.65 = $159.15

Total Cost Including Overhead and Profit = $201.00

Initial savings for Single Ply Roofing = $290.00 - $201.00 = $89.00 per 100 sq.ft.

Total initial saving for Prototype Elementary School = $44,500

(Roof Area X savings per 100 sq. ft. /100 sq. ft. = 50,000 sq. ft. X 89.00 / 100)

Single ply roofing provides more energy savings than built-up roofing, for the same amount of R-value of the roof (Roof Calculator, 2006). See appendix for roof calculator results.

Annual Energy savings achieved = 50,000 sq. ft. X 0.15 sq. ft. per year = $7,500 per year (Roof Calculator, 2006)

Total life cycle of Single ply roofing = 50 years (Sarnafil, 2006)

Total life cycle saving for single ply roofing = 50 year X $7,500 per year = $375,000

Total savings by using single ply roofing = (Initial savings + energy savings) = $44,500 + $375,000 = $419,500

84

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Credit 8 – **Light Pollution Reduction**

To achieve this credit the exterior fixture needs to meet the full IESNA cutoff requirements. We are using Kim Lighting Forward throw metal halide wall director model # WD18D4/ 250MH/277/DB-P/5DS18 using lamp type MXR259/Med/E 250 watt lamp. The wall director meets full IESNA cutoff requirements and the cutoff level can be adjusted according to distance to the property line from the fixture (Kim Lighting, 2006). See appendix for more information on the product.

**Water Efficiency**

Credit 1 – **Water Efficient Landscaping**

There are two points to be earned from this credit. Even though the amount of water needed for irrigation depends on the size and location of the site. Desert smart landscaping, along with drip and micro irrigation can significantly reduce the amount of water used for irrigation.

The evapotranspiration rate ($ET_0$) is 9.0 for arid climate like Las Vegas (Evapotranspiration rate, 2006). The Artificial Turf does not require irrigation, therefore the $K_b$ is zero and therefore $ET_l$ and TPWA is zero (LEED Reference Guide NC 2.1, 85).
### Table 11  Design case (July) (LEED Reference Guide NC 2.1, 87)

<table>
<thead>
<tr>
<th>Landscape Type</th>
<th>Area (sf)</th>
<th>Species Factor $K_s$</th>
<th>Density Factor $K_d$</th>
<th>Microclimate Factor $K_{mc}$</th>
<th>$K_l$</th>
<th>$ET_L$</th>
<th>IE</th>
<th>TPWA (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrubs</td>
<td>1000</td>
<td>0.2</td>
<td>0.5</td>
<td>1.2</td>
<td>0.12</td>
<td>1.08</td>
<td></td>
<td>Drip 1200</td>
</tr>
<tr>
<td>Trees</td>
<td>1000</td>
<td>0.2</td>
<td>0.5</td>
<td>1.0</td>
<td>0.1</td>
<td>0.9</td>
<td></td>
<td>Drip 1000</td>
</tr>
<tr>
<td>Artificial Turf</td>
<td>87,000</td>
<td>0</td>
<td>1.0</td>
<td>1.0</td>
<td>0</td>
<td>0</td>
<td></td>
<td>None 0</td>
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<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

July Graywater Use (2,220)

Net GPWA (gpwa) 0

### Table 12  Baseline case (July) (LEED Reference Guide NC 2.1, 87)

<table>
<thead>
<tr>
<th>Landscape Type</th>
<th>Area (sf)</th>
<th>Species Factor $K_s$</th>
<th>Density Factor $K_d$</th>
<th>Microclimate Factor $K_{mc}$</th>
<th>$K_l$</th>
<th>$ET_L$</th>
<th>IE</th>
<th>TPWA (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrubs</td>
<td>1000</td>
<td>0.2</td>
<td>0.5</td>
<td>1.2</td>
<td>0.12</td>
<td>1.08</td>
<td></td>
<td>Drip 1200</td>
</tr>
<tr>
<td>Trees</td>
<td>1000</td>
<td>0.2</td>
<td>0.5</td>
<td>1.0</td>
<td>0.1</td>
<td>0.9</td>
<td></td>
<td>Drip 1000</td>
</tr>
<tr>
<td>Turf</td>
<td>87,000</td>
<td>0.7</td>
<td>1.0</td>
<td>1.3</td>
<td>0.9</td>
<td>8.1</td>
<td></td>
<td>Sprinkler 1,127,520</td>
</tr>
<tr>
<td><strong>Net GPWA (gal)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,129,720</td>
</tr>
</tbody>
</table>

On the Baseline case, the water bill amounts to $3,108.01 per month, compared with the design case, where we do not use potable water. Just by using artificial turf, we will be able to save this amount in water bills.

The cost of Natural turf = 87,000 sq.ft. X $ 0.33 = $ 28,710 (RSMeans 2006, 76)

The cost of NewGrass turf = 87,000 sq.ft. X $ 3.79 = $ 329,730
Initial extra cost of installing New Grass turf = $ 301,020 (329,730 – 28,710)

Savings on Turf Irrigation = 87,000 X 0.85 = $ 73,950 (RSMeans 2006, 64)

Actual initial cost after savings from not installing turf irrigation = $ 227,070 (301,020 – 73,950)

Cost saving in water bill per month = $ 3,108.01 (Water Bill Calculator, 2006)

Cost savings in water bill per year = $ 37,296.12 (3,108.01 X 12)

Lifetime of NewGrass turf = 10 years

Total cost savings in water bill over lifetime = 10 X $ 37,296.12 = $ 372,961.20

Total numbers of years to break even = 6 years (227,070 / 37,296)

Total payback over lifetime = $ 145,891.20 (372,961.20 – 227,070)

Total amount of water savings over lifetime =

1.13 million gallons X 12 months X 10 years = 135.6 million gallons

1.1 50% Reduction

By using the water smart planting, the need of water can be significantly reduced. Currently, the school district is using water smart plants, in the forms of trees and shrubs that do not require a lot of water for growth. See Table 11 and 12 for total reduction in amount of water used for irrigation.

Using treated gray water for landscaping will eliminate the use of potable water for the irrigation system. For grey water treatment, Cycle-Let on-site wastewater treatment system will be used, which combines membrane technology with biological processes and disinfection to produce colorless and odorless effluent that can be reused in applications for irrigation and toilet flushing. The system is capable of handling flows of up to 100,000 gpd (Wastewater treatment, 2006).

1.2 No Potable Use or No Irrigation

See Table 11 and 12 for total reduction in amount of water used for irrigation. Using Cycle-Let on-site wastewater treatment system and using it for irrigation, will stop
using potable water for irrigation. See appendix for more information (Wastewater treatment, 2006).

To achieve this point, the potable water use for the sewage treatment needs to be 50% less than the baseline model. By using Mansfield’s Quantum Model 148-154 for toilets (High Efficiency Toilets, 2006) and Solan’s WES-1000 Waterfree Urinal (Water free Urinal 2006), potable water savings can be increased by 50%.
### Table 13  Wastewater volume for design case (LEED Reference Guide NC 2.1, 96)

<table>
<thead>
<tr>
<th>Fixture Type</th>
<th>Daily Uses</th>
<th>Flowrate (gpf)</th>
<th>Occupants</th>
<th>Sewage Generation (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra Low-Flow Water Closet (Male)</td>
<td>1</td>
<td>1.0</td>
<td>370</td>
<td>370</td>
</tr>
<tr>
<td>Ultra Low Flow Water Closet (Female)</td>
<td>3</td>
<td>1.0</td>
<td>370</td>
<td>1,110</td>
</tr>
<tr>
<td>Waterless Urinal (Male)</td>
<td>2</td>
<td>0</td>
<td>370</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total Daily Volume (gal)</strong></td>
<td><strong>1,480</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Annual Work Days</strong></td>
<td><strong>260</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Annual Volume (gal)</strong></td>
<td><strong>384,800</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 14  Wastewater volume for baseline design (LEED Reference Guide NC 2.1, 97)

<table>
<thead>
<tr>
<th>Fixture Type</th>
<th>Daily Uses</th>
<th>Flowrate (gpf)</th>
<th>Occupants</th>
<th>Sewage Generation (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Flow Water Closet (Male)</td>
<td>1</td>
<td>1.6</td>
<td>370</td>
<td>592</td>
</tr>
<tr>
<td>Low Flow Water Closet (Female)</td>
<td>3</td>
<td>1.6</td>
<td>370</td>
<td>1,776</td>
</tr>
<tr>
<td>Low Flow Urinal (Male)</td>
<td>2</td>
<td>1.0</td>
<td>370</td>
<td>740</td>
</tr>
<tr>
<td><strong>Total Daily Volume (gal)</strong></td>
<td><strong>3,108</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Annual Work Days</strong></td>
<td><strong>260</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Annual Volume (gal)</strong></td>
<td><strong>808,080</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A total of 423,280 (808,080 – 384,800) gallons of potable water is saved over a period of one year. Total savings in dollars will be shown in Credit 3.
Credit 3 – Water Use Reduction

There are two points to be earned from this credit. The baseline requirements as set forth by EPA are provided below

<table>
<thead>
<tr>
<th>Table 15</th>
<th>EPACT Fixture Rating (LEED Reference Guide NC 2.1, 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flow Requirement</td>
</tr>
<tr>
<td>Water Closets [gpf]</td>
<td>1.6</td>
</tr>
<tr>
<td>Urinals [gpf]</td>
<td>1.0</td>
</tr>
<tr>
<td>Faucets [gpf]</td>
<td>2.5</td>
</tr>
</tbody>
</table>

By using Mansfield's Quantum Model 148-154 for toilets (High Efficiency Toilets, 2006), Solan’s WES-1000 Waterfree Urinal (Water free Urinal 2006), Instant-Flow micro non-public lavatory (Instant flow micro, 2006) and Instant-Flow micro Kitchen/Bar Sink (Instant flow micro, 2006), it is possible to reduce water use significantly. Mansfield's Quantum Model reduces the amount of water used per flush to 1 gpf from 1.6 gpf used by low flow models. Solan’s WES-1000 Waterfree urinals do not use any water for flushing, thereby saving 1.0 gallons per use. While both the Chronomite’s instant flow micro lavatory and sink reduce the amount of water used per minute to 1 gpm from 2.5 gpm.

The amount of rainfall in Las Vegas is 4.46 inches (Las Vegas Data, 2006), thus the amount of rainwater harvested annually is 164,086 gallons.

Rainwater volume (gal) = collection area (sf) X collection efficiency (%) X average rainfall (in) X 0.6233 (gal/in) (LEED Reference Guide NC 2.1, 97)

Rainwater volume = 65,584 X 0.90 X 4.46 X 0.6233 = 164,086.32 gallons

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Table 16 Water use volume for design case (LEED Reference Guide NC 2.1, 104)

<table>
<thead>
<tr>
<th>Flush Fixture</th>
<th>Daily Uses</th>
<th>Flowrate (gpf)</th>
<th>Duration (flush)</th>
<th>Occupant</th>
<th>Water use(gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Flow Water Closet (Male)</td>
<td>1</td>
<td>1.0</td>
<td>1</td>
<td>370</td>
<td>370</td>
</tr>
<tr>
<td>Low Flow Water Closet (Female)</td>
<td>3</td>
<td>1.0</td>
<td>1</td>
<td>370</td>
<td>1,110</td>
</tr>
<tr>
<td>Waterless Urinal (Male)</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>370</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flow Fixture</th>
<th>Daily Uses</th>
<th>Flowrate (gpm)</th>
<th>Duration (sec)</th>
<th>Occupant</th>
<th>Water use (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low flow Lavatory</td>
<td>3</td>
<td>1</td>
<td>15</td>
<td>740</td>
<td>555</td>
</tr>
<tr>
<td>Sink</td>
<td>1</td>
<td>1</td>
<td>15</td>
<td>740</td>
<td>185</td>
</tr>
</tbody>
</table>

Total Daily Volume (gal) 2,220
Annual Work Days 260
Total Annual Volume (gal) 577,200
Annual rainwater harvested (gal) 164,086
Total Annual Volume of water used (gal) 413,114
Table 17  

<table>
<thead>
<tr>
<th>Flush Fixture</th>
<th>Daily Uses</th>
<th>Flowrate (gpf)</th>
<th>Duration (flush)</th>
<th>Occupants</th>
<th>Water use (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra Low-Flow Water Closet (Male)</td>
<td>1</td>
<td>1.6</td>
<td>1</td>
<td>370</td>
<td>592</td>
</tr>
<tr>
<td>Ultra Low Flow Water Closet (Female)</td>
<td>3</td>
<td>1.6</td>
<td>1</td>
<td>370</td>
<td>1,776</td>
</tr>
<tr>
<td>Low Flow Urinal (Male)</td>
<td>2</td>
<td>1.0</td>
<td>1</td>
<td>370</td>
<td>740</td>
</tr>
<tr>
<td>Conventional Lavatory</td>
<td>3</td>
<td>2.5</td>
<td>15</td>
<td>740</td>
<td>1,387.5</td>
</tr>
<tr>
<td>Conventional Sink</td>
<td>1</td>
<td>2.5</td>
<td>15</td>
<td>740</td>
<td>462.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flow Fixture</th>
<th>Daily Uses</th>
<th>Flowrate (gpm)</th>
<th>Duration (sec)</th>
<th>Occupants</th>
<th>Water use (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Lavatory</td>
<td>3</td>
<td>2.5</td>
<td>15</td>
<td>740</td>
<td>1,387.5</td>
</tr>
<tr>
<td>Conventional Sink</td>
<td>1</td>
<td>2.5</td>
<td>15</td>
<td>740</td>
<td>462.5</td>
</tr>
</tbody>
</table>

Total Daily Volume (gal) 4,958  
Annual Work Days 260  
Total Annual Volume (gal) 1,289,080

A total of 875,966 (1,289,080 - 413,114) gallons of potable water is saved over a period of one year, by using water efficient fixtures. This constitutes to a 68% reduction in water use.

A typical 1.0 gpf urinal costs $315.00 (RSMeans 2006, 449), while the cost of Solan’s WES-1000 Waterfree Urinal is $535.70 (Water free Urinal 2006). The cost and installation of ½” water pipe is $18.35 per linear feet (RSMeans 2006, 434). The length of the water pipe going to the urinals is 20 feet. The cost of Low consumption flushometer is $159.15 (Water free Urinal 2006).

Extra cost of using WES-1000 = $220.70 (535.70 – 315)  
Savings for water pipe and flush valve = $526.15 ((18.35 X 20) + 159.15)
Initial savings for using WES-1000 = $305.45 (526.15 – 220.70)
Total savings by using 14 WES-1000 = $4,276.30 (305.45 X 14)

The cost of Mansfield’s Quantum Model 148 Toilets is $531.40 (High Efficiency Toilets, 2006), while the cost of low flow 1.6 gpf toilet is $390.00 (RSMeans 2006, 453)
Initial cost for using Mansfield Quantum Toilet = $141.40 (531.40 – 390)
Total initial cost for using 38 Mansfield Toilet = $5,373.20 (141.40 X 38)

The cost of Instant-Flow micro non-public lavatory is $350 (Instant flow micro, 2006), while a conventional lavatory cost is $247 (RSMeans 2006, 452).
Initial cost for Instant Flow lavatory = $103 (350 – 247)
Total initial cost for 34 Instant Flow lavatory = $3,502 (103 X 34)

The cost of Instant-Flow micro Kitchen/Bar Sink is $325 (Instant flow micro, 2006), while a conventional lavatory cost is $217 (RSMeans 2006, 453).
Initial cost for Instant Flow lavatory = $108 (325 – 217)
Total initial cost for 53 Instant Flow Sinks = $5,724 (108 X 53)

Total initial cost of changing to water efficient fixtures = $10,322.90
(5,724 + 3,502 + 5,373.20 – 4,276.30)

Savings in water bill: (Water Bill Calculator, 2006)
Bill for design Case (annual) = $621.84 (51.82 X12)
Bill for baseline Case (annual) = $5,221.32 (435.11 X 12)
Annual savings in water bill = $4,599.48 (5,221.32 – 621.84)

Payback period = 2.4 years (10,322.90 / 4,599.48)
Cost savings from low flow fixtures will be achieved after the initial period of 2.5 years, while 875,966 gallons of water will be saved annually.

Credit 3.1  20% Reduction
Since the water savings achieved are 55% we are in compliance with this credit.

Credit 3.2  30% Reduction
Since the water savings achieved are 55% we are in compliance with this credit.

Energy and Atmosphere
Prerequisite 1 – Fundamental Building Systems Commissioning
CCSD currently is incorporating fundamental commissioning in their contract. The cost of fundamental commissioning is 0.5-1.7% for projects between 10 to 50 million (LEED Reference Guide NC 2.1, 113). The total cost of the elementary school is 18.4 million dollars (Bailey Bid). A total of $0.10 / sq.ft. savings per year can be achieved by commissioning (LEED Reference Guide NC 2.1, 112).

Total cost of Commissioning = $ 202,400 (1.1% of 18.4 million)
Total amount of saving per year = $ 6,558.40 (0.10 X 65,584)
Total number of payback years = 30.86 years (202,400 / 6558.40)

Prerequisite 2 – Minimum Energy Performance
To complete this prerequisite, the project should be in compliance with ASHRAE 90.1-1999. The attached certificates generated from COMcheck shows compliance with ASHRAE 90.1-1999 (Comcheck Generator, 2006).

Prerequisite 3 – CFC Reduction in HVAC&R Equipment
To complete this prerequisite, the project should not be using CFC as a refrigerant. Currently, in prototype elementary school HFC-134a is being used as a refrigerant. HFC-134a
has a lifetime of 14.6 years, zero ozone-depleting potential, and 1,300 global-warming potential (LEED Reference Guide NC 2.1, 131). Therefore, this prerequisite is satisfied.

Credit 1 – Optimize Energy Performance

The number of points earned in this credit, will be dependent on the percentage of energy savings achieved. The building simulation was done on eQuest to drive two cases, baseline case and proposed design case.

The total Energy Cost Budget breakdown is as follows:

Proposed Design Case
Total Electricity Consumption = 407,500 kWh
Total Gas Consumption = 132,480,000 Btu
Total Annual Bill = $ 45,506

Total renewable energy generated = 134,378.40 kWh
Total cost of renewable energy = $ 15,343.66 ((134,378.40 X 0.25 X 0.18139) + (134,378.40 X 0.75 X 0.09178)) (Nevada Power energy, 2006)

Total energy cost with renewable energy = $ 30,162.34 (45,506-15,343.66)

Baseline Case
Total Electricity Consumption = 784,740 kWh
Total Gas Consumption = 1,403,500,000 Btu
Total Annual Bill = $ 97,931

Total reduction in energy cost over baseline case= $67,769 (97,931 – 30,162)
Total reduction in energy cost and total renewable energy
Percent savings = 69.2% (67,769 / 97,931 X 100)
Points earned from credit = 10 (LEED Reference Guide NC 2.1, 133)

See appendix for energy simulation results. The changes to the building design include, installing shade over the windows and, using low e glazing. Using low e-glazing, significantly reduces the amount of heat gained. Adding light wells / clerestory areas further reduced the load on area lighting by bringing more in daylighting. To achieve further control on the lighting the use of motorized louvers will cut off excess lighting for the classrooms (Vision Control, 2006). Adding Solar Panels over light wells and at learning area generates renewable energy. Increasing the R value of the building reduces the heating and cooling loads. The R values have been revised from R-12 to R-30 for the walls and from R-22 to R-45 for the roof. The HVAC system will be changed to Dual condenser chiller and boiler (DX coil system). It significantly decreases the cooling and heating energy use. Changing the exit signage from electric powered to self-glow exit fixtures, will help in reducing further energy.

Cost of non load bearing 4" framing = $1.14 per sq. ft. (RSMeans 2006, 281)
Cost of exterior Stucco = $13.50 per sq. yd. (RSMeans 2006, 286)
Cost of 6' X 3'-6" windows with double insulated glass = 295 (RSMeans 2006, 263)
Cost of 6' X 1' window with low e glass = 251 (RSMeans 2006, 286)
Cost of light well = $703.45 (75 X 1.14 + 5.33 X 13.50 + 295 + 251)
Cost of motorized louvers = $150 (Vision Control, 2006)
Cost of 43 light wells = $36,698.35 ((703.45 + 150) X 43)

Total cost of Solar Panels = $538,300 (See calculation in EA credit 2 Renewable Energy)

Cost of clear glazing = $13.00 per sq.ft. (RSMeans 2006, 273)
Total cost of clear glazing = $37,700 (13 X 2900)
Cost of low e-glazing = $32.50 per sq.ft. (RSMeans 2006, 273)
Total cost of low e-glazing = $ 94,250 (32.50 X 2900)

Total cost of changing to new glazing = $ 56,550 (94,250 – 37,700)

Cost of R-12 rigid wall insulation = $ 1.88 per sq. ft. (RSMeans 2006, 211)

Total Cost of R-12 rigid wall insulation = $ 55,764.56 (1.88 X 29,662)

Cost of R-30 batt wall insulation = $ 1.17 per sq. ft. (RSMeans 2006, 212)

Total Cost of R-30 batt wall insulation = $ 34,704.54 (1.17 X 29,662)

Cost of R-22 rigid roof insulation = $ 2.05 per sq. ft. (RSMeans 2006, 213)

Total Cost of R-22 rigid roof insulation = $ 134,447.20 per sq. ft. (2.05 X 65,584)

Cost of R-45 rigid roof insulation = $ 3.94 per sq. ft. (RSMeans 2006, 213)

Total Cost of R-45 rigid roof insulation = $ 258,400.96 per sq. ft. (2.05 X 65,584)

Total cost of changing insulation R values = $ 123,953.76

\[(258400.96 + 34704.54 - 134447.20 - 55764.56)\]

Cost of conventional exit sign = $ 81.00 (Self Luminous Exit Sign, 2006)

Cost of self glow exit sign = $ 151.00 (Self Luminous Exit Sign, 2006)

Extra cost of using self glow exit sign = $ 70 (151-81)

Total extra cost of using self glow exit signs = $ 1,750 (70 X 25)

Total cost of all changes = $ 757,262.11 (36,698.35 + 538,300 + 56,550 + 123,953.76 + 1,750)

Annual cost savings in energy bills = $ 67,769

Total payback period = 11.17 years (757,262 / 67,769)

Credit 2 – Renewable Energy

By using the two Bluelink 480 panel over the lightwell, a lot of solar energy can be generated. Each solar panel can generate a 480 W of power (Solar PV, 2006). Another place to install the solar panels is over the Learning Area high roofs. This will have additional benefit of hiding the mechanical AHU which will be moved over the Learning Area. The mechanical yards
will be moved to accommodate the light wells over the classrooms. There will be 4 solar panels of Bluelink 960 used to hide the mechanical AHU (Solar PV, 2006). The panels will be added on the south side only and the other sides will have perforated metal deck screen. The size covered by the panels will be 30’ wide by 10’ high.

The average noon sun hours for Las Vegas = 6.5 (Solar data, 2006)
Total energy produced by PV panels at one light well = 960 W (2 X 480) (Solar Calculations, 2006)
Energy produced daily at each light well = 6.24 kWh (960W X 6.5 sun hours/1000) (Solar Calculations, 2006)
Total energy produced annually at 43 light wells = 97,936.80 kWh (6.24 kWh X 43 X 365 days)

Cost of Bluelink 480 PV = $ 4,650 (Solar PV, 2006)
Total cost of PV used at light wells = $ 399,900 (4,650 X 43 X 2)

Total energy produced by PV panels at one learning area = 1,920 W (2 X 960) (Solar Calculations, 2006)
Energy produced daily at each learning area = 24.96 kWh (1,920 W X 6.5 sun hours/1000) (Solar Calculations, 2006)
Total energy produced annually at 4 learning area = 36,441.60 kWh (24.96 kWh X 4 X 365 days)

Cost of Bluelink 960 PV = $ 8,650 (Solar PV, 2006)
Total cost of PV used at learning area = $ 138,400 (8,650 X 4 X 4)
Total renewable energy produced annually = 134,378.40 kWh (97,936.80 + 36,441.60)
Total cost of renewable energy = $ 15,343.66 ((134,378.40 X 0.25 X 0.18139) + (134,378.40 X 0.75 X 0.09178)) (Nevada Power energy, 2006)
Total cost of using solar panels = $ 538,300 (399,900 + 138,400)
Total payback period for using solar panels = 35.08 years (538,300/15,344)

Total percentage of renewable energy = 50.9% (15,344 / 30,162 X 100) (LEED Reference Guide NC 2.1, 158)

Credit 2.1 5%

One credit will be earned from this credit, since the renewable energy used is more than 50%.

Credit 2.2 10%

One additional credit will be earned from this credit, since the renewable energy used is more than 50%.

Credit 2.3 20%

One additional credit will be earned from this credit, since the renewable energy used is more than 50%.

Credit 3 – Additional Commissioning

The cost of additional commissioning is 0.2-0.3% for projects between 10 to 50 million (LEED Reference Guide NC 2.1, 113). The total cost of the elementary school is approximately 20 million dollars. Since, additional commissioning is more related to bringing an independent commissioning company into early stage of design and through the design and construction document phase. So the amount of savings cannot be quantified. One credit can be earned from this credit by getting into a contract with a commissioning agency.

Total cost of Additional Commissioning = $ 46,000 (0.25% of 18.4 million)

Credit 4 – Ozone Protection

To complete this prerequisite, the project should not be using HCFC or Halons as a refrigerant. Currently, in prototype elementary school HFC-134a is being used as a refrigerant. HFC-134a has a lifetime of 14.6 years, zero ozone-depleting potential, and 1,300 global-warming potential (LEED Reference Guide NC 2.1, 131). Thus one point will be earned from this credit.
Credit 5 – Measurement & Verification

To earn one credit from this point, the project team needs to create a Measurement and Verification (MV) plan to have continuous metering using metered data. The MV plan will be developed early to incorporate CCSD’s goals. The minimum LEED requirements for MV is Option B of 2001 International Performance Measurement & Verification Protocol (IPMVP). The typical costs for option B are between 3-10% of project construction cost, depending more on the number and type of systems measured (LEED Reference Guide NC 2.1, 175).

Total cost of MV plan = $ 1,300,000 (6.5% of 20 million)

Credit 6 – Green Power

To achieve one credit from this point, CCSD needs to form a contract with Nevada Power to get 50% of the electricity used by the schools to be from renewable sources (like hydro-electric) for two years (LEED Reference Guide NC 2.1, 181).

Total Annual Electricity Consumption of school = 407,500 kWh
Total annual solar electricity generated = 134,378 kWh
Net annual electricity consumption from Nevada Power = 273,122 kWh (407,500 - 134,378)

Since Nevada Power buys 235 MW of hydro-electricity each year (Nevada Power, 2006). CCSD will be able to get into an agreement with Nevada Power for a total of 273,122 kWh of hydro-electric power for two years.

Materials and Resources

Prerequisite 1 – Storage & Collection of Recyclables

To satisfy this prerequisite, we need to provide a minimum of 225 sq. ft. of secure space to be used for separation, collection and storage of recycled materials (LEED Reference Guide NC 2.1, 189). The area needs to be easily accessible from the school building and should be capable of storing more than lbs of waste (LEED Reference Guide NC 2.1, 188).
The total waste generated = 505 lbs (6 X 55 + 0.25 X 700) (LEED Reference Guide NC 2.1, 188)

To provide storage for more than 500 lbs of recycled material, a separate area needs to be created. The covered space will be added next to the mechanical yard and showers area.

Cost of sorting room addition = $69,120 (540 X 128) (RSMeans 2006, 748)

Credit 2 – Construction Waste Management

This credit will be completed by the contractor and will require documentation from the contractor on this part. Completion of this credit will be a part of the construction documents. Asphalt, concrete, cardboard, drywall, metals and wood are easy to recycle. See the appendix for recycling companies in Las Vegas (CC Recycling Guide, 2006). There are a number of ways for planning on the recycling plan, depending on the recycling company. Some companies accept commingled materials, while others only accept separated materials. The savings will be dependent on the recycling company used.

Total volume percentage of concrete, cardboard, drywall, metals and woods = 78.1% (28.8 + 3.5 + 14 + 11.2 + 20.6) (LEED Reference Guide NC 2.1, 201)

Estimated construction waste generated = 147,564 lbs (2.25 X 65,584) (LEED Reference Guide NC 2.1, 201)

Credit 2.1 Divert 50% from Landfill
Since by recycling concrete, cardboard, drywall, metals and woods constitutes 78% of waste reduction from landfill, one credit will be earned from this credit.

Credit 2.2 Divert 75% from Landfill
Since by recycling concrete, cardboard, drywall, metals and woods constitutes 78% of waste reduction from landfill, one credit will be earned from this credit.
Credit 3 – Resource Reuse

The total construction cost of the CCSD school is 18.4 million dollars (Bailey Bid). The total material cost for the project is 45% of the total construction cost (LEED Reference Guide NC 2.1, 210). The salvaged materials that are commonly available are doors, wood flooring and wooden beams and columns. Since we do not use either wood flooring and wooden beams and columns in our schools, we will not be able to use these materials in our buildings. The only salvaged material we can use is wooden doors.

Total number of doors leaves in our school = 137
Cost of door leaf = $ 47.25 (RSMeans 2006, 249)
Total cost of using salvaged doors = $ 6,473.25 (137 X 47.25)
Total material cost used in school = $ 8,280,000 (45% of 18.4 million dollars)

Percentage of salvaged material used = 0.08% (6,473 / 8,280,000 X 100)

Credit 3.1 5%
There will be no point earned from this credit, since our material use will be less than 5%. Therefore, the credit will not be pursued.

Credit 3.2 10%
There will be no point earned from this credit, since our material use will be less than 10%. Therefore, the credit will not be pursued.

Credit 4 – Recycled Content

The total construction cost of CCSD school is 18.4 million dollars and the total cost of the material at 45% of the total construction cost is 8.2 million dollars. For calculation on this credit the total material cost should not include mechanical equipment cost (LEED Reference Guide NC 2.1, 213). The total mechanical and electrical equipment cost is 850,376 (Bell, Kent 2006).
Following is the product list with recycled content which are either being currently being used or will replace old product.

HDPE pipes used for storm drainage and sewage transportation. Ecofirst HDPE pipe manufactured by Hancor has a 100% post-consumer recycled content, while the price for pipe is $40/l.f. Approximately 1,200 l.f. of HDPE pipe is used on a site. (Hancor HDPE, 2006)

The playground equipment has a 3" thick recycled safety surface, manufactured by Child Safe. It has a 100% post-consumer recycled content and is $9.25 / sq.ft. (Child Safe, 2006). There is 9,600 sq.ft. of safety surface used on the school site.

Chainlink fence will be substituted by HDPE MN-L77 security fence as manufactured by Master Net. The MN-L77 security fence is suitable in Las Vegas climate and provide same crushing and impact resistance than a traditional chainlink fence. There is 97% post-consumer recycled content in this product. This product cost $3/l.f. as compared to chainlink fence, which is traditionally at $19/l.f. (HDPE fence, 2006). There is approximately 2,500 l.f. of fence used on the schools.

Dietrich metal is currently being used on the CCSD schools and is an approved manufacturer by CCSD. Cold formed metal framing is has a 23.5% post-consumer content and 6.4% post-industrial content. Structural Steel has a 57.5% post-consumer content and 32.5% post-industrial content (Dietrich Metal, 2006). There is 4,200 l.f. of cold formed metal framing, while there is 67.5 tons and 21,000 l.f. of light structural steel. The cost of cold formed metal framing is $7.55/l.f. (RSMeans 2006, 158) and the cost of structural steel is $1900/ton (RSMeans 2006, 150) and $9.40 l.f. of light structural steel (RSMeans 2006, 148). The metal deck area is 65,584 sq.ft. while the cost of metal deck is $2.10 (RSMeans 2006, 156).

USG is being used for acoustical ceiling tile and sheetrock gypsum. There is a total of 47,100 sq.ft. of Fizzured acoustical ceiling tile being used, while there is total of 58,900 sq.ft. of sheetrock being used for walls and ceilings. The cost of the Fizzured ceiling tile is $1.81/sq.ft. (RSMeans 2006, 294) and the cost of sheetrock is $0.30/sq.ft. (RSMeans 2006, 287). There is 5% post-consumer recycled content and 36.5% post-industrial recycled content in sheetrock, while there is 78% post-industrial recycled content in acoustical ceiling tiles (USG, 2006).
Daltile is being used for ceramic tiles. The total area of ceramic tile used is 5700 sq.ft. The cost of ceramic tile is $5.60 (RSMeans 2006, 291). There is a total of 43% post-industrial recycled content in the ceramic tiles (Daltile, 2006).

Superlite CMU block has a 28% post-consumer recycled content in the form of fly-ash (Superlite, 2006). The cost of CMU block is $13.86 /sq.ft. (RSMeans 2006, 121) and the area of CMU block wall is 28,800 sq.ft.

There are a total of 32 partitions used in CCSD school. The cost of each partition is $770 (RSMeans 2006, 321). The plastic partitions being used for the school have 95% post-industrial recycled content (Accurate Partitions, 2006).

The ecological paving system being used is replacing asphalt and concrete. The total area being covered by pavers is approximately 217,000 sq.ft. The cost of the pavers is $5.75/sq.ft. It has a 17% post-industrial recycled content in it (Pavement System, 2006).

The VCT floor tiles are used on an area of 22,000 sq.ft. The cost of VCT floor tiles is $1.95/sq.ft. VCT tiles have a 30% post-consumer recycled content (Mannington, 2006).

The carpet is used on an area of 35,150 sq.ft. The cost of Lees carpet is $3.35/sq.ft. Lees carpet has a 20% post-consumer recycled content (Lees Carpet, 2006).
**Table 18**

Letter Template for Recycled Content Materials (LEED Reference Guide NC 2.1, 218)

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Company</th>
<th>Product Cost</th>
<th>% post-consumer</th>
<th>% post-industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE pipes</td>
<td>Hancor</td>
<td>$48,000</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>MN-I77 HDPE fence</td>
<td>Master Net</td>
<td>$7,200</td>
<td>97%</td>
<td>0%</td>
</tr>
<tr>
<td>Ecological paver system</td>
<td>Advanced Pavement</td>
<td>$1,247,750</td>
<td>0%</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playground Safety</td>
<td>Child Safe</td>
<td>$88,800</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal framing</td>
<td>Dietrich Metal</td>
<td>$31,710</td>
<td>23.5%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Metal Deck</td>
<td>Dietrich Metal</td>
<td>$137,726</td>
<td>23.5%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>Dietrich Metal</td>
<td>$326,125</td>
<td>57.5%</td>
<td>32.5%</td>
</tr>
<tr>
<td>CMU block</td>
<td>Superlite</td>
<td>$399,168</td>
<td>28%</td>
<td>0%</td>
</tr>
<tr>
<td>Toilet Partitions</td>
<td>Accurate Partitions</td>
<td>$24,640</td>
<td>0%</td>
<td>95%</td>
</tr>
<tr>
<td>Ceramic Tile</td>
<td>Daltile</td>
<td>$31,920</td>
<td>0%</td>
<td>43%</td>
</tr>
<tr>
<td>Gypsum Drywall</td>
<td>USG Sheetrock</td>
<td>$17,670</td>
<td>5%</td>
<td>36.5%</td>
</tr>
<tr>
<td>Fizzured acoustical</td>
<td>USG</td>
<td>$85,251</td>
<td>0%</td>
<td>78%</td>
</tr>
<tr>
<td>ceiling tile</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpet</td>
<td>Lees Carpet</td>
<td>$117,752</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>VCT floor tiles</td>
<td>Mannington</td>
<td>$42,900</td>
<td>30%</td>
<td>0%</td>
</tr>
</tbody>
</table>

|                          |                       |              |                 |                   |
| Total value of post-consumer content | $520,231               |
| Total value of post-industrial content | $439,035               |
| Combined value of post-consumer and half post-industrial content | $753,582               |
| Combined value of post-consumer and half post-industrial content as a percentage of total value of all materials | 10.07%                 |

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Credit 4.1 5% (post-consumer + \( \frac{1}{2} \) post-industrial)

One point will be earned from this credit since the total recycled content is more than 10%.

Credit 4.2 10% (post-consumer + \( \frac{1}{2} \) post-industrial)

One point will be earned from this credit since the total recycled content is more than 10%.

Credit 5 – **Regional Materials**

Lots of products are made in California and Arizona and are within 500 miles of Las Vegas.

Gypsum Drywall is extracted and manufactured at Plaster City, CA (USG, 2006)

Acoustical ceiling tiles are manufactured at Greenville, MS (USG, 2006)

Mannington VCT tiles are extracted and manufactured at SouthGate, CA (Mannington, 2006)

Superlite CMU block is manufactured at Needles, CA (Superlite, 2006)

Ecological paver systems are manufactured in Nevada and Arizona depending on the contract between Advanced Pavement technology and the concrete plants (Pavement System, 2006).

Playground safety surface is manufactured by Child Safe in Phoenix, AZ (Child Safe, 2006).

Accurate Partitions are manufactured at McCook, IL (Accurate Partitions, 2006).
### Table 19  
**Letter Template for Regional Materials** (LEED Reference Guide NC 2.1, 225)

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Company</th>
<th>Product Cost</th>
<th>Distance between project &amp; manufacturer</th>
<th>Distance between project &amp; extraction site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological paver system</td>
<td>Advanced Pavement Technology</td>
<td>$1,247,750</td>
<td>50</td>
<td>650</td>
</tr>
<tr>
<td>Playground Safety</td>
<td>Child Safe</td>
<td>$88,800</td>
<td>287</td>
<td>287</td>
</tr>
<tr>
<td>Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal framing</td>
<td>Dietrich Metal</td>
<td>$31,710</td>
<td>287</td>
<td>287</td>
</tr>
<tr>
<td>Metal Deck</td>
<td>Dietrich Metal</td>
<td>$137,726</td>
<td>287</td>
<td>287</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>Dietrich Metal</td>
<td>$326,125</td>
<td>287</td>
<td>287</td>
</tr>
<tr>
<td>CMU block</td>
<td>Superlite</td>
<td>$399,168</td>
<td>111</td>
<td>650</td>
</tr>
<tr>
<td>Gypsum Drywall</td>
<td>USG Sheetrock</td>
<td>$17,670</td>
<td>404</td>
<td>404</td>
</tr>
<tr>
<td>VCT floor tiles</td>
<td>Mannington</td>
<td>$42,900</td>
<td>275</td>
<td>350</td>
</tr>
</tbody>
</table>

**Total value of regionally manufactured products**  
$2,291,949

Value of regionally manufactured products as a percentage of the value of all materials  
31.18%

**Total value of regionally extracted products**  
$644,931

Value of regionally extracted materials as a percentage of regionally manufactured products  
24.14%
Credit 5.1 20% Manufactured Regionally

Since 36.35% of the material is manufactured within 500 miles of the project site, one point can be achieved from this credit.

Credit 5.2 50% Extracted Regionally

Since only 24.14% of the material is manufactured locally is extracted within 500 miles, no point can be earned from this credit.

Credit 6 – Rapidly Renewable Materials

The rapidly renewable materials used in the school are – Carpet and MDF (Medium density Fiberboard) cabinetry. The total carpet area is 35,150 sq.ft. and the total cabinetry is 11,450 l.f. The cost of the Lees carpet is $ 3.35/sq.ft. (Lees Carpet, 2006) and the cost of MDF cabinetry is $ 8/lf.ft. (Medex MDF, 2006).

Table 20 Letter Template for Rapidly Renewable Materials (LEED Reference Guide NC 2.1, 225)

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Company</th>
<th>Product Cost</th>
<th>Renewable</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDF cabinetry</td>
<td>SierraPine</td>
<td>$91,600</td>
<td></td>
</tr>
<tr>
<td>Carpet</td>
<td>Lees Carpets</td>
<td>$117,752</td>
<td></td>
</tr>
</tbody>
</table>

Total value of rapidly renewable products 209,352

Rapidly renewable products as a percentage of the value of total materials cost 2.85%

Since the percentage of rapidly renewable materials cost is less than 5% of the total material cost, no point can be earned from this credit.
Credit 7 – Certified Wood

This credit requires a lot of coordination with the owner and the contractor. The contract documents will require the contractor to use more than 50% of FSC certified wood in the construction of wood related products. The doors, cabinetry will need to have FSC certified wood. In addition to that all the temporary wood used in the construction for support or bracing will also be required to be FSC certified wood.

CCSD will need to provide all the furniture that has more than 50% of the wood to be FSC certified. The items under CCSD control will include furniture, workstations, other miscellaneous wood products used in the school. The Sierra Pine MDF will be used for door panels and cabinetry and is SCS certified, which comes under FSC chain of custody certification (Medex MDF, 2006).

Both owner and the contractor will provide the information to the architect/LEED accredited professional to be completed in LEED template.

Indoor Environmental Quality

Prerequisite 1 – Minimum IAQ Performance

This prerequisite needs to be completed by the Mechanical Engineer. This prerequisite states that the air quality standards are to be maintained in the site and the air intake should be located, such that it takes fresh air and away from sources of contamination. CCSD school sites are located away from industrial sites or heavy traffic site. While on the design of the building, the air intake is far away from sources of contamination by as much as 50 feet. The mechanical engineer will verify that the school design is in compliance with the prerequisite.

Prerequisite 2 – Environmental Tobacco Smoke (ETS) Control

Smoking is prohibited on all CCSD school properties, therefore school design is in compliance with the prerequisite.
Credit 1 – Carbon Dioxide (CO2) Monitoring

This credit will be completed by the mechanical engineer. This credit requires CO2 monitoring devices. Typically, the sampling points are needs, where there are variable densities. Further, spaces with static occupant densities can have one monitoring devices at the return duct. There also needs to be automatic ventilation controls tied to the CO2 monitoring devices. Since the classrooms have same densities, therefore one sampling point can be used for two classrooms. (LEED Reference Guide NC 2.1, 250)

Number of sampling points needed for 43 classrooms = 22
Number of sampling points for Library, Office 4 Learning Areas, M.P. room and ELL room, General Office, Faculty room and work area (one each) = 11
Number of sampling points for 7 Offices = 4
Total number of sampling points in the school = 37
Cost of one sampling point = $1,250 (LEED Reference Guide NC 2.1, 250)
Total initial cost of all sampling points = $46,250 (1,250 X 37)
Overall annual maintenance costs = $2,000 (LEED Reference Guide NC 2.1, 250)
There is no direct payback for this initial investment. But there is increased comfort to the building users. The proper calibration and testing of CO2 monitoring will be a part of the building commissioning process (LEED Reference Guide NC 2.1, 251).

Credit 2 – Ventilation Effectiveness

This credit will be completed by the mechanical engineer. To achieve this credit, the building must be designed to have air change effectiveness equal to or greater than 0.9. The building will be designed to be mechanically ventilated. There are two ways of completing this credit with the air change effectiveness. One way is to field-test with tracer gas the completed HVAC system, the other way is design verification, which is done by the mechanical engineer, by simulation as defined by ASHARE 129-1997. One point can be earned from this credit, by achieving air change effectiveness (LEED Reference Guide NC 2.1, 255).
Credit 3 – Construction IAQ Management Plan

There are two points to be earned from this credit. This credit requires a lot of compliance from the general contractor, with controls on the construction site. The requirements for completion of this credit will be included in the contract documents.

3.1 During Construction

Since the school building is a new building, SMACNA guidelines will not be applicable. But the contractor will need to protect absorptive materials stored or installed from moisture damage. The contractor needs to use filtration media with a MERV of 8 on the return air grill and replace all filtration media with a MERV of 13 immediately prior to occupancy. After completion of construction, general contractor will be required to submit all relevant documents for completion of the credit. Therefore one point can be earned from this credit. (LEED Reference Guide NC 2.1, 265)

3.2 After Construction/Before Occupancy

To achieve one point from this credit, one of the two things can be completed. One is to run a minimum two-week building flush out with outside air with a MERV 13 filtration media. Or IAQ testing must be done and all the areas with pollutant sources must be identified and mitigated and conduct a partial two week flush out of the building for two weeks. The requirements will be added to the contract documents, requiring general contractor to comply with the credit requirements (LEED Reference Guide NC 2.1, 266).

Credit 4 – Low-Emitting Materials

There are four points to be earned from this credit.

4.1 Adhesives and Sealants

The adhesives to be used for schools will have VOC content lower than the South Coast Air Quality Management District (SCAQMD) regulations and the sealants will have the VOC contents lower than the Bay Area Air Quality Management District (BAAQMD). The SCAQMD accepts a VQC content of 650g/l in some cases, while the
BAAQMD accepts a VOC content of 750g/l in some cases (LEED Reference Guide NC 2.1, 274). The use of Safe-set adhesives (Chicago Adhesive, 2006) and Quick shield no VOC sealant (Geocel, 2006) will complete the requirements of this credit. Safe-Set products are solvent-free, zero-VOC, nonflammable, nontoxic floor covering adhesives (Chicago Adhesive, 2006). Quick Shield is a white, one-part, quick-setting, interior/exterior flexible sealant that contains no VOCs. It is resistant to water within 5 minutes and is paintable within 10 minutes. Quick Shield bonds to wood, aluminum, brick, and concrete without a primer. It cleans up with water, is mold- and mildew-resistant, and is rated to last 50 years (Geocel, 2006).

4.2 Paints and Coatings

Currently, on CCSD school, Frazee, Dunn Edwards and other major paint manufacturers are listed and all of them have zero VOC, low odor paints available. One such paint is ENVIROKOTE from Frazee (Frazee, 2006). By comparison, The Green Seal Standard accepts a maximum of 150g/l of VOC (LEED Reference Guide NC 2.1, 274). By specifying Zero-VOC and low odor paints, one point can be earned from this credit.

4.3 Carpet

By using Lees Carpet for the school building, one point can be achieved from this credit. All Lees Carpet are CRI Green Label Plus Certified and are above the requirement of this credit (Lees Carpet, 2006).

4.4 Composite Wood

One point will be earned from this credit by using composite wood which is has no urea-formaldehyde resins in it. SierraPine's Medex MDF, is for use in interior high-moisture applications, and Medite II MDF, for interior non-structural applications, are manufactured with a polyurethane binder, methyl disocyanate(MDI), rather than conventional formaldehyde-based resins. SierraPine has earned certification from Scientific Certification Systems (SCS) for using up to 100% recovered and recycled wood fiber for their MDF products (Medex MDF, 2006).
Credit 5 – **Indoor Chemical & Pollutant Source Control**

To be in compliance with this credit, all high volume exterior entryways (5 entryways) will be installed with permanent grate like G-575P Thin-line grate (Thin Line Grates, 2006). Since all the storage spaces and accessory spaces have to be smoke sealed per International Building Code section 302.1.1.1 for E use facility. Therefore, the chemical use spaces (2 Janitor and 1 Custodian rooms) are already segregated. The mechanical engineer will provide an exhaust with a negative pressure in such areas. Finally, by providing separate plumbing waste for drains for cleaning or other liquid uses, one point can be earned from this credit.

The cost of installing grate on exterior entryways = $1,480 (5 X 296) (Thin Line Grates, 2006)

Cost of installing one exhaust fans = $82.50 (RSMeans 2006, 465)

Total cost of installing exhaust fans = $247.50 (3 X 82.50)

Total additional cost for achieving credit = $1,728

Credit 6 – **Controllability of Systems**

There is only one point that can be earned from this credit, since there cannot be perimeter operable windows.

6.2 **Non-Perimeter Spaces**

Except for Kindergarten 1, all other classrooms and rooms come under the non-perimeter spaces, as their area at 15’ line is less than 75% of the classroom areas. While in single user occupancy the Principal, Assistant Principal and the conference room will be considered perimeter spaces. Since all our classrooms have daylight controls with motorized louver, occupancy sensor and manual on and off switch, these will be counted as 3 controls, which is the required number of control for multi-occupancy areas. Further there is one control each for air flow control and temperature control. While all our areas which are single occupant will have single lighting control and occupancy sensor, which makes two controls and air flow control and temperature control to it (LEED Reference Guide NC 2.1, 289). Therefore, one point can be earned from this credit.
Table 21  Calculations for single occupancy non perimeter spaces (LEED Reference Guide NC 2.1, 289)

<table>
<thead>
<tr>
<th>Non-Perimeter Areas (SF)</th>
<th>Occupants</th>
<th>Air Flow Controls Qty Pass</th>
<th>Temperature Controls Qty Pass</th>
<th>Lighting Controls Qty Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,222</td>
<td>9</td>
<td>9</td>
<td>Yes</td>
<td>18</td>
</tr>
</tbody>
</table>

Table 22  Calculations for multi occupancy non perimeter spaces (LEED Reference Guide NC 2.1, 290)

<table>
<thead>
<tr>
<th>Room size Range (SF)</th>
<th># of Rooms (Qty)</th>
<th>Per Area (SF)</th>
<th>Air Flow Controls Qty Pass</th>
<th>Temperature Controls Qty Pass</th>
<th>Lighting Controls Qty Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2,500</td>
<td>50</td>
<td>34,600</td>
<td>57</td>
<td>Yes</td>
<td>157</td>
</tr>
<tr>
<td>&gt;=2,500 and &lt;5,000</td>
<td>1</td>
<td>3,333</td>
<td>4</td>
<td>Yes</td>
<td>8</td>
</tr>
</tbody>
</table>

Credit 7 – Thermal Comfort

7.1  Compliance with ASHRAE 55-1992

Building mechanical system will be designed to be in compliance with this credit. The mechanical engineer needs to design to the set criteria of ASHRAE 55 -1992.

7.2  Permanent Monitoring System

By using an OptiNet IEQ Monitoring System, the requirements of this credit will be completed. OptiNet™ is a permanent, automated, building-integrated system for continuously sampling and analyzing indoor air for contaminants. The OptiNet system relies on a network of MicroDuct™ structured...
cable that collects air samples from throughout the building for analysis using the centralized SST600 Sensor Suite instrumentation. Measurable environmental parameters include temperature, relative humidity, carbon dioxide, particulates, total volatile organic compounds (TVOCs), and carbon monoxide. The cost of installing OptiNet for the elementary school is $27,500 (OptiNet, 2006).

Credit 8 – Daylight and Views

8.1 Daylight 75% of Spaces

There is more than 2% daylight factor for more than 75% of the spaces. The spaces like storage, corridor and utilities areas are not counted in the spaces for daylighting. With the new design, more than 75% of spaces have more than 2% daylight factor. See the appendix for results from ecotect simulation. Therefore, one point can be earned from this credit.

8.2 Views for 90% of Spaces

No point can be earned from this credit, since 90% spaces could not meet the glazing view.

Innovation & Design Process

Credit 1 – Innovation in Design

1.1 Alternate Transportation – Additional Bicycle Storage and Changing Rooms

Under Sustainable Site credit 4.2 Bicycle storage and changing rooms, CCSD elementary school is only required to have 29 spaces and 4 showers. With the new design modifications for the shower area, the new school will boast a total of 60 bicycle storage spaces and 8 showers. Since this is twice the amount required by the established credit, an additional point will be earned under Innovation in Design (LEED Reference Guide NC 2.1, 315).
1.2 **Heat Island – Non Roof**

Under Sustainable Site credit 7.1 Non-Roof, 30% of the non-porous paved area needs to be changed to open grid pavement. Using Advanced Pavement Technology (Pavement System, 2006) porous pavement system over all existing non-porous area’s, the requirements of the credit have been met and the usage of the system has been on more than double the area required. Therefore, it is possible to earn another point for this technology under Innovation in Design (LEED Reference Guide NC 2.1, 315).

1.3 **Water Use Reduction – 55%**

Under Water Efficiency credit 3 Water Use Reduction the total water use reduction achieved is 55% over the baseline case. Since there are only two sub credits requiring 20% and 30% reduction in water use, an additional point can be earned from Innovation in Design since the incremental reduction saving value will be 40% (LEED Reference Guide NC 2.1, 315).

1.4 **Renewable Energy – 50%**

Under Energy and Atmosphere Credit 2 Renewable Energy, there are three points to be earned for 5%, 10% and 20% use of renewable energy. Since the renewable energy used has been 50% one additional credit will be earned from this credit, since the next benchmark in renewable energy will be 40% (LEED Reference Guide NC 2.1, 315).

Credit 2 – **LEED™ Accredited Professional**

One point will be earned from this credit, as both the owner and the architect have LEED accredited Professionals on their staff who will be able to take a lead on the application and certification process.
CHAPTER 6

RECOMMENDATIONS AND CONCLUSIONS

For a LEED gold rated system, only 39 points needs to completed for the rating system. Generally, 2-3 more points are applied for, in case there are some problems in completing one or more credit points or problems getting documentation, which is not under the direct control of the LEED accredited professional.

There are a total 56 points that can be completed and therefore the CCSD prototype elementary school can be converted to LEED platinum rated green building. The LEED platinum rated green building needs to have 52 or more points (LEED Reference Guide NC 2.1, 6). For the LEED gold rated building, there are more than 56 credits available, so a total of 17 credits can be dropped and not pursued. The credits will be dropped on the amount of complexity and the cost of completing the credit.

First credit to be dropped is Energy and Atmosphere Credit 5 – Measurement and Verification. The credit required approximately 1.3 million dollars and the results cannot be quantified. This will result in a drop of 1 point.

Second credit to be dropped is Indoor Environmental Quality credit 7.2 – Permanent Monitoring System, This will result in an additional drop of 1 point and saving of $27,500.

Third credit to be dropped is Sustainable Site credit 7.1 Heat Island Effect Non-Roof. By deleting the ecological pavers systems, a total of 0.97 million dollars can be saved. This will lead to an additional drop of 4 points. The additional credits that will be directly affected by this are Sustainable Site credit 6.1 – Rate and Treatment, Material and Resources credit 4.2 Recycled Content 10% (post-consumer + ½ post-industrial), Material and Resources credit 5.1 20% manufactured regionally. Innovation and Design credit 1.2 – Heat Island Effect, Non-roof.
### Table 23 Results of LEED evaluation

<table>
<thead>
<tr>
<th>LEED Credit</th>
<th>Credit Name</th>
<th>Points</th>
<th>Initial Cost</th>
<th>Payback period in years</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS Pre 1</td>
<td>Erosion and Sedimentation control</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SS 1</td>
<td>Site Selection</td>
<td>- 1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SS 4.1</td>
<td>Public Transportation Access</td>
<td>- 1</td>
<td>-</td>
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<td>Bicycle Storage and Changing Rooms</td>
<td>1 1</td>
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<td>Parking Capacity</td>
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<td>Protect or Restore Open Space</td>
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<td>1 1</td>
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<td>Roof</td>
<td>1 1</td>
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<td>Innovative Waste Water Technologies</td>
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<td>EA 4</td>
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<td>Measurement &amp; Verification</td>
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<td>Credits</td>
<td>Value</td>
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<td>10% (post-consumer + ½ post-industrial)</td>
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<td>IEQ 8.1</td>
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Total Credits: 52 55 3,607,950.00
Fourth credit to be dropped will be Sustainable Site credit 4.2 – Bicycle Storage and Changing Rooms. This will save an additional $51,200. Another credit that will be deleted by this change is Innovation and Design 1.1 – Additional Bicycle storage and changing rooms.

Fifth credit to be dropped will be Material and Resources credit 7 Certified Wood. This will drop an additional point.

Final credit to be dropped is Sustainable Site credit 6.2 – Treatment. This will result in an additional drop of 1 point.

A total of $2,322,917 dollars will be saved by dropping 8 credit points. Therefore the total number of credits that will be filed without the site specific credit will be 45 points (53 - 8) for an additional cost of $1,264,673.

To achieve an CCSD prototype elementary school and LEED Gold certified green building, the following issues need to be kept in mind. The use of sedimentation logs, silt traps, silt fence fabrics for erosion control; filtering roofwasher for filtering rain water collected, rainwater harvesting and collection system for using rain water for flushing purposes; Sarnafil single ply roofing system for reducing heat island effect; using Kim lighting fixtures for exterior lighting shielding; NewGrass turf for reducing water used for irrigation; Mansfield’s Quantum Model 148-154, Solan’s WES-1000 water free urinals, Instant flow micro non-public lavatory and sink for water savings, Solar Panels for renewable energy; Lees carpet for indoor air quality and recycled content; HDPE MN-77 fence from MasterNet; using Envirokoto paint from Frazee for low voc paints; using safeset adhesives from Chicago adhesive for voc free content; Quick Shield sealant from geocel for voc free content; MDF panels from SierraPine for composite wood; increasing R-values from 22 to 45 for roof and 12 to 30 for walls for energy savings; providing overhang over the window, using low e-glazing, adding light wells with clerestory windows and providing motorized louvers will increase the amount of lighting levels inside and provide energy savings; changing the HVAC system to DX coils system will further provide energy savings and all these changes will be required to get LEED certification.
In conclusion, CCSD prototype elementary school can be converted to a LEED Gold certified green building with the changes discussed above.
CHAPTER 7

SUMMARY

The purpose of this study was to determine whether an already designed CCSD Prototype Elementary School can be converted into a LEED rated building without any major changes to design. The need for changing the CCSD Elementary school to a LEED building was to achieve energy savings and to minimize environmental effects by the construction of the school. Since there are many elementary schools being built each year, even a small amount of saving or environmental benefits become multifold because of the large number of schools built with the same prototype. The study showed that the highest possible LEED certification for the school can be achieved. The study also calculated the additional initial cost of converting into LEED rated building.

In conclusion, a total of 55 points can be achieved from the LEED rating system. Therefore, CCSD prototype Elementary School can be converted into a LEED Platinum rated building. The following design changes for the elementary school will be required for achieving LEED certification:

- Adding light wells over classrooms and other large space areas like faculty room and work rooms.
- Integrating solar panels with solar panels.
- Adding overhangs over windows.
- Increasing the R-value of the insulation.
- Installing OptiNet IEQ monitoring system.
- Changing water fixtures to low-flow fixtures.
- Wastewater treatment plant for grey water to be used for irrigation.
The following material changes will have little design change effect but significant environmental benefits and some material changes will be required for achieving LEED certification:

- Sarnafil single ply roofing system for reducing heat island effect.
- NewGrass turf for reducing water used for irrigation.
- Lees carpet for indoor air quality and recycled content.
- HDPE MN-77 fence from MasterNet.
- Using Envirokoto paint from Frazee for low voc paints.
- Using safeset adhesives from Chicago adhesive for voc free content.
- Quick Shield sealant from geocel for voc free content.
- MDF panels from SierraPine for composite wood.

Key Findings

The most important finding of the study is that certain credits provide more environmental benefits or energy savings than other credits do. There are alternative materials that can provide more environmental benefits and still be cost effective. The study is limited in scope that it does not quantify the savings or environmental benefits that are achieved by the community by making the school a LEED building. For example, the amount of energy savings will reduce the amount of electricity consumption by the school, but this study does not provide the amount of environmental benefits achieved by not using the energy generated by the Nevada Power from gas fired generators. Another example is the environmental benefits achieved from reduction in the amount of water usage. Since southern Nevada is in drought watch, the amount of water use reduction is more beneficial to southern Nevada than the savings achieved in water bill by CCSD.

Recommendations for future work

Future studies should be on the total environmental benefits or savings achieved at the source by any savings achieved or alternate material use at the school. Another study could focus on the making already constructed elementary school to be more energy and environmentally sensitive with minimum changes to the building structure or finishes.
Finally this study determined that the CCSD elementary school can be converted into a LEED rated elementary school. The findings of this study may or may not be generalizable to other elementary schools or other similar projects.
APPENDIX - A

SIMULATION RESULTS AND DATA
APPENDIX – B

MATERIALS AND PRODUCTS
APPENDIX - C

CASE STUDIES


Comprehensive Plan Elements
http://www.co.clark.nv.us/comprehensive_planning/CompPlanElements/Population_Element/Population_Element_Chapter1.htm


428

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LEED Green Building Rating System for New Construction and Major Renovations (LEED-NC) Version 2.1, November 2003 Revised 3/14/03; Published by U.S. Green Building Council


431

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Thesis Title: Converting CCSD Prototype Elementary School into LEED™ Rated Building

Thesis Examination Committee:
Chairperson, Alfredo Fernández-González, M. Arch.
Committee Member, Dr. Michael Kroeling, PhD
Committee Member, David Palumbo, M.S.
Graduate Faculty Representative, Dr. Robert Boehm, PhD