

FINAL DRAFT

June 2007

# SUSTAINABLE DESIGN and ENERGY REDUCTION MANUAL



Department of  
Veterans Affairs

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# Executive Summary

In the fall of 2005 the U.S. Congress passed the Energy Policy Act (EPAAct – 2005), which required Federal agencies to achieve mandated sustainability goals to protect the environment. Subsequently, the Department of Veterans Affairs (VA), along with 18 other Executive Branch agencies, signed a Memorandum of Understanding (MOU) to work together to achieve these goals. The MOU was followed by Executive Order 13423, Strengthening Environmental, Energy, and Transportation, which extended the MOU to all Executive Branch agencies and set forth additional goals for sustainability. The Department of Energy (DOE) has also issued an Interim Final Rule that outlines energy targets required by EPAAct for Executive branch agencies. This manual is in response to these Federal Mandates, and provides guidance and assistance to achieve them.

The Federal Mandates require all Federal government construction projects to comply with sustainability and energy reduction requirements. For VA, the Federal Mandates will affect the design and construction of existing buildings, [VA initiated] leased space, grants, and land development projects such as cemeteries<sup>1</sup>. However, some requirements will require additional funding, which VA will request in the FY 2009 budget cycle. Until full funding occurs, projects in progress shall incorporate the sustainability and energy requirements, using life-cycle costing to determine viable energy reduction goals, as scope and budget permit. Where the Mandates are not achievable, written justification must be provided.

VA has determined that using the widely adopted U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED<sup>®</sup>) rating system will provide a well known industry framework to achieve the Federal Mandates. LEED has several rating systems for various building types. At this time two<sup>2</sup> will be used by VA: LEED – NC (New Construction) is appropriate for all stand-alone and major renovations at VA buildings and individual credits can be used as applicable for new construction, renovation, and cemetery use; LEED – CI (Commercial Interiors) is applicable for interior work only, such as for VA initiated leased office space.

After complying with all the credits to achieve the Federal Mandates, VA research indicates that new stand-alone construction and major renovation projects should be able to achieve LEED Silver status with minimum extra effort and cost; those projects should register with the USGBC with the goal of obtaining LEED Silver or LEED Silver equivalency. Nationwide markets will vary in LEED sophistication, however. Consequently, VA encourages project teams to achieve the highest LEED level possible within the scope and budget of each project. The project team is also encouraged, but not required, to pursue third party review and formal LEED Certification with the U.S. Green Building Council and display the seal in the facility.

Each project is unique. This manual is intended as a reference guide and source of design direction. It is not intended to limit the potential for innovation that each project presents, nor does it stipulate internal design team procedures. Firms that are selected to design VA projects should already have demonstrated their sustainable design capabilities through the VA selection process. They will find the criteria and procedures in this manual a baseline for developing the design according to the unique conditions that each project represents.

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<sup>1</sup> VA Green Buildings Action Plan Implementing the Memorandum of Understanding on Federal Leadership in High Performance and Sustainable Buildings, signed by Robert J. Henke, VA Assistant Secretary for Management, March 30, 2007

<sup>2</sup> There are efforts currently underway to create a national standard for sustainability that is specific to healthcare facilities. This guide will be adapted to LEED healthcare standards that are more appropriate as time goes on.



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Note: This document contains hyperlinks to locations within the document, as well as to locations on VA's website ([www.va.gov](http://www.va.gov)). Hyperlinks are visible when the mouse scrolls over linked text. For users referencing a printed version of the Sustainable Design Manual, the internet address of each link is listed in parentheses.



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# 1. Introduction

## 1.1 OBJECTIVES

As the environmental impacts and energy costs that accrue due to the construction and operation of facilities have become known, the Federal government has implemented three Federal Mandates (one law and two Executive Branch policies) for Executive Branch agencies that outline sustainable and energy goals. In addition, on March 30, 2007 VA signed a *Green Buildings Action Plan* that provides guidance for compliance. Instituting these objectives in Federal construction programs will help diminish America's dependence on foreign energy and conserve valuable domestic resources for future generations of Americans.

The VA Sustainable Design Manual is the agency's guidance to define a methodology to achieve these Federal Mandates. The Manual provides guidance in incorporating sustainable design on every phase of a project, from proposals, goal setting, and preliminary planning through design and construction for projects of all sizes. Recognizing that each space acquisition project is unique and will require different strategies, all projects are, nevertheless, required to meet the Federal Mandates as appropriate given the project scope and budget.

## 1.2 FEDERAL MANDATES

### 1.2.1 ENERGY POLICY ACT OF 2005 (EPACT) AND DOE INTERIM FINAL RULE

The EPACT requires a minimum 30 percent improvement in energy cost savings from a baseline (not including receptacle and process loads) established in accordance with ASHRAE 90.1 – 2004 for all *new* Federal buildings, where life-cycle cost-effective.

### 1.2.2 FEDERAL LEADERSHIP IN HIGH PERFORMANCE AND SUSTAINABLE BUILDINGS: MEMORANDUM OF UNDERSTANDING (MOU)

Along with 18 other Federal agencies, VA signed the MOU committing to leadership in the design, construction and operation of high performance/sustainable facilities.

The MOU contains specific measurable requirements for design and construction of all new construction and major renovations, owned or leased, grouped into five main areas:

1. Employ Integrated Design Principles
  - Integrated Design
  - Commissioning
2. Optimize Energy Performance
  - Energy Efficiency
  - Measurement and Verification
3. Protect and Conserve Water
  - Indoor Water
  - Outdoor Water
4. Enhance Indoor Environmental Quality
  - Ventilation and Thermal Comfort

- Moisture Control
  - Daylighting
  - Protect Indoor Air Quality during Construction
5. Reduce Environmental Impact of Materials
- Recycled Content
  - Low-Emitting Materials
  - Biobased Content
  - Construction Waste
  - Ozone Depleting Compounds/Substances

### **1.2.3 EXECUTIVE ORDER 13423, STRENGTHENING FEDERAL ENVIRONMENTAL, ENERGY, AND TRANSPORTATION MANAGEMENT (EO)**

The Executive Order consolidates five prior Executive Orders, integrates sustainable practices into a more cohesive approach to environmental and energy management, and extends the MOU agreement as a mandatory requirement to all Executive Branch Federal agencies. It outlines the following objectives:

- Reduction in life-cycle cost of facilities' environmental and energy attributes
- Improvement in energy efficiency, water conservation, and utilization of renewable energy
- Provision of safe, healthy, and productive built environments
- Promotion of sustainable environmental stewardship

To accomplish these objectives, agencies shall locate, design, construct, maintain, and operate its buildings and facilities in a resource-efficient, sustainable, and economically viable manner, consistent with its mission. The policy includes specific reductions in energy and water use, reductions in the uses of toxic materials and solid waste, increased use of materials with sustainable attributes, and increased amount of offsite and onsite renewable energy generation.

## **1.3 IMPLEMENTATION**

The Federal Mandates for sustainability and energy reduction require all construction projects to comply with sustainability and energy reduction requirements. The Mandates apply to VA new buildings, existing buildings, [VA initiated] leased space, grants, and land development projects such as cemeteries.<sup>1</sup> Although efforts have been made to be comprehensive, no manual or set of instructions will cover every possible building type or option. VA project teams should carry out the Federal Mandates wherever possible, whether or not instructions for a specific project have been included in this manual.

The funding to meet all the Federal Mandates should be included in project budgets starting with the FY2009 budget. Until full funding occurs, projects in progress shall incorporate the sustainability and energy requirements (using life-cycle costing to determine viable energy reduction goals, Energy Savings Performance Contracts, Utility Energy Service Contracts, Enhanced Use Leasing, and other strategies) to the fullest extent possible within the scope and

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<sup>1</sup> VA Green Buildings Action Plan Implementing the Memorandum of Understanding on Federal Leadership in High Performance and Sustainable Buildings, signed by Robert J. Henke, VA Assistant Secretary for Management, March 30, 2007

budget allotted. Where full compliance is determined to not be achievable, written justification must be provided to the VA Project Manager and to the VA Central Office responsible for standards that apply to the project.

### **1.3.1 LEED AND FEDERAL MANDATES**

VA has adopted the U.S. Green Building Council LEED rating system as the primary methodology to achieve the Federal Mandates for sustainability and energy efficiency. In addition to meeting the Federal Mandates, VA also supports the goal of LEED Silver or LEED Silver equivalency. Although not required at this time, the project team is encouraged to pursue third party review and formal LEED Certification with the U.S. Green Building Council and display the seal in the facility. At a minimum documentation is required for all LEED credits related to Federal Mandates.



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## 2. Federal Mandates Mapped to LEED

The Federal Mandates define the goals and objectives for sustainability and energy performance for the Department of Veterans Affairs. VA has three Administrations with different missions and building types. VA shall incorporate sustainability and energy reduction strategies wherever possible, as instructed in the VA Green Building Action Plan dated March 30, 2007.

VA is committed to design, construct, and operate energy efficient buildings. Because no guidance can cover all situations or opportunities that each project encounters, project teams and individuals are encouraged to apply creativity in finding solutions that save resources and energy. Solutions that require adjustments to VA standards and criteria will be considered but must be presented to the VA Central Office responsible for those standards for review and approval.

VA has chosen the LEED rating system as a tool to demonstrate compliance with the Federal Mandates, as it has become well known and accepted in the building industry. It should be emphasized that LEED is only a means to a larger end, and not the end in itself.

LEED is organized around building types. The following are most applicable to VA<sup>1</sup>:

- **LEED – NC** (New Construction)<sup>2</sup> will apply to all stand alone buildings, substantial renovations, and other work as applicable (e.g., acute care, long-term care, new office buildings, build to suit lease projects, cemetery buildings and grounds, etc).
- **LEED – CI** (Commercial Interiors) will apply to new construction or renovation work that involves only building interiors. For VA lease projects, the evaluation of proposals should give additional points to those facilities that have a LEED rating, and the number of points should be scaled to the successive LEED levels.

Each LEED building type is organized around a series of categories (below). Within each category there is a list of credit strategies that outline the performance goals for that credit. Some of the credits are required to achieve the Federal Mandates and some will be selected by the design/construction team depending on the design. The categories are:

- SS – Sustainable Sites
- WE – Water Efficiency
- EA – Energy and Atmosphere
- MR – Materials and Resources
- EQ – Indoor Environmental Quality
- ID - Innovation & Design Process

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<sup>1</sup> LEED for Healthcare is under development by the USGBC

<sup>2</sup> New enhanced use leases where new facilities are to be built shall apply either LEED – NC or LEED – CI as appropriate. State Home and State Cemetery Grant programs are encouraged, but not required, to apply this guidance.

LEED assigns points for each credit achieved. The more points achieved the higher designated level. The LEED levels are:

	LEED-NC	LEED-CI
Certified	26-32 Points	21-26 Points
Silver	33-38 Points	27-31 Points
Gold	39-51 Points	32-41 Points
Platinum	52-69 Points	42-57 Points

The use of the LEED rating program is required for VA projects construction projects as the methodology to achieve the sustainability and energy reduction Federal Mandates. The LEED methodology shall be used in whole or in part, depending on the scope of the construction project. A roof replacement, for instance, would use only those individual LEED credits which would be applicable (e.g. SS Credit 7.2). In the case where there is no specific LEED credit that applies, the *spirit* of sustainability should be kept in mind when selecting materials or options.

The VA goal is to obtain at least LEED Silver/Silver equivalency for most construction projects, which should be obtainable in the course of meeting VA criteria, the Federal Mandates, and the inclusion of a few additional low cost credits. VA encourages project teams to creatively strive to achieve the highest LEED level possible *given the project scope and budget*.

Although not required at this time, VA recommends the project team consider pursuing a third party review and formal LEED Certification with the U.S. Green Building Council. However, the decision on certification with the USGBC is currently to be made at the project team level.

At a minimum, major and minor program projects as listed in the table below will be registered with USGBC which will allow access to the LEED credit templates. Project teams will submit documentation, using the LEED templates, to VA as described in Section 3 for all LEED credits related to Federal Mandates.

Category	LEED Rating System	VA Goal
<b>For the Major Program: (&gt;\$10M)</b>		
New construction, Facility renovation  Build to suit w/ VBA lease	LEED – NC	LEED Silver/Silver equivalency or higher if stand-alone building or major renovation, or use LEED credits as appropriate
<b>For the Minor Program: (&lt;\$10M)</b>		
New construction, Facility renovations	LEED – NC	LEED Silver/Silver equivalency or higher if stand-alone building or major renovation, or use LEED credits as appropriate
NRM (Non-Recurring Maintenance)	LEED – NC LEED – CI	Use LEED credits as appropriate, or spirit of sustainability in decision making
Cemetery Program	LEED – NC	LEED Silver/Silver equivalency or higher if stand-alone building or major renovation, or use LEED credits as appropriate
VA leased, enhanced-use lease, or renovations only to bldg interiors	LEED – CI	LEED Certified Level, higher if scope & budget available

## 2.1 INTEGRATED DESIGN

**FEDERAL MANDATES:** Use a collaborative, integrated planning and design process that:

- Initiates and maintains an integrated project team in all stages of a project's planning and delivery
- Establishes performance goals for siting, energy, water, materials, and indoor environmental quality along with other comprehensive design goals; and, ensures incorporation of these goals throughout the design and lifecycle of the building; and,
- Considers all stages of the building's lifecycle, including deconstruction.

### Applicable LEED Requirements:

There are no specific requirements under LEED – NC or CI in this section, although compliance with the Mandates will generally be sufficient to achieve one or more of the LEED Innovation credits with either system.

### Optional:

LEED – NC

- ID Credit 1.1 – 1.4: Innovation in Design
- ID Credit 2: LEED Accredited Professional

LEED – CI

- ID Credit 1.1 – 1.4: Innovation in Design
- ID Credit 2: LEED Accredited Professional

## 2.2 COMMISSIONING

**FEDERAL MANDATES:** Employ total building commissioning practices tailored to the size and complexity of the building and its system components in order to verify performance of the building components and systems and help ensure that design requirements are met. This should include a designated commissioning authority, inclusion of commissioning requirements in construction documents, a commissioning plan, verification of the installation and performance of systems to be commissioned, and a commissioning report

### Applicable LEED Requirements:

LEED – NC

- EA Prerequisite 1: Fundamental Commissioning of the Building Energy Systems
- EA Credit 3: Enhanced Commissioning

## LEED – CI

- EA Prerequisite 1: Fundamental Commissioning of the Building Energy Systems
- EA Credit 2: Enhanced Commissioning

## 2.3 OPTIMIZE ENERGY PERFORMANCE

The Federal Mandates defining methodology for energy metrics have not been standardized. In order to clarify instructions and to insure that the primary rating controlling design shall be consumption (BTUs/GSF/YR), and that energy costs (\$/GSF/YR) should be secondary drivers of the design, VA has defined the primary energy goal as:

*To improve energy efficiency and reduce greenhouse gas emissions of the agency through reduction of energy consumption wherever possible given the project scope and budget.*

In some cases to create energy efficiency, such as having a co-generation plant on site, or by using other energy efficient options, the actual on-site BTUs for the project will increase. VA does not intend to discourage these options if they make sense and are life-cycle cost effective. Although in general consumption should control design, it is important to balance consumption, efficiency, sensitive/mission critical needs, and energy costs when design decisions are being made to assure the best overall solution.

**FEDERAL MANDATES<sup>3</sup>:**

- *Establish a whole building consumption performance target to earn the Energy Star® targets where applicable.*
- *ASHRAE/ IESNA Standard 90.1 – 2004 Energy Standard, Appendix G shall be used to create the baseline building performance ratings. Projects using Building Information Modeling (BIM) software may also use software such as Green Building Studio or similar to access DOE-2 for early design energy evaluations.*
  - *For new construction, reduce the energy consumption by 30 percent if lifecycle cost effective compared to the baseline.*
  - *For major renovations, reduce the energy consumption cost budget by 20 percent below pre-renovations 2003 baseline if lifecycle cost effective compared to the baseline, providing building functions remain similar.*
  - *Energy modeling is required for new buildings over 8,000 GSF.*
- *For acute care buildings, 30 percent shall be used as the receptacle and process loads in determining the baseline building performance rating.*

<sup>3</sup> As defined by VA

- *If the 30 percent energy reduction is not life-cycle cost effective (using OMB Circular Number A – 94 Guidelines and Discount Rates for Benefit – Cost Analysis of Federal Programs”), evaluate the cost-effectiveness of alternative designs at successive decrements below 30 percent (e.g., 25 percent, 20 percent, etc) in order to identify the most energy-efficient design that is life-cycle cost effective for that building.*
- *To the extent feasible and life-cycle cost effective, implement renewable energy generation and bioenergy projects on agency property for agency use.*
- *Where life-cycle cost effective, each agency shall implement distributed generation systems in new construction or retrofit projects, including renewable systems such as solar electric, solar lighting, geo (or ground coupled) thermal, small wind turbines, as well as other generation systems such as fuel cell, co-generation, or highly efficient alternatives. Projects are encouraged to use distributed generation systems when a substantial contribution is made towards enhancing energy reliability or security. Utilize products that have the Energy Star® rating identified by DOE and EPA and/or FEMP-designated energy-efficient products.*

### **Applicable LEED Requirements:**

#### LEED – NC

- EA Prerequisite 2: Minimum Energy Performance
- EA 1.1 – 1.5: Optimize Energy Efficiency
- EA 2: On-site Renewable Energy
- SS 7-2: Heat Island Roof

Compliance with the Mandates and achievement of appropriate LEED – NC credits will require significant attention to all aspects of the design of the project. Many energy efficiency strategies can be incorporated into the project with little or no additional cost, provided they are addressed through an integrated design approach at the earliest possible stages in the project. Achievement of Energy and Atmosphere credits can be very dependent on regional factors and strategies will vary greatly by building type and climate. The use of analytical computer software tools, such as DOE-2, Energy Plus, Green Building Studio, Equest, etc. to evaluate preliminary energy performance is essential in determining early on in the design which concept solutions hold the most promise.

#### **Optional:**

- EA 6: Green Power

In addition to encouraging the use of onsite renewable energy, the Executive Order encourages the use of distributed generation systems such as fuel cells, cogeneration, combined heat and power systems, etc., where life-cycle cost effective. These measures can provide significant energy use reductions as well as improve the passive survivability of the facility. In addition, the systems can contribute to an overall reduction in source energy usage and carbon emissions.

## LEED – CI

- EA Prerequisite 2: Minimum Energy Performance
- EA 1.1: Optimize Energy Efficiency, Lighting Power
- EA 1.2: Optimize Energy Efficiency, Lighting Controls
- EA 1.3: Optimize Energy Efficiency, HVAC
- EA 1.1: Optimize Energy Efficiency, Equipment and Appliances

**Additional LEED credits which should be readily achievable:**

## LEED – NC

- SS 1: Site Selection
- SS 2: Development Density and Community Connectivity
- SS 4-1: Alternative Transportation – Public Transportation Access
- SS 4-2: Alternative Transportation – Bicycle Storage and Changing Rooms
- SS 5-1: Reduced Site Disturbance – Protect or Restore Habitat
- SS 5-2: Reduced Site Disturbance – Maximize Open Space
- SS 7-1: Heat Island Effect – Non-Roof

## LEED – CI

- SS 2: Development Density and Community Connectivity
- SS 3-1: Alternative Transportation – Public Transportation Access
- SS 3-2: Alternative Transportation – Bicycle Storage and Changing Rooms

## 2.4 MEASUREMENT AND VERIFICATION

**FEDERAL MANDATES:**

- *To the maximum extent practicable, agencies should install building level utility meters in new major construction and renovation projects to track and continuously optimize performance to measure consumption of potable water, electricity, and thermal energy in Federal buildings and other facilities and grounds.*
- *For applicable facilities, agencies should meet Energy Star® Building criteria, and score the energy performance of buildings using the Energy Star® Portfolio Manager rating tool as part of comprehensive facility audits. Agencies may use the Energy Star® Portfolio Manager rating tool to track energy and water use in all facilities. ([www.eere.energy.gov/femp/highperformance/index.cfm](http://www.eere.energy.gov/femp/highperformance/index.cfm))*
- *Agencies should conduct energy and water audits of at least 10 percent of facility square footage annually and conduct new audits at least every 10 years thereafter. This audit requirement can be met by audits done in conjunction with ESPC or UESC projects.*
- *Agencies should consider inclusion of metering requirements in all ESPCs and UESCs, as appropriate.*

**Applicable LEED Requirements:**

## LEED – NC

- EA 5: Measurement and Verification

## LEED – CI

- EA 3: Energy Use, Measurement and Payment Accountability

In new construction, the following systems should be metered: electricity, natural gas, purchased chilled water and steam, VA produced chilled water and steam, water, and sewer. Further information regarding specific meter requirements will be available in the VA specifications.

## 2.5 PROTECT AND CONSERVE INDOOR WATER

**FEDERAL MANDATES:**

- *Employ strategies that in aggregate use a minimum of 20 percent less potable water than the indoor water use baseline calculated for the building, after meeting the EPA Act – 1992 fixture performance requirements.*
- *Beginning in FY 2008, reduce water consumption intensity, relative to the baseline of the agency's water consumption in FY 2007, through life-cycle cost effective measures by 2 percent annually through the end of FY 2015 or 16 percent by the end of FY 2015.*
- *Give preference, where applicable, to water-efficient products, including those meeting EPA's WaterSense standards.*

**Applicable LEED Requirements:**

## LEED – NC

- WE 3-1: Water Use Reduction – 20 Percent Reduction

## LEED – CI

- WE 3-1: Water Use Reduction – 20 Percent Reduction

Expected levels of achievement vary to some degree by building type or function. Higher levels of water efficiency can be more challenging in acute care and long-term care facilities where infection-control concerns are greater. For medical office buildings there may be greater opportunities for water efficiency, particularly in the area of water reclamation and reuse. Low-flow lavatories and toilets should be used wherever possible in all facilities.

## 2.6 PROTECT AND CONSERVE OUTDOOR WATER

### **FEDERAL MANDATES:**

- *Employ design and construction strategies that reduce storm water runoff and polluted site water runoff.*
- *Use water efficient landscape and irrigation strategies, including water reuse and recycling, to reduce outdoor potable water consumption by a minimum of 50 percent.*
- *Give preference, where applicable, to water-efficient products, including those meeting EPA's WaterSense standards*
- *Choose irrigation contractors who are certified through a WaterSense labeled program.* (EPA's WaterSense program is a voluntary public-private partnership that identified and promotes high-performance projects and programs that help preserve the nation's water supply. More information can be found at [www.epa.gov/watersense](http://www.epa.gov/watersense))

### **Applicable LEED Requirements:**

#### LEED – NC

- SS Prerequisite 1: Construction Activity Pollution Prevention
- SS 6-1: Stormwater Management – Quantity Control
- SS 6-2: Stormwater Management – Quality Control
- WE 1-1: Water Efficient Landscaping – Reduce potable water by 50 Percent

Cemetery facilities have significantly different open site to building ratios and, in most cases, require extensive irrigation and grounds care use of water. Because potable water requires a substantial amount of energy, reductions or elimination of potable water use for grounds keeping can also reduce energy. Cemeteries should continue to review strategies to reduce the amount of potable water used for landscape watering to determine if there are appropriate alternatives, including wells, non-potable water, rainwater storage, etc.

#### LEED – CI

- SS 1: Site Selection

### **Additional LEED credits which should be readily achievable:**

#### LEED – NC

Acute Care and Long Term Care

- WE 1-2: Water Efficient Landscaping – No Potable Use or No Irrigation

Medical Office Buildings

- WE 1-2: Water Efficient Landscaping – No Potable Use or No Irrigation
- WE 2: Innovative Wastewater Technologies

Cemetery Facilities

- WE 2: Innovative Wastewater Technologies

## 2.7 ENHANCE INDOOR ENVIRONMENTAL QUALITY

### **FEDERAL MANDATES:**

- *Meet the current ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy, including continuous humidity control within established ranges per climate zone, and ASHRAE Standard 62.1-2004, Ventilation for Acceptable Indoor Air Quality.*
- *Establish and implement a moisture control strategy for controlling moisture flows and condensation to prevent building damage and mold contamination.*
- *Achieve a minimum of daylight factor of 2 percent (excluding all direct sunlight penetration) in 75 percent of all space occupied for critical visual tasks. Provide automatic dimming controls or accessible manual lighting controls, and appropriate glare control.*
- *Follow the recommended approach of the Sheet Metal and Air Conditioning Contractor National Association Indoor Air Quality Guidelines for Occupied Buildings under Construction, 1995. After construction and prior to occupancy, conduct a minimum 72-hour flush-out with maximum outdoor air consistent with achieving relative humidity no greater than 60 percent. After occupancy, continue flush-out as necessary to minimize exposure to contaminants from new building materials.*

### **Applicable LEED Requirements:**

#### LEED – NC

- EQ Prerequisite 1 Minimum IAQ Performance
- EQ Prerequisite 2 Environmental Tobacco Smoke
- EQ 1: Outdoor Air Delivery Monitoring
- EQ 3.1 Construction IAQ Management Plan (During Construction)
- EQ 3.2 Construction IAQ Management Plan (Before Occupancy)
- EQ 4.1 Low-Emitting Materials (Adhesives and Sealants)
- EQ 4.2 Low-Emitting Materials (Paints)
- EQ 4.3 Low-Emitting Materials (Carpet)
- EQ 4.4 Low-Emitting Materials (Composite Wood and Agrifiber)
- EQ 5: Indoor Chemical and Pollutant Source Control
- EQ 7.1 Thermal Comfort (Design)

#### EQ 8.1 Daylight and Views (Daylight 75 percent of spaces) LEED – CI

- EQ Prerequisite 1 Minimum IAQ Performance
- EQ Prerequisite 2 Environmental Tobacco Smoke

- EQ 3.1 Construction IAQ Management Plan (During Construction)
- EQ 3.2 Construction IAQ Management Plan (Before Occupancy)
- EQ 4.1 Low-Emitting Materials (Adhesives and Sealants)
- EQ 4.2 Low-Emitting Materials (Paints)
- EQ 4.3 Low-Emitting Materials (Carpet)
- EQ 4.4 Low-Emitting Materials (Composite Wood and Agrifiber)
- EQ 4.5 Low-Emitting Materials (Systems Furniture and Seating)
- EQ 7.1 Thermal Comfort (Compliance)
- EQ 8.1 Daylight and Views (Daylight 75 percent of spaces)

Meeting the requirement for daylight and views can be very difficult in acute care facilities; however, new construction teams are encouraged to incorporate as much daylight as possible.

**Additional LEED credits which should be readily achievable:**

LEED – NC & CI

- EQ 2: Increase Ventilation
- EQ 6-1: Controllability of Systems – Lighting
- EQ 7-2: Thermal Comfort – Verification

## 2.8 REDUCE ENVIRONMENTAL IMPACT OF MATERIALS

**FEDERAL MANDATES:**

- **Recycled Content:** *Specify materials and products with low pollutant emissions, including adhesives, sealants, paints, carpet systems, and furnishings.*
- **Biobased Content:** *For USDA-designated products, use products meeting or exceeding USDA biobased content recommendations. For other products, use biobased products made from rapidly renewable resources and certified sustainable wood products.*
- **Construction Waste:** *During a project planning stage, identify local recycling and salvage operations that could process site related waste. Program the design to recycle or salvage at least 50 percent construction, demolition and land clearing waste, excluding soil, where markets or on-site recycling opportunities exist.*
- **Ozone Depleting Compounds:** *Eliminate the use of ozone depleting compounds during and after construction where alternative environmentally preferable products are available, consistent with either the Montreal Protocol and Title VI of the Clean Air Act Amendments of 1990, or equivalent overall air quality benefits that take into account life cycle impacts.*

**Applicable LEED Requirements:**

## LEED – NC

- EA Prerequisite 3: Fundamental Refrigerant Management
- EA 4: Enhanced Refrigerant Management
- MR Prerequisite 1: Storage and Collection of Recyclables
- MR 2-1 and 2-2: Construction Waste Management
- MR 4-1: Recycled Content
- MR 6: Rapidly Renewable Materials
- MR 7: Certified Wood

## LEED – CI

- EA Prerequisite 3: CFC Reduction in HVAC&R Equipment
- MR 2-1 and 2-2: Construction Waste Management
- MR 4-1: Recycled Content
- MR 6: Rapidly Renewable Materials
- MR 7: Certified Wood

**Additional LEED credits which should be readily achievable:**

## LEED – NC &amp; CI

- MR 5-1: Local/Regional Materials – 10 percent extracted, processed and manufactured regionally



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## 3. Adjustments to the Delivery Process

Using an integrated design process is one of the Federal Mandates and is foundational to success in achieving sustainable, energy efficient, high performing buildings. An *integrated design* process is different from the typical linear project delivery methodology where technical decisions by the design team are made independently, such as when the architect determines the building floorplate and exterior skin of the building and then hands it to the mechanical engineer to place the mechanical systems to fit within it.

An integrated design process requires a true collaborative effort between technical disciplines, one where from the beginning of the project there is interactive dialogue and interaction to find the most appropriate design solution. The ability to identify synergies across systems when the design solution is still flexible, to bring in divergent viewpoints to solve problems, and to seek inter-relationships between technical disciplines in formulating solutions, is key to lower cost, high-quality sustainable designs that provide long-term value to the facility and occupants.

### 3.1 TEAM COMPOSITION AND WORK FLOW

In order to fully integrate sustainability into the design process, participation of a diverse representative project team is required. The team should include traditional A/E and VA project team members, potential new design and construction team members such as cost estimating, VA architects and interior designers, environmental and energy program managers, and the VA asset manager. For VHA projects, this could also include medical and operating staff.

In addition to these new team members, work flow and project solution formulation between technical disciplines will also need to be adjusted. Traditionally, decisions are made somewhat independently by the technical disciplines. To truly achieve an integrated solution, design decisions must be made collaboratively with all disciplines at the table, so that implications of those decisions will be fully evaluated for their effectiveness.

To achieve the Federal Mandate goals, some VA projects will necessitate additional work that will provide information for decision making, such as:

- **Energy Modeling:** Provides the project team with critical information to measure and guide design decisions against the energy reduction Mandates. The energy modeling should begin at early concept design, be used to evaluate which design alternative provides the best energy performance, and be used to refine the design solution during the project delivery process. The complexity of the energy model should be in keeping with the design stage, progressing from simple<sup>1</sup> during schematic design to a final analysis in DOE2 for the final design development design. The energy modeling can be provided by specialty consultants or within the scope of the MEP consultant.

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<sup>1</sup> For BIM projects, the use of Green Building Studio ([greenbuildingstudio.com](http://greenbuildingstudio.com)) or similar software will be acceptable for early concept energy modeling.

- **Daylight Modeling:** Provides the opportunity to verify and test the design to maximize daylighting while reducing glare.
- **LEED Management/Documentation and Energy Performance Tracking:** Coordinates tasks across all team members to assure that the appropriate focus on meeting the Federal Mandates is followed throughout project delivery. Tracks LEED requirements and energy performance metrics against goals. Where LEED certification is being pursued, this should include coordination and preparation of documentation for submittal to the U.S. Green Building Council. For teams new to LEED, use of an outside LEED consultant can speed this process and assist the project team with the LEED rating system contents and process.
- **Commissioning:** The Federal Mandates require total building commissioning for all new construction and major renovations in order to verify performance of building components and systems and to ensure design requirements are met. It requires a designated commissioning authority to develop a commissioning plan, inclusion of commissioning requirements in construction documents, verification of installation and performance of commissioned systems, and a commissioning report. A/E teams will work with the commissioning agent throughout the design and construction process to assure all sustainable objectives are met. For further information, reference the Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (<http://www.va.gov/facmgt/standard/etc/moufinal.pdf>).
- **Life-Cycle Cost Analysis:** The Federal Mandates state that the energy efficiency measures required to meet the 30 percent energy cost reduction goal must be life-cycle cost effective. In order to demonstrate this, the project team will need to undertake a life-cycle cost analysis of the proposed energy efficiency measures. See Section 3.4.

## 3.2 USE OF BUILDING INFORMATION MODELING

There is a natural synergy between the complexity of buildings, the integrated design process, and the use of Building Information Modeling (BIM). Unlike CAD, which uses geometric shapes to represent three dimensional objects, BIM uses a relational, parametric database to link information about the building together. The information can be then viewed in any form desired: in the 2D traditional way with elevation views, plan views, and schedules; or as a 3D model with associated attributes; or as a spreadsheet. Changes made in one view will automatically be reflected in all views. The flexibility provided by BIM fosters an integrated, collaborative approach to problem solving, particularly enhancing the ability to evaluate various design solutions against sustainable goals such as targets for energy, daylighting, and material usage, as well as functional and programmatic objectives such as roll-ups of department square footage and room types.

The ability to view the building in three dimensions also helps solve construction coordination conflicts (building structure with mechanical ducts, for instance) which decreases or eliminates change orders, thereby providing additional cost control.

A team with a sophisticated expertise in BIM and related tools will be able to provide a higher degree of confidence early in the project execution process that the proposed design solution will achieve project goals. For these reasons, VA strongly encourages the use of BIM for VA construction projects, especially those buildings with complicated healthcare infrastructure.

### 3.3 SURVIVABILITY

VA medical facilities must remain operational and survive a four day power supply disruption and an uninterrupted water supply in the event of a natural disaster, pandemic or bio-chemical attack (see the VA Physical Security Design Manuals). VA encourages design teams to consider survivability and sustainability as mutually supporting goals and to explore possible ways to use sustainable practices to accomplish the survivability goals. Possible options may be the use of rain water harvesting, potable water storage, well water, photovoltaics, fuel cells, natural lighting, natural ventilation, co-generation, geothermal, wind sources, etc. If survivability goals are merged with sustainable goals at the outset of a project and carried forward using an integrated design process the result can be the ability to accomplish both with little or no cost premium.

### 3.4 ESTIMATING PROCESS

It is essential for the project cost estimating team to understand and incorporate the sustainability goals within the estimating process in order for the project to meet the requirements for sustainability and energy performance in a cost effective manner.

The cost estimator must be involved in the design process from the start of the project and, as part of an integrated design process, provide dynamic cost modeling and control as opposed to static end of phase modeling only. The estimator must also be familiar with sustainable design strategies, and their cost implications.

- **Dynamic Cost Modeling versus Static End of Phase Estimating**

The design team is responsible for managing the total scope within the project budget. The budget should not be viewed as one amount for the building and a separate amount for sustainability, but rather as a total to be achieved through integrated design.

In the schematic phases of the project, it is essential to develop high quality cost models that provide a sufficient level of detail to allow the project team to make informed decisions regarding the overall scope relative to the established project budget.

The cost modeling process should include the following specific steps with respect to incorporation of sustainable design elements:

- Establish sustainability and energy goals and expectations.
- Identify sources of information and team expertise, particularly with respect to advanced strategies.
- Include specific goals in the program.
- Align program with budget. Address program to budget conflicts as early as possible.

- **Life-Cycle Cost Analysis**

VA policy requires that projects use the current Building Life-cycle Cost program (BLCC 5.3) developed by the National Institute of Standards and Technology (NIST). This program contains several sophisticated tools that will allow for evaluation of alternative design

solutions. Other tools can be used to supplement the BLCC program, particularly with respect to communication of the results to the project team.

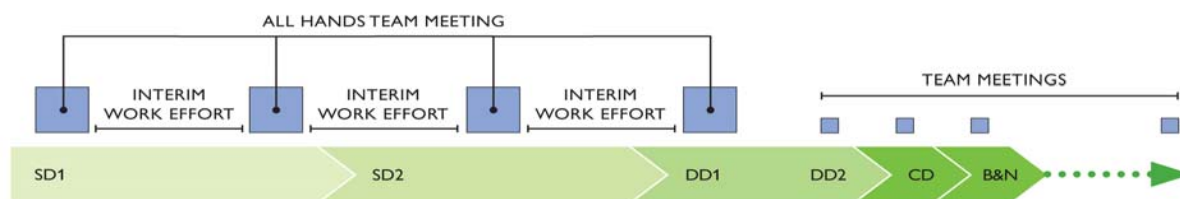
Building the alternative models within the program requires careful attention to a wide range of parameters and costs. Project teams should include sufficient time within the design schedule to allow for comprehensive life-cycle cost analysis.

VA and Federal Mandate energy requirements state that the energy efficiency measures required to meet the 30 percent energy reduction goal must be life-cycle cost effective. In order to demonstrate this, the project team will need to undertake a life-cycle cost analysis of the proposed energy efficiency measures. The analysis should take into account energy, operations and maintenance, and periodic replacement cost impacts, and should include sensitivity analysis reflecting uncertainty in escalation and energy performance. Where 30 percent energy reductions are not life-cycle cost effective, analysis should be undertaken at decreasing increments of 25 percent and 20 percent. It should be noted that there is no similar exception for the Executive Order's agency-wide requirement to reduce overall energy use by 3 percent per annum. Until such time as this discrepancy between is resolved A/E firms shall follow the requirements of EPA/DOE Interim Final Rule and provide a life-cycle cost analysis for energy cost reductions ranging from the target 30 percent down to the achievable range.

## 3.5 SCHEDULE

The integrated design process has the greatest impact at the earliest stages of design. More frequent coordination should take place early in the process, particularly during pre-design and schematic design phases. These early meetings take advantage of the opportunities to make decisions that have the greatest benefit at least cost. The following diagram illustrates this approach.

### INTEGRATED DESIGN PROCESS MEETINGS



Source: Bill Reed, *Integrative Design*

Each large square represents a meeting with broad project representation. The meetings should cover the following key topics:

1. **Sustainability Kick-Off Meeting** – Goal setting
2. **Preliminary Evaluation Meeting** – Identify potential strategies, target energy reduction
3. **Ongoing Evaluation Meetings** – Confirm strategies, confirm energy reductions

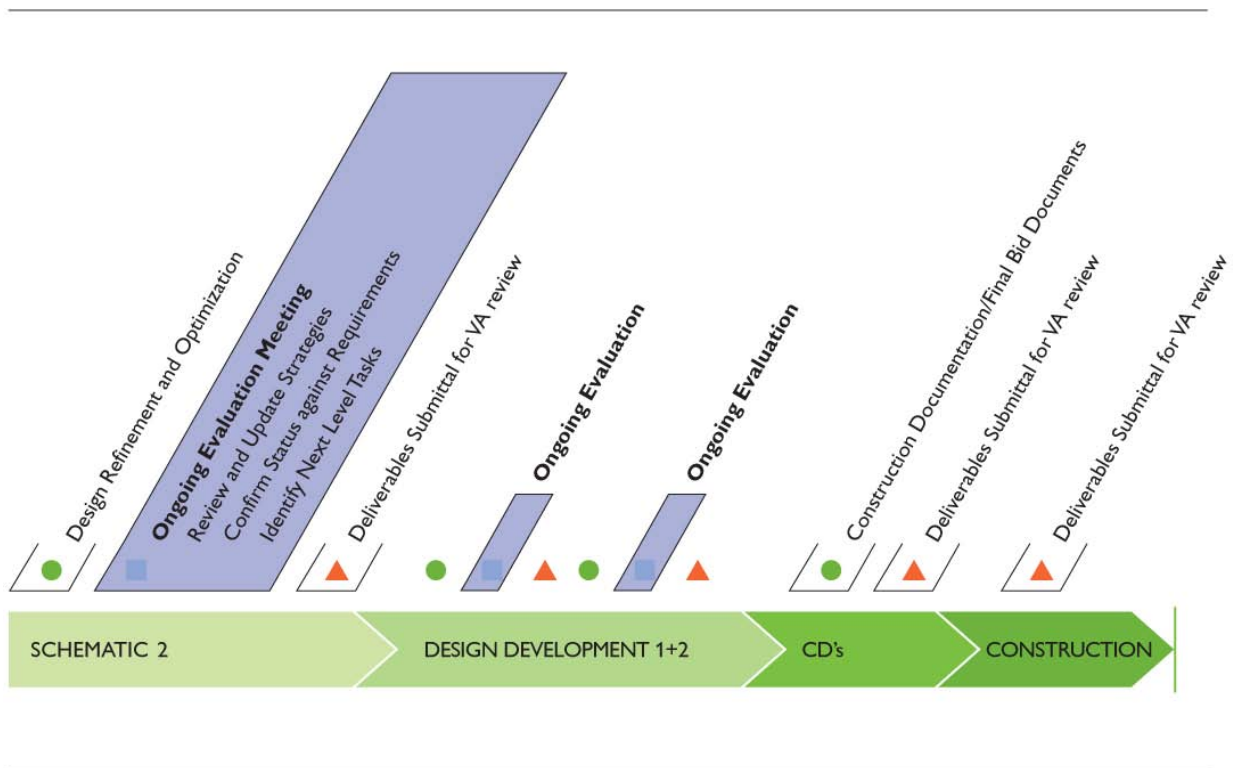
The goal in an integrated design schedule is to balance out the total number of project meetings by increasing the number and type in the early phases and reducing those for resolving issues that traditionally take place later in design, since potential conflicts and problems have already been addressed through early collaboration.

### 3.6 KEY STEPS AND DELIVERABLES BY PHASE

The diagrams and descriptions on the following pages illustrate in more detail the integration of sustainable design meetings and deliverables into VA’s existing design process.

**KEY STEPS AND DELIVERABLES BY PHASE**





## 3.7 SCHEMATIC 1

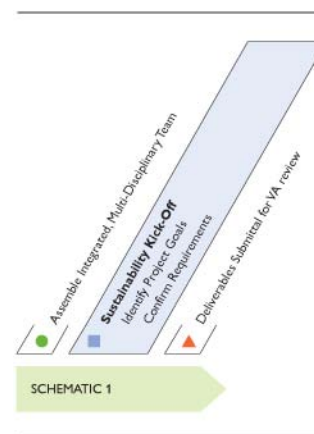
VA requires the A/E team to provide alternative approaches during Schematic 1. (A/E Design Submission Instructions - [http://www.va.gov/facmgt/ae/des\\_sub.asp](http://www.va.gov/facmgt/ae/des_sub.asp)).

### 3.7.1 SUSTAINABILITY KICK-OFF MEETING

Held at the beginning of Schematics 1, the Sustainability Kick-Off Meeting is a collaborative goal setting session where the full team identifies project specific requirements, priorities, and measurable goals.

This broad-based team meets and discusses:

- VA sustainable goals/requirements, including the specific requirements based on the Federal Mandates and the LEED points that apply.
- Project-specific goals based on specific challenges and opportunities for project type, scope, location, and program.
- Regional/local environmental goals based on specific challenges and opportunities.



### SUSTAINABILITY KICK-OFF DELIVERABLES

The following results of the Kick-Off meeting should be submitted to the VA Project Manager:

1. Identification of five to ten project-specific priority environmental goals and target measurements (e.g. 100 percent of stormwater to remain on site).
2. Life-cycle cost parameters for decision making. These will include establishment of the key analysis metrics, such as discount rate, inflation rates, analysis time horizon etc.

### 3.7.2 PRELIMINARY EVALUATION MEETING

#### PRE-MEETING ACTIONS

In order to make informed decisions, the following actions at minimum should be taken prior to the Preliminary Evaluation Meeting:

- **Site Base Conditions Analysis:**
  - Sun conditions: Study site sun path, shading conditions, average number of sunny days, latitude, and technical potential for solar harvesting.
  - Wind conditions: Develop wind rose diagram for site and study potential for wind harvesting.
  - Geo-thermal energy: Study soil types and site geology.
  - Climate: Study high/low temperatures, humidity, unusual conditions, and hazards.
  - Site hydrology: Determine rainfall, natural topography flow, and groundwater.
  - Habitat: Identify animal and plant types and conditions on site and in the general locale.
  - Cultural context.

- **Base Case Analysis:**
  - Begin core project programming, including identification of basic areas, functions and adjacency requirements.
  - Evaluate energy requirements including building base, receptacle and process loads.
  - Evaluate water requirements for building and site use.
  - Define program areas suitable for daylighting.
  - Develop and test a simple base case massing model to understand optimal site orientation/massing, daylighting, and wind opportunities for energy load reductions. For buildings over 8000 GSF, perform preliminary energy analyses.
- **Financial Assessment/Incentives:**
  - Identify local utility companies' rates, including peak load rates and load shedding arrangement opportunities
  - Utility Energy Service Contract (UESC) opportunities
  - Energy Savings Performance Contract (ESPC) opportunities
  - Enhanced use leasing opportunities
  - Ratepayer incentive opportunities
  - Investigate co-generation partnership opportunities
    - Research utility rebate/ potential partnerships/sell back rates
    - Research incentives potential for renewables and energy efficiency (see DSIRE website - [www.dsireusa.org](http://www.dsireusa.org))

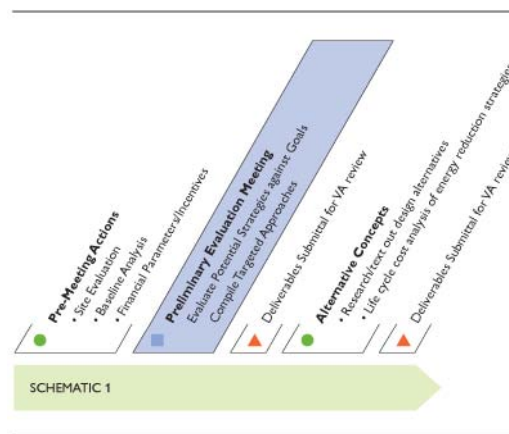
### PRELIMINARY EVALUATION MEETING

The full project team should be in attendance at the Preliminary Evaluation Meeting to participate in an integrated, collaborative work-session to identify a preliminary set of sustainable strategies that they will pursue towards meeting the Federal Mandates and LEED requirement. Each discipline should be present in order to share expertise and explore strategies that seek synergies across requirements and goals. Team members should include key client decision makers, including cost estimating, facilities, VA energy and environmental managers, and operations personnel, in order to benefit from diverse experience.

This meeting should take place early in the Schematics 1 phase before development of alternative solutions.

The team should identify strategies to achieve the goals:

- **Federal Mandates:** Design/construction approaches to meet Federal Mandates as mapped to LEED credits. These are described in Section 2.
- **Energy Efficiency Strategies:** Solutions to help reach the 30 percent energy reduction goal. Some strategies must be considered at earliest phases of design while others will be applicable at later stages. Some suggested strategies are outlined in Section 4.
- **Integrated Strategies:** Solutions that work across systems to achieve multiple benefits in terms of energy savings, resource use reduction, survivability, occupant health and productivity, and so forth. These strategies require early assessment and analysis by the



team in order to be incorporated into the design with minimal cost impacts. Selected strategies are outlined in Section 4.

### **PRELIMINARY EVALUATION MEETING DELIVERABLES**

The following deliverables should be submitted to the VA Project Manager:

1. A preliminary VA sustainable checklist for the project identifying targeted solutions to the Federal Mandates by LEED credit.
2. The results of the site base conditions analysis
3. An integrated budget estimate incorporating the planned sustainable strategies.

### **3.7.3 ALTERNATIVE CONCEPT DEVELOPMENT**

The design team should research and test out targeted sustainable strategies as alternative design solutions are being developed, always seeking those solutions that will give the greatest benefit through integrated system strategies.

Alternative solutions to reach the 30 percent energy consumption reduction requirement should be tested through energy modeling and life-cycle costing to determine the best solution. In order to meet VA requirements, solutions should be evaluated at successive decrements below 30 percent, (e.g. 25 percent, 20 percent, etc.).

### **3.7.4 SCHEMATIC 1 DELIVERABLES**

The following documents must be submitted before a final decision is made on the preferred design concept at end of Schematic 1.

1. A preliminary VA sustainable checklist for the project identifying targeted solutions to the Federal Mandate by LEED credit.
2. Preliminary energy models for alternative schemes indicating at least relative percent reductions. Green Building Studio, Trane, or other similar software may be used for this stage.
3. An integrated budget estimate incorporating the planned sustainable strategies

NOTE: The energy calculations and backup material for each alternative shall be presented at the Central Office concept presentation.

## **3.8 SCHEMATIC 2/ DESIGN DEVELOPMENT 1 AND 2**

The integrated team should continue to work together on the solutions for sustainable strategies during Schematic 2 and Design Development 1 and 2. After selecting a design, the design team will continue refining the plans, optimizing the design and testing the solutions, moving from larger scale to smaller scale systems decisions. The team should work with different combinations of members depending upon issues being addressed, always seeking the maximum benefit across systems by involving team players from relevant design, construction, operations, and maintenance as needed.

The entire integrated team should meet before commencement of Design Development 2 to verify the final design and sign off on all decisions that will have impact on the project's sustainable strategies. A decision on the final Energy Efficiency Measures (EEMs) to be incorporated into the project must be made with VA approval, by the applicable VA

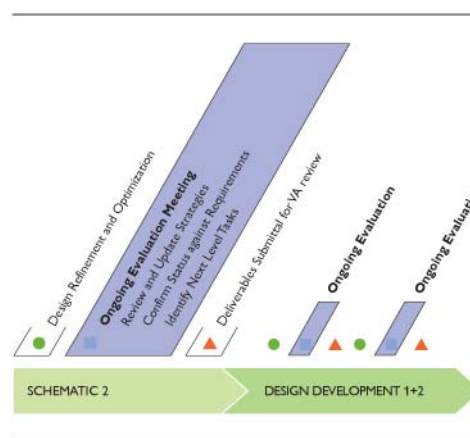
Administration's office responsible for standards, prior to finalization of design, based on the life-cycle analysis results.

Beginning in the Schematic 2 phase, the consulting design team should register the project, based on criteria outlined in Section 2, on the USGBC LEED website. This will give the team access to the LEED online site which can be used to track the status of LEED credits and documentation requirements. Documentation based on LEED requirements will be submitted to VA in later phases for Federal Mandates linked to LEED credits. A designated team member should be responsible for keeping the LEED-related information up to date for credits being pursued by the project.

### 3.8.1 ONGOING EVALUATION MEETINGS

At each meeting the following agenda items should be covered:

1. Confirmation of VA requirements and project goals.
2. Review of environmental standards that should be incorporated into the sustainable strategy
3. Review an update of sustainable and energy reduction strategies to meet requirements:
  - a. Status of strategy refinement – what's working, not working, next level of tasks.
  - b. Review of any new or alternative approaches to meet requirements and agree on next steps.
  - c. Review of energy reduction status based on above.
  - d. Confirm project budget and life-cycle cost analysis.
4. Reconfirm LEED target certification level status and documentation requirements, where applicable.
5. Identification of next level tasks and responsibilities for team refinement.
6. Coordinate decision making against larger schedule so that design opportunities are not lost.



### 3.8.2 SCHEMATIC 2 DELIVERABLES

1. An updated VA sustainable checklist for the project with written narrative summarizing status of meeting full Federal Mandates.
2. Refine the energy model of the design building
  - Generate an ASHRAE 90.1-2004 Appendix G compliant base case to compare with the design case, for all buildings over 8000 GSF.
  - Use the energy model to simulate Energy Efficiency Measures (EEMs) for the proposed design and show the associated energy consumption and cost savings for each
  - Prepare an energy model report describing all assumptions used in creating the model and summarizing the energy and cost savings associated with each EEM simulated, as well as summarizing the projected savings vs. the ASHRAE 90.1-2004

Appendix G base case. The savings vs. the ASHRAE case will be summarized based on the following comparisons:

- **Consumption:** BTU/GSF/year, including receptacle and process loads.
- **Energy Cost:** \$/GSF/YR for regulated energy (excluding receptacle and process loads)
- **LEED:** \$/GSF/YR for total energy (including receptacle and process loads)

NOTE: For calculating energy for acute care projects, 30% shall be used as the receptacle and process loads in determining the baseline building performance rating.

3. Document showing life-cycle cost analysis against varying levels of energy reduction target levels.
4. Updated cost estimate.

NOTE: The energy calculations and backup material shall be presented at the concept presentation at Central Office.

### 3.8.3 DESIGN DEVELOPMENT 1 + 2 DELIVERABLES

The deliverables for Schematic 2 phase should be continually updated and submitted for VA Project Manager review at the end of each Design Development phase. In particular, the energy model requirements are to:

1. Update the energy model based on design changes and added design detail
2. Use the energy model to simulate any additional EEMs considered
3. Update energy model report, summarize the energy and cost savings of each EEM simulated. Update the projected savings vs. the ASHRAE 90.1-2004 Appendix G case, using the same comparison metrics as in the Schematic 2 phase.
4. Identify percentage of energy savings achieved
5. Document showing life-cycle cost analysis against varying levels of energy reduction target levels.

## 3.9 CONSTRUCTION DOCUMENTATION

Sustainability-related meetings should occur during Construction Documentation as needed among related team members to finalize details on sustainable strategies. Careful attention to final project drawings and specifications to incorporate requirements for identified sustainable strategies is critical. Existing VA specifications may need modifications to incorporate these requirements until such time that standard specifications are modified.

By the end of Construction Documentation phase, the Federal Mandates linked to LEED credits that are based on design solutions will be finalized. The construction project team will use the LEED online website to prepare documentation for the VA Project Manager for those design phase credits to confirm compliance. For those project teams choosing to pursue official LEED certification, documentation for all design phase credits can be completed at this time and submitted to the USGBC for review. See the VA Project Start Point charts in the Appendix for designation of LEED credits by design and construction phase.



### 3.9.1 CONSTRUCTION DOCUMENT DELIVERABLES

1. An updated VA sustainable checklist for the project with written narrative summarizing status of meeting full Federal Mandates.
2. For each design phase LEED credit mapped to a Federal Mandate, submit documentation per requirement on USGBC LEED online website.
3. Final energy model report as follows:
  - Update the energy model during the Construction Document phase based on the final design documents. Provide final information regarding the three energy measurements to Central Office.
  - Update energy model report, summarizing the projected savings vs. the ASHRAE 90.1-2004 Appendix G case, using the same comparison metrics as in the Schematic 2 phase.
4. Updated cost estimate.

## 3.10 CONSTRUCTION PHASE

During the construction phase the A/E team should coordinate with the VA Resident Engineer, the commissioning agent, and the contractor to insure that sustainable requirements are realized in the final construction. The following areas require particular attention:

- Care to assure that the design intent, especially of those that cross systems, are fully employed and operational
- Review of submittals against specifications:
  - Review submittals, samples, and product literature to meet specified standards.
  - Substitutions must meet specified recycled, bio-based, and IAQ, and other requirements.
  - Ensure that special installation requirements are being met.
- Observation of Construction Waste Management Plan execution.
- Documentation and warranties of all systems is provided to VA to operate the building
- Observation of Indoor Air Quality Guidelines execution.



After completion of construction, documentation for the Federal Mandates linked to construction-based LEED credits should be submitted to the VA Project Manager to confirm compliance. For those project teams choosing to pursue official LEED certification, documentation for all construction phase credits should be completed at this time and submitted to the USGBC for final review and certification.

### 3.10.1 CONSTRUCTION PHASE DELIVERABLES

1. Final VA sustainable checklist for the project with written narrative summarizing status of meeting full Federal Mandates.
2. For each construction phase LEED credit mapped to a Federal Mandate, submit documentation per requirement on USGBC LEED online website.



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## 4. Methods to Achieve the Goals

This section summarizes strategies that can help teams meet the Federal mandates and LEED certification where pursued. These strategies have been determined to have particular application to VA facilities and fall into two sections:

- **Integrated Strategies:** those that require early team consideration and have the potential to have multiple benefits across sustainable requirements, and
- **Energy Efficiency Strategies:** strategies that will help meet the mandates for energy reduction.

### 4.1 INTEGRATED STRATEGIES

Integration takes advantage of synergies in design and of specific design solutions meeting more than one sustainability or energy requirement. It views the building and site as a series of interdependent systems rather than a collection of separate components. Integrated strategies can only be maximized through a comprehensive integrated design process.

In addition to the integrated strategies outlined in the Energy Efficiency section, this section examines opportunities for additional cost effective implementation of sustainable design and energy efficient elements through early integration of strategies. *It is intended as an overview of selected common integrated strategies, and is not an exhaustive list of all possible opportunities for integration.*

The following strategies pertain to siting of the facility:

- Orientation
- Massing
- Storm Water

#### 4.1.1 ORIENTATION

Building orientation is one of the most important first steps in determining key sustainable design elements of the project. Building orientation related to the sun and prevailing winds will have a significant impact on the required heating and cooling systems and thus the overall energy efficiency of the project. In general, it is recommended to orient the elongated dimensions of the building along the east-west axis so that a majority of the wall surface area faces north or south. This will minimize heat gain through east and west facing glazing and maximize suitable day lighting. Orientation should also be considered in relation to prevailing winds to optimize natural ventilation or shield the project from unwanted winds.

Building orientation can typically be accomplished with no appreciable construction cost impact. On some sites, however, it is impractical to achieve optimum orientation. This is typically due to other site constraints, such as site slope, adjacent roads or buildings, etc. In these cases, it is usually cost prohibitive to improve the building orientation.

### 4.1.2 MASSING

Proper building massing should be determined in conjunction with building orientation. Building massing refers to the way in which building elements are put together in terms of volume and can be used to optimize passive heating and cooling strategies, optimize resource efficiency, and maximize open space. For passive heating and cooling, building massing can be designed to slowly absorb heat during the day so that the volume does not reach outside temperatures until those higher temperatures begin to drop in the evening. Then, as the outside temperatures drop, the mass slowly releases the heat into the space. Massing can also be used to deflect prevailing winds or to optimize natural ventilation.

In terms of resource efficiency, massing can refer to program and equipment. Massing similar building programs together can provide for a more efficient use of space and allowing increased productivity. Also, stacking and massing mechanical equipment can minimize the use of space and in some cases minimize the exterior envelope, providing it is efficiently designed.

**Context:** Massing also often refers to the relation of the building mass to the open space on the site and should be considered in relation to optimizing the amount of natural light in the building, providing views and visual access to the exterior as well as the surrounding site context.

Building massing can have a significant impact on construction cost, particularly for acute care facilities which have traditionally been developed with very large, deep floor plates. Medical office buildings also often have relatively deep floor plates. Long-term care facilities, in contrast, are more often fairly shallow; therefore, improving the massing will represent less of a change to current practice for this facility type.

**Building Skin:** Selecting narrow floor plate increases the exterior cladding quantity for a given floor area. Since the skin cost is a major contributor to the overall cost of construction for healthcare facilities, increasing the skin ratio increases the overall cost of construction. For acute care facilities, a common exterior skin ratio is in the range of 0.4 to 0.5 SF of wall area per square foot of gross floor area. Good massing would increase that ratio typically to around 0.7 to 0.8, an increase of roughly 60 percent. However, this would translate into a cost increase to the total building of around 10 percent for the increased skin costs.

Balancing the increased skin cost is a reduction in the cost of other systems: with greater daylight penetration, lighting loads can be reduced significantly, leading to lower power demands and lower cooling demands. The offsetting reduction in systems costs will amount to roughly 2 percent, leaving a net increase in cost of around 8 percent. The long term cost savings in energy demand will provide a payback for this premium over time, usually in the range of seven to ten years. Including the benefits of improved staff retention in the analysis will further reduce the length of the payback period.

**Operating Costs:** In addition to reducing the first costs of the mechanical and electrical systems, improved massing can reduce the operating cost of the facility through reduced energy demand and reduced system maintenance. Studies have demonstrated improvements in both staff and patient well-being resulting from improved access to views and daylight. Benefits include improved patient outcomes, reduced stays in acute care facilities, reduced medical error and staff injuries, better staff retention, etc.

### 4.1.3 STORM WATER

Development often disrupts natural hydrological cycles by reducing surface permeability and increasing stormwater run-off. Paved areas also increase the velocity of run-off and can cause significant erosion problems. The stormwater run-off collects contaminants from roofs and

paved surfaces and carries them to either existing water bodies or municipal sewer systems where treatment is required. All of these impacts can be mitigated and at times neutralized by conscious design decisions. Means by which a project can reduce the quantity of stormwater run-off include pervious paving, vegetated roof surfaces, diversion channels to on-site infiltration basins, and stormwater collection cisterns. Pervious paving and vegetated roof surfaces can retain between 20 and 50 percent of stormwater, depending on the materials. Collecting stormwater for use as irrigation or gray water creates a valuable synergy of environmental measures by reducing the project's demand of municipally provided potable water.

**Treating Stormwater:** Treatment of contaminated stormwater can be accomplished on-site in a variety of ways including contaminant source reduction, using landscape features, and structural Best Management Practices (BMPs). Reducing the source of contaminants such as phosphorous on site can easily be accomplished by prohibiting the use of phosphate-based cleaners for exterior building maintenance and specifying submergible time-release phosphate fertilizers for landscaping if necessary. Landscape features such as bioswales or vegetated filter strips are also effective at removing both phosphorous and other solids from run-off. There are also several types of structural BMPs that are effective and available as both off-the-shelf sand filters and built-to-spec guidelines available from the EPA.

Stormwater detention or retention ponds can also be incorporated into bioswale systems, but these can add significantly to the cost and required site area. Retention ponds are not suitable for rainwater harvesting in all locations, although they have proven successful for cemetery use.

Stormwater retention tanks are the most expensive integrated solution, but they do provide the added benefit of rainwater harvesting, allowing the reuse of the collected rainwater for irrigation or other purposes. In areas with sufficient year round rainfall, this can result in a significant long term reduction in water usage. The typical cost of rainwater harvesting is in the range of \$3 to \$5/gallon, or \$2,000 to \$4,000/ hundred cubic feet. This would translate into roughly \$2 to \$4/GSF if the project were to collect the entire roof runoff. In many areas the current cost of potable domestic water is too low to provide a meaningful payback for rainwater harvesting alone.

The primary benefit of integrating stormwater management strategies is to minimize first costs by combining systems. The most common and lowest cost integrated strategy is simply to use the landscaping to dissipate the stormwater flow through swales and rain gardens. This allows for a certain amount of stormwater infiltration into the ground in most conditions, and will reduce peak flow offsite. It also serves to reduce the suspended solids and silt in the rainwater, and, through the use of appropriate plant material, even eliminate some pollutants. This strategy often results in overall first cost savings, by reducing the extent of below grade piped stormwater systems.

**Green Roofs:** Vegetated roofs can play a similar role to bioswale systems where site area is insufficient to provide for adequate swales. Green roofs dissipate rainwater flows, leading to reduced peak runoff, and also treat the rainwater by reducing suspended solids and other pollutants. Other advantages of green roofs are that they improve the insulation of the roof and reduce the heat island effect, thus lowering the energy demand within the building. They can also increase the longevity of the roof by eliminating UV and chemical degradation of the roof membrane. In addition, they can be very valuable in providing views and roof gardens on lower roofs. The green roofs cost from two to three times the cost of a conventional roof, but since the roof is a relatively small contributor to overall cost of a healthcare facility, the overall cost impact is less than 1 percent. The long term cost benefits however, while appreciable, are rarely sufficient to justify the added cost through a payback analysis.

## 4.2 ENERGY EFFICIENCY STRATEGIES

Energy efficiency measures are organized into three groups: 1) strategies which reduce the overall energy load within the building; 2) strategies which improve the efficiency of the systems; and 3) strategies incorporating on-site generation of electricity through the use of renewable resources.

Many of the energy reduction strategies discussed in this section can provide other benefits to the project, and will improve the overall sustainable performance of the facility. Examples include improved access to daylight and views, improved indoor air quality, and improved occupant comfort. For this reason many of these strategies should be considered as part of the overall integrated design strategy, rather than as individual, stand-alone strategies.

The cost effectiveness of individual energy efficiency measures varies greatly by region and climate, and there is no one combination of measures that will always provide the optimal energy efficiency. Project teams must carefully evaluate all possible and appropriate actions to ensure that the most cost-effective solutions are attained.

### 4.2.1 BUILDING LOAD REDUCTION STRATEGIES

#### 4.2.1.1 FENESTRATION

Suggested strategies for fenestration include the use of high performance glazing products, sun shading/light shelves, operable windows (in areas that do not impact infection control and patient safety), fritted glass, and for skylights and other appropriate locations, insulated translucent composite panels.

While each strategy on its own may have a first cost impact, it can also deliver significant operational cost savings in reduced energy. In addition, these strategies can improve the interior environment through better access to daylight, views, and outdoor ventilation.

High performance glass includes both high insulation and low emissivity (low 'e') glazing. Insulation reduces conductive heat gain/loss, while low 'e' reduces radiant heat gain/loss. Performance requirements will vary greatly by location and exposure. Typically high performance glass can add 5 to 10 percent to the glazing cost. The added glazing cost is, however, usually more than offset by reductions in energy load, and is economically desirable in most climates. Using windows with an Energy Star® designation is recommended.

Sun shading and light shelves increase daylight penetration into a building while reducing the energy load on windows from direct sunlight, which can also reduce glare for building occupants. There is a wide range of premium cost, but the normal range runs from 20 to 40 percent of the glazing cost. Not all glazing will require sun shading, and so the total cost can be reduced by selective application of sunshades and light shelves. Sun shading and light shelves can form a critical part of an integrated energy design, and can significantly reduce the energy demand from solar gain on the windows and from artificial lighting. The payback for sun shading and light shelves is usually positive, but depends greatly on the design.

Operable windows can reduce requirements for forced air ventilation, and in many climates, cooling. They also improve the sense of connection to the outdoors, which enhances the occupant sense of wellbeing in most cases. There are two main contributors to the costs for operable glazing: the direct cost of the glazing units, and the cost of any added controls to the HVAC system to eliminate running the air conditioning systems while windows are open.

The premium cost for the glazing is in the range of 10 to 20 percent of the glazing cost for institutional quality windows. The control costs can vary greatly, but can be significant, since operable windows can lead to much smaller and much more frequent control zones. Many times the control cost is markedly higher than the cost of the windows. For long term care facilities, however, usually the controls zones are already such that operable windows impose no significant added cost.

For acute care facilities, operable windows should be considered in non-critical areas such as public circulation spaces, places of respite, offices, etc.; however, they must be used judiciously in order to not compromise the air pressure balancing necessary for infection control.

Operable windows are well suited to long term care facilities and to medical office buildings, and in certain climates can provide a reduced first cost, as well as reduced operating expenses.

#### **4.2.1.2 WALLS, ROOF AND SLAB**

It is vitally important in any strategy trying to reduce energy use to maximize the thermal performance of envelope construction by minimizing heat transfer according to climate needs. More insulation is usually beneficial but there is a point at which additional insulation is not justified. Energy modeling is used to determine the optimal U-value of the walls, roof and slab construction. The effective U-value, which is calculated by factoring in the negative effect of thermal bridges, can then be used in energy modeling to more accurately simulate thermal performance. Thermal lag benefits of heavy mass construction versus light weight, highly insulated construction should be considered.

#### **4.2.1.3 AIR BARRIERS**

Heat loss/gain results from air infiltration caused by temperature differential, wind and stack effect. By placing air barriers correctly within the opaque wall assembly, or, in appropriate climatic areas, a combined air and vapor barrier, substantial energy can be saved that would normally escape through the building enclosure. Attention to the wall assembly, lighting fixtures, stairwells, shafts, chutes, elevator lobbies, spaces under negative pressure, and air ducts during design and construction is necessary to assure that a continuous air barrier “system” is place to control air leakage into, or out of, the conditioned space. ASHRAE 90.1 Addendum Z is a source of information on standards for air barriers.

The most significant costs associated with improving the thermal performance of the envelope come from eliminating thermal bridging and reducing the degree of air infiltration through the façade. Elimination of thermal bridging can be quite challenging, and requires significant attention to architectural detailing. It can, however, provide additional benefits in the reduction of internal condensation and improved occupant comfort. Increasing wall thicknesses to accommodate additional insulation can also have a significant cost impact. In most cases the cost of the insulation itself is relatively small.

#### **4.2.1.4 DAYLIGHT DIMMING CONTROLS FOR PERIMETER AREAS**

Daylight dimming lighting controls rely on photocells to maintain the necessary lighting levels (foot candles) in the space by reducing the lighting output from electric lighting based on the quantity of daylight in the space. The photocell is generally placed such that it reads

the lighting level of the space at three feet above the floor and ten to 15 feet from the exterior wall. The photocell monitors the lighting level in the space and dims the electronic lights accordingly to maintain the required foot candles, based on the natural daylight available at any given time in the space.

In large open perimeter spaces, only lighting that is within 15 feet off the perimeter is assumed to need daylight controls.

The cost for incorporating daylight dimming controls at perimeter areas includes both the cost of the control system and the additional cost associated with dimmable fixtures. Typically the cost increase is in the range of 1 to 2 percent of the overall lighting budget. However by limiting artificial light, the heat load is also reduced, which reduces both the initial system size and long term energy costs. A rule of thumb is that for every watt of artificial light, there is an increase of 1/3 watt air conditioning load.

#### 4.2.1.5 VARIABLE ACH VENTILATION RATES

The ventilation rates, in areas determined acceptable by VA, are reduced based on occupancy and or time clock. For the occupancy sensor based controls, a space occupancy sensor identifies if the space is unoccupied, similar to lighting controls but with a longer time delay to prevent HVAC cycling. When the space is determined unoccupied for 30 minutes (either by sensor or time clock) the ventilation rates to the space are reduced by 50 percent, and the fan VFDs throttled down. This in effect forces VAV operation for these spaces, thereby saving significant fan, cooling and reheat energy.

The following table identifies the minimum standard for the areas having reduced ventilation rates:

Space Type	Occupancy Control	Occupied ACH	Unoccupied ACH
Office	Time Clock	4	2
Education	Time Clock	6	2
Library	Time Clock	6	2
Emergency	Time Clock	8	4
Dermatology	Time Clock	8	4
Endocrinology	Time Clock	8	4
Neurology	Time Clock	8	4
Woman's Clinic	Time Clock	8	4
Cardiology	Time Clock	8	4
Mental Health	Occ Sens	6	2
Rehab	Occ Sens	6	2
Eye Clinic	Occ Sens	6	2
Geriatric	Occ Sens	6	2
Speech	Occ Sens	6	2
Dialysis	Occ Sens	6	4

Space Type	Occupancy Control	Occupied ACH	Unoccupied ACH
Digestive Disease	Occ Sens	8	4
Patient Film Records (archive)	Occ Sens	4	2
Gantry Room	Occ Sens	12	6
Dental Admin Offices	Occ Sens	6	2
Patient Areas	Occ Sens	6	2
Vent. Test Rm / Spirometry	Occ Sens	6	4
Blood Gas Analysis	Occ Sens	6	4
Sp. Procedures / Bronchoscopy	Occ Sens	8	4
Sleep Labs	Occ Sens	6	2
Exercise Room	Occ Sens	10	6
MAS Spaces	Time Clock	6	4
Laboratory	Occ Sens	12	12
Medical Research	Occ Sens	12	12
Cardiology Lab	Occ Sens	12	12
Medical R&D	Occ Sens	12	12
Surgery	Occ Sens	20	10
Ambulatory Surgery	Occ Sens	15	8
Hyperbaric Surgery	Occ Sens	15	8
Kitchen, Dietetics	Time Clock	10	4
Canteen	CO2	10	4
Outpatient Pharmacy	Occ Sens	6	2
Exempt repackaging/compound	Occ Sens	6	2

Cost premiums associated with variable ventilation rates are very small, essentially comprising additional control systems and occupancy sensors. The potential energy reductions are substantial with reductions in fan energy, heating, and cooling loads.

#### **4.2.1.6 LIGHTING AND OCCUPANCY SENSOR LIGHTING CONTROLS**

As artificial lighting is a large contributor to energy use, it is important to choose the type of lighting wisely. Energy efficient fixtures and lamp types, including compact florescent lighting (CFL) and other highly efficient types, should be selected for their energy efficiency in addition to their appropriateness in color rendition, functional use, cost, longevity, etc.

Occupancy sensors turn off the space lights when no movement is detected (therefore the space is assumed unoccupied) for a period of time. As per ASHRAE 90.1 2004 the occupancy sensors are assumed to reduce the space lighting load by 15 percent, which can translate into an overall energy cost reduction of 2 – 3 percent.

Typically the cost increase for incorporating occupancy sensors in all enclosed offices and other similar regularly occupied spaces (excepting patient rooms and some other specialty spaces) includes the cost of the control system, and is in the range of 2 to 3 percent of the overall lighting budget.

#### **4.2.7 WARMEST SUPPLY TEMPERATURE RESET**

Control systems can be designed to reset air delivery temperatures as required by the zone with the highest cooling load, rather than delivering a constant 55°F supply temperature when cooling is required by some zone. With this measure the control system monitors the position of each supply box and raises the supply air temperature when no boxes are fully opened. When one of the boxes is fully opened the supply air temperature is set at that temperature until either the box closes or one of the zone thermostats requires more cooling. This measure can significantly reduce reheat loads.

The primary cost impact of this measure is the cost related to the controls system hardware. If sophisticated controls hardware is installed that allows monitoring of VAV box airflow or damper position, then the additional controls costs related to supply air temperature reset have very little cost. However, if the extensive controls hardware is not part of the initial system, the hardware upgrade can increase the overall cost of the air-conditioning system by 1 to 2 percent. The energy reductions, however, can be very substantial.

### **4.2.2 HIGH EFFICIENCY SYSTEMS**

Most high efficiency systems have a higher first cost, but deliver improved long-term operating costs. Most of the improved long-term operating costs come in the form of reduced energy demand, but some can come from reduced maintenance or improved equipment life. More efficient systems can also lead to downsizing of equipment or systems, which will provide some offsetting initial cost savings.

#### **4.2.2.1 HIGH EFFICIENCY CHILLER SYSTEMS**

Using a highly efficient chiller, or using chillers with an efficiency of 0.50 kW/Ton for the central plant saves energy by using less electricity to produce the same quantity of chilled water. In areas where cooling loads are a significant contributor to the energy usage, high efficiency chillers can provide significant energy savings, and are very cost effective.

#### **4.2.2.2 INCREASED CHILLED WATER DELTA-T**

Increasing the temperature rise (delta T) on the chilled water system to 16°F can produce modest energy savings, particularly in areas where cooling loads are significant contributors to the energy cost. The delta T increase has a very slight effect on the construction costs as it requires slightly larger cooling coils on the Air Handling equipment. The cost increase would typically be less than 1 percent of the overall cost of the HVAC system.

#### **4.2.2.3 COGENERATION – COMBINED HEAT AND POWER (CHP)**

Incorporating cogeneration with combined heat and power for some or the entire electrical load of the facility provides several energy efficiencies, some of which extend beyond the simple reduction in energy demand at the facility. Cogeneration plants are usually more efficient generators of electricity than many commercial power plants, and there is none of the transmission loss associated with electricity received from the grid. As a result,

cogeneration plants consume significantly less source energy to deliver the same level of power.

The use of combined heat and power systems allows a facility to extract additional energy from the cogeneration plant through capturing reject heat from the electricity generation for use in heating, steam generation, dehumidification, etc.

Cogeneration systems can also provide much higher levels of energy security, and can in some cases reduce the extent of emergency generation capacity required on-site.

Cogeneration systems typically have a very high first cost, and their cost effectiveness depends greatly on the electricity rate structure and the local utility's policies related to zero net metering or electricity resale. The cost effectiveness can be greatly enhanced where the cogeneration can be fueled in whole or in part through the use of reject or non-commercial fuels, such as medical waste, biomass, methane, etc.

#### **4.2.2.4 ENERGY RECOVERY**

The most effective energy recovery approach is a Total Energy Recovery Wheel, although heat pipes and run around coils can also be utilized.

The Total Energy Recovery Wheel requires an increase in space for the air handling units, since the wheels are often large diameter. These systems also require that the exhaust and supply air ducts run close together which may lead to increased quantities of ductwork. Heat pipes and run around coils have less design impact, but are also significantly less effective.

Total Energy Recovery Wheels are particularly effective in humid climates since both sensible (heat) and latent (humidity) energy are exchanged, which in effect pre-heats the outside air during the heating season and pre-cools the outside air during the cooling season.

It should be noted that the use of Total Energy Recovery Wheels is not allowed for heat recovery from labs and surgery suites due to the possibility of cross contamination of the air streams.

#### **4.2.2.5 CONDENSING BOILERS**

Condensing boilers are widely available and widely used, and are very economical. They can provide very good energy cost efficiency. The most significant limitation is that they are typically limited in size range, and not available at the size required by very large facilities, particularly those with high heating loads. This limitation can be addressed through installation of multiple smaller boilers, or through installation of condensing heat recovery on a conventional boiler stack.

#### **4.2.2.6 GROUND SOURCE HEAT PUMPS**

Ground source heat pumps use the ground or ground water as a sink for heat rejection. Ground temperatures are usually very favorable for heat rejection, being generally consistently cooler than the design temperature of spaces. Ground source can also be used for heating, but with less energy efficiency. Another advantage is that ground temperatures are usually very stable, and so heat pumps can be designed more efficiently.

The primary challenge is getting a sufficient area of contact with the ground or ground water, since the ground does not conduct heat well, while protecting the ground from contamination

by coolant liquids. The systems can use vertical drilled shafts, or horizontal pipe fields. Horizontal pipe fields are generally the less expensive option, but they require large open site areas.

The choice of system and its size will depend greatly on ground conditions, but because of the extent of the piping in either system, ground source heat pumps are usually more suited to buildings up to 50,000 SF. VA cemetery buildings would be ideal candidates for ground source heat pumps, since they are typically quite small, and have large site areas, allowing for the use of horizontal pipe fields.

Another potential strategy that can be examined is the use of cool incoming domestic water or sewage lines to partially pre-cool the condenser water loops. One possible application would be to have the incoming domestic hot water line and the condenser water return line running to a plate and frame heat exchanger, where the domestic hot water line is pre-heated by the condenser water loop and the condenser water loop is pre-cooled by the domestic hot water loop. The heat from the condenser water (where it is not needed) is passed to the domestic hot water (where it is needed), with the only energy ramification being the additional pump power needed to push the water streams through the heat exchanger. Water loop locations and space constraints may restrict some applications of this measure.

### **4.2.3 RENEWABLE SYSTEMS**

The use of renewable energy sources should be considered by VA project teams, as one half of VA's renewable energy requirements must come from new sources (available after January 1, 1999) or if feasible, generated on site. By using renewable energy either off site or on site, VA will be contributing to reducing greenhouse emissions by reducing non-renewable energy demand.

There are several advantages to generating energy on site, such as increasing electrical reliability and providing an emergency backup system. In addition, every kWh provides a renewable energy credit (REC) which may be exchanged with the local utility for credits, or used as a part of an Energy Savings Performance Contract (ESPC) arrangement. The energy may also be useful if the VA facility participates in the local utility company's peak demand response program. During the peak demand time, the renewable kWh can be "sold" back to the utility at the peak rate, and the value recovered as a credit by the VA facility during regular billing. Of course, this type of arrangement must be worked out with the local utility.

In addition, if the renewable energy is generated on site, VA will receive credit for double the energy actually generated for use in reporting on the Federal Energy Report Card.

The following are examples of renewable systems:

#### **4.2.3.1 OFF SITE**

Purchasing green power (power derived from solar, wind, geothermal, biomass or low-impact hydro sources), by selecting a Green-e certified power provider for a portion of electric purchases, purchasing a portion of electric power through a Green-e accredited utility program, or by purchasing Green-e accredited Tradable Renewable Certificates (RECs).

### 4.2.3.2 ON SITE

**Photovoltaics (PV):** PVs can be placed on the exterior of a building and generate electricity through collection of solar energy. Light shining on a PV cell, which is a solid-state semiconductor device, liberates electrons that are collected by a wire grid to produce direct current electricity which is then converted to alternating current for use by the facility.

There are two types of PV cells: crystalline and amorphous. Crystalline cells are more expensive at around \$60 to \$80/SF. Amorphous cells are usually in the range of \$40 to \$60/SF. The crystalline are generally provide a higher electrical output per square foot than amorphous at peak generation at 8 to 10 W/SF, compared to 4 to 6W/SF for amorphous. Amorphous will typically provide good energy output over a wider range of solar conditions, however. Crystalline cells are panelized, with frames and glass covers, and so must be mounted on structures or frames which can increase the cost further. Amorphous cells are more flexible, and can be applied to a variety of substrates, including roofing membranes, cladding panels, window glazing and similar. Photovoltaic window or glazing modules can be integrated into a building as non-view windows, skylights, greenhouse windows, curtain walls, facades, etc.

**Wind Energy:** Wind energy can be harnessed by wind turbines, located either on the building or at an adjacent site. Wind rotates the turbine which converts the mechanical movement into electric power. Locating wind turbines physically on the building can be a cause for concern, since dealing with vibration being passed to the building from the turbines and from the quality of the wind flow hitting the turbine (wind is often distorted by the building structure). As a result, if the option of wind turbines is considered, a turbine site close to building areas may be more appropriate. New “micro-turbine” solutions which minimize vibration and are not dependent on wind direction are also possibilities.

**Geothermal:** Geothermal systems take advantage of local reservoirs of hot water or steam which can be drilled into for use in generating electricity and heating buildings. Geothermal energy is usually capital intensive, and is unlikely to be a significant contributor to the production of renewable energy except in optimal cases, such as large facilities located in geothermal zones.

**Biomass:** Biomass systems can be fed from a variety of sources, and can directly use gasses emitted from the decomposition of biomass, or can use the biomass in high temperature reformers to generate hydrogen, which is then fed into fuel cells. Some biomass can also be converted to biodiesel for use in diesel generators.

In the first case, biomass is composted to produce the methane. The biomass can be sewage, garbage, or other organic material. In most VA settings, it is unlikely that it would be desirable to collect biomass for methane generation, but if methane were available from existing sources, such as sewage treatment plants or landfill, it could be used. On site sewage treatment could also be a potential source of biomass methane.

Reformation of organic waste to generate hydrogen can be used both as an energy source and a means of reducing waste from the facility. One start up company, Medergy, has developed a process for using medical waste as a feedstock for reformers. This consumes significant portions of the medical waste, and sterilizes the residue. In the process, it produces hydrogen for use in a fuel cell, which in turn generates electricity and heat.

The use of biomass to generate biodiesel would be very limited in most healthcare settings, but may be practical in small scale applications.

## 4.3 FUNDING OPTIONS

The Energy Policy Act of 2005 (EPAAct 2005) reauthorized through 2016 the use of private sector financing to assist Federal agencies in achieving energy and water efficiency goals. Energy savings performance contracts (ESPCs), utility energy service contracts (UESCs), and enhanced use leasing (EUL) are instruments available to VA to finance project costs so scope can be optimized and reductions in energy intensity and water consumption realized. Ratepayer incentives and retention of funds are additional tools that can help offset the initial capital costs of efficiency projects. Renewable energy technologies can play an important role in reducing traditional energy consumption and costs, and should be considered along with other measures.

- **ESPC:** A legislatively authorized contracting vehicle that allows the private sector to assume the capital costs of energy improvements in Federal facilities. An ESPC project is a partnership between a customer (VA) and an energy services company (ESCO) in which the ESCO finances, designs, constructs, and potentially operates and maintains a project that meets the agency's requirements. The ESCO guarantees that the improvements will generate dollar savings sufficient to pay for the project over the term of the contract, and that savings will exceed costs (i.e., agency payments) in each contract year. After the contract ends, all additional cost savings accrue to the agency.
- **UESC:** Contract arrangement with a local utility in which the utility provides financing and expertise to implement energy and water efficiency projects. Projects using UESCs can include services such as energy audits, project design and installation, construction management, commissioning, measurement and verification, as well as operations and maintenance. The Federal agency repays the utility over the contract term from the cost savings generated by the efficiency measures. Typically repayments are made via the utility bill. Many utilities have programs to defray energy infrastructure costs, and will sometimes provide grants or share in the cost to build energy reduction improvements. New construction projects, particularly mid-to-large in size, should contact the local electric and water companies to determine what services may be available.
- **Enhanced Use Leasing:** A legislated authority unique to VA that allows VA to execute long term out-leases of VA property through cooperative arrangements with public or private partners. In return, VA receives consideration in the form of revenue and/or in-kind consideration (e.g., provision of energy services such as electricity, steam and hot water). The lessee owns the property/facilities for the term of the lease. This arrangement provides financing, private sector ownership and operation of a physical asset for a period of time. EUL is appropriate consideration for large or long-term projects such as renewable and cogeneration plants and roof replacements with integral or roof-mounted photovoltaic cells.
- **Ratepayer Incentives:** Ratepayer-supported rebates from public benefit funds or utilities for the purpose of offsetting energy efficiency project costs. These incentives where available should be utilized to reduce initial capital costs.
- **Retention of Funds:** Allows retention of unused appropriated funds directly related to energy and water cost savings to be reinvested in energy reduction, water conservation, and sustainable building enhancements.

VA's guidance for energy investments is contained in Directive and Handbook 0055, published in July 2003. VA has considerable experience in negotiating energy savings performance contracts and using other financing vehicles for private sector financing of energy improvements. If considering these funding options to improve energy and water efficiency, please contact CJ Cordova in VA's Office of Asset Enterprise Management for assistance ([cynthia.cordova@va.gov](mailto:cynthia.cordova@va.gov)).



Department of  
Veterans Affairs

## **5. Appendix A: Cost Implications by LEED Credit**

**5.1 SUSTAINABLE SITES**

**5.2 WATER EFFICIENCY**

**5.3 ENERGY AND ATMOSPHERE**

**5.4 MATERIALS AND RESOURCES**

**5.5 INDOOR ENVIRONMENTAL QUALITY**





## 5. Appendix A: Cost Implications by LEED Credit

This section supplements information found in Section 2, *Mapping the Federal Mandates to LEED*. In this section, each LEED credit is reviewed individually and the overall likely cost effect is documented for the following categories: construction cost, design and construction management cost, and documentation cost. The section is organized by LEED-NC requirements with tracking to appropriate LEED-CI credits.

### 5.1 SUSTAINABLE SITES

LEED-CI credits for Sustainable Sites are similar in requirements to the LEED-NC credits, but points are structured differently, and awarded in a different manner. Because of this, LEED-NC and LEED-CI Sustainable sites are addressed separately.

#### LEED-NC

- **SS Prerequisite 1: Construction Activity Pollution Prevention**

LEED-NC

*Create and implement an Erosion and Sedimentation Control (ESC) Plan for all construction activities associated with the project. The ESC Plan shall conform to the erosion and sedimentation requirements of the 2003 EPA Construction General Permit OR local erosion and sedimentation control standards and codes, whichever is more stringent.*

In order to comply, it is necessary to develop a compliant site sedimentation and erosion control plan. These plans are mandatory in many parts of the country. Compliance with this credit is generally within customary practices for design and construction teams.

In most cases, this credit has no construction or design and construction management cost impact. The standards and technologies required for this point are standard to most projects; if not, they are achieved at minimal added cost. The credit can generate a very small reduction in overall construction costs by reducing cleanup and corrective action which would otherwise arise following significant storm events.

Overall Likely Cost Effect: SS Prerequisite 1	
Construction Cost	None
Design and Construction Management Cost	None
Documentation	None

- **SS 1: Site Selection**

LEED-NC

*Do not develop buildings, hardscape, roads or parking areas on portions of sites that meet any one of the following criteria:*

- *Prime farmland as defined by the United States Department of Agriculture in the United States Code of Federal Regulations, Title 7, Volume 6, Parts 400 to 699, Section 657.5 (citation 7CFR657.5)*

- *Previously undeveloped land whose elevation is lower than 5 feet above the elevation of the 100-year flood as defined by FEMA (Federal Emergency Management Agency)*
- *Land that is specifically identified as habitat for any species on Federal or State threatened or endangered lists*
- *Within 100 feet of any wetlands as defined by United States Code of Federal Regulations 40 CFR, Parts 230-233 and Part 22, and isolated wetlands or areas of special concern identified by state or local rule, OR within setback distances from wetlands prescribed in state or local regulations, as defined by local or state rule or law, whichever is more stringent*
- *Previously undeveloped land that is within 50 feet of a water body, defined as seas, lakes, rivers, streams and tributaries which support or could support fish, recreation or industrial use, consistent with the terminology of the Clean Water Act*
- *Land which prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner (Park Authority projects are exempt)*

Most healthcare site selection is driven by a wide range of factors, and appropriateness of the site is usually a result of, not a driver of the site selection. Because of this, the credit is usually suited to urban projects where the site happens to comply, and not to rural/suburban projects where the requirements are more likely to be violated.

There are typically no construction or design and construction management costs associated with the credit, since there is no mitigation other than avoiding non-compliant sites. However, choice of location can affect feasibility and cost of sustainable design measures, and thus overall project costs. Rural sites are more likely to be noncompliant with this credit, and possible increased construction costs in such cases would be related to land value where appropriate sites are available at an added cost.

Overall Likely Cost Effect: SS 1	
Construction Cost	
Urban	None
Rural	<0.1%
Design and Construction Management Cost	None
Documentation	<40 hrs

## ▪ **SS 2: Development Density and Community Connectivity**

### LEED-NC

#### OPTION 1 — DEVELOPMENT DENSITY

*Construct or renovate building on a previously developed site AND in a community with a minimum density of 60,000 square feet per acre net (Note: density calculation must include the area of the project being built and is based on a typical two-story downtown development).*

#### OPTION 2 — COMMUNITY CONNECTIVITY

*Construct or renovate building on a previously developed site AND within 1/2 mile of a residential zone or neighborhood with an average density of 10 units per acre net AND within 1/2 mile of at least 10 Basic Services AND with pedestrian access between the building and the services.*

As with SS 1, this credit is usually a result of, rather than a driver of site selection, and credit compliance is a consequence of other factors. As a result the credit is usually suited to urban projects where the site happens to comply, and not to rural/suburban projects.

Overall Likely Cost Effect: SS 2	
Construction Cost	None
Design and Construction Management Cost	None
Documentation	<40 hrs

■ **SS 3: Brownfield Redevelopment**

LEED-NC

*Develop on a site documented as contaminated (by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local Voluntary Cleanup Program) OR on a site defined as a brownfield by a local, state or federal government agency.*

This credit is usually a result of, rather than a driver of site selection, and credit compliance is a consequence of other factors.

There are a variety of strategies for mitigating soils contamination, including encapsulation, remediation, etc. These can lead to a variety of costs, depending on the strategies selected or required (such as hazardous materials removal or encapsulation during demolition or renovation, removal or encapsulation of contaminated soils, and/or remediation of contaminated soils using chemical additives).

While the cost of this credit can be substantial, it is rarely a significant factor in site selection for healthcare projects. A brownfield site may be selected for other reasons, such as property availability, transit connections, etc. Costs to mitigate hazardous materials in an existing building (demolition or renovation) would typically be incurred regardless of sustainable design goals.

The cost of basic remediation of a brownfield site can range from \$50,000/acre to as much as \$2 million/acre, although the typical range is \$300,000 to \$500,000. For development densities of 80,000 SF to 120,000 SF/acre, this amounts to \$3.00 to \$6.00/SF of building area. There will also be additional design and construction management cost for design, testing and monitoring.

Overall Likely Cost Effect: SS 3	
Construction Cost	0.1% to 0.25%
Design and Construction Management Cost	1% to 2.5%
Documentation	40 to 120 hrs

■ **SS 4-1: Alternative Transportation - Public Transportation Access**

LEED-NC

*Locate project within 1/2 mile of an existing, or planned and funded, commuter rail, light rail or subway station.*

OR

*Locate project within 1/4 mile of one or more stops for two or more public or campus bus lines usable by building occupants.*

This credit is usually a result of, rather than a driver of site selection, and credit compliance is a consequence of other factors. Because of this, the credit is usually suited to urban projects where the site happens to comply.

If the site is not close to public transportation, it may be possible to work with transit providers to bring bus lines to the site. The project can also provide shuttle buses to transport staff and patients from the project site to bus or train stops to meet the credit requirements. This is more likely to be a concern for rural sites. In many cases this credit is simply not achievable in such settings.

Alternative transportation measures can reduce the amount of parking needed, and therefore reduce project costs. These strategies also allow healthcare access to persons without private transportation, thus providing social equity and sustainability.

In practice, this credit typically has no construction or design and construction management cost implications.

Overall Likely Cost Effect: SS 4-1	
Construction Cost	
Urban	Savings/None
Rural	Not Available
Design and Construction Management Cost	None
Documentation	<40 hrs

#### ■ SS 4-2: Alternative Transportation - Bicycle Storage and Changing Rooms

##### LEED-NC

*For commercial or institutional buildings, provide secure bicycle racks and/or storage (within 200 yards of a building entrance) for 5 percent or more of all building users (measured at peak periods), AND, provide shower and changing facilities in the building, or within 200 yards of a building entrance, for 0.5 percent of Full-Time Equivalent (FTE) occupants.*

OR

*For residential buildings, provide covered storage facilities for securing bicycles for 15 percent or more of building occupants in lieu of changing/shower facilities.*

This is a relatively inexpensive credit with low design impact and simply requires the installation of adequate bicycle racks.

In practice, this credit typically has no construction or design and construction management cost implications. Most healthcare facilities have adequate shower facilities for staff, which can also be made available for bicycle users. The number of racks and showers is usually quite small, typically in the range of eight to 12 racks and one to two showers even for large full-service hospitals.

Encouragement of the staff to use bicycles and other alternate transportations may alleviate the need for parking spaces and actually save money.

Overall Likely Cost Effect: SS 4-2	
Construction Cost	0% to <0.1%
Design and Construction Management Cost	None
Documentation	<40 hrs

■ **SS 4-3: Alternative Transportation - Low-Emitting and Fuel-Efficient Vehicles**

LEED-NC

OPTION 1

*Provide low-emitting and fuel-efficient vehicles for 3 percent of Full-Time Equivalent (FTE) occupants AND provide preferred parking for these vehicles.*

OPTION 2

*Provide preferred parking for low-emitting and fuel-efficient vehicles for 5 percent of the total vehicle parking capacity of the site.*

OPTION 3

*Install alternative-fuel refueling stations for 3 percent of the total vehicle parking capacity of the site (liquid or gaseous fueling facilities must be separately ventilated or located outdoors).*

This credit is typically achieved in the least costly manner – that is, by providing preferred parking for hybrid and alternatively fueled vehicles. In practice, provision of preferred parking for fuel efficient vehicles is unlikely to be acceptable to many projects since parking is generally highly constrained and any limitation or allocation is undesirable.

Electric refueling locations can be added almost any time during design and construction. This point could also be awarded if the owner provides a fleet of alternatively fueled vehicles, but typically few facilities take this route.

This credit typically has very minor construction and design and construction management cost implications, but the very high parking requirements associated with most healthcare facilities makes it impractical in most cases. This is driven more by impact on parking rather than cost.

Overall Likely Cost Effect: SS 4-3	
Construction Cost	<0.1%
Design and Construction Management Cost	Minor
Documentation	<40 hrs

■ **SS 4-4: Alternative Transportation - Parking Capacity**

LEED-NC

OPTION 1 — NON-RESIDENTIAL

*Size parking capacity to meet, but not exceed, minimum local zoning requirements, AND, provide preferred parking for carpools or vanpools for 5 percent of the total provided parking spaces.*

OPTION 2 — NON-RESIDENTIAL

*For projects that provide parking for less than 5 percent of FTE building occupants: • Provide preferred parking for carpools or vanpools, marked as such, for 5 percent of total provided parking spaces.*

OPTION 3 — RESIDENTIAL

*Size parking capacity to not exceed minimum local zoning requirements, AND, provide infrastructure and support programs to facilitate shared vehicle usage such as carpool drop-off areas, designated parking for vanpools, or car-share services, ride boards, and shuttle services to mass transit.*

OPTION 4 — ALL

*Provide no new parking.*

As with SS 4-3, this credit is not difficult to achieve, but compliance may be unacceptable in most VA facilities due to the restriction on available parking for users. Where sites are highly constrained and parking limited by available space, the credit may be met simply as a result of the program limitations. Also, in many projects parking is constrained to such a degree that it would not be possible to exceed local zoning requirements.

In practice, this credit can be difficult to achieve because of the preference for more, not less parking.

This credit can actually reduce construction and design and construction management costs by reducing overall parking and vehicular circulation area.

Overall Likely Cost Effect: SS 4-4	
Construction Cost	Savings/None
Design and Construction Management Cost	None
Documentation	<40 hrs

## ■ SS 5-1: Reduced Site Disturbance - Protect or Restore Habitat

### LEED-NC

#### OPTION 1

*On greenfield sites, limit all site disturbance to 40 feet beyond the building perimeter; 10 feet beyond surface walkways, patios, surface parking and utilities less than 12 inches in diameter; 15 feet beyond primary roadway curbs and main utility branch trenches; and 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities and playing fields) that require additional staging areas in order to limit compaction in the constructed area.*

#### OPTION 2

*On previously developed or graded sites, restore or protect a minimum of 50 percent of the site area (excluding the building footprint) with native or adapted vegetation. Native/adapted plants are plants indigenous to a locality or cultivars of native plants that are adapted to the local climate and are not considered invasive species or noxious weeds. Projects earning SS Credit 2 and using vegetated roof surfaces may apply the vegetated roof surface to this calculation if the plants meet the definition of native/adapted.*

This credit can be very challenging to achieve because of limitations in the site area which make it difficult to find the required site area for restoration. This is particularly true for dense urban healthcare campuses.

For greenfield sites, the main strategies relate to managing the construction and ensuring that construction activities are kept within the limitations specified in the requirement. While this is a construction management issue, it is essential that the design team understand the constraints, and that these are detailed within the construction bid documents.

Credit requirements can be difficult if not impossible to achieve at greenfield sites with excavation below grade of more than one story.

For previously developed sites, the main strategies relate to designing appropriate site restoration. For sites with large impervious areas, such as surface parking lots, strategies can include construction of parking structures to allow for conversion of paved areas into landscaped areas, and replacement of impervious paved areas with pervious paving. Green roofs at parking structures and buildings can contribute to this point.

Many of the strategies for achieving this credit can be combined with other credits. For example, landscaped areas can be designed to provide natural habitat, to manage and filter stormwater, to facilitate both heat island credits, and to create healing gardens for places of respite. In many jurisdictions, strict stormwater mandates can be cost-effectively met using native landscape. Where strategies and credits can be integrated, costs can be greatly minimized.

This credit can have significant construction costs, either in the provision of pervious parking or in the cost of restoration of native planting areas. There are usually relatively small design and construction management cost implications. If measures can be used that allow achievement of several sustainable design goals at once, costs can be controlled.

Overall Likely Cost Effect: SS 5-1	
Construction Cost	
Urban	>0.25%
Rural	0.1% to 0.25%
Design and Construction Management Cost	<1%
Documentation	<40 hrs

#### ■ SS 5-2: Reduced Site Disturbance - Maximize Open Space

##### LEED-NC

##### OPTION 1

*Reduce the development footprint (defined as the total area of the building footprint, hardscape, access roads and parking) and/or provide vegetated open space within the project boundary to exceed the local zoning's open space requirement for the site by 25 percent.*

##### OPTION 2

*For areas with no local zoning requirements (e.g., some university campuses, military bases), provide vegetated open space area adjacent to the building that is equal to the building footprint.*

##### OPTION 3

*Where a zoning ordinance exists, but there is no requirement for open space (zero), provide vegetated open space equal to 20 percent of the project's site area.*

The main strategy for meeting this credit is to increase the density of construction by building more stories, as opposed to spreading development over the site. For a primary health care facility, number of stories and footprint area are usually defined by program, and it is often not possible or practical to increase the density in order to meet this credit. For secondary facilities, such as vehicular parking, it is possible to build structured parking as opposed to surface parking lots. This can have a significant impact on the developed footprint.

The credit is easier to achieve in rural sites, where there may be sufficient site area to allow for setting aside adequate open space.

Overall Likely Cost Effect: SS 5-2	
Construction Cost	
Urban	>0.25%
Rural	0.1% to 0.25%
Design and Construction Management Cost	<1%
Documentation	<40 hrs

■ **SS 6-1: Stormwater Management - Quantity Control**

LEED-NC

**CASE 1 — EXISTING IMPERVIOUSNESS IS LESS THAN OR EQUAL TO 50 PERCENT**

*Implement a stormwater management plan that prevents the post-development peak discharge rate and quantity from exceeding the pre-development peak discharge rate and quantity for the one- and two-year 24-hour design storms.*

OR

*Implement a stormwater management plan that protects receiving stream channels from excessive erosion by implementing a stream channel protection strategy and quantity control strategies.*

**CASE 2 — EXISTING IMPERVIOUSNESS IS GREATER THAN 50 PERCENT**

*Implement a stormwater management plan that results in a 25 percent decrease in the volume of stormwater runoff from the two-year 24-hour design storm.*

Stormwater can be detained on site prior to release to the stormwater system. Detention can involve dissipating the flow through swales, or holding the water in detention ponds, surge chambers or tanks. Water can also be retained on site for other uses, or for infiltration into the ground. Retention can involve holding the water in ponds, surge chambers or tanks, or the use of landscaped areas or permeable paving for infiltration. Detention ponds or tanks are usually smaller than retention ponds or tanks, since they typically need to hold water for shorter periods.

Site size plays a significant role in whether or not the stormwater related points result in additional cost. Swales tend to have a minimal cost impact; retention or detention ponds are more expensive, and installation of stormwater collection tanks can be very costly. Projects on large sites tend to install swales or ponds, while buildings on limited sites (usually urban) use collection tanks and filters to meet the requirements.

Increasingly, stormwater management is required by local jurisdictions, in which case there is no added cost for achieving this credit. In some cases, the project may be required to foot the bill to increase capacity of the local infrastructure; in such cases on site measures may be more cost-effective.

Local weather patterns will impact cost; frequency and amount of rainfall will determine the scale of both landscape and tank interventions. Soil conditions also can affect cost; sites with clay soils, high water tables or bedrock will not be able to use the swale and surface infiltration approaches.

In practice, many healthcare projects do not have sufficient site area to develop the less costly solutions to this credit, and as a result, the credit can be very challenging or expensive to achieve.

Overall Likely Cost Effect: SS 6-1	
Construction Cost	
Urban	>0.25%
Rural	0.1% to 0.25%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

## ■ SS 6-2: Stormwater Management - Quality Control

### LEED-NC

*Implement a stormwater management plan that reduces impervious cover, promotes infiltration, and captures and treats the stormwater runoff from 90 percent of the average annual rainfall<sup>1</sup> using acceptable best management practices (BMPs).*

*BMPs used to treat runoff must be capable of removing 80 percent of the average annual post development total suspended solids (TSS) load based on existing monitoring reports.*

The strategies for meeting this credit depend greatly on the extent of site area available for stormwater management. In sites with large landscaped areas, it is possible to provide treatment through the use of landscape elements such as vegetated swales and retention ponds to infiltrate water. Where site conditions do not allow use of landscaping to meet this credit, it is necessary to provide filtration tanks and oil separators at inlets. On very constrained sites, it may be necessary to capture rainwater in tanks and reuse it for irrigation and/or cooling towers.

An additional element is the development of a landscape management plan, aimed at reducing the total phosphorus load entering the stormwater system. This management plan includes both selection of appropriate landscaping and planting, and long-term fertilizer management by the facility.

In practice, most healthcare projects do not have sufficient site area to develop the less costly solutions to this credit, and as a result, the credit can be very challenging or expensive to achieve. However, many jurisdictions require the filtration of stormwater before it enters the municipal system; in such cases the cost is included in the base design, not added. An integrated design that uses landscape and other design elements to help meet credit requirements will reduce construction and operations costs.

Overall Likely Cost Effect: SS 6-2	
Construction Cost	
Urban	>0.25%
Rural	0.1% to 0.25%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

## ■ SS 7-1: Heat Island Effect - Non-Roof

### LEED-NC

#### OPTION 1

*Provide any combination of the following strategies for 50 percent of the site hardscape (including roads, sidewalks, courtyards and parking lots):*

- *Shade (within 5 years of occupancy)*
- *Paving materials with a Solar Reflectance Index (SRI)<sup>2</sup> of at least 29*
- *Open grid pavement system*

#### OPTION 2

*Place a minimum of 50 percent of parking spaces under cover (defined as under ground, under deck, under roof, or under a building). Any roof used to shade or cover parking must have an SRI of at least 29.*

This credit is most often achieved by changing the color of concrete paving and adding shade elements at relatively low cost. Where surface parking is provided, this credit can be

achieved at minimal or no added cost by using white asphalt or by providing open grid paving or gravel at parking stalls, leaving only the aisles asphalt.

By providing a parking structure, the site area can be freed for use in landscaping, which will help achieve other LEED or GGHC credits including stormwater management and filtration, open space and natural habitat, and places of respite.

In practice, this credit typically has very minor construction and design and construction management cost implications, since the most economical way in which to achieve this credit is to provide shade trees in parking areas, or to provide structured parking. Both of these strategies are common design elements of healthcare facilities regardless of this credit.

Overall Likely Cost Effect: SS 7-1	
Construction Cost	
Shading	<0.1%
Structured parking	>0.25%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

#### ■ SS 7-2: Heat Island Effect - Roof

##### LEED-NC OPTION 1

*Use roofing materials having a Solar Reflectance Index (SRI) equal to or greater than 78 for a low sloped or 29 for a high sloped roof for a minimum of 75 percent of the roof surface.*

##### OPTION 2

*Install a vegetated roof for at least 50 percent of the roof area.*

##### OPTION 3

*Install high albedo and vegetated roof surfaces that, in combination, meet the criteria*

The typical approach to this credit is to use a high emissivity roof. While costs for these are usually more than conventional black roofs, the overall impact on the cost of a healthcare facility is usually relatively low, since roofs make up a very small part of the total project cost.

Some hospital projects have used a green roof to achieve this credit. The added cost is significant, but green roofs can facilitate achievement of LEED or GGHC credits for places of respite, stormwater management and filtration, open space, and natural habitat, as well as contributing to energy efficiency. Few healthcare projects have attempted to achieve this point via a green roof, although the use of green roofs is increasing as designers and owners become more familiar with them and as the value of green roofs as places of respite or for views are more widely accepted.

Overall Likely Cost Effect: SS 7-2	
Construction Cost	
High Emissivity Roof	<0.1%
Green Roof	0.1% to 0.25%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

## ■ SS 8: Light Pollution Reduction

### LEED-NC

#### FOR INTERIOR LIGHTING

*The angle of maximum candela from each interior luminaire as located in the building shall intersect opaque building interior surfaces and not exit out through the windows.*

OR

*All non-emergency interior lighting shall be automatically controlled to turn off during non-business hours. Provide manual override capability for after hours use.*

AND

#### FOR EXTERIOR LIGHTING

*Only light areas as required for safety and comfort. Do not exceed 80 percent of the lighting power densities for exterior areas and 50 percent for building facades and landscape features as defined in ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting Section, without amendments.*

*All projects shall be classified under zones, as defined in IESNA RP-33, and shall follow all of the requirements for that specific zone*

The primary strategy for this credit involves careful site lighting design and fixture selection. Many projects attempt this credit, but not all achieve it. Clients and code officials often perceive this point to be at odds with security requirements. In order to be successful with this credit, it is important to include site lighting in the earliest stages of site planning and to include security and site safety in the considerations of the design.

Specific strategies include:

- Selecting energy efficient lighting fixtures and lamps
- Avoiding uplighting of buildings and trees
- Using bollard fixtures and cut-off fixtures
- Using lower light levels and closer spacing between fixtures
- Identifying high-use paths and concentrating lighting in those areas, while minimizing lighting in less traveled areas
- Designing interior lighting to cast direct beams only internally

Where the credit is attempted, the credit typically has very low cost impact, both for construction and design and construction management costs.

Overall Likely Cost Effect: SS 8	
Construction Cost	None to <0.1%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

### LEED-CI

LEED-CI credits for Sustainable Sites closely mirror the LEED-NC credits, but points are awarded in a different manner. LEED-CI awards three points for locating in a LEED certified building, alternatively, projects can achieve up to three points, in half point increments by locating in a building which meets specific LEED-NC criteria. A further four points are available for Development Density and Alternative Transportation Strategies.

Most of the cost impact of achieving LEED-CI Sustainable Sites credits will be in the rent, as opposed to direct construction cost, since most relate to building selection rather than the design and construction of Tenant Improvements.

■ **SS 1: Site Selection**

LEED-CI

Select a LEED Certified Building (3 points), or locate the tenant space in a building that has two or more of the following characteristics:

- Brownfield Redevelopment (Corresponds to LEED NC SS3)*
- Stormwater Management: Rate and Quantity (Corresponds to LEED NC SS6.1)*
- Stormwater Management: Treatment (Corresponds to LEED NC SS6.2)*
- Heat Island Reduction, Non-Roof (Corresponds to LEED NC SS7.1)*
- Heat Island reduction, Roof (Corresponds to LEED NC SS7.2)*
- Light Pollution Reduction (Corresponds to LEED NC SS8)*
- Water Efficient Irrigation (Reduce by 50%) (Corresponds to LEED NC WE1.1)*
- Water Efficient Irrigation (No potable use or no irrigation) (Corresponds to LEED NC WE1.2)*
- Innovative Wastewater Technologies (Corresponds to LEED NC WE2)*
- Water Use Reduction (20% reduction) (Corresponds to LEED NC WE3.1)*
- On-Site Renewable Energy (Corresponds to LEED NC EA2)*
- Other Quantifiable Environmental Performance*

In most cases building selection is driven by a wide range of factors, including availability and cost of the space. Sustainable performance of a core/shell is usually a result of, not a driver of the selection. As such, achievement of these credits is usually not a cost factor. As more LEED certified Core/Shell projects become available, it is possible that there will be a small, but marked, lease rate premium associated with the higher performance that such buildings offer.

Overall Likely Cost Effect: SS 1	
Construction Cost	None
Design and Construction Management Cost	None
Documentation	<40 hrs

■ **SS 2: Development Density and Community Connectivity**

LEED-CI

Select space in a building that is located in an established, walkable community with a minimum density of 60,000 square feet per acre net

OR

Select space in a building that is located within ½ mile of a residential zone or neighborhood (with an average density of 10 units per acre net)

AND

The building has pedestrian access to at least 10 of the basic services below within ½ mile:  
 Bank; Place of Worship; Convenience Grocery; Day Care; Cleaners; Fire Station; Hair Care; Hardware; Laundry; Library; Medical/Dental; Senior Care Facility; Park; Pharmacy; Post Office; restaurant; School; Supermarket; Commercial Office; Community Center

As with SS 1, this credit is usually a result of, rather than a driver of site selection, and credit compliance is a consequence of other factors. Sustainable performance of a core/shell is usually a result of, not a driver of the selection. As such, achievement of these credits is usually not a cost factor. As more LEED certified Core/Shell projects become available, it is possible that there will be a small, but marked, lease rate premium associated with the higher performance that such buildings offer.

Overall Likely Cost Effect: SS 2	
Construction Cost	None
Design and Construction Management Cost	None
Documentation	<40 hrs

■ **SS 3-1: Alternative Transportation - Public Transportation Access**

LEED-CI

*Select building within 1/2 mile of a commuter rail, light rail or subway station or 1/4 mile of one or more stops for two or more public or campus bus lines usable by building occupants.*

This credit is usually a result of, rather than a driver of site selection, and credit compliance is a consequence of other factors. Because of this, the credit is usually suited to urban projects, where the site happens to comply.

Overall Likely Cost Effect: SS 3.1	
Construction Cost	None
Design and Construction Management Cost	None
Documentation	<40 hrs

■ **SS 3-2: Alternative Transportation - Bicycle Storage and Changing Rooms**

LEED-CI

*Provide secure bicycle storage with convenient changing/shower facilities (within 200 yards of the building) for 5 percent or more of tenant occupants*

This can be a challenging credit for TI projects, particularly for small leased spaces, unless the selected building already complies. Simply finding space for bicycle storage and showers can be difficult, and the cost of adding shower facilities within a tenant space can be prohibitive. The most economical way to comply with this credit is to select a building which already meets the criteria

Encouragement of the staff to use bicycles and other alternate transportations may alleviate the need for parking spaces and actually save money.

Overall Likely Cost Effect: SS 4-2	
Construction Cost	
Provided by Core/Shell	None
Not provided by Core/Shell	>0.25%
Design and Construction Management Cost	None
Documentation	<40 hrs

■ **SS 3-3: Alternative Transportation - Parking Capacity**

LEED-CI

*For projects occupying less than 75% of gross building square footage*

*Parking spaces provided to tenant shall not exceed minimum number required by local zoning regulations*

AND

*Priority parking for carpools or vanpools will be provided for 5% or more of tenant occupants*

OR

*No parking will be provided or subsidized for tenant occupants*

*For projects occupying 75% or over of Gross building Square Footage:*

*Parking capacity shall not exceed minimum local zoning requirements*

AND

*Priority parking for carpools or vanpools will be provided capable of serving 5% or the building occupants*

OR

*No new parking will be added for rehabilitation projects*

AND

*Preferred parking for carpools or vanpools will be provided capable of serving 5% or the building occupants*

This credit is not difficult to achieve, but compliance may be unacceptable in most VA facilities due to the restriction on available parking for users. Where sites are highly constrained and parking limited by available space, the credit may be met simply as a result of the program limitations. Also, in many projects parking is constrained to such a degree that it would not be possible to exceed local zoning requirements.

In practice, this credit can be difficult to achieve because of the preference for more, not less parking.

This credit can actually reduce construction and design and construction management costs by reducing overall parking and vehicular circulation area.

Overall Likely Cost Effect: SS 4-4	
Construction Cost	Savings/None
Design and Construction Management Cost	None
Documentation	<40 hrs

## 5.2 WATER EFFICIENCY

LEED-CI credits for Water Efficiency are limited to the reduction of water use. Reductions in the use of potable water for irrigation and Innovative Wastewater strategies can contribute to Credit SS 1, Site Selection. The Water Use Reduction credits are identical to the LEED-NC credits, but are numbered differently.

■ **WE 1-1: Water Efficient Landscaping - Reduce by 50 Percent**

LEED-NC

*Reduce potable water consumption for irrigation by 50 percent from a calculated mid-summer baseline case.*

LEED-CI

No corresponding credit.

■ **WE 1-2: Water Efficient Landscaping - No Potable Use or No Irrigation**

LEED-NC

Achieve WE Credit 1.1.and:

*Use only captured rainwater, recycled wastewater, recycled greywater, or water treated and conveyed by a public agency specifically for non-potable uses for irrigation.*

OR

*Install landscaping that does not require permanent irrigation systems. Temporary irrigation systems used for plant establishment are allowed only if removed within one year of installation.*

LEED-CI

No corresponding credit.

There are two main strategies for meeting these credits: the first is to use planting that requires less irrigation and potable water primarily by reducing the extent of grass and by increasing the use of native, and/or drought tolerant plants; the second is to use more efficient irrigation methods or reclaimed water for irrigation. Often elements of both strategies are combined to achieve this credit. There can be a sanitation issue with using reclaimed, grey, or rainwater for irrigation in healthcare settings. Some projects address such concerns by ensuring that the untreated irrigation water is never touchable by humans; this is done by using below-ground irrigation, such as drip irrigation systems.

Specific actions include:

- Providing native, and/or drought tolerant plants
- Avoiding the use of turf grass
- Using high efficiency irrigation methods such as drip irrigation or automated controls with moisture sensors
- Using municipally provided reclaimed water for irrigation
- Capturing site rainwater to reuse for irrigation
- Using cooling tower waste water for irrigation (only possible with non-chemical cooling tower treatments systems)

Installing hose bibs on the outside of each side of the building is usually necessary for maintenance purposes. However, the hose bibs can also be used for temporary irrigation purposes for establishment of plants as well.

In practice, these credits typically have very small construction and design and construction management cost implications. If no permanent irrigation system is installed, costs can actually be reduced. WE 1-1 is usually accomplished by the use of drought tolerant planting and efficient irrigation.

Where municipally provided reclaimed water is used, the cost is limited to the cost of connecting to the reclaimed water system, and of providing filtration if needed. In many areas where reclaimed water is municipally provided, it is mandatory to use it for irrigation; in such cases there is no added cost.

The most expensive strategies involve rainwater storage. The costs for water storage are significant, since large volumes are required for irrigation, particularly in climates with long dry seasons.

If cooling tower waste water is to be used for irrigation, storage tanks can be minimal in size, since cooling towers are likely to be running year round and will provide a consistent supply of water. Costs associated will be for collection, storage, and minimal filtration.

While potable water costs are currently quite low, it is extremely likely that costs will rise dramatically in the near future. Minor design changes now could save major costs later.

Overall Likely Cost Effect: WE 1-1, 1-2	
Construction Cost	
Xeriscape/no irrigation	Savings/None
Water storage / harvesting, cooling tower water	>0.25%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

## ■ WE 2: Innovative Wastewater Technologies

### LEED-NC

#### OPTION 1

*Reduce potable water use for building sewage conveyance by 50 percent through the use of water conserving fixtures (water closets, urinals) or non-potable water (captured rainwater, recycled greywater, and on-site or municipally treated wastewater).*

#### OPTION 2

*Treat 50 percent of wastewater on-site to tertiary standards. Treated water must be infiltrated or used on-site.*

### LEED-CI

*No corresponding credit.*

Low-flow and waterless flush fixtures are typically available at no added cost. Reclaimed water, grey water, and rainwater systems (which would typically include cisterns and filtration systems) all require the provision of additional supply. There would be minor increases in design and inspection costs, and moderate documentation costs associated with the necessary calculations and demonstration of compliance. On-site wastewater treatment adds significantly to the cost of a facility.

In practice, this credit is rarely achievable in acute care and long-term care facilities due to concerns about infection control and other operational considerations, both with low-flow fixtures and with non-potable water systems.

Overall Likely Cost Effect: WE 2	
Construction Cost	
Dual flush valves or low-flow fixtures	None
Reclaimed Water	0.1% to 0.25%
Gray Water	0.1% to 0.25%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

### ■ WE 3-1: Water Use Reduction – 20 Percent Reduction

#### LEED-NC

*Employ strategies that in aggregate use 20 percent 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. Calculations are based on estimated occupant usage and shall include only the following fixtures (as applicable to the building): water closets, urinals, lavatory faucets, showers and kitchen sinks.*

#### LEED-CI

*This credit is CI Credit WE 1-1. The credit requirements are identical*

### ■ WE 3-2: Water Use Reduction – 30 Percent Reduction

#### LEED-NC

*Employ strategies that in aggregate use 30 percent 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. Calculations are based on estimated occupant usage and shall include only the following fixtures (as applicable to the building): water closets, urinals, lavatory faucets, showers and kitchen sinks.*

#### LEED-CI

*This credit is CI Credit WE 1-2. The credit requirements are identical*

This credit is typically approached first by reducing the flow rates of lavatories and showers. There is often a perceived connection between reduced flow rates and compromised sanitary conditions, but reduced flow rate fixtures are steadily becoming more common. Such measures are usually enough to ensure achievement of the first point associated with this credit.

Additional savings can be achieved by reducing the rate of water use in flush fixtures. It seems likely that, given the concerns about infection control, the most that many projects will be willing to consider is the use of dual flush valves at toilets and 0.5 gallon flush urinals. Both products are widely available and cost competitive. Use of low-flush fixtures may make the second point of this credit available.

In practice, this credit is rarely attempted in health care settings due to concerns about infection control and other operational considerations. It is, however, achievable at relatively low cost and without negative health implications. Low-flow and conventional flow fixtures are equivalent in terms of cost both for materials and installation.

For LEED-CI projects, the fixture count is typically very low, particularly for small TI projects where most plumbing is provided in the Core/Shell portion of the work, and the only fixtures are sinks or dishwashers. In this case, it is still possible to achieve the credits, but it will usually require the use of low flow fixtures and motion sensor faucets. If the CI project does not include any plumbing fixtures, these credits can not be used.

Overall Likely Cost Effect: WE 3-1, 3-2	
Construction Cost	
WE 3-1 (20% Red.)	<0.1%
WE 3-2 (30% Red.)	0.1% to 0.25%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

## 5.3 ENERGY AND ATMOSPHERE

Some of the LEED-CI credits for Energy and Atmosphere are similar to LEED-NC credits, but several, particularly the credits related to Optimization of Energy Performance (EA 1) are substantially different.

### ■ EA Prerequisite 1: Fundamental Commissioning of the Building Energy Systems

#### LEED-NC

*The following commissioning process activities shall be completed by the commissioning team, in accordance with the LEED-NC 2.2 Reference Guide.*

- 1) Designate an individual as the Commissioning Authority (CxA) to lead, review and oversee the completion of the commissioning process activities.*
- 2) The Owner shall document the Owner's Project Requirements (OPR). The design team shall develop the Basis of Design (BOD). The CxA shall review these documents for clarity and completeness. The Owner and design team shall be responsible for updates to their respective documents.*
- 3) Develop and incorporate commissioning requirements into the construction documents.*
- 4) Develop and implement a commissioning plan.*
- 5) Verify the installation and performance of the systems to be commissioned.*
- 6) Complete a summary commissioning report*

#### LEED-CI

*This credit is CI Prerequisite 1. The credit requirements are identical*

This credit has construction and design and construction management cost implications, although many healthcare facilities do undertake basic commissioning regardless of this credit. Usually commissioning is viewed as a design and construction management cost, and so the primary cost impact shows up in that category. There are, however, some additional construction costs related to commissioning arising from the additional work required of the contractor to support the commissioning process and the corrective work required as a result of the commissioning. Basic commissioning typically costs in the range of \$0.50 - \$1.00/SF.

This credit can provide significant benefits, both in the short and long term. The greatest benefits are achieved with the use of Additional Commissioning (GGHC and LEED EA 3), but even the basic conditioning under this prerequisite can provide significant benefits.

In the short term, commissioning can help the project team develop an efficient design, and in conjunction with design modeling, serve to reduce overall design and construction time. With the increasing use of 3-D modeling, significant time and cost savings are possible.

For CI projects, the cost impact of this prerequisite could be higher, proportionately, than for NC projects. The commissioning is not limited to work within the tenant space, but should extend to the systems serving the space. This means that the project could end up commissioning a much larger scope of plant and equipment, resulting in significantly higher commissioning costs, unless the building has already had commissioning as part of the Core/Shell project.

Overall Likely Cost Effect: EA Prerequisite 1	
Construction Cost	<0.1%
Design and Construction Management Cost	
NC	0.1% to 0.25%
CI	0.1% or greater
Documentation	<40 hrs

#### ■ EA Prerequisite 2: Minimum Energy Performance

##### LEED-NC

*Design the building project to comply with both—*

- *the mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4) of ASHRAE/IESNA Standard 90.1-2004 (without amendments); and*
- *the prescriptive requirements (Sections 5.5, 6.5, 7.5 and 9.5) or performance requirements (Section 11) of ASHRAE/IESNA Standard 90.1-2004 (without amendments).*

##### LEED-CI

*This credit is CI Prerequisite 2. The credit requirements are similar, but the scope of the requirement is limited to the tenant scope of work.*

The energy performance standards set by the prerequisite are not particularly difficult to meet, but will require some change in VA's existing practice and procedures. They should not, however, lead to significant increases in first cost. If the decision to pursue energy efficiency is made early in design, it should be possible to meet minimum requirements without adding cost. With an integrated design approach, savings may even be realized. If energy efficiency is not addressed early the costs can become significant.

For CI projects, achievement of this credit will be dependent, in many instances, on the primary systems provided by the Core/Shell portion of the project. The costs for compliance will be lowest if the Core/Shell systems already meet ASHRAE standards. For buildings that do not, the cost of compliance is likely to be prohibitive.

Overall Likely Cost Effect: EA Prerequisite 2	
Construction Cost	<0.1%
Design and Construction Management Cost	0.1% or greater
Documentation	<40 hrs

### ■ EA Prerequisite 3: Fundamental Refrigerant Management

#### LEED-NC

Zero use of CFC-based refrigerants in new base building HVAC&R systems. When reusing existing base building HVAC equipment, complete a comprehensive CFC phase-out conversion prior to project completion. Phase-out plans extending beyond the project completion date will be considered on their merits.

#### LEED-CI

This credit is CI Prerequisite 2. The credit requirements are similar, but the scope of the requirement is limited to systems within the tenant scope of work.

New facilities will automatically meet this prerequisite, unless an existing central plant uses CFC refrigerants. Equipment replacement can be costly and is typically undertaken only when that equipment has reached the end of its useful life. Since the prerequisite only requires the commitment to future replacement, there are no construction cost implications.

For CI projects, this should be achievable, since the credit is limited to systems within the tenant scope of work, and those should normally be CFC free.

Overall Likely Cost Effect: EA Prerequisite 3	
Construction Cost	None
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

### ■ EA 1: Optimize Energy Performance (1 to 10 points)

#### LEED-NC

##### OPTION 1 — WHOLE BUILDING ENERGY SIMULATION (1–10 Points)

Demonstrate a percentage improvement in the proposed building performance rating compared to the baseline building performance rating per ASHRAE/IESNA Standard 90.1-2004 (without amendments) by a whole building project simulation using the Building Performance Rating Method in Appendix G of the Standard.

##### OPTION 2 — PRESCRIPTIVE COMPLIANCE PATH (4 Points)

Comply with the prescriptive measures of the ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004. The following restrictions apply: Buildings must be under 20,000 square feet, Buildings must be office occupancy, and Project teams must fully comply with all applicable criteria as established in the Advanced Energy Design Guide for the climate zone in which the building is located

##### OPTION 3 — PRESCRIPTIVE COMPLIANCE PATH (1 Point)

Comply with the Basic Criteria and Prescriptive Measures of the Advanced Buildings Benchmark™ Version 1.1 with the exception of the following sections: 1.7 Monitoring and Trend-logging, 1.11 Indoor Air Quality, and 1.14 Networked Computer Monitor Control. The following restrictions apply: Project teams must fully comply with all applicable criteria as established in Advanced Buildings Benchmark for the climate zone in which the building is located.

#### LEED-CI

##### EA 1.1 Optimize Energy Performance – Lighting Power:

Reduce density to:

15% below the standard (1 point)

25% below the standard (1 point)

35% below the standard (1 point)

##### EA 1.2 Optimize Energy Performance – Lighting Controls

Install daylight responsive controls in all regularly occupied spaces within 15 feet of windows and under skylights

**EA 1.3 Optimize energy Performance - HVAC****Option A***Equipment Efficiency (1 point)**Appropriate Zoning and controls (1 point)***Option B***Demonstrate that HVAC system component performance is 15% better than ASHRAE 90.1-2004 (not Appendix G) (1 point)**Demonstrate that HVAC system component performance is 30% better than ASHRAE 90.1-2004 (not Appendix G) (2 points)***EA 1.4 Optimize energy Performance – Equipment and Appliances***70%, by rated power, of EnergyStar eligible equipment shall be EnergyStar rated (1 point)**90%, by rated power, of EnergyStar eligible equipment shall be EnergyStar rated (2 point)*

The cost for compliance with the different requirements will vary greatly depending on the type of building and the extent of the energy saving sought. For most VA facilities, achieving the mandated energy reductions of 30 percent better than ASHRAE 2004, Appendix G will not be economically feasible. The LEED-NC requirements are also likely to be challenging and expensive for acute care facilities. The LEED-CI requirements are less challenging and projects should be able to achieve reasonable credit compliance with little added cost.

Energy performance costs and strategies are discussed under Section 4.2 Energy Efficiency Strategies.

- **EA 2: Onsite Renewable Energy (1 to 3 points)**

LEED-NC

*Use on-site renewable energy systems to offset building energy cost. Calculate project performance by expressing the energy produced by the renewable systems as a percentage of the building annual energy cost.*

LEED-CI

*No corresponding credit.*

On-site generation of renewable energy has a substantial construction cost impact. Installation of these systems usually provides a long-term cost savings, although the life cycle cost payback is usually very long even with available credits and incentives. Incorporating renewable energy into design will earn the project at least one additional energy use reduction point.

This credit can be cost effective for cemetery projects, where power needs are typically fairly low, and the cost of providing grid-based power to remote buildings and shelters can be substantial. Many cemetery projects are beginning to incorporate PV panels into shelters.

Overall Likely Cost Effect: EA 2	
Construction Cost	>0.25%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

- **EA 3: Enhanced Commissioning**

LEED-NC

*Implement, or have a contract in place to implement, the following additional commissioning process activities in addition to the requirements of EA Prerequisite 1 and in accordance with the LEED-NC 2.2 Reference Guide:*

1. Prior to the start of the construction documents phase, designate an independent Commissioning Authority (CxA) to lead, review, and oversee the completion of all commissioning process activities.
2. The CxA shall conduct, at a minimum, one commissioning design review of the Owner's Project Requirements (OPR), Basis of Design (BOD), and design documents prior to mid-construction documents phase and back-check the review comments in the subsequent design submission.
3. The CxA shall review contractor submittals applicable to systems being commissioned for compliance with the OPR and BOD. This review shall be concurrent with A/E reviews and submitted to the design team and the Owner.
4. Develop a systems manual that provides future operating staff the information needed to understand and optimally operate the commissioned systems.
5. Verify that the requirements for training operating personnel and building occupants are completed.
6. Assure the involvement by the CxA in reviewing building operation within 10 months after substantial completion with O&M staff and occupants. Include a plan for resolution of outstanding commissioning-related issues.

LEED-CI

This credit is CI EA2. The credit requirements are similar.

This credit has construction and design and construction management cost implications. Usually commissioning is viewed as a design and construction management cost, and so the primary cost impact shows up in that category. There are, however, additional construction costs related to commissioning arising from the additional work required of the contractor to support the commissioning process and the corrective work required as a result of the commissioning. Additional commissioning typically costs in the range of \$1.00 - \$2.00/SF.

This credit can provide significant benefits, both in the short and long term. In the short term, it can help the project team develop an efficient design, and in conjunction with design modeling, serve to reduce overall design and construction time. With the increasing use of 3-D modeling, significant time and cost savings are possible. The short term benefit can be found to some degree with Basic Commissioning (LEED EA Prerequisite 1), but it is most achievable with the additional commissioning.

Overall Likely Cost Effect: EA 3	
Construction Cost	0.1% to 0.25%
Design and Construction Management Cost	>0.25%
Documentation	<40 hrs

■ **[EA 3: Energy Use, Measurement, and Payment Accountability]**

LEED-NC

No corresponding credit.

LEED-CI

Provide for the ongoing accountability and optimization of tenant energy and water consumption performance over time.

■ **EA 4: Enhanced Refrigerant Management**

LEED-NC  
OPTION 1

*Do not use refrigerants.*

#### OPTION 2

*Select refrigerants and HVAC&R that minimize or eliminate the emission of compounds that contribute to ozone depletion and global warming.*

#### LEED-CI

*No corresponding credit.*

This credit is becoming quite easy to achieve, as more and more manufacturers provide compliant equipment. Typically, this credit has minor construction cost implications if any, and minimal design and construction management cost and documentation requirements.

Overall Likely Cost Effect: EA 4	
Construction Cost	None to <0.1%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

### ■ EA 5: Measurement and Verification

#### LEED-NC

*Develop and implement a Measurement and Verification (M&V) Plan consistent with Option D: Calibrated Simulation (Savings Estimation Method 2), or Option B: Energy Conservation Measure Isolation, as specified in the International Performance Measurement and Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April, 2003.*

*The M&V period shall cover a period of no less than one year of post-construction occupancy.*

#### LEED-CI

*This credit is CI EA3. The credit requirements are similar to NC where the tenant space constitutes 75% or more of the total building area. Where the tenant space is less than 75% of the total building area, the requirements are:*

*Install sub-metering to the tenant space*

*Negotiate a lease where energy costs are paid by the tenant, and not included in the base rent.*

The cost of metering to the level required by this credit can be significant. Individual meters are relatively inexpensive, but to provide the quantity required and to provide a good quality reporting system, this can add \$2.00 to \$4.00/SF to the overall cost of the project. For some projects, the initial cost is sufficiently high that adoption of this credit is not considered. It is possible that EPA compliance will drive achievement of this credit.

The CI requirement for smaller leased spaces is not expensive, but may not be achievable in some leases.

Overall Likely Cost Effect: EA 5	
Construction Cost	<0.1%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

## ■ EA 6: Green Power Strategies

### LEED-NC

Provide at least 35 percent of the building's electricity from renewable sources by engaging in at least a two-year renewable energy contract.

### LEED-CI

This credit is CI EA4. The credit requirements are similar to NC, but the requirement is for 50% of tenant power to come from renewable sources.

The first cost of green power contracts is relatively low, but operationally it can add to overall long term costs. Currently VA contracts do not meet the level established by this credit.

Overall Likely Cost Effect: EA 6	
Construction Cost	<0.1%
Design and Construction Management Cost	0.1% to 0.25%
Documentation	<40 hrs

## 5.4 MATERIALS AND RESOURCES

Most of the LEED-CI credits for Materials and Resources are identical to LEED-NC credits. Two (MR 1, Long Term Commitment, and MR 3.3 Resource Reuse, Furniture and Furnishings) are new requirements. Of the remaining credits, some have different thresholds, and several have furnishings are include in the calculations

## ■ MR Prerequisite 1: Storage and Collection of Recyclables

### LEED-NC

Provide an easily accessible area that serves the entire building and is dedicated to the collection and storage of non-hazardous materials for recycling, including (at a minimum) paper, corrugated cardboard, glass, plastics and metals.

### LEED-CI

This credit is CI prerequisite 1. The credit requirements are similar, but the scope of the requirement is limited to the tenant scope of work.

In most cases, this credit has no construction or design and construction management cost impact. Most healthcare facilities have significant waste handling areas and procedures, and the incorporation of dedicated recycling areas represents a very small increase in program. In many healthcare facilities this is incorporated regardless of the credit.

Overall Likely Cost Effect: MR Prerequisite 1	
Construction Cost	None
Design and Construction Management Cost	None
Documentation	<40 hrs

■ **MR 1-1 to 1-3: Building Reuse**

LEED-NC

1.1 Maintain at least 75 percent (based on surface area) of existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and non-structural roofing material).

1.2 Maintain an additional 20 percent (95 percent total, based on surface area) of existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and non-structural roofing material).

1.3 Use existing interior non-structural elements (interior walls, doors, floor coverings and ceiling systems) in at least 50 percent (by area) of the completed building (including additions).

LEED-CI

These credits are CI credits MR 1-1 to 1-3. Credits 1-2 and 1-3 are similar, but with different thresholds, Credit 1-1 is fundamentally different.

*MR 1-1 Tenant Space, Long Term Commitment*

*Occupant commits to remain in the same space for not less than 10 years*

*MR 1-2 Building Reuse, maintains 40% of interior non-structural components*

*MR 1-3 Building Reuse, maintains 60% of interior non-structural components*

These credits simply require the reuse of specified percentages of a building's fabric. While many healthcare projects involve the reuse of existing buildings, few projects incorporate these points. It can be difficult for remodeling projects to achieve other points, especially site and energy use reduction, without significant increase in cost. Few remodel projects typically seek to pursue certification. These points in themselves do not necessarily add cost to a project; it is the impact of the cost of achieving other necessary points that tends to make these points uncommon.

■ **MR 2-1 and 2-2: Construction Waste Management - Divert From Landfill**

LEED-NC

2.1 Recycle and/or salvage at least 50 percent of non-hazardous construction and demolition debris. Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or commingled.

2.2 Recycle and/or salvage an additional 25 percent beyond MR Credit 2.1 (75 percent total) of non-hazardous construction and demolition debris.

LEED-CI

These credits are CI MR 2-1 and 2-2. The credit requirements are identical.

The ease and cost of compliance with this credit varies greatly by location. In areas where construction waste management is widely used, the costs are minimal, if any. In other areas, or with contractors unfamiliar with construction waste management, the costs can be substantial. In most areas there is no substantial difference between the two levels. Once the contractor has committed to achieving the first point, the second usually follows.

The cost premium can be seen in two forms. In the first instance there is the direct cost of waste management: developing procedures, training, recycling charges, savings in dump fees, etc. The second cost impact is less measurable, and that is the impact on bidders. In periods of high construction demand and limited competition, inexperienced bidders may view these requirements as unduly onerous, and as a result decline to bid, or bid high to cover what they perceive as the risk. This can be mitigated to some degree through bidder outreach and training, but the cost can, nevertheless, be significant in certain locations at periods of low competition. Where the contractor can be engaged during the design

process, the costs associated with this point can be reduced or eliminated simply through education.

There should be no additional design and construction management cost, but there will be moderate documentation requirements if the project wishes to demonstrate compliance with the credit.

Overall Likely Cost Effect: MR 2-1, 2-2	
Construction Cost	
Good Market	Savings/None
Poor Market	<0.1%
Design and Construction Management Cost	
Good Market	None
Poor Market	None
Documentation	
Good Market	40 to 120 hrs
Poor Market	40 to 120 hrs

#### ■ MR 3-1 and 3-2: Materials Reuse

##### LEED-NC

3.1 Use salvaged, refurbished or reused materials such that the sum of these materials constitutes at least 5 percent based on cost, of the total value of materials on the project.

3.2 Use salvaged, refurbished or reused materials for an additional 5 percent beyond MR Credit 3.1 (10 percent total, based on cost).

##### LEED-CI

These credits are CI MR 3-1 to 3-3. The credit requirements are identical for credits 3-1 and 3-2. CI adds credit 3-3 for a 30% reuse of Furniture and Furnishings

These credits are usually not readily achievable in healthcare settings, primarily because there is not enough opportunity for use of salvaged, refurbished or reused materials, products or furnishings to meet the five or ten percent thresholds. Even though some reclaimed materials or products can be incorporated at low cost or even for a reduction in cost, the cost for compliance with these credits can be significant since the percentage thresholds are quite high. Achievement of this credit may not be achievable for all but a very few healthcare projects.

#### ■ MR 4-1 and 4-2: Recycled Content

##### LEED-NC

4.1 Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10 percent (based on cost) of the total value of the materials in the project.

4.2 Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes an additional 10 percent beyond MR Credit 4.1 (total of 20 percent, based on cost) of the total value of the materials in the project.

##### LEED-CI

These credits are CI MR 4-1 and 4-2. The credit requirements are similar, except that CI includes furniture in the calculation.

The use of recycled content is usually not difficult for most projects, and can be done at minimal or no added cost. Most buildings qualify for at least one point for recycled content with no additional cost impact, and minimal or no design effort.

The second point can be challenging for healthcare projects since the thresholds (20 percent by value) are quite high.

There should be no additional design and construction management cost, but there will be significant documentation requirements should the owner wish to demonstrate compliance with this credit.

Documentation involves tracking recycled content materials. This can be done with a simple one-page form that each trade is required to fill out for each product. Product manufacturers are familiar with this requirement and often provide recycled content data whether or not it has been requested. Trades are also asked to isolate the cost for materials, separate of labor and other costs. Once the general contractor has set up a tracking document and process, the added labor is not significant.

Overall Likely Cost Effect: MR 4-1, 4-2	
Construction Cost	
4-1 (10%)	None
4-2 (20%)	0.1% to 0.25%
Design and Construction Management Cost	None
Documentation	40 to 120 hrs

## ■ MR 5-1 and 5-2: Local/Regional Materials

### LEED-NC

*5.1 Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for a minimum of 10 percent (based on cost) of the total materials value.*

*5.2 Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for an additional 10 percent beyond MR Credit 5.1 (total of 20 percent, based on cost) of the total materials value.*

### LEED-CI

*These credits are CI MR 2-1 and 2-2. The credit requirements are similar, except that CI includes furniture in the calculation.*

Use of locally harvested and/or produced materials is usually neither difficult nor costly for most projects to achieve. Experience shows that more projects actually earn these points than initially expect to. This is because the difficulty of these points lies more with the documentation than with the actual specification. Once the contractor develops a documentation procedure, meeting the points becomes relatively straightforward.

As with recycled content, these points are typically earned using standard materials. The ease and cost of compliance with this credit varies greatly by location. Achieving the second point can be challenging because of the high threshold level.

There should be no additional design and construction management cost, but there will be significant documentation requirements.

Overall Likely Cost Effect: MR 5-1, 5-2	
Construction Cost	
5-1 (10%)	None
5-2 (20%)	0.1% to 0.25%
Design and Construction Management Cost	None
Documentation	>120 hrs

#### ■ MR 6: Rapidly Renewable Materials

##### LEED-NC

Use rapidly renewable building materials and products (made from plants that are typically harvested within a ten-year cycle or shorter) for 2.5 percent of the total value of all building materials and products used in the project, based on cost.

##### LEED-CI

This credit is CI MR 6. The credit requirements are similar, except that CI includes furniture in the calculation.

Even though some rapidly renewable materials can be incorporated at low cost, the cost for compliance with these credits can be significant, since the percentage threshold is quite high.

There should be no additional design and construction management cost but there will be significant documentation requirements.

Overall Likely Cost Effect: MR 6	
Construction Cost	>0.25%
Design and Construction Management Cost	None
Documentation	>120 hrs

#### ■ MR 7: Certified Wood

##### LEED-NC

Use a minimum of 50 percent of wood-based materials and products, which are certified in accordance with the Forest Stewardship Council's (FSC) Principles and Criteria, for wood building components

##### LEED-CI

This credit is CI MR 7. The credit requirements are similar, except that CI includes furniture in the calculation.

The cost of certified wood varies widely with location and timing, and is dependent primarily on supply and demand. Project teams should continually monitor supply and price and consider making a final decision as close to bid as possible.

For buildings using certified wood only in finished carpentry, and in areas where there is more than one supplier, the cost premium is minimal. For buildings requiring large quantities of dimensional softwood or sheet goods, the cost can be significant.

There should be no additional design and construction management cost but there will be significant documentation requirements.

Overall Likely Cost Effect: MR 7	
Construction Cost	
Steel or Concrete Frame	<0.1%
Wood Frame	0.1% to 0.25%
Design and Construction Management Cost	None
Documentation	40 to 120 hrs

## 5.5 INDOOR ENVIRONMENTAL QUALITY

Most of the LEED-CI credits for Indoor Environmental Quality are identical to LEED-NC credits. Two of the credits, EQ 4 and EQ 8 have been expanded with the addition of credits for Low Emitting Materials in Furniture and Seating, and for Views from 90 percent of Seated Spaces (EQ 4-5 and EQ 8-3)

### ■ EQ Prerequisite 1: Minimum IAQ Performance

#### LEED-NC

*Meet the minimum requirements of Sections 4 through 7 of ASHRAE 62.1-2004, Ventilation for Acceptable Indoor Air Quality. Mechanical ventilation systems shall be designed using the Ventilation Rate Procedure or the applicable local code, whichever is more stringent.*

#### LEED-CI

*This credit is prerequisite EQ1. The credit requirements are similar*

In most cases, this prerequisite has no construction or design and construction management cost impact. The standards and technologies required for this point are standard to most projects. The documentation requirements are not onerous.

Overall Likely Cost Effect: EQ Prerequisite 1	
Construction Cost	None
Design and Construction Management Cost	None
Documentation	<40 hrs

### ■ EQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

#### LEED-NC

##### OPTION 1

*Prohibit smoking in the building and locate any exterior designated smoking areas at least 25 feet away from entries, outdoor air intakes and operable windows.*

##### OPTION 2

*Prohibit smoking in the building except in designated smoking areas, locate any exterior designated smoking areas at least 25 feet away from entries, outdoor air intakes and operable windows, and locate designated smoking rooms to effectively contain, capture and remove ETS from the building.*

##### OPTION 3 (For residential buildings only)

*Prohibit smoking in all common areas of the building, locate any exterior designated smoking areas at least 25 feet away from entries, outdoor air intakes and operable windows opening to*

common areas, and minimize uncontrolled pathways for ETS transfer between individual residential units by sealing penetrations in walls, ceilings and floors in the residential units, and by sealing vertical chases adjacent to the units.

#### LEED-CI

This credit is prerequisite EQ2. The credit requirements are similar

Smoking is not permitted in Federal buildings, and there should be no new procedures or costs to comply with this credit

Overall Likely Cost Effect: EQ Prerequisite 2	
Construction Cost	None
Design and Construction Management Cost	None
Documentation	None

### ■ EQ 1: Outdoor Air Delivery Monitoring

#### LEED-NC

Install permanent monitoring systems that provide feedback on ventilation system performance to ensure that ventilation systems maintain design minimum ventilation requirements. Configure all monitoring equipment to generate an alarm when the conditions vary by 10 percent or more from setpoint, via either a building automation system alarm to the building operator or via a visual or audible alert to the building occupants.

#### LEED-CI

This credit is CI EQ1. The credit requirements are similar

In most cases, this credit has little construction or design and construction management cost impact. The added sensors and the modifications to the control systems make a very small contribution to the overall cost of the air conditioning systems. The standards and technologies required for this point are standard to most projects or easily achieved at minimal added cost.

Overall Likely Cost Effect: EQ 1	
Construction Cost	<0.1%
Design and Construction Management Cost	None
Documentation	None

### ■ EQ 2: Increase Ventilation

#### LEED-NC

##### FOR MECHANICALLY VENTILATED SPACES

Increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30 percent above the minimum rates required by ASHRAE Standard 62.1-2004 as determined by EQ Prerequisite 1.

##### FOR NATURALLY VENTILATED SPACES

Design natural ventilation systems for occupied spaces to meet the recommendations set forth in the Carbon Trust "Good Practice Guide 237" [1998]. Determine that natural ventilation is an effective strategy for the project.

#### LEED-CI

This credit is CI EQ 2. The credit requirements are similar

VA has made some adjustments in the VA HVAC criteria that will help achieve this credit. Compliance with this credit has a very small construction cost impact, but can have a significant impact on the operational cost of the facility, particularly in areas where the outside air temperature or humidity is significantly different from the required indoor conditions. Increasing outdoor air quantities will usually lead to increased coil sizes, and possibly increased chilling and heating plant capacity. The increased operational costs can be offset to some degree through the use of total heat recovery.

Overall Likely Cost Effect: EQ 2	
Construction Cost	<0.1%
Design and Construction Management Cost	0.1% to 0.25%
Documentation	<40 hrs

■ **EQ 3-1: Construction IAQ Management Plan - During Construction**

LEED-NC

*Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and pre-occupancy phases of the building as follows:*

- *During construction meet or exceed the recommended Control Measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 1995, Chapter 3.*
- *Protect stored on-site or installed absorptive materials from moisture damage.*
- *If permanently installed air handlers are used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 shall be used at each return air grille, as determined by ASHRAE 52.2-1999. Replace all filtration media immediately prior to occupancy.*

LEED-CI

*This credit is CI EQ 3-1. The credit requirements are similar*

This credit is one that many projects aim for but fail to achieve. This is because the credit requires significant coordination and management on the part of the contractor and all members of the construction crew, as well as a strong commitment by all members of the construction crew to abide by the rules.

The ease and cost of compliance with this credit varies greatly by location. In areas where construction IAQ management is widely used, the costs are minimal, if any. In other areas or with contractors unfamiliar with construction IAQ management the costs can be substantial.

The cost premium can be seen in two forms. In the first instance there is the direct cost of IAQ management: developing procedures, training, material handling, etc. The second cost impact is less measurable, and that is the impact on bidders. In periods of high construction demand and limited competition, inexperienced bidders may view these requirements as unduly onerous, and as a result decline to bid, or bid high to cover what they perceive as the risk. This can be mitigated to some degree through bidder outreach and training, but the cost can be significant in certain locations at periods of low competition.

There should be minimal additional design and construction management cost, mainly related to collaboration with the contractor in developing and overseeing the operation of the IAQ plan, but there will be moderate documentation requirements in order to monitor and demonstrate compliance.

Overall Likely Cost Effect: EQ 3-1	
Construction Cost	
Good Market	<0.1%
Poor Market	<0.1%
Design and Construction Management Cost	
Good Market	<0.1%
Poor Market	<0.1%
Documentation	
Good Market	40 to 120 hrs
Poor Market	40 to 120 hrs

■ **EQ 3-2: Construction IAQ Management Plan - Before Occupancy**

LEED-NC

*Develop and implement an Indoor Air Quality (IAQ) Management Plan for the pre-occupancy phase as follows:*

*OPTION 1 — Flush-Out*

*After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total air volume of 14,000 cu.ft. of outdoor air per sq.ft. of floor area while maintaining an internal temperature of at least 60 degrees F and relative humidity no higher than 60 percent.*

*OR*

*If occupancy is desired prior to completion of the flush-out, the space may be occupied following delivery of a minimum of 3,500 cu.ft. of outdoor air per sq.ft. of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm/sq.ft. of outside air or the design minimum outside air rate determined in EQ Prerequisite 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14,000 cu.ft./sq.ft. of outside air has been delivered to the space.*

*OPTION 2 — Air Testing*

*Conduct baseline IAQ testing, after construction ends and prior to occupancy, using testing protocols consistent with the United States Environmental Protection Agency Compendium of Methods for the Determination of Air Pollutants in Indoor Air and as additionally detailed in the Reference Guide.*

*Demonstrate that the contaminant maximum concentrations are not exceeded.*

LEED-CI

*This credit is CI EQ 3-2. The credit requirements are similar*

The feasibility of this credit depends a great deal on the climate. In hot, dry areas a two week flush-out with outdoor air is quite feasible as long as it is planned into the construction schedule. In areas where there is high humidity, however, this point is simply not feasible, since a two week flush-out with outdoor air in wetter climates is more likely to expose the interior of the building to mold and other problems.

Overall Likely Cost Effect: EQ 3-2	
Construction Cost	<0.1%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

■ **Low Emitting Materials: EQ 4-1: Adhesives and Sealants; EQ 4-2: Paints and Coatings; EQ 4-3: Carpet Systems; EQ 4-4: Composite Wood and Agrifiber Products**

LEED-NC

4.1 All adhesives and sealants used on the interior of the building (defined as inside of the weatherproofing system and applied on-site) shall comply with the requirements of the reference standards

4.2 Paints and coatings used on the interior of the building (defined as inside of the weatherproofing system and applied on-site) shall comply with the specified criteria

4.3 All carpet installed in the building interior shall meet the testing and product requirements of the Carpet and Rug Institute's Green Label Plus program. All carpet cushion installed in the building interior shall meet the requirements of the Carpet and Rug Institute Green Label program. All carpet adhesive shall meet the requirements of EQ Credit 4.1: VOC limit of 50 g/L."

4.4 Composite wood and agrifiber products used on the interior of the building (defined as inside of the weatherproofing system) shall contain no added urea-formaldehyde resins. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies shall contain no added urea-formaldehyde resins.

LEED-CI

These credits are CI EQ 4-1 to 4-5. The credit requirements are similar, except that CI adds a credit EQ 4-5: Low Emitting Materials, Systems Furniture and Seating

The first three of these credits are fairly easy to achieve. In many cases, local or regional ordinances may already require that projects meet the required standards. Where local or regional regulations do not already establish the use of low emitting materials, making use of these should have only minimal – if any – impact on cost, as these are usually widely available. The requirement for composite wood and agrifiber products can be harder to achieve, as suitable products are less readily available.

In most cases, these credits have no construction or design and construction management cost impact. The standards and technologies required for these points are standard to most projects, or easily achieved at minimal added cost. The one exception is EQ 4-4: Composite Wood and Agrifiber Products. Prices for composite wood materials with no added urea-formaldehyde can vary widely depending on the product selected and market conditions. Documentation of the use of materials is a concern for contractors.

For CI projects, the credit 4-5 can be challenging, and have a significant cost impact.

Overall Likely Cost Effect: EQ 4-1 to 4-4	
Construction Cost	<0.1%
Design and Construction Management Cost	None
Documentation	<40 hrs

■ **EQ 5: Indoor Chemical and Pollutant Source Control**

LEED-NC

*Design to minimize and control pollutant entry into buildings and later cross-contamination of regularly occupied areas:*

*Employ permanent entryway systems at least six feet long in the primary direction of travel to capture dirt and particulates from entering the building at all entryways that are directly connected to the outdoors.*

*Where hazardous gases or chemicals may be present or used (including garages, housekeeping/laundry areas and copying/printing rooms), exhaust each space sufficiently to create negative pressure with respect to adjacent spaces with the doors to the room closed. For each of these spaces, provide self-closing doors and deck to deck partitions or a hard lid ceiling. In mechanically ventilated buildings, provide regularly occupied areas of the building with air filtration media prior to occupancy that provides a Minimum Efficiency Reporting Value (MERV) of 13 or better. Filtration should be applied to process both return and outside air that is to be delivered as supply air.*

LEED-CI

*This credit is CI EQ 5. The credit requirements are similar*

This credit is usually fairly easy to achieve with little added cost. In most cases, the air intake placement requirements are easy to achieve; where they are not the cost of complying by building additional ductwork and structures can be very high.

In most cases, this credit has minor construction and no design and construction management cost impact. The standards and technologies required for this point are standard to most projects, or easily achieved at minimal added cost.

Overall Likely Cost Effect: EQ 5	
Construction Cost	<0.1%
Design and Construction Management Cost	None
Documentation	None

■ **EQ 6-1: Controllability of Systems – Lighting;**

**EQ 6-2: Controllability of Systems – Thermal Comfort**

LEED-NC

*Provide individual lighting controls for 90 percent (minimum) of the building occupants to enable adjustments to suit individual task needs and preferences.*

AND

*Provide lighting system controllability for all shared multi-occupant spaces to enable lighting adjustment that meets group needs and preferences.*

*Provide individual comfort controls for 50 percent (minimum) of the building occupants to enable adjustments to suit individual task needs and preferences. Operable windows can be used in lieu*

*of comfort controls for occupants of areas that are 20 feet inside of and 10 feet to either side of the operable part of the window.*

**AND**

*Provide comfort system controls for all shared multi-occupant spaces to enable adjustments to suit group needs and preferences.*

**LEED-CI**

*These credits are CI EQ 6.1 and 6.2. The credit requirements are similar*

These credits can be difficult to achieve in healthcare settings, where many areas are not directly under the control of a single occupant. Most patient rooms now incorporate some degree of lighting and ventilation control for the patient, and many of the individual workstations have individual lighting control. Nevertheless, achieving the 90 percent and 50 percent of occupants' level for lighting and ventilation is sometimes challenging.

The costs associated with credit 6-1 (lighting) are primarily those for daylight harvesting and automatic controls. In some locations, these are required by code. The added individual switching is not a significant cost. This can add \$2-\$3.00/SF in the perimeter areas.

The costs associated with credit 6-2 (ventilation) are primarily the added air conditioning zones, which can add from \$1,000 - \$2,000 per zone.

Overall Likely Cost Effect: EQ 6-1, 6-2	
Construction Cost	0.1% to 0.25%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

■ **EQ 7-1: Thermal Comfort – Design; EQ 7-2: Thermal Comfort - Verification**

**LEED-NC**

*Design HVAC systems and the building envelope to meet the requirements of ASHRAE Standard 55-2004, Thermal Comfort Conditions for Human Occupancy. Demonstrate design compliance in accordance with the Section 6.1.1 Documentation.*

*Agree to implement a thermal comfort survey of building occupants within a period of six to 18 months after occupancy. This survey should collect anonymous responses about thermal comfort in the building including an assessment of overall satisfaction with thermal performance and identification of thermal comfort-related problems. Agree to develop a plan for corrective action if the survey results indicate that more than 20 percent of occupants are dissatisfied with thermal comfort in the building. This plan should include measurement of relevant environmental variables in problem areas in accordance with ASHRAE Standard 55-2004.*

**LEED-CI**

*These credits are CI EQ 7-1 and 7-2. The credit requirements for 7-1 are similar to those for NC. For 7-2, the CI requirements include installation of a permanent comfort monitoring system*

Since most projects will have a Building Management System (BMS) as part of their basic design, complying with this credit usually involves small increases to the capabilities of the BMS as opposed to adding new systems. The cost impact of this credit is therefore typically relatively low.

Overall Likely Cost Effect: EQ 7-1, 7-2	
Construction Cost	<0.1%
Design and Construction Management Cost	<0.1%
Documentation	<40 hrs

■ **EQ 8-1: Daylight and Views – Daylight 75 Percent of Spaces; EQ 8-2: Daylight and Views – Views for 90 Percent of Spaces Strategies**

LEED-NC

8.1 **OPTION 1 — CALCULATION**

*Achieve a minimum glazing factor of 2 percent in a minimum of 75 percent of all regularly occupied areas.*

**OPTION 2 — SIMULATION**

*Demonstrate, through computer simulation, that a minimum daylight illumination level of 25 footcandles has been achieved in a minimum of 75 percent of all regularly occupied areas.*

*Modeling must demonstrate 25 horizontal footcandles under clear sky conditions, at noon, on the equinox, at 30 inches above the floor.*

**OPTION 3 — MEASUREMENT**

*Demonstrate, through records of indoor light measurements, that a minimum daylight illumination level of 25 footcandles has been achieved in at least 75 percent of all regularly occupied areas.*

*Measurements must be taken on a 10-foot grid for all occupied spaces and must be recorded on building floor plans.*

8.2 *Achieve direct line of sight to the outdoor environment via vision glazing between 2'6" and 7'6" above finish floor for building occupants in 90 percent of all regularly occupied areas.*

LEED-CI

*These credits are CI EQ 8-1 to 8-3. The credit requirements are similar, except that CI adds credit 8-3 for views from 90% of spaces*

There are two main elements in the strategy to achieve these credits. The first is to reduce the maximum distance from the exterior by narrowing the floorplate as far as possible. The second is to maximize the daylight penetration into the building by the use of good orientation, high quality glazing, and effective light shelving.

In acute care facilities, the floor plate size is set by program, and it can be challenging to reduce the overall depth of the floorplate. For this reason, these credits can be challenging in acute care buildings. In long-term care and medical office buildings, it is generally easier to configure the floorplates to allow for greater daylight penetration and provide for the required views, but even so, it can be difficult to get enough daylight and views to achieve compliance with these credits.



Department of  
Veterans Affairs

## **6. Appendix B: Case Studies**

**6.1 HEALTH CARE FACILITIES**

**6.2 COMMERCIAL INTERIORS**

**6.3 CEMETERIES**

As part of the development of this manual, a number of sustainably designed projects were reviewed. This study helped the project team determine appropriate and applicable strategies that can be widely applied.

Case study facilities came from a variety of sources including existing VA facilities, consultant team projects, GGHC projects, and LEED projects.

The case study section is divided into three portions: health care facilities (applicable to VHA projects), commercial interiors (applicable to VBA projects), and cemetery projects (applicable to NCA projects).

## 6.1 HEALTH CARE FACILITY CASE STUDIES

The following health care projects were LEED rated as of January 2007:

- The Patrick H. Dollard Discovery Health Center, Harris, NY – LEED-NC, v.2.0 Certified
- Boulder Community Foothills Hospital, Boulder, CO – LEED-NC, v.2.0 Silver
- Lacks Cancer Center at Saint Mary's Health Care, Grand Rapids, MI – LEED, NC, v. 2.0 Certified
- Isaac Ray Treatment Center, Logansport, IN – LEED, NC v. 2.0 Silver
- Providence Newberg Medical Center, Newberg, OR – LEED, NC v. 2.0 Gold
- Jewish Hospital Medical Center South, Hillview, KY – LEED, NC v. 2.0 Silver
- Affinity Health System Family Practice Clinic – Greenville, Greenville, WI – LEED, NC v.2.0 Certified
- The Angel Harvey Infant Welfare Society of Chicago Community Health Center, Chicago, IL – LEED, NC v. 2.0 Certified
- Duluth Clinic - First Street Building, Duluth, MN – LEED, NC v. 2.0 Gold
- Pearland Pediatrics, Pearland, TX – LEED, NC v.2.0 Certified
- Southeast Regional Treatment Center Building 2, Madison, IN – LEED, NC v. 2.0 Certified
- Southeast Regional Treatment Center Building 13, Madison, IN – LEED, NC v. 2.0 Certified
- Southeast Regional Treatment Center Building 21, Madison, IN – LEED, NC v. 2.0 Certified

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### 6.1.1 DELL CHILDREN'S MEDICAL CENTER OF CENTRAL TEXAS

Location: Austin, TX

Certification: TBD, anticipated LEED-NC Platinum

Set to open in summer of 2007, the Dell Children's Medical Center of Texas is a 455,000 square foot facility that will serve as an emergency center, children's surgery center, and pediatric critical care facility.

The facility is located on a 37-acre site located off Interstate 35, approximately 10 miles north of Austin. The site is planned for up to 1.4 million square feet of development. Phase one includes the hospital, an energy plant, a medical office building, parking facilities, and a Ronald McDonald House.

The design team adopted the goal of LEED Platinum in 2002, while the hospital's program of requirements was being finalized. The design process was then developed around the LEED goals. This allowed an integrated design approach and helped create a sense of ownership and collegiality among the various team members and involved municipal agencies. Inclusion of municipal agencies in the process resulted in expedited design reviews.

Major sustainable initiatives included:

- Cogeneration. Austin Energy funded the design, engineering, and equipment of an on-site combined heating and power plant. This resulted in reduction of capital costs, as well as greater energy efficiency. The CHP can be 75 percent more efficient at primary fuel conversion to useful energy and on-site location brings transmission loss close to zero. This results in a 42 percent savings in primary energy utilization as compared to a typical power delivery model. Steam from the CHP was used for heating, food service, and medical equipment, as well as in absorption chillers. The team calculated a 4.9 year payback for Austin Energy's initial investment.
- Air exchange. The courtyards provided cooler fresh air to the air handlers than if intake air was drawn from the facility's roof. Air handlers were strategically located throughout the facility, and units were "right sized" for their specific zones, thereby reducing the amount of energy required for operation.
- Daylighting. The team developed a modular structural grid and incorporated open air courtyards throughout the building. Daylight is provided to 64 percent of the non-exempted spaces. Although this is not enough to earn a LEED point, the Green Guide for Health Care awarded Dell Children's a point for daylighting.
- Construction Waste Management. 5.7 million pounds of construction debris (97 percent) was recycled or reused.
- Concrete. As the structure of Dell Children's is 90 percent concrete, the team made a concerted effort to incorporate fly-ash into the concrete mix. The final result was 32 percent fly ash, resulting in keeping nearly 5 million pounds of CO<sub>2</sub> emissions from the atmosphere.

The business case for sustainable design was critical in the success of the Dell Children's project. After completion of careful cost-benefit studies, the team determined that the overall payback for sustainable design initiatives would be approximately 5.9 years. In energy cost savings alone, the hospital expects to save \$6 to 8 million in the first 20 years. Productivity gains are expected to be between 1 and 5 percent of employee costs.

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### 6.1.2 BOULDER COMMUNITY FOOTHILLS HOSPITAL

Location: Boulder, Colorado

Certification: LEED – NC v. 2.0 - Silver

The first hospital in the United States to earn certification from the USGBC, Boulder Community Foothills Hospital (BCFH) is a three-story, 200,000-square-foot facility with 60 beds, as well as a 24-hour emergency department, an intensive care unit, surgery, radiology, and laboratory services.

Air quality and energy efficiency were given high priority when designing and constructing the facility. A highly efficient power plant was built to provide heat, lighting, and hot water. Requiring an initial investment of \$1.3 million, this plant is expected to have a 12-year payback through energy savings.

Numerous additional energy-efficiency measures were employed throughout Boulder Community Foothills Hospital, including variable speed high-efficiency chillers, high-efficiency fans, and fan motors. Energy modeling shows BCFH operating at a 27.6 percent savings above ASHRAE 90.1-1999.

In addition to energy savings, BCFH also focused on providing a sustainable environment around the hospital. Outdoor lighting was carefully designed to reduce light pollution in the night sky. To conserve water, drought tolerant plantings and other xeriscaping surround the area. Additionally, the hospital left 31 acres of the campus undeveloped. The northern section of this area is part of a wildlife corridor and includes a wetlands area.

### 6.1.3 PROVIDENCE NEWBERG MEDICAL CENTER

Location: Newberg, OR

Certification: LEED – NC v. 2.0 - Gold

In 2006, Providence Newberg Medical Center (PNMC) became the first LEED-NC Gold certified hospital. The 56-acre campus houses an interconnected hospital, administration center, and medical office building.

In just 14 months, the facility will have repaid its initial investment and is expected to save nearly 26 percent in annual energy costs by the end of its first year. PNMC is also expected to use 40 percent less water than a facility constructed to code standards.

Energy savings measures include:

- 100 percent outdoor air
- Occupancy sensors, daylight controls and centralized lighting control systems
- Screens over windows
- Occupancy sensors control HVAC systems
- Natural light in all public spaces and waiting areas

Providence Newberg Medical Center meets 100 percent of all electrical needs by purchasing green power (50 percent wind, 25 percent geothermal, 25 percent low impact hydro).

PNMC also participates in the Dispatchable Standby Generation program through Portland General Electric (PGE), which allows PNMC to sell power produced by the medical facility's two 750 kilowatt emergency generators to PGE in times of peak demand for the utility.

Challenges experienced in the design of PNMC included balancing sustainable goals with programmatic needs. For example, while lots of windows provide natural daylighting and reduce lighting energy costs, they can pose privacy issues for a hospital.

### 6.1.4 PETER LOUGHEED CENTRE



Location: Calgary, Alberta, Canada

Certification: LEED – NC Registered

One of four acute care hospitals in the Calgary area, the Peter Lougheed Centre lies in the northeast section of the city. With Calgary's changing demographics and large population influx, programming dictated that a new wing as well as extensive internal renovations were required. The shift to outpatient care has also driven extensive changes to program and facilities.



The 32,000 square meter new East Tower will contain a new Intensive Care Unit, Cardiac Care Unit, and five Inpatient Units. Outpatient facilities will include a Hemodialysis unit, Mental Health Short Stay unit, and Emergency Department handling up to 75,000 visits per year.

The Peter Lougheed Centre is pursuing LEED certification, with highly efficient mechanical systems, benign materials, and increased natural daylighting. This project, under construction at the time of this manual's publication, uses "off the shelf" technologies to reduce energy consumption at little to no additional cost.



Sustainable strategies used in this facility include but are not limited to:

- Advanced envelope design
- 100 percent natural air with no remixing
- 80 percent efficient heat exchangers
- Condensing boilers exceeding 70 percent efficiency
- Natural daylighting
- Operable windows and advanced balancing system to maintain appropriate pressures
- Radiant heating at perimeter to limit heat loss
- Green roof over one quarter of surface area; remainder of roof is high albedo
- Rainwater retention and reuse for system water and irrigation
- Use of recycled materials

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Designers believe that much of the project's success can be attributed to the involvement of the entire team from the beginning of the project. This includes an experienced and involved engineer, as well as a consultative group of operations staff.

### **6.1.5 OREGON HEALTH AND SCIENCE UNIVERSITY**

Location: Portland, Oregon

Certification: LEED – NC Platinum

The first medical and research facility to achieve LEED-NC Platinum, Oregon Health and Science University is a 16-story, 400,000 square foot building housing clinical offices, ambulatory surgery suites, a rehabilitation center, research laboratories, educational facilities, a conference center, and a wellness and fitness center. The ground floor of the facility houses a pharmacy, an optical shop, and a café.

The project team set up “Big Hairy Audacious Goals” for the building, including:

- 60 percent energy savings below Oregon Energy Code
- Reduce initial MEP budget by 25 percent

The project began with a two-day charrette that enabled the team to identify integrated design goals. From the charrette, the team decided to further study several ideas, including rainwater reuse, a microturbine system for the central utility plant, and photovoltaic panels on the building's south elevation. Roof-mounted turbines were also investigated, but were ultimately excluded from the design.

Located just south of downtown Portland, the Oregon Health and Science University is the state's main teaching hospital. Its expanded facility uses building orientation, as well as other measures, to reduce the building's energy consumption. The building's long east-west axis, dictated by the local street layout, takes advantage of passive solar heating in winter, as well as providing daylighting to the interior.

Sustainable strategies integrated into the design of Oregon Health and Science University include, among others:

- 100 percent of the sewage generated in the building treated in a membrane bioreactor on site
- Integrated daylighting system
- Naturally ventilated stair towers
- Radiant heating and cooling
- Eco-roofs
- Rainwater and wastewater harvest and reuse for landscaping
- The south façade of the building on the 15th and 16th floors serves as a giant solar air heater by the creation of a 6,000 square foot trombe wall consisting of two glass skins
- Sunshades on the south side that double as solar electricity generators
- Occupancy sensors for lighting
- Reduced lighting in lobbies and other pass-through areas
- A gas-fueled cogeneration system powered by five 60-kilowatt microturbines

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- Chilled beams that combine convective cooling systems with displacement ventilation
  - Use of sustainable and lower toxicity materials in interior finishes and furnishings

The building is 61 percent more energy-efficient than required by Oregon code. It uses 56 percent less potable water than a similar conventional building does.

Key to the design of this facility was cost savings. Overall, the net mechanical and electrical systems costs are 10 percent under the \$30 million allotted based on a conventional design. The designers attribute cost savings to integrating the design team and sustainable goals early in the building's design process.

In the planning process, the team identified the financial advantages of building green:

- High-performance green buildings may have reduced capital costs due to using an integrated design process.
- Reduced operating costs for energy and water.
- Increased worker productivity.
- Better employee attraction and retention.
- Reduced liability for future issues related to sick buildings.
- Opportunities for positive marketing and public relations.
- Increased real estate value.
- Opportunities for financial and tax incentives.

Key challenges encountered by the design team included:

- Providing for the comfort, productivity and health of the building's occupants while still meeting aggressive sustainable design goals.
- Achieving LEED platinum required "thinking outside the box."
- Meeting the goal of energy savings 60 percent greater than code required the team to use energy modeling as a design tool to determine the most effective energy-efficiency measures. In the final building design, 42 specific measures were included. Key design points for energy efficiency include:
  - Right-size the HVAC system
  - Use free energy such as sun, wind, water, or geothermal
  - Reduce demand
  - Shift loads from peak to off-peak periods
  - Use radiant heating and cooling instead of convective heat transfer
  - Challenge restrictive codes
  - Embrace every opportunity, no matter how small
- The three-story atrium made smoke control challenging. This was solved by integrating the garage exhaust with the smoke evacuation system. Typically, the garage exhaust runs; however, in the case of a fire emergency, a damper closes the garage exhaust and opens the atrium exhaust ducts.

- Building height and profile limitations made including a standard mechanical penthouse on the roof challenging. This was solved by grouping smaller fans into a fan-wall array which is not only smaller, but also more energy efficient.
- The use of captured rainwater accounts for only 10 percent of the building's needs, so the designers had to look for other water efficiency opportunities. Solutions included low-flow fixtures for sinks, urinals and showers, an on-site bioreactor which is used to treat sewage. Non-potable water is only used for landscaping, in core water closets and urinals, not in the clinics or exam rooms.

### 6.1.6 EMORY UNIVERSITY WHITEHEAD BIOMEDICAL RESEARCH BUILDING



Location: Atlanta, GA

Certification: LEED – NC v.2.0 Silver

An eight story, 325,000 square foot laboratory building, housing 148,000 square feet of research laboratories, an extensive vivarium, and a central Environmental Health and Safety facility, the Emory University Whitehead Biomedical Research Building is the largest of its kind in the southeastern United States.



Major sustainable goals included the desire to save energy and water. Achieving LEED certification was not required until the project was already underway.

The Whitehead Biomedical Research Building employs the following sustainable strategies:

- Low irrigation landscaping
- Stormwater harvesting for site irrigation
- Condensate recovery for cooling towers
- Automated cage-washing system for vivarium
- Energy recovery via four enthalpy wheels, which reduces the building's cooling load by approximately 20 percent.
- Mixing return air (75 percent outside air to all zones)
- Building glazing to reduce ultraviolet transmittance
- Photo sensor and motion detector control of lighting
- Recycled and local materials
- Flexible modular design
- Construction recycling – a program which saved approximately \$20,000

The primary post-occupancy issues relate to inadequate free area for the volume of exhaust air flow, which results in high static energy and thus additional fan energy use. Additionally, the exhaust from the facility's vivarium did not mix well.

The building was completed for a total construction cost of \$65 million. The additional cost incurred to achieve a LEED Silver rating was estimated to be approximately \$990,000, or 1.5 percent of the building's total construction cost. Significant long-term reductions in operations

and maintenance offset this investment. Savings in energy cost alone over the first ten years are estimated to offset the additional first cost.

### 6.1.7 WASHINGTON VETERANS HOME



Location: Retsil, WA

Certification: LEED-NC v. 2.0 - Gold

A 240 bed long-term care facility for veterans, Washington Veterans Home includes a 160,000 square foot residential and administration building and a 10,000 square foot kitchen and dining facility. The facility was designed to focus on patient care, reduce overall expenses, and offer residents the health benefits of a sustainable facility.

Washington Veterans Home was designed to use exclusively natural ventilation for cooling. For the facility's naturally ventilated spaces, the design provides effective ventilation in at least 90 percent of each room or zone in the direction of airflow for 95 percent of the hours of occupancy.



Aided by a mild microclimate and sea breezes from the nearby Sinclair Inlet, the carefully engineered natural cooling system includes 240 operable windows. To better serve the Home's elderly residents, windows were specially manufactured to be lighter than normal. The project was required to request a code exemption to allow natural ventilation.

Additionally, the Washington Veterans Home utilizes an improved thermal envelope to reduce the facility's energy load.

Among others, the key lessons learned include:

- Involve stakeholders from the beginning to gain momentum
- Involve a fully integrated design team from the beginning

### 6.1.8 MONTEFIORE MEDICAL CENTER

Location: Bronx, NY

Certification: None

A Solar Turbines Taurus 60 generator set drives Montefiore Medical Center's combined heat and power system. Montefiore operates its own 14-megawatt cogeneration plant, and all its critical loads are backed up by emergency power generators. This system enabled Montefiore Medical Center to be the only hospital in New York City to continue to operate with full power during the first night of the 2003 regional blackout.

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## 6.2 COMMERCIAL INTERIORS CASE STUDIES

### 6.2.1 RANCHO CORDOVA CITY HALL

Location: Rancho Cordova, CA

Certification: LEED-CI – Certified

The City of Rancho Cordova's 40,000 square foot build-out of the City Hall facility took eight months from start to finish and incorporated sustainable design elements with little or no costs to earn a total of 24 LEED-CI credits. Some of the elements included in this facility are:

- Installation of a new white, single-ply roof directly over the top of the existing roof, lessening the need for cooling in the summer.
- Installation of high efficiency HVAC units.
- Selection of water conserving plumbing fixtures, resulting in more than 43 percent water savings.
- Recycling of more than 77 percent of the project's construction waste resulted in donations of more than 30 tons of materials to Habitat for Humanity.
- Retention of existing trees resulted in more than 53 percent shading.
- Use of low-emitting materials.
- Use of recycled and renewable materials.
- Creation of educational materials including building signage and development of a building tour.
- Participation in SMUD's 50 percent Greenenergy program.
- Use of green cleaning practices and products.

### 6.2.2 VANCOUVER PORT AUTHORITY - CORPORATE HEADQUARTERS

Location: Vancouver, BC

Certification: LEED-CI – Gold

At 55,000-square-feet, the Vancouver Port Authority building is the largest LEED-CI project in Canada.

Green highlights include recycled materials, energy savings, and water efficiency. When compared to standard building requirements, VPA uses 20 percent less energy for lighting, 36 percent less power for heating, ventilation, and air conditioning, and 39 percent less fresh water than comparable buildings.

Additionally, this building eliminates the use of fossil fuels for heating.

This \$8 million investment has resulted in the Port's achievement of "Top 100 Employers."

### 6.2.3 HOK SAN FRANCISCO OFFICE



Location: San Francisco, CA

Certification: LEED-CI – Certified

The intent of this project was to create a great workplace by being smarter and creating real value, while being practical stewards of the environment and meeting a tight construction budget and schedule.

The 34,000 square foot studio is spacious, light-filled and highly flexible. Environmentally-friendly materials were carefully selected. The entrance lobby, which is awash with daylight, welcomes staff and guests and provides display space for current work.



Architects, urban designers, landscape architects, interior designers and engineers occupy this highly collaborative environment.

#### Site

The office is situated in a prominent building in downtown San Francisco; downtown city densities minimize urban sprawl and related impacts on undeveloped open spaces.

The building is located near excellent public transportation, and has bicycle storage and shower facilities.

HOK decided not to lease any parking spaces for personal vehicles in order to encourage employees to try alternative modes of traveling to work.



#### Energy

Fundamental commissioning was performed on all tenant-installed systems.

The tenant space exceeds the energy efficiency requirements of Title 24, even though the building is a San Francisco historical landmark and is exempt from Title 24.

The energy-efficient lighting system has a low lighting power density and was designed to utilize an advanced Digital Addressable Lighting Interface (DALI) lighting control system.

#### Materials

Materials were specified from manufacturers that are sustainable design leaders. Recycled-content materials include carpeting, metals, drywall, insulation, and ceiling tiles. Rapidly renewable materials include linoleum and bamboo. In addition, many materials were manufactured locally, including metals, drywall and wall panels. Eco-Panels, FSC MDF with Flat-line finish, were used for all wall accent panels.

Waste materials were recycled during construction. Paper, glass, metal and plastic recycling is integrated into the design.

#### **Indoor Environmental Quality**

The building is non-smoking. Additionally, care was taken during construction to avoid affecting other tenants in the building with dust, odors, etc.

Low-VOC adhesives and sealants were used throughout, also low-VOC paints, and low-emission carpeting. Engineered wood products have no added formaldehyde.

The HOK office was designed to provide natural daylight and views. Staff workstations are never further than 25 feet from the floor-to-ceiling exterior glazing.

### **6.2.4 INTERFACE ENGINEERING**

Location: Portland, OR

Certification: LEED-CI – Gold

For its new 20,000 square foot headquarters facility, Interface focused on indoor environmental quality and energy efficiency.

To achieve maximum energy efficiency, Interface used energy-efficient "direct/indirect" lighting fixtures, occupancy sensors and lighting timers. Additionally, the company's in-house expert commissioning technicians tested and balanced the firm's two floors for continued energy savings.

To maximize indoor environmental quality, more than 50 percent of the work spaces have daylighting for critical visual tasks, and more than 90 percent of the work spaces have a direct line-of-sight to vision glazing.

Site selection for the new facility was driven in part by the desire to locate the space close to public transportation. The site selected is flanked by two light rail lines and is two blocks from Portland's downtown bus mall.

Total cost for participating in the LEED-CI pilot was covered by a small tenant improvement allowance and a modest rent concession.

### **6.2.5 PUGET SOUND ENERGY CORPORATE HEADQUARTERS**

Location: Bellevue, WA

Certification: LEED-CI – Certified

Puget Sound Energy's sustainable goals for their new corporate headquarters focused on energy efficiency and improving employee satisfaction, without increasing costs.

Strategies used to improve energy efficiency included:

- Use of software to monitor and manage energy consumption of the computer network
- Use of lighting controls and sensors
- Installation of energy-efficient appliances

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The additional cost of the energy measures totaled approximately \$59,000, but Puget Sound Energy was able to offset 43 percent of this cost through rebates.

Puget Sound Energy found that their new facility not only saved 199,431 kWh annually (approximately \$10,000 in annual energy cost savings), but it also improved employee satisfaction and provided an opportunity for excellent public relations.

Additionally, this facility used low-VOC paints and adhesives and doors, paneling and cabinets were built with formaldehyde-free core materials. 95 percent of all construction debris was recycled.

## 6.2.6 HARVARD SCHOOL OF PUBLIC HEALTH

Location: Boston, MA

Certification: LEED-CI – Certified

The design of the 40,000 square foot Harvard School of Public Health focused on conserving energy and water. The building's cutting-edge features were designed not only to increase energy efficiency, but also to promote the health, comfort, and productivity of the staff and students. Specific strategies included:

- Use of standard low-flow technologies resulting in reduction in total water use by 20 percent.
- Use of T5 lights, occupancy programming and sensors resulting in reduction in the total energy used for lighting by 40 percent.
- Use of under-floor ventilation systems resulting in increase in performance of HVAC by 15 percent.
- Purchase of renewable energy certificates to offset 50 percent of the electricity for the space.
- Provide daylight to 75 percent of the space within the building.

Additionally, the space includes bicycle storage and changing rooms to accommodate people using alternative transportation.

Total costs for the space were \$6.1 million. Of that, \$77,000 (1.3 percent) was attributed to "green" costs. The annual savings for energy and productivity gains were estimated conservatively at \$82,000, resulting in a 0.9 year simple payback.

## 6.2.7 SCA AMERICAS

Location: Philadelphia, PA

Certification: LEED-CI – Gold

SCA's design priorities for its 81,200 square foot space included natural elements (water, earth and light), employee inclusiveness, and sustainability.

Unique features of the design include:

- Optimization of the HVAC system to minimize air stratification.
- Installation of more than 90 percent EPA Energy-Star rated office equipment, including computers, copiers, and other office technologies.
- Installation of submeters on each floor to identify inefficiencies and hasten their repair.

- Use of aerators on all faucets to reduce water use by 20 percent. The building owner later installed this technology throughout the entire building after conducting an analysis of the return on investment.
- Recycling of 81 percent of construction-related waste
- Use of more than 50 percent local materials and more than 32 percent recycled materials in construction
- Purchase of wind power certificates to offset 100 percent of energy use.

Large building floor plates made achieving the credit for daylight and views difficult. SCA was able to provide daylighting to 75 percent of the occupants by moving open work stations to the exterior and using interior glazing systems. Additionally, all interior offices have glass. SCA focused efforts on daylighting because of the multiple benefits of the strategy: reduced lighting loads, saving energy, and improved overall work environment.

## 6.3 CEMETERY CASE STUDIES

The following projects demonstrate the use of sustainable design strategies that may be applied to NCA cemeteries.

### 6.3.1 GOLDEN CEMETERY

Location: Golden, CO

Certification: None

The city of Golden, Colorado has begun a rigorous city-wide sustainability effort. The following are some of the sustainable measures taken on the grounds of Golden Cemetery.

- Conversion of automatic gates at the Golden Cemetery to solar power
- Installation of permanent gas and diesel tanks at Golden Cemetery, eliminating trips to transport in 5-gallon containers
- Replacement of a pickup truck with a small utility vehicle, a tractor with a small utility vehicle, and purchased an electric cart to transport families, visitors and etc. around the cemetery grounds
- Installation of a computer-programmed automatic sprinkler system that waters at night, saving millions of gallons of water annually (system is also automatically shut off upon one quarter inch of rainfall)
- Use of non-potable water for irrigation

### 6.3.2 WOODLAWN CEMETERY

Location: Santa Monica, CA

Certification: None

Recycled urban runoff is being used for irrigation at the City's cemetery. The treated water meets all of California's Title 22 requirements

### **6.3.3 RIVERSIDE NATIONAL CEMETERY**

Location: Riverside, CA

Certification: None

Vehicles/equipment at VA's Riverside National Cemetery require washing prior to maintenance and to maintain an acceptable appearance. The wash water previously contained grease, oil, and grass clippings, and drained into a grassed swale or storm water drain. This procedure used approximately 400,000 gallons of potable water per year.

The redesigned wash rack, with the WaterStax Wash Water Treatment System, collects the wash water for reuse. This resulted in 100 percent reduction in potentially grease and oil-containing wash water run off and 99 percent reduction in potable water use, saving an estimated \$11,400 per year.



Department of  
Veterans Affairs

## **7. Appendix C: Tools**

**7.1 SUSTAINABILITY KICK-OFF MEETING TOOL KIT**

**7.2 DESIGN CHECKLISTS**

## 7.1 SUSTAINABILITY KICK OFF

### 7.1.1 SAMPLE ENVIRONMENTAL HEALTH GOALS

#### Environmental Health Goals

Sustainable design for healthcare facilities is particularly appropriate as a natural extension of the hospital's mission to promote healing and wellness. Trinity and SJRMC will lead the industry in designing and constructing buildings in ways that enhance health.

An integrated design approach to sustainability addresses the shared mission of providing the finest patient care while also ensuring the health of the environment and providing economic benefits from reduced operating costs, improved productivity, and better patient environments.

- To integrate the building with its environment: by retaining stormwater onsite, reducing heat island effect, and minimizing light trespass.
- To maximize efficiency for building systems, including site and building water and energy systems.
- To select wherever possible building materials and indoor furnishings that are manufactured with low or no toxic chemicals, recycled content, or even reuse materials to further reduce the use of raw materials.
- To build responsibly by recycling construction waste and establishing a process for continued occupant recycling for the life of the building.
- To reduce or eliminate the use of toxic materials, adhesives, paints, and cleaning products in the indoor environment.
- To create an occupant-centered healthy healing environment that encourages patient recovery and staff comfort. Aesthetics, daylight, connection to the outdoors, access to areas that provide solitude and social activities, and welcoming patient areas will provide vital support for a patient's well-being.

*Site Reference: Saint Joseph Regional Medical Center, South Bend, IN*

#### Environmental Health Goals

Four rules against which each design decision must be measured:

- We will not do anything dumb to achieve a LEED credit
- Dumb was anything that doesn't have a Return on Investment (ROI) of 8.33 years or less and anything that created additional maintenance.
- We must know if we are being dumb; every decision needs to be tested
- We will achieve a Platinum Certification

*Site Reference: Dell Children's Medical Center of Central Texas, Austin, TX*

## 7.1.2 SAMPLE AGENDA



Department of Veterans Affairs  
PROJECT NAME

### Environmental Health Kick-Off

**Date:** TBD

**Location:** TBD

**Participants:** VA Design Team; VA Functional Team;  
VA Operational Staff; VA Financial Staff;  
A/E Consultant; Design Consultants;  
Engineering Consultants; Estimator; Construction Manager



#### Introduction

The purpose of the Environmental Health Kick-Off is to identify the ultimate sustainable goals and objectives of the project and the measures for success. Performance criteria identified in this session will be used as part of the analysis and evaluation and serve as the basis for design.

The desired outcome of this meeting is to create the business and design context for the project. The Vision Session will result in a combined statement representing all aspects of the planning problem, including:

- Establish Project Environmental Health Targets
- Understand Priorities
- Determine Measurable Outcomes

#### Why Do We Need a Vision? Why Can't We Just Start Drawing?

Like any other important business initiative, a successful implementation results from a solid strategy. Successful project implementation depends on the VA's ability to flex and change, as it positions itself for the future.

#### AGENDA

- A. Welcome and Introductions
- B. Establish Ground Rules
- C. Discussion of Purpose
- D. Activity
- E. Brainstorm Environmental Health Goals
- F. Establish Consensus
- G. Write Goal Statement
- H. Next Steps / Wrap Up

### 7.1.3 FACILITATION RULES

When facilitating a meeting, it is important to be sure that all opinions are valued and all ideas heard. The following tips should be used in any exercise requiring facilitation, sustainable or not. The facilitator should:

- Establish ground rules
- Provide a safe and welcoming environment
- Encourage participation from all members of the group
- Define the mission of the meeting
- Keep group on task and schedule
- Remain neutral
- Listen actively and recognize participants' input
- Manage conflict
- Build consensus
- Be flexible and adaptable
- Be sensitive to group and individual dynamics
- Recognize that all ideas are good ideas (critique of others' ideas and comments is not allowed)
- Remind participants that ideas can be used to create hybrid solutions
- Encourage building upon the ideas of others
- Establish record keeping system
- Ask questions, but avoid loaded and leading questions, as well as yes/no questions
- Seek clarification, translate, or rephrase unclear comments
- Avoid giving lengthy comments
- Avoid negative tone of voice

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## 7.2 DESIGN CHECKLISTS

### INTEGRATED DESIGN CHECKLIST

The following checklist should be filled out by the AE and submitted with the other checklists required for end of phase review by VA.

## A/E REVIEW CHECKLIST

### INTEGRATED DESIGN

- Reviewers should** - Use Checklists when reviewing any type of VA construction project for the following disciplines:
- Sustainable Design
  - Site and Landscape,
  - Architectural,
  - Structural,
  - Plumbing, Fire Protection, and Sanitary,
  - Heating, Ventilating, and Air Conditioning (HVAC),
  - Steam Generation,
  - Steam Distribution,
  - Incineration/Solid Waste, and
  - Electrical.
- Reviewers should** - Insure that A/E Submission Instructions (PG-18-15) for Schematic, Design Development, and Construction Documents are followed for various types of VA construction projects.
- Reviewers should** - Insure that every VA construction project is in compliance with all life safety issues.
- Reviewers should** - Be aware that these checklists are not all-inclusive but only provide minimum review items.

## A/E CHECKLIST

**TITLE** \_\_\_\_\_ **PROJECT NO.** \_\_\_\_\_

**LOCATION** \_\_\_\_\_ **DATE** \_\_\_\_\_

**REVIEWED BY** \_\_\_\_\_

**ORGANIZATION** \_\_\_\_\_

### GENERAL INFORMATION FOR REVIEWERS

#### INTEGRATED DESIGN REVIEW

The reviewer should be thoroughly familiar with the following VA standards before conducting a design review. These are available on *Internet/Intranet*:

[http://www.va.gov/facmgt/standard/va\\_gov.htm](http://www.va.gov/facmgt/standard/va_gov.htm)

[http://vawww.va.gov/facmgt/standard/va\\_gov.htm](http://vawww.va.gov/facmgt/standard/va_gov.htm)

<b>1.</b>	<b>DESIGN MANUALS (PG-18-10)</b>
<b>2.</b>	<b>MASTER CONSTRUCTION SPECIFICATIONS (PG-18-1)</b>
<b>3.</b>	<b>STANDARD DETAILS (PG-18-4)</b> (Available in AutoCAD 2000 format)
<b>4.</b>	<b>DESIGN AND CONSTRUCTION PROCEDURES (formerly Construction Standards) (H-18-3)</b> (Policies defining the minimum level of excellence in the design of VA facilities)
<b>5.</b>	<b>DESIGN GUIDES (PG-18-12)</b> (Graphic information on specific programs in the design development of VA facilities)
<b>6.</b>	<b>DESIGN ALERTS</b> (These alerts are issued on a regular basis for design and construction related issues)
<b>7.</b>	<b>A/E QUALITY ALERTS</b> (These alerts are issued to guard against common and repeat design errors)
<b>8.</b>	<b>A/E SUBMISSION INSTRUCTIONS, PROGRAM GUIDE, PG-18-15</b>
<b>9.</b>	<b>TECHNICAL SUMMARIES</b> (The summaries of HVAC design requirements for special and critical areas)
<b>10.</b>	<b>VA NCS APPLICATION GUIDE</b>
<b>11.</b>	<b>NCS (NATIONAL CAD STANDARD)</b>
<b>12.</b>	<b>VA SUSTAINABLE DESIGN MANUAL</b>

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## A/E CHECKLIST

**TITLE** \_\_\_\_\_ **PROJECT NO.** \_\_\_\_\_

**LOCATION** \_\_\_\_\_ **DATE** \_\_\_\_\_

**REVIEWED BY** \_\_\_\_\_

**ORGANIZATION** \_\_\_\_\_

### SUSTAINABILITY KICK-OFF MEETING

#### INTEGRATED DESIGN REVIEW

NO.	ITEM	COMMENTS/ YES/NO/NA
1	Five to ten project-specific priority environmental goals and target measurements	
2	Life-cycle cost parameters for decision making	

**PRELIMINARY EVALUATION MEETING****INTEGRATED DESIGN REVIEW**

NO.	ITEM	COMMENTS/ YES/NO/NA
1	A preliminary VA sustainable checklist for the project identifying targeted solutions to the Federal mandates by LEED credit.	
2	The results of the site base conditions analysis	
3	An integrated budget estimate incorporating the planned sustainable strategies.	

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## A/E CHECKLIST

**TITLE** \_\_\_\_\_ **PROJECT NO.** \_\_\_\_\_

**LOCATION** \_\_\_\_\_ **DATE** \_\_\_\_\_

**REVIEWED BY** \_\_\_\_\_

**ORGANIZATION** \_\_\_\_\_

### SCHEMATIC 1

#### INTEGRATED DESIGN REVIEW

NO.	ITEM	COMMENTS/ YES/NO/NA
1	A preliminary VA sustainable checklist for the project identifying targeted solutions to the Federal Mandate by LEED credit.	
2	Preliminary energy models for alternative schemes indicating at least relative percent reductions. Green Building Studio, Trane, or other similar software may be used for this stage.	
3	An integrated budget estimate incorporating the planned sustainable strategies	

## A/E CHECKLIST

**TITLE** \_\_\_\_\_ **PROJECT NO.** \_\_\_\_\_

**LOCATION** \_\_\_\_\_ **DATE** \_\_\_\_\_

**REVIEWED BY** \_\_\_\_\_

**ORGANIZATION** \_\_\_\_\_

### SCHEMATIC 2

#### INTEGRATED DESIGN REVIEW

NO.	ITEM	COMMENTS/ YES/NO/NA
1	An updated VA sustainable checklist for the project with written narrative summarizing status of meeting full Federal mandates.	
2	<p>Refine the energy model of the design building</p> <ul style="list-style-type: none"> <li>• Generate an ASHRAE 90.1-2004 Appendix G compliant base case to compare with the design case, for all buildings over 8000 GSF.</li> <li>• Use the energy model to simulate Energy Efficiency Measures (EEMs) for the proposed design and show the associated energy consumption and cost savings for each</li> <li>• Prepare an energy model report describing all assumptions used in creating the model and summarizing the energy and cost savings associated with each EEM simulated, as well as summarizing the projected savings vs. the ASHRAE 90.1-2004 Appendix G base case. The savings vs. the ASHRAE case will be summarized based on the following comparisons: <ul style="list-style-type: none"> <li>○ <b>Consumption:</b> BTU/GSF/year, including receptacle and process loads.</li> <li>○ <b>Energy Cost:</b> \$/GSF/YR for regulated energy (excluding receptacle and process loads)</li> <li>○ <b>LEED:</b> \$/GSF/YR for total energy (including receptacle and process loads)</li> </ul> </li> </ul> <p>NOTE: For calculating energy for acute care projects, 30% shall be used as the receptacle and process loads in determining the baseline building performance rating.</p>	
3	Document showing life-cycle cost analysis against varying levels of energy reduction target levels.	
4	Updated cost estimate.	

## A/E CHECKLIST

**TITLE** \_\_\_\_\_ **PROJECT NO.** \_\_\_\_\_

**LOCATION** \_\_\_\_\_ **DATE** \_\_\_\_\_

**REVIEWED BY** \_\_\_\_\_

**ORGANIZATION** \_\_\_\_\_

<b>Design Development 1 (DD1)</b>		
<b>INTEGRATED DESIGN REVIEW</b>		
NO.	ITEM	COMMENTS/ YES/NO/NA
1	Update the energy model based on design changes and added design detail	
2	Use the energy model to simulate any additional EEMs considered	
3	Update energy model report, summarize the energy and cost savings of each EEM simulated. Update the projected savings vs. the ASHRAE 90.1-2004 Appendix G code case, using the same comparison metrics as in the Schematic 2 phase.	
4	Identify percentage of energy savings achieved	
5	Document showing life-cycle cost analysis against varying levels of energy reduction target levels.	

## A/E CHECKLIST

**TITLE** \_\_\_\_\_ **PROJECT NO.** \_\_\_\_\_

**LOCATION** \_\_\_\_\_ **DATE** \_\_\_\_\_

**REVIEWED BY** \_\_\_\_\_

**ORGANIZATION** \_\_\_\_\_

<b>Design Development 2 (DD2)</b>		
<b>INTEGRATED DESIGN REVIEW</b>		
NO.	ITEM	COMMENTS/ YES/NO/NA
1	Update the energy model based on design changes and added design detail	
2	Use the energy model to simulate any additional EEMs considered	
3	Update energy model report, summarize the energy and cost savings of each EEM simulated. Update the projected savings vs. the ASHRAE 90.1-2004 Appendix G code case, using the same comparison metrics as in the Schematic 2 phase.	
4	Identify percentage of energy savings achieved	
5	Document showing life-cycle cost analysis against varying levels of energy reduction target levels.	

## A/E CHECKLIST

**TITLE** \_\_\_\_\_ **PROJECT NO.** \_\_\_\_\_

**LOCATION** \_\_\_\_\_ **DATE** \_\_\_\_\_

**REVIEWED BY** \_\_\_\_\_

**ORGANIZATION** \_\_\_\_\_

<b>Construction Documents (CD1)</b>		
<b>INTEGRATED DESIGN REVIEW</b>		
NO.	ITEM	COMMENTS/ YES/NO/NA
1	An updated VA sustainable checklist for the project with written narrative summarizing status of meeting full Federal mandates.	
2	For each design phase LEED credit mapped to a Federal mandate, submit documentation per requirement on USGBC LEED online website.	
3	Final energy model report as follows: <ul style="list-style-type: none"> <li>• Update the energy model during the Construction Document phase based on the final design documents. Provide final information regarding the three energy measurements to Central Office.</li> <li>• Update energy model report, summarizing the projected savings vs. the ASHRAE 90.1-2004 Appendix G code case, using the same comparison metrics as in the Schematic 2 phase.</li> </ul>	
4	Updated cost estimate.	

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## A/E CHECKLIST

**TITLE** \_\_\_\_\_ **PROJECT NO.** \_\_\_\_\_

**LOCATION** \_\_\_\_\_ **DATE** \_\_\_\_\_

**REVIEWED BY** \_\_\_\_\_

**ORGANIZATION** \_\_\_\_\_

<b>Construction Phase</b>		
<b>INTEGRATED DESIGN REVIEW</b>		
NO.	ITEM	COMMENTS/ YES/NO/NA
1	Final VA sustainable checklist for the project with written narrative summarizing status of meeting full Federal mandates.	
2	For each construction phase LEED credit mapped to a Federal mandate, submit documentation per requirement on USGBC LEED online website.	

## **8. Appendix D: Resources**

**8.1 WEBSITES**

**8.2 GLOSSARY OF TERMS**

**8.3 GLOSSARY OF ACRONYMS**

**8.4 BIBLIOGRAPHY**

**8.5 PROJECT TEAM**

## 8.1 WEBSITES

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<b>Office of Construction and Facilities Management</b> .....	<a href="http://www.va.gov/facmgt">http://www.va.gov/facmgt</a>
Academy Journal .....	<a href="http://www.aia.org">www.aia.org</a>
Advanced Buildings .....	<a href="http://www.advancedbuildings.org/">www.advancedbuildings.org/</a>
American Academy of Architecture for Health .....	<a href="http://www.aia.org/aah/aah">www.aia.org/aah/aah</a>
American Hospital Association .....	<a href="http://www.aha.org">www.aha.org</a>
American Indoor Air Quality Council .....	<a href="http://www.aiaqcouncil.org">www.aiaqcouncil.org</a>
American Planning Association Smart Growth Resources .....	<a href="http://www.planning.org/sgreader">www.planning.org/sgreader</a>
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) .....	<a href="http://www.ashrae.org">www.ashrae.org</a>
American Society for Testing and Materials (ASTM) .....	<a href="http://www.astm.org">www.astm.org</a>
American Solar Energy Society .....	<a href="http://www.ases.org/">www.ases.org/</a>
Academy of Neuroscience for Architecture .....	<a href="http://www.anfarch.org/">www.anfarch.org/</a>
American Society of Healthcare Engineering .....	<a href="mailto:www.ashe@aha.org">www.ashe@aha.org</a>
Building Design and Construction .....	<a href="http://www.bdcnetwork.com">www.bdcnetwork.com</a>
Building Green .....	<a href="http://www.buildinggreen.com">www.buildinggreen.com</a>
BREEAM, ECD Energy and Environment Canada .....	<a href="http://www.breeamcanada.ca">www.breeamcanada.ca</a>
Center for the Built Environment (CBE) .....	<a href="http://www.cbe.berkeley.edu">www.cbe.berkeley.edu</a>
Center for Health Design .....	<a href="http://www.healthdesign.org">www.healthdesign.org</a>
Center for Resourceful Building Technology .....	<a href="http://www.crbt.org/">www.crbt.org/</a>
Center for Sustainable Systems .....	<a href="http://css.snre.umich.edu/">http://css.snre.umich.edu/</a>
Certified Forest Products Council .....	<a href="http://www.certifiedwood.org">www.certifiedwood.org</a>
Coalition for Health Environments Research (CHER) .....	<a href="http://www.chereseach.org">www.chereseach.org</a>
Construction Materials Recycling Association .....	<a href="http://www.cdrecycling.org/">www.cdrecycling.org/</a>
DOE High-Performance Buildings Database .....	<a href="http://www.eere.energy.gov/buildings/database">www.eere.energy.gov/buildings/database</a>
Ecological Design Institute (EDI) .....	<a href="http://www.ecodesign.org/edi/">www.ecodesign.org/edi/</a>
Energy Efficiency and Renewable Energy Network (EERN) .....	<a href="http://www.eere.energy.gov">www.eere.energy.gov</a>
Environmental Design and Construction Magazine .....	<a href="http://www.edcmag.com/">www.edcmag.com/</a>
Environmental Design Research Association (EDRA) .....	<a href="http://www.edra.org">www.edra.org</a>
Federal Suppliers Guide .....	<a href="http://www.federalsuppliers.com">www.federalsuppliers.com</a>
Forest Stewardship Council .....	<a href="http://fscus.org/">http://fscus.org/</a>
Green Building Databases and Design Resources .....	

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.....	<a href="http://www.greenbuilder.com/general/GreenDBs.html">www.greenbuilder.com/general/GreenDBs.html</a>
Greenguard.....	<a href="http://www.greenguard.org">www.greenguard.org</a>
Green Roofs.....	<a href="http://www.greenroofs.com">www.greenroofs.com</a>
Green Round Table: Sustainable Architecture and Design .....	<a href="http://www.greenroundtable.org/">http://www.greenroundtable.org/</a>
Green Seal.....	<a href="http://www.greenseal.org">www.greenseal.org</a>
GreenSpec.....	<a href="http://www.greenspec.com">www.greenspec.com</a>
GSA .....	<a href="http://www.gsa.gov">www.gsa.gov</a>
GSA E-Library.....	<a href="http://www.gsaelibrary.gsa.gov">www.gsaelibrary.gsa.gov</a>
Green Guidelines for Health Care.....	<a href="http://www.gghc.org">www.gghc.org</a>
Institute for Healthcare Improvement (IHI) .....	<a href="http://www.ihl.org">www.ihl.org</a>
Institute of Medicine (IOM).....	<a href="http://www.imu.edu">www.imu.edu</a>
Lawrence Berkeley National Laboratory .....	<a href="http://eande.lbl.gov/btp/btp.html">http://eande.lbl.gov/btp/btp.html</a>
LEED.....	<a href="http://www.usgbc.org/LEED/">www.usgbc.org/LEED/</a>
National Environmental Trust.....	<a href="http://www.environet.org/">http://www.environet.org/</a>
Natural Resources Defense Council.....	<a href="http://www.nrdc.org">www.nrdc.org</a>
Soil and Water Conservation Society (SWCS) .....	<a href="http://www.swcs.org/">http://www.swcs.org/</a>
Sustainable Buildings Industry Council (SBIC) .....	<a href="http://www.sbicouncil.org/">http://www.sbicouncil.org/</a>
U.S. Dept. of Agriculture, BioPreferred(sm) Program.....	<a href="http://biobased.oce.usda.gov/fb4p">http://biobased.oce.usda.gov/fb4p</a>
U.S. EPA Comprehensive Procurement Guideline.....	<a href="http://www.epa.gov/cpg">http://www.epa.gov/cpg</a>
U.S. EPA Environmentally Preferable Purchasing.....	<a href="http://www.epa.gov/epp/">www.epa.gov/epp/</a>
U.S. Green Building Council (USGBC) .....	<a href="http://www.usgbc.org">www.usgbc.org</a>
Whole Building Design Guide .....	<a href="http://www.wbdg.org">www.wbdg.org</a>
World Green Building Council.....	<a href="http://www.worldgbc.org/">http://www.worldgbc.org/</a>

The following lists a selection of print resources that may be helpful:

Ray Anderson. *Mid-Course Correction: Toward a Sustainable Enterprise: The Interface Model*. White River Junction, VT: Chelsea Green Publishing Company, 1999.

Janine M. Benyus. *Biomimicry: Innovation Inspired by Nature*. New York: Perennial, 2002.

G.Z. Brown and Mark DeKay. *Sun, Wind and Light: Architectural Design Strategies, 2nd Edition*. New York: John Wiley & Sons, 2000.

Building Design + Construction. *White Paper on Sustainability / Progress Report on Sustainability*. Oak Brook, IL: Reed Business Information, November 2003 and November 2004.

Craig S. Campbell and Michael Ogden. *Constructed Wetlands in the Sustainable Landscape*. New York: John Wiley & Sons, 1999.

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## 8.2 GLOSSARY OF TERMS

This glossary is intended to be general in nature and includes common sustainability-related terms that may not be used in the Sustainable Design Manual but may be found in documents referenced in the Manual.

**Air Changes Per Hour (ACH):** Ventilation or infiltration rate that denotes the number of complete changes of the air within the volume of a given space each hour.

**Air Infiltration Barrier (AIB):** An AIB consists of one or more air-impermeable components, sealed at all seams and penetrations to form a continuous wrap around building walls. Air infiltration barriers can dramatically reduce the air infiltration rates through a building envelope.

**Biobased Materials:** Fuels, chemicals, building materials, or electric power or heat produced from biomass. Definition from Federal Green Construction Guide for Specifiers.

**Biobased Content:** The weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Definition from Federal Green Construction Guide for Specifiers. Also see definition in Section 9002 of the 2002 Farm Security and Rural Investment Act and the USDA BioPreferred website.

**Biomass:** Organic matter available on a renewable basis. Biomass includes forest and mill residues, agricultural crops and wastes, wood and wood wastes, animal wastes, livestock operation residues, aquatic plants, fast-growing trees and plants, and municipal and industrial wastes.

**Brownfields:** Abandoned, idled, or underused industrial and commercial facilities/ sites where expansion or redevelopment is complicated by real or perceived environmental contamination.

**Building Envelope:** The elements of a building that enclose conditioned spaces through which thermal energy may be transferred to or from the exterior or to or from unconditioned spaces.

**Building Integrated Photovoltaics (BIPV):** Portions of a building envelope that not only provide enclosure, but also incorporate photovoltaic materials that create useful electricity.

**Cogeneration:** Using waste heat (1) from an industry to produce electricity, or (2) from electric utilities to produce steam for an industry or hot water for a building.

**Commissioning:** Commissioning is a comprehensive and systematic process to verify that the building systems perform as designed to meet the Owner's requirements. Commissioning during the construction, acceptance, and warranty phases is intended to achieve the following specific objectives: verify and document that equipment is installed and started per manufacturer's recommendations, industry accepted minimum standards, and the Contract Documents; verify and document that equipment and systems receive complete operational checkout by installing contractors; verify and document equipment and system performance; verify the completeness of operations and maintenance materials; ensure that the Owner's operating personnel are adequately trained on the operation and maintenance of building equipment. The commissioning process does not take away from or reduce the responsibility of the system designers. Definition from Federal Green Construction Guide for Specifiers.

**Commissioning Agent:** A contractor responsible for providing the overall coordination and management of the commissioning plan. Definition from Federal Green Construction Guide for Specifiers.

**Comprehensive Procurement Guideline (CPG):** The CPG program is part of EPA's continuing effort to promote the use of materials recovered from solid waste, and provides information regarding recommended recycled-content levels for CPG items.

**Commissioning Plan:** An overall plan that provides the structure, schedule and coordination for the commissioning process.

**Constant Air Volume (CAV):** Mechanical system that delivers a constant rate of air while varying the temperature of the supply air. Supply air is cooled to meet the need of the zone with highest demand, and air is reheated at the terminal units to achieve comfort.

**Contaminant:** Foreign and unwanted physical, chemical, biological, or radiological material in a product or in the environment.

**Daylight Factor:** Under totally overcast sky conditions, the percentage of light that arrives on a horizontal surface within a building compared to the amount of light arriving on an unshielded horizontal surface outside.

**Daylight Sensing Control (DS):** A device that automatically regulates the power input to electric lighting near fenestration to maintain the desired workplace illumination. This system takes maximum advantage of direct or indirect sunlight.

**Daylighting Strategies:** Methods that use natural light to minimize the need for artificial lighting during the day.

**Design Energy Consumption (DECON):** The computed annual energy usage of a proposed building design. Terminology used in the energy efficiency standard, ASHRAE 90.1.

**Design Energy Cost (DECOS):** The computed annual energy expenditure of a proposed building design. Terminology used in the energy efficiency standard, ASHRAE 90.1.

**Direct Cooling:** Direct cooling has four major components: keeping heat out, providing ventilation, underground construction, and evaporative cooling. Most of the strategies for keeping the heat out of a building involve avoiding direct solar gain. They include orienting the building away from intense solar exposure; using indirect daylighting instead of artificial lighting; shading roofs, walls, and windows with overhangs, wing walls, and vegetation; adjusting surface-area-to-volume ratios.

**Direct Expansion (DX) Cooling:** Mechanical cooling system in which the air of the space being cooled passes directly over the cooling coil (evaporator).

**Direct Gain System:** Uses vertical and generally south-faced glazing and materials inside to absorb heat (thermal mass). The most widely used passive solar design approach. With direct gain, the occupants are in direct contact with all five elements of the passive solar system: collector, absorber, storage, distribution, and controls.

**Drip Irrigation:** Above ground low-pressure watering system with flexible tubing that releases small, steady amounts of water through emitters placed near individual plants.

**Energy Cost:** The cost of energy by unit and type of energy as proposed to be supplied to the building, including variations such as time of day, season, and rate of usage.

**Energy Cost Budget (ECB):** The maximum allowable computed annual energy expenditure for a proposed building.

**Energy Management System:** A control system capable of monitoring environmental and system loads to adjust HVAC output in order to conserve energy while maintaining comfort.

**Energy Recovery Ventilator (ERV):** Draws exhaust air from the building and transfers the heat or coolness in that air to the outside air that is being pulled into the building.

**Energy Star:** A voluntary labeling program of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy that identifies energy efficient products. Qualified products exceed minimum federal standards for energy consumption by a certain amount, or where no federal standards exist, have certain energy saving features. Such products may display the Energy Star label.

**Enthalpy:** Total heat (both sensible and latent) present in an air-moisture mix.

**Enthalpy Wheel:** Heat or enthalpy wheels are rotary air-to-air heat exchangers. Adjacent supply and exhaust air counter flow streams each flow through half of the wheel. Heat wheels have a fill that transfers only sensible heat while an enthalpy wheel's fill transfers total heat.

**Environmentally Preferable Products:** Products and services that have a lesser or reduced effect on the environment in comparison to conventional products and services. Definition from Federal Green Construction Guide for Specifiers.

**Environmentally Preferable Purchasing:** EPA program that promotes federal government use of products and services that pose reduced impacts to human health and the environment.

**Evaporative Cooling:** The phase change of water from liquid to gas is a heat-absorbing process. The result is effective cooling of the air as water evaporates. This technique can be used to significantly reduce reliance on mechanical refrigeration, particularly in hot, dry climates.

**Geothermal Reservoirs:** Subsurface sources of heat that are believed to be fueled by radioactive decay occurring deep within the earth. In most areas, this heat reaches the surface in a very diffuse state; however, due to a variety of geological processes, some areas are underlain by relatively shallow geothermal resources.

**Gray Water:** Domestic wastewater; composed of wash water from kitchen, bathroom and laundry sinks, tubs, and washers. Does not include human waste.

**Green Guide for Health Care:** Green Guide for Health Care™, the healthcare sector's first quantifiable sustainable design toolkit integrating enhanced environmental and health principles and practices into the planning, design, construction, operations and maintenance of their facilities. This Guide provides the healthcare sector with a voluntary, self-certifying metric toolkit of best practices that designers, owners, and operators can use to guide and evaluate their progress towards high-performance healing environments. Definition by GGHC.

**Green Roof:** Vegetation cover on roof surfaces. There are two types: extensive and intensive. Extensive green roofs, also referred to as eco-roofs or living roofs, utilize a thin soil layer with horizontally spreading, low-growing vegetation cover over the entire roof surface that adds minimal loads to structure and serves as ecological stormwater management control by eliminating or delaying runoff. These also effectively reduce temperatures of the roof surface by absorbing heat from the sun, which may reduce the urban heat island effect. Intensive green roofs, also referred to as traditional roof gardens, utilize a thick soil layer or planters for vegetation (including trees and shrubs) and add substantial loads to the building structure.

**Greenfield Site:** Sites in both rural and urban areas, which have not experienced previous development. It also includes forestry and agricultural land and buildings, as well as previously developed sites which have blended into the natural landscape over time.

**Heat Island Effect:** A microclimate in which the air temperature is slightly higher than in the surrounding area. In an urban heat island, for example, the temperature in the city is 1-2°C higher than in the rural area around it.

**Heat Recovery:** Heat utilized that would otherwise be wasted. Sources of heat include machines, lights, process energy, and people.

**Impervious Surface Area:** Area that has been sealed and does not allow water to infiltrate, such as roofs, plazas, streets, and other hard surfaces.

**Indirect Gain System:** In indirect gain systems, sunlight strikes a thermal mass located between the sun and the space. The sunlight is absorbed by the mass, converted into thermal energy, and transferred into the conditioned spaces. Because conditioned spaces do not receive solar radiation immediately, indirect gain systems offer greater control over temperature swings and overheating. The two basic types of indirect gain systems are thermal storage walls and roof ponds.

**Indoor Air Quality (IAQ):** ASHRAE defines acceptable indoor air quality as air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80 percent or more) of the people exposed do not express dissatisfaction.

**Indoor Environmental Quality (IEQ):** Characteristics of the indoor climate of a building, including the gaseous composition, temperature, relative humidity, and airborne contaminant levels.

**Integrated Waste Management:** Using a variety of practices, including source reduction, recycling, incineration, and land filling, to minimize the amount of municipal solid waste.

**Interstitial Floor:** In architectural terms, the “interstitial floor” refers to an entire floor or level of a building that houses electrical, plumbing and mechanical systems (phone and network cables, heating ducts and piping, for example). Usually these systems are packed tightly in the crawlspace between floors, so the beauty of an interstitial floor is its sheer expansiveness. Maintenance personnel can walk about easily, making repairs to electrical equipment, heating ducts, plumbing, telephone, and network cables. They allow maintenance personnel to expedite service and make repairs on all the hospital’s essential systems, keeping disturbance to patients and staff to a minimum.

**Isolated Gain System:** In isolated gain systems, the solar collection and storage elements are separate from the spaces they provide heat. Generally south-facing solariums, greenhouses, and atriums are common examples of sun spaces in isolated gain systems.

**LEED:** The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings’ performance. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. Definition from the U.S. Green Building Council.

**Life-Cycle:** All stages of development, from extraction to production, marketing, transportation, use, and disposal.

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**Life-Cycle Assessment (LCA):** A process or framework to evaluate the environmental burdens associated with a product, process, or activity by identifying, quantifying, and assessing its energy and material usage and environmental releases, to identify opportunities for environmental improvements. Extraction and processing of raw materials, manufacturing, transportation and distribution, use/reuse/maintenance, recycling, and final disposal are all considered.

**Life-Cycle Cost:** A measurement of understanding the cost of a product initially, the cost to maintain the product, the life time of replacement cost.

**Low-Impact Development:** New development that minimizes disturbance on-site due to construction and erosion. Low-impact developments are designed to blend well into their environmental setting to preserve natural features and the maximum amount of open space.

**Makeup Air:** Outdoor air supplied to replace exhaust air and exfiltration.

**Non-Renewable Energy:** Sources of energy such as oil, coal, or natural gas that are not replaceable after they have been used.

**Non-Renewable Resource:** A resource that exists in a fixed amount that cannot be replenished on a human time scale. Non-renewable resources have the potential for renewal only by geological, physical, and chemical processes taking place over of millions of years. Examples include iron ore, coal, and oil. Definition from Federal Green Construction Guide for Specifiers.

**Occupancy Sensor:** A device that detects the presence or absence of people within an area and causes any combination of lighting, equipment, or appliances to be turned on, turned off, or adjusted accordingly.

**Off-Gassing:** The releasing of gasses or vapors into the air.

**Passive Solar Cooling:** Building design that avoids unneeded solar heat, utilizes natural ventilation, and employs thermal mass (especially in hot, dry climates) to retain coolness.

**Passive Solar Heating:** Building design that uses natural processes to collect, store, and distribute heat for a building. Most passively solar-heated buildings require an auxiliary heating system for periods when solar heat is unavailable or insufficient.

**Payback Analysis:** Evaluation of the period of time in which initial expenditures are recovered through subsequent savings. Simple payback can be calculated as follows: simple payback period = initial cost / annual savings.

**Peak Electrical Demand:** The peak electrical demand is the maximum instantaneous load or the maximum average load over a designated interval of time, usually 15 or 30 minutes measured by meter by the utility or power provider. Also known as peak power.

**Peak Load Shedding:** Peak load shedding defers system loads from peak periods to periods of low demand. The result is a flattening of the system load schedule, thus decreasing demand charges from the electric utility. Design strategies that reduce the peak load are often referred to as “peak shaving.”

**Persistent Bioaccumulative Toxin (PBT):** Highly toxic, long-lasting substances that can build up in the food chain to levels harmful to human and environmental health.

**Pervious Paving:** Paving material that allows water to penetrate to the ground below.

**Photovoltaic:** Capable of generating a voltage as a result of exposure to visible or other radiation. Solid-state cells (typically made from silicon) directly convert sunlight to electricity. The electricity can be used immediately, stored in batteries, or sold to a utility.

**Post-Commercial Material:** Material that has been recovered or otherwise diverted from the solid-waste stream during the manufacturing process. Does not include used, reconditioned, or remanufactured components. Also known as pre-consumer recycled content.

**Post-Consumer Material:** An end product that has completed its life cycle as a consumer item and would otherwise have been disposed of as a solid waste. Post-consumer materials include recyclables collected in commercial and residential recycling programs, such as office paper, cardboard, aluminum cans, plastics, and metals.

**Post-Industrial Material:** Manufacturing waste that has been cycled back into the production process. These products do not represent the significant resource savings that post-consumer products do, but are usually preferable to those that use virgin materials.

**Potable Water:** Water suitable for drinking.

**Recovered Material:** Waste materials and by-products that have been recovered or diverted from solid waste. Excludes those materials and by-products generated from and commonly reused within an original manufacturing process.

**Runoff:** Surface streams that appear after precipitation or irrigation. A lost resource and contributor to nonpoint source pollution.

**Scheduled Switching:** Scheduled switching is the most basic type of automatic lighting control. Lights are programmed to turn on or off (and brighten or dim) at prescribed times, according to the expected patterns of occupancy.

**Shading Coefficient:** The ratio of solar energy transmitted through a window to incident solar energy that is normal to it. Used to express the effectiveness of glazing or a shading device.

**Solar Heat Gain Coefficient (SHGC):** Preferred terminology for solar heat gain through glazing and fenestration. Weighted average of solar radiation penetrating glass at different angles (typically 86 percent).

**Source Reduction:** Any practice that reduces the amount of hazardous substance, pollutant, or contaminant prior to recycling, treatment, or disposal, and reduces the hazards to public health and the environment associated with release of these materials. Includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control.

**Source Separation:** Separating waste materials by type at the point of discard so that they can be efficiently recycled.

**Stack Effect:** Pressure-driven airflow produced by convection, by the difference between confined warm air in chimney or stack and cool air surrounding the outlet. The stack effect can be used to drive natural ventilation systems; however, it can also overpower a building's mechanical system and disrupt ventilation and circulation.

**Surface-Area-to-Volume Ratio:** One potential and often misleading indicator of building energy performance. The smallest ratios apply to buildings that are spherical or, more practically, squarish in shape. Disregarded is the fact that surface area can also be very useful if it

increases the potential for passive solar heating, natural ventilation, and / or daylighting of buildings.

**Task Lighting:** Any form of light that is focused on a specific surface or object. It is intended to provide high-quality lighting that can be directed toward a specific predetermined activity.

**Thermal Envelope:** The shell of a building that essentially creates a barrier from the elements. A highly insulated thermal envelope allows maximum control of interior temperature with minimal outdoor influence.

**Total Lighting Power Allowance:** The calculated lighting power allowed for the interior and exterior space areas of a building or facility.

**U.S. Green Building Council (USGBC):** The U.S. Green Building Council is the nation's foremost coalition of leaders from every sector of the building industry working to promote buildings that are environmentally responsible, profitable and healthy places to live and work. The U.S. Green Building Council's core purpose is to transform the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life. Source: U.S. Green Building Council.

**Value Engineering:** An analysis of material, processes, and products in which functions are related to cost and from which a selection may be made so as to achieve the desired function at the lowest overall cost consistent with performance.

**Variable Air Volume (VAV):** Mechanical system that varies the amount of air supplied to a zone while keeping the supply air temperature constant. This strategy saves fan energy and uses less reheat than in a Constant Air Volume (CAV) system.

**Ventilation Air:** The portion of supply air that is outdoor air plus any recirculated air that has been treated for the purpose of maintaining acceptable indoor air quality.

**Voltaic Organic Compound (VOC):** Chemicals that contain carbon molecules and have high enough vapor pressure to vaporize from material surfaces into indoor air at normal room temperatures (referred to as off-gassing).

**Waste Heat:** Heat escaping from combustion that can be captured and used for other processes.

**Water Budget:** The calculated amount of water a household should use based on the type and number of fixtures, landscape requirements, and number of occupants.

**Water-Conserving Irrigation:** Drip irrigation, soaker hoses, bubblers, and low-trajectory spray heads for water distribution; zoning irrigation for different water-demand plant types; electronic timers with five-day programming and rain override devices; irrigation schedules for early-morning watering every five to seven days; soil moisture sensors.

**Water Economizer:** A system by which the supply air of a cooling system is cooled directly or indirectly or both by evaporation of water or by other appropriate fluid (in order to reduce or eliminate the need for mechanical refrigeration).

**Wind Turbine:** A machine that generates electricity from the wind by turning a generator-connected wind propeller.

**Xeriscape:** Landscaping for water and energy efficiency and lower maintenance. The seven xeriscape principles are: good planning and design, practical lawn areas, efficient irrigation, soil improvement, use of mulches, low-water-demand plants, and good maintenance.

## 8.3 GLOSSARY OF ACRONYMS

ACH .....	Air Changes per Hour
ADPSR.....	Architects, Designers and Planners for Social Responsibility
A/E .....	Architect / Engineer
AHU .....	Air Handling Unit
ASHRAE .....	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASTM.....	American Society of Testing and Materials
BIM.....	Building Information Modeling
BMS .....	Building Management System
BREEAM.....	Building Research Establishment Environmental Assessment Method
CAD .....	Computer Aided Design
CARES.....	Capital Asset Realignment for Enhanced Services
CBE.....	Center for the Built Environment
CD.....	Construction Document
CFC.....	Chlorofluorocarbon
CHER.....	Coalition for Health Environments Research
CO2.....	Carbon Dioxide
CPM .....	Critical Path Method
DD .....	Design Development
DOE .....	Department of Energy
EA .....	Energy and Atmosphere
EDI .....	Ecological Design Institute
EDRA.....	Environmental Design Research Association
EERN .....	Energy Efficiency and Renewable Energy Network
EO.....	Executive Order
EPA.....	Environmental Protection Agency
EPAct.....	Energy Policy Act of 2005
EQ.....	Environmental Quality
ETS .....	Environmental Tobacco Smoke
GSF.....	Gross Square Foot
GSA .....	General Services Administration
HCFC .....	Hydrochlorofluorocarbon
HVAC.....	Heating, Ventilation and Air Conditioning

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IHI .....	Institute for Healthcare Improvements
IAQ.....	Indoor Air Quality
IEQ.....	Indoor Environmental Quality
LCA .....	Life Cycle Assessment
LEED.....	Leadership in Energy and Environmental Design
LEED-EB.....	LEED Existing Building
LEED-CI.....	LEED Commercial Interiors
LEED-CS .....	LEED Core and Shell
LEED-H.....	LEED Homes
LEED-NC .....	LEED New Construction
LEED-ND .....	LEED Neighborhood Development
MOU.....	Memorandum of Understanding
MR .....	Materials and Resources
NBIM .....	National Building Information Modeling
NCA .....	National Cemetery Administration
NIBS.....	National Institute of Building Sciences
OR.....	Operating Room
PBT .....	Persistent Bioaccumulative Toxin
PM.....	Project Manager
PV .....	Photovoltaic
REC .....	Renewable Energy Certificates
SBIC.....	Sustainable Buildings Industry Council
SD .....	Schematic Design
SF .....	Square Foot
SS .....	Sustainable Sites
SWCS .....	Soil and Water Conservation Society
TIL.....	Technical Information Library
USGBC .....	U.S. Green Building Council
VA .....	Department of Veterans Affairs
VBA.....	Veterans Benefits Administration
VAV .....	Variable Air Volume
VHA.....	Veterans Health Administration
VISN.....	Veterans Integrated Service Network
VOC .....	Voltaic Organic Compounds

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WBDG .....	Whole Building Design Guide
WE .....	Water Efficiency

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