Sustainability Initiatives for Beaumont Health System

School of Natural Resources and Environment Master's Project

Final Report

4/22/2014

Prepared for Beaumont Health System

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1. Abstract

The Sustainability Initiatives for Beaumont Health System (SIBHS) masters project team worked with Beaumont Health System, Practice Greenhealth (PGH) and Jones Lang LaSalle (JLL) to research and implement various sustainability initiatives to help Beaumont earn credits towards Leadership in Energy and Environmental Design (LEED) accreditation with the goal of achieving Existing Building Operations & Maintenance (LEED EBOM) certification for the Royal Oak campus. The SIBHS team investigated and analyzed the feasibility of implementing sustainability strategies that align with specific LEED credits, focusing on Sustainable Sites, Energy & Atmosphere and Innovation in Operations. The project aimed to help Beaumont Royal Oak Hospital, a sprawling campus of nearly 1.3 million square feet, reduce energy use, create green spaces that support healing and caregiver respite, improve communication about sustainability activities on campus, and become a model for other healthcare facilities pursuing LEED EBOM certification for a healthcare campus. The project highlighted how a partnership with masters' level programs at academic institutions can benefit hospitals interested in exploring both the return on investment and appropriate implementation strategies for sustainability initiatives. JLL provided frontline exposure to the LEED rating and documentation system, while PGH provided peer-to-peer connectivity related to implementation of specific credits, as well as documentation of the organizational learning process to benefit its hospital members.

2. Executive Summary

Sustainability in healthcare is growing in prominence as organizations are faced with new challenges and increased scrutiny surrounding their environmental impact. To be an environmental steward, economically prosperous and socially responsible, healthcare organizations are implementing initiatives that save energy and money, while also reducing adverse impacts on the surrounding community.

To green Beaumont Health System's Royal Oak campus in Royal Oak, Michigan, the Sustainability Initiatives for Beaumont Health System (SIBHS) master's project team worked with Beaumont Health

System, Practice Greenhealth (PGH) and Jones Lang LaSalle (JLL) to research and implement sustainability initiatives. Beaumont is striving to improve its Royal Oak campus facilities to earn Leadership in Energy and Environmental Design (LEED) Existing Building: Operations and Maintenance (EBOM) certification. The SIBHS team focused on projects that reduced energy consumption, created green space facilitating healing and well-being, and improved communication and awareness of sustainable practices at Royal Oak Beaumont. Through the implementation of initiatives developed by the SIBHS team, Royal Oak Beaumont aims to become a model for other healthcare facilities interested in LEED EBOM certification.

To achieve points towards LEED certification in the Sustainable Sites category, the SIBHS team designed a therapeutic garden space to be utilized by patients, family members and staff. The SIBHS team performed site surveys and sun-shade analyses for three potential garden locations and assisted Beaumont in determining the final land allocation. Interviews were conducted with doctors, nurses and physical therapists to tailor the designs to the needs of the garden's users. The SIBHS team provided Royal Oak Beaumont with plan drawings to aid in the design and implementation of the therapeutic garden, which include site renderings, plant inventory lists, sun-shade analysis, and healing element inventory. In addition to the therapeutic garden space design, the SIBHS team researched green roofs and provided Royal Oak Beaumont with options for the inclusion of more green space on campus. The results were presented to the Beaumont group in a report addressing key design elements, cost information and the benefits of green roofs in a hospital setting. A land management framework was developed to help guide Beaumont in more sustainable grounds maintenance practices. Based upon the National Renewable Energy Laboratory's (NREL) environmentally-oriented landscape management plan, the proposed framework will help to reduce maintenance costs while further developing Beaumont's dedication towards a more sustainable campus.

To further Beaumont's efforts to reduce their energy consumption, the SIBHS team researched and reported recommendations on implementation of window films. They also conducted an American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Level 1.5 energy audit. The Window Film Report analyzed the atriums in the South Hospital Addition and the East Critical Care Tower and determined what aspects of the atriums contributed to poor thermal comfort in the buildings. Solar heat gain and daylight hour analyses helped to illuminate where the installation of window films would be most effective. Four potential film options were researched, including basic, medium, high and low-e performance grade and financial and sensitivity analyses were performed to determine the overall cost and return on investment for these films. The results of the analyses allowed the SIBHS team to recommend solutions that would eliminate the thermal comfort issues in both locations. Installing low-e window film in the South Hospital Addition was the first recommendation as it has a lower payback period and the space is large and more utilized. The SIBHS team also recommended that Beaumont install high performance window films in the East Critical Care Tower atrium, even though this smaller space had a longer payback period.

To further improve Beaumont's energy conservation measures, the ASHRAE Level 1.5 energy audit benchmarked the energy usage of Beaumont's Medical Office Building (MOB). The audit included a building walkthrough and detailed lighting survey that allowed the SIBHS team to develop strategic energy conservation measures. The results documented in the audit report will help the building manager optimize the energy performance of the MOB.

Communication of sustainability initiatives to the Royal Oak Beaumont community is crucial for successful implementation. Promoting Beaumont's sustainability mission helps to better engrain it in the hospital's daily culture and operations. Dissemination of information about not only green projects being conducted, but also about the cost savings associated with such projects, encourages greater support from top leadership, as well as catch the eye of potential donors. To improve communication on the sustainability initiatives at Royal Oak Beaumont, the SIBHS team developed a short, 8 page review highlighting Beaumont's performance and cost savings in reducing energy and water consumption, reducing waste generation, promoting alternative transportation, introducing Beaumont's Green Team, and discussing the importance of sustainability in healthcare. The pamphlet also provides tips on things employees can do to get involved in the greening of the hospital. To further increase awareness and promote sustainability, the SIBHS team conducted a one hour presentation at Beaumont in April 2014 detailing the projects it has completed for Beaumont and how such projects benefit the hospital and its sustainability mission.

Upholding Beaumont's sustainability mission depends upon the hospital's ability to easily new practices into the operation and maintenance of the building. To this end, the SIBHS team developed three policies and procedures for the integration of sustainable materials and the reduction of waste generation. These include: (1) the Sustainable Purchasing Policy, (2) the Solid Waste Management Policy, and (3) the Construction and Demolition Waste Management Policy. Each policy clearly outlines procedures for purchasing products and materials that are more environmentally friendly, for disposing of solid waste and recycling, and for establishing waste stream management during facility alterations. All three policies were developed corresponding to LEED Material and Resource credit requirements and Healthier Hospitals Initiative guidelines.

In support of LEED, Practice Green Health (PGH) publishes case studies on its website related to sustainable initiatives implemented by their member healthcare facilities for other facilities to reference when greening their organizations. As Beaumont Health System is a PGH member hospital, PGH personnel worked with the SIBHS team to identify other member hospitals that had already implemented initiatives similar to those Beaumont was looking to implement. Through collaboration with PGH, the SIBHS team was introduced to four PGH member hospitals to conduct interviews and develop case studies. The following cases studies were developed on measures implemented at the hospitals listed:

TABLE 1: PGH CASE STUDIES AND PARTNER HOSPITALS

Case Study	Partner Hospital
Combined Heat and Power (CHP)	New York Presbyterian Weill Cornell Medical Center, New York, New York
Light Emitting Diode (LED) Implementation	LifeBridge Health System, Baltimore, Maryland
Therapeutic Gardens	Legacy Health System, Portland, Oregon
Tackling Reheat	University of Michigan Cardiovascular Center, Ann Arbor, Michigan

The partnership between the University of Michigan SIBHS team and Royal Oak Beaumont facilitated the exploration of innovative sustainability initiatives that will allow Beaumont to be a leader in healthcare sustainability. Through this project, the benefits of healthcare organizations partnering with students in master's level academic programs was realized and resulted in a variety of final recommendations and deliverables. As Royal Oak Beaumont continues to pursue LEED EBOM certification, they will build upon the work the SIBHS team conducted, to reduce their environmental impact, and become a positive influence on the surrounding community, and serve as a model of sustainability for other healthcare organizations.

3. Introduction

3.1. The Problem and Need

Royal Oak Beaumont Hospital teamed up with University of Michigan master's students, Practice Green Health and Jones Lang LaSalle to conduct research on technologies and methodologies to improve the hospital's impact on the environment and to implement new strategies that will earn Beaumont LEED credits with the goal of achieving LEED Existing Building Operations & Maintenance (EBOM) certification based upon the LEED Version 4 (v4) platform (USGBC, 2013). As healthcare facilities are among the highest energy-consuming structures and can psychologically impact employees and patients, as well as physically impact the surrounding communities, this project aims to help Beaumont reduce its energy usage, create sustaining green spaces and act as an example for other healthcare facilities to follow.

Beaumont Hospital in Royal Oak, Michigan and similar healthcare facilities were the target audiences for this master's project.

1.1.1. Sustainability in the Healthcare Sector

Today the healthcare industry faces many challenges, such as reducing rising healthcare costs and lowering adverse environmental impact. Environmental sustainability is coming to the forefront as a way to address these challenges. Cost reduction from greater energy, water and material efficiency and conservation efforts can address rising healthcare costs.

3.1.1. Energy & Atmosphere

In 2009, healthcare organizations spent $7.4 billion on energy, an estimated 1-3% of their total operating expenses or 15% of profits (Singer et al., 2009; U.S. DOE, 2009). As hospitals operate 24 hours a day and run high energy-demanding heating, ventilation and air conditioning (HVAC) systems and equipment, hospitals contribute to 8% of commercial energy consumption in the United States despite accounting for only 4% of the commercial floor space, and their energy demands are rising (U.S. DOE, 2010). With constant changes requiring health providers to become increasingly operationally efficient, energy efficiency improvements provide an opportunity to reduce operating costs without sacrificing service quality. With the unpredictability of future energy costs, it is not only financially smart, but necessary when taking into account the energy security that comes from reducing energy consumption. Furthermore, trends in hospital construction suggest that the healthcare facility market sector will continue to be an important target for energy efficiency measures; studies have shown that hospital energy use intensity is increasing because advances in medical and information technology (U.S. DOE, 2007; Guenther, 2013). As Beaumont Health System works towards LEED EBOM, the energy and atmosphere credit area represents a unique challenge because many of their older buildings consume more energy per square foot than prerequisite requires. Beaumont will have to make widespread energy efficient upgrades to reach the energy use benchmark.

3.1.2. Sustainable Sites

Large scale developments covered with buildings can have a major impact on the environment due to the extent of impervious surface coverage and site location within the watershed. Impervious surfaces impede the infiltration of stormwater through soil for water quality improvement and to replenish the local water table. As impervious surface area increases, more stormwater remains above ground until it is directed into Beaumont's combined sewer systems. During large storm events, this system can overflow and pollute the environment with raw sewage and contaminated surface runoff. LEED sustainable sites credits, as well as the standards set by the Sustainable Sites Initiative, require the use of strategies to minimize the impact of problems such as stormwater runoff and Greenhouse Gas emissions from transportation, urban heat island effects, groundwater pollution associated with the application of synthetic herbicides and pesticides, and overuse of freshwater resources. Proper land development can help to reduce localized ambient air temperatures by 30°C and irrigation needs by up to 100%. The cumulative power of urban trees alone creates significant savings when accounted for throughout an entire region. For instance, in New York City it is estimated that "urban trees intercept almost 890 million gallons of rainwater each year… saving the city an estimated $35 million annually." Additionally, Chicago saves about $9.2 million each year as trees help to remove 6,000 tons of air pollutants (SITES, 2014).

1.2. Materials & Resources

In the United States, hospitals produce 5.9 million tons of waste every year (PGH, 2014). It is vital for hospitals to consider how the materials they purchase and use within the building impact their staff and patients as well as what happens to the materials at the end of their life. Incorporating product life cycle thinking into material purchasing and usage plans allows hospitals to gain a better understanding of the impacts materials and resources have on people and the environment beyond their initial use. This in turn promotes wiser purchasing and product usage decisions that reduce the overall environmental impact of a hospital by using more sustainable products. Several LEED EBOM v4 prerequisites require Beaumont Health System to adopt policies around sustainable purchasing, material conservation, and waste reduction.

3.2. Green Education and Communication

To support the energy and atmosphere and sustainable sites initiatives, engaging Beaumont Health Systems staff and potential donors is crucial. Efforts to increase awareness of the projects being implemented in the hospital will foster an environment of acceptance and pride in changes to improve hospital sustainability practices and enhance staff and patient well-being in the hospital. Ensuring hospital leadership for implementation of sustainability initiatives is particularly crucial as it communicates the importance of sustainability to the health system as a whole.

4. Background

4.1. Beaumont and the Green Team

Founded in 1955, the William Beaumont Hospital is the 20th largest hospital in the United States, and is a regional health care provider for Metro Detroit. Opening with 238 beds in Royal Oak, the hospital continued to expand to neighboring Troy and Grosse Point, adding nearly 700 beds (Beaumont, 2013). The largest of the three Beaumont Campuses, Royal Oak Beaumont is a 1,070 bed tertiary hospital with an Imaging Center, the Comprehensive Breast Center, the Beaumont Cancer Center, the Vascular Services Center, the Beaumont Heart Center, the Research Institute and the Medical Office Building (Beaumont, 2013).

Beaumont is devoted to the health of its patients, employees, guests and community. As such, it is integrating sustainability measures throughout its healthcare system, and its sustainability mission is as follows:

Beaumont Health System is committed to providing the highest quality health care services in an efficient, effective and compassionate manner and to implementing solutions to provide a healthy environment for patients, guests, staff and the local community to ensure optimal public health and to reduce the Health System's impact on the environment for a healthier future (Beaumont, 2013).

To better uphold the sustainability mission, Beaumont's Green Team was established in 2010 to implement cost-effective solutions to reduce waste and conserve energy while educating employees about sustainability issues. To date, the Green Team has about 550 members including doctors, nurses, administrative staff and others, with the goal of increasing its membership to 1,000 members system wide by the end of 2014.

To further its mission, the Green Team implemented its Sustainability Kaizen program. "Kaizen," the Japanese for "improvement," means the opportunity for quick initiatives performed to improve hospital-wide sustainability and save money. Through Sustainability Kaizens at Beaumont, 6-8 Green Team members examine a hospital department to determine areas of improvement and next steps to implement change. Green Team members work closely with department staff to educate them about greening their departments and quickly making changes to ensure ongoing, sustainable savings. Sustainability Kaizen events last two days and are performed on a monthly basis (Winokur, 2014).

4.2. LEED

Leadership in Energy & Environmental Design (LEED) is a rating system that evaluates the design, construction, operation and maintenance of buildings, homes and neighborhoods. Developed by the

U.S. Green Building Council (USGBC), LEED certification verifies that a building was designed and built to achieve high performance ratings across a variety of categories that affect human and environmental health. These categories of sustainable action - sustainable site development, water savings, energy efficient, materials and resources, and indoor environmental quality, are defined in lists of prerequisites and credits. To become LEED certified, the prerequisites must be met while credits are strategies that can be selected among as long as total project credits meet a set standard. The number of credits achieved by a project determines its certification level: Certified (40-49 points), Silver (50-59 points), Gold (60-79 points), or Platinum (80 points and above) (USGBC, 2013).

4.2.1. LEED v4.0

At the beginning of the SIBHS team's project, LEED Version 3 (v3) was the most current version being used to certify buildings. In November2013, Version 4.0 (v4) was released, which improved the rating system and broadened the scope of credits. Version 4.0 is not only technically more rigorous, but also has greater clarity, usability, and functionality than LEED v3. LEED v4 requires greater material transparency, which allows for a better understanding of product composition, use and lifecycle, as well as the origin of product materials. Consequently, the SIBHS team's deliverables are based on LEED v4, whose contents and details of the credits remained the same as LEED v3 but with credit titles changed.

4.2.2. LEED EBOM

LEED for Existing Buildings: Operations & Maintenance (EBOM) encourages building owners of existing buildings to implement sustainable practices to reduce their environmental impact. Major aspects of daily building operations addressed in LEED EBOM include exterior building site maintenance programs, water and energy use, environmentally preferred products and practices for cleaning and alterations, sustainable purchasing policies, waste stream management, and ongoing indoor environmental quality. By continuously applying sustainable strategies throughout its life, a building can maintain and improve its performance over time (USGBC, 2013)

In 2011, LEED for Healthcare was launched. This rating system was tailored to distinguish high performance healthcare projects. However, LEED for Healthcare only addresses new building design and construction.

4.2.3. LEED Categories Chosen

The SIBHS team addressed four specific sections of LEED EBOM credits: (1) Sustainable Sites; (2) Energy and Atmosphere; (3) Material and Resources; and (4) Innovation in Operations. Within these sections, the SIBHS team chose specific prerequisites or credits to address, choosing the most feasible credits based on project timeline, team interest and client need.

For the Sustainable Sites category, the team focused on Site Management Policy (a prerequisite), Rainwater Management, Site Management and Site Improvement Plan (Section 7).Details of the credits can be found in Appendix .

For the Energy and Atmosphere category, Optimizing Energy Performance and Existing Building Analysis were in focus (Section 8).

For the Materials and Resources category, the policies were developed (Section10) to satisfy the prerequisite credits of LEED EBOM, shown in Table 2.

TABLE 2: LEED EBOM MATERIALS AND RESOURCES CREDITS AND POSSIBLE POINTS

Credit	Name	Possible Points
MR – Credit 2	Purchasing – Facility Management and Renovation	2
MR – Credit 4	Solid Waste Management – Ongoing	2
MR – Credit 5	Solid Waste Management – Facility Management and Renovation	2

Source: USGBC, 2013, http://www.usgbc.org/sites/default/files/LEED%20v4%20User%20Guide_Final_0.pdf

Innovation in Operations allocates 5 possible points to encourage projects to achieve exceptional or innovative performance. Innovations in Operations credits allow any combination of innovation, pilot and exemplary performance strategies. To meet the credit requirements, the SIBHS team created a therapeutic garden design to promote patient healing and provide multiple areas for families to gather and doctors to utilize the therapeutic garden space (Section 7).

4.3. Practice Greenhealth

Practice Greenhealth (PGH) is the Nation's leading nonprofit membership and networking organization for healthcare community organization committed to sustainable, environmentally preferable products and practices. Members include hospitals and healthcare systems, healthcare providers, manufactures and service providers, architects, engineer and designers, group purchasing organizations and other affiliated non-profit organizations. PGH provides environmental solutions for the healthcare sector and lends support in hopes of creating better, safer, greener workplaces and communities. Practice Greenhealth promotes sustainable health care that is good for the environment, good for patients and staff, and good for the bottom line (PGH, 2014) Primary foci are to eliminating mercury, reduce and recycle solid waste, reduce regulated and chemical waste, reduce energy and water consumption and establish green purchasing policies to create healing environments for patients.

5. Case Studies for Practice Greenhealth

For PGH, the SIBHS team developed four case studies. The case studies were developed for the use of other partner hospitals as a reference tools for implementing sustainability projects in their hospitals.

5.1. Methodology

The SIBHS team's primary PGH contact, Cecilia DeLoach Lynn, placed the SIBHS team in touch with three PGH member hospitals to conduct the case studies. Mrs. DeLoach Lynn provided a suggested list of preliminary questions, as well as a template for the case studies consistent with the format of the other PGH case studies. Given the case study topics (discussed further in Section 5.2), the SIBHS team expanded upon the preliminary list of questions and outline template. The SIBHS team conducted interviews of staff from the partner hospitals. This provided a detailed understanding of sustainability projects established in the hospitals. Following interviews, the SIBHS team drafted the case studies and shared first drafts with the parties interviewed to verify the information and to expand descriptions where necessary. Revised drafts were then delivered to Mrs. DeLoach Lynn at PGH for review.

The next round of revisions began once edits were received from PGH. The SIBHS team conducted follow-up interviews with the partner hospitals to fill in gaps and receive clarifications on the case studies as necessary. Final drafts of the case studies were then delivered to PGH for publication on their website (practicegreenhealth.org).

5.2. Topics

Four topics were researched, one concerning sustainable sites and the three others focusing on energy efficiency.

1) Therapeutic Gardens – Legacy Health System, Portland, Oregon
2) Combined Heat and Power (CHP) – New York Presbyterian Weill Cornell Medical Center, New York City, New York
3) Light Emitting Diode (LED) Implementation – LifeBridge Health System, Baltimore, Maryland
4) Tackling Reheat – University of Michigan Cardiovascular Center, Ann Arbor, Michigan[1]

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[1] See Appendix A, Appendix B, Appendix C and Appendix D for the completed case studies.

6. LEED Credits

Leadership in Energy and Environmental Design (LEED) credits pertaining to the SIBHS project are outlined in this section. To better understand the credit coverage associated with all facets of the SIBHS project, each of the following will be addressed:

- Description of LEED v4 credit criteria;
- What the SIBHS team did to address the credit (i.e. formal report or incorporation into proposed redevelopment); and
- Description of how each process was developed.

6.1. Initial Credit Research

Preliminary research was conducted to address LEED v3 credits under three categories: (1) sustainable sites; (2) energy and atmosphere; and (3) innovation. During the time in which the initial project proposal was delivered to Beaumont Hospital, USGBC had not rolled out a final draft of LEED v4, as discussed in Section 4.2.1.Therefore, LEEDv3 was referenced in order to begin research with the intention of transitioning into LEED v4 upon its release in November 2013.This shift into LEED v4 created the opportunity to further develop additional credits.

It is important to note that the SIBHS team encountered difficulty in thoroughly addressing credits associated with stormwater management, ecological restoration, water-efficient landscaping, and on-site renewable energy. Unforeseen barriers associated with site development for the proposed therapeutic garden forced many proposed sustainable sites credits to be delayed (see Section 11.9). Although three sustainable sites credits were not developed as thoroughly as anticipated, each is incorporated into the therapeutic garden design provided.

6.1.1. Sustainable Sites Credit Coverage[2]

Focusing on the grounds of the Royal Oak Beaumont Hospital rather than the hospital buildings, primary Sustainable Sites (SS) credits concentrated on stormwater reduction and sustainable land development and management. Habitat restoration was also addressed through the proposed Sustainable Land Management Framework. The following provides an overview of SS credits addressed:

- SS Credit 1: Site Development – Protect or Restore Habitat Option 2 (2 points)

  "To conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity." – LEED v4

  - **Criteria:** Ensure 20% of total site area contains native or adaptive vegetation.
  - **What:** Incorporate said vegetation into final therapeutic garden design.
  - **How:** Approximately 25% of all vegetation in the garden has been designed as a native prairie ecosystem. Flowering perennials such as coneflower and sunflower as well as native grasses and forbs are proposed. These provide habitat restoration for butterflies and birds as well as aid in stormwater management.

- SS Credit 2: Rainwater Management (1-3 points)

  "To reduce runoff volume and improve water quality by replicating the natural hydrology and water balance of the site, based on historical conditions and undeveloped ecosystems in the region." – LEED v4

  - **Criteria**: Use low-impact development to capture and treat stormwater runoff from at least 25% of impervious surfaces.

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[2] Shown point values are potential points available under each credit, not actual points awarded to Beaumont through these processes.

- **What**: Incorporate low-impact features into the therapeutic garden and vegetated roof design.
- **How**: Michigan's Low Impact Development guide was consulted to further develop Beaumont's efforts to recharge the local water table and reduce burden on the combined sewer system. In order to retard discharge initially, two vegetated roofs are proposed directly adjacent to the healing garden. When captured rain exceeds the holding capacity of the green roof, stormwater will be directed to a rain garden within the therapeutic garden space relieving the load being placed upon the combined sewer system.

- SS Credit 3: Heat Island Reduction Option 3 (2 points)

  "To minimize effects on microclimates and human and wildlife habitats by reducing heat islands." – LEED v4

  - **Criteria:** Total vegetated non-roof area + high reflectance roof area + vegetated roof area ≥ total site paved area + total roof area
  - **What**: Incorporate these features into the roof design.
  - **How**: To achieve this credit in the most economical manner while taking into account aesthetics and public awareness opportunities, it is advised to use vegetated roof installations only on visible rooftops directly adjacent to larger facilities (further outlined in vegetated roof section within this document). All other roof retrofits should be white roof installations. Future renovations of parking structures/lots should be focused on vertical extension rather than creating new surface lots if Beaumont wants to achieve this credit. Unutilized hardscaping should be converted to native plant softscapes.

- SS Credit 5: Site Management Option 1 (1 point)

"To preserve ecological integrity and encourage environmentally sensitive site management practices that provide a clean, well-maintained, and safe *building exterior* while supporting high-performance building operations and integration into the surrounding landscape." – LEED v4

- **Criteria**: Employ environmentally sensitive site management practices to provide a clean, well-maintained, and safe building exterior.
- **What**: Incorporate these practices into a land management plan.
- **How**: Currently, Beaumont's softscape is primarily turf. A key component supporting a more sustainable land management plan is the reduction of turf. Turf requires high maintenance which is capital and time intensive. Additionally, turf management typically adds harmful pollutants to the environment through pesticide runoff and mower emissions. Much of the existing turf could be redeveloped as native prairie, reducing the costs of maintenance as well as the cost of stormwater runoff to the client. This is further outlined in the land management plan.

6.1.2. Water Efficiency Credit Coverage

Costs incurred through irrigation are unnecessary in Michigan's water-rich climate. Instead, the proposed land management plan focuses on the incorporation of native plants. This will help Beaumont save money while creating an aesthetically pleasing atmosphere for employees, patients and visitors alike. The following credit was addressed:

- WE Credit 1: Outdoor Water Use Reduction (2 points)

  "To reduce outdoor water consumption." – LEED v4

  - **Criteria:** Reduce site irrigation by 40%.
  - **What**: Incorporate reduced irrigation into land management plan.
  - **How**: To help further reduce irrigation demands, drought-resistant plant species should be selected for future land renovations. The replacement of traditional turf with low-mow,

low-irrigation grasses such as buffalo grass will also conserve water. Detailed information is included in the proposed Sustainable Land Management Framework.

6.1.3. Energy and Atmosphere Credit Coverage

Seventy percent of Metro Detroit's electricity is produced through the combustion of coal, a finite resource. Energy and Atmosphere credits aim to reduce utility usage therefore reducing the cost of building operations in the long-term and the need of fossil fuel resources immediately. This reduction also promotes the growth of cleaner, more sustainable energy systems throughout the region. The following credits were addressed in the SIBHS project:

EA Credit 1: Existing Building Commissioning – Analysis (2 points)

"To use the existing building commissioning process to improve building operations, energy, and resource efficiency." – LEED v4

- **Criteria**: Develop an energy audit plan following the requirements of ASHRAE Level 2, Energy Survey and Analysis, to evaluate efficiency opportunities.
- **What**: Energy audit findings reported in ASHRAE Level 2 energy audit.
- **How**: The ASHRAE document provides suggested energy conservation measures (ECMs) that would reduce the energy consumption of the Medical Office Building. The document focuses on three types of ECMs: Lighting Energy Conservation Measures, Other Energy Conservation Measures, and Low Cost/No Cost Opportunities.

- EA Credit 4: Optimize Energy Performance (20 points)

  "To reduce environmental and economic harms associated with excessive energy use by achieving higher levels of operating energy performance." – LEED v4

  - **Criteria**: Demonstrate increased energy efficiency or efficiency improvement beyond EA Prerequisite Minimum Energy Performance. Each building must provide actual metered energy data. A full 12 months of continuous energy data is required.

- **What**: Conducted an ASHRAE Level 2 energy audit of the Medical Office Building and developed a report summarizing audit findings.
- **How**: Energy performance of the Medical Office Building is tracked and reported in the ASHRAE document, with breakdowns of the natural gas and electricity usage. The document also details the unit cost of energy, the seasonal loads and the pounds of carbon dioxide emitted.

6.1.4. Materials and Resources Coverage

To better manage the sustainability of Royal Oak Beaumont's material purchasing and waste management, the SIBHS developed policies addressing the following Materials and Resources (MR) credits:

- MR Prerequisites 1 and 2: Ongoing Purchasing and Waste Policy & Facility Maintenance and Renovation Policy (required)

  "To reduce the environmental harm from materials purchased, used, and disposed of in the operations within buildings." --"To reduce the environmental harms associated with the materials purchased, installed, and disposed of during maintenance and renovation of buildings." – LEED v4

  - **Criteria**: Implement an environmentally preferable purchasing policy as well as a solid waste management policy which encourages reuse or recycling of materials or composting of proper food waste.
  - **What**: Procedures and guidelines to practices revolving around purchasing and waste are outlined in sustainable purchasing policy and solid waste management policy.
  - **How**: The SIBHS team provided policies that touch base on each of these prerequisites. The scope of these policies include all purchasing activities that are within the Beaumont purchasing department and JLL property management's control as well as management of

the property's solid waste. Purchasing includes, but is not limited to, ongoing consumables, electric-power equipment, maintenance and renovation materials, furniture and furnishings, reduced mercury light bulbs, surgical kit and single use devices. Waste management includes, but is not limited to, recycling and waste control efforts for ongoing consumables; durable goods; construction and demolition activities; batteries and mercury-containing light bulbs, hazardous and medical waste.

- MR Credit 1: Purchasing – Ongoing (1 point)
  "To reduce environmental harm from materials used in the operations and maintenance of buildings." – LEED v4
  - **Criteria**: Purchase 60%, by cost, of ongoing consumables and 40%, by cost, of electric-powered equipment using standards and metrics set by USGBC LEED v4.
  - **What**: Best practices for purchasing outlined in sustainable purchasing policy.
  - **How**: Ongoing purchasing should focus on products manufactured sustainably. Some criteria, but not all, are as follows: postconsumer recycled content, rechargeable batteries, sustainable agriculture (USDA Organic, Rainforest Certified, Fair Trade, etc.) as well as local sourcing of food and beverages, bio-based materials, and sustainably harvested paper and wood products. Additionally, to meet this requirement, appliances must have an Energy Star or EPEAT rating.
- MR Credits 4 and 5: Solid Waste Management – Ongoing & Facility Management and Renovation (2 points each).

  "To reduce the waste that is generated by building occupants and hauled to and disposed of in landfills and incinerators." – "To divert construction, renovation, and demolition debris from disposal in landfills and incinerators and recover and recycle reusable materials." – LEED v4
  - **Criteria**: Fifty percent of ongoing waste should be diverted from landfills while 75% of all durable goods should be recycled or reused. All batteries and mercury-containing bulbs

should be safely disposed of. Additionally, 70% of all base building materials not posing a threat to human health should be diverted from landfills. Percentages are by weight or volume. However, durable goods percentages can be calculated using replacement cost rather than weight or volume.

- **What**: Outlined in solid waste management policy
- **How**: The SIBHS team proposed solid waste management policies promoting material reuse and recycling onsite. The scope of these policies includes management of the property's construction and demolition waste as well as solid waste. Beaumont should ensure construction of eligible alterations or additions will occur during the performance period and work with the contractor and waste hauler to establish a system for managing and tracking construction waste diversion, isolated from ongoing consumable waste. Additionally included, but not limited to, are recycling and waste control efforts for ongoing consumables; durable goods; construction and demolition activities; batteries and mercury-containing light bulbs, hazardous and medical waste.

6.2. Additional Accreditations

It should be advised that LEED is not the only accreditation program which Beaumont has the opportunity to take part in. Additionally, the Sustainable Sites Initiative (SITES) and Healthier Hospitals Initiative (HHI) are programs through which Beaumont has the opportunity to gain certification. The Sustainable Sites Initiative, soon to be further incorporated into LEED, is a certification program focusing on the grounds of a facility. Sustainable land management measures are taken to help reduce the amount of maintenance needed onsite, as well as how much stormwater is discharged from the site to the municipal system. The Healthier Hospitals Initiative takes into account nutrition, energy, and waste, as well as a few other categories similar to LEED, but HHI offers a healthcare-specific certificate. As a participant in HHI, Beaumont has achieved many of the standards necessary for accreditation. The six HHI challenges include:

1) Engage in leadership on environmental health and sustainability
2) Serve healthier foods and beverages
3) Reduce energy use
4) Reduce waste and recycle
5) Use safer chemicals
6) Purchase environmentally preferable products

7. Sustainable Sites

The Sustainable Sites Initiative (SITES) is a collaborative effort between the American Society of Landscape Architects, Lady Bird Johnson Wildflower Center, and US Botanic Garden aimed at reducing environmental impacts created by modern developmental practices. Modeled after the LEED certification system, SITES is also point-based with a total of 250 available points. Certification is divided into a four-tier system; coverage of 40, 50, 60, and 80% of the total 250 points awards 1, 2, 3, and 4 stars to the participating development (ASLA 2014).

Updates in LEED v4 have taken a page out of SITES' book and more LEED credits now address the lands surrounding the building structures. As such, Beaumont has become increasingly interested in pursuing LEED credits related to SITES specifications. Additionally, due to high grounds maintenance expenses associated with a large campus of nearly 1.3 million square feet, Royal Oak Beaumont is looking for innovative strategies to reduce costs and green the campus. Areas of interest for improvements at Royal Oak Beaumont include the use of drought-resistant plants, naturalized areas where mowing is unneeded, onsite stormwater infiltration, habitat restoration and even public usage with the intent of reducing long-term operations and maintenance costs, as well as supporting the growth of a healthier microenvironment.

The National Renewable Energy Laboratory (NREL) in Colorado is a SITES-certified project with a similar size and function as the Royal Oak Beaumont Hospital. Achieving a 3-star rating, the total area of the suburban project adds up to a little less than 30 acres. NREL has developed a comprehensive "Landscape Maintenance Procedure" providing mandatory guidelines for existing and future grounds projects on their 327-acre property. A landscape management plan was developed for Royal Oak Beaumont based on the NREL guidelines to provide guidance for future landscape modifications.

7.1. Therapeutic Garden Report and Designs

7.1.1. Goal

The United States is seeing a large therapeutic gardening movement including hospitals such as Portland's Legacy Health System and the Kellogg Eye Center in Ann Arbor. Chicago's Botanical Gardens offer an extensive therapeutic gardening research program and degrees are even being created to help support the growing demand for horticultural therapists. Studies show that patient exposure to natural green space can help reduce stress in patients, visitors and employees alike; this reduction in stress can lead to quicker patient recovery and lower operational costs for the hospital (Marcus and Barnes 1999).

Lacking proper outdoor space for patients and employees alike, Royal Oak Beaumont has a need for a functional, accessible green space. To address Beaumont's need for an outdoor therapy space, the SIBHS team worked to develop plans for a therapeutic garden that includes design elements necessary to meet LEED v4 criteria. Specifically, the SIBHS team aimed to develop designs for a custom therapeutic garden design with a report detailing the key elements essential to a therapeutic garden (see Appendix E), while also providing information that is pertinent to the success of a therapeutic garden.

7.1.2. Methodology

Initial research began with a review of the literature and the development of a case study based on the therapeutic garden work implemented by Legacy Health System in Portland, Oregon. Legacy is the nation's leader in healthcare gardening and has developed various gardens with accompanying data to help show that therapeutic gardens are feasible and lucrative. Other literature by industry professionals such as Roger Ulrich, Claire Cooper Marcus and Marni Barnes was reviewed. Through this research, the SIBHS team gained insight into the types of elements that needed to be incorporated into the design.

With relevant therapeutic elements in mind, the SIBHS team conducted extensive interviews with doctors, patients, horticultural therapists, therapeutic garden professionals, and landscape architects. These professionals were asked what kind of garden elements would be valuable for future users of the garden space at Royal Oak Beaumont. Additional interviews were conducted with Theresia Hazen of Legacy Health System and Brian Bainnson of Quatrefoil, Inc., both experts on therapeutic garden design.

7.1.3. Results

Three different sites were thoroughly evaluated and then compared for their potential to house the therapeutic garden. Although the final space recommended for the construction of the garden was the smallest of the three proposed sites, it had the best visibility and accessibility, being directly adjacent to the cafeteria and a primary patient entrance. After client approval to move forward on the team's selected site, a therapeutic garden design was developed based on analysis of physical characteristics of the site, the stakeholder interviews and the literature review. These considerations were also applied with consideration of how other LEED certification credits might be satisfied. The final garden design included elements intended for use in patient therapy. These include stairs, ramps, and plants for sensory impact (textural and aromatic species), plus raised and lowered beds for horticultural therapy. In addition, the use of native and water-efficient plant species, plus the re-use of existing materials for hardscape areas helped to earn other credits associated with LEED v4 certification. Accessible on three sides, the therapeutic garden space is the most centrally located of the three proposed areas first marked for redevelopment.

7.2. Vegetated Roof Analysis

7.2.1. Goal

The SIBHS team developed a report detailing the benefits of installing green roofs, as well as the costs associated with installation and return on investment (ROI) (see Appendix). Vegetated roofs are appealing to healthcare facilities due to their air pollution mitigation capabilities. Common urban air pollutants tend to be reduced in the immediate vicinity of vegetated roofs (Getter and Rowe 2006). In a setting where patients can be very susceptible to airborne bacteria and particulate matter, vegetated roofs can help reduce the chance of patients being affected by sulfur dioxide, nitrogen dioxide, and nitrous acid. As such, Royal Oak Beaumont, its patients, staff and visitors would greatly benefit from the installation of vegetated roofs.

7.2.2. Methodology

Research for the proposed vegetated roof installation was performed by conducting a formal literature review. Case studies primarily focused on vegetated roofs in climates similar to Royal Oak, Michigan. In addition, multiple interviews were conducted with retired architect Paul Goldsmith of Harley Ellis Devereaux. Mr. Goldsmith played a major role in the design and development of the Ford Rouge Plant in Dearborn, MI. This building houses one of the largest vegetated roof installations in the world at 10.4 acres. It served as inspiration for the team report which discusses the pros and cons of vegetated roof installations and the basis of a final recommendation.

7.2.3. Results

Due to Royal Oak Beaumont's upcoming expansion on the north side of the campus, the proposed vegetated roof installation takes into account the additional, currently non-existent roof area. Since 50% of Beaumont's entire roof must be vegetated to gain LEED accreditation, nearly eight acres of vegetation must be installed. With an initial investment of nearly $15 million, the return on investment would be nearly 130% over the lifetime of the roof (40 years) or about $4.2 million. The installation also has the potential to save Royal Oak Beaumont Hospital between 5-15% on annual heating and cooling costs. In addition to the economic benefits of installing a vegetated roof, LEED credits would be earned.

Recommendations included the following: The majority of the installations should be located on low-lying rooftops where a cost savings from heating and cooling can be best realized (FLL, 2002). Since visibility and therefore awareness, is greater for lower rooftops, patients, staff and visitors are more likely to see and enjoy them. The green roof will be an “extensive” system, meaning that it holds less than 4 inches of planting media. The team was told that most of Beaumont’s roof structure is strong enough to support loads associated with such systems. Additionally, in areas where roof restructuring would potentially be an issue, a lightweight tray system should be used to reduce additional live loads.

7.3. Sustainable Land Management Framework

7.3.1. Goal

To achieve LEED credits under the Sustainable Sites umbrella, Beaumont hospital is required to develop and employ a site management policy fostering sustainable land management practices. Although no credits are awarded initially through this process, as it is a prerequisite, the foundation upon which it sets will lead to further accreditations within the Sustainable Sites category.

7.3.2. Methodology

As LEED continues to absorb additional Sustainable Sites Initiative (SITES)[3] credits each year, the focus of the framework proposed to Beaumont is modeled to not only achieve LEED certification but to account for supplementary SITES credits as well.

In order to develop a more-standardized framework for Beaumont, existing management plans within SITES were sought out. The most pertinent framework was the United States Department of Energy's National Renewable Energy Laboratory's *Site Sustainability Plan FY 2013*. This plan addresses and defines ecologically sustaining land management practices for existing grounds as well as for new construction.

7.3.3. Results

The proposed *Sustainable Land Management Framework* that SIBHS has provided to Beaumont acts as a reference for future land management practices throughout the Royal Oak campus (see Appendix). Best management practices regarding erosion and sedimentation control, invasive and exotic plant species management, and fertilizer use were selected. There are also recommendations for LEED's Site Management Policy prerequisite that include the use of low emissions maintenance equipment, exterior cleaning supplies, and storage of materials and equipment.

8. Energy and Atmosphere

The Energy and Atmosphere section of the SIBHS project aimed to optimize the energy performance of Beaumont Health System buildings and reduce the inefficiency of building systems during operation. The team conducted an analysis of installing window films in two large atriums and an energy audit of the Medical Office Building (MOB) on campus based on ASHRAE 90.1 guidance. The estimated payback

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[3] The Sustainable Sites Initiative is a separate accreditation system headed by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at The University of Texas at Austin and the United States Botanic Garden.

period for replacing the window films currently on the atriums of the South Hospital addition and the East Critical Care Tower is only three years. Implementing twelve energy conservation measures (ECMs) would improve the energy performance of the MOB and lead to an annual saving of $123,067 and ROI of 33%.

8.1. Window Film Report

8.1.1. Goal

Beaumont Health System at the Royal Oak campus is striving to improve the energy efficiency of their buildings and move towards a LEED EBOM certification. In both atriums of the South Hospital Addition and the East Critical Care Tower, Beaumont has experienced recurring issues with poor thermal comfort. Complaints have been reported in both atriums. Poor thermal comfort is linked to low employee productivity and organization efficiency. The high temperatures in the atriums during afternoons in the summer months also require the HVAC system to work at its maximum capacity in order to cool the spaces. As such, the SIBHS team analyzed the feasibility of installing window films in the atriums of the South Hospital Addition and in the East Critical Care Tower.

The goal of the window film installation feasibility analysis (see Appendix) developed by the SIBHS team was to provide a comprehensive evaluation on solar heat gain and daylight hours in both atriums, and the potential solutions to eliminate the comfort issues as a result of the daylight and solar heat gain. It also provided insight on replacing the existing window films in the atriums of the South Hospital Addition and the East Critical Care Tower. Overall, the analysis found that installation of window films would improve the energy efficiency, while also being cost-effective.

8.1.2. Methodology

The SIBHS Team conducted two on-site visits at the Beaumont Royal Oak campus to take pictures and measurements in both atriums. Beaumont personnel provided detailed technical drawings of the atriums and properties of the atrium glass. This enabled the SIBHS team to set up a daylight-analyzing model in AutoDesk's Ecotect software. Ecotect is able to produce detailed daylight and solar heat gain analysis of the atrium. Only the South Hospital Addition atrium was modeled. Other buildings surround the East Critical Care Town, thus it was not possible to model this atrium. The average daylight hour distribution diagram (See Appendix A, Figure2) was developed to illustrate the importance of applying shading devices and where to prioritize the installation of such devices. Several retrofit and replacement options were analyzed regarding project cost, payback period, performance, and operation and maintenance. The options analyzed and presented include window replacement, shading devices, and window films.

Upon analysis of the various options, window films were recognized as the best option. In turn, a comprehensive technical and market research analysis was conducted to determine the most desirable properties of window films (U-value, total solar energy rejected, net visible transmittance, and solar heat gain coefficient), as well as the most appropriate products on the market. Four grades of window films, namely basic performance, medium performance, high performance and low-e window film were selected for analysis. A financial analysis was conducted to ensure the payback period was within Beaumont's maximum acceptable payback period. A sensitivity analysis was also used to investigate the impact of higher or lower window film prices on the payback period.

8.1.3. Results

The daylight model simulation showed that the center of the South Hospital Addition atrium is exposed to the sun for more than eight hours a day, while the ridges of the atrium receive less sunlight, in terms of daylight hours (see Appendix H). As such, the SIBHS team recommended Beaumont focus resources on shading the center of the South Hospital Addition atrium first. Window films are also the best option as installation and maintenance costs are lower in comparison to the other options analyzed in the report. As window films were identified as the most feasible option, it was also recommended that

Beaumont focus on the following properties when selecting window film for the atriums as these properties have the greatest impact on heat and solar reduction in colder climates:

- U-value: A measure of heat transmitted through a building element with a lower number indicating better insulating properties
- Total Solar Energy Rejected (TSER): The percentage of all energy from the sun reflected away from a surface
- Net Visible Transmittance (NVT): Amount of light in the visible portion of the spectrum that is being transmitted through the window
- Solar Heat Gain Coefficient (SHGC): The fraction of incident solar radiation admitted through the window, both directly transmitted and absorbed and subsequently released inward

The financial analysis showed that the low-e window film is the most appropriate product for both atriums. In the South Hospital Addition atrium, the payback is estimated at 3.1 to 3.6 years with annual CO_2 emission savings of around 156,000 pounds, assuming a price range of $14 to $15 per square foot, respectively. In the East Critical Tower atrium, the payback is estimated at 3.3 to 3.9 years with annual CO2 emission savings of around 54,000 pounds assuming a price range of $14 to $15, respectively. The sensitivity analysis showed that marginal benefits of installing window film in the atriums decreased significantly after the price rose over $11 per square foot.

Based on the results, it is recommended that Royal Oak Beaumont first explore retrofitting the atrium in the South Hospital Addition with low-e window film because the payback period is low, and, as the space is larger, retrofitting it would have a greater impact on adjacent offices. After retrofitting the South Hospital Addition atrium, it is recommended that the East Critical Care Tower atrium then be retrofitted with high performance window film because the space is smaller and payback is longer.

8.2. ASHRAE Level 1.5 Energy Audit for Medical Office Building

8.2.1. Goal

The ASHRAE Level 1.5 Energy Audit report was conducted to benchmark energy usage in the Medical Office Building (MOB) on Beaumont's Royal Oak campus (see Appendix). Through this audit, the facility manager will be able to better compare the performance of the MOB to other buildings of similar use. In addition to benchmarking, the report was also developed to determine energy conservation measures that would lower the MOB's operational and maintenance costs.

8.2.2. Methodology

The methodology applied to conduct the audit was based on the Level II Energy Survey and Engineering Analysis of the 2004 edition of Procedures for Commercial Building Energy Audits published by the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE). A Level II energy audit Report includes an executive summary, billing analysis of a 12 to 36 month period, a systems/equipment inventory, energy conservation measures (ECMs) with detailed financial analysis, and detailed incentives available for retrofitting.

The detailed processes of conducting an energy audit are shown below:

1) Pre-site work: Utility energy data collection and review, benchmarking, mechanical, architectural and electrical drawings and specifications collection.
2) Site visit: Interview with building manager, visual inspection and take notes of all systems, taking pictures, identify weakness that could be improved and potential ECMs and O&M.
3) Post-site work: Review and input notes for analysis, conduct research and analysis, propose ECMs and O&M lists, and write all of the finding in a report.

During the processes, the SIBHS team worked together with Beaumont Service Company team and JLL facility management team at Beaumont. JLL facility management provided detailed building schedule, system schedule and information for the MOB.

8.2.3. Results

The energy use benchmarking result shows the annual average energy use intensity (EUI) for the MOB is 80.4 kBtu per square foot during the 2011-2012 period, which is lower than the average EUI for a typical health care building in the U.S. of 95 kBtu per square foot per year. However through the interview with facility management team and the site walk-through, 12 ECMs including low cost/no cost opportunities have been identified to improve the operation and occupancy comfort and reduce energy consumption and costs.

Table 3summarizes the recommended projects, their annual energy savings, installation costs, and payback periods.

TABLE 3: SUMMARY OF ENERGY CONSERVATION MEASURES

ECM	Description	Cost ($)	Annual Utility Savings ($/Year)	Simple Payback (Years)	ROI
1001	Delamping	$300	$1,270	0.24	423%
1002	Lighting Occupancy Controls	$4,224	$780	5.4	18.5%
1003	Daylight Harvesting	$10,000	$6,570	1.52	65.7%
1004	Apply VFDs to Fan Motors	$66,500	$41,100	1.62	62%
1005	Premium Efficiency Motor Replacements	$ 32,232	$ 41,276	0.78	128%
1006	Pneumatic to DDC	$ 264,000	$30,223	8.74	11.4%
1008	Unoccupied Setback	N/A	N/A	N/A	N/A
1009	Building Envelope Improvements	$200	$1,848	0.11	909%
1010	Training Cleaning Crew	N/A	N/A	N/A	N/A
1012	Vending Machine Energy Misers	$129/unit	$149/unit	.86	115%

9. Communications

Communicating and quantifying how sustainability initiatives can save money and support the mission of hospitals to promote and protect health is integral to the implementation of and continued support for sustainability activities. Educational materials promoting the greening of the hospital assist in disseminating information about various activities taking place in the hospital and provide employees, visitors and patients with the opportunity to make an impact and get involved. By providing communication materials both in hard-copy and online, Beaumont is solidifying environmental sustainability as a core value in its business culture.

Through this project, the SIBHS team created a variety of educational and informational materials. Documents, such as the Window Film Report, Therapeutic Gardens Report, and Vegetated Roof Analysis (see Appendix H , Appendix E and Appendix F respectively) served as educational tools and guidance documents to inform Beaumont of its options moving forward with various initiatives. As discussed in Sections 7 and 0, these documents provided Beaumont with the information necessary to pursue viable options for improving the environmental sustainability of the hospital, meeting LEED EBOM requirements, and doing so in a cost effective manner.

The 2014 Royal Oak Beaumont Sustainability Review (see Appendix J) served as the SIBHS team's primary outreach document. The Sustainability Review was created to communicate the importance of sustainability in healthcare and highlights the most prominent initiatives Beaumont has undertaken to further its sustainability mission. Quantitative information regarding cost savings realized through the implementation of practices such as the Sustainability Kaizens and reductions in water and energy consumption is provided in the Sustainability Review. Data presented encompasses Beaumont's efforts to green the Royal Oak campus from 2010 through 2013. In addition, the Sustainability Review summarizes Beaumont's commitment to the Healthier Hospitals Initiative (HHI),[4] its achievements in addressing HHI challenges and Beaumont's future outlook on improvements to be made to optimize the health environment of the hospital.

The SIBHS team also conducted an interactive presentation with nearly 50 Beaumont employees to communicate the benefits of their work for the hospital. The SIBHS team provided an overview of the project, the Window Films Report, the ASHRAE Audit, the 2014 Royal Oak Beaumont Sustainability Review and the therapeutic garden designs. Through the presentation, Beaumont employees were encouraged to promote sustainability in their departments and the SIBHS team helped them think of new ways to green the hospital.

10. Materials & Resources

10.1. Introduction

Material and Resources (MR) is one of the six main credit categories listed in the LEEDv3 Rating System. The MR credit encourages the use of sustainable materials and the reduction of waste throughout the operation and maintenance of the building life cycle. The MR rating system includes two pre-requisite policies and nine credits, as shown below.

Pre-requisite Policies

- MRp 1 Sustainable purchasing policy
- MRp 2 Solid waste management policy

Credits

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[4] HHI is an organization that has developed six challenges "to help healthcare organizations commit to sustainability goals and track their environmental efforts" (HHI 2014). Beaumont joined HHI in 2011 to reduce adverse health and environmental impacts.

- MRc 1 Sustainable purchasing - ongoing consumables
- MRc 2.1 Sustainable purchasing - electric-powered equipment
- MRc 2.2 Sustainable purchasing - furniture
- MRc 3 Sustainable purchasing - facility alternations and additions
- MRc 4 Sustainable purchasing - reduced mercury in lamps
- MRc 5 Sustainable purchasing - food
- MRc 6 Solid waste management - waste stream audit
- MRc 7 Solid waste management - ongoing consumables
- MRc 8 Solid waste management - durable goods
- MRc 9 Solid waste management - facility alternations and additions

In 2013, Beaumont Health System asked the SIBHS team to investigate the MR credits for LEED certification and to draft corresponding policies recording current conditions and providing future guidance. The SIBHS team conducted interviews and site visits, and based on the information gathered, the SIBHS team drafted three policies in compliance with LEED MR requirements: (1) Sustainable Purchasing; (2) Solid Waste Management; and (3) Construction and Demolition Waste Management.[5]

10.2. Sustainable Purchasing

10.2.1. Goal

In developing a new Environmental Building Operations Policy for Sustainable Purchasing (see Appendix), the SIBHS team's goal was to prioritize the purchasing of products that are environmentally friendly and socially beneficial. Overall, the Sustainable Purchasing Policy is a document used to ensure

[5]The policies were written prior to the adaptation of the new LEED v4 Rating System. The specific changes in LEED v3 versus LEED v4 are discussed in Section 4.2.1.

Beaumont is being economical, environmentally friendly and socially responsible. Additionally, all products purchased and services contracted must support the following key concerns:

- Energy Efficiency
- Water Conservation
- Indoor and Outdoor Air Quality
- Waste Reduction and Management
- Improved Live/Work/Therapeutic Environment
- Bottom Line Improvements

Specifically, the building management seeks to purchase the following:

- At least 60%, by cost, of total ongoing consumables that meet the criteria specified;
- At least 40%, by cost, of electric-powered equipment;
- At least 50%, by cost, of the total maintenance and renovation materials; and/or
- At least 75% by cost of total furniture and furnishings and/or make no alternations to the project space and purchase no furniture; and
- An overall building average of 70 picograms/lumen-hour or less for mercury-containing bulbs.

In addition, the Sustainable Purchasing Policy aims to achieve the Level III Smart Purchasing Challenge established by the Healthier Hospital Initiative. The Level III Smart Purchasing Challenge requires the hospital to commit to surgical kit review, single use device reprocessing and electronic products environmental assessment tool (EPEAT) purchasing goals.[6]

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[6]Surgical Kit Review: review at least 30 custom surgical O.R. kits or 80 percent of O.R. kits type
Single use device reprocessing: increase expenditure of reprocessed FDA-eligible single use device by 50 percent
Electronic Products Environmental Assessment Tool (EPEAT): Specify and report expenditures on EPEAT registered devices

10.2.2. Methodology

Prior to the SIBHS team's development of the Sustainable Purchasing policy, Beaumont's purchasing department did not have a standardized policy purchasing more sustainable products. The SIBHS team documented Beaumont's current purchasing practices, compared them to the LEED MR Sustainable Purchasing Policy criteria and informed Beaumont of recommended changes to their purchasing policies that would need to be made to comply with LEED. The SIBHS team then developed a Sustainable Purchasing policy in compliance with LEED that was tailored to Beaumont's needs and operations.

The scope of the Sustainable Purchasing policy includes all purchasing activities that are within the Beaumont purchasing department's and JLL property management's control. This includes, but is not limited to, the purchase of ongoing consumables, electric-power equipment, maintenance and renovation materials, furniture and furnishings, reduced mercury light bulbs, surgical kit and single use devices. The policy also specifies the procedures and strategies that will be employed. The Director of Purchasing Operations will be responsible for informing all hospital personnel and occupants of this policy.

The information contained in the Sustainable Purchasing Policy was based on the requirements of LEED MRp1, and MRc1 through MRc5. In addition, the SIBHS team gathered feedback through interviews with the Beaumont Purchasing Team in Troy, Michigan and with the property management company, Jones Lang LaSalle. Necessary amendments were made and incorporated into the final version of the policy to justify Beaumont's limitations.[7]

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[7]Personnel interviewed for Sustainable Purchasing Policy:

1. Geraldine Drake, NCIDQ, LEED Green Associate, Interior Design Program + Standards Manager, Real Estate Development + Planning, Jones Lang LaSalle at Beaumont Health System
2. John Harrnois, Beaumont Purchasing Manager

10.2.3. Results

The Sustainable Purchasing Policy developed for Beaumont Health System's Royal Oak Campus by the SIBHS team satisfies Pre-requisites 1 and 2, and Credits 3 through 5 within the Material & Resources Category of the LEED Rating System. The policy was implemented at Beaumont on January 1st, 2014 and will be included in future purchasing and service contracts.

10.3. Solid Waste Management

10.3.1. Goal

In developing a new Environmental Building Operations Policy for Solid Waste Management (see Appendix), the SIBHS team's goal was to reduce the amount of solid waste that is transported to landfills or incineration facilities through the practices of recycling, reusing or composting materials through the implementation of the policy. The policy also aims to divert 50% of recyclables from landfill or incineration.

10.3.2. Methodology

The scope of the Solid Waste Management Policy developed for Beaumont by the SIBHS team includes management of the property's solid waste. This includes, but is not limited to, recycling and waste control efforts for ongoing consumables, durable goods, construction and demolition activities, batteries, and mercury-containing light bulbs, hazardous and medical waste.

The Solid Waste Management Policy developed by the SIBHS team specifies the procedures and strategies that will be implemented at Royal Oak Beaumont. Service providers are responsible for carrying out their services in accordance with this policy without exception.

The information contained in the Solid Waste Management Policy was gathered through interviews with several Beaumont Health System and Jones Lang LaSalle personnel.[8] In addition, the SIBHS team conducted a visual inspection of the waste management area at the Royal Oak Campus. The data collected during the visual inspection, along with additional information provided by email after the onsite visit, was incorporated into the final version of the policy.

10.3.3. Results

The Solid Waste Management Policy for Royal Oak Beaumont satisfies Prerequisite #2 within the Material & Resources Category. The policy was implemented on January 1, 2014 and will be included in future waste management contracts. In the future, Royal Oak Beaumont will need to meet the following standards in order to comply with LEED EBOM:

- Divert 50% of all ongoing consumable solid waste produced by the facility
- Recycle 100% of mercury containing lamps
- Divert 75% of all durable goods from landfills
- Recycle of reuse, at a minimum, 80% of total waste generated from facility alterations and additions

10.4. Construction and Demolition Waste Management

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[8]Personnel interviewed for the Solid Waste Management policy:

1. Geraldine Drake, NCIDQ, LEED Green Associate, Interior Design Program + Standards Manager, Real Estate Development + Planning, Jones Lang LaSalle at Beaumont Health System
2. Kris Browning
3. Scott Maglott
4. Mark Simmons

10.4.1. Goal

The Construction and Demolition Waste Management Policy (see Appendix) was created by the SIBHS team to establish best management practices for construction and demolition operation that considers the long-term health and environmental effects of solid waste practices. Construction waste management choices impact the environment by curbing high demand for virgin natural resources while protecting ecosystems from the negative impacts of materials misplaced as a result of poor choices in waste stream management. The Solid Waste Management Policy for Alterations and Additions developed by the SIBHS team addresses these issues by employing environmentally acceptable standards in recycling and waste disposal practices. The following concerns that were highlighted in the policy:

- Diverting waste from landfills
- Improving the live/work environment
- Improving the economic bottom line

The Construction and Demolition Waste Management Policy set a goal of diverting 80% of waste generated by alterations and additions from landfills. This policy also provided details on how performance should be monitored, as well as specific procedures and strategies to be followed when handling construction and demolition waste.

10.4.2. Methodology

The scope of the Construction and Demolition Waste Management Policy includes management of the property's solid waste due to construction and demolition. The policy specifies the procedures and strategies that will be employed and the service providers that are responsible for carrying out their services in accordance with the policy without exception.

The details of the policy were gathered through interviews with Jones Lang LaSalle. A visual inspection of the construction and waste management area at the Royal Oak Campus was conducted and data was collected during the walk-through, as well as through email correspondence after the site visit.

10.4.3 Results

The Construction and Demolition Waste Management Policy went into effect January 1st, 2014 and all construction projects are expected to immediately abide by the policy requirements. The policy will be reviewed and updated in two years and satisfies the MRc2 Solid Waste Management – Facility Maintenance and Alterations portion of LEED EBOM. The policy also satisfies the Healthier Hospitals Initiative of Less Waste: Construction and Demolition Debris Recycling.

11. Challenges

Throughout the project, the SIBHS team encountered various challenges. This section highlights major challenges.

11.1. Topics

In January 2013, the SIBHS project was originally two separate projects, one with Practice Greenhealth and one with Beaumont. However, through the project planning process, it was found that Practice Greenhealth was in need of a healthcare institution looking to pursue LEED, and Beaumont Health System in Royal Oak, MI was in the process of developing initiatives to become LEED certified. As such, the pairing of the two projects was beneficial for both clients and the University of Michigan students as separately neither project had enough students for a full team. With the merging of the two clients into one project, originally seven students from different disciplines were attracted to the project, comprising a full team.

11.2. Team Formation

After about three weeks, seven students were part of the SIBHS team. The team was comprised of two landscape architects, three sustainable systems students, one environmental policy student and one behavior, education and communications (BEC) student. While seven team members provided great diversity in disciplines, the team found it difficult to coordinate the schedules of seven people. The initial team dynamics were strong, however, two students left the team after a few weeks. The BEC student left and joined a different master's project as it tied more closely to his interests, and one of the landscape architects left the SNRE degree program entirely. With the loss of one landscape architecture student, the team found it necessary to recruit a second landscape architect student as significant landscape design work was anticipated in the project. As such, a first-year landscape architecture student joined the group. Although master's teams are typically comprised of second-year landscape architects, all second-year landscape architect students were already working on different projects. However, through negotiations with the Office of Academic Programs and some paperwork, a first year landscape architect student was able to join the SIBHS team.

11.3. Team Scheduling

Having a team comprised of six members proved challenging at times for scheduling purposes. With such a large team and a range of topics covered in one project, the SIBHS team determined that it would be best to meet on a weekly basis to discuss the project. Though designating a time to meet weekly was difficult, the team managed extremely well and had full attendance at all meetings except a handful. Meeting dates were established at the beginning of each semester at a time agreed upon by all members. Flexibility on behalf of the team helped members who were not able to make some meetings, or were only able to join via phone or Skype. For example, one teammate has a full time job in Detroit, another has taken advantage of a career training opportunity onsite in New York City, and during the summer, two team members called-in to meetings from countries abroad. Fortunately, all members of the team have contributed and the team did not experience any major issues.

11.4. Clients

While the SIBHS team's original clients were Practice Greenhealth and Beaumont Health Systems, Beaumont's property management company, Jones Lang LaSalle (JLL), became more heavily involved in the project as it progressed. As the clients wanted to focus on LEED EBOM certification, it was important that they be familiar with the LEED certification process. However, as the SIBHS team's primary Beaumont contact, Kay Winokur, did not have an extensive background in LEED certification, she connected the SIBHS team with a LEED professional from JLL, Jasmine Davis.

The SIBHS team soon found that it was primarily working with Ms. Davis, who had been working on a LEED Audit that would address all of the credits Beaumont could feasibly achieve. As Ms. Davis had not been a part of original project development between the SIBHS team and Beaumont, she was not aware of the arrangement to prioritized LEED credit projects per the needs of both Beaumont and the SIBHS team. As such, the SIBHS team found it was dealing with an ever-expanding scope, through a series of discussions, were able to help her better understand the project objectives, the number and type of deliverables Beaumont wanted in the project's timeframe, and were also able to prove the team's skill level, causing Ms. Davis to have greater confidence in the team.

As the project progressed, the SIBHS team found their clients at Beaumont and PGH could be difficult to contact, creating a bottleneck effect on the progress of deliverables. For example, the SIBHS team found it difficult to contact the PGH client by any means, experiencing over five months of no communication or response from the contact to emails and phone calls. As such, the SIBHS team continued to work on deliverables with case study partners and advice from their advisor to deliver high quality products. The Beaumont client was also quite busy and often unresponsive. This caused much of the review work fell to Ms. Davis, the JLL consultant. The SIBHS team kept the Beaumont client, Mrs. Winokur, apprised of their progress, upcoming deadlines and action items and sought her input on initiatives she was interested in conducting. However, the team often found Mrs. Winokur was interested in all initiatives suggested. As a result, the SIBHS team took this opportunity to fully embrace their role as student research consultants and established an outline prioritizing projects that would be most beneficial to Beaumont. Mrs. Winokur was receptive to the projects and guidance provided by the SIBHS team and was pleased with the deliverables throughout the project.

11.5. Project Scope

The project scope changed dramatically throughout the project, from case studies and LEED credits to project goals. For sustainable sites initiatives, two of the SIBHS team's original goals were to (1) design a therapeutic garden space and to (2) create a green stormwater mitigation plan. Originally, the SIBHS team had committed to writing a case study on therapeutic garden space and a case study on green stormwater mitigation, followed by the development of a functional design for each topic. However, due to financial issues and plans for construction, Beaumont changed the location for the proposed therapeutic garden three times during the course of the project. As such, three separate, in depth site inventories and analyses were conducted, while only one in depth site inventory and analysis had originally been planned. As these inventories and analyses took a significant amount of time, the SIBHS team foresaw time being an issue if the location of the therapeutic garden was continuously changed. As a result, the SIBHS team discussed Beaumont's priorities concerning sustainable sites initiatives. Given financial issues and time constraints, Beaumont found it most beneficial to solely concentrate on the implementation of a therapeutic garden rather than investing in an overhaul of their stormwater infrastructure. Upon mutual agreement between the SIBHS team and Beaumont, the scope of sustainable sites projects changed to focus on therapeutic gardens and not stormwater management. In addition to the therapeutic garden, and to supplement the project in place of stormwater management, the SIBHS team recommended the hospital look into green roofs to gain LEED credits. The green roof report was proposed to include cost estimates and design features that could be built into the therapeutic garden design. Beaumont was receptive to the idea, particularly as it related to therapeutic garden spaces, which Mrs. Winokur had become especially passionate about. Additionally, as a stormwater management plan was no longer being pursued, the project scope regarding case studies also changed to only focus on a study on therapeutic garden spaces.

The project scope for the Energy & Atmosphere Credits also changed several times over the past year. One of the main challenges with this part of the project is that there were not concrete areas that Beaumont needed help with at the beginning. This created an opportunity for the SIBHS team to suggest projects that interested them, such as lighting energy efficiency analysis, but meant that there was not always buy-in from the clients. Another example is that the team originally proposed conducting a renewable energy analysis and included it in the project scope, but despite checking in with Beaumont on almost every call, the team never got enough guidance to start this initiative. Another area of project scope challenges was that the client asked the Energy & Atmosphere team to add deliverables that were not part of the project plan.

11.6. Case Studies

The idea behind the case studies was to interview experts and research topics related to sustainability initiatives and LEED credits the SIBHS team was focusing on for Beaumont so that inspiration from the studies could be applied to project deliverables. Four case studies were completed: (1) Healing Gardens, (2) Combined Heat and Power, (3) LED Lighting, and (4) HVAC Energy Efficiency. More case studies had been budgeted for in the original project proposal, however, given the lack of communication and feedback, and the busy schedule of our contact at Practice Greenhealth, Cecelia DeLoach Lynn, only four were pursued and completed in the time allotted for the project.

11.7. Advisors

The SIBHS team began the project with two advisors, one from SNRE and the other a visiting professor and original founder of the Detroit Chapter of USGBC. Unfortunately, from the onset of the project, both advisors failed to communicate with and respond to the SIBHS team in a timely fashion. Due to the advisors' inability to designate time to advise the SIBHS team, the SIBHS team found it necessary to seek a new advisor. The SIBHS team's current advisor, MaryCarol Hunter, was contacted during summer 2013, while on sabbatical, and agreed to work with the SIBHS team if our previous advisors were unable to perform. With assistance from OAP and a little paperwork, the SIBHS team was able to switch advisors, which has proven to be greatly beneficial.

11.8. LEED Credit Distribution

Once the SIBHS team received the list of LEED credits Beaumont was interested in completing, the team distributed the workload. One challenge encountered was that many of the topics did not fit within the project's original scope or timeline, thus the SIBHS team chose those credits that would be most beneficial to the client and to furthering the team's knowledge and skills. In particular, the SIBHS team found it had to be cognizant of the fact that Beaumont was looking at a timeline of over five years to establish and implement initiatives, while the team itself only had about a year to develop initiatives for the hospital. As such, those credits that were most feasible to address and complete quality deliverables in a timely manner were identified and prioritized.

11.9. Therapeutic Garden Space Design

The therapeutic garden design was one of the two major proposed topics to pursue at the start of the project, though many barriers arose as the team progressed. Overall, the location of the therapeutic garden changed a total three times before the SIBHS team settled on the final location. The first space was a remote area on Beaumont's campus that took between five and ten minutes to reach at a brisk pace. The SIBHS team performed an in depth inventory and analysis of the site and produced schematic plans and perspective drawings of what the site may look like. After consultation with Legacy Healthcare experts, they found that the distance alone drove them to seek a new location where they would perform another in depth site inventory analysis. This time, they had spoken with OT/PT professionals, nurses, visitors and other staff of the hospital and produced an entire plan that was ready for final renderings. Unfortunately, the team was informed by Mrs. Winokur that the space had plans for a building expansion, making the space undesirable. A few weeks later, they were given a third location to assess, which was positioned just north of the previous site and still set in a central location of the campus. After performing the third overall in depth site inventory and analysis, the team found the third space to be unacceptable to design a functional and pleasing therapeutic healing garden based on the presence of large building units (vents, etc.), loud noise, excessive shade, and lack of access from the building's interior. After consultation with Mrs. Winokur and Ms. Davis, they agreed that the second location would be the most effective space to implement a therapeutic healing garden regardless of the building expansion. The constant reevaluation of potential garden locations made it a great challenge to budget time for the other proposed projects, though the SIBHS team learned a great deal about client interaction and how design works in a professional environment.

11.10. Contact Management

As Beaumont Health System is a very large organization and the SIBHS team focused on a variety of topic areas within the one project, an everyday challenge was managing the number of contacts. For example, 5 to 15 people from Beaumont typically attended each conference call with at least one new participant per call. In addition to numerous Beaumont contacts, the SIBHS team was also in contact with many engineers, administrators, or managers from JLL. There were also a variety of experts and Practice Greenhealth partner hospital contacts to coordinate with for the development of the case studies. To best track all contacts involved in the project, the SIBHS team developed a contact spreadsheet to organize contacts by either their company affiliation or SIBHS task. The SIBHS team also established separate monthly or bi-monthly calls with Beaumont, JLL and Practice Greenhealth[9] to ensure all parties were able to equally communicate their needs and the SIBHS team could give them all the attention needed to develop quality deliverables and guidance.

12. Lessons Learned

Over the course of this 14-month master's project, the SIBHS team learned many lessons about conducting a large project for numerous clients and for an organization with diverse interests. They gained both academic and professional knowledge and experience that will help them in their future careers. The sections below details some of the key lessons learned.

12.1. Obtaining Pricing Data

Through the development of the Window Films Feasibility Report, the SIBHS team learned that obtaining pricing data can be challenging. When developing proposals for energy conservation measures or green space additions, the SIBHS team learned that it is important to provide an estimated budget supported by real-world pricing data. On the other hand, accurate pricing is often proprietary and only provided when a hospital releases a formal request for proposals, there by receiving bids from

[9] Due to the PGH client's busy schedule, the client unfortunately cancelled monthly calls after the first four months of the project, even after the SIBHS team's efforts to reschedule.

practitioners. As such, it is most effective to contact multiple industry experts to determine appropriate pricing estimates and then conduct a sensitivity analysis to support pricing estimates.

12.2. Methodologies for Projecting Energy Savings

There is a lack of standardization among methodologies for projecting energy savings. This is challenging when trying to:

1) Prioritize energy conservation measures when the return on investment calculation methods vary
2) Compare across hospitals when each hospital has different needs, priorities, and buildings
3) Develop measurement and verification standards

As such, it is necessary to develop standards internally to make an effort to compare energy conservations measures on an apples-to-apples basis.

12.3. Construction Project Timelines Change

Hospitals are constantly updating buildings and adding new facilities. Most health care systems will have a capital improvement plan conceptualized far in advance in preparation for the annual approval process. Facility upgrades often depend on donor interest, thus facility improvement plans can change shape when a healthcare system receives new funding. When spearheading sustainability initiatives that will require facility or grounds alterations, it is necessary to fully understand the capital improvement planning process to ensure the new project proposal abides by the appropriate guidelines and timelines.

12.4. Complex Organizational Structure

The SIBHS team found it a challenge to strike a balance between including all necessary parties and maintaining clear roles and responsibilities. As an outside team working for the first time with a large healthcare organization, it took time to grasp who is responsible for what part of the process, and who is best to contact for particular types of information. The development of a contact tracking sheet helped the SIBHS team to better manage the organizational structure and quickly pinpoint contacts needed for certain projects.

12.5. Decision Making

During this project, the SIBHS team often went into client meetings expecting to receive feedback and guidance on the direction to take with the project activities. The client usually provided exclusively positive feedback, little guidance and often did not have a clear vision for the direction of the project. As such, the SIBHS team found that this gave them the opportunity to propose new projects and guide the client. However, at times it was difficult to determine when the deliverable was finalized, but allowed the SIBHS team to make the decision.

In addition, the people making the decisions at senior levels may not always be on board with the sustainability initiatives the SIBHS team's client, Kay Winokur and the Green Team, is interested in implementing. As such, the SIBHS team learned that it is important to secure approval from senior level decision makers early in the process to ensure work conducted and deliverables produced will be used and policies and design plans implemented. Throughout the project, the SIBHS team seized the opportunity to fully step into their roles as student research consultants and advise Beaumont on the projects they should implement and the direction they should take to gain LEED certification. In the future, the SIBHS team will be sure all stakeholders are clearly identified and involved from the beginning of the project to ensure delays are not encountered with senior management later in the process. Additionally, the SIBHS team will ensure the client and decision makers have a clear vision of the project scope and goals, and if not the SIBHS team will more rigorously assist in the development of the client's vision using technical and financial analysis.

12.6. Budgetary Constraints

There is ever increasing pressure on healthcare systems to reduce operating costs. Although sustainability initiatives often lead to cost savings, many organizations are looking to more drastic measures, such as layoffs and budget cuts, to achieve immediate reductions in expenses. Sustainability initiatives must first and foremost address how adopting the proposed initiative will result in either increased revenue or cost savings. This will better allow senior management to support new efforts once understanding the clear connection to the bottom line.

12.7. Slow Communication Leading to Delayed Project Activities

There were times when the SIBHS team was not able to move forward because they were waiting on communication from one or more of their clients. These delays caused the project to deviate from the initial timeline. To counter such delays, the SIBHS team found it helpful to build in time buffers and work with the client to emphasize the importance of timely turn-around. The SIBHS team also implemented monthly calls with Royal Oak Beaumont and bi-weekly calls with JLL to maintain communication.

12.8. Importance of Education and Outreach

As previously mentioned, Beaumont has a large Green Team with many people involved in the implementation of sustainability initiatives throughout the hospital. Education and outreach activities are essential to communicate Beaumont's vision and keep everyone on the same page. In order to get people on board early with the SIBHS project, knowing who the stakeholders were in the process was essential. For example, during the therapeutic garden design process, it was invaluable to speak with physical therapists who would ultimately be the people using the garden space.

12.9. Lack of Expertise to Solve Technical Problems

For the Energy and Atmosphere projects, the SIBHS team worked outside of their comfort zone on extremely technical deliverables. They spent significant time gathering information on methodologies and developing educated hypotheses. It would have benefitted the team to find a mentor through SNRE or Beaumont earlier in the process familiar with topics related to the Energy and Atmosphere deliverables. Towards the end, Beaumont placed the SIBHS team in touch with an expert, but time and effort would have been saved if the contact had been identified earlier. In the future, the team realized it should ask more strategic questions to advisors and sponsors to identify subject matter experts at the start of a project.

12.10. Scope Definition

With every large project, there is the potential for scope creep, especially when the process for defining the scope is unclear. The challenge with this project was balancing the learning objectives of the SIBHS team with the needs and priorities of the client. The activities that were within scope were added according to the students' interest and to Beaumont's anticipated needs. Various activities and new deliverables that were slightly out of the original scope were added to the project over time to address the clients' developing needs. This taught the SIBHS team that they needed to have more direct conversations with the clients at the beginning of the project to better tailor project tasks and not allow the client to maintain an unclear vision of what they want to get out of the project.

13. Conclusion

Through this project and its partnership with the SIBHS team, Royal Oak Beaumont Hospital initiated exploration into sustainability strategies that will propel them towards being a leader in healthcare sustainability. Final recommendations and deliverables produced by the SIBHS team provided Royal Oak Beaumont with a better idea of the feasibility of implementing certain sustainability initiatives, as well as a greater depth of knowledge concerning next steps to be taken in greening the hospital. By building upon the work conducted by the SIBHS team and continuing to improve the hospital to achieve LEED EBOM certification, Royal Oak Beaumont will reduce its environmental impact on the surrounding community, thereby enhancing local environmental and public health.

14. References

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Appendix A: Case Study: Combined Heat and Power

Case Study of CHP in New York Presbyterian Weill Cornell Medical Center

Demographic information

Facility name: New York Presbyterian Weill Cornell Medical Center (NYP WCMC)
Location of the facility: Weill Cornell Medical Center, 445 E 69th St, New York

Organization

New York Presbyterian Weill Cornell Medical Center is a multi-hospital-facility, which includes five major campuses. Across the five campuses, there are 2,400 beds, 843 staffed in-patient beds and 7,600 employees. Weill Cornell Medical Center was founded in 1898, and has been affiliated with what is now New York-Presbyterian Hospital since 1927. New York Presbyterian Weill Cornell Medical Center is a biomedical research unit, and serves as Cornell University's medical school, which is one of the top-ranked clinical and medical research centers in the country. It offers degrees in medicine, as well as PhD programs in biomedical research and education of medical science.

Executive Summary Statement

As is common in most hospitals, the heat and electricity demand was substantial at New York Presbyterian Hospital. For Weill Cornell Medical Center alone, peak demand is 14 megawatts (MW). Weill Cornell Medical Center's total annual energy expenses (including fuel, natural gas and electricity) were$20,373,406. As a significant portion of Weill Cornell Medical Center's budget was devoted to energy expenses, as increasing energy costs and environmental and climate change concerns were growing, Weill Cornell Medical Center realized it needed an alternative energy source. After considerable research, Weill Cornell Medical Center chose to install a combine heat and power (CHP, also called co-generation) plant on its campus. The CHP system commissioned in June 2009 has proven to be a huge success. While the total cost to install the CHP system was $30.6 million, the payback period was only 4.79 years. The new CHP system has significantly improved energy efficiency from 35% to 72%, and has also reduced carbon dioxide emissions by 27,000 tons per year.

The Problem

New York-Presbyterian Hospital (NYPH) consumes 200 million kWh of electricity and 2.3 million MMBTUs of fuel annually. The peak load is up to 42 MW. Weill Cornell Medical Center has a 12,000 ton hybrid power generation plant, and consumes 570,000 PPH (pound per hour) of steam with a peak load of 14 MW. Given increasing energy costs and raising concerns about climate change, NYPH needed a solution that could cut utility costs, reduce the hospital's environmental impact, and help to mitigate climate risk. Additionally, NYPH was interested in increasing the capacity of the Heat Recovery Steam Generator (HRSG) and avoiding the cost of replacing the boiler.

Prior to the installation of CHP in 2009, electricity supply to WCMC was fully depending on the local utility company - Con Edison with a supply efficiency of only 35%. More than 67% of the power generated at Con Edison's plant was wasted during the generation and transmission phases.

To reduce the energy cost, NYPH developed several strategies to better manage their energy portfolio, such as lock in fuel and electricity futures hedging strategies. However, none of these strategies provided a solution to significantly improve NYPH's energy efficiency. In addition, NYPH participated in the PlaNYC Mayor's Challenge, which requires the Greenhouse Gas (GHG) emission to be reduced by 30% from 2005 baseline by 2018. Improve the energy efficiency was the only feasible solution for NYPH to accomplish this challenge

Energy Management Strategy at NYPH

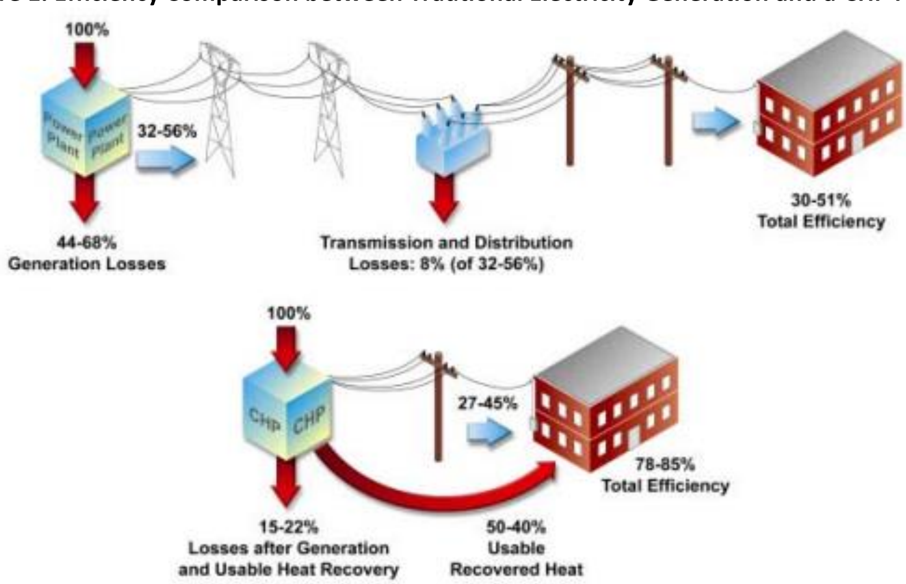
Competitive Energy Purchasing

- Lock in fuel & electricity futures
- Hedging strategies
- Natural gas & fuel oil switching

The Strategy Selected

Combined heat and power (CHP) systems (or cogeneration) are designed to combine production of heat and power in a single process. Different from a traditional power plant, CHP plants located onsite utilize the heat rejected in the conversion process of primary fuel to power, which has a much higher overall efficiency of 78-85%. Through CHP, recovered heat can be utilized for various heating or cooling purposes.

Figure 1. Efficiency Comparison between Tradtional Electricity Generation and a CHP Plant



As NYPH operates around the clock every day demanding a consistent supply of power and heat, a CHP system would serve as an ideal alternative to their current energy system.

In June 2004, a feasibility study conducted to investigate the use of CHP in WCMC found that the CHP system could significantly reduce the cost for high tension power and yield total energy savings of $4.030 million annually. The estimated installation cost installation was $16.90 million, or $2,319 per kW of generating capacity. The total cost was $20.1 million, including replacement of the chiller and improvement of required infrastructures. The study showed that in the best scenario, the life cycle cost of a CHP system would be $32.7 million with a breakeven of five years. Alternatively, worst case scenario was a life cycle cost of $5.1 million with breakeven of 13 years.

After the feasibility study had been conducted, CHP was recognized as the 'single greatest opportunity to reduce utility costs at Weill Cornell Campus'. The goal of the project was to supply the entire output of the onsite CHP system to site demand and not exporting any of the loads to utility. However, the utility would still need to provide a service called "Standby" which means it must be prepared to supply the additional demand in case of supply shortage.

The Senior VP made the decision to implement the CHP project. The Finance department was responsible for securing loans to support the project.

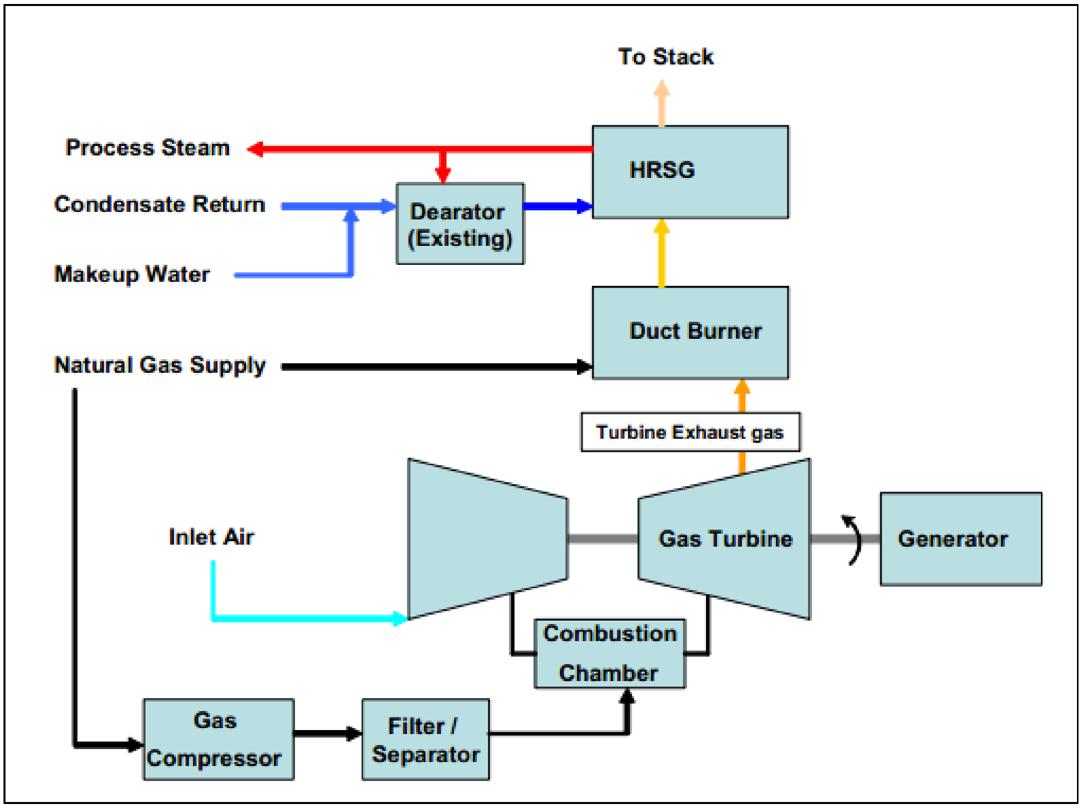
Implementation Process

The implementation of CHP plant required the cooperation of many departments at both the organizational and the state levels. After the initial design was developed, NYPH and Con Edison discussed whether or not Con Edison would need to import or export electricity to or from the hospital. Con Edison was supportive of NYPH's project, but needed ensure that a faulty current at WCMC would not disrupt the entire electrical grid. Con Edison performed an evaluation to determine where fault current mitigation would be needed, and New York State Energy Research and Development Authority (NYSERDA), a public benefit corporation to promote sustainability for New York, provided a solution called Commutating Current Limiter (CCL). CCL was designed to disconnect NYPH from the grid if a fault was created at the hospital so that Con Edison's entire electrical grid would not be impacted. The installation of CCL also avoided $380 to $1,000 per kW in substation upgrades.

Figure 2: Dynamo room after installation of CHP system (Courtesy of NYPH)

Prior to the installation of the CHP system, three old chillers and two transformers were demolished to provide space for new plant. Then the largest available CHP system was put into the dynamo room (where the previous plant located), which included a gas turbine generator, a 7.5 MW Solar Taurus 70 electric generator, a duct burner, a heat recovery steam generator (HRSG) and two chillers. The rest of the system was installed on the rooftop, which included fans, cooling tower air cooler, gas compressor and exhaust duct. The system was connected to the high tension service distribution system. The generator used natural gas supplied at 60 psgi as the primary fuel and No.2 fuel oil as back-up.

Figure 3: Schemetic diagram of the CHP system in NYP WCMC



During the construction phase, NYPH developed a detailed schedule and received approvals and permits from a list of departments and organizations to begin the project. The following departments and organizations were contacted to provide the necessary approvals and permits:

- Fire Department of New York (FDNY)
  - Fire protection
  - Egress/Life safety
  - Process hazard issues
- NYC Department of Buildings (DOB)
  - Structural
  - Field inspection
- Department of Health (DOH)
  - Approval process
- Department of Transportation (DOT)
  - Traffic Patterns
- Local Community Board
- NYSDEC
  - Title V permit

Within NYPH's organization, the Facilities Development and Construction Department was responsible for the implementation process, as well as the maintenance after the project was completed. The Facility Operations Department was responsible for day-to-day operations of the power plant.

As the construction and installation of the CHP system created a lot of noise, NYPH provided general education to the public about the project. Employee education was also carried out in hospital to better inform staff about the new CHP system. A director specialized in CHP was hired for operation and maintenance of the system.

Benefits

The implementation of the CHP project brought NYPH many benefits in terms of economic, environmental, and system reliability.

In addition to the benefits listed in Table 1, switching to CHP plant also reduced financial risk by lowering the exposure to utility cost volatility and enhanced steam power and steam reliability. On-site power plant is more reliable and more resilient to natural disasters. The CHP plant also added 23% firm steam capacity which improved the steam reliability.

Table 1: Economic and Environmental Benefits of CHP

Economic Costs and Benefits	
Total Project Cost Average Annual Savings Net Present Value Cumulative Savings since 2009	$30.6 million[a] $6.92 million $42.9 million $19 million[b]
Avoided Future Capital Costs	
New Boilers (5 years) Chiller Replacement Project (1-3 years) Additional Emergency Generator (2-4 years)	$6 million $3 million $2 million
Environmental Benefits	
Operating Efficiency Electricity Saving Reduced CO_2 Emissions Lower line losses	72% 80% (10% more fuel) 27,000 tons annually

[a]Simple Payback Period: 4.79 years

[b]Based on a NYSERDA $1.1 million grant

Challenges and Lessons Learned

Although CHP systems provide many benefits in a hospital setting, risks do exist. One of the major risk factors requiring consideration in the evaluation process is overruns in the initial design and construction costs (risk of IRR). However, a well conducted feasibility study will help to predict and prevent potential overruns. The space availability and performance should also be carefully considered to cope with the existing plant and meet hospital energy needs. Another risk may be the divergence between fuel and electricity rates. Higher fuel rates and lower electricity rates may lead to fewer savings. Other CHP users may pay extra attention to the air compressor as the air compressor in the cogeneration system of WCMC needed to be replaced recently.

Since installing the cogeneration plant is requires the cooperation of several entities, good project management skills and anticipation of potential barriers are necessary to avoid project delay and additional construction costs. Good communication with local utilities, the public, employees and other departments will also help to streamline the implementation process.

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NYPH Turbine Provides HVAC and Electricity – Project Profile: http://dataint.cdhenergy.com/Fact%20Sheets/New%20York%20Presbyterian%20Hospital%20Fact%20Sheet.pdf

NYSERDA Presentation on NYPH-WCMC CHP Project

Keywords/Topics: CHP, NYPH, Weill Cornell Medical Center

Appendix B: Case Study: Light Emitting Diode Implementation

LED Lighting Strategy for the LifeBridge Health System

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Demographic Information

Based in northwest Baltimore city and Baltimore County, LifeBridge Health includes Sinai Hospital, Northwest Hospital, Levindale Hebrew Geriatric Center and Hospital, Courtland Gardens Nursing and Rehabilitation Center, and LifeBridge Health and Fitness. This regional health care organization is one of the largest, most comprehensive and most highly respected providers of health-related services to the Northwest Baltimore region. LifeBridge Health has been targeting sustainability improvements for over a decade, and has won multiple awards for their continued drive to make their healthcare campuses more environmentally responsible.

Executive Summary Statement

As LifeBridge Health System adopted a new Green Policy Statement, they focused on becoming more sustainable and reducing energy consumption across their hospitals and other centers. In June of 2010, an Light Emitting Diode (LED) Lighting Strategy was implemented that successfully reduce energy consumption for lighting purposes. The project is ongoing and is being expanded to other areas of the hospital to further their savings.

The Problem

Prior to implementation of the LED lighting strategy, interior lighting accounted for roughly 30% of the total building energy consumption across their buildings. While interior lighting was not the largest energy sink, it was one of the easiest and least expensive options to bring forth energy reduction and cost savings.

The original lighting installation utilized mercury-containing fluorescent T8 lamps which drew a considerable amount of energy at 259.25 kWh per bulb. They also operated at a higher temperature of 83.6 Fahrenheit—requiring heating, ventilation and air conditioning (HVAC) units to work extra to mitigate this added heat. Table 1 shows detailed specifications of the original lamps and the LED replacements that were introduced in 2010.

	Original T8 Fluorescent Lamps	New LED Lamps
Model	F32T8	15-watt lamps
Temp	83.6 F	74.2 F

Load	259.25 KWH	144.38 KWH
Length	48 inches	48 inches
Lumens	39.6 foot candles	48.8 foot candles
Lifespan	12,000 hours	80,000 hours

Table 1: Specifications for the T8 lamps and new LED lamps installed in 2010.

Other problems with the old lighting systems included a short bulb lifespan of 12,000 hours (around 500 days). This required frequent maintenance to replace the bulbs. While the T8 bulbs, at 39.6 foot candles of lumens provided substantial lighting, the new LEDs provide more lumens while requiring fewer bulbs to be installed across an area to achieve the same lighting standard.

Fluorescent T8 lamps also required special disposal considerations. Because the T8 bulbs contain low levels of mercury—a hazardous waste per the Environmental Protection Agency's Resource Conservation and Recovery Act (RCRA), they must be recycled as Universal Waste or disposed of as a hazardous waste. Additionally, if a fluorescent lamp is broken, there are special clean-up requirements [EPA, 2013]. Hospital staff must also be properly trained to use a mercury spill kit for clean-up.

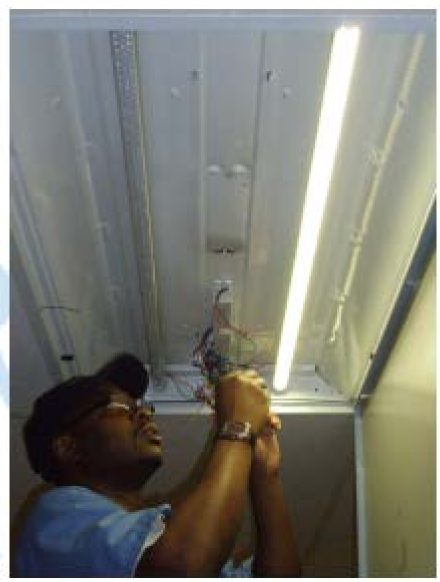

Image on left: Hallway with new white light LEDs installed; Image on right: installation of new bulbs.

The Strategy Selected

To reduce energy consumption and to mitigate the issues previously mentioned, the Facilities Management Team chose to retrofit the current lighting fixtures with LEDs. A liner tube external driver LED was chosen after testing determined it the most effective at providing energy savings, matching lighting quality and increasing the lifespan of the bulbs. The new bulbs were tested and arranged to match the existing lumen output in selected areas through pre- and post-occupancy testing.

To determine the economic feasibility of the project, the team calculated the expected cost including materials and labor less the rebates. Rebates were attained through the BGE Energy Savers Program. This program provides energy savings for businesses when energy efficient improvements are made. It is intended to promote energy efficient upgrades by reducing the time for return on investment, making projects more economically feasible [BGE, 2012]. The calculated rebate for LifeBridge was $620,693 with the net cost coming to $510,613 as shown in Table 3.

The Team:

- Vice President of Facilities
- Director of Facilities
- Facilities Management
- Lead Electrician

The primary source of funding came through the capital budget. The Director of Facilities applied for the capital and the President decided on the allocation of the funds. This project is still in its implementation phase and as new capital becomes available, the lighting strategy expands to new areas of the hospital.

Annual energy cost savings were calculated at $141,967 and the expected lifespan of each bulb is 5.7 years (more than 4 times longer than T8s). Using these figures and the estimated deferred maintenance savings, a lifetime savings of $882,785 was calculated. Other savings not taken into consideration in the calculation include a reduced recycling fee, and reduced load on the HVAC system to maintain temperatures. More details of the savings and calculations are shown in Tables 2 and 3.

Using net cost and the annual cost savings, a return on investment (ROI) was calculated. The time for the ROI was estimated to be 3.30 years. An ROI close to 3 and below 5 is preferred when considering funding capital projects of this magnitude. This promising ROI helped demonstrate that the project was economically feasible and beneficial to the hospital.

		Fluorescents		LEDs		Savings		
Length of Bulb	**# of bulbs**	**Watts per bulb**	**Total Load in KW**	**Watts per bulb**	**Total Load in KW**	**Saved Load in KW**	**Saved Energy in KWh**	**Savings in Annual Electric Cost**
4 Foot	14,916	27.46	409.57	15.76	235.002	174.5665	1,529,203	$132,276.02
3 Foot	50	23.04	1.15	15	0.75	0.402083333	3,522	$304.67
2 Foot	417	17.17	7.16	9	3.753	3.4055	29,832	$2,580.48
U-tube	721	27.46	19.80	15	10.815	8.982458333	78,686	$6,806.37
						Total Annual Savings		$141,967.55

Table 2: Energy usage and expected savings from switching to LEDs. The table also provides the savings in annual electric cost and the total annual savings found from the new lighting strategy.

Project Costs	
Materials	$1,046,760.00

Labor	$84,546.00
Total Cost	$1,131,306.00
Rebate	$620,693.00
Net Cost	$510,613.00
Operation Information	
Life of Bulb in Hours	50000
Hours per Year	8760
Life of Bulb in Years	5.707762557
Lifetime Savings	
Savings over life of LED	$810,317.04
Deferred Maintenance	$72,468.00
Net Gain	$882,785.04

Table 3: Project costs, operation information and lifetime savings from the implementation of the new lighting strategy.

Return on Investment	
Payback Period (years)	3.3014
ROI	72.89%
IRR - 3 years	1.85%
IRR - 5 years	21.54%
IRR - 10 years	32.51%

Table 4: Return on Investment calculations from the implementation of the new lighting strategy including payback period and IRR at 3, 5 and 10 years.

Implementation Process

In 2008, the Facilities Management team brought the first LEDs into the Health System, installing them for a trial run in non-patient areas. Locations were selected and 4 fixtures would be replaced. The team would then let the testing period begin, monitoring energy consumption and visual performance. Multiple stakeholders were gathered--including the President, Vice Presidents, nurses, lab technicians and others to assess the new LEDs and provide their impression of the new lighting strategy. Feedback revealed that the LEDs provided a crisper light, and surfaces were better lit. Upon this positive review of the new lighting strategy, the team began securing capital to expand the lighting strategy starting in June of 2010.

The implementation of the lighting strategy had two major phases, the first being the introduction of the LEDs in non-patient service areas such as administrative buildings and labs. A handful of new fixtures were installed and the Facilities team would then wait for feedback from occupants. Generally there were no negative comments—allowing the installation to continue during off-peak hours. The second stage of the implementation process occurred in patient care public areas, such as waiting rooms and hallways.

	Phase 1	Phase 2
Location	Non-patient service areas	Patient care public areas
# bulbs installed	10,673 bulbs	11,141 bulbs
Completion date	5/3/10	7/31/11

Table 5: Details of the 2 phases of implementation for the initial LED lighting plan.

The Courtland Gardens Nursing and Rehabilitation Center has now been fully converted to LED lighting and the Lifebridge Health and Fitness Center is 75% completed. Sinai Hospital has had 50% of their T8 lamps converted to LED, while Levindale Hebrew Geriatric Center and Hospital, and Northwest Hospital have only seen a 10% conversion rate.

At the start of the project, there was education and training for those installing the LED system, including journeyman electricians, electrical contractors and the lead electrician. No additional training was needed for the maintenance staff as the installation process was very similar to the fluorescent lighting that was previously installed, and maintenance for the new bulbs will be much less frequent with each bulb lasting 50,000 hours with a very small failure rate.

Benefits

The new lighting strategy was economically beneficial for the hospital. With an ROI of 3.3 years and an annual savings close to $150,000, the savings from the implementation of this project can be put towards future energy efficient upgrades and retrofits. The avoided costs from maintenance and relamping are an added economic benefit.

In addition to the cost savings is the avoided energy use and environmental benefit due to the reduced energy load required for lighting, and in response to the lower operating temperatures of the LED bulbs, the HVAC system load is also reduced. With all the reductions in energy consumption, there are avoided emissions from the power plants and the avoided health impacts due to those emissions. Reduced emissions of sulphur dioxide, nitrogen oxides and mercury correlate to a lower occurrence of premature deaths, chronic bronchitis, asthma attacks and emergency room visits.

Safety benefits include the removal of hazardous bulbs containing mercury. Other less quantifiable benefits came in the form of self-reported improvements in staff morale and productivity due to the increased visibility and lighting performance.

Challenges and Lessons Learned

The team encountered minimal difficulties during the trial phases of the implementation process and there were virtually no barriers for the installation to occur in non-patient service areas and patient care public areas. The most obvious challenge during implementation was scheduling, with majority of the installation occurring during off-peak hours.

The operating rooms and patient rooms have not seen wide spread LED lighting implementation yet. Currently, an OR is in its trial phase and more are expected to see changes if there is no negative feedback from doctors, staff and patients.

Initially, there was an assumption that LEDs would make the environment look blue in color, and the first LEDs that were tested 5 years ago did have a slightly purple tint when interacting with the off-white wall color. Those issued were addressed and fixed during the testing phase.

As with any capital improvement, there were some barriers to acceptance out of general uncertainty, but they proved to be limited and short-lived once the rebates and ROI were calculated and explained. The strong ROI proved to be the greatest tool to overcome obstacles and get the stakeholders to buy-in to the project.

(THIS IS FOR INTERNAL USE)
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Keywords/Topics: LED lighting strategy, energy reduction, energy efficiency, sustainability, energy conservation, energy savings

Appendix C: Case Study: Therapeutic Gardens

Therapeutic Gardens: Legacy Health Systems

Prepared for: Practice GreenHealth
Prepared by: Dan Buckley, Jake Hamilton, and Lauren Smith of the University of Michigan

Demographic information

Legacy Health System, located in the Portland, Oregon metropolitan area, was established in 1989 when Good Samaritan and Hospital and HealthLink merged (Legacy 2013). Legacy Health System is comprised of two regional hospitals, three community hospitals, and a number of other specialized treatment centers and laboratories, with over 1,100 total beds. Legacy provides a variety of healthcare services, such as acute care, critical care, behavioral health, outpatient and health education programs.

Executive Summary Statement

Aware of the stale and un-engaging atmospheres associated with hospitals and the impact such an environment has on patient healing, Legacy Health Systems implemented therapeutic gardens across their campuses to improve patient healing. In addition to installing therapeutic gardens, Legacy also established horticultural therapy programs to assist in patient recovery. Additionally, Legacy has found that therapeutic gardens and horticultural therapy programs not only facilitate better patient recovery, but also provide the hospital, patients, employees, visitors and the community with a range of economic, social and intellectual benefits. As such, Legacy's gardens are internationally recognized, and Legacy is continuously expanding upon its gardens and programs to further health care.

The Issue

To enhance the healing of its patients, Legacy Health began to establish therapeutic gardens and horticultural therapy programs in 1991. Since the inception of the gardens, Legacy has built nine therapeutic gardens in the Portland, Oregon area. To better engage patients, to help them cope with stress, and to expand upon therapy targeting the senses and strengthening body and mind, Legacy strives to include it in "every special education class and senior center" (Nafsinger 2010).

From Alzheimer's to child patients, employees to neighbors, it is important for therapeutic gardens to hold restoration properties for a wide range of users. As such, Legacy has involved as many stakeholders as possible in the design phase and maintenance of the gardens. Visitors, patients, employees and neighbors were all included in the development of the gardens to ensure they would be properly designed to accommodate a variety of uses, and continue to support garden activities and programs.

While constructing and caring for the gardens requires substantial funding, Legacy's fundraising department is constantly raising money for therapeutic gardens. Also of concern in the gardens is the privacy security of its users. To encourage usage, the gardens must be inviting and provide a sense of security to calm users and better facilitate restoration. As such, Legacy's gardens incorporate private spaces for self or group reflection, which are located throughout the gardens, and provide various sources of subtle lighting for security during night-time usage.

The Strategy Selected

Legacy Healthcare Systems is a pioneer in the development of therapeutic gardens, successfully providing amenities for all users in each unique garden space. To ensure the success of each garden, the spaces needed to be designed to the specific uses of the individuals that will be interacting with the garden. As each garden targets a different audience, such as children or burn patients, Legacy has created a design program consisting of three one-hour meetings comprised of interdisciplinary team members. Through these meetings, participants share their visions for garden usage, assisting in the design process to determine the design features that will best meet the needs of clients, families, visitors, staff and the community.

In addition to identifying intended uses of the gardens, Legacy also recognized that privacy and security in the gardens was paramount in encouraging restoration and stress coping. Many of the patients and their families will be faced with difficult decisions. As such, it is essential to provide intimate and secluded spaces set aside from the main thoroughfare for private discussions. It is also important to have a least one larger space that will be able to accommodate larger groups of 8-10 people. Legacy also determined that attention needs to be paid to the placement of larger gathering spaces, but that their inclusion in the garden will not cause congestion or disrupt flow (Hazen 2013).

Security is also important to consider as most gardens are accessible 24 hours a day and 7 days a week. Legacy has found that centrally located gardens provide the greatest sense of security as they are most protected from the outside world. If neighborhoods are of concern, it is possible to provide a gate that will be locked at dark and open at dawn. At Legacy, gardens accessible during all hours are outfitted with lighting that allows for proper night-vision and provides a sense of safety and security. Legacy uses lighting in the sides of raised beds or small ground lights on posts which will be no higher than 36 inches off the ground. Legacy also ensures spaces are not over-illuminated so that visitors may enjoy the night sky. Above all, Legacy designs its gardens with great attention to the privacy and security of all possible users (Hazen 2013).

Implementation Process

To best inform the designs for Legacy's therapeutic gardens, the three one hour meeting model was developed and implemented. Through this model, landscape architects responsible for the design and construction of the gardens facilitated one-hour meetings with focus groups to determine how the space is intended to be used. Focus groups typically include horticultural therapists, physical therapists, occupational therapists, doctors, nurses, and can include patients or visitors. During the one-hour meetings, the benefits of therapeutic gardens are explained to the participants, and each participant is asked to share their vision on how they will use the garden both professionally and personally. Once the intended use has been identified, the focus groups are asked to brainstorm and share the types of programs and activities they would like to hold in the garden space. Such programs include Horticultural Therapy, Physical Therapy, Occupational Therapy and Speech Therapy, which direct the use of the gardens for therapeutic purposes, governing the success of the gardens in providing restorative environments to promote healing.

Although horticultural therapy has been used in the United States since World War II to help veterans cope with stress (BOOM, 2010) its use has not been widespread. Through horticultural therapy, professional therapists work directly with patients living with a variety of medical conditions, from memory loss to traumatic spinal injuries. Many patients participating in therapy will visit the gardens with their therapists, who tailor therapeutic activities to an individual patient's needs, as well as features built into the garden space (BOOM, 2010). For example, Alzheimer's patients may practice passing a flower around a table, allowing them to exercise their ranges of motion, improve their attention span, and enhance their ability to follow directions while remaining social (Hazen, 2013). In addition, a patient with a spinal injury may participate in therapy prescribing tasks such as raking or watering flowers, which can give a sense of accomplishment and significance. Garden elements specifically designed with therapy in mind provide patients, therapists and the hospital with the opportunity to explore various methods of healing. Altered features at Legacy include raised planting beds at various heights, access to a number of water sources to avoid dragging hoses, a variety of plantings that change with the seasons to encourage use of the garden and interaction with the plants year-round. Such garden features allow therapists to guide patients through restorative activities focusing on hand functioning, cognitive development, or improved problem solving.

In addition to horticultural therapy for occupational therapy, physical therapy and speech therapy patients, therapeutic gardens also provide space to facilitate movement, improve spatial skills and coordination. By providing various walking surfaces, such as gravel, tile, turf, or concrete, and transitions from one type of surface to another, the garden helps to familiarize patients with altering friction and textured surfaces, furthering their reintegration into life outside a hospital. Physical activities and mild exercise, such as walking, raking, sweeping or watering in the garden, also improve physical wellbeing (Hazen, 2013).

Although patient recovery drives the development and use of the therapeutic gardens, Legacy also designs the gardens for families, neighbors and hospital staff. As the gardens are open to the public in addition to recovering patients, careful consideration is taken to ensure adequate privacy is provided to encourage patients to feel comfortable using the garden for rehabilitation while others are present in the garden (Hazen, 2013). Legacy has also found that provision of intimate seating for families and caregiver to hold private conversations is crucial. The incorporation of such spaces and private areas in gardens has assisted in user restoration and ability to cope with stress.

Benefits

Gardening provides many physical, emotional, economic, social and intellectual benefits.

> ***"Regardless of ability or disability, the pursuit of gardening can enhance physical conditions, can provide relief from tension, and can surround an individual with the sense of accomplishment."***
> – Steven H. Davis, former Executive Director, American Horticultural Society

Although there are many potential returns, Roger Ulrich explains that there are three critical benefits of gardens which need to be highlighted when proposing the construction of therapeutic gardens to hospitals. These benefits include physical, emotional and economic benefits. For simplicity, these will be the three benefits discussed in this section.

Physical benefits are quite literal. Patients can utilize the garden as a place to work through physical and occupational therapy. Through the development of therapy tailored to an individual's needs, gardens can further help healing by reintroducing patients to physical exercises, such as raking, planting, and harvesting in a secure space outside of the general, potentially confiding hospital atmosphere. Such activities help patients redevelop simple motor skills that may have been lost to an accident or illness. In her book Accessible Gardening for People with Physical Disabilities, Janeen Adil (Adil 1994) mentions that motor skills are enhanced as your body performs movements that "stretch and strengthen the muscles and joints." Adil also states that coordination, stamina, flexibility and even eyesight can be improved through therapeutic garden programming. At Legacy, physical therapy is encouraged by the range of walking surfaces included in the gardens, as well as features that introduce elevation changes in the garden.

The Randall Children's Hospital, and Legacy hospital, utilizes multiple walking surfaces such as concrete, brick and gravel, as well as stairs and ramps, to help with the physical rehabilitation of the patients. Other features, such as raised planting beds, allow patients in wheelchairs to gain greater access to gardening activities that can help to enhance motor skills. At Legacy's Mount Hood Healing Garden, paths are kept at a lower grade to help to accommodate weaker patients. Lightweight, moveable seating at this site also allow patients and visitors to easily rearrange spaces, creating the ideal setting of their choosing (Hazen 2013).

Emotional benefits can also be gained through therapeutic gardening. Twentieth century hospitals have inadvertently been designed as stressful settings built for efficiency and functionality rather than emotional health. However, healthcare specialists are beginning to recognize the importance of patients' mental health in relation to their physical health. Through exposure to a natural environment, patients release tension and anxiety that can hinder recovery time. Research has shown that when exposed to visuals of natural landscapes rather than built environment, stress is more quickly alleviated (Ulrich 1999). The Alnarp Rehabilitation Garden in Alnarp, Sweden was specifically designed to treat patients suffering from stress-related illness. This reduction in stress in both patients and employees can lead to shorter hospital stays (Adevi 2012).

To help patients cope with stress, Legacy has designed the gardens to give patients a sense of privacy and security, while also providing them with control over their environment. To achieve this sense of security, private meeting areas have been designed by incorporating planting designs and built structures, such as pavilions and gazebos. Trees also offer overhead protection from sun. The presence of animal life at Legacy hospitals also helps patients feel more at ease (Hazen 2013).

Lastly, to help encourage more hospitals to implement therapeutic horticultural programming into their health systems, the economic benefits of the program must be presented to the hospital. These gains can come in the form of shorter patient recovery, more affordable treatment, lower employee turnover rates, and, if designed well, lower continual maintenance costs. Unfortunately, exact savings are hard to estimate due to a high number of variables impacting a garden's effectiveness. However, Legacy has found that employee turnover rates are lower in facilities that have close ties to nature, resulting in less time and capital necessary to train new employees (Hazen 2013).

In Legacy's case, the hospital has found that although gardens take capital to build and funds to maintain, they also serve as attractions to which people are very willing to donate money (Hazen 2013). Legacy Foundation raises funding for over 200 projects throughout the entire system. Annually, Legacy Foundation raises over $8 million to help with these projects. Funding is always raised before garden construction. Additionally, through arranged endowments, Legacy is able to purchase ongoing supplies and additional services if needed (Hazen and Helgerson 2013).

Challenges and Lessons Learned

Teresia Hazen, Coordinator of Therapeutic Gardening and horticultural therapy at Legacy Health, states that "from the beginning of garden development in 1991, we (Legacy) have used an interdisciplinary model, including facilities team members, therapists, managers, families, patients, spiritual care, volunteers, leadership, landscape architect, nurses, and others to problem solve issues to improve patient outcomes" (Hazen and Helgerson 2013). This model has since been used to develop every garden constructed at Legacy. If it were not for this vast network of resources, the gardens at Legacy would not have been what they are now.

Additionally, Hazen claims that to have a successful horticultural therapy program, the participating hospital must focus on patient outcomes and satisfaction, demonstrate and maintain quality, and be able to adapt to change and growth. Since the gardens at Legacy have been widely and positively received by the administration, funding has been relatively easy to procure from within the organization. Bryce Helgerson, Vice President of Hospital Operations at Legacy Health, explains that once there is the sense of support from superiors within the hospital, funding is not very difficult to come by when needed (Hazen and Helgerson 2013).

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Citations:

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List of all contacts spoken to at case study site:
Teresia Hazen (teleconference)

Keywords/Topics:
Therapeutic gardens, Legacy Health System, healing gardens, security, privacy, landscape design, Horticultural Therapy

Appendix D: Case Study: Tackling Reheat

Tackling Reheat in University of Michigan's Cardiovascular Center

Kathryn Newhouse
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School of Natural Resources and Environment and
Stephen M. Ross School of Business
University of Michigan

Figure 1. University of Michigan's Cardiovascular Center

Demographic information
University of Michigan Hospital Cardiovascular Center
48 Beds, 10 ORs
Ann Arbor, Michigan
Specialty Facility

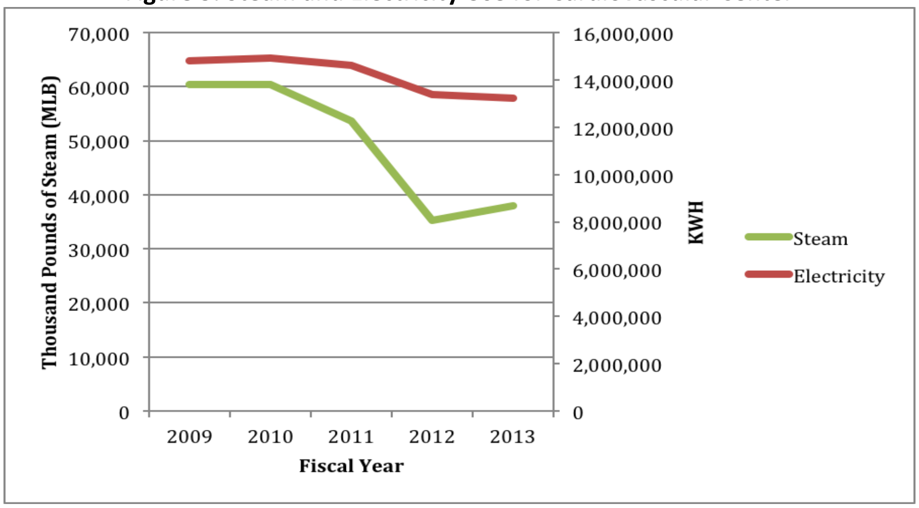
Executive Summary Statement

The main campus for the University of Michigan Hospitals and Health Centers (UMHHC) is located on a sprawling campus of over 60 buildings adjacent to University of Michigan's (U of M) main campus in Ann Arbor. After benchmarking all buildings in their portfolio, the UMHHC Energy Conservation Team identified the Cardiovascular Center (CVC) as the next target to reduce energy consumption due to high steam usage. The CVC is a 444,952 ft^2 specialty facility with 48 beds and 10 operating rooms. When the team first started proposing energy conservation measures (ECM) for the CVC, steam consumption was 14.8 Mlb/ft^2/year (see Figure 3), and the utility costs were \$5.65/ft^2 – the highest of any healthcare facility on campus. Before conservations measures were implemented, the CVC's HVAC equipment accounted for 70% of the building's utility costs. Although a bit high, U of M's HVAC energy costs are consistent with hospital energy usage, and are in line with the U.S Department of Energy's Building Technologies Program's estimate that "HVAC can account for nearly half of a hospital's total energy use [due to substantial] requirements for outdoor air," (Taddonio 2011). By using the results of a Test and Balance Contractor, U of M found that a majority of the steam was going to Variable Air Volume (VAV) reheat coils. Other research has also shown that a significant quantity of steam is utilized to reheat air to the appropriate temperature. A Targeting 100! study, entitled "Energy Use and Model Calibration Study: Legacy Salmon Creek Medical Center, Vancouver, Washington," highlights the fact that the largest portion, 42.3%, of Salmon Creek Medical's annual energy use goes to reheat (Hatten et. al 2010). By buckling down and proposing four projects to reduce the reheat load in the CVC, the Energy Conservation Committee

Figure 2. Three Heat Exchangers in the CVC Mechanical Room

saved $370,000 in one year. The building's steam consumption is now at 13.2Mlb/ft^2/year and utility costs are $4.03/ft^2.

Figure 3: Steam and Electricity Use for Cardiovascular Center



The Problem

Utility bills at the U of M hospital are a very large operational cost, accounting for tens of millions of dollars every year. By benchmarking U of M's hospital buildings with the same functional use, the team realized that the CVC consumed 60% more steam per square foot than other hospital buildings (Murphy 2013). It was clear that there was waste in how the steam was used in the building. Factors potentially contributing to high steam use include inefficient heating plant equipment, or inefficient building HVAC equipment, which includes variable air volume (VAV) boxes, air handling units (AHU), valves, reheat coils, pumps, dampers and fans. However, without a detailed engineering analysis, it is impossible to identify the cause of excess steam use.

The Strategy Selected

U of M Hospital has an Energy Conservation Team comprised of Colin Murphy, two mechanical engineers, one electrical engineer, the Director of Maintenance and Operations and the Support Services Financial Director. Colin Murphy is UMHHC's Energy Conservation Engineer. This group meets monthly to review energy conservation proposals and potential future efforts. The UMHHC Energy Conservation Team considered several strategies to pinpoint inefficiencies between the steam input and the heating energy output. On the hospital campus there is one meter for each utility per building. One option was to install submeters, either mag meters or differential pressure meters, at the equipment level. Mag meters "generate a magnetic field in a conductive liquid that causes a voltage signal to be sensed by electrodes located on the flow tube wall" (Treddinick 2013). These and other options were not chosen, as a system shutdown is required for installation, which is extremely difficult in a hospital setting. Some differential pressure flow meters can be installed without a shutdown, and cost an estimated $17,000 per meter for the equipment, plus labor costs. However, due to these high capital costs associated with differential pressure flow meters, U of M needed to consider other options. The team looked to develop an alternate solution.

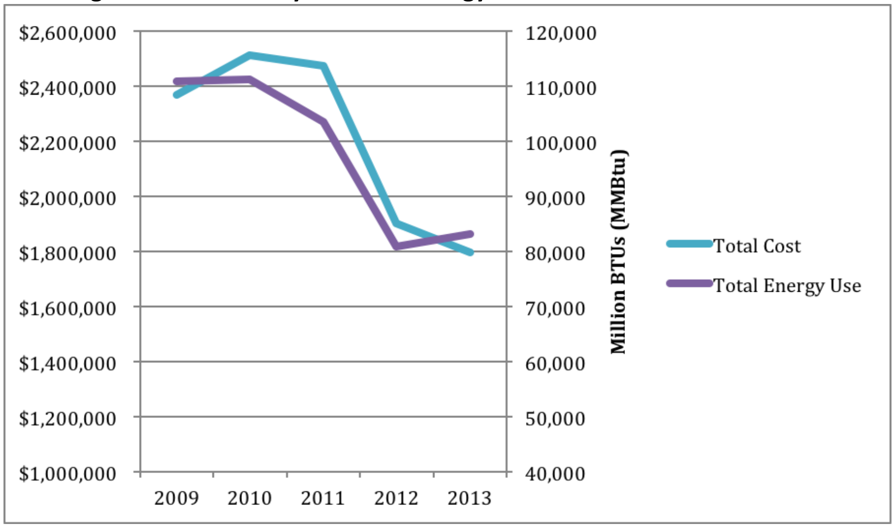
After comparing the various options, the U of M team decided the most cost effective option would be to hire a Testing, Adjusting and Balancing (TAB) Contractor to measure energy use and steam flow, and to use their results, in conjunction with U of M's data, to determine the necessary steps needed to conserve energy. TAB contractors have the equipment and expertise to measure the flow of hot water and temperature at different locations of an HVAC system. By reading the flow and temperature differential, the contractors and U of M team are able to understand the heating energy distribution at various parts of the building.

TAB contractors use a Shortridge Multimeter to measure the flow, and infrared temperature gun or local gauges for temperature readings. By using such instruments, the TAB contractors are able to measure the total system heating output and compare it to the heating energy consumption of various building zones. The TAB contractor used these measurements to identify building zones using the greatest amount of heating energy, as well as to identify any losses from the heating hot water (HHW) system or other HHW operational issues. The engineering analyses helped show U of M the "energy flow, anomalies and wastes" (Murphy 2013).

Implementation Process

The U of M Hospital Energy Conservation Team "looks for opportunities on a top down basis" (Murphy 2013). They receive monthly utility bills that list the consumption of steam (1,000 lbs of steam), electricity (kWh), gas (CCF), and water (CCF) for each building. U of M Hospital receives energy from both the University of Michigan's onsite power plant and Detroit Edison, an investor-owned utility company servicing eastern Michigan. U of M Hospital keeps records of energy data from monthly utility bills in customized spreadsheets and in ENERGY STAR Portfolio Manager (see Figure 3). Conversion factors are used to convert all levels of consumption into BTUs. Once energy data has been entered into Portfolio Manager, hospital buildings are grouped based on building type (commercial, office, clinic, hospital, etc.) to assist in identifying underperforming buildings of each type.

Figure 4: Total Utility Cost and Energy Use for Cardiovascular Center



Through this process, the team identified the CVC as an underperforming building due to a history of high district steam consumption. To improve the CVC's performance, they hired a TAB contractor from one of the three firms U of M regularly uses. Murphy developed a very detailed project scope and provided drawings to guide the contractors' analysis. A team of two people conducted walkthroughs of the building and then completed their flow and temperature readings over a seven-day period. The Energy Conservation Committee then analyzed the data internally. Through this process, the results provided by the TAB contractors "validated that the majority of the steam was used in the reheat coils" (Murphy 2013). The results showed that 80% of the heating energy goes to the reheat coils, and also indicated that conservation efforts needed to target Floors 2A and 4 as these floors used 50% of that load.

Using the results from the TAB contractors as ammunition, the team proposed four related projects aimed at reducing unnecessary heating and cooling, and included calculations estimating potential energy savings for each project. Once the committee agrees to support a project, the proposal is sent to the Director of Facilities for funding.

The following section provides a brief synopsis of the four main projects proposed to improve energy consumption at the CVC. The four proposed projects include:

1. Pretreatment (PT) Unit Discharge Air Temperature (DAT) controls
2. Air Handling Unit (AHU) DAT Reset Controls
3. Variable Air Volume (VAV) Box Schedule
4. VAV Minimums (Mins)

Project 1: Pretreatment (PT) Unit Discharge Air Temperature (DAT) Controls

At the time of investigation, "minimum outside air [was] supplied to [AHUs] by two 100% outside air units which are currently controlled to discharge 55°F air year round"

(Murphy 2010, Report #1). These air units have heating coils that supplement the normal HVAC system. It was discovered that heating the outside air during the heating season is unnecessary, except for on the coldest winter days. Without the preheat coils, the mixed AHU unit could discharge air at the proper temperature by mixing it with the return air.

To turn down the temperature on the preheat coils on the pretreatment units during the heating season, the Energy Conservation Committee created a new algorithm. Initially the preheat coils were set to a temperature of 55°F, equal to the desired supply temperature. This temperature was lowered to 42°F because it is mixed with the return air that is often as warm as 75°F. The temperature setting for the preheat coils cannot be any lower without affecting the coil freeze protection systems. Also, the preheat coils cannot be turned off altogether because the units are designed to be used as a smoke purge in the event of a fire.

This project required that U of M hire a direct digital control (DDC) service technician. The estimated savings were $100,000/year. For a detailed description of the estimated energy savings, please see Appendix A.

Project 2: Air Handling Unit (AHU) Discharge Air Temperature (DAT) Reset Controls

The air provided to the CVC was at a constant temperature designed to accommodate maximum cooling demand conditions, not making it the most energy efficient option for normal operation (Murphy 2011, Report #2). Cooling air to a certain temperature makes sense during the summer, since the weather in Michigan is fairly humid, resulting in dehumidification requirements since the outside air has more moisture. This is not necessary during the winter months since there is low humidity. This means that the temperature or setpoint of the AHU DAT reset controls can be adjusted to save energy.

The Energy Conservation Committee:

- Energy Conservation Engineer
- Two Mechanical Engineers
- Electrical Engineer
- Director of Maintenance and Operations
- Support Services Financial Director

The Energy Conservation Committee was able to create a new procedure simply by adjusting the setpoint based on the outside air temperature in the University of Michigan HHC Direct Digital Control (DDC) system. The DDC system automatically resets the DAT setpoint based on the outside air temperature sensor and corresponding table setpoints. The new settings are as follows:

- If OAT (Outdoor Air Temperature) is less than 40°F, then DAT (Discharge Air Temperature) = 60°F
- If OAT is greater than 70°F, then DAT = 55°F
- If the OAT is greater than 40°F and less than 70°F, then the DAT setpoint is reset proportionally between 60°F and 55°F.

The savings from this project result from a reduction in the terminal reheat coil loads, and to a lesser extent from reduced AHU cooling coil loads. While the initial project proposal stated that outside air temperature would not be changed to 60°F until outside air temperatures reached 35°F, this was overly conservative and they are able to increase the setpoint to 60°F once the outside air temperature drops below 40°F.

Project 3: VAV (Variable Air Volume) Box Schedule

Since opening in 2008, "The entire CVC building [has been] ventilated continuously, which is unnecessary for a significant portion of the building during unoccupied periods" (Murphy 2010, Report #3). By meeting with administration staff at the CVC, Murphy and team identified the specific staff and clinical areas of the building that do not operate on a 24/7 schedule and therefore are vacant at times during the nights and weekends.

This project consisted of installing new Direct Digital Control (DDC) equipment that allows certain, unoccupied areas to be turned to zero air changes per hour. They also considered installing occupancy sensors but the existing VAV controllers do not have an input where an occupancy sensor could be installed. In other, newer hospital buildings, they are able to take a three-pronged approach. Some areas are conditioned 24 hours a day, some are conditioned on a set schedule because the occupancy is regular enough to accurately predict when ventilation will be needed, and then other areas, such as conference rooms with unpredictable occupancy schedules, have occupancy sensors.

They are still able to accommodate people working in the evening, such as cleaning staff, by continuing to condition the hallway air and by automatically maintaining temperature ranges in all unoccupied areas.

Project 4 : Variable Air Volume (VAV) Minimums (Mins)

Some of the areas within the Cardiovascular Center were designed so the "DDC VAV boxes installed did not include set minimum airflow levels and [were] therefore operating as a constant volume system" (Murphy 2010, Report #4). Upon inspection, it was discovered that several areas could in fact be heated and cooled at a variable air volume using the existing equipment.

The Energy Conservation Team analyzed applicable codes and regulations to develop a list of minimum ACHs (air changes per hour) for different parts of the building. Specifically, "setting minimum airflow levels will reduce ventilation requirements and will reduce heating, cooling and motor horsepower requirements" (Murphy 2010, Report #4). Some rooms were not adjusted at all because they are ventilated with exhaust air instead of return air, which did not allow the flow to be modulated.

Since these areas are controlled by networked DDC controllers, the new "minimum airflow levels can be set remotely by UMHHC Systems Monitoring technicians" and thus project costs were estimated to be $0 (Murphy 2010, Report #4). The savings were estimated to be $20,000 using the following calculation:

= $5.62/ft^2 (total CVC utility cost per square foot) * 23,500ft^2 (square footage of the first floor of the CVC building) * 70% (percentage of utility costs that come from HVAC) * 20% (percentage savings assuming and average operational airflow of 80%).
= $20,000/year

The projects above were proposed starting in August 2010 and were completed by the end of 2012. These four projects alone resulted in saving $370,000 over the first year and had an average payback period of less than 0.1 years.

Table 1: Project Costs, Savings and Payback Time

Project #	Project Name	Cost	Predicted Energy Savings	Actual Energy Savings	Actual Payback
1	Pretreat AHU DAT Control	$3,738	$100,000	$75,000	0.05 years
2	AHU DAT Reset Controls	$13,944	$80,000	$115,000	0.12 years
3	VAV Box Schedules	$20,722	$160,000	$160,000	0.13 years
4	AHU/Office VAV Mins	$0	$70,000	$70,000	N/A

Benefits

- ENERGY SAVINGS: The main benefits, as shown in Table 1, from these projects are substantial heating and cooling energy savings. The annual energy savings in Projects 1and 2 came from adjusting the temperature control settings. The annual savings in Project 3 came from shutting off VAV boxes when not needed. Project 4 savings came from setting up minimum air changes per hour (AHU) in certain areas.

- WELL-MAINTAINED HVAC: The HVAC systems in this building were fairly new and well-maintained, therefore savings from changes in maintenance costs, operational benefits and improved indoor air quality benefits were not significant with the HVAC upgrades.

- EMPLOYEE SATISFACTION: In terms of employee satisfaction, Murphy sees it as a very positive sign that there was next to zero feedback from building occupants. He attributes this to their approach of engaging the CVC maintenance and administration staff early and often as the projects progressed.

- ENVIRONMENTAL STEWARDSHIP: This project is part of the larger organization-wide environmental stewardship goals at the U of M. Energy conservation is one way through which the hospital can help to contribute towards meeting the University's energy goals. Currently, U of M has an overarching goal of reducing their greenhouse gas emissions by 25% by 2025.

Challenges and Lessons Learned

Challenges Addressed:

- At the very beginning of this project, the Energy Conservation Team was uncertain as to how to feasibly and effectively address the hospital's high steam use. They addressed this by developing a plan to quantify where the steam was going. Once results from the TAB contractor measurements were available, it was easy to identify next steps.
- If the Energy Conservation Team wants to make adjustments to certain aspects of the HVAC in a building, they need to get approval from a state board. This prevents them from moving quickly and testing out new heating and cooling strategies in the hospital environment. Although this was thought to be a challenge at first, the approval process ended up being quick and seamless.
- Another challenge was gaining support from administrative staff and identifying feasible schedules for adjusting the HVAC settings in portions of the CVC that are not operated 24/7. Fortunately, the CVC administration and maintenance staff is extremely supportive of energy conservation measures and was willing to work with the team early on in the process.

Lessons Learned:

- There is not always a need for a submeter. Exploring alternatives can provide cost effective options that do not require any capital expenditure.
- At times, a back of the envelope calculation can get you close enough, even to the point where a TAB contractor may not be needed.
- There is not always a need for occupancy sensors – it is often feasible to develop schedules for the HVAC equipment based on the predicted occupancy schedule as well.
- Engage maintenance and administrative staff early for the best results.

(THIS IS FOR INTERNAL USE)

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Citations:

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List of all contacts spoken to at case study site: Colin Murphy
Keywords/Topics: HVAC, energy conservation measures

APPENDIX A

ESTIMATED ENERGY SAVINGS
Provided by Colin Murphy

The changes in this project will result in electrical, heating, and cooling energy savings. Based on FY2011 utility rates for this facility, the estimated energy savings are as follows:

Heating Savings:

The average minimum outside air concentration of the AHUs served by PT-1 and PT-2 is approximately 20%. Therefore, assuming 70°F return air temperatures, on average, preheating in these AHUs is not necessary when outside air temperature is greater than -5°F in order to achieve a 55°F mixed air temperature. The proposed heating setpoint is 40°F. When outside air temperature is between -5°F and °F, 15°F (55°F – 40°F) of heating savings are applied. Based on TMY3 data for Ann Arbor, outside air temperatures are between -5°F and 40°F approximately 2,800 hrs/yr with an average temperature of 27°F during that period. Based on TMY3 data for Ann Arbor, outside air temperatures are between 40°F and 55°F approximately 2,400 hrs/yr with an average temperature of 48°F during that period, therefore yielding an average savings of 7°F (55°F – 48°F). The observed airflow total from PT-1 and PT-2 is approximately 65,000 CFM. Therefore, the estimated energy savings are as follows:

Estimated Savings:

= 1.08 x 65,000 CFM x 15°F x 2,800 hrs/yr + 1.08 x 65,000 CFM x 7°F x 2,400 hrs/yr
= 4,128 MMBtu / 80% HX Eff.
= 5,160 MMBtu x $19.42/MMBtu
= $100,000/yr

Appendix E: Therapeutic Garden

Therapeutic Garden Analysis:

Beaumont Health System, Royal Oak, Michigan

Summary Report

Sustainability Initiatives for Beaumont Health System Project Team
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University of Michigan
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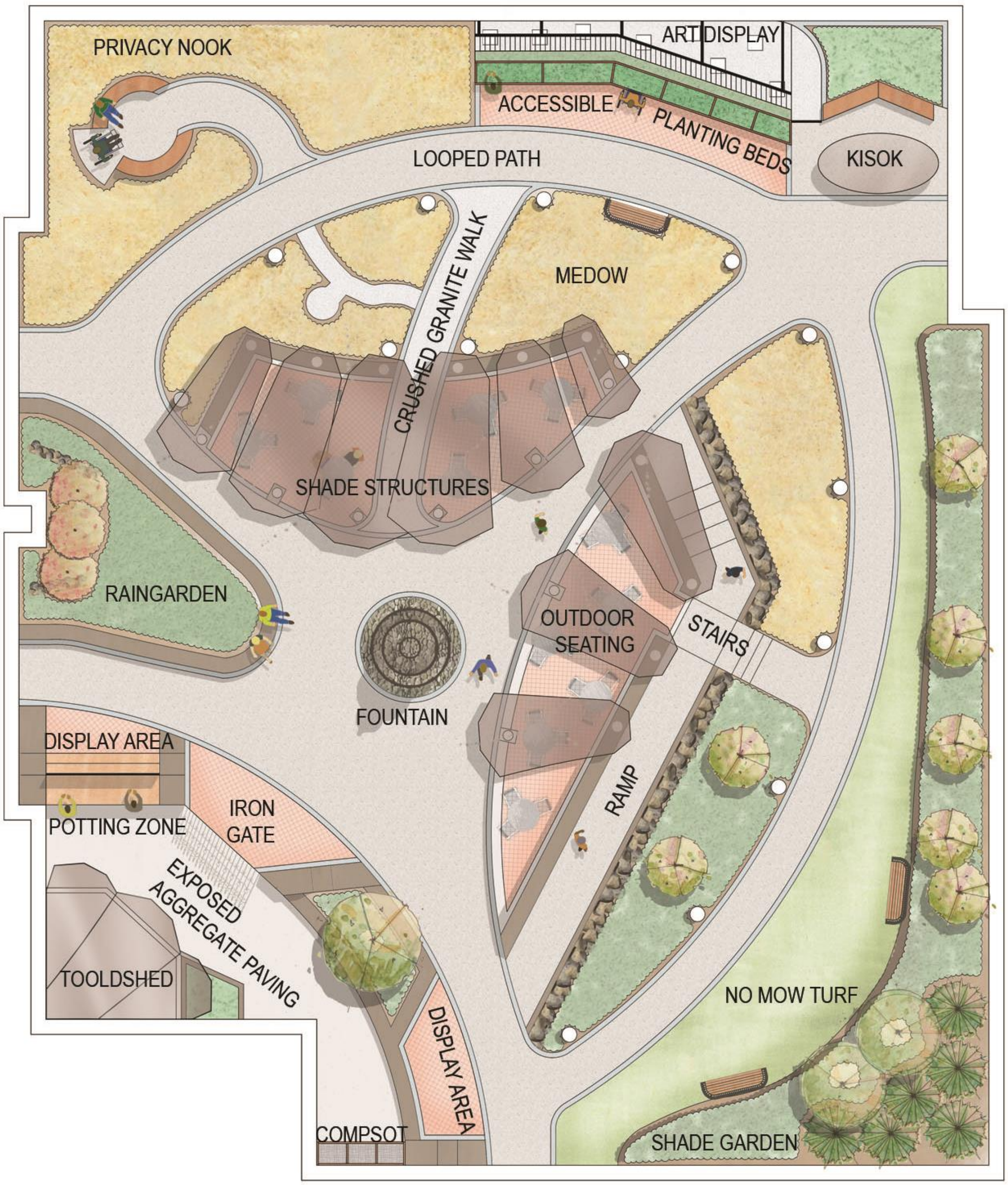
1/1/2014

Contents

Figure 1:Therapeutic Garden Design



1. Executive Summary

Purpose

The purpose of this project was to design a space catering to patients in physical and occupational therapy programs at William Beaumont Hospital in Royal Oak, Michigan. With the input of doctors and patients as well as national leaders in healthcare design, the designed space at Beaumont incorporates many elements that can be used to help with patient recovery. Other users are meant to utilize the space as well. Lounging areas are spread throughout the garden, and there is even space for visitors to purchase plants for patients residing within the hospital. Widely viewable and easily accessible, the new healing garden at Beaumont will be not only aesthetically pleasing but very functional as well.

Beaumont Health System

Founded in 1955, the William Beaumont Hospital is the 20th largest hospital in the United States being a regional health care provider for Metro Detroit. Opening with 238 beds in Royal Oak, the hospital continued to expand to neighboring Troy and Grosse Point adding nearly 700 beds. The largest of the three Beaumont Campuses, Royal Oak Beaumont is a 1,070 bed tertiary hospital with an Imaging Center, the Comprehensive Breast Center, the Beaumont Cancer Center, Vascular Services Center, the Beaumont Heart Center, the Research Institute and the Medical Office Building.

SIBHS Background

The University of Michigan's School of Natural Resources and Environment's Sustainability Initiatives for Beaumont Health System (SIBHS) master's project team conducted a Level 1.5 audit of the MOB with Glen Staton and Rob Friebe in November 2013. The audited areas consist of the common hallways and spaces on the first floor as well as the equipment room located on the top floor of the MOB.

Garden Functionality

Primarily focusing on the needs of physical and occupational therapy programs at Beaumont, the proposed therapeutic garden will incorporate elements to help patients recover from numerous conditions. Spinal, neck, joint, hand, neuromuscular re-education, and shoulder therapy are a few healing regions when gardens can be utilized during therapeutic programming. Additionally, the space will provide a place of respite for patients, employees, and visitors. Versatile seating arrangements allow for programming for larger or smaller groups depending upon need. A small sales area will be used to help support ongoing efforts within the garden. Potted plants can be purchased for patients within the hospital. Lastly, LEED accreditation will be pursued through native plantings, onsite stormwater management, and sustainable construction techniques.

2.Design Process

The process of design can have a suggested structure; however, oftentimes the order in which each step is completed can change. In regards to a project with so many facets, many opportunities can arise that force the designer to be more flexible and adaptable to design. In the case of this specific design, unforeseen client needs as well as an unexpected hospital expansion created the need to actually work on more than one step of the design process in unison rather than sequentially.

The entire design process can be whittled down to six primary steps encompassing many other secondary steps. Research, site analysis, site layout, layout refinement, detailing of individual sections within garden, and final document preparation are the overlying steps we followed while completing the garden design. Each of these key components has additional steps within them to be further covered in the following sections.

3. Research

In order to present an effective healing garden design to Beaumont Health System, it was necessary to begin by researching historic examples of hospital gardens as well as reviewing current research within the field of therapeutic gardening. Through our research, we were able to determine a proper starting point in which to begin a site analysis that will be further discussed later.

3.1 Document Review

Initial research began with a formal review of published articles and research papers authored by prominent leaders in healthcare garden design such as Roger Ulrich. Additional materials by the American Horticultural Therapy Association were reviewed during this phase to help develop a stable foundation before any formal design was to begin. Ulrich's *Health Benefits of Gardens in Hospitals* and Clare Cooper Marcus and Marni Barnes' *Healing Gardens: Therapeutic Benefits and Design Recommendations* provided a strong foundation to begin further research specific to our site. Additional documents, interviews, and personal experiences as studied landscape architects reinforced this foundation throughout the entire analysis.

3.2 Case Study

In addition to our formal document review, an in-depth case study was completed. This case study focused on Portland-based Legacy Health, arguably the nation's leader in healthcare garden programming implementation. Our primary source of contact at Legacy was registered horticultural therapist Teresia Hazen. Hazen, who has an extensive background in the planning and development of therapeutic garden programming, connected us with Brian Bainnson of Quatrefoil, Inc., the landscape architecture firm Legacy Health has used for its design work. Through numerous emails and phone interviews, Hazen and Bainnson provided us with a wealth of material[1] to further fuel our design for Beaumont Hospital.

[1] Throughout this report the authors will reference a series of interviews with T. Hazen of Legacy as a one interview. (Hazen, 2013)

4 Site Analysis

"Site analysis is a vital step in the design process. It involves the evaluation of an existing or potential site in relation to the development program, environmental impact, impacts on the community and adjacent properties, project budget, and schedule. The site analysis identifies environmental, program, and development constraints and opportunities. A well-executed site analysis forms the essential foundation for a cost-effective, environmentally sensitive, and rational approach to project development."-Excerpt from *The Architect's Handbook of Professional Practice*

Site analyses can be considered pre-design processes. Numerous site visits are made, existing infrastructure is studied, interviews with the client and users are conducted, and an initial feeling is developed as to what can realistically be designed for the site. This approach helped further develop the therapeutic garden space for Beaumont. This section will outline current conditions of the site(s) and begin to discuss which site option was chosen and why.

4.1 Analytical Process

Based on initial research of existing healthcare garden designs and personal site visits, it was found necessary to consult with a diverse group of users of the future site. Efforts were made over a two-month period to connect with as many potential users as possible. Individual interviews were conducted with physical and occupational therapists, nurses, patients, and casual visitors asking each of them their wants and needs for a space within the hospital campus aimed to function as a place for relaxing, enjoying, learning, and healing Generally, a site will not function properly unless time is taken to get as much input as possible from the end user (Hazen 2013).

During these site visits, SIBHS also documented dimensions of each potential garden location and photographed as many locations as possible. Site visits were followed with blueprint reviews of existing infrastructure as well as expansion projects already on the calendar. Exterior Services Manager Nicholas Aseltine, Jones Lang LaSalle, provided blueprints of the sites.

4.2 Existing Infrastructure (Site Inventory)

Site visits and blueprints show a wealth of existing infrastructure. Irrigation lines currently run throughout the entire site and can easily be tapped into for use in the proposed garden space. Electric lines are also accessible at all three potential site locations. Additionally, there is a preexisting stormwater management system on the campus. However, if Beaumont desires to qualify for LEED SS Credit: Rainwater Management, it would be wise to divert water from the existing stormwater system and through natural swale systems instead. The final design proposed utilizes a rain catchment system that retains rainwater for irrigation within the garden itself. Other amenities existing onsite are points of public access, sun exposure, sources of acoustic interference, etc.

4.3 Specific Findings at Each Site

Site A: Northwest of Employee Fitness Center

- Site currently holds defunct garden space (needs updating itself)
- Low traffic by patients

- Low-to-moderate traffic by staff to access fitness center (heaviest during lunch breaks)
- Adjacent to road on three sides and parking lot on fourth
- Flat topography
- Adjacent to stormwater management swale
- Disturbed soil
- Planted with grass and a few (10) young ornamental trees
- Few windbreaks

Site B: South of East Tower

- Site currently holds moderately well-maintained formal garden space (hospital would like to deconstruct site to repair membrane rupture below surface)
- High traffic by patients
- High traffic by staff due to ease of access (heaviest during lunch breaks)
- Adjacent to patient drop-off on one side
- Flat topography
- Stormwater directed to municipal system through paved drainage
- Disturbed soil under existing hardscaping and relatively fertile soil within planters
- Planted with various perennial grasses and herbaceous species as well as larger woody shrubs and birch trees
- Surrounded on three sides by tall structures providing more than adequate shelter from winds

Site C: North of East Tower

- Site currently functions as a stone-paved stormwater management system
- No traffic by patients
- No by staff
- Adjacent to patient drop-off on one side
- Flat topography
- Stormwater directed to municipal system through stone-paved drainage as well as trench drainage
- Disturbed soil under existing hardscaping
- No vegetation
- Surrounded on two sides by tall structures providing adequate shelter from winds

4.3 Summary of Additional Findings

Initially, only one site location was to be evaluated. The original site is directly northwest of the Employee Fitness Center. This location is not centrally located and would make transporting patients time-consuming relative to the short therapy sessions (0.5-1 hour).Due to the site's relative inaccessibility, two additional potential sites were analyzed for the installation of a healing garden.

These additional sites, found directly adjacent to the East Tower are much more centrally-located, have greater accessibility/visibility, and are more favorable in light of patient needs. Currently, the south location is an existing garden space while the north space is undeveloped. While each space posed some accessibility challenges for patients and employees, visibility from within the hospital, size of the space, and access to existing infrastructure (electrical, irrigation, stormwater, etc.) were benefits of these two sites. Furthermore, each of the two East Tower locations had a substructure under a large portion of the space reducing the potential for tree plantings.

Due to the height of the East Tower, Central Tower, and South Tower, the southern site garden location receives little direct sunlight throughout the year. Similar results were found on the northern site, although it receives slightly more sun throughout the year. If the proposed north expansion is taken into account, formal sun/shade analysis indicates nearly equal insolation for both sites. Although the northern site is larger and receives slightly more sunlight throughout the year, the southern site provides more accessibility and visibility.

4.4 Advantages and Disadvantages of Two Sites

Southern Site Observations

- Reusable materials contribute to LEED (Leadership in Energy & Environmental Design) v4 materials resource credit (i.e. salvaging brick pavers to use in construction of newly proposed planters, paths and seating elements).
- Existing infrastructure (irrigation, stormwater, electrical, plantings, furnishings, etc.) is located on site in thanks to the existing gardens space.
- Adjacency to a cafeteria and soon-to-be pedestrian thoroughfare creates a location of high visibility.
- Adjacency to two low-level rooftops allows incorporation of vegetated roofs[2] into the garden space. Although these rooftops will not be accessible by patients, they will be viewable from above on three sides by many patients who are limited to the indoors. (LEED v4 Heat island reduction)
- A fully enclosed courtyard lowers noise from automobiles and HVAC equipment and creates accessibility on four sides. This also creates a more private setting for patient-doctor appointments.
- Each of the four sides of the southern location is public space within the hospital. This allows the opportunity for many more visitors to experience the space rather than if offices and exam rooms surround the garden, much like the northern location.

Northern Site Observation

- The site currently contains two large, immovable ventilation structures detracting from quiet atmosphere of potential healing garden and blocking many views.
- There is a lack of accessibility on all four sides; only one side would be accessible by public.
- Surrounding rooms are primarily doctors’ offices at ground level limiting visual access to the area by hospital visitors.
- There are no reusable materials like the southern site.
- Beaumont’s proposed northern expansion precludes the ability to install deep-rooted woody plants, one of the only major benefits of northern site in relation to southern site.

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[2] A formal analysis of vegetated roof technology was also performed. Many details of the findings are not found within this document but are more thoroughly discussed in the *Vegetated Roof Analysis*.

5. Final Therapeutic Design Elements

After discussions with our client, we decided to focus on designing a therapeutic garden space to address the needs of physical therapy(PT) and occupational therapy(OT) patients. These patients are recovering from a range of injuries and traumas including broken bones, torn muscles, and memory loss. Interviews with OT and PT staff at Beaumont and Legacy have provided us with information about how to program the site and what kind of essential healing elements to include. Some of the main elements incorporated are alternative surfaces (brick, gravel, concrete), sloped walkways, handicapped-accessible planting beds of altering heights, intimate spaces for private discussion, arrays of textured and scented plants with labels to help with identification exercises for memory loss, water features for ambient white noise, etc. All of these therapeutic elements will be placed throughout the site for best aesthetic effect and physical function. Below is a discussion of the desired design elements from the interviews.

Raised Cultivation Beds

Raised cultivation beds can provide space for very demanding therapeutic exercises(Stigsdotter 2003).Through the use of variable-height cultivation beds, patients can sit comfortably with knees beneath the planters. This allows patients confined to wheelchairs to garden more comfortably. The depth of each cultivation bed is designed for easy arm reach while sitting. Other planting beds, set lower to the ground, are designed to allow patients to garden from the side of a wheelchair. Areas of therapy covered can include spinal, neck, joint, hand, neuromuscular re-education, and shoulder therapy.

Figure 2:Raised Cultivation Beds

Source: Green Thumbs 2014

Ground-level Cultivation Beds

Ground-level cultivation beds offer similar therapy options to raised cultivation beds. However, they allow for a differing range of motion not provided by raised cultivation beds. See ‘Raised Cultivation Beds’ for therapies covered.

Figure 3:Ground-level Cultivation Bed

Source: Wright Stuff 2014

Ramps and Stairs

Ramps and stairs are other common components to therapeutic garden design. They can be used to help regain coordination and fine motor skills after spine and neck injuries or aid in the conditioning of arthritis and joint replacement patients (Leibrock 2011).Evidence found from the research of Janice Eng (OT/PT professional) suggests that the ability to walk improves with repetitive and intensive practice where there are different increments of difficulty according to the tolerance of the patient (Eng 2004).Some of these practices include walking on surfaces with various slopes that provide a physical challenge for the patient to overcome.

Eng's findings are addressed in the final site design. Paths with slopes set at 1-2%, 5% and 10% for patient therapy as well as two to four-stair staircases will be placed throughout the garden. The steeper slopes are accompanied by rails for safety precautions following ADA standards.[3]Likewise for safety, the sloped surfaces are paved with brushed concrete that provide high traction.

[3] "The ADA is one of America's most comprehensive pieces of civil rights legislation that prohibits discrimination and guarantees that people with disabilities have the same opportunities as everyone else to participate in the mainstream of American life -- to enjoy employment opportunities, to purchase goods and services, and to participate in State and local government programs and services." (http://www.ada.gov/ada_intro.htm)

Figure 4: Ramps and Stairs

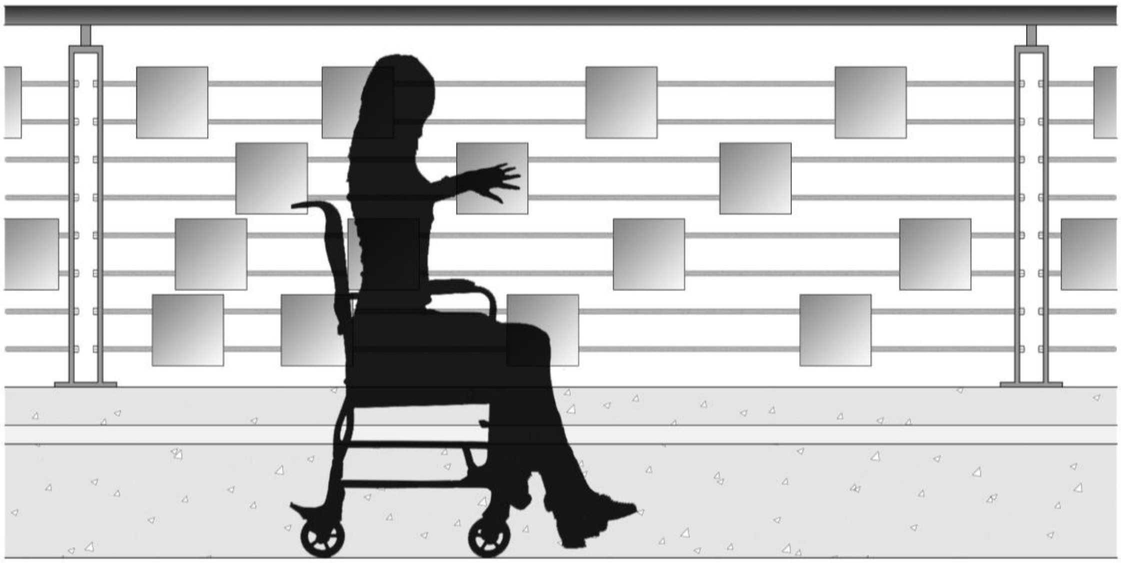
Mixed Surface Materials

After consultation with the OT staff, it was found to be imperative for recovering patients to experience the different types of walking surfaces that they are likely to encounter in public. These surfaces include brushed concrete, brick, gravel and turf. All of these will be integrated into one singular, walkable garden. Making multiple surface materials available in the design helps patients to regain motor skills after spine and neck injuries.

Resistance and Mobility Fence

Serving as a space divider, this fence has been engineered to accommodate patients through rotator cuff and labrum therapy as well as spine and shoulder instability, ligament sprains and muscle strains. Author J. Hamilton's knowledge through personal experience was utilized to help develop this system.

Figure 5:Resistance and Mobility Fence



Fragrant Plantings

Fragrance has long been used to relieve stress and depression (Fujiwara 1995).Although it is not clinically proven to cure disease, there is evidence that it is a, “complementary therapy…[for] people who have cancer to reduce anxiety, depression, tension, and pain”(AMS 2008).Additionally, it has been proven that stress slows the physical healing process keeping patients in the hospital for a longer period (Christian 2006).

Textural Plantings

Plantings with a diverse range of textures facilitate the opportunity to improve fine motor skills and remediate sensory deficits in the hands. Elderly patients losing strength in their hands as well as patients suffering from Parkinson Disease can utilize delicate plantings as a source of precision grip therapy.

Private Areas

As stated by Clare Cooper Marcus, "the evidence for the importance of access to nature is there - and growing - the actual provision of appropriate outdoor space in healthcare facilities is often less than adequate, with limited "green nature" and unmet needs for privacy and "getting away" (Barnes 1999)."Privacy can be achieved with well-designed niche spaces. This can be where a family might gather for privacy and time to support one another through difficult challenges. It may also be where a patient goes during free time to get away from things to have quieter moments" (Hazen 2013).Carefully placed throughout our design are semi-private and private spaces that allow for the intimate needs of patients, staff and visitors. These spaces include overhead structures for shade, tall grasses for screening or unique seating options that encourage thoughtful conversations.

6. Final Non-Therapeutic Design Elements

Although the primary function of this space is to provide a multitude of therapies for patients at Beaumont Hospital, it is important that visitors, employees, and patients also enjoy the natural area. Therapy components will be spread amongst additional features serving as functional spaces for people to dine, reflect, and relax. A successful garden is designed for multiple uses and users. Additional features are as follows:

Accessibility

As this garden is located in a public setting, accessibility is a top priority. Throughout the garden, all paths are wide enough to accommodate foot traffic and wheelchair access with or without an IV in tandem. Automatic doors will be required at all access points, and there will be access on all four sides of the space.

Communal Space

Communal spaces have been incorporated to allow for different programming and activities such as dining, fundraisers, group therapy, etc. Three primary seating areas with movable chairs and tables have been proposed close enough to function as a singular space but bordered with visible dividers (fences, walls, and elevation) as to make them individual private areas as well inviting smaller groups. Movable chairs and tables are rather vital in allowing guests to create their own spaces if they would like to. Throughout our research, T. Hazen and B. Bainnson repeatedly advocated the use of movable furniture for this specific reason.

Since the addition of the indoor thoroughfare bisects an existing dining area just outside of the cafeteria, it is important to design enough space to accommodate those seating areas being offset. This communal space should provide adequate seating for the displaced tables. Each of the three communal areas will be accented with different planting designs. One borders a low-light rhododendron and azalea garden while another is directly adjacent to a rain garden. The third space borders a patch of grasses and wildflowers native to Michigan encouraging a habitat for local avian fauna.

Potting Area and Storage

In the southwest corner of the existing garden is a relatively sparse area. There are no windows and very few plantings. On one wall of this corner is an existing intake for HVAC equipment that must remain in place. Rather than redesigning this corner to house many therapeutic elements, a storage facility and potting area are being proposed. The storage area is an open-air structure with enough cover from the elements and will be able to be locked and inaccessible to the public as to avoid any sort of accident or theft.

Just outside of the storage area are a few potting tables. This is where patients can pot and repot plants to be used within the hospital, out in the garden, or to be sold for fundraisers. These potting areas and the programming developed through their utilization also function as a source of PT for patients as mentioned in the previous section.

This area will also provide opportunities for fundraising to help maintain the garden itself. Sales space where visitors can come in and purchase plants, for patients or to take home, that have been potted and cared for by therapy patients will be incorporated. The sales of the potted plants could also help employee a part time cashier for the space.

Figure 6:Potting Display

Local Artwork

We encourage hiring local sculptors and metalworkers to construct arbors, trellises, and any ornamental gate (cordoning off storage and potting area) work within the garden. This adds a touch of personality to the space helping to detract from the sterile environment within the hospital. Additionally, it helps to employee a local workforce, which helps to keep funds within the community surrounding Beaumont hospital.

7. Planting Plan

Many factors play a role in creating an effective planting design and may require analyzing the soil type and moisture, sun and shade exposure, intended aesthetic, and intended use. This plan includes 11 unique garden spaces that are designed to function in their own unique way. Overall, there are three main planting types that respond to each of the above criteria. One overarching concept is to imitate a plant pallet that could be found in a midwestern forest edge that transitions to a meadow. This concept is a response to the sun/shade analysis where a portion of the site that receives no sun during the day transitions to full sun. The plants called out in the shaded zone will be installed in a slightly acidic and highly organic soil composition and will be composed species found on the edge of a forest floor. The planting beds that represent the meadow will contain hardy grasses and forbs planted in circumneutral loamy sand soils representative of a dry mesic prairie. The second planting concept is a rain garden plan that is part of a proposed stormwater management system that catches excess stormwater overflow from the extensive greenroof system on the building tops to the west via rain chains. The plants in this area are selected to sustain periods of wet and dry conditions while maintaining four seasons of interest.

In response to sustainable design, this plan focuses on using planting techniques that meets a substantial portion of the LEED v4 EBOM and SITES v2 credits. In order for Beaumont to receive the LEED v4 credits listed in LEED v4 Existing Building Operations and Maintenance (EBOM) and The Sustainable Sites Initiatives (SITES)v2 section of this document, the entire campus must meet the standards. The following materials mentioned in this section are examples of some of the LEED v4 EBOM and SITES credits covered in the Therapeutic Garden Design. This design acts as a model for how other portions of the Beaumont Campus can be designed to meet the required LEED and SITES credit criteria. By selecting an overwhelming majority of native plants, LEED v4, SS Credit: Site Development - Protect or Restore Habitat Option 2 is met. The non-native plant selections are used for areas that require a particular design aesthetic that a Michigan native could not fill.SS Credit: Site Management is met as all vegetation selected for the design requires watering only during extremely hot and dry periods. Total irrigation for this design is reduced by more than 40%.Further, SITES 2009 Credit 3.5: Manage stormwater on site is also met as each garden is designed to collect and maintain stormwater runoff from the design. Any excess stormwater from large rain events is directed to one of the emergency overflow pipes that connect to the existing municipal stromwater lines. For a more exhaustive list of credits met, refer to the LEED v4 Existing Building Operations and Maintenance (EBOM) and The Sustainable Sites Initiative (SITES) v2 section of this document.

Thinking further into the therapeutic properties of the planting plan, qualities such as plant texture, smell, and color are all considered for horticultural therapy. Every plant has a set of unique characteristics that have potential to provide comfort and happiness to recovering patients, boosting their morality and overall recovery time. The use of plants such as *Monardafistulosa*, also known by the common name "Wild Bergamot", can stimulate senses memory with its recognizable and pleasant orange citrus scent. Wild Bergamot is a Michigan native perennial that will showcase soft pink blooms during midsummer, which can be a beautiful and soothing scene for visitors and patients. Another plant, *Baptisiaaustralis*, commonly known as "False Blue Indigo," is another herbaceous perennial plant possessing a number of interesting characteristics associated with its rapid growth habit, specifically the persistent seed heads it produces following its bloom from May - June. Hospital patients recovering from motor skill injuries in their hands or arms have the potential to exercise fine muscle tissue by extracting the seeds from the large seedpods for their therapy. The use of plant material for muscle therapy can be engaging, educational and more exciting than some traditional exercise techniques. A final example of horticultural therapy, for this section of the document, is designed for patients recovering from injuries such as head trauma or conditions such as Alzheimer's disease. Every plant selection will be labeled with a tag that user be required to flip in order to reveal the scientific and common names. This practice will allow OT/PT therapists to help patients use and train their minds to remember plant characteristics and names. This can be an exciting, stimulating, rewarding and enjoyable activity for recovering patients to partake in.

Though this Therapeutic Garden is designed to contain sustainable properties and functional healing elements, aesthetics and beauty were paramount when making each design decision. As such, this space is designed to contain four seasons of interest that is overall pleasant and engaging for hospital patients as well as their families, hospital staff, visitors, and the community.

8. LEED v4 Existing Building Operations and Maintenance (EBOM) and The Sustainable Sites Initiative (SITES) v2

LEED v4 EBOM is the most current set of standards created by the United States Green Building Council (USGBC) and was originally proposed to serve as a baseline for design throughout the duration of our project. The Sustainable Sites Initiative v2 is a joint partnership between the American Society of Landscape Architects, United States Botanical Garden, and the USGBC.SITES promotes sustainable land develop and management practices (SITES2014). The USGBC hopes to incorporate SITES accreditation into future versions of LEED; because of this, we find it necessary to show which SITES credits the therapeutic garden addresses. Since the garden space is a small percentage of total site area, it is unlikely that Beaumont will gain entire credits solely from its installation. However, most LEED and SITES credits are measured by entire site; the healing garden will undeniably help gain LEED v4 EBOM and SITES v2 accreditation.

8.1 LEED v4 Credit Coverage

- SS Credit: Site Development – Protect or Restore Habitat Option 2 (2 points)
  Ensure 20% of total site area contains native or adaptive vegetation.
- SS Credit: Rainwater Management (1-3 points)
  Use low-impact development to capture and treat stormwater runoff from at least 25% of impervious surfaces.
- SS Credit: Heat Island Reduction Option 3 (2 points)
  Total vegetated non-roof area + high reflectance roof area + vegetated roof area ≥ total site paved area + total roof area
- SS Credit: Site Management (1 point)
  Employ environmentally sensitive site management practices to provide a clean, well-maintained, and safe building exterior.
- WE Credit: Outdoor Water Use Reduction (2 points)
  Reduce site irrigation by 40%.
- MR Credit: Purchasing – Facility Maintenance and Renovation (1 point)
  Purchase at least 50%, by cost, of total maintenance and renovation materials meeting the following criteria: recycled content, wood products, bio-based materials, reused materials, as well as others.

*It is possible to gain innovation credits as well for advanced projects.(1-5 points)

8.2 SITES 2009 Credit Coverage

- Credit 3.2 (2 points)
  Reduce potable water use for landscape irrigation by 75% or more from established baseline
- Credit 3.5 (5-10 points)
  Manage stormwater on site
- Credit 3.6 (3-9 points)
  Protect and enhance on-site water resources and receiving water quality
- Credit 3.7 (1-3 points)

Design rainwater/stormwater features to provide a landscape amenity

- Credit 4.9 (1-4 points)
  Restore plant communities native to the ecoregion (1 point for 25% coverage, 2 points for 50% coverage, and 4 points for 75% coverage)
- Credit 4.12 (3-5 points)
  Reduce urban heat island effects
- Credit 5.4 (2-4 points)
  Reuse salvaged materials and plants
- Credit 5.5 (2-4 points)
  Use recycled content materials
- Credit 5.6 (1-4 points)
  Use certified wood
- Credit 5.7 (2-6 points)
  Use regional materials
- Credit 5.9 (3 points)
  Support sustainable practices in plant production
- Credit 5.10 (3-6 points)
  Support sustainable practices in materials manufacturing
- Credit 6.6 (4-5 points)
  Provide opportunities for outdoor physical activity
- Credit 6.7 (3-4 points)
  Provide views of vegetation and quiet outdoor spaces for mental restoration
- Credit 6.8 (3 points)
  Provide outdoor spaces for social interaction
- Credit 8.4 (1-4 points)
  Reduce outdoor energy consumption for all landscape and exterior operations
- Credit 8.6 (1-2 points)
  Minimize exposure to environmental tobacco smoke

Note: SITES is primarily a rating system for new construction projects. However, since the USGBC is likely to absorb SITES in future iterations of LEED, it is important to pay attention to all of the credits that can be attributed to with the implementation of a therapeutic garden.

9. Budget/Cost Estimate

As it stands, the therapeutic garden plan is still in its preliminary stages, suggesting that we do not currently have a comprehensive budget report. That being said, we have precedence from Legacy Health Systems showing that gardens of a similar size and function have cost between $17.00 and $33.00 per square foot. In order to give Beaumont an idea of the maximum and minimum possibilities associated with price of the garden, we will use Legacy gardens as a baseline. Between five of Legacy's therapeutic gardens, the minimum, maximum, and average prices per square foot of installed garden space $17,

$33, and $26 respectively. Beaumont's garden space is roughly 10,000 square feet making the range of total cost installed between $170,000 and $330,000 with a median price of $250,000.

10. Concluding Remarks

Based upon multiple site visits and interviews with Beaumont's staff and clientele, the need for an accessible mixed-use garden exists. The proposed garden has been developed to include spaces in which patients can perform a multitude of therapies including, but not limited to, spinal, neck, shoulder and leg conditioning, as well as more delicate exercises associated with hand grip and joint replacement conditioning. Plant labels will help patients work through memory exercises.

Attention was made to provide employees, patients, and visitors with adequate space for dining and leisurely activities since this space will be open to the public. Through the availability of movable chairs and tables, guests of the garden can create space according to their needs. This allows for much more diverse utilization of the garden. Programming opportunities include group therapy sessions and space for fundraising.

As a final point, as Beaumont's long term goal is to become a LEED certified campus, this garden has many features that can be used to collect certification points. The rain catchment garden redirects water from the municipal stormwater infrastructure to groundwater instead. Efforts will be made to harvest runoff from the rooftop to the west side of the garden that could be used to water plants. Native plantings and other low-water plants help to conserve potable water through the reduction of irrigation needs. Moreover, many materials can be reclaimed from the existing site including plantings, brick pavers, concrete, and some seating.

11. References

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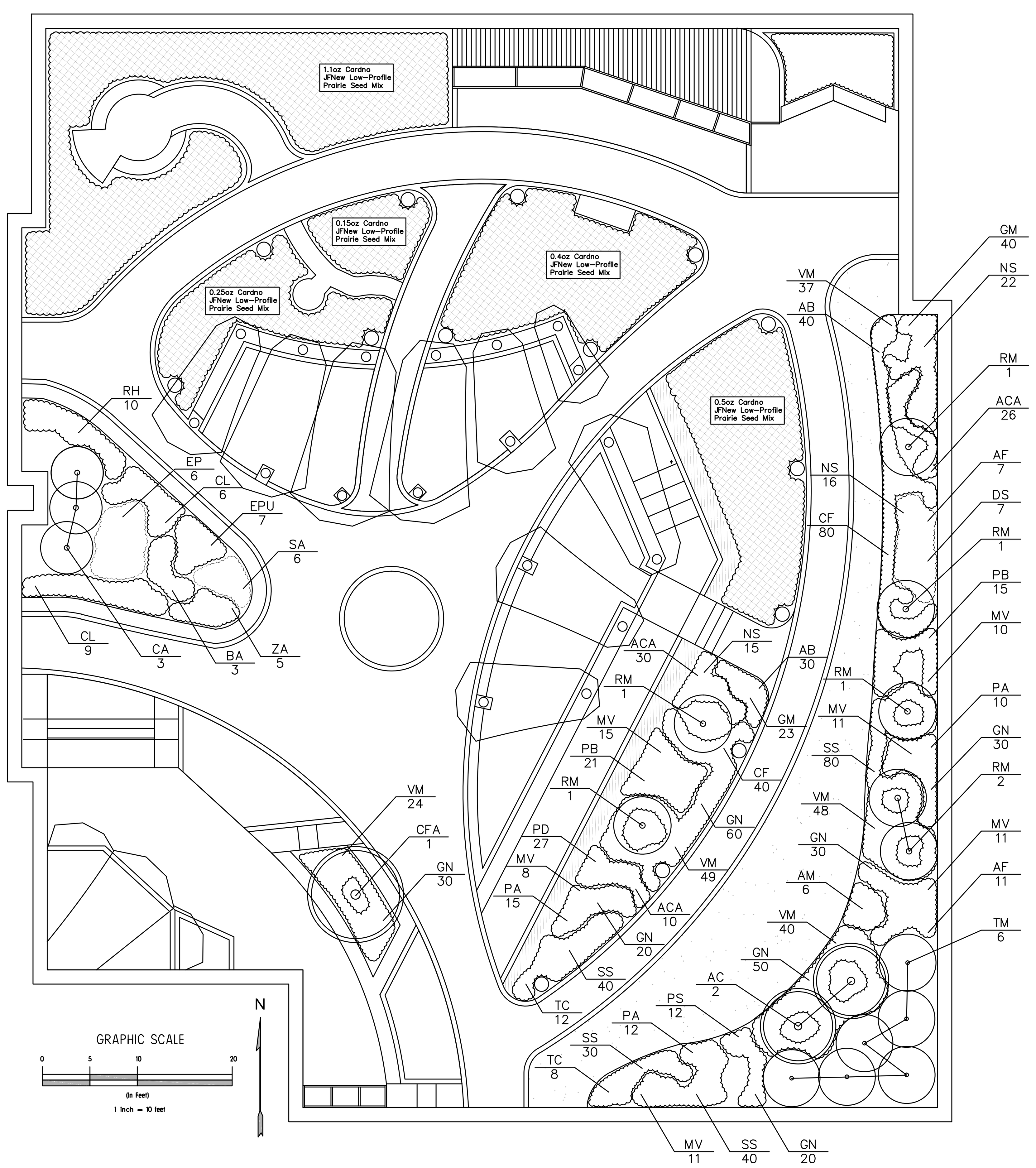
KEY:

(symbol)	= DECIDUOUS TREES
(symbol)	= SHRUBS
(symbol)	= PERENNIALS
(symbol)	= Cardno JFNew Low Profile Prairie Seed Mix
(symbol)	= NO MOW TURF
(symbol)	= STONE WALL

THERAPEUTIC GARDEN PLANTING PLAN

GENERAL PLANTING NOTES:

1. Landscape contractor shall visit site, inspect existing site conditions and review proposed planting and related work. In case of discrepancy between plan and plant list, plan shall govern quantities. Contact Landscape Architect with any concerns.
2. Contractor shall verify locations of all on site utilities prior to beginning construction on his/her phase of work. Electric, gas, telephone, cable television may be located by calling MISS DIG 1–800–482–7171. Any damage or interruption of services shall be the responsibility of Contractor. Contractor shall coordinate all related activities with other trades on the job and shall report any unacceptable job conditions to Owner's Representative prior to commencing.
3. All plant material to be premium grade nursery stock and shall satisfy American Association of Nurserymen standard for Nursery Stock. All landscape material shall be Northern Grown, No. 1. Grade.
4. Contractor is responsible for verifying all quantities shown on landscape plan prior to pricing the work.
5. The owner's representative reserves the right to reject any plant material not meeting specifications.
6. All single stem shade trees to have straight trunks and symmetrical crowns.
7. All single trunk shade trees to have a central leader; trees with forked or irregular trunks will not be accepted.
8. All multi stem trees shall be heavily branched and have symmetrical crowns. One sided trees or those with thin or open crowns shall not be accepted.
9. All evergreen trees shall be heavily branched and full to the ground, symmetrical in shape and not sheared for the last five growing seasons.
10. All trees to have clay or clay loam balls, trees with sand balls Will Be Rejected.
11. No machinery is to be used within the drip line of existing trees; Hand grade all lawn areas within the drip line of existing trees.
12. All tree locations shall be staked by Landscape Contractor and are subject to the approval of the landscape Architect prior to installation of the plant material.
13. It is mandatory that positive drainage is provided away from all buildings.
14. All planting beds shall receive 3" organic pine bark mulch. Shredded palette and died mulch will not be accepted.
15. All landscaped areas shall receive 3" compacted topsoil.
16. Maintenance: All plant material shall be maintained in good condition by mowing, watering, mulch, etc., so as to present a healthy neat and orderly appearance free from refuse and debris.
17. Refer to Cardno JFNew specifications for installation of low profile prairie seed mix
18. Shade garden planting beds to receive 18" of highly organic soil with a 5.5– 6.5pH rating.
19. Aluminum edging to be installed along planting bed edge where turf meets the bed.



PLANT LIST

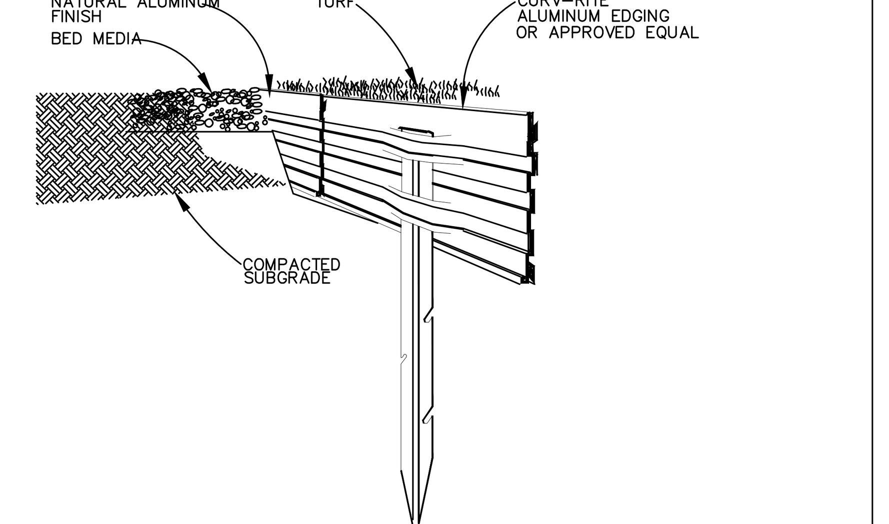
Initial	Botanical Name	Common Name	Quantities	Sun	Native	Height x Width	Size	Remarks
AB	*Anemone blanda*	Windflower	40	Full Sun - Part Shade	N	4" x 3"	Bulb	Randomly plant clusters of 5 - 7 bulbs 3" below soil through mulch
AC	*Amelanchier canadensis*	Shadblow	2	Full Sun - Full Shade	Y	15-20' x 10-15'	1.5" Cal	B & B
ACA	*Aquilegia canadensis*	Wild Columbine	66	Part Shade - Shade	Y	2' x 1'	Plug	Plant Through Mulch 1' on center
AF	*Athyrium filix-femina*	Lady Fern	18	Part Shade - Full Shade	Y	2-3' x 2'	Plug	Plant Through Mulch 2' on center
BA	*Baptisia australis*	Blue False Indigo	3	Full Sun - Part Shade	Y	3.5' x 3.5'	3 gal. pot	Remove pot before planting, separate from media
CA	*Cornus alba 'Elegantissima'*	Variegated Redtwig Dogwood	3	Full Sun - Part Shade	Y	6' x 6'	5 gal. pot	Remove pot before planting, separate from media
CF	*Chionodox forbesii*	Glory-of-the-Snow	120	Full Sun - Part Shade	N	5" x 4"	Bulb	Randomly plant clusters of 12 - 15 bulbs 3" below soil through mulch
CFA	*Cornus florida*	Flowering Dogwood	1	Full Sun - Part Shade	Y	25' x 20'	Transplant	Transplant existing tree to new designated locatoin
CL	*Chasmanthium latifolium*	Northern Sea Oats	14	Full Sun - Part Shade	Y	3' x 2'	1 gal. pot	Remove pot before planting, separate from media
DS	*Dicentra spectabilis*	Bleeding Heart	7	Part Shade - Full Shade	N	3' x 2'	Plug	Plant Through Mulch 2' " on center
EP	*Eupatorium purpureum*	Joe Pye Weed	6	Full Sun - Part Shade	Y	5' x 4'	1 gal. pot	Remove pot before planting, separate from media
EPU	*Echinacea purpurea*	Purple Coneflower	6	Full Sun - Part Sun	Y	3' x 3'	Plug	Plant Through Mulch 1.5' on center
GM	*Geranium maculatum*	Wild Geranium	63	Full Sun - Part Shade	Y	1.5' x 1'	Plug	Plant Through Mulch 1' on center
GN	*Galanthus nivalis*	Snowdrop	190	Full Sun - Full Shade	N	6" x 4"	Bulb	Randomly plant clusters of 5 - 7 bulbs 3" below soil through mulch
MV	*Mertensia virginica*	Virgina Bluebell	66	Part Shade - Full Shade	Y	1-2' x 1'	Plug	Plant Through Mulch 1' on center
NS	*Narcissus spp.*	Daffodil	53	Full Sun - Part Shade	N	1.5' x 8"	Bulb	Randomly plant clusters of 3 - 5 bulbs 3" below soil through mulch
PA	*Polystichum acrostichoides*	Christmas Fern	37	Part Shade - Shade	Y	1-1.5' x 1-1.5'	Plug	Plant Through Mulch 1' on center
PB	*Polygonatum biflorum*	Solomons Seal	36	Part Shade - Shade	Y	2-3' x 1.5 - 2'	Plug	Plant Through Mulch 1.5' on center
PD	*Phlox Divaricata*	Wild Blue Phlox	17	Part Shade - Shade	Y	1' x 1'	Plug	Plant Through Mulch 1' on center
PS	*Phlox stolonifera*	Creeping Phlox	12	Part Sun - Part Shade	Y	1' x 1.5'	Plug	Plant Through Mulch 1' on center
RH	*Rudbeckia hirta*	Black Eyed Susan	10	Full Sun - Part Shade	Y	2.5' x 2'	Plug	Plant Through Mulch 1.5' on center
RM	*Rhododendron mucronulatum*	Korean Rhododendron	7	Part Shade	N	4-8' x 4-8'	5 gal. pot	Remove pot before planting, separate from media
SA	*Sedum 'Autumn Joy'*	Autumn Joy Sedum	12	Full Sun - Part Shade	N	2' x 2'	Plug	Plant Through Mulch 1' on center
SS	*Scilla siberica*	Siberian Squill	190	Full Sun - Full Shade	N	6" x 4"	Bulb	Randomly plant clusters of 12 - 15 bulbs 3" below soil through mulch
TC	*Tiarella cordifolia*	Foamflower	20	Part Shade - Full Shade	Y	1' x 2'	Plug	Plant Through Mulch 1.5' on center
TM	*Taxus x media*	Anglojap Yew	6	Full Sun - Full Shade	N	6' x 6-8'	5 gal. pot	Remove pot before planting, separate from media
VM	*Vinca Minor*	Lesser Periwinkle	198	Full Sun - Shade	N	.5' x 1.5'	Plug	Plant Through Mulch 1' on center
ZA	*Zizia aurea*	Golden Alexander	6	Full Sun - Part Shade	Y	1.5-3' x 1.5-3'	Plug	Plant Through Mulch 1.5' on center

SEASONAL INTEREST CHART

Initial	Botanical Name	Common Name	Interest	Bloom Time and Color: Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
AB	*Anemone blanda*	Windflower	Early spring bloom												
AC	*Amelanchier canadensis*	Shadblow	Edible Fruit, cut flowers, bees, nesting, fall interest												
ACA	*Aquilegia canadensis*	Wild Columbine	Attracts hummingbirds and pollinators, good cut flowers												
AF	*Athyrium filix-femina*	Lady Fern	Good cut flowers												
BA	*Baptisia australis*	Blue False Indigo	Winter interest												
CA	*Cornus alba 'Elegantissima'*	Variegated Redtwig Dogwood	Attracts birds, has red bark all seasons												
CF	*Chionodox forbesii*	Glory-of-the-Snow	Early spring bloom												
CFA	*Cornus florida*	Flowering Dogwood	Showy flowers, four seasons of interest												
CL	*Chasmanthium latifolium*	Northern Sea Oats	Attracts birds, strong winter presense												
DS	*Dicentra spectabilis*	Bleeding Heart	Attracts butterflies, good cut flowers												
EP	*Eupatorium purpureum*	Joe Pye Weed	Attracts butterflies, has strong winter presense												
EPU	*Echinacea purpurea*	Purple Coneflower	Attracts butterflies, has winter presense												
GM	*Geranium maculatum*	Wild Geranium	Early spring bloom												
GN	*Galanthus nivalis*	Snowdrop	Early spring bloom												
MV	*Mertensia virginica*	Virgina Bluebell	Attracts pollinators												
NS	*Narcissus spp.*	Daffodil	Fragrant, cut flower												
PA	*Polystichum acrostichoides*	Christmas Fern	Good cuts												
PB	*Polygonatum biflorum*	Solomons Seal	Four seasons of interest												
PD	*Phlox Divaricata*	Wild Blue Phlox	Fragrant flowers												
PS	*Phlox stolonifera*	Creeping Phlox	Late Bloom												
RH	*Rudbeckia hirta*	Black Eyed Susan	Attracts butterflies, winter presense												
RM	*Rhododendron mucronulatum*	Korean Rhododendron	Attracts pollinators, four seasons of interest												
SA	*Sedum 'Autumn Joy'*	Autumn Joy Sedum	Late Bloom, winter interest												
SS	*Scilla siberica*	Siberian Squill	Early spring bloom												
TC	*Tiarella cordifolia*	Foamflower	Long Bloom, winter presense												
TM	*Taxus x media*	Anglojap Yew	Four seasons of interest												
VM	*Vinca Minor*	Lesser Periwinkle	Four seasons of interest												
ZA	*Zizia aurea*	Golden Alexander	Attracts polinators, has winter presense												

MEADOW SEED MIX

TYPE	Quantity	PLS Seeds / sq. ft.
Cardno JFNew - Low Profile Prairie Seed Mix	1/4 acre (smallest size)	163
	Covers 15.94 Ounces/Acre	



SPECIFICATION FOR LANDSCAPE BED EDGING

LANDSCAPE BED EDGING SHALL BE CURV–RITE DESIGN 2 (CRD2) AS MANUFACTURED BY CURV–RITE INC. WAYLAND, MICHIGAN 1 – 800 366 – 2878.

EIGHT (8) OR SIXTEEN (16) FOOT SECTIONS SHALL BE USED WITH ONE STAKE PER (38) INCHES OF EDGING EDGING SHALL BE ALUMINUM ALLOY 6063 – T6 WITH STAKES BEING 6061 – T6

STAKE SHALL SECURELY ENGAGE EDGING AND SHALL BE ENTIRELY BELOW TOP SURFACE OF EDGING. EDGING SHALL HAVE A MINIMUM OF (2) INCHES OF INTERLOCKING OVERLAP BETWEEN SECTIONS.

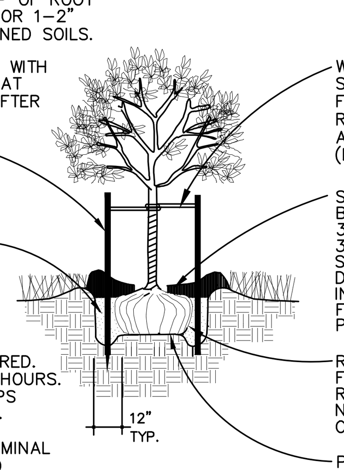
INSTALL AS PER MANUFACTURER'S SPECIFICATIONS WITH TOP OF EDGING 1/4" TO 1/2" ABOVE COMPACTED FINISH GRADE. FINISH GRADE TO BE COMPACTED ON EITHER SIDE OF EDGING TO MAINTAIN STABILITY.

ALUMINUM EDGE DETAIL

NOT TO SCALE

NOTE: PLANT SO THAT TOP OF ROOT BALL IS FLUSH TO GRADE OR 1–2" HIGHER IF IN POORLY DRAINED SOILS.

NOTE: SECURE TREE WRAP WITH BIODEGRADABLE MATERIAL AT TOP & BOTTOM, REMOVE AFTER FIRST WINTER.



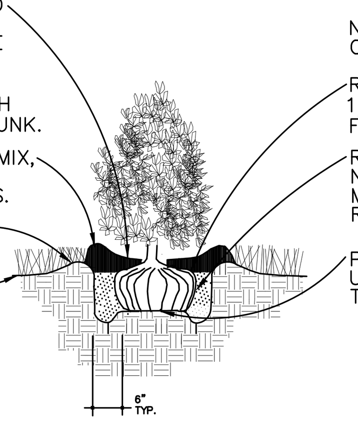
NOTE: STAKING AS REQUIRED. STAKE PLANTS WITHIN 24 HOURS. REMOVE STAKE AND STRAPS AFTER 1 GROWING SEASON.

NOTE: DO NOT PRUNE TERMINAL LEADER PRUNE ONLY DEAD BROKEN BRANCHES.

DECIDUOUS TREE PLANTING DETAIL

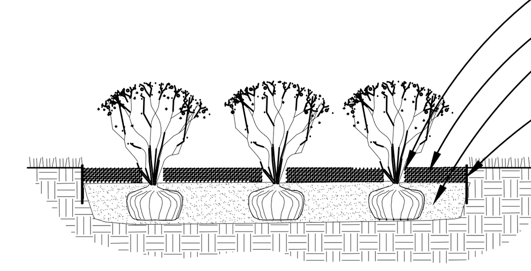
NOT TO SCALE

NOTE: PLANT SO THAT TOP OF ROOTBALL IS EVEN WITH THE FINISHED GRADE OR 1–2" HIGHER IF IN POORLY DRAINED SOILS.



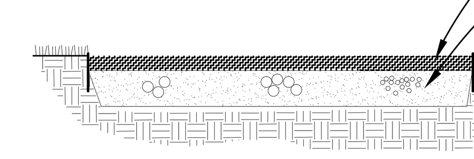
SHRUB PLANTING DETAIL

NOT TO SCALE



PERENNIAL PLANTING DETAIL

NOT TO SCALE



BULB PLANTING DETAIL

NOT TO SCALE

No.	BY	CHK	DESCRIPTION

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ORIGINAL
ISSUE DATE: APRIL 19TH, 2014

JOB NO. 2014-001

SCALE: 1" = 10'

DRAWING NUMBER:
L – 1

Appendix F: Vegetated Roof Analysis

Vegetated Roof Analysis

Beaumont Health System, Royal Oak, Michigan

Summary Report

Sustainability Initiatives for Beaumont Health System Project Team
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4/13/2014

Contents

1. Purpose

To reduce urban heat island effect and onsite stormwater runoff, Leadership in Energy and Environmental Design (LEED) accreditation and the Sustainable Sites Initiative (SITES) both encourage the installation of vegetated roofs and have established extensive point brackets vegetated roof installations. Vegetated roof installations have many ecological benefits and can be implemented in an economical fashion. Royal Oak Beaumont Hospital, having received private donor support amounting to about $300,000 specifically for green roof installations, has the potential to invest in a large-scale green/white roof installation. Installation would not only help Royal Oak Beaumont economically, but it would also assist Beaumont in achieving LEED Existing Buildings: Operations and Maintenance (EBOM) certification.

This document discusses the benefits of vegetated roof implementation at Royal Oak Beaumont Hospital. A comparison of the payback associated with traditional black tar roofs versus modern white roofs is presented primarily in regards to LEED Version 4 (v4) accreditation. Optimal installation locations for the greatest return from a vegetated roof are also provided. Since a third party contractor will most likely be required to design and develop any future rooftop renovations, this document is intended as a guide which Beaumont can refer to in their pursuit of LEED accreditation.

It should be noted that the point sets identified in this report may not be fully covered by a vegetated roof installation. Other measures throughout the grounds may need to be taken to obtain full credit. Additionally, white roof installations may be paired with vegetated roof installations to obtain credit for certain categories (e.g. urban heat island effect) but may not contribute to other categories (e.g. stormwater reduction).

1.1. LEED v4 Credit Coverage

Following LEED v4 criteria, the proposed vegetated roof system at Beaumont Hospital will primarily cover two Sustainable Sites credits. In addition to diverting nearly 70% of stormwater runoff from the municipal system, vegetated rooftops can also reduce ambient air temperatures around the installed facility (USDOE 2004).

- SS Credit: Rainwater Management (1-3 points)
  Use low-impact development to capture and treat stormwater runoff from at least 25% of impervious surfaces.
- SS Credit: Heat Island Reduction Option 2 (1 point)
  At least 50% of roof is vegetated.

1.2. SITES v2 Credit Coverage

Complementary to LEED v4 accreditation, credits can be achieved under SITES, a separate certification process that is further being absorbed into future LEED iterations.[1] SITES credits 3.7 and 4.12 are similar to the credits covered under LEED v4. SITES credit 3.7 utilizes onsite storage mechanisms such as rain barrels, cisterns, and other devices to store rainwater for use throughout the site.

- Credit 3.5 (5-10 points)
  Manage stormwater on site
- Credit 3.7 (1-3 points)
  Design rainwater/stormwater features to provide a landscape amenity
- Credit 4.12 (3-5 points)
  Reduce urban heat island effects

2. Background

In the last few decades, a movement towards more sustainable building development has progressed, and in developed countries, state and national sustainability standards are becoming more common. Germany, in particular, has developed guidelines for all vegetated roof construction in the country. The Landscaping and Landscape Development Research Society (FLL) of Germany released the *Guideline for Planning, Execution and Upkeep of Green-Roof Sites* in 1995 and last updated the guidelines in 2002. This document sets a global precedence for vegetated roof design and was the primary document referred to in this study.

As Beaumont Hospital in Royal Oak, Michigan is pursuing LEED EBOM accreditation, investment in the installation of vegetated rooftops would bring them closer to earning LEED Sustainable Sites credits. Green roofs have the potential to benefit the local environment by managing stormwater runoff and regulating building temperatures therefore reducing chemical runoff into the municipal stormwater system, and reduce the number of finite resources needed to heat and cool the hospital. Green roofs would also save Royal Oak Beaumont money by reducing stormwater management fees and heating and cooling costs. As such, and in consideration of Royal Oak Beaumont's financial and operational needs and desire to be LEED certified, the SIBHS team conducted an analysis of the technologies available for an extensive vegetated roof system.

3. Vegetated Roof Technology

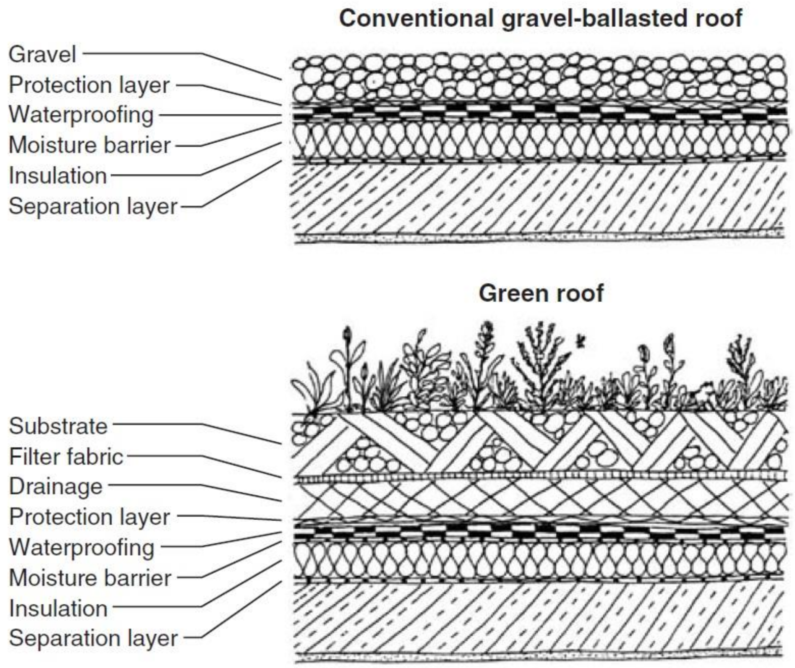
Construction of traditional rooftops incorporates three general components: (1) protection; (2) waterproofing; and (3) insulation. Protection refers to the upper-most layers of the roof that are in place to ease natural deterioration of the waterproof membrane to sun exposure. This layer is commonly made up of gravel. Waterproofing is generally a poly-based layer designed to withstand the weight of

[1] SITES is primarily a rating system for new construction projects. However, since the USGBC is likely to absorb SITES in future iterations of LEED, it is important to pay attention to all of the credits that can be attributed to with the implementation of a therapeutic garden.

the protection layer for roughly twenty years. Insulation helps lower heat transfer between the structure and atmosphere (USDOE 2004).

However, when constructing a vegetated roof, two additional components are included in the installation, substrate and drainage. Substrate is the layer in which plants are grown, and the drainage layer provides space for excess stormwater to be evacuated from the roof when the substrate cannot support retention (USDOE 2004). Ideally, vegetated roofs should retain as much water as possible to relieve discharge to the municipal stormwater system and to promote plant growth. Extensive vegetated roofs can retain between 40% and 60% of stormwater, whereas intensive vegetation can retain up to 90% of all average runoff (FLL 2002).[2] As Michigan receives about 38 inches of rain yearly, this amounts to 32% to 50% stormwater retention for extensive roofs, and up to 73% for intensive roofs. Figure 1 shows the basic structure of both traditional and vegetated roofs.

Figure 1: Traditional and Vegetated Roof Structures



Source: USDOE (2004)

Vegetated roofs are primarily categorized by the depth of the planting media. There are three types of vegetated roofs based on the depth of planting media: (1) extensive (Figure 2); (2) simple intensive; and (3) intensive. Extensive vegetated roof systems have the shallowest planting media of about 4-20cm and can only grow a limited variety of herbaceous plants. These systems also retain the least amount of water, but are generally the cheapest to install creating a shorter return on investment (ROI). Intensive systems are more complex and can sustain the growth of large trees in some instances. Intensive vegetated roofs have the largest range of soil depth reaching depths greater than 200 centimeters. Chicago's Millennium Park is a great example of an intensive green roof system, which sits upon a large,

[2] Percentages based upon an average annual precipitation value of ~31". Michigan's Lower Peninsula receives on average ~38" rainfall annually. (Andresen 2009)

underground parking structure (Figure 3). Simple intensive roof systems generally fall in between extensive and intensive systems and can support shrubs and coppices, but cannot support many trees.

Figure 2: German Garage – Extensive Vegetated Roof System

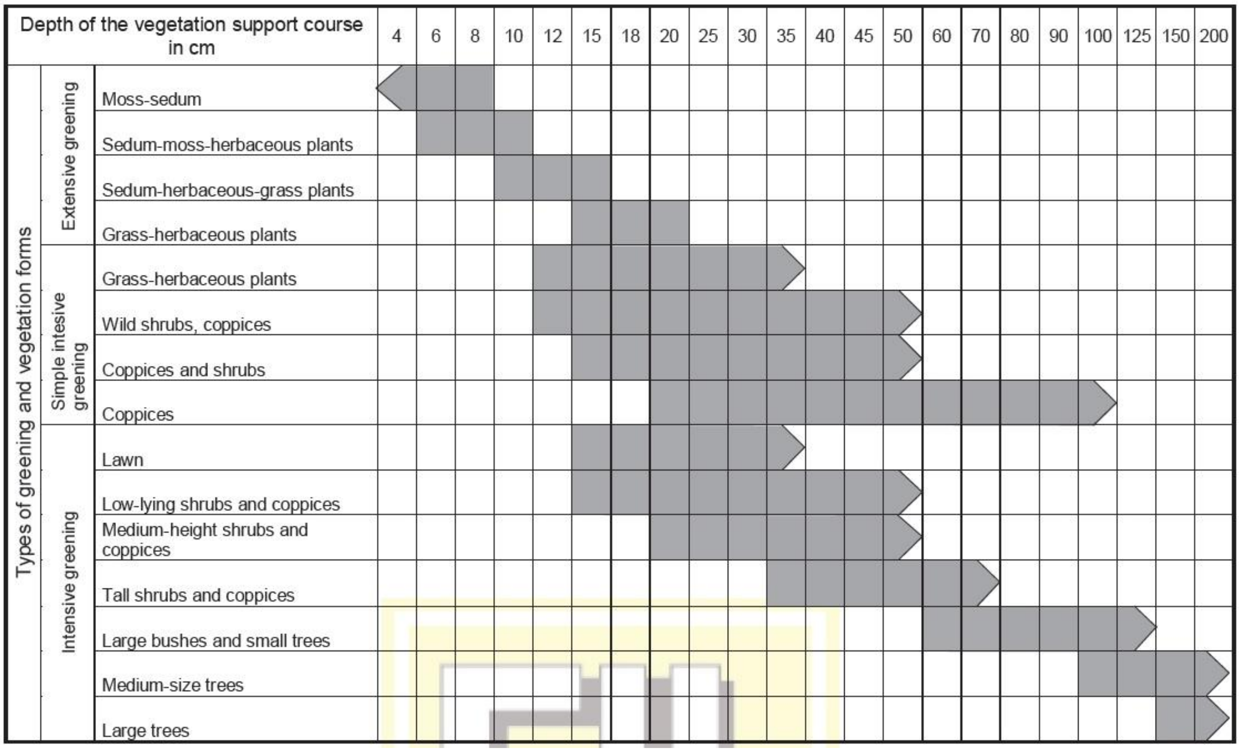
Source: Loder (2008)

Figure 3: Millennium Park – Intensive Vegetated Roof System

Source: Wikipedia (2005)

Water retention is generally associated with substrate depth; the greater the substrate depth, the great the retention rate. A four-inch substrate can retain 70%-100% of the rainfall depending on installation region and annual precipitation. In addition to substrate depth, plant type and maturity each play a role in stormwater retention. Over time, as plants mature, they can absorb greater volumes of rainwater. Additionally, woody plants generally retain more rainwater than herbaceous plants (USDOE 2004).To help provide an idea of what plants can be included into the three primary vegetated roof systems, please refer to the table below. Figure 4 shows the substrate boundaries associated with each type of roof system.

Figure 4: Vegetated Roof Substrate Boundaries for Extensive, Simple and Intensive Vegetated Roofs



Source: FLL (2002)

As previously mentioned, installation fees associated with vegetated roof installations increase with substrate depth. These costs are derived from not only from the need for more materials to be purchased, but also for additional roof support that is needed to withstand the added weight of more complex gardens and fully saturated planting media. Dead loads, as well as live loads, are taken into account when engineering support structures for green roof installations. Dead load refers to the maximum weight placed upon the roof structure purely by the vegetation and added water retained. Live load refers additional, short-term loads created primarily through maintenance activities. Costs for vegetated roof installations can range anywhere from “$10 per square foot for simpler extensive roofing, and $25 per square foot for intensive roofs. Annual maintenance costs for either type of roof may range from $0.75–$1.50 per square foot (US EPA 2008).”

4. Benefits of Vegetated Roof Implementation

Vegetated rooftops provide numerous direct and indirect benefits to their immediate site, as well as the surrounding environment. Direct and indirect benefits could include reduced heating and cooling loads within the installed facility as well as a reduction in chemical runoff to the surrounding environment. Such benefits are realized through in the reduction of heat transfer from host structure to outside ambient air, delayed runoff and improved stormwater quality, increased biodiversity, extended life of waterproof membrane, reduced maintenance, improved building aesthetics and reduced air pollution (Getter and Rowe 2006). With the installation of long-term vegetated roofs, Beaumont could have the opportunity to reap similar benefits. With a conservative lifespan of 40 years, more than twice that of a traditional roof or white roof (Adriaens 2014), vegetated roofs can reduce the cost of replacement significantly by eliminating the need for replacement after twenty years, the industry norm for traditional roof installations.

4.1. Stormwater Retention and Filtration

According to Getter and Rowe's study, *The Role of Extensive Green Roofs in Sustainable Development*, water retention volume is dependent upon not only substrate depth, but also on substrate composition. For instance, substrates incorporating higher amounts of silicate into the mix will tend to retain less than those that use a higher percentage of organic matter. Retention is also dependent upon plant type. Large, woody plants with a more significant root system tend to hold more water than those with a weaker root system such as sedums and grasses (Getter and Rowe 2006).

Vegetated roofs can divert anywhere from 32% to 73% of rainfall in Southeast Michigan (FLL 2002). Average commercial drainage fees around the country lie between $50 and $150 per acre of impervious surface per month depending on the region's population density and existing load on the stormwater infrastructure. For the purposes of this report, the median national average is used; it is assumed that commercial drainage fees are an average rate of $100/impervious acre/month. At this rate, considering Royal Oak Beaumont has about 90 acres of impervious surfaces, drainage fees or taxes can amount to nearly $9000 per month and over $100,000 per year. The proposed 8-acre vegetated roof could help to reduce these fees by between $8,000 and $10,000 per year.

In addition to the benefits of retention, vegetated roofs also play a role in stormwater filtration. Plants, as well as organic matter within the substrate, help to remove heavy metals such as lead, zinc, cadmium and copper from runoff (Kosareo and Ries 2006). This benefit promotes development of biodiversity within the region and helps reduce toxin build-up in the local water table.

4.2. Heat Gain Reduction and Energy Conservation

When incorporating the heating and cooling costs of Beaumont's three million square foot campus, it can be seen that the hospital would undoubtedly benefit through the incorporation of a large-scale vegetated roof installations. Vegetated roofs also act as insulating barriers and are more efficient than traditional roofs with the potential to redirect up to 90% of all incoming solar heat gain (Getter and Rowe 2006). Instead of absorbing heat energy, vegetated roofs utilize solar energy in plant photosynthesis. "Air temperatures above the building have been shown to be 30° C lower when vegetated compared with a conventional roof, resulting in up to 15% annual energy consumption savings" (Getter and Rowe 2006).

While Beaumont may the opportunity to save a similar 15% in energy consumption costs, Savings are more likely to be realized from reduced heating and cooling needs on the floor directly under the roof. This reduction has been estimated to be between 25% and 50% on single floor buildings per entire building (Getter and Rowe 2006). For example, when looking at a five story structure, these heating and cooling loads can be reduced by between 5% and 20%.

Ford's Rouge Assembly Plant in Dearborn, MI is perhaps the most relevant example of the impact an extensive green roof can have on the heating and cooling needs of a commercial building in southeast

Michigan. The installation, a 10.4 acre vegetated roof, helps to reduce heating and cooling demands by 5% by reducing the amount of heat entering the plant by 70% (Ford 2013).

4.3. Wildlife Habitat

Vegetation naturally attracts living organisms. Studies from around the world have shown significant increases in localized biodiversity following vegetated roof installations. A three-year study of seventeen roof locations throughout Switzerland revealed "78 spider and 254 beetle species" (Getter and Rowe 2006). Not only were these insects primarily native, but 18% of all spiders and 11% of all beetles catalogued were classified as endangered or rare (Getter and Row 2006). Since its construction in 2002, the Rouge Plant has become a safe nesting location for migratory Canadian Geese. Additionally, Ford employees harvest honey made by bees housed atop the factory (Ford 2013). As the Royal Oak Beaumont Hospital campus is in an ecosystem similar to that of the Rouge Plant, it may a habitat comparable to that of the Rouge Plant, attracting the same wildlife and insects to enrich the local biodiversity.

5. Vegetated Roof Installations at Beaumont

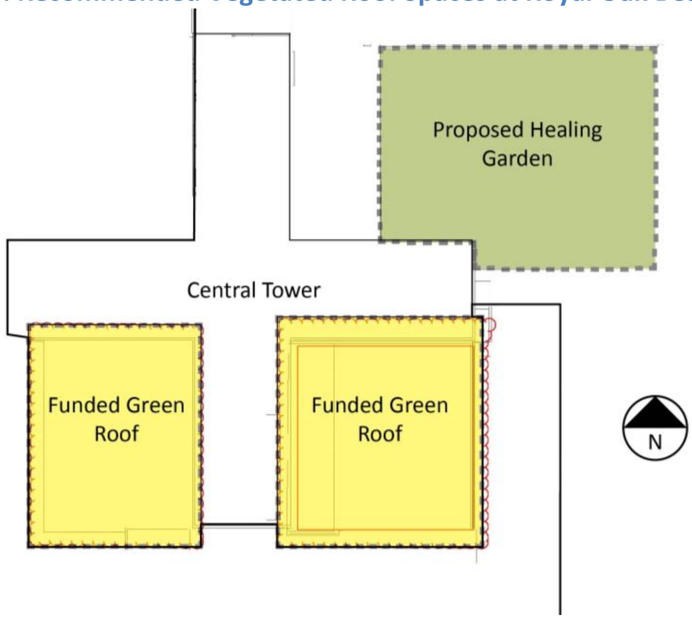
Beaumont has received funding from the Kellogg family to install a vegetated roof on a portion of the hospital. Up unto this point, $300,000 has been procured, and proposed installations have been limited to the southwest and southeast corners of the central tower. To receive LEED accreditation through the use of vegetated roof installations, future developments will need to be incorporated. Discussed in this section are the currently funded projects, as well as future needs to achieve certification.

5.1. Funded Installation

Given Beaumont's future plans to install a vegetated roof per their recent donation, the SIBHS team studied the hospital structure and recommends two roof spaces for the installation (see Figure 5). These spaces are located on the southwest and southeast sides of the Central Tower. Predevelopment for an extensive vegetated roof has already begun on the southeast location. Utilizing Live Roof's standard and lite extensive systems, Beaumont's existing funding covers the cost of the installation on the southeast roof. Live Roof's standard system has a substrate depth of 4 ¼ inches while the lite system is around 2 ½ inches (Live Roof 2014). The standard system is relatively easily to retrofit on existing buildings, whereas the lite system has been specially designed for existing buildings with a smaller saturated weight of between 15 and 17 pounds per square foot (Live Roof 2014).

Currently, the spaces proposed for installation are not easily accessible. Through additional discussions with Beaumont and JLL staff, it was determined that an additional $1.5 million would be needed to support a proper live load and to create a point of accessibility. For the purpose of LEED accreditation, the SIBHS team suggests that rather than using such funds to further-develop accessibility, Beaumont instead should acquire funding to expand extensive, non-accessible green roof, and potentially white roof, installations.

Figure 5: Recommended Vegetated Roof Spaces at Royal Oak Beaumont



5.2. Proposed Installation

Beaumont Hospital has nearly 13 acres of roof space at the Royal Oak campus, upon which two acres of white roofing is currently installed. Taking into account heating, ventilation and air conditioning (HVAC) equipment housed on the existing roof through visual analysis, conservative estimates show that about 85%, or 9.35 acres, of the remaining 11 acres of roof space are potentially developable. To meet LEED SS Credit: Heat Island Reduction, 50% of the existing roof must be vegetated. To fulfill this credit, 6.5 acres of roof need to be vegetated. However, since Beaumont has made plans for an expansion on the north side of the hospital, an 8-acre, extensive vegetated roof installation is being proposed.

5.3. Cost of Proposed Installation

Jorg Breuning of Green Roof Service, LLC based in Baltimore has provides a comprehensive cost-benefit analysis for extensive vegetated roofs in multi-season climates. This model was used in calculating installation costs and ROI for the proposed vegetated roof at Beaumont.

At a national average of $33 per square foot, installation of an 8-acre green roof would amount to $11.5 million. Installation costs can be broken down into three categories: (1) the system itself ($14/square foot); (2) maintenance over a forty-year lifespan ($15/square foot), and (3) the cost of increasing roof load ($4/square foot) (Breuning 2014). If there is no additional cost for load improvements, the total installation cost could be as low as $10.8 million for Royal Oak Beaumont. It is advised that primary vegetated roof expansion be implemented on the lower roofs. This is beneficial for two primary reasons. First, this would allow for better visibility for patients and increase awareness of Beaumont's efforts to become a more sustainable institution. Secondly, structures with fewer floors are affected more when factoring in heating and cooling load reductions.

5.4. Return on Investment

While $11.5 million is a notable investment, data shows that vegetated roofs permit savings through reduced operating costs over a lifetime, which is double that of a traditional black tar roof. The average vegetated roof has a lifetime of forty years. This eliminates the need of a replacement roof after twenty years of use, which can cost $25 per square foot (Getter and Rowe 2006). Savings found in avoided heating and cooling costs can be estimated at $3 per square foot. Elimination of repair and maintenance expenses to the roof is about an additional $4 per square foot. By diverting stormwater runoff from the combined sewer system, a lifetime savings of $1 per square foot is estimated. Additional savings can be seen in reduction of insurance costs ($5/square foot) and federal tax write-offs ($3/square foot) (Breuning 2014).

A net total savings of $8 per square foot is potentially obtainable through the installation of an extensive vegetated roof. This is a total savings of $2.8 million over the period of forty years. If no load improvements were needed during installation, a potential net savings of $12 per square foot would achievable. This would produce positive ROI of $4.2 million over the same forty-year period (Breuning 2014).

6. Conclusion

To meet LEED accreditation on such a large campus, it is important to note that significant financial investment will be needed. However, for Royal Oak Beaumont, it is estimated that returns could be between $2.8 and $4.2 million over a period of forty years. Steven Peck, founder of Green Roofs for Healthy Cities and member of the American Society of Landscape Architects calculates that vegetated roof infrastructure increases surrounding property values by 11%. This in turn inherently increases property values on the installation site. (Green 2011).

Not only is private and public stormwater infrastructure improved, but the local environment will also be improved aesthetically. Harder to calculate are the impacts upon the surrounding environment, but improvements in air quality will be seen in the reduction of sulfur dioxide, nitrogen dioxide, and nitrous acid levels directly above and adjacent to green roof installations. This is particularly important when thinking of patient care at a health institution. Providing habitat for birds and other insects, vegetated rooftops will also attribute to the positive psychological wellbeing of patients, employees and visitors.

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Appendix G: Sustainable Land Management Framework

Sustainable Land Management Framework:

Beaumont Health System, Royal Oak, Michigan

Summary Report

Sustainability Initiatives for Beaumont Health System Project Team
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Contents

1. Introduction

In pursuit of Sustainable Sites Leadership in Energy and Environmental Development (LEED) Version 4 (v4) credits, Royal Oak Beaumont must employ a site management policy embracing ecologically responsible grounds maintenance practices. This LEED v4 prerequisite focuses on the " best management practices to reduce harmful chemical use, energy waste, water waste, air pollution, solid waste, and/or chemical runoff" (LEED v4).

As LEED continues to absorb criteria from the Sustainable Sites Initiative (SITES) program into LEED certification criteria, and as SITES Version 2 (v2) is based on the LEED framework, this report focuses on both LEED and SITES credits to provide broad credit coverage. This report is intended to be used as a guide to select best practices for further development of Royal Oak Beaumont's grounds maintenance program. The framework is based primarily upon the United States Department of Energy's National Renewable Energy Laboratory's (NREL) *Site Sustainability Plan FY 2013* and provides guidance for achieving certain credits discussed in the report. Best practices for grounds management are presented

2. LEED v4 Credit Coverage

The following are the primary LEED v4 credits covered in this report. Primary areas of focus include large-scale reintroduction of native plant species throughout the project site reducing the impact of invasive species, as well as the introduction of sediment control mechanisms.

- SS Prerequisite: Site Management Policy (Prerequisite)
  Implement a site management strategy utilizing best management practices to reduce chemical use, energy waste, water waste, air pollution, solid waste, and/or chemical runoff.
- SS Credit: Site Development – Protect or Restore Habitat Option 2 (2 points)
  Ensure 20% of total site area contains native or adaptive vegetation.
- SS Credit: Rainwater Management (1-3 points)
  Use low-impact development to capture and treat stormwater runoff from at least 25% of impervious surfaces.

3. SITES v2 Credit Coverage

The following are the primary SITES v2 credits covered in this report. Similar to LEED v4 project development focuses, SITES credits are surrounded heavily by the need of native plant introduction and turf removal. Additionally, stormwater harvesting mechanisms should be considered to reduce not only the load on the municipal combined sewer system, but also to reduce water usage for irrigation purposes throughout the site.

- Credit 3.2 (2 points)
  Reduce potable water use for landscape irrigation by 75% or more from established baseline
- Credit 3.5 (5-10 points)
  Manage stormwater on site
- Credit 3.6 (3-9 points)
  Protect and enhance on-site water resources and receiving water quality
- Credit 3.7 (1-3 points)
  Design rainwater/stormwater features to provide a landscape amenity
- Credit 4.9 (1-4 points)
  Restore plant communities native to the ecoregion (1 point for 25% coverage, 2 points for 50% coverage, and 4 points for 75% coverage)

4. Research

A review of existing research was conducted to present an effective framework to guide future development of ecologically responsible grounds maintenance practices at Royal Oak Beaumont Hospital. To provide a better overview of the details recommended for inclusion in a grounds maintenance plan, portions of NREL's existing plan are presented.

4.1. Document Review

First, LEED v4 was reviewed and credit criteria were examined. Although SITES has more stringent standards, Beaumont is pursuing LEED v4 certification and must address LEED's accreditation programs criteria. However, in anticipation of LEED further absorbing SITES criteria, criteria from the SITES v2 program is frequently referenced in this report.

After reviewing projects that have been awarded accreditation through the SITES 2009 pilot program, it was determined that the National Renewable Energy Laboratory's *Site Sustainability Plan FY 2013* would serve as a robust foundation on which to outline a similar plan for Beaumont. *The Sustainable Sites Handbook* by Meg Calkins, member of the American Society of Landscape Architects, was also referenced as a source of current strategies used to initiate SITES accreditation.

Between Calkins' book and NREL's sustainability plan, this report provides a comprehensive list of available solutions for the implementation of a sustainable land management program at Royal Oak Beaumont.

5. Benefits of Site Sustainability

No other nation in the world has such an infatuation with turf lawns as does the United States (Bormann 2001). Herbert Bormann and his colleagues' primary goal in their book *Redesigning* *the American Lawn* was to render a concrete understanding of traditional turf lawns and the role they play in a global deterioration of the environment. By modern standards, lawns require mowing and oftentimes herbicide application. Over-application of these chemicals and the combustion of fossil fuels through repeated maintenance procedures can deteriorate the ozone, promote acid rain, pollute the freshwater system, and reduce diversity of flora and fauna (Bormann 2001). Requiring fertilization, herbicide application, mowing, and irrigation, one can begin to see how wide of an effect lawns can have on the ecosystem.

Bormann states that it is difficult for humans to realize the impact they are having on the greater environment. To develop an understanding for their impacts on a human level would allow for more well-informed decisions to be made throughout the future in regards to a given site's influence on the surrounding ecosystem (Bormann 2001).

Beaumont's Royal Oak campus, sitting on roughly 100 acres, is much larger than the average residential parcel in Southeast Michigan. With nearly ten acres of turf grass on the campus, Beaumont has the opportunity to help the surrounding ecosystem and act as a model development for future projects in the area. Measures taken to create not only more sustainable means of site maintenance throughout the future, but also to help promote more environmentally-sound construction processes are necessary for Beaumont to become a sustainable leader in the healthcare sector and to achieve LEED accreditation.

The incorporation of sustainable land practices can provide environmental, financial and social benefits to Beaumont. Low-maintenance native plantings can reduce the need for irrigation and fertilization, as well as eliminate the need for mowing. This reduction and elimination can not only save Beaumont money through fewer maintenance needs, but can also play a vital role in promoting increased biodiversity, thereby helping to develop a less stressful atmosphere for patients and employees.

Along with reintroduction of native species, measures reducing stormwater runoff can help to mitigate a site's impact on the municipal stormwater system. Royal Oak utilizes a combined sewer system (CSS), which, during heavy rain events, can overflow and pollute local streams with raw sewage. Any diversion from the CSS helps to reduce the likelihood of sewer overflow and can reduce the taxes or fees associated with stormwater management.

6. Solutions to Site Demands

To address the needs Beaumont has in regards to LEED accreditation, each credit focused upon will be briefly described and solutions will be provided. Once again, this document is a reference guide for Beaumont to use as a means of determining which projects they would like to pursue.

6.1. SS Prerequisite: Site Management Policy (Prerequisite)

Implement a site management strategy utilizing best management practices to reduce chemical use, energy waste, water waste, air pollution, solid waste, and/or chemical runoff.

6.1.1. Goal

Intended to reduce chemical use, energy waste, water waste, air pollution, solid waste and chemical runoff, the site management policy is a written document outlining procedures which Beaumont intends to follow to mitigate the aforementioned issues. Because it is a prerequisite, Beaumont must develop a management policy before any credit is earned through the sustainable sites category in LEED v4. Issues requiring a site management policy may include the following (USGBC 2013):

- use of low emissions maintenance equipment
- snow and ice removal
- erosion and sedimentation control (for ongoing operations and for construction activity)
- organic waste management (returned to the site or diverted from landfills)
- invasive and exotic plant species management (through monitoring and eradication)
- fertilizer use (testing soils before using fertilizer to prevent over-application of nutrients)
- irrigation management (monitor irrigation systems manually or with automated systems at least every two weeks during the operating season for appropriate water usage, system times, leaks, or breaks)

6.1.2. Method

The following sections address criteria to be addressed in each type of site management policy.

6.1.2.1. Low Emissions Maintenance Equipment

While more attention should be given to native plant reintroduction so lawn maintenance becomes a minor task throughout the grounds, the use of equipment with lower emissions is encouraged. Alternative technology is available for low emissions commercial grounds maintenance equipment. Since the majority of grounds maintenance is for turf grass upkeep, alternative fuel mowers were researched. The United States Department of Energy has a reference guide available for alternative fuel commercial lawn equipment. Primary alternatives are powered by biodiesel, compressed natural gas (CNG), liquid propane and electricity (USDOE 2010).

It is suggested that Beaumont implement the usage of propane equipment. Propane lawn equipment is second only to gasoline/diesel equipment in terms of availability. Since propane is an accessible resource in many states and is considered low emissions, it is recommended that efforts are taken to replace current equipment with propane in the near future. Additionally, commercial propane grounds maintenance equipment is up to $10,000 cheaper for an equivalent biodiesel or CNG mower (USDOE 2010).

6.1.2.2. Snow and Ice Removal

To help reduce ecosystem contamination through excessive deicing, measures should be taken to utilize more environmentally friendly deicers. The use of alternative stormwater management practices, including vegetated swales and retention systems, is also recommended to reduce the quantity of contaminants from traditional deicers that could runoff into the greater freshwater supply.

Traditional deicers include sodium chloride and calcium magnesium acetate, which adversely affect surface water, groundwater and soils (Ramakrishna 2005). However, through proper site planning and native plant reincorporation, excess salinity in snowmelt can be remediated through phytoremediation processes. Incorporating drainage swales and curb cuts along primary thoroughfares receiving deicer in the winter would be an ideal solution to reduce salt infiltration into the local water table.

Efforts can also be made to reduce the area deiced during the winter. Many large-campus facilities close unnecessary walkways during snowy weather. Rendering certain areas inaccessible inherently reduces the need for a deicer.

6.1.2.3. Erosion and Sedimentation Control

Efforts must be taken to reduce erosion and sediment runoff during ongoing operations and all future construction projects. Attention must be paid to four primary areas when considering future erosion and sediment control projects: (1) stabilization; (2) runoff control and conveyance; (3) inlet and outlet protection; and (4) sediment collection (Calkins 2012).

1) Stabilization is primarily a concern during new construction projects. To prevent unnecessary erosion and sedimentary runoff, take efforts to save any existing top soil to reapply after construction. Additionally, vegetation should be reincorporated to the site as soon as possible as to reduce erosion from stormwater runoff and high wind events.

2) Runoff control and conveyance measures are incorporated to engineer a specific path for stormwater runoff with the goal of diverting runoff from the CSS. The use of vegetated swales is recommended allowing infiltration into the groundwater as well as a means of retarding runoff therefore reducing erosion along swale banks.

3) Inlet and outlet protection should be initiated to reduce any erosion on site. Since Beaumont lies on a relatively flat site, this is not as much an issue since stormwater most likely does not gain enough momentum to require significant changes in design to the existing inlets and outlets. However, level spreaders and riprap filter strips should be included in future stormwater infrastructure systems (Calkins 2012).

4) Sediment collection can be accomplished through vegetated swale installations. Currently on the north end of Beaumont's site are three detention ponds. The reincorporation of native plants into these fields would aid in the collection of sediment runoff.

6.1.2.4. Organic Waste Management

Lawn trimmings and prunings should be processed onsite with the utilization of a compost system rather than hauled off to landfills. Large, woody plants incapable of being composted can be taken to shredding facilities where they are mulched and reapplied throughout the city in garden beds and on trails. Additionally, through the increased incorporation of native vegetation, trimming is less-needed and organic waste is reduced.

6.1.2.5. Invasive and Exotic Plant Species Management

There are two primary means of invasive and exotic species management that can be utilized on Beaumont's campus: (1) pulling by hand and (2) prescribed burns. Smaller vegetated areas in close proximity to the hospital should be monitored monthly during the growing season and efforts should be made to pull any existing invasive species before they seed. Common invasive species in Southeast Michigan, such as garlic mustard and dames rocket, are easily identifiable and could even be pulled by therapy patients as a form of muscular rehabilitation.

6.1.2.6. Fertilizer Use

Through the reincorporation of native species on the campus, fertilizer usage is naturally reduced. Native species have naturally evolved and adapted to the region in which they grow, therefore, additional fertilizers are unnecessary. If fertilizer must be used on smaller green spaces, a spoon-fed system utilizing organic fertilizers is advised. Spoon-feeding consists of lower application volumes allowing plants to absorb the nutrients rather than creating an opportunity for excess fertilizer to be carried away via rainwater.

6.1.2.7. Irrigation Usage

To ensure excess water is not being used during irrigation operations, biweekly checks of the system should be made to identify leaks and breaks.

6.1.3. Results

To obtain LEED accreditation, a land management policy must be in place. Ideally, a written procedure would address each of these primary areas, and operational standards would be established to address future projects. The finalized land management policy could be publically available as to promote awareness of Beaumont's efforts towards a more sustainable campus and could serve as a means to obtain donor support in the future.

6.2. SS Credit: Site Development – Protect or Restore Habitat Option 2 (2 points)

Ensure 20% of total site area contains native or adaptive vegetation.

6.2.1. Goal

Twenty percent of the total site must be native or adaptive vegetation utilizing little-to-no irrigation.

6.2.2. Method

Beaumont's nearly 100-acre site is roughly 10% vegetated. To receive this credit would be difficult, but not impossible. Through the wide-scale reintroduction of native flora on site, Beaumont could redevelop 10% of the entire site into a native ecosystem. In addition, a ten-acre extensive vegetated roof installation could be implemented and the credit could be obtained. This vegetated roof would have a positive return on investment (ROI) of between $3.5 and $5.3 million over the course of its forty-year lifespan.

6.2.3. Results

A long-term implementation program would need to be created and funding would need to be raised to incorporate a large scale green roof. However, if Beaumont were to initiate such a large installation, they would undoubtedly be seen as a leader in healthcare sustainability and could create a standard for hospitals across the country.

6.3. SS Credit: Rainwater Management (1-3 points)

Use low-impact development to capture and treat stormwater runoff from at least 25% of impervious surfaces.

6.3.1. Goal

"Low Impact Development (LID) is the cornerstone of stormwater management with the goal of mimicking a site's presettlement hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source" (SEMCOG 2008). To lower the impact of onsite stormwater runoff upon the surrounding environment, Beaumont is required by LEED standards to receive and treat at least 25% of all stormwater.

6.3.2. Method

Multiple methods of stormwater infiltration can be utilized in order to obtain a 25% infiltration rate. Vegetated roofs, swales and rain gardens are the three primary initiatives upon which Beaumont should focus.

In unison with the proposed 8-acre vegetated roof, it is recommended that measures should be taken to develop green space throughout the campus primarily alongside roadways and boarding parking lots. Vegetated swales and rain gardens designed to detain water and release it to the ground should be implemented in these locations. Relatively simple to retrofit on site, access to swales and rain gardens can be created through curb cuts. Curb cuts create passages for water collected in curbside gutters to escape into the vegetated swales and rain gardens. Figure 1 shows a simple infiltration curb cut allows drainage from an impervious surface to a native grass swale.

Figure 1: Curb Cut

Source: City of Sandy (2011)

Other measures can be taken to actually harvest rainwater onsite and use it for future irrigation needs. Underground cisterns can be tied into the irrigation system on site and rainwater can be directed through swales to the cistern. This not only reduces the load on the municipal CSS but also provides a resource to further reduce consumption of potable water resources.

6.3.3. Results

Simple site retrofits should be made allowing for stormwater infiltration through vegetated swales and rain gardens. Such incorporations, when combined with the proposed vegetated roof, should take minimal engineering and LEED credits can be earned easily. In the long run, it is likely Beaumont will see financial savings through reduced stormwater fees and taxes, as well as a reduction in the need for potable water for irrigation purposes if on site cisterns are installed.

7. Concluding Remarks

In developing a more sustainable outdoor environment, Beaumont is not only fostering a healthier local environment through reductions in chemical runoff and greenhouse gas emissions, but they are creating a healthier environment for patients and employees. Benefits seen in reduced stormwater management fees and taxes can be made through not only technical implementations, such as a vegetated roof, but also through simple processes such as native flora reintroduction and swale and rain garden installation. In addition, positive externalities can be found in reducing the runoff load on the municipal stormwater system, as well as in increasing local biodiversity through the reintroduction of native prairie grasses and wildflowers.

In the pursuit of LEED accreditation and a more energy-efficient facility, the outdoor environment is the first sign of Beaumont's dedication to sustainability. Having a Sustainable Land Management Framework in place will allow future development on site to create systemically sustainable environment for Beaumont and will help to increase awareness on their efforts.

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Appendix H: Window Film Report

Beaumont Health System Royal Oak Campus Window Film Energy Conservation Measure Report

March 2014

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Executive Summary

The University of Michigan's School of Natural Resources and Environment's Sustainability Initiatives for Beaumont Health System (SIBHS) master's project team conducted an analysis to evaluate the thermal comfort and energy conservation issues in two atriums at Beaumont's Royal Oak Hospital. The first atrium is located in the South Hospital Addition and the second is in the East Critical Tower. The results show that by installing high performance window films on the windows in these two areas, Beaumont would experience a payback of 4-6 years, depending on the price of the selected product, and save upwards of 148,000 tons of CO_2.

Motivation for Change

To further Beaumont's efforts to improve energy efficiency at the Royal Oak campus and enhance employee satisfaction, the installation of window films provides the opportunity to not only address the aforementioned efforts, but also to advance Beaumont towards LEED Existing Buildings: Operation & Maintenance certification. As a result of poor indoor thermal regulation due to the large window space in the atriums, the hospital's heating, ventilation and air conditioning (HVAC) system could not meet the required cooling load even running on its full load during the summer months[i]. A reduction in energy usage from a decrease in cooling demand during the summer months will lead to financial savings. It will also help Beaumont achieve their sustainability goals of reducing their energy use.

It is also important to note that heat gain in the atriums through the windows may be advantageous in the winter months as it reduces the energy required to heat the atriums. However, while it is important to consider the heating benefits, for the purposes of this report, it is assumed that because of low solar radiance in the winter and the sun's position in the sky, Beaumont will experience little reduction in winter solar heat gain in the atriums. Other cost savings from installing upgraded glazing, window films or shading devices are an increase in the furniture and artwork lifetimes in these spaces. Specifically, by preventing 99% of UV rays, window films can slow down the fading process of furniture, which accounts for 90% of fading[ii].

In both the South Hospital Addition atrium and the East Critical Care Tower atrium, Beaumont has experienced recurring issues with poor thermal comfort. Through inquiries by the University of Michigan SIBHS team, it was found that there have been 2-4 complaints per year about the temperature in both atriums.[iii] Such complaints are cause for concern as a lack of thermal comfort has been linked to low employee productivity, resulting in decreased organization efficiency.

The application of the window films to both atriums will significantly improve the thermal comfort of the spaces, but will also reduce the peak load of the HVAC system in summer months and reduce furniture fading rates.

Description of Application Sites

South Hospital Addition

The South Hospital addition was constructed in 2002 with skylight installments that span the entirety of the atrium ceiling. With six floors, the atrium height is 132 feet. The Viracon glass installed had a 10 year warranty, which expired in 2012.

The curved atrium is divided into 28' by 28' sections with 420 individual windows in a configuration of 10 by 42. The skylight glass is 1-2/16" Viracon "VE-2M Silkscreen Insulating" glass. The glass is divided with a first layer of ¼"(6mm) VE1-2M (low e coating on #2 surface) with V-175 standard color (opaque brown) silkscreen dots on the #2 surface with a ½"(13.2 mm) airspace and a final 3/16" 0.060 laminate clear glass[iv]. Other glass specifications include[v]:

- Visible light transmittance: 50%
- Solar energy transmittance: 24%
- Ultra-violet transmittance: 7%
- Visible light exterior reflectance: 19%

- Visible light interior reflectance: 21%
- Solar energy reflectance: 30%
- ASHRAE u-value: 0.29
- Shading Coefficient: 0.33
- Solar Factor (SHGC): 0.29
- Relative Heat Gain: 70 Btu/hr x sq.ft.

Figure 1 Partial view of South Hospital Addition Atrium from 4th floor garden space

To evaluate the feasibility of installing additional window films to the skylight, an Ecotect by Autodesk model was built to simulate the solar access to the South Tower Atrium, shown in Figure 2. The sunlight hours range from five to nine with the windows at the center seeing more hours of sunshine than the side windows. During winter months (December to February), the north side of the atrium receives low solar exposure, ranging from zero to three hours. Figure 3 below shows the shading of the atrium skylights. The white space in this Figure 3 shows that from 9 am to 5 pm on a daily basis, the atrium windows are not shaded.

Figure 2: Daily average skylight sunlight hours for the South Hospital Addition Atrium

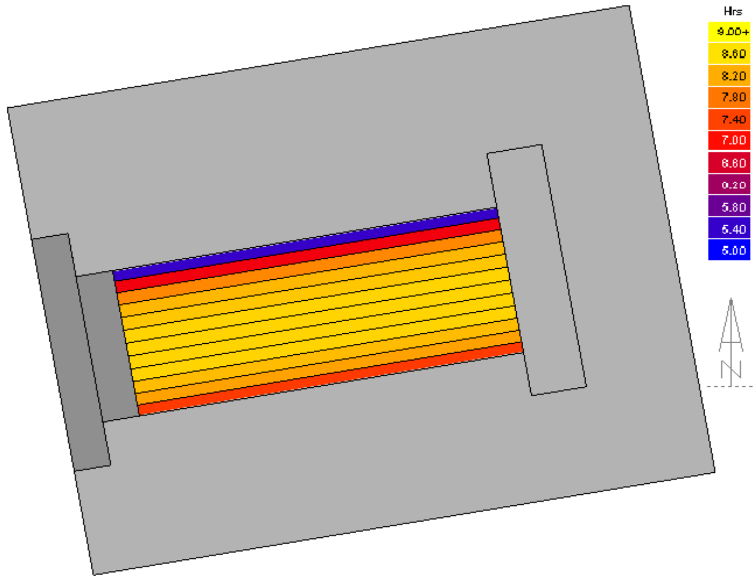
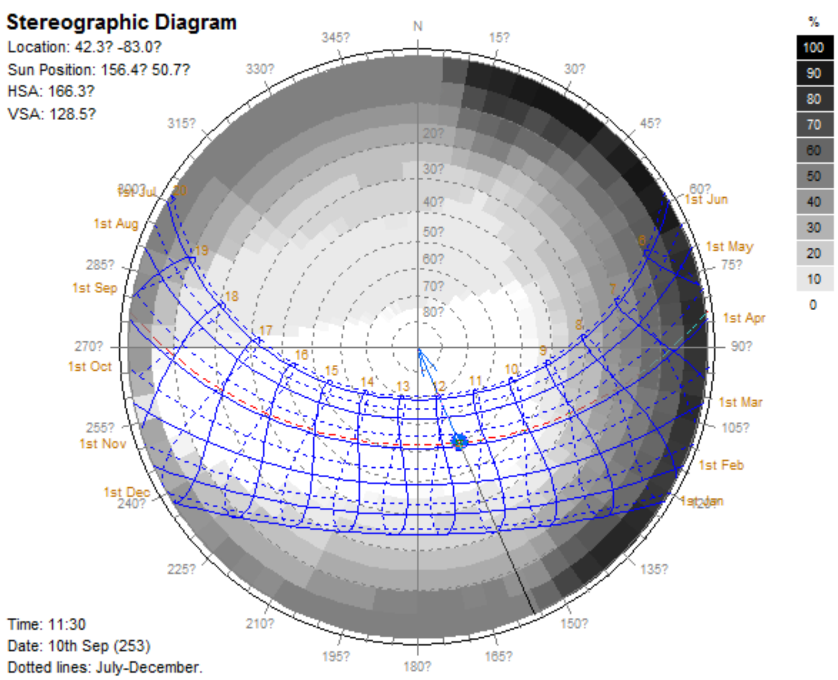


Figure 3: Stereographic Diagram of South Hospital Addition Based on Geographic Location



Note: Diagram shows the solar path over the course of the year

East Critical Care Tower

The East Critical Care Tower was built in 1993 and is approximately a quarter the size of the South Hospital Addition at just over 210,000 square feet. The East Critical Care Tower atrium is four stories tall and has slightly peaked windows as shown in Figure 4 below.

The East Critical Care Tower skylight configuration is ten windows across measuring 34'5" by 11'9." The total window coverage is 34'5" by 117'6". The skylight glass is 1-5/16" clear insulated units with Low-E for sloped application. 1-5/16" thick unit constructed of ¼" clear heat strengthened (or fully tempered) exterior light, ½" clear air space, with argon gas, and ½" laminated interior light consisting of 2 layers of ¼" clear heat strengthened glass lights laminated together with a 0.060 inch PVB interlayer. There is a low-emissivity coating on the No. 2 surface[vi]. Other glass specifications include[vii]:

- Daylight Transmittance: 72%
- Outside Reflectance: 12% min
- Nighttime Winter U-Value: 0.25 max
- Shading Coefficient: 0.64 max
- Relative Heat Gain: 133 Btu/hour/sq. ft. max
- TSER: 24%
- Solar Factor (SHGC): 0.29
- U- Value: 0.29

Figure 4: View of East Critical Care Tower Atrium from Ground Floor

Figure 5: Close-up View of Sloped Windows in East Critical Care Tower

Note: Discoloration and fading of previous window film applications can be seen.

Energy Conservation Options

To increase energy conservation and regulate thermal comfort conditions in the South Hospital Addition atrium and the East Critical Care Town atrium, several options are available that will assist Beaumont in improving the thermal comfort of these spaces. Based on research conducted, window replacement, installation of shading devices and window films are a few options for Beaumont to consider.

Window Replacement

Window technology has advanced in the last several decades. The commercialization of many technologies and application in commercial and residential buildings has resulted in further innovation. Low-e coating, triple and quadruple glazing, inert gases between glass layers, improved glass spacers, and insulated window frame are technologies available for window retrofitting projects to greatly improve the window insulation performance and reduce the energy losses.[viii] However, replacing the windows would require a significant capital investment and a long payback period of over ten years in common cases. Typical replacement cost ranges from $650 to $750 per window for a commercial application, thus reducing the feasibility of replacing the windows in Beaumont's atriums.[ix]

Shading Devices

Window shading devices are commonly installed to provide immediate and manually controlled shade over the solar insolation. A variety of shading systems are available, such as motorized shading system, exterior sun control louvers and exterior blind shades.[x] However, installing these devices is also capital intensive and requires a great deal of coordination between the contractor and application site manager, especially in medical buildings.[xi] Additionally, the maintenance of such devices is more intense as such devices need to be adjusted daily, whether manually or through an automated control system.

This increases the wear and tear on the product and the overall maintenance cost, thus making them less attractive compared to window films.

Window Films

Window films are applied to the indoor surface of flat glass, and are typically used in building retrofit upgrades. Window films vary in types, grades, colors and properties and are able to provide a variety of benefits such as furniture fading prevention, safety and security improvement, and indoor air temperatures regulation. The window film material is composed of a protective liner, adhesive, polyester film, scratch resistant coating, and UV inhibitors.[xii] Window film efficiency is related to local weather, building orientation, window size and other exterior shading conditions.[xiii] Although Beaumont Royal Oak Hospital's orientation and location in Michigan may impact optimal efficiency of window films as compared to other regions; window film technology is being recognized by more facility managers as the most cost-effective measure of building upgrade, particularly with increasing energy costs.[xiv]

Design Objectives and Goals

When evaluating retrofitting the two atrium spaces with window films, the team considered several design objectives. These design objectives directly relate to achieving the goals of increasing energy efficiency and thermal comfort mentioned in the Motivations for Change section.

The first design objective is to select a window film product that when combined with the window will provide the lowest U-value as economical. U-value measures how well a piece of material transfer heat and low U-value means better insulation. U-values are generally in the range of 0.25 and 1.25 $Btu/h{\cdot}ft^2{\cdot}{}^\circ F$[xv]. Beaumont's primary concern is to reduce the amount of solar heat gain during summer months, this is an important metric. A lower U-value prevents heat loss through the window due to convective heat transfer. Ideally, a minimum of 40-50% daylight will be able to pass through the window films and windows.[xvi] This amount of daylight ensures there is no need for supplemental artificial lighting in the atriums.

The solar heat gain coefficient (SHGC) demonstrates the amount of solar energy transmitted through a window, allowing the space to passively gain heat from solar radiation. The design objective is to achieve a low SHGC for the windows in the atriums. This is especially important during cooler months when passive solar energy can heat the space thus reducing the reliance on a traditional heating system. The team selected SHGC instead of shading coefficient (SC) as SHGC is the industry standard for calculating solar energy transmittance. It is possible to calculate the SHGC from the SC by taking the SC*0.087.

Another parameter evaluated is the Total Solar Energy Rejected (TSER), this represents the amount of solar energy rejected by the glazing system. It is an overall indication of how effectively a window film blocks the heat of the sun from the indoor environment. Generally, higher TSER is desired because cooling load represents a significant part of the total building energy consumption.

The Net Visible Transmittance (NVT) is the amount of light that can pass through a film as a percentage. It is optimal to have a greater number to capitalize on natural lighting and bring sunlight down to the lower levels of the atriums. If this number drops too low, light will not be able to penetrate to the ground floor and the space will require more traditional lighting strategies. Most importantly, it was necessary to identify technology that has less than a six-year payback. This length of payback meets the internal requirements for capital improvements for Beaumont.

Technical Analysis

Four window films performance levels were analyzed to determine the most appropriate product for installation in Beaumont's atriums. These products were analyzed according to the four design objectives, the U-Value, SHGC, TSER, and NVT, which have the largest impact on window film performance and the importance of such measures in the atriums. Listed below in Table 1 are the technical components for the windows currently installed, the optimization goal and the recommended products.

The goal for the SHGC for the window film is approximately 0.25. This number represents the amount of heat coming through the material divided by the heat hitting the outside. For the U-value, we are targeting a lower number – the lower the U-value, the higher the level of insulation. The 3M Window Film Payback & ROI Calculator sets four grades of window films including basic performance, medium performance, high performance and low-e[1xvii]. Table 2 below provides the range of properties for four grades of window films based on the product catalogues and price information from several manufacturers.

Table 1: Technical Components of the Glass Currently Installed

Technical Components	South Hospital Addition	East Critical Care Tower
SHGC	0.29	0.29
U-Value	0.29	0.29
NVT	50%	72%
TSER	30%	24%

Source: Beaumont Architectural Drawings

Table 2: Technical Components for Window Films Analyzed

Technical Components	Basic performance	Medium performance	High performance	Low-e
TSER	30-45	46-60	61-80	61-80
U-Value	1.00-1.10	0.90-0.99	0.80-0.89	0.70-0.79
SHGC	0.7-0.8	0.4-0.6	0.2-0.4	0.2-0.4

Sources: 3M Window Film[xviii], SunTek Window Film[xix], Llumar Window Film [xx]

Financial Analysis

Installing window films reduces the building energy consumption by reducing solar heat gain and improving the insulation capabilities of the windows. The Window Film Payback & ROI calculator from 3M was used in this analysis to estimate payback periods for four types of window films specified in Table 2. Table 3 provides the input values used in the 3M calculator to determine the performance of

[1] Low-e window film is high performance window film with a low-e coating which improve the film's heat rejection capability.

each type of window film in the South Hospital addition and in the East Critical Care Tower. The calculator only requires the total building square footage and percentage of roof covered by skylight as inputs, not the square footage of the glass skylight.

It is important to note that the prices listed in this section and that below are speculative as manufacturer prices were not available to us. Beaumont should check with local window film dealers for more accurate pricing information.

Table 3: South Hospital addition and East Critical Care Tower information

	South Hospital Addition	East Critical Care Tower
Number of floors	10	8
% of roof covered by skylight	20%	20%
Total building square footage	853,488	210,338
Window type	Double tinted	Double tinted
Location	Detroit	Detroit

Source: Glen Staton [2014][xxi]

Based on the 3M ROI calculator, in the South Hospital Addition, low-e window films have the shortest payback period of 3.1 years, while basic performance window films will have the longest payback period of 49.1 years (see Table 4). In the South Hospital Addition, low-e window films will also provide for the greatest savings in annual CO_2 emissions, avoiding 155,911 lbs of CO_2 per year (see Table 4).

Table 4: South Hospital Addition Payback Period and CO_2 Savings

Window Film Type	Payback Period (yrs)	Annual CO_2 Emission Savings (lbs)
Basic performance	49.1	-24,452[1]
Medium performance	11.4	41,347
High performance	4.7	111,885
Low-e	3.1	155,911

1 The negative CO2 emission saving means basic performance window film causes more energy to be used during its life cycle.

In the East Critical Care Tower, low-e window films have the shortest payback period of 3.3 years, while basic performance window films have longest payback period of 68.9 years (see Table 5). Additionally, low-e window films in the East Critical Care Tower will provide the greatest annual CO_2 emission savings (53,959 lbs CO_2/yr), which is about 30 percent greater than annual CO_2 emission savings from high performance window films (see Table 5).

Table 5: East Critical Care Tower Payback Period and CO_2 Savings

Window Film Type	Payback Period (yrs)	Annual CO_2 Emission Savings (lbs)
Basic performance	68.9	-7,477[1]
Medium performance	12.2	14,371
High performance	5.2	37,983
Low-e	3.3	53,959

1 The negative CO2 emission saving means basic performance window film results in more energy being used during its life cycle.

Sensitivity Analysis

A sensitivity analysis was conducted based on the financial analysis. Four 3M window film products were chosen corresponding to different types of window films; basic, medium and high performance and low-e. The product specifications are shown in Table 6. For the sensitivity analysis shown in Table 8, the price and the payback period were assumed to have a linear relationship. The prices per square foot listed in Table 8 do not include the installation cost.

Table 6: Window Film Product Specifications

Product	Category	U-value	Visible Light Transmission (%)	SHGC	Total Solar Energy Rejected (TSER)	Price ($/sqft)
Affinity 30	High performance	0.94	33	0.21	78	12
PR 40	Medium performance	0.99	39	0.4	60	8
Neutral 70	Basic performance	1.08	66	0.76	34	4
Amber 35	Low e	0.74	31	0.29	75	15

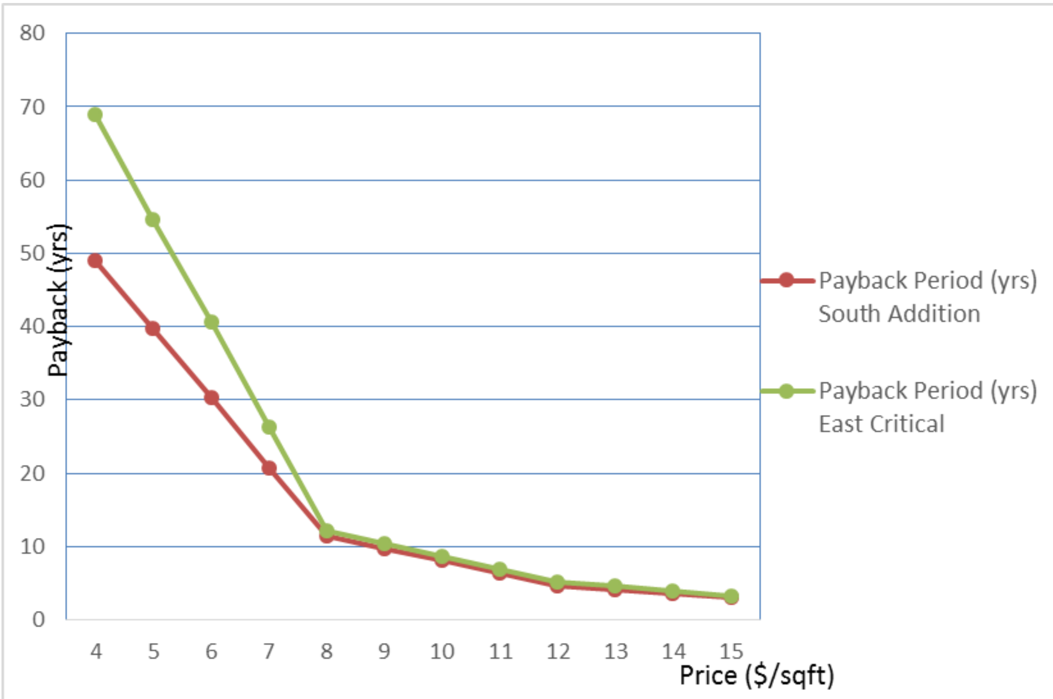
Source: 3M Window Film[xxii]

Table 7: Sensitivity Analysis of Window Films by Price (from $4/sqft to $15/sqft)

Price ($/sqft)	4	5	6	7	8	9	10	11	12	13	14	15

Payback Period (yrs)	**South Addition**	49.1	39.7	30.3	20.8	11.4	9.7	8.1	6.4	4.7	4.2	3.6	3.1
	East Critical	68.9	54.7	40.6	26.4	12.2	10.5	8.7	7.0	5.2	4.6	3.9	3.3

Figure 6: Payback Period for South Addition and East Critical Care Tower Atriums per Window Film Cost



As seen in Figure 6, as the price of window films increases from $4 to $8 per square foot, the payback periods for both atriums decrease significant from 70 years and 50 years to around 11 years. However significantly, 11 years payback is still not acceptable as Beaumont is looking for technologies with up to six years of payback. In the price range of $8 to $11 per square foot, the payback periods of both atriums are similar and decline gradually, but still are above six years. As the price rises from $11 to $15 per square foot, the payback lines for both atriums merged and become more gradual, indicating the marginal benefit of applying window film over $11 per square foot decreases with added cost. Generally smaller payback period is desired. If Beaumont is considering more about upfront cost, it is suggested to pursue the window film with price around $12 per square foot.

Project Feasibility

Based on the technical and financial feasibility analyses, it is recommended that Beaumont invest in installing either the high performance window film or the low-e window film based on the values in Table 8. The variation in payback period and price per square footage is due to uncertainty around the actual per unit cost Beaumont will receive during the competitive bidding process. Application of high performance window film in the South Tower Atrium would result in a payback period of 4.2 to 6.4 years assuming the price of the window film was $11 to $13 per square foot respectively. These price ranges do not include installation costs. The South Hospital Atrium glass extends over three separate spaces that would be impacted during the window film installation process – the second floor Surgical Waiting, fifth floor pediatrics and the Saber Salisbury Memorial Garden. The East Critical Care Tower would result in a payback period of 4.6 to 7 years assuming the price of the window film was $11 to $13 per square foot respectively.

Application of low-e window film in the South Tower Atrium would result in a payback period of 3.1 to 3.6 years assuming a price range of $14 to $15 per square foot respectively. The East Critical Care Tower would result in a payback period of 3.3 to 3.9 years assuming the price of the window film was $14 to $15 per square foot respectively.

Recommendation

Given the results of the analyses, it is recommended that Royal Oak Beaumont first explore retrofitting the window in the South Tower Atrium with low-e window film because:

1) This project has the quickest return on investment; and
2) Application to the South Tower Atrium would have a larger effect on occupants and adjacent offices since the space is larger and there are more occupants in this area.

After retrofitting the South Tower Atrium and measuring performance by monitoring indoor thermal conditions and energy saved in heating and cooling, it is recommended that Beaumont then install high performance window films in the East Critical Care Tower Atrium because:

1) The space is smaller, therefore application would be quicker; and
2) The window films currently installed are damaged and detracting from the physical attractiveness of the space.

Further Reading

3M Window Film Solutions:

http://solutions.3m.com/wps/portal/3M/en_US/Window_Film/Solutions/Markets-Products/Commercial/

SunTek Window Film Solutions: http://www.suntekfilms.com/architectural/suntek-window-films-architectural.aspx

Llumar Window Film Solutions: http://northamerica.llumar.com/choose-a-product/architectural-window-films

Department of Energy – Federal Energy Management Program – Window Film Page:

http://www1.eere.energy.gov/femp/technologies/eut_window_films.html

International Window Film Association - Window Films 101: http://www.iwfa.com/ConsumerInfo.aspx

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Appendix I: ASHRAE Level 1.5 Energy Audit for Medical Office Building

ASHRAE Level 1.5 Energy Audit:

Medical Office Building, Beaumont Health System, Royal Oak, Michigan

Summary Report

Sustainability Initiatives for Beaumont Health System Project Team
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Contents

1. Executive Summary

This report details the Level 1.5 audit of the Beaumont Health System's Royal Oak Campus' Medical Office Building. The University of Michigan's School of Natural Resources and Environment's Sustainability Initiatives for Beaumont Health System (SIBHS) master's project team, Glen Staton of JLL, and Rob Guay of JLL at Beaumont conducted the audit in November 18th, 2013. To further its sustainability mission and better conserve energy, the Royal Oak Beaumont hospital is systematically conducting ASHRAE audits in buildings across its Royal Oak campus.

The objective of this study was to identify opportunities to reduce the energy costs of the facility through changes in operating strategies and retrofit measures. Specifically, this report describes the findings and recommendations developed over the course of the energy audit and subsequent lighting survey. Through two on-site walkthroughs and a review of the building schematics and energy consumption patterns, the SIBHS team identified 12 potential energy conservation measures (ECMs).

Table 1 shows the 12 ECMs prioritized by payback time.

ECM	Description	Cost ($)	Annual Utility Savings ($/Year)	Simple Payback (Years)	ROI
1001	Delamping	$300	$1,270	0.24	423%
1002	Lighting Occupancy Controls	$4,224	$780	5.4	18.5%
1003	Daylight Harvesting	$10,000	$6,570	1.52	65.7%
1004	Apply VFDs to Fan Motors	$66,500	$41,100	1.62	62%
1005	Premium Efficiency Motor Replacements	$32,232	$41,276	0.78	128%
1006	Pneumatic to DDC	$ 264,000	$30,223	8.74	11.4%
1008	Unoccupied Setback	N/A	N/A	N/A	N/A
1009	Building Envelope Improvements	$200	$1,848	0.11	909%
1010	Training Cleaning Crew	N/A	N/A	N/A	N/A
1011	Exterior Heating Lamp Controls	N/A	N/A	N/A	N/A
1012	Vending Machine Energy Misers	$129/unit	$149/unit	.86	115%

Table 1. Summary of Energy Conservation Measures

<u>The main recommendations resulting from the audit are as follows:</u>

- Although the lighting systems in the building have been recently retrofitted, there are several simple lighting energy conservation measures that could reduce energy consumption in the restrooms and hallways.
- The walkthrough surfaced several low-cost/no-cost measures that would be simple to implement.
- Switch the constant running motors to premium efficiency motors is very economic and has less than a year payback.
- Install weather-stripping on all exterior doors.

2. Background

Founded in 1955, the William Beaumont Health System is the 20th largest health system in the United States being a regional health care provider for Metro Detroit. Opening with a 238-bed hospital in Royal Oak, Michigan, the health system continued to expand to the neighboring cities of Troy and Grosse Point adding nearly 700 beds. The largest of the three Beaumont Campuses, Royal Oak Beaumont is a now a 1,070 bed tertiary hospital with an Imaging Center, the Comprehensive Breast Center, the Beaumont Cancer Center, Vascular Services Center, the Beaumont Heart Center, the Research Institute and the Medical Office Building.[i]

The Beaumont Health System Green Team and a team of graduate students from the University of Michigan's School of Natural Resources and Environment teamed up to address several sustainability initiatives across the Royal Oak Hospital campus. Their 15-month long master's project focuses on helping the Royal Oak Campus attain credits that will the hospital attain LEED-Existing Building Operation and Maintenance certification.

3. Medical Office Building

3.1. Building Description

The Medical Office Building (MOB) consists of two towers connected by a narrow span. The west building (MOB West) was originally constructed in 1967 and the east building (MOB East) was built in 1986. The gross area of MOB West is approximately 167,000 square feet and MOB East is approximately 210,442 square feet. There is a sky bridge connecting the MOB to the free parking garage on the 2nd floor. Mechanical equipment rooms located on the 8th floor house the building's major air handling systems and building automated system control panel. Some of the original air handling systems are still in place and other systems have been updated since the building was built (Guay, 2014).

The street level of the building includes the building's main entry lobby, banking facilities (Credit Union ONE), café facilities (The Coffee Shop), a pharmacy and private clinical offices. Floors 2 through 7 are primarily clinic space, physicians' private practices and spaces available for several other Beaumont services.

The leased spaces on floors 1-7 are situated in MOB East and West on either side of the central hallway consisting of six elevators and men's and women's restrooms. Beaumont leases all spaces in the MOB. Tenants are responsible for paying for electricity based on the square footage of their space and also responsible for paying for chilled water according to meter readings.

Figure 1: Aerial View of the Medical Office Building

3.2. Facility Operating Schedule

Normal building occupancy occurs Monday through Friday, 7:00 a.m. to 6:00 p.m., with the exception of the after hour clinics that are open until 10:00 p.m. on weekdays and weekends. Per the February 2014 building occupancy schedule, heating, ventilation and air conditioning (HVAC) systems are operated to ensure that the occupied tenant spaces reach the desired setpoint prior to the 7:00 a.m. occupancy start time. To achieve optimal indoor air temperatures, the MOB's major HVAC systems are typically started at 5:00 a.m. Detailed HVAC schedules are provided in Section 4.5 below.

3.3. Cooling

Chilled water for cooling is provided by gas-powered chillers in the hospital's central power plant. The water is chilled to 40 degrees Fahrenheit by central chillers and is then piped to the various hospital buildings. The supply air is cooled by cooling coils located in air handlers and is reheated before entering occupied spaces as needed.

3.4. Heating

Steam for heating is provided by the central power plant on Royal Oak's campus. The power plant is natural gas fired and has five steam boilers capable of producing a total of 120,000 pounds of steam. The boilers vary in age from 10 years old to over 30 years old (Site Audit, 2013). All of the boilers have been upgraded with O^2 trim, economizers, and controls. The steam leaves the power plant in five locations and goes to the heat exchanger located in the MOB West, which transfers heat to water. One air-handling unit (AH-21) is used for all of the water heating system in the MOB West. It sends 55°F water through heating coil convectors and 70° F water through a cooling coil in the winter (Guay, 2014). Once the steam heats the air it turns to condensate and is routed back to the power plant for reuse. The steam trap helps lower the rate of humidification, which is around 80% in the summer and 45% in the winter (Site Audit, 2013). There is radiant heating in the hallway between the two buildings. All thermostats have pneumatic controls located in respective zone.

3.5. Ventilation

The ventilation system used in the MOB is a Constant Volume All Air System with Terminal Reheat. The two large air-handling units located in the equipment room on the 8th floor of MOB West (AH-20 and AH-22) are rated at 17,500 cfm and 27,500 cfm, respectively (Guay, 2014). Each air-handling unit serves a different zone. AH-20 serves the lower level and first floor. AH-22 serves the suite overhead diffusers and hallways. AH-21 serves all of the convectors in the MOB West. The settings for AH-20 and AH-22 are listed in
Table 3. All air AHUs in MOB West has duty cycle and the supply fans are equipped with Variable Frequency Drives (VFDs).

The duty cycle has been implemented and the setting is based on the occupancy schedule. There is only one AHU (AH-1) located in MOB East rated at 90,000 cfm and it does not have duty cycle and the fans are not upgraded with VFDs (Guay, 2014). Variable air volume (VAV) boxes serve as the terminal units in each individual zone and provide local temperature control using reheat coils. Exhaust fans on the roof vent air from the restrooms throughout the building. The detailed fan inventory is shown in
Table 4. The AHU operating schedules for all of the units are shown in

Table 2.

Table 2: MOB AHU Schedule

	Monday-Friday	Saturday	Sunday
AH-20	5am-10pm	5am-6pm	7am-noon
AH-21 (Water)	5am-10pm	5am-6pm	Off
AH-22	5am-6pm	5am-6pm	Off
AH-1	6am-10pm	6am-10pm	Noon-10pm

Table 3: West MOB AHU Settings

	Setting Temperature (F)	Relative Humidity (%)	Static Pressure (psi)
AH-20	60	35	2.6
AH-21 (Water)	55 (Winter)	35	3.25
	70 (Summer)	35	3.25
AH-22	60	35	2.6

Table 4: MOB Fan Inventory

Location	Number of fans	Fan Type	Rated HP	Schedule	VFD Installed
AHU-20 Supply	1	Inline barrel	30	Same w/ AHU schedule	Yes
AHU-20 Return	1	Inline barrel	10	Same w/ AHU schedule	Yes
AHU-21 Supply	1	Inline barrel	40	Same w/ AHU schedule	Yes
AHU-21 Return	2	Vertical fan wall	5	Same w/ AHU schedule	Yes
AHU-22 Supply	1	Inline barrel	50	Same w/ AHU schedule	Yes
AHU-22 Return	1	Inline barrel	20	Same w/ AHU schedule	Yes
AHU-1 Supply	2	Inline barrel	100	Same w/ AHU schedule	No
AHU-1 Return	2	Inline barrel	50	Same w/ AHU schedule	No
Toilet Exhaust	2	Exhaust fan	3	Same w/ Supply fan schedule	No

3.6. Energy Management System

There is a TRANE programmable control system in the equipment room on the 7th floor. This system centrally controls the following equipment and set points: chilled water coil, reheat coil, local discharge, AHU discharge air temperature, system static pressure, fan speed, heating coil discharge, AHU chilled water discharge, local reset humidity, and OSA temperature for steam. The TRANE system is monitored and controlled 24/7 by an operating engineer in the control room.

3.7. Lighting

The T-12 fluorescent tubes have been upgraded with T-8 fluorescent tubes throughout the common areas of MOB East and West. Magnetic ballasts have been upgraded to electronic ballasts. In addition to T8 lamps, Dulux lamps are being used extensively in the MOB. The four main elevators still have T-12 lamps in use and it is recommended to switch them to LED tubes given 24/7 operation hour. The utilization of occupancy sensors has not been observed in the building. A detailed inventory of lighting system is presented in Appendix 1. In general, the MOB lighting system is well designed as most of the locations have proper lighting level and lighting power density based on ASHRAE 90.1 and properly upgraded and no further large-scale upgrades are needed.

4. Energy Profile

4.1. Energy Consumption

The energy consumption analysis of the MOB utility bills from the years 2011 through 2013 revealed that the MOB is relatively energy efficient in comparison to the other building in U.S. of similar use. According to the analysis, the energy consumption of the MOB on a per square footage basis is 87.2 kBtu in 2011 and 73.6 kBtu in 2012, which is lower than the average Energy Use Intensity (EUI) for typical a health care building in America (95 kBtu/ft^2/yr)[ii]. However the interview with the facility manager confirmed that considerable potential savings could be achieved if the MOB building systems operate on a schedule that more closely matches building occupancy. Despite attempts to curtail the energy use by improve the building schedule and applying duty cycle on the AHUs, the attributes of the building's tenant agreements[1] make it difficult to justify using funds for large energy saving programs.

The utility data is comprised of two parts – electricity consumption and steam (natural gas) consumption. Table 5 shows the total energy consumption in 2011, 2012 and 2013 (from January to October).

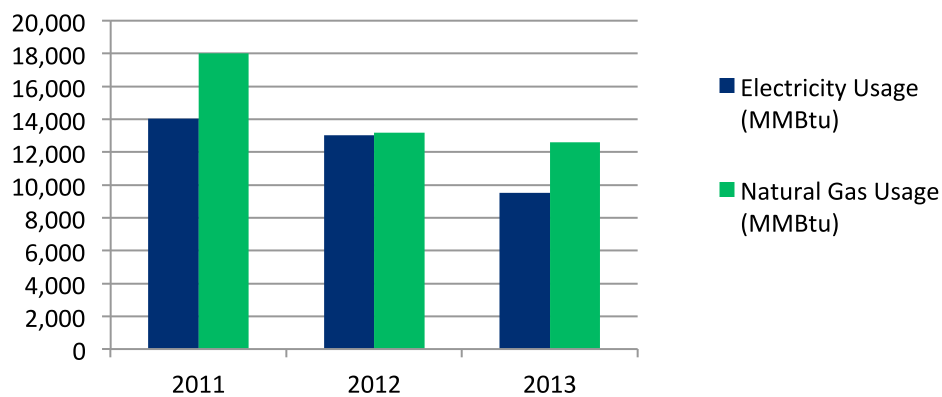
Table 5: Total Energy Consumption of MOB (2011-2013)

Year	Total Energy Consumption (MMBTU)
2011	32,985
2012	27,784
2013 (Jan to Oct)	22,132

Source: Staton (2013)

Figure 2 provides the data on the energy usage by fuel type. The boilers located in the plant room burn natural gas and create steam, which is piped through campus and used for heating and other purposes, such as sterilizing equipment. There is a huge heat loss converting natural gas to steam and piping steam to MOB. Electricity is also a large source of energy consumption. From 2011 to 2012, the general energy consumption went down by 15.8% Energy consumption likely decreased due to local weather variations.

Figure 2: Total energy use breakdown at Medical Office Building (2011 to 2013) (MMBtu)



[1] Currently the MOB is fully leased out to various tenants who pay the utility costs based on the square footage of each space, thus providing the health system with less incentive to implement upgrades. In addition, user behaviors vary which prevents Beaumont from implementing low-cost energy conservation measures such as modifying the operating schedule of the building.

Figure 3: Natural Gas Usage of the Medical Office Building (Therms)

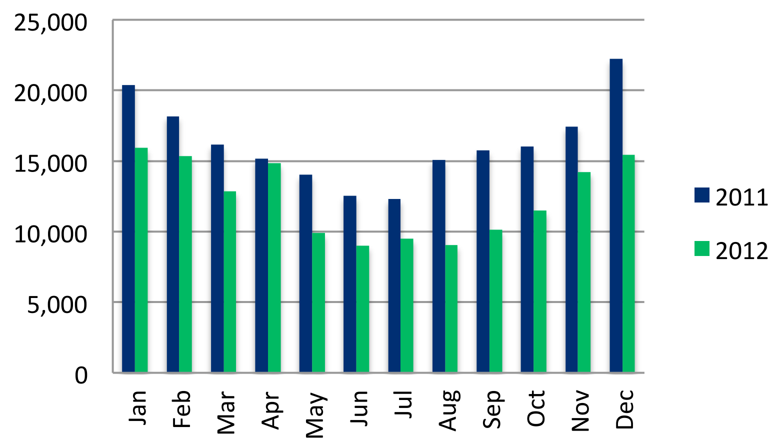
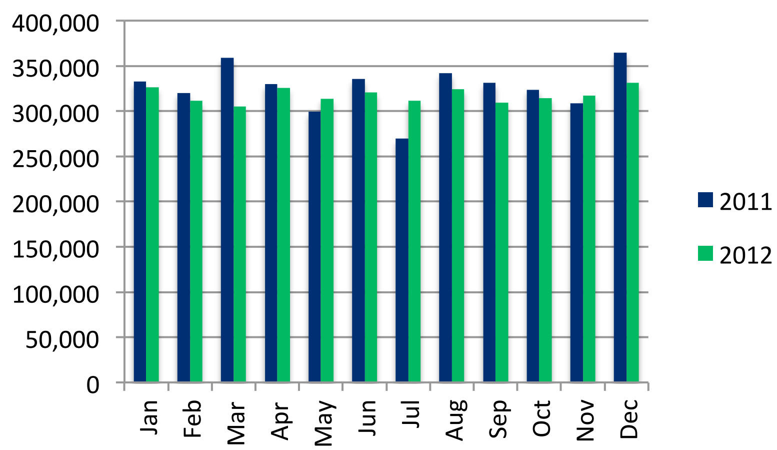


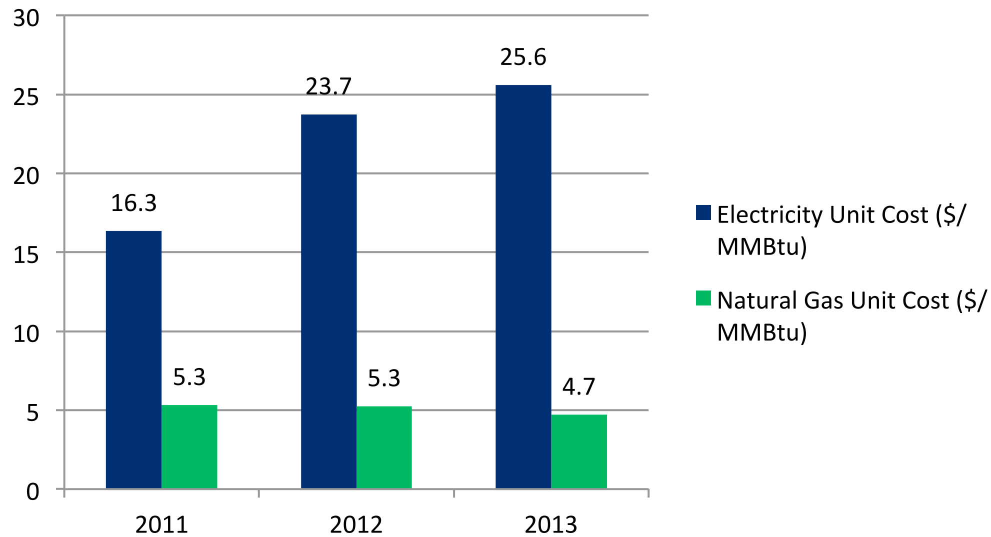
Figure 4: Electricity Usage of the Medical Office Building (kWh)



4.2. Energy Cost

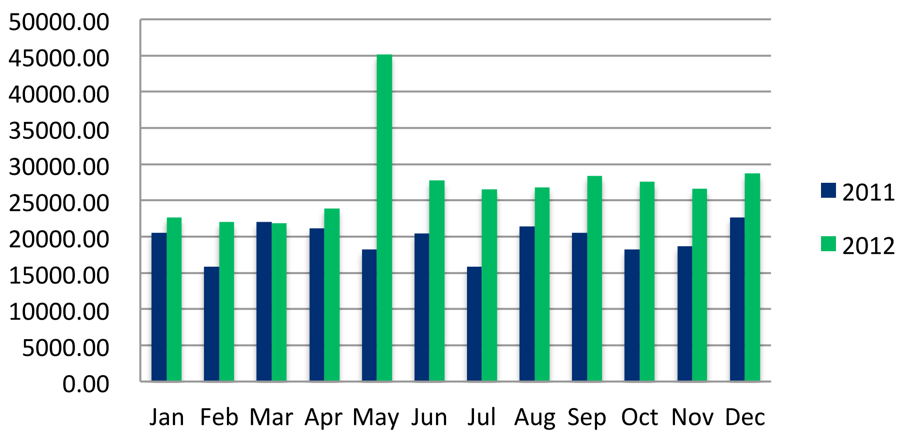
Although electricity consumption is lower than natural gas consumption, it is significantly more expensive than natural gas in terms of unit cost. For example, in 2013, electricity costs were about 18% higher than natural gas costs (see Figure 2).

Figure 5: Unit Cost of Energy (2011-2013)



NOTE: The electricity cost in 2012 increased significantly while the general consumption decreased shows that there is an upsurge in electricity price.

Figure 6: Natural Gas Cost (2011-2013) (USD)



The total energy cost by source from 2011 to 2013, Beaumont spent $782,035 on electricity while the price of natural gas declined. The price of natural gas gradually decreased from over $5 per thousand cubic feet (Mcf) in 2011 to about $4.7 per Mcf in 2013. The decrease in natural gas prices was a result of a shale gas boom[2]. The cost of natural gas from 2011 to 2013 was $224,600, as shown in Figure 6 (Staton, 2013).

[2] Shale gas is natural gas found in shale formations, and is produced by the process called hydraulic fracturing (also known as fracking), the boom has taken place in U.S. since the start of the century with the invention of horizontal drilling - a drilling method that is more efficient and has lower cost.

Figure 7: Total Energy Cost by Source (2011-2013)

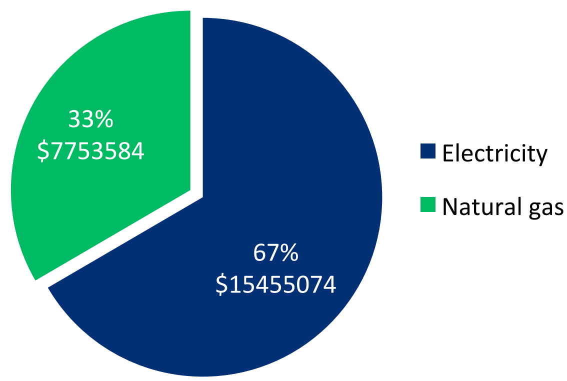
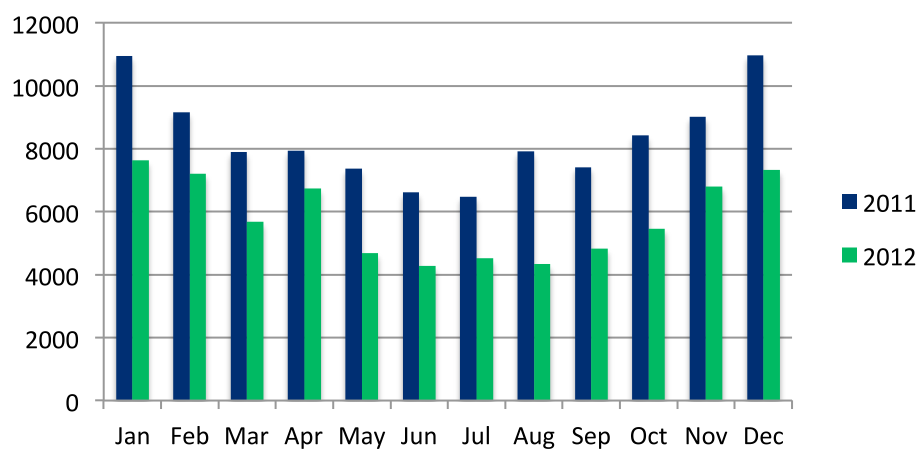


Figure 8: Natural Gas Cost by Month (2011-2012)



4.3. Seasonal Loads

Generally, electricity demand is higher in summer months due to air conditioning use, while natural gas demand is higher during the winter as a result of space heating. A seasonal load analysis is performed for MOB and results are shown in Table 6 and Table 7 below. Table 6 shows the negative cooling load. This shows there is no large variation in electricity consumption over the course of the year. Table 7 shows that there is an annual base load for the MOB, but it typically varies with weather. Generally, the consumption of both electricity and natural gas are quite stable throughout the year.

Table 6: Electricity Seasonal Loads

Electrical Seasonal / Cooling Load		
Description	2012	2011
Total Annual Electricity Use (kWh)	3,812,393	3,916,464
Average Non-Cooling Month Electric Use	317,748	334,790
Total Annual Base Load	3,812,974	4,017,480
Total Cooling Load	N/A	N/A
Per square foot	N/A	N/A
Total Cooling Cost	N/A	N/A
Per square foot	N/A	N/A

Table 7: Natural Gas Seasonal Loads

Fuel Seasonal / Heating Load		
Description	2012	2011
Total Annual Fuel Use (Therm)	147,721	195,282
Average Non-Heating Month Fuel Use	10,404	14,146
Total Annual Base Load	124,846	169,747
Total Heating Load	22,875	25,535
Per square foot	0.06	0.07
Total Heating Cost	10774.3	13114.4
Per square foot	$0.06	$0.08

4.4. Carbon

As Beaumont expressed in its 2012 Sustainability Plan, reducing the hospital's impact on the environment is important to the administration, staff, and patients for a healthier hospital environment Carbon dioxide is emitted into the atmosphere through the combustion of fossil fuels and is the primary greenhouse gas[iii]. The sources of carbon dioxide emissions from the Medical Office Building are from the natural gas used in the boilers and the grid provided electricity. The majority of utility provided electricity in southeastern Michigan comes from coal fired power plants. Figure 9 presents Royal Oak Beaumont's MOB consumption of natural gas and electricity from 2011 and 2012, it shows a reduction of nearly 4 million pounds of CO_2 emitted by the Medical Office Building.[3] Figure 10 shows the allocation of the CO_2 emissions by fuel source, with grid electricity only accounting for 13% of the emissions.

[3] 2013 data is currently unavailable.

Figure 9: Total Pounds of Carbon Dioxide Emitted from Energy Consumption in the Medical Office Building

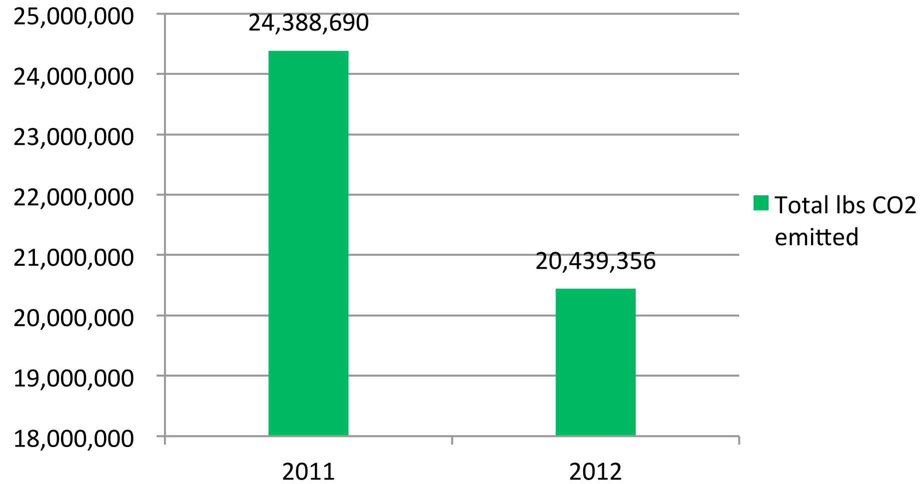
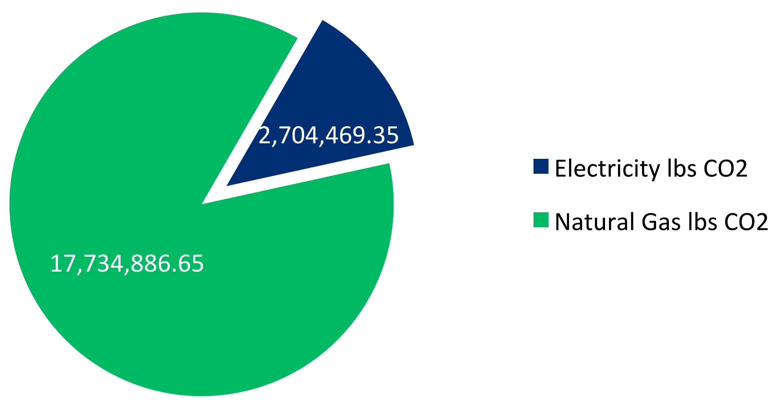


Figure 10: Total Pounds of Carbor Dioxide Emitted in 2012 Divided by Fuel Source



NOTE: Natural Gas accounts for 87% of CO_2 emissions for the Medical Office Building.

4.5. Benchmarking

Table 8 provides a summary of the 2011 and 2012 energy use benchmarking analysis of energy use in 2011 and 2012. Electricity usage unit is kWh and natural gas usage unit is therm. Benchmarking is being mandated by many states in U.S. (NY, MA, WA). It provides an easier way for buildings of different sizes to compare their energy use status with buildings of similar use.

Table 8: Benchmarking Summary

Benchmarking Summary									
Fuel Type	Year	Total Energy Use	Per Sqft	Total Energy Cost ($)	Per Sqft	Total kBTUs	Per Sqft	Total CO2 (lbs)	Per Sqft
Electricity	2012	3,812,393	10.1	327,927	$0.87	13,007,885	34.5	3,957,264	10.5
	2011	3,916,464	10.4	235,677	$0.62	13,362,975	35.4	4,065,290	10.8
Natural Gas	2012	147,722	0.4	69,492	$0.18	14,772,145	39.1	1,820,519	4.8
	2011	195,282	0.5	100,125	$0.27	19,528,211	51.7	2,406,657	6.4
Total	**2012**	**N/A**	**N/A**	**397,418**	**$1.05**	**27,780,030**	**73.6**	**5,777,783**	**15.3**
	2011	**N/A**	**N/A**	**335,802**	**$0.89**	**32,891,186**	**87.1**	**6,471,946**	**17.1**

5. Energy Audit

5.1. Audit Procedures

The team conducted a visual inspection of the following systems:

- Lighting systems
- Mechanical rooms
- Energy management system
- Roof
- Central chiller plant
- Heating plant

6. Energy Conservation Measures

6.1. General Overview

The majority of the building systems are operating optimally. However, several worthwhile opportunities have been identified through this audit that would improve the operation of some of the major systems serving the building. Additionally, several low cost and no cost opportunities that would strategically improve the efficiency of the building at a smaller scale are also available. Energy conservation measures (ECMs) that would improve the building's performance, reliability, and efficiency are briefly discussed in this section as well as their Operations and Maintenance (O & M) Impact, Measurement and Verification (M & V) methods, and the Return on Investment (ROI) methodology.

The energy savings detailed below are estimates based on the SIBHS team's methodologies and analysis. The payback is the cost divided by the annual savings.

Lighting Energy Conservation Measures

- ECM – 1001: Delamping
- ECM – 1002: Lighting Occupancy Controls
- ECM – 1003: Daylight Harvesting

Other Energy Conservation Measures

- ECM – 1004: Apply VFD to Fan Motors
- ECM – 1005: Premium Efficiency Motor Replacements
- ECM – 1006: Pneumatic to DDC
- ECM – 1007: Static Pressure Reset
- ECM – 1008: Unoccupied Setback

Low Cost/No Cost Energy Conservation Measures

- ECM – 1009: Building Envelope Improvements
- ECM – 1010: Training Cleaning Crew
- ECM – 1011: Exterior Heating Lamp Controls
- ECM – 1012: Vending Machine Energy Misers

6.2. Lighting Energy Conservation Measures

ECM – 1001: Delamping the restrooms

Description: Based on the lighting survey conducted in March of 2014, all of the restrooms, especially the restrooms in the 1st, 2nd, 4th, 5th and 6th floor lobbies in the MOB are brighter than recommended (the light level recommended for restroom is 300 lux while from the lighting audit majority of the restrooms have lighting level at around 500 lux) (US ACE Lighting Levels, 2014). For the restrooms, it is recommended to delamp one or more of the fixtures in each of the restrooms based lux levels.

Applicable Equipment: Restroom lighting fixtures, typically two Dulux lamps fixture and three T8 lamps fixtures

O&M Impact: Initial work to delamp areas with regular replacement intervals throughout operation.

Expected Life of ECM: Bulbs will perform as previously expected, replacement may become more frequent due to burnt out bulbs being more obvious, but overall lighting consumption per bathroom will decrease.

Staff Training Requirements: None.

Recommended M&V Method: Monitor lighting energy consumption sector by installing submeters for lighting controls.

Rebates/Incentives Available: None.

Gas Reduction (MMBtu)	Electric Reduction (kWh)	Cost to Implement	Annual $ Savings	Payback Years	Return on Investment
N/A	5,081	$300	$1,270	0.24	423%

ROI Methodology:
- Estimated implementation cost: 3 hours at $100/hour for labor.
- Calculated annual reduction in electricity consumption: Delamp 35 lamps throughout the restrooms in MOB and 1,160W in total, assume lamps work 12 hours per day, electricity consumption is 5,081 kWh.
- Calculated annual savings: 5,081kWh * $0.25/kWh = $1,270.

ECM – 1002: Lighting Occupancy Controls

Description: Currently, occupants using the public restrooms control the lights with an ordinary light switch. Upon entering and exiting, occupants are expected to use the switch. Often times upon exiting, the lights remain on and continue to illuminate a space that is not being utilized. It is recommended that occupancy/vacancy sensors be installed to control lighting in portions of the building. Occupancy/vacancy sensors could also be used in hallways by utilizing bi-level lighting. Bi-level lighting is when a portion of the lights would remain on at all times while extra lighting would be provided when an occupant enters the space.

Applicable Equipment: Ordinary light switches in public bathrooms and other areas where constant lighting is common that are rarely occupied (public hallways on certain floors).

O&M Impact: Reduces re-lamping requirements. There may be minimal work to ensure that occupancy sensors are working properly.

Expected Life of ECM: Vacancy sensors have a life span of 12 to 15 years (Light Search, 2014).

Staff Training Requirements: None.

Recommended M&V Method: Monitor lighting energy consumption by installing submeters for lighting controls.

Rebates/Incentives Available: None.

Gas Reduction (MMBtu)	Electric Reduction (kWh)	Cost to Implement	Annual $ Savings	Payback Years	Return on Investment
N/A	3,121	$4,224	$780	5.4	18.5%

ROI Methodology:

- Calculated the energy usage for lighting prior to implementation (same 35% as in ECM-1001).
- Calculated future energy usage after implementation. Estimated how many hours of lighting annually will be reduced at the target locations. Using the reduced hours of operation (8 hours fewer) and the consumption rate for the bulbs calculated the reduced electricity usage.
- Implementations cost:$66 per vacancy sensor (Leviton, 2014).

ECM – 1003: Daylight Harvesting

Description: The lux meter readings taken during the lighting survey showed that in certain areas of the hallway connecting MOB East and MOB West, the lamps could be turned off during the day and daylight alone was sufficient to light hallways. Currently, the ability to control the switches limits the feasibility of daylight harvesting, thus it is recommended that the lamps in the hallway be re-wired and a time clock be installed to automatically turn on and off the lights at certain times.

Applicable Equipment: All lamps in the east and west hallway connecting MOB East and MOB West.

O&M Impact: Work to rewire the lighting and install controls. Reduced re-lamping and O&M costs.

Expected Life of ECM: 10 years.

Staff Training Requirements: None.

Recommended M&V Method: Monitor energy consumption of the pharmacy pre and post daylight sensor installation.

Rebates/Incentives Available: None.

Gas Reduction (MMBtu)	Electric Reduction (kWh)	Cost to Implement	Annual $ Savings	Payback Years	Return on Investment
N/A	26,280	$10,000	$6,570	1.52	65.7%

ROI Methodology:

- The total wattage of hallway lighting fixtures equals 9kW.
- Assume that after installation the amount of time the lights are illuminated decreases by 8 hours per day. This would save 26,280 kWh of electricity
- Assume that the electricity price = $0.25/kWh, then the savings = $6,570/yr
- Assume the cost is $350 per fixture (including the ballast and lamp) in addition to $200 for rewiring and installing = $550
- Assume adjustments occur on approximately 18 fixtures leading to a total cost just shy of $10,000

6.3. Other Energy Conservation Measures

ECM – 1004: Apply VFD to fan motors

Description: Most HVAC fan systems are designed for peak load operation, but the system does not constantly operate at peak load. As a result, fans and pumps typically operate at full load for more time than is needed. The application of VFD to supply and return fans of AHU-1 and return fans of AHU-20, 21, and 22 of the MOB could reduce the amount of energy wasted by continuous, full load operation.

Applicable Equipment: Supply and return fans of AHU-1, return fans of AHU-20, 21 and 22.

O&M Impact: operation and maintenance impacts are negligible. No significant impact is found on user comfort, service and safety.

Expected Life of ECM: 10 years.

Staff Training Requirements: Facilities staff may require training on coding and programming.

Recommended M&V Method: Compare fan operating hours pre and post reschedule.

Rebates/Incentives Available: None.

Gas Reduction (MMBtu)	Electric Reduction (kWh)	Cost to Implement ($)	Annual $ Savings	Payback Years	Return on Investment
N/A	456,489	$66,500	$41,100	1.62	62%

ROI Methodology:

- Assume all fan motors ride fan curve before upgrade, and VFD after upgrade
- Given a fan at 60% max flow, the ratio before upgrade is 0.94 and after upgrade is 0.32.
- The savings are calculated by multiplying the kW of motor by the difference in power ratios, and then multiplying this number by the operating hours.
- Assume an upgrade to VFD costs $350 per HP.

ECM – 1005: Premium Efficiency Motor Replacements

Description: Motors are a huge source of energy use. 40 percent of total electricity consumption in building operation is used by motors.[iv] Some exhaust fans may need to be replaced not because of the efficiency but because of other operational issues such as insufficient power. In the MOB, nearly all the motors are run over 90 hours a week, which means these motors should be upgraded with premium efficiency motors, especially when a motor breaks down and a new one has to be installed.

Applicable Equipment: Supply, return, and exhaust fan motors.

O&M Impact: Maintenance of new motors.

Expected Life of ECM: Based on motor situation, usually around 10 years.

Staff Training Requirements: None.

Recommended M&V Method: Install control connected to BMS to monitor hours used.

Rebates/Incentives Available: N/A.

Gas Reduction (MMBtu)	Electric Reduction (kWh)	Cost to Implement	Annual $ Savings	Payback Years	Return on Investment
N/A	458,626	$ 32,232	$ 41,276	0.78	128%

ROI Methodology:

- Typically a high efficiency motor saves 25% of the current motor's energy consumption.
- Savings are calculated by totaling up the energy consumption of all fans (the team is currently aware of 14 fans), multiplying this by 0.25 to arrive at the energy saving. The savings are calculated based on the current situation, if both ECM – 1004 and ECM – 1006 are implemented, the savings would shrink.

ECM – 1006: Pneumatic to DDC

Description: Currently, all the Variable Air Volume(VAV) terminal boxes are controlled by pneumatic control systems. Compared with pneumatic control systems, direct digital controls (DDC) are more effective and efficient in terms of controllability and also improve the energy efficiency of the HVAC system. DDC consists of microprocessor-based controllers with the control logic coded by the user and performed by digital devices (computers) (Successful DDC System Retrofit, ASHRAE Journal, 2004). Most systems distribute the software to remote controllers to avoid the need for continuous communication. Central control systems are primarily used to monitor the status of the system and store the data. DDC provides more effective control of the HVAC system by providing more accurate data. DDC has higher operational efficiency due to its capabilities of data visualization and remote accessing. Many complex energy-efficient strategies are readily available in the software, which could be easily integrated into the DDC system, thus greatly improving the HVAC energy efficiency.

Pneumatic to DDC conversion is expensive and it is not recommended to install all of the DDC at once. The central plant conversion is necessary in order to proceed with zone control upgrades. The MOB should selectively upgrade at the zone level, starting with zones where thermal comfort is a larger issue and proceeding to the whole building upgrade process gradually.

Applicable Equipment: Pneumatic thermostats.

O&M Impact: During the conversion process, since DDC powers the system components electronically, wherever a thermostat is required, control wiring and in some cases additional power circuits are required. Also, sensing devices must be replaced with new sensors designed to communicate with the new DDC controllers. Valves and dampers could be reused. VAV boxes will need a new control module for heating and cooling coils as well as fans.

Expected Life of ECM: Expected life of DDC controllers are 10 years.

Staff Training Requirements: Training of using DDC controllers and software is needed.

Recommended M&V Method: Central control system could measure the operation of all terminal units to verify the effectiveness.

Rebates/Incentives Available: N/A.

Gas Reduction (MMBtu)	Electric Reduction (MMBtu)	Cost to Implement	Annual $ Savings	Payback Years	Return on Investment
1760	240,000	$ 264,000	$30,223	8.74	11.4%

ROI Methodology:

- If Beaumont only upgrades the central system, the cost is roughly $0.5/ft^2 for the HVAC system. At zone level the cost could be up to $2/ft^2, but zone level upgrades do not need to be implemented at the same time as central system upgrades. (Successful DDC System Retrofit, ASHRAE Journal, 2004)
- The initial cost is 377442 ft2*$0.5/ft2 = $188,721 for central air handling units upgrade.
- 10% of the whole building goes through zone level upgrade 377442 ft2*10%*$2/ft2 = $75488
- Total cost is about $264,000.
- Assume savings are the same as the static pressure reset (ASHRAE, 2009).

ECM – 1007: Static Pressure Resets

Description: Supply air fans are typically used to maintain the static pressure in the duct system at a given setpoint. The fan efficiency is directly related to the operating setpoint. The lower the setpoint, the lower the fan energy and the lower the air flow rate before the fan operates in the surge region. For systems with digital controls at the zone level, the static pressure setpoint should be reset based on the zone requiring the most pressure. This will result in huge energy savings as the fan does not need to generate more pressure than necessary to satisfy the critical zone.

Applicable Equipment: All air supply fans.

O&M Impact: Little or no cost, DDC control is required. The demand for static pressure for each zone should be investigated before the reset is implemented.

Expected Life of ECM: Static pressure reset is expected to have permanent life, modification based on demand change is needed.

Staff Training Requirements: Staff should be able to adjust the setpoint based on the demand and need, which could change due to load variance and other reasons.

Recommended M&V Method: The operation of fans could be monitored pre and post reset to verify the saving.

Rebates/Incentives Available: N/A

Gas Reduction (MMBtu)	Electric Reduction (kWh)	Cost to Implement	Annual $ Savings	Payback Years	Return on Investment
1,760	240,000	Programming cost	$30,223		

ROI Methodology:

- The AHU energy consumption could be roughly estimated by using energy use in the ratio of energy sources of a typical building. AHU energy consumption mainly includes the cooling (15%), heating (14%), and fan energy (18%) (See A Guide to Energy Audits, Page 5).
- Total building energy consumption is 30,340 MMBtu per year. Cooling energy is 4,551 MMBtu, heating energy is 4,248 MMBtu and fan energy is 5,461 MMBtu. Heating and cooling energy are converted from gas. Given the boiler efficiency equals 0.75, gas saving is 117,320 therms. 5,461 MMBtu is equivalent to 1,600,073 kWh. A 15% reduction on gas and electricity use would be 1,760 MMBtu and 240,000 kWh, respectively. Therefore, the cost saving is $8,623 + $21,600 = $30,223

ECM – 1008: Unoccupied Setback

Description: When a space in unoccupied, temperatures do not need to be held to occupancy requirements. The SIBHS team recommends allowing the system to setback to a lower setpoint at night or during other low- or non-operation periods. Setback could generate considerable savings.

Four potential setback scenarios (5 Degree F setback, 10 Degree F setback, 15 Degree F setback, and 20 Degree F setback) are shown in table 17 below. For each scenario, the table 17 presents energy savings and cost savings for the heating season only. Facility managers should be aware that the setback temperature should be determined based on experiments as there is no rule of thumb to determine which setback temperature best suits a particular building. Setback temperatures may vary depending on occupancy level, relative humidity, building air tightness, and other building operating policies. In general, greater setback temperatures accrue large savings during summer months and lower setback temperatures would be more desirable during winter months. For higher savings, the setback should be integrated with the application of optimum system start-up and shut-down times.

Applicable Equipment: Thermostats/BAS.

O&M Impact: None.

Expected Life of ECM: 10 years.

Staff Training Requirements: Education to building occupants and cleaning staff. Annually tune back is recommended.

Recommended M&V Method: Provide BAS trend logs to verify proper operation.

Rebates/Incentives Available: N/A.

Setback temperature (F)	Energy saving (MMBtu)	Cost saving ($)
5	5,662	$15,406
10	15,097	$41,082
15	18,117	$49,300
20	22,647	$61,623

ROI Methodology:

- Determine the degree-days location. Royal Oak, Michigan = 5,907
- Calculate the Btu/ft^2/year used for heating: 4,248MMBtu/377,442ft^2=111,258Btu/ft^2/year
- Draw a line horizontally from specified degree-days to intersection of setback temperature. Extend line vertically and proceed along sloped lines.
- Draw a line horizontally from Btu/ft^2/year until it intersects the sloped line. Proceed vertically and read Btu/ft^2/year savings on upper horizontal axis.
    a. 5 degree setback: 15*10^3 Btu/ft^2/yr
    b. 10 degree setback: 40*10^3 Btu/ft^2/yr

c. 15 degree setback: 48*10^3 Btu/ft^2/yr
d. 20 degree setback: 60*10^3 Btu/ft^2/yr

6.4. Low Cost/No Cost Opportunities

ECM – 1009: Building Envelope Improvements

Figure 11: Image of the Door Gap from North Deck Parking Entrance

The double doors leading from the North parking deck to the interior of the MOB are a large source of conditioned air loss. Applying weather stripping to the door to create a tight seal through which air cannot pass will reduce the energy draw on the HVAC system. Any other doors or operable windows that have similar gaps would benefit from the addition of weather stripping. The expected lifetime of weather stripping depends upon its material, but can be expected to last around five years before needing to be replaced[v]. Application of weather stripping is simple, and verification of its effectiveness can be quickly conducted by physically examining the lack of air flow between the doors.

Calculating air leakage prior to and after the installation of weather stripping will provide the return on investment (ROI). To calculate the ROI, one will need to know the boiler energy consumption to calculate the total energy savings, and the price for the weather stripping material. Expected energy savings from applying weather stripping to the 80 square foot (see Figure 11) are about $1,848 per year.

ECM – 1010: Training Environmental Services Crew

The MOB generally is occupied from 9am-6pm Monday through Friday. The environmental services staff cleans the clinical spaces in the evenings after the building is mostly vacant. There is the potential that by training the environmental services crew, Beaumont could reduce the amount of energy consumed in the building in the evenings and weekends. Training topics could include requesting that environmental services staff to turn off lights when conducting their duties and to turn down temperature setpoints on manual thermostats to a predetermined setback temperature.

ECM – 1011: Exterior Heating Lamp Controls

The rear entrance of the MOB has two infrared electric heaters directly outside the sliding doors that are controlled by an on/off switch inside the door. It is unknown whether or not these heaters increase patient or visitor comfort. To conserve energy, it is recommended that controls are installed that trigger the heat lamps only during the winter months or during days below a certain temperature. Controls would also increase the likelihood that the heating lamps are shut off during the building's off-hours. A simple, low-cost solution could also be to install a locked cover on the control that maintenance staff could unlock during winter months. Staff would need to install the controls or locked covers and someone would be assigned the task of unlocking and relocking the covers on particular days throughout the winter months.

The ROI of this low cost ECM would require obtaining the energy consumption rates of the heaters, estimating the cost for the cover/cages, and estimating the hours currently used, as well as expected usage after installation.

ECM – 1012: Energy Miser for Vending Machines

Simple infrared motion detectors attached to vending machines can save energy used for lighting and cooling the contents of vending machines. As there are few occupants in the MOB at night and on weekends, there are long periods of time when the vending machines can be switched off, and the energy miser will only turn the machines on when there is a person nearby. More advanced options conduct a short cooling cycle every now and then to keep the contents at the manufacturer's recommended temperature.[vi] The energy miser sensors have an average lifespan of fifteen years.[vii]

The expected ROI for installing energy misers in the vending machines is 115%, with payback occurring after .86 years. The annual savings is $149 per machine and the cost to implement is $129 (Energy Misers, 2014).

7. References

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Appendix A.

Table A1: Results of Lighting Survey Conducted in March 2014

No.	Light Level (Lux)	Area/Location	Fixture Qty.	Lamp (bulbs) Per Fixture	Lamp (bulb)Type	Lamp (bulb) Existing Input Watts	Fixture Type
1	1409	1 Lobby East Hallway	1	3	T8	32	Troffer
2		1 Lobby East Hallway	4	2	T8	40	Troffer
3	1296	1 Lobby West Hallway	1	3	T8	32	Troffer
4		1 Lobby West Hallway	4	2	Dulux	40	Troffer
5	335	1 Lobby Main	26	2	Dulux	40	Troffer
6		1E East Hallway	3	3	T8	32	Troffer
7		1E East Hallway	11	2	Dulux	40	Troffer
8		1E South Hallway	8	2	T8-U	32	Troffer
9		1E South Hallway	2	2	Dulux	40	Troffer
10		1E Mens Bathroom	5	2	Dulux	40	Troffer
11		1E Mens Bathroom	1	1	T8 (type unknown)	32	Troffer
12		1E Womens Bathroom	5	2	Dulux	40	Troffer
13		1E Womens Bathroom	1	1	T8 (type unknown)	32	Troffer
14	699	1W West Hallway	2	3	T8	32	Troffer
15		1W West Hallway	12	2	Dulux	40	Troffer
16		1W South Hallway	7	3	T8	32	Troffer
17		1W South Hallway	12	2	Dulux	40	Troffer
18	1630	1W Womens Bathroom	4	2	T8 (type unknown)	32	Troffer
19		1W Mens Bathroom	2	2	T8 (type unknown)	32	Troffer
1	930	2 Lobby East Hallway	1	3	T8	32	Troffer
2		2 Lobby East Hallway	4	2	Dulux	40	Troffer
3	1321	2 Lobby West Hallway	1	3	T8	32	Troffer
4		2 Lobby West Hallway	4	2	Dulux	40	Troffer
5	208	2 Lobby Main	28	2	Dulux	40	Troffer
6	206	2E East Hallway	3	2	T8-U	32	Troffer
7		2E East Hallway	2	2	Dulux	40	Troffer
8	265	2E North Hallway	4	2	T8-U	32	Troffer
9		2E North Hallway	17	2	Dulux	40	Troffer
10	249	2E South Hallway	1	2	T8-U	32	Troffer
11		2E South Hallway	6	2	Dulux	40	Troffer

12	151	2E Mens Bathroom	6	2	Dulux	40	Troffer
13		2E Mens Bathroom	1	1	T8 (type unknown)	32	Troffer
14	258	2E Womens Bathroom	5	2	Dulux	40	Troffer
15		2E Womens Bathroom	1	1	T8 (type unknown)	32	Troffer
16	327	2W West Hallway	6	2	T8-U	32	Troffer
17		2W West Hallway	4	2	Dulux	40	Troffer
18	353	2W North Hallway	3	2	T8-U	32	Troffer
19		2W North Hallway	3	2	Dulux	40	Troffer
20	220	2W South Hallway	5	2	T8-U	32	Troffer
21		2W South Hallway	5	2	Dulux	40	Troffer
22	344	2W Womens Bathroom	3	2	T8 (type unknown)	32	Troffer
23		2W Mens Bathroom	2	2	T8 (type unknown)	32	Troffer
1	879	3 Lobby East Hallway	1	3	T8	32	Troffer
2		3 Lobby East Hallway	4	2	Dulux	40	Troffer
3	1331	3 Lobby West Hallway	1	3	T8	32	Troffer
4		3 Lobby West Hallway	4	2	Dulux	40	Troffer
5	228	3 Lobby Main	14	2	Dulux	40	Troffer
6	219	3E East Hallway	3	2	T8-U	32	Troffer
7		3E East Hallway	6	2	Dulux	40	Troffer
8	118	3E South Hallway	4	2	T8-U	32	Troffer
9		3E South Hallway	5	2	Dulux	40	Troffer
10	337	3W West Hallway	6	2	T8-U	32	Troffer
11		3W West Hallway	6	2	Dulux	40	Troffer
12	168	3W North Hallway	3	2	T8-U	32	Troffer
13		3W North Hallway	3	2	Dulux	40	Troffer
14	431	3W South Hallway	7	2	T8-U	32	Troffer
15		3W South Hallway	6	2	Dulux	40	Troffer
16	337	3W Womens Bathroom	3	2	T8 (type unknown)	32	Troffer
17	190	3W Mens Bathroom	2	2	T8 (type unknown)	32	Troffer
1	1091	4 Lobby East Hallway	1	3	T8	32	Troffer
2		4 Lobby East Hallway	4	2	Dulux	40	Troffer
3	1456	4 Lobby West Hallway	1	3	T8	32	Troffer
4		4 Lobby West Hallway	4	2	Dulux	40	Troffer
5	396	4 Lobby Main	14	2	Dulux	40	Troffer
6	340	4 Lobby Mens Bathroom	5	2	Dulux	40	Troffer

7	343	4 Lobby Womens Bathroom	5	2	Dulux	40	Troffer
8	178	4E East Hallway	3	2	T8-U	32	Troffer
9		4E East Hallway	2	2	Dulux	40	Troffer
10	390	4E North Hallway	1	2	T8-U	32	Troffer
11		4E North Hallway	6	2	Dulux	40	Troffer
12	236	4E South Hallway	4	2	T8-U	32	Troffer
13		4E South Hallway	8	2	Dulux	40	Troffer
14	231	4W West Hallway	6	2	T8-U	32	Troffer
15		4W West Hallway	4	2	Dulux	40	Troffer
16	164	4W North Hallway	3	2	T8-U	32	Troffer
17		4W North Hallway	2	2	Dulux	40	Troffer
18	196	4W South Hallway	6	2	T8-U	32	Troffer
19		4W South Hallway	6	2	Dulux	40	Troffer
20	449	4W Mens Bathroom	2	2	T8 (type unknown)	32	Troffer
21	619	4W Womens Bathroom	3	2	T8 (type unknown)	32	Troffer
1	1260	5 Lobby East Hallway	1	3	T8	32	Troffer
2		5 Lobby East Hallway	4	2	Dulux	40	Troffer
3	1403	5 Lobby West Hallway	1	3	T8	32	Troffer
4		5 Lobby West Hallway	4	2	Dulux	40	Troffer
5	247	5 Lobby Main	14	2	Dulux	40	Troffer
6	340	5 Lobby Mens Bathroom	5	2	Dulux	40	Troffer
7	340	5 Lobby Womens Bathroom	5	2	Dulux	40	Troffer
8	483	5W West Hallway	6	2	T8-U	32	Troffer
9		5W West Hallway	4	2	Dulux	40	Troffer
10	170	5W North Hallway	3	2	T8-U	32	Troffer
11		5 North Hallway	3	2	Dulux	40	Troffer
12	203	5W South Hallway	6	2	T8-U	32	Troffer
13		5W South Hallway	6	2	Dulux	40	Troffer
14	340	5W Mens Bathroom	2	2	T8 (type unknown)	32	Troffer
15	340	5W Womens Bathroom	3	2	T8 (type unknown)	32	Troffer
1	1120	6 Lobby East Hallway	1	3	T8	32	Troffer
2		6 Lobby East Hallway	4	2	Dulux	40	Troffer
3	1670	6 Lobby West Hallway	1	3	T8	32	Troffer
4		6 Lobby West Hallway	4	2	Dulux	40	Troffer
5	340	6 Lobby Main	14	2	Dulux	40	Troffer

6		6 Lobby Mens Bathroom	5	2	Dulux	40	Troffer
7		6 Lobby Womens Bathroom	5	2	Dulux	40	Troffer
8	248	6E East Hallway	3	2	T8-U	32	Troffer
9		6E East Hallway	4	2	Dulux	40	Troffer
10	213	6E North Hallway	1	2	T8-U	32	Troffer
11		6E North Hallway	6	2	Dulux	40	Troffer
12	253	6E South Hallway	4	2	T8-U	32	Troffer
13		6E South Hallway	12	2	Dulux	40	Troffer
14	424	6W West Hallway	6	2	T8-U	32	Troffer
15		6W West Hallway	4	2	Dulux	40	Troffer
16	209	6W North Hallway	2	2	T8-U	32	Troffer
17		6W North Hallway	1	2	Dulux	40	Troffer
18	153	6W South Hallway	7	2	T8-U	32	Troffer
19		6W South Hallway	8	2	Dulux	40	Troffer
20		6W Mens Bathroom	2	2	T8 (type unknown)	32	Troffer
21	564	6W Womens Bathroom	3	2	T8 (type unknown)	32	Troffer
1	2010	5 Lobby East Hallway	1	3	T8	32	Troffer
2		5 Lobby East Hallway	4	2	Dulux	40	Troffer
3	1350	5 Lobby West Hallway	1	3	T8	32	Troffer
4		5 Lobby West Hallway	4	2	Dulux	40	Troffer
5	381	5 Lobby Main	14	2	Dulux	40	Troffer
6	293	7E East Hallway	3	2	T8-U	32	Troffer
7		7E East Hallway	4	2	Dulux	40	Troffer
8	253	7E North Hallway	1	2	T8-U	32	Troffer
9		7E North Hallway	6	2	Dulux	40	Troffer
10	203	7E South Hallway	4	2	T8-U	32	Troffer
11		7E South Hallway	11	2	Dulux	40	Troffer
12	329	7W West Hallway	6	2	T8-U	32	Troffer
13		7W West Hallway	4	2	Dulux	40	Troffer
14	309	7W North Hallway	2	2	T8-U	32	Troffer
15		7W North Hallway	1	2	Dulux	40	Troffer
16	348	7W South Hallway	5	2	T8-U	32	Troffer
17	200	7W Mens Bathroom	2	2	T8 (type unknown)	32	Troffer
18	541	7W Womens Bathroom	7	2	Dulux	40	Troffer
1	631	BE East Hallway	2	2	Loop (F32T8SPX41-U6)	32	Troffer

2		BE East Hallway	8	2	Dulux	40	Troffer
3		BE East Hallway	3	3	T8	32	Troffer
4	404	BE South Hallway	7	2	T8-U	32	Troffer
5		BE South Hallway	4	2	Dulux	40	Troffer
6	533	BW West Hallway	8	3	F032-841-XP-ECO3	32	Troffer
7	170	B Lobby	2	3	F032-841-XP-ECO3	32	Troffer
8		B Lobby	37	2	Dulux	40	Troffer
9	500	Stairwell A	32	1	LED (SW-DG186)	18	Wrap
10	267	Stairwell B	32	1	LED (SW-DG186)	18	Wrap
11	277	Stairwell C	5	2	LED (SW-DG186)	18	Wrap
12		Stairwell C	6	1	PAR 30	Unknown	Recessed
13	122	Stairwell D	16	2	LED (SW-DG186)	18	Wrap
14	468	Main Elevators x 4	2	1	T12	40	Strip
15		Service Elevators x 2	2	1	LED Tube	18	Strip

Appendix J: Royal Oak Beaumont Sustainability Review 2014

ROYAL OAK BEAUMONT SUSTAINABILITY REVIEW 2014

Beaumont® HEALTH SYSTEM

ROYAL OAK BEAUMONT SUSTAINABILITY

Sustainability in Health Care

As health care professionals, it is important for us to understand the **critical linkages between the health of the environment and human health.** Human health is influenced by a variety of factors. By minimizing chemicals of concern, serving healthier foods, reducing waste and resource use and building the next generation of high-performance healing environments, hospitals are demonstrating their commitment to healthier communities and to a healthy work force.

Sustainability Mission

We are committed to providing the **highest quality health care services** in an efficient, effective and compassionate manner and to implementing solutions to provide a healthy environment for patients, guests, staff and the local community to ensure optimal public health and to **reduce our impact on the environment for a healthier future.**

Healthier Hospitals Initiative

We joined the Healthier Hospitals Initiative (HHI) in 2011 to **reduce adverse health and environmental impacts** of our hospital and the healthcare industry. Through HHI, six challenges have been developed "to help health care organizations commit to sustainability goals and track their environmental efforts."

Engaged Leadership

Environmental sustainability is engrained in our culture and strongly supported by top leadership

Healthy Food

Decreased meat purchases by 15%, more vegetable options available & 54% of all beverages are healthy

Leaner Energy

11,060 barrels of oil saved equivalent to reduced electricity consumption from 2010-2013

Less Waste

Improved landfill waste diversion rate from 20% to 27% in 2013

Safer Chemicals

Over 80% of cleaning chemicals are Green Seal or EcoLogo certified

Smarter Purchasing

Purchasing reprocessed devices saved $3.2 million from 2009-2013

Human health

is dependent on

planetary health

GREEN TEAM

To better uphold our Sustainability Mission, the Green Team was established in 2010 to implement **cost-effective solutions to reduce waste and conserve energy**, while providing education to employees to learn more about environmental issues.

550 members & counting

1,000 2014 membership goal

Health care costs are on the rise. By focusing on our sustainability efforts, we can reduce expenses and free up other resources to do what we do best, provide the highest quality of care at the best value for our patients.

- Kay Winokur, VP of Quality and Professional Services and Green Team co-chair

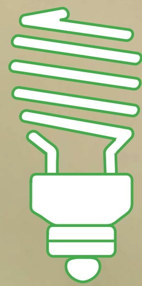
Sustainability Kaizen

To further our mission, the Green Team implemented its Sustainability Kaizen program. "Kaizen," Japanese for "improvement," means the opportunity for quick initiatives performed to **enhance hospital-wide sustainability and save money**. Through Sustainability Kaizens at Beaumont, Green Team make observations in a department and implement immediate "green" changes. Small changes add up to big savings.

Kaizen Initiatives

Replacement of inefficient sinks, toilets & urinals with low-flow models

$43,000 saved annually



Removal of infrequently used, non-value adding lighting

$60,000 saved annually

Installation of timers to heat coffee pots only during business hours

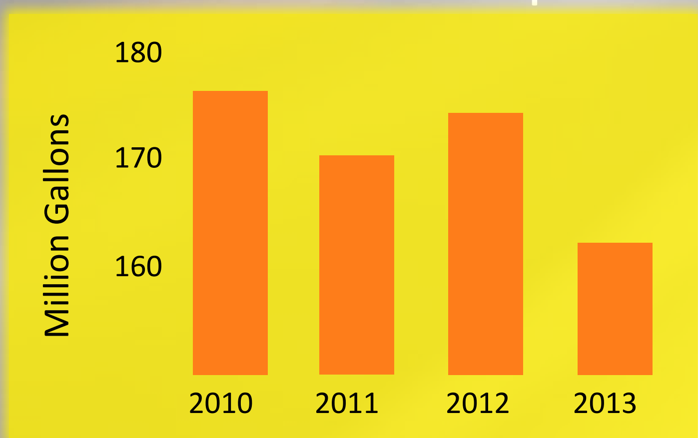
$34,000 saved annually

PERFORMANCE & COST SAVINGS

Water

From 2010 to 2013, we **reduced our water consumption by 13,128,312 gallons**. Lower water usage in 2013 resulted in **8% cost savings** from the preivous year. We also replaced the powerhouse water heaters with new, efficient models, greatly contributing to the reduction in our water usage.

2010-2013 Water Consumption



Waste Generation & Recycling

Since 2010, we have tripled our recycling efforts. In 2012, we **earned $53,000** in recycling rebates and **avoided $80,000** by recycling materials instead of sending them to a landfill.

30 percent of total waste stream recycled

35 types of waste recycled

3.4 million pounds of waste recycled per year

Energy

Since 2010, we have been **reducing our energy consumption** through the replacement of old equipment with the installation of energy efficient technologies such as air handling units, LED lights and motion sensors.

781 cars taken off the road equivalent to 2010-2013 reduction in natural gas consumption

925,000 dollars saved in 2013 from reduced energy consumption

Alternative Transportation

Environmentally friendly transportation is important in furthering our sustainability mission. In May 2013, we sponsored the release of a **bike safety brochure and map** of bike-friendly routes within a 6 mile radius of the Royal Oak Beaumont Hospital campus.

150 employees carpool

FUTURE OUTLOOK

In the years to come, we will continue to make the following improvements to **optimize the health environment** for patients, guests, staff and the local community and to **reduce our impact on the planet**:

- Recruit more green officers
- Reduce energy consumption by 3% per year through 2017
- Review our existing buildings & new buildings using LEED (Leadership in Energy & Environmental Design) guidelines

Awards and Recognitions

2012 Michigan Green Leader
Detroit Free Press

2013 101 Best & Brightest Sustainable Companies
Corp! Magazine

2013 Elite Winner: Best of the Best
Michigan Business & Professional Association and Corp! Magazine

2013 Bicycle Friendly Business
League of American Bicyclists

2013 Environmental Excellence Award: Partner for Change
Practice Greenhealth

How You Can Help!

- ***Join the Green Team***
  Sign up for a training session
- ***Participate in Sustainability Kaizens***
  Join us on a walk-through
- ***Bike or Walk to Work***
  Bike parking & showers are open to employees
- ***Reduce Trash***
  Use reusable mugs, bottles, dishes and utensils
- ***Use Revolving Doors***
  Saves energy by preventing conditioned air loss
- ***Change Your Exit Habits***
  Turn off lights, computers & printers
- ***Recycle***
  Bottles, cans, paper, plastic, cardboard, glass, batteries

Beaumont®

Royal Oak Campus
3601 W. Thirteen Mile Road
Royal Oak, MI 48073

beaumont.edu

Beaumont is a private, not for profit hospital serving the metro Detroit area since 1955.

Beaumont Health System GREEN TEAM

Healthier Hospitals INITIATIVE

JLL® at Beaumont Health System

Appendix K: Sustainable Purchasing Policy

Sustainable Purchasing Policy

Beaumont Health System: Royal Oak Campus
Implemented Jan, 2014

1. Introduction

This policy establishes the best management practices for sustainable purchasing in hospital. Purchases and operating behavior impact occupants' well-being as well as help transform the marketplace. This Sustainable Purchasing Policy reflects this responsibility by addressing economically appropriate, environmentally sound, and socially acceptable standards in purchasing operations. This Sustainable Purchasing Policy ensures that products purchased and services contracted support the following key concerns:

- *Energy Efficiency* – Minimizing the environmental impact of business practices by choosing energy-efficient equipment, products, services, and practices
- *Water Conservation* – Reducing the use of potable water and contributing to the preservation of natural water supplies
- *Indoor and Outdoor Air Quality* – Eliminating or managing volatile organic compounds and toxic off-gassing to maintain a healthy work environment
- *Waste Reduction and Management* – Curbing consumption, reducing unnecessary tools, recycling materials and devices, and purchasing reprocessed products or products with recycled content in order to reduce overall waste generated
- *Improved Live/Work/Therapeutic Environment* – Providing a safe, comfortable, and accessible live/work/Therapeutic environment for patients, employees and other building occupants
- *Bottom Line Improvements* – Environmentally responsible purchasing practices will cut operational costs by reducing material consumption and waste as well as minimizing energy and water usage. Encouraging a competitive market for sustainable products and services will also lead to lowering costs.

"Green Purchasing refers to the practice of preventing waste and pollution by considering environmental impacts, along with price, performance, and other traditional selection factors, when making purchasing decisions. Green purchasing often is included within the definition of pollution prevention, since the selection and use of green products can reduce both the quantity and toxicity of waste streams."

- EPA, Integrating Green Purchasing into your Environmental Management System, 2005

The policy is based on the requirements of the LEED Existing Building Operation & Maintenance (EBOM) v4.0 rating system as excerpted from the v4.0 Edition and HHI Smart Purchasing Challenge 2012 Edition:

LEED EBOM Requirements

MRp1 Ongoing purchasing and waste policy

Have in place an environmentally preferable purchasing (EPP) policy for products purchased during regular operations of the building. Include at a minimum, ongoing purchases and durable goods purchases.

MRp2 Facility maintenance and renovation policy

Have in place a facility maintenance and renovation policy that includes guidelines for renovation and maintenance activities, using LEED rating system strategies, to be implemented at the discretion of building owners, operators, or tenants. Renovation activities include building improvements and tenant fit-outs. Maintenance activities include general repair and replacement.

The policy must cover at least those product purchases within the building and site management’s control. The policy must address purchasing, waste management and indoor air quality.

Additionally, the policy should address the criteria in the following credits:

- MRc3 —Materials and Resources Credit: Purchasing—Lamps
- MRc4 —Materials and Resources Credit: Purchasing—Ongoing
- MRc5 —Material and Resources Credit: Purchasing—Facility Maintenance and Renovation

HHI Smart Purchasing Challenge

Level 1: Commit to **one** of the Challenges below;

Level 2: Commit to **two** of the Challenges below;

Level 3: Commit to **three** of the Challenges below;

- Surgical Kit Review: Review at least 30 custom surgical O.R. kits or 80 percent of O.R. kit types, whichever is greater in efforts to eliminate unneeded materials.
- Single Use Device Reprocessing: Increase expenditure of reprocessed FDA-eligible single use devices by 50 percent.
- Electronic Products Environmental Assessment Tool (EPEAT): Specify and report expenditures on EPEAT registered devices.

2. Goal

The goal of the Environmental Building Operations Policy for Sustainable Purchasing is to ensure that spending is prioritized on products that are environmentally sound and socially beneficial. Integrating sustainability considerations into sourcing activities under site management control, and specifying products for building occupants and operations, while meeting business requirements and goals, is also a primary focus. This includes but is not limited to purchasing under the control of the director of purchasing opeartions, and extends to consumables purchased within the building, as well as other commodities as appropriate. Measureable purchasing goals for each category are detailed within each section but in summary, the building management seeks to purchase at least 60%, by cost, of total ongoing consumables that meet the criteria specified, at least 40%, by cost, of electric-powered equipment, at least 50%, by cost, of the total maintenance and renovation materials and/or at least 75% by cost of total furniture and furnishings and/or make no alternations to the project space and purchase no furniture, and an overall building average of 70 picograms/lumen-hour or less for mercury-containing bulbs.

In addition to achieving MR Prerequisite 1 and 2, the policy also aims to achieve the Level 3 Smart Purchasing Challenge established by Healthier Hospital Initiative. Build upon the baseline which requires hospital to pledge to support Group Purchasing Organization (GPO) in contracting for, and to start purchasing applicable products based on the environmentally preferred attributes in the Standardized Environmental Question for Medical Products, Level 3 Smart Purchasing Challenge requires the program to commit surgical kit review, single use device reprocessing and electronic products environmental assessment tool (EPEAT) purchasing goals.

3. Scope

The scope of this policy includes all purchasing activities that are within the Beaumont purchasing department and JLL property management's control. This includes, but is not limited to, the purchase of ongoing consumables, electric-power equipment, maintenance and renovation materials, furniture and furnishings, reduced mercury light bulbs, surgical kit and single use devices. The policy specifies the procedures and strategies that will be employed.

4. Responsibilities

The Director of Purchasing Operations will be responsible for informing all hospital personnel and occupants of this Sustainable Purchasing Policy and Smarter Purchasing Challenge. Moreover, he or she will be responsible for implementing the practices set forth in this document in order to ensure the standards specified within are upheld. He or she may delegate certain duties relating to sustainable purchasing to staffers but will bear ultimate responsibility for the effective implementation of the policy.

5. Time Period

This policy is to take effect as of January 2014. While some outstanding contracts may prevent building operations and maintenance personnel from immediately abiding by certain policy requirements, persons responsible for drafting purchasing-related contracts will ensure that new policy language is included in all subsequent contracts.
Once the policy is fully implemented and the staff is following the requirements, the performance period will begin. The performance period for which this policy is in effect shall be two years, at which point the policy will be reviewed and updated.

6. Performance Metric

Performance will be measured by means of a detailed log documenting purchases and through compliance with the requirements of the following LEED EBOM credits:

- MRc3 Purchasing – lamps
- MRc4 Purchasing – ongoing
- MRc5 Purchasing – facility maintenance and renovation

The purchasing organizations will report sustainable purchases as a percent (by cost) of total purchases for each of the categories listed herein.

The performance of Smarter Purchasing Challenge will be measured through continuous tracking of energy, waste and cost reduction built upon the bottom line and the requirements of the following three action items:

- Surgical Kit Review
- Single Use Device Reprocessing
- Electronic Products Environmental Assessment Tool (EPEAT)

7. Procedures and Strategies

A. General Criteria for Products and Services

The following criteria will be considered along with economic considerations when deciding to purchase particular products or contract services, or when choosing between brands, manufacturers, and companies:

- The long-term environmental impact and social cost of a product or service
- The overall quality of goods and services beyond their sole purpose. Key product and service characteristics to consider are durability and long-term use, efficiency, recycled content, disposal impact, third-party certification, and location.
- The content of a product. No products containing hazardous substances such as CFCs, arsenic, or lead, or containing a threatened species of wood will be purchased.
- The sustainable practices of a specific manufacturers' or service provider's business. Check to see if the parent company provides a sustainability report of their business practices or a summary of sustainable product/service characteristics.
- The sustainability of the service provider's operations along with their attitude toward sustainability issues.
- Select a service provider who uses either renewable energy or biofuels, purchases renewable energy credits, offsets their carbon footprint, or at a minimum attempts to limit their power consumption.
- Select a service provider who limits potable water usage in their operations.
- Select a service provider who will generate the least amount of material waste throughout the life of their contract.
- Select a service provider who provides a clean, healthy, and socially responsible work environment for their employees.
- Select a courier service whose couriers use bicycles or public transportation for deliveries within a 10-mile radius of the property.

In compliance with MRp1, establish an environmentally preferable purchasing (EPP) policy for products purchased during regular operations of building. Include at a minimum:

- Ongoing purchases
  - The five most purchased product categories based on total annual purchases.
  - Paper, toner cartridges, binders, batteries, and desk accessories.
  - Lamps (indoor and outdoor, hard-wired and portable fixtures)
  - Food
- Ongoing purchases
  - Office equipment, appliances, and audiovisual equipment
  - Electric powered equipment

B. Reduced Mercury in Lamps

Implement the lighting purchasing plan that specifies an overall building average of 70 picograms of mercury per lumen-hour or less for all mercury-containing lamps purchased for the building and associated grounds within the project boundary. Include lamps for both indoor and outdoor fixtures, as well as both hard-wired and portable fixtures. Lamps containing no mercury may be counted only if their energy efficiency at least equals that of their mercury-containing counterparts.

Implement the lighting purchasing plan during the performance period such that all purchased mercury-containing lamps comply with the plan. One point is awarded to projects for which at least 90% of all mercury-containing lamps purchased during the performance period (as measured by the number of lamps) comply with the purchasing plan and meet the following overall target for mercury content of 70 picograms per lumen-hour.

C. Ongoing

Ongoing Consumables

Ongoing consumables are materials with a low cost per unit that are regularly used and replaced through the course of business. These materials include, but are not limited to, paper (printing or copy paper, notebooks, notepads, envelopes), toner cartridges, binders, batteries and desk accessories, food and beverages. For materials that may be considered either ongoing consumables or durable goods, the responsible team is free to decide which category to put them in as long as consistency is maintained without exclusions or double-counting. Consistency must also be maintained with MRc 5. Each purchase can receive credit for each sustainable criterion met. Ongoing consumables must be purchased during the performance period to earn points in this credit

- Post-consumer recycled content. The content of purchases must meet or exceed the levels listed in the U.S. Environmental Protection Agency Comprehensive Procurement Guidelines. Products not covered by the Guidelines can get credit for their recycled content with no minimum.
- Extended use. Batteries must be rechargeable. Toner cartridges for laser printers must be remanufactured.
- Sustainable agriculture. Food and beverages must be labeled USDA Organic, Food Alliance Certified, Rainforest Alliance Certified, Protected Harvest Certified, Fair Trade, or Marine Stewardship Council’s Blue Eco-Label, or labeled with the European Community Organic Production logo in accordance with Regulations (EC) No. 834/2007 and (EC) No. 889/2008.
- Local sourcing of food and beverages. The food or beverage must contain raw materials harvested and produced within 100 miles (160 kilometers) of the site. If that is not applicable at current stage, 250 miles (400 kilometers) standard should be adopted.
- Bio-based materials. Bio-based products must meet the Sustainable Agriculture Network’s Sustainable Agriculture Standard. Bio-based raw materials must be tested using ASTM Test Method D6866 and be legally harvested, as defined by the exporting and receiving country. Exclude hide products, such as leather and other animal skin material.
- Paper and wood products. Paper and wood products must be certified by the Forest Stewardship Council or USGBC-approved equivalent.

Electric-powered equipment

Purchase at least 40%, by cost, electric-powered equipment that meets at least one of the following criteria. Include product categories specified in Materials and Resources prerequisite: Ongoing Purchasing and Waste Policy. In addition, create a phase-out plan to replace remaining products with compliant equipment at the end of their useful life.

- EPEAT silver rating or better will be required for every purchased computer.
- ENERGY STAR rating. If the equipment does not yet fall under the EPEAT rating systems, it must be ENERGY STAR® qualified or performance equivalent for projects outside the U.S.

D. Facilities maintenance and renovation

Option 1. Products and materials

Purchase at least 50%, by cost, of the total maintenance and renovation materials that meet at least one of the following criteria. Include products specified in Materials and Resources prerequisite: Facility Maintenance and Renovation Policy. There is no minimum scope of renovation or new construction work required for eligibility of this credit. Each purchase can receive credit for each criterion met.

- Recycled content. Recycled content is the sum of postconsumer recycled content plus one-half the preconsumer recycled content.
- Wood products. Wood products must be certified by the Forest Stewardship Council or USGBC-approved equivalent.
- Bio-based materials. Bio-based products must meet the Sustainable Agriculture Network’s Sustainable Agriculture Standard. Bio-based raw materials must be tested using ASTM Test Method D6866 and be legally harvested, as defined by the exporting and receiving country. Exclude hide products, such as leather and other animal skin material.
- Materials reuse. Reuse includes salvaged, refurbished, or reused products.
- Extended producer responsibility. Products purchased from a manufacturer (producer) that participates in an extended producer responsibility program or is directly responsible for extended producer responsibility. Products valued at 50% of their cost.
- GreenScreen v1.2 Benchmark. Products that have fully inventoried chemical ingredients to 100 ppm that have no Benchmark 1 hazards.
  - If any ingredients are assessed with the GreenScreen List Translator, value these products at 100% of cost.
  - If all ingredients are have undergone a full GreenScreen Assessment, value these products at 150% of cost.
- Cradle to Cradle Certified. End use products are certified Cradle to Cradle. Products will be valued as follows:
  - Cradle to Cradle v2 Gold: 100% of cost
  - Cradle to Cradle v2 Platinum: 150% of cost
  - Cradle to Cradle v3 Silver: 100% of cost

    - Cradle to Cradle v3 Gold or Platinum: 150% of cost

- International Alternative Compliance Path – REACH Optimization. End use products and materials that do not contain substances that meet REACH criteria for substances of very high concern. If the product contains no ingredients listed on the REACH Authorization or Candidate list, value at 100% of cost.
- Product Manufacturer Supply Chain Optimization. Use building products that:
    - Are sourced from product manufacturers who engage in validated and robust safety, health, hazard, and risk programs which at a minimum document at least 99% (by weight) of the ingredients used to make the building product or building material, and
    - Are sourced from product manufacturers with independent third party verification of their supply chain that at a minimum verifies:
        - Processes are in place to communicate and transparently prioritize chemical ingredients along the supply chain according to available hazard, exposure and use information to identify those that require more detailed evaluation
        - Processes are in place to identify, document, and communicate information on health, safety and environmental characteristics of chemical ingredients
        - Processes are in place to implement measures to manage the health, safety and environmental hazard and risk of chemical ingredients
        - Processes are in place to optimize health, safety and environmental impacts when designing and improving chemical ingredients
        - Processes are in place to communicate, receive and evaluate chemical ingredient safety and stewardship information along the supply chain
        - Safety and stewardship information about the chemical ingredients is publicly available from all points along the supply chain
- Low emissions of volatile organic compounds. The following products must either be inherently non-emitting or be tested and determined compliant in accordance with California Department of Public Health Standard Method V1.1–2010, using the applicable exposure scenario. The default scenario is the private office scenario; classroom furniture may use the school classroom scenario. Both first-party and third-party statements of product compliance must follow the guidelines in CDPH SM V1.1–2010, Section 8. Organizations that certify manufacturers' claims must be accredited under ISO Guide 65. Laboratories that conduct the tests must be accredited under ISO/IEC 17025 for the test methods they use. Projects outside the United States may use (1) the CDPH standard method or (2) the German AgBB Testing and Evaluation Scheme (2010). Test products either with (1) ISO 16000-3: 2010, ISO 16000-6: 2011, ISO 16000-9: 2006, ISO 16000-11:2006, or (2) the DIBt testing method (2010). U.S. projects must follow the CDPH standard method.
    - thermal and acoustic insulation
    - flooring materials and finishes

    - ceiling materials and finishes
    - wall materials and finishes

- VOC content requirements for wet-applied products. In addition to meeting the general requirements for VOC emissions (above), on-site wet-applied products must not contain excessive levels of VOCs, for the health of the installers and other trades workers who are exposed to these products. To demonstrate compliance, a product or layer must meet the following requirements, as applicable. Disclosure of VOC content must be made by the manufacturer. Any testing must follow the test method specified in the applicable regulation.
    - All paints and coatings wet-applied on site must meet the applicable VOC limits of the California Air Resources Board (CARB) 2007, Suggested Control Measure (SCM) for Architectural Coatings, or the South Coast Air Quality Management District (SCAQMD) Rule 1113, effective June 3, 2011.
    - All adhesives and sealants wet-applied on site must meet the applicable chemical content requirements of SCAQMD Rule 1168, July 1, 2005, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168. The provisions of SCAQMD Rule 1168 do not apply to adhesives and sealants subject to state or federal consumer product VOC regulations.
    - For projects outside North America, all paints, coatings, adhesives, and sealants wet-applied on site must either meet the technical requirements of the above regulations, or comply with applicable national VOC control regulations, such as the European Decopaint Directive (2004/42/EC), the Canadian VOC Concentration Limits for Architectural Coatings, or the Hong Kong Air Pollution Control (VOC) Regulation.
    - If the applicable regulation requires subtraction of exempt compounds, any content of intentionally added exempt compounds larger than 1% weight by mass (total exempt compounds) must be disclosed.
    - If a product cannot reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, part 1; ASTM D6886-03; or ISO 11890-2.
    - For projects in North America, methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealants.
- Low emissions of formadehyde. Built-in cabinetry and architectural millwork containing composite woods must be constructed from materials documented to have low formaldehyde emissions that meet the California Air Resources Board requirements for ultra-low-emitting formaldehyde (ULEF) resins or no-added formaldehyde based resins. Salvaged and reused architectural millwork more than one year old at the time of occupancy is considered compliant, provided it meets the requirements for any site-applied paints, coatings, adhesives, and sealants.

- USGBC approved program. Other USGBC approved programs meeting leadership extraction criteria.

For credit achievement calculation, products sourced (extracted, manufactured, purchased) within 100 miles (160 km) of the project site are valued at 200% of their base contributing cost.

Option 2. Furniture

Purchase at least 75%, by cost, of total furniture and furnishings that meet one or more of the following criteria. Each purchase can receive credit for each criterion met.

- Recycled content. Recycled content is the sum of postconsumer recycled content plus one-half the preconsumer recycled content, based on cost. The recycled content value of an assembly is determined by weight. The recycled fraction is multiplied by the cost of the assembly to determine the recycled cost value.
- Wood products. Wood products must be certified by the Forest Stewardship Council or USGBC-approved equivalent.
- Bio-based materials. Bio-based products must meet the Sustainable Agriculture Network's Sustainable Agriculture Standard. Bio-based raw materials must be tested using ASTM Test Method D6866 and be legally harvested, as defined by the exporting and receiving country. Exclude hide products, such as leather and other animal skin material.
- Materials reuse. Reuse includes salvaged, refurbished, or reused products.
- Extended producer responsibility. Products purchased from a manufacturer (producer) that participates in an extended producer responsibility program or is directly responsible for extended producer responsibility. Products valued at 50% of their cost.
- GreenScreen v1.2 Benchmark. Products that have fully inventoried chemical ingredients to 100 ppm that have no Benchmark 1 hazards.
    - If any ingredients are assessed with the GreenScreen List Translator, value these products at 100% of cost.
    - If all ingredients are have undergone a full GreenScreen Assessment, value these products at 150% of cost.
- Cradle to Cradle Certified. End use products are certified Cradle to Cradle. Products will be valued as follows:
    - Cradle to Cradle v2 Gold: 100% of cost
    - Cradle to Cradle v2 Platinum: 150% of cost
    - Cradle to Cradle v3 Silver: 100% of cost
    - Cradle to Cradle v3 Gold or Platinum: 150% of cost
- International Alternative Compliance Path – REACH Optimization. End use products and materials that do not contain substances that meet REACH criteria for substances of very high concern. If the product contains no ingredients listed on the REACH Authorization or Candidate list, value at 100% of cost.
- Product Manufacturer Supply Chain Optimization. Use building products that:
    - Are sourced from product manufacturers who engage in validated and robust safety, health, hazard, and risk programs which at a minimum

document at least 99% (by weight) of the ingredients used to make the building product or building material, and

- Are sourced from product manufacturers with independent third party verification of their supply chain that at a minimum verifies:
    - Processes are in place to communicate and transparently prioritize chemical ingredients along the supply chain according to available hazard, exposure and use information to identify those that require more detailed evaluation
    - Processes are in place to identify, document, and communicate information on health, safety and environmental characteristics of chemical ingredients
    - Processes are in place to implement measures to manage the health, safety and environmental hazard and risk of chemical ingredients
    - Processes are in place to optimize health, safety and environmental impacts when designing and improving chemical ingredients
    - Processes are in place to communicate, receive and evaluate chemical ingredient safety and stewardship information along the supply chain
    - Safety and stewardship information about the chemical ingredients is publicly available from all points along the supply chain

- Low emissions of volatile organic compounds. Products must have been tested, following ANSI/BIFMA Standard Method M7.1–2011, and must comply with ANSI/BIFMA e3-2011 Furniture Sustainability Standard, Sections 7.6.1 (valued at 50% cost) or 7.6.2 (valued at 100% cost), using either the concentration modeling approach or the emissions factor approach. For classroom furniture, use the standard school classroom model in CDPH Standard Method v1.1. Salvaged and reused furniture more than one year old at the time of use is considered compliant, provided it meets the requirements for any site-applied paints, coatings, adhesives, and sealants.
- USGBC approved program. Other USGBC approved programs meeting leadership extraction criteria that.

For credit achievement calculation, products sourced (extracted, manufactured, purchased) within 100 miles (160 km) of the project site are valued at 200% of their base contributing cost.

Option 3. No alterations or furniture purchasing (1 point)
Make no alterations to the project space and do not purchase any furniture.

E. Hospital Surgical Kit Review

Hospital administrators will attempt to balance the cost and the quality of surgical kit and limit surgeons to a pre-selected or standardized group of supplies. The surgical kit review program could help to establish such a system. The surgical kit review process is continuously going on in Beaumont Health System handled by Beaumont's value analysis teams (VATs). The target of this challenge is to review at least 30 custom surgical O.R. kits or 80 percent of O.R. kit types, whichever is greater in efforts to eliminate unnecessary materials.

F. Single Use Device Reprocessing

Reprocessed single-use devices were proved by FDA and Government Accountability Office that no increased risk compared with originally manufactured single-use devices while cost much less and prevent medical waste. With a lot of surgeons and O.R. staff still being skeptical of the use reprocessed single-use medical devices, the hospital administrator should proceed to help ease the transition. The target of this challenge is to increase expenditure of reprocessed FDA-eligible single use devices by 50 percent based on the expenditure of previous operation cycle.

8. Recordkeeping Documents

All documentation relating to the tasks required by this Sustainable Purchasing Policy will be kept on file for purposes of LEED EBOM (re)certification. All sustainable products, materials, durable goods, and facilities equipment shall be documented. The Director of Purchasing Operations is to provide an Environmental Sustainability Report as per specific instructions from the building owner detailing the year's environmental achievements. Since LEED EBOM requires ongoing monitoring, it is also important to include product specifications and reports, photographs, and a written description of any findings which concern any of the activities found herein.

The Smarter Purchasing Challenge requires data submission through the Institute for Health Care Improvement's Extranet Site (www.ihi.org). Refer to the Resource Section for the Smarter Purchasing Measures for data collection details and the Data Submission Guide for guidance on IHI Registration and data submission.

9. References

- **Responsible Purchasing Network:** A provider of sustainable purchasing guidelines and news
  www.responsiblepurchasing.org
- **U.S EPA and DOE Energy Star Program:** Provides information on energy efficient products along with guidelines to becoming energy efficient while saving money
  www.energystar.gov
- **Green Seal:** Provides environmental standards and certification of products
  www.greenseal.org
- **Adhesives and Sealants per SCAQMD:** The South Coast Air Quality Management District Rule #1168 provides environmental standards for adhesives and sealants that have VOC content.
  www.aqmd.gov/rules/reg/reg11/r1168.pdf
- **Carpet Rug Institute:** The CRI provides a testing program that certifies carpet and carpet cushion products that are healthy. The CRI Green Label Plus program provides a list of products that meet the requirements.
  www.carpet-rug.com
- **Scientific Certification Systems:** A third-party provider of certification, auditing, testing services, and standards for sustainable products
  www.scscertified.com

- **Environmental Defense Fund:** Resources for Companies business practices www2.edf.org/page.cfm?tagID=2307
- **Harvard Green Campus Initiative:** Purchasing information www.greencampus.harvard.edu/greenoffice/purchasing.php
- **Electronic Product Environmental Assessment Tool:** Aids in the selection of energy efficient and environmentally friendly computer electronics www.epeat.net
- **Healthier Hospital Initiative: Smarter Purchasing** healthierhospitals.org/hhi-challenges/smarter-purchasing

Appendix L: Solid Waste Management Policy

MRp2: Solid Waste Management

Beaumont Health System: Royal Oak Campus

Implemented January 1st, 2014

1. Introduction

This policy establishes the best management practices for operating in a manner that takes into consideration the long-term health and environmental effects of solid waste management practices. Solid waste management choices impact the environment by curbing the high demand for virgin natural resources while protecting ecosystems from the negative impacts of materials misplaced as a result of poor choices in waste stream management. This Solid Waste Management Policy addresses this by employing environmentally acceptable standards in recycling and solid waste disposal practices.

Recycling materials and reducing waste helps minimize the amount of waste entering landfills, preserve natural resources, and reduce the need for energy and potable water in the process of raw materials. Through this Solid Waste Management Policy, Beaumont Health System: Royal Oak Campus ensures that business practices and contracting of services support the following key concerns:

- *Energy Efficiency* – Minimizing the environmental impact of business practices by choosing long-lasting, energy-efficient equipment and products
- *Waste Management* – Curbing consumption, recycling materials, and purchasing durable products with recycled content in order to reduce overall waste generated
- *Improved Live/Work Environment* – Providing a safe, comfortable, and accessible live/work environment for employees and building occupants
- *Bottom Line Improvements* – Environmentally responsible practices will cut operational costs by minimizing energy and water usage

The policy is based on the requirements of the LEED EBOM rating system as excerpted from v4.0 of LEED OBOM:

LEED EBOM Requirements
MRp2 Ongoing Purchasing and Waste Policy (prerequisite)
Have in place a solid waste management policy for the building and site addressing the requirements of the waste management credits listed below as well as recycling of all mercury-containing light bulbs. At a minimum, the policy must cover the waste streams that are within the building and site management's control.

- *MRc1 Solid Waste Management: Ongoing*
- *MRc2 Solid Waste Management: Durable Goods*
- *MRc9 Solid Waste Management: Facility Maintenance and Renovations*

2. Goal

The goal of the Environmental Building Operations Policy for Solid Waste Management is to reduce the amount of solid waste that is disposed of in landfills or incineration facilities through recycling, reuse and composting practices and to divert 50% of recyclables from landfill or incineration.

3. Scope

The scope of this policy includes management of the property's solid waste. This includes, but is not limited to, recycling and waste control efforts for ongoing consumables; durable goods; construction and demolition activities; batteries and mercury-containing light bulbs, hazardous and medical waste.

The policy specifies the procedures and strategies that will be employed. Service providers are responsible for carrying out their services in accordance with this policy without exception.

4. Responsibilities

The Corporate Administration will be responsible for informing all building personnel and occupants of this Solid Waste Management Policy. Moreover, he or she will be responsible for implementing the practices set forth in this document in order to ensure the standards specified within are upheld. He or she may delegate certain duties relating to sustainable purchasing to staffers but will bear ultimate responsibility for the effective implementation of the policy.

Responsible Party: Corporate Administration

5. Time Period

This policy is to take effect January 1st, 2014. While some outstanding contracts may prevent building operations and maintenance personnel from immediately abiding by certain policy requirements, persons responsible for solid waste management contracts will ensure that new policy language is included in all subsequent contracts.
Once the policy is fully implemented and the staff is following the requirements, the performance period may begin. The performance period for which this policy is in effect shall be no longer than a year, at which point the policy will be reviewed and updated with Beaumont and contracted waste hauler and vendors.

6. Performance Metric

Performance will be measured through compliance with the requirements of the following
LEED EBOM credits:

- MRp1 Ongoing Purchasing and Waste Policy
- MRc1 Solid Waste Management: Ongoing
- MRc2 Solid Waste Management: Durable Goods
- MRc9 Solid Waste Management: Facility Maintenance and Renovations

7. Procedures and Strategies

A. Property Facilitation of Recycling and Waste Disposal

A recycling and waste disposal plan describing recycling and waste measures instituted throughout the building has been developed. This plan includes the following:

- Recycling and waste stations
  - Paper
    - Reused copy paper boxes used to collect paper throughout the hospital collected by Materials Handling
    - Small paper containers at every desk in office areas
    - 50 gallon locked containers used for sensitive documents in some areas
    - Transferred to one of 12 large bins. These bins are 48"H x 52"W x 32"D
  - Large paper
    - 50 gallon containers used to collect books, magazines and tablets that cannot go through the shredder
  - Cardboard
    - 100 green bins placed in recycling station of each utility room and collected every other day Monday-Friday
  - Compost
    - 12 168 gallon containers
    - Exchanged once daily from the two lower level kitchen staging areas
  - Plastics
    - Collected from hospital and placed in light green bins then compacted and bailed to prepare for pickup
  - Hard Plastics
    - Collected separately in order to take advantage of rebate
  - Blue Wrap
    - Collected from operating rooms
  - Metal/Wire
    - Collected from contractors doing project work on site
  - Glass
    - Clear glass collected from hospital and placed in large container
  - Aluminum
    - Collected from hospital and placed in large container
  - Electronics
    - Collected from hospital and placed in large container, except for products with hazardous waste, such as the monitor on an ultrasound, which are disposed of by a hazardous waste hauler
  - Fabrics

        - Sheets, towels, etc. that are not longer usable are sent to a recycler and turned into insulation
    - Garage Sale
        - Leftover material stored for quarterly garage sale. Items are measured by weight
    - World Relief
        - Extra, usable items collected from hospital and packed in large paper sacks
    - Trash
        - Collected from patient rooms multiple times daily and placed in 30 gallon bags
        - Comes down through chutes and in gray bins

- Exterior dumpsters
    - Located in the exterior loading dock
    - 1 – 75 yard cardboard recycling container
    - 1 – 10 cubic yard compactor for cardboard
    - 1 – 125 yard compactor for trash
    - 1 – 25 yard construction waste dumpster

- Recycling signage and container designations
    - Containers are properly labeled with signage identifying use of container
    - Frequent notifications are sent regarding the entire recycling program

- Schedule
    - Occupant Space: Daily, Monday through Friday in some areas and Monday through Sunday in other areas
    - Trash: Pickup 3 times per week
    - Cardboard: 1 time per week based on compactor monitoring system
    - Compost: 3 times per week, Monday/Wednesday/Friday
    - Paper/Plastics/Blue Wrap: Royal Oak Beaumont takes in truck to NPR as needed Monday through Friday
    - Glass: Hauls to SOCCRA 2 times per month
    - World Relief: Collected every Wednesday

- Vendor
    - Paper/Cardboard/Plastics/Blue Wrap: NPR
    - Compost: Revalue Waste
    - Glass: SOCCRA
    - Cardboard/Trash: Waste Management

B. Encouraging Occupants to Reduce Solid Waste

Encouraging occupants to consume less, whether recyclable or not, is the first step towards reducing the amount of solid waste produced. The following measures shall be employed to promote occupant participation in material reduction:

1) Employee and staff Education, training, and participation

- All employees and staff shall be informed about the facility's solid waste management policy and given access to a shared printed or digital copy of the policy.
- All employees and staff shall receive an update, either annually or when significant changes occur, regarding the latest company goals and protocols concerning solid waste disposal and recycling.
- All employees and staff are encouraged to contact building management at any time with comments and questions in order to encourage feedback on ways to improve the solid waste management policy.
- Latest achievements and related news will be placed on material created by the Green Team and Environmental Services in order to encourage other forms of participation in recycling and waste reduction efforts. There will also be information provided through the Green Team web page, Green Team blog, Green Office Town Hall meetings and Halogen Online education.

2) Reuse of previously or gently used furniture and equipment

- Corporate Administration will provide a list of local companies that accept used furniture, equipment, electronics, and semi-durable office supplies to all occupants in the building.

3) Monitoring participation/measuring results

- Corporate Administration will monitor approximate:
    - Quantities of purchased paper products, seeking ways to reduce these purchases and to use paper products more efficiently
    - Purchases of ongoing consumables, comparing weight of similar products and their packaging material
    - Quantities of durable goods sent in for refurbishment versus disposed of as waste
    - Tonnages of total recycled solid waste, composted solid waste, and non-recyclable solid waste
    - Occupant participation in recycling and composting efforts
- Employees and staff are encouraged to monitor approximate:
    - Quantities of purchased paper products, seeking ways to reduce these purchases and to use paper products more efficiently
    - Purchases of ongoing consumables, comparing weight of similar products and their packaging material
    - Quantities of durable goods sent in for refurbishment versus disposed of as waste

C. Recycling Program

The following outlines what items shall be targeted for recycling and how best to meet the goals set forth. These measures shall be followed when possible and within reason:

1) Recycling ongoing consumables

- All non-organic, non-hazardous materials that are considered ongoing consumables are to be collected in a single-stream, co-mingled compactor to be recycled or reused by a designated solid waste processing facility.
- At a minimum, 50% of all ongoing consumable solid waste produced by the facility must be diverted from landfill in order to meet the requirements of LEED EBOM.
- The following materials will be collected for recycling:
    - Paper products
    - Office supplies
    - Corrugated cardboard
    - Plastics
    - Aluminum
    - Metals
    - Wire
    - Compost
    - Plastics
    - Hard Plastics
    - Blue Wrap
    - Glass
    - Aluminum
    - Electronics
    - Sheets/towels
- Products or materials which are composed of mixed materials are acceptable for recycling and must be recycled, provided they are not hazardous, organic wet wastes, or durable goods.
- See "Property Facilitation of Recycling and Waste Disposal" section for facility specific recycling protocols.

2) Hazardous lamps and battery collection

- Lamps that contain mercury are considered hazardous material and will not be combined with other waste streams, including the single stream recycling collection.
- In order to fulfill LEED EBOM requirements, 100% of mercury containing lamps from the facility will be recycled.
- Many types of batteries are also considered hazardous waste and therefore, no batteries will be combined with other waste streams, including the single-stream recycling collection.
- Environmental services will collect all batteries (including portable drycells, single-use batteries, and rechargeables) and hazardous lamps to be recycled. Material Handling staff picks them up hospital-wide for mass collection at the dock.

- At a minimum, 80% of batteries discarded throughout the facility on an annual basis will be diverted from landfills to meet the requirements of LEED EBOM.
- All lamps containing mercury will be collected for proper disposal.

3) Recycling durable goods
- All durable goods that have ceased to be of use will be recycled, reused, or refurbished in order to divert the materials from landfills.
- Durable goods include, but are not limited to: furniture, office equipment, computers, monitors, copiers, printers, scanners, fax machines, and maintenance equipment.
- In order to fulfill the LEED EBOM requirements, 75% of all durable goods being disposed of must be diverted from landfills.

4) Facility alterations and additions
- Construction and demolition waste from all facility alterations and additions will be diverted from landfills or incineration to the greatest extent possible. At a minimum, 80% of the total waste generated, by volume, must be processed for recycling or reuse to meet the requirements of LEED EBOM.
- Materials to be recycled or reused include, but are not limited to: studs, insulation, hardware, drywall, trim, millwork, casework, countertops, doors, windows, ceiling systems, carpets, flooring, adhesives, sealants, paints, coatings, cardboard, plastic, wood, and glass.
- Furniture, fixtures, and equipment, along with MEP systems and specialty items, do not count towards the 80% minimum of materials diverted from landfills. However, all materials will be considered of value for another use, and a responsible destination must be considered for these items.
- The acceptable rate of recycling is the annual rate achieved by the processing plant where the construction and demolition waste is hauled. The volume of each material type will be multiplied by the processing plant's annual recycling rate for that particular material. This final number is the amount of material diverted from landfill that can be counted towards the 80%.
- Incineration is not considered an acceptable end use for diverted construction waste, even if used for energy generation.

D. Regulated Medical and Hazardous Waste

The following materials will be collected and disposed of according to Regulated Medical Waste guidelines. Material Handling staff collects hazardous waste and collected by the Environmental Staff collects medical waste. The material is collected a maximum of once per day and a minimum of once per week.

- Medical Waste
    - Collected in biohazard tubs located in soiled utilities in all patient care and lab areas. Environmental Services removes the tubs from these areas daily and takes them to the loading dock.
    - Stored in secure room in the loading dock area and collected daily by Stericycle, the hospital's vendor.
- Pharmaceutical Waste

    - Collected in locked containers in all areas that dispense pharmaceuticals.
    - Deposited in a secure waste room in the loading dock and collected 6 days/week by Stericycle
- Regulated Medical Waste (Red Bag Waste)
    - Sharps
        - Collected in reusable containers in all areas that utilize sharps.
        - Recycle sharps containers and incinerate non-recyclable portion
        - Program is called the sharp exchange management program
    - Picked up daily and changed routinely by Stericycle, the hospital's vendor
- Hazardous Waste
    - Chemicals, batteries, bulbs, etc. are collected as needed by Advanced Resources Management (ARM)

E. Non-Recyclable Solid Waste

Materials that cannot be recycled will be removed from the site by a licensed waste hauler and disposed of either in a landfill or a combustion facility. All hazardous materials will be disposed of according to applicable laws and regulations.

8. Recordkeeping Documents

Beaumont Health System utilizes Key Green Solutions software and data provided by waste haulers to monitor and track all waste and recycling quantities on a monthly basis.

All documentation relating to the tasks required by this Solid Waste Management Policy will be kept on file for purposes of LEED EBOM (re)certification. All waste generated on the property under the auspices of the property management team will be tracked and recorded.

The following is a list of records that will be created and maintained by the waste hauler: 1) diversion calculation of ongoing consumable solid waste; 2) monthly battery collection tracking; 3) durable goods disposal summary; 4) facility alteration and addition waste diversion; 5) sample monthly construction waste tracking report and 6) monthly medical and hazardous waste tracking.

The Corporate Administration is to provide an Environmental Sustainability Report as per specific instructions from the building owner detailing the year's environmental achievements. Since LEED EBOM requires ongoing monitoring, it is also important to include product specifications and reports, photographs, and a written description of any findings which concern any of the activities found herein.

9. References

- **U.S EPA Waste Resources:** Provides information on waste disposal options and strategies. www.epa.gov/epaoswer/osw/index.htm
- **U.S. Green Building Council**: Provides information on the LEED EBOM requirements. http://www.usgbc.org/credits/existing-buildings/v4
- **Healthier Hospital Initiatives**: Contains information and resources for the seven challenges meant to engage the healthcare sector around leadership, food, purchasing, energy, waste and chemical use: http://healthierhospitals.org/

Appendix M: Construction and Demolition Waste Management Policy

MRc2: Solid Waste Management – Facility Maintenance and Renovations

Beaumont Health System: Royal Oak Campus

Implemented January 1st, 2014

1. Introduction

This policy establishes the best management practices for operating in a manner that takes into consideration the long-term health and environmental effects of solid waste management practices. Construction waste management choices impact the environment by curbing the high demand for virgin natural resources while protecting ecosystems from the negative impacts of materials misplaced as a result of poor choices in waste stream management. This Solid Waste Management Policy for Alterations and Additions addresses this by employing environmentally acceptable standards in recycling and waste disposal practices.

Recycling materials and reducing waste helps minimize the amount of waste entering landfills, preserve natural resources, and reduce the need for energy and potable water in the process of raw materials. Through this Solid Waste Management for Alterations and Additions Policy, Beaumont Health System: Royal Oak Campus ensures that business practices and contracting of services support the following key concerns:

- *Diverting Waste from Landfills* – Curbing consumption, recycling materials, and purchasing durable products with recycled content in order to reduce overall waste generated
- *Improved Live/Work Environment* – Providing a safe, comfortable, and accessible live/work environment for employees and building occupants during times of construction
- *Bottom Line Improvements* – Environmentally responsible practices will show returns through recycling programs

The policy is based on the requirements of the LEED EBOM rating system as excerpted from the most recent version v4 and the Healthier Hospital Initiative (HHI) from Practice Greenhealth:

> **LEED EBOM**
> **MRc2 Solid Waste Management – Facility Maintenance and Alterations (2 credit)**
> *To divert construction, renovation, and demolition debris from disposal in landfills and incinerators and recover and recycle reusable materials.*
>
> **Healthier Hospitals**
> **Less Waste: Construction and Demolition Debris Recycling**
> *Implement a construction and demolition debris recycling program for major renovations and new construction to achieve at least 80 percent recycle and diversion rate.*

2. Goal
The goal of the Environmental Building Operations Policy for Solid Waste Management of Facility Alterations and Additions is to reduce the amount of solid waste that is disposed of in landfills or incineration facilities through recycling and reuse practices and to divert 80% of waste generated by alterations and additions as directed by the HHI. LEED EBOM only requires a 70% diversion rate.

3. Scope
The scope of this policy includes management of the property's construction and demolition waste. This includes making sure construction of eligible alterations or additions will occur during the performance period and working with the contractor and waste hauler to establish a system for managing and tracking construction waste diversion, isolated from ongoing consumable waste.

The policy specifies the procedures and strategies that will be employed. Service providers are responsible for carrying out their services in accordance with this policy without exception.

4. Responsibilities
The Director of Supply Chain will be responsible for orienting contractors and subcontractors to expectations at the start of construction as well as tracking all applicable material waste generated and diverted and implementing a quality-control program to ensure diversion targets are being met. Moreover, he or she will be responsible for implementing the practices set forth in this document in order to ensure the standards specified within are upheld. He or she may delegate certain duties relating to sustainable purchasing to staffers but will bear ultimate responsibility for the effective implementation of the policy.

Responsible Party: Ken Hedgepath, Director of Supply Chain

5. Time Period
This policy is to take effect January 1st, 2014. All construction projects will be expected to immediately abide by certain policy requirements, persons responsible for the waste hauling contracts will ensure that new policy language is included in all subsequent contracts.

Once the policy is fully implemented and the contractor is following the requirements, the performance period may begin. The performance period for which this policy is in effect shall be no longer than two (2) years, at which point the policy will be reviewed and updated.

6. Performance Metric
Calculations are based on the amount of waste diverted from landfill or incineration compared with the total amount of waste generated on-site. Convert all materials to either weight or volume to calculate the percentage. Exclude excavated soil and land-clearing

debris from calculations. Projects that crush and reuse existing concrete, masonry, or asphalt on-site should include the weight or volume of these materials in the calculations. Any construction debris processed into a recycled content commodity that has an open-market value may be applied to the construction waste calculation. Projects that use commingled recycling rather than on-site separation should obtain summaries of diversion rates form the recycler.

Hazardous waste should be excluded from calculations and should be disposed of according to relevant regulations.

7. Procedures and Strategies

A. Property Facilitation of Recycling

A construction and demolition recycling and waste disposal plan describing recycling and waste measures instituted has been developed. This plan includes the following:

1) Exterior dumpsters
   - Located in the exterior loading dock or at construction site
   - 1 – 30 yard "open top" trash container
   - 3 – 10 cubic yard recycling containers (metals, drywall, ceiling tiles)
   - Additional containers may include wood and carpeting
2) Recycling signage and container designations
   - Containers are properly labeled with signage identifying use of container
   - Signage will be provided in both English and Spanish on containers
   - Frequent notifications are sent regarding the entire recycling program
3) Schedule
   - Trash Container: Pickup 3 times per week
   - Recycling: 1 time per week
4) Vendor
   - TBD
   - Primary Contact: XXXXXXX
   - Phone Number: (XXX) XXX-XXXX

B. Recycling Program

The following outlines what items shall be targeted for recycling and how best to meet the goals set forth. These measures shall be followed when possible and within reason:

1) Lumber and Paper Products
   - Products or materials which are composed of mixed materials are acceptable for recycling and must be recycled.
   - At a minimum, 80% of all deconstructed or scrap lumber and paper products must be diverted from the landfill in order to meet the requirements of the HHI Less Waste Challenge.
   - At a minimum, 70% of lumber and paper products must be recycled or diverted to meet the requirements of LEED EBOM.

2) Hazardous lamps & thermostats containing mercury

- Lamps and thermostats that contain mercury are considered hazardous material and will not be combined with other waste streams.
- In order to fulfill LEED EBOM requirements, 100% of mercury containing lamps from the facility will be recycled.
- Contractors will be required to collect all mercury containing lamps and thermostats.

3) Metals

- All salvaged metals or unused metals will be placed in the designated bin by contractors.
- Metals include, but are not limited to:
  - Copper
  - Steel
  - Iron
  - Aluminum
- In order to fulfill the LEED EBOM requirements, 75% of all metals being disposed of must be diverted from landfills.
- Rebates will provided by the hauler for metals that are recycled.

4) Others

- Other materials to be recycled or reused include, but are not limited to: studs, insulation, hardware, drywall, trim, millwork, casework, countertops, doors, windows, ceiling systems, carpets, flooring, adhesives, sealants, paints, coatings, cardboard, plastic, concrete, and glass.
- The acceptable rate of recycling is the annual rate achieved by the processing plant where the construction and demolition waste is hauled. The volume of each material type will be multiplied by the processing plant's annual recycling rate for that particular material. This final number is the amount of material diverted from landfill that can be counted towards the 80%.
- Incineration is not considered an acceptable end use for diverted construction waste, even if used for energy generation.

8. Recordkeeping Documents

Beaumont Health System utilizes Key Green Solutions software to monitor and track all waste and recycling quantities on a monthly basis.

All documentation relating to the tasks required by this Solid Waste Management Policy – Maintenance and Alterations will be kept on file for purposes of LEED EBOM (re)certification. All construction waste generated on the property under the auspices of the property management team will be tracked and recorded. Waste and Recycling Hauler will provide metrics for documentation.

The following is a list of records that will be created and maintained for the property: 1) diversion calculation of ongoing construction project; 2) monthly lamps and ballast collection tracking; 3) rebates collected for recycled metals

Kay Winoker is to provide an Environmental Sustainability Report as per specific instructions from the building owner detailing the year's environmental achievements. Since LEED EBOM requires ongoing monitoring, it is also important to include product specifications and reports, photographs, and a written description of any findings which concern any of the activities found herein.

9. References

- **U.S EPA Waste Resources:** Provides information on waste disposal options and strategies. www.epa.gov/epaoswer/osw/index.htm
- **USGBC –** Provides requirements for obtaining LEED Credit MRc9 http://www.usgbc.org/node/1731290?return=/credits/existing-buildings/v2009/material-%26-resources