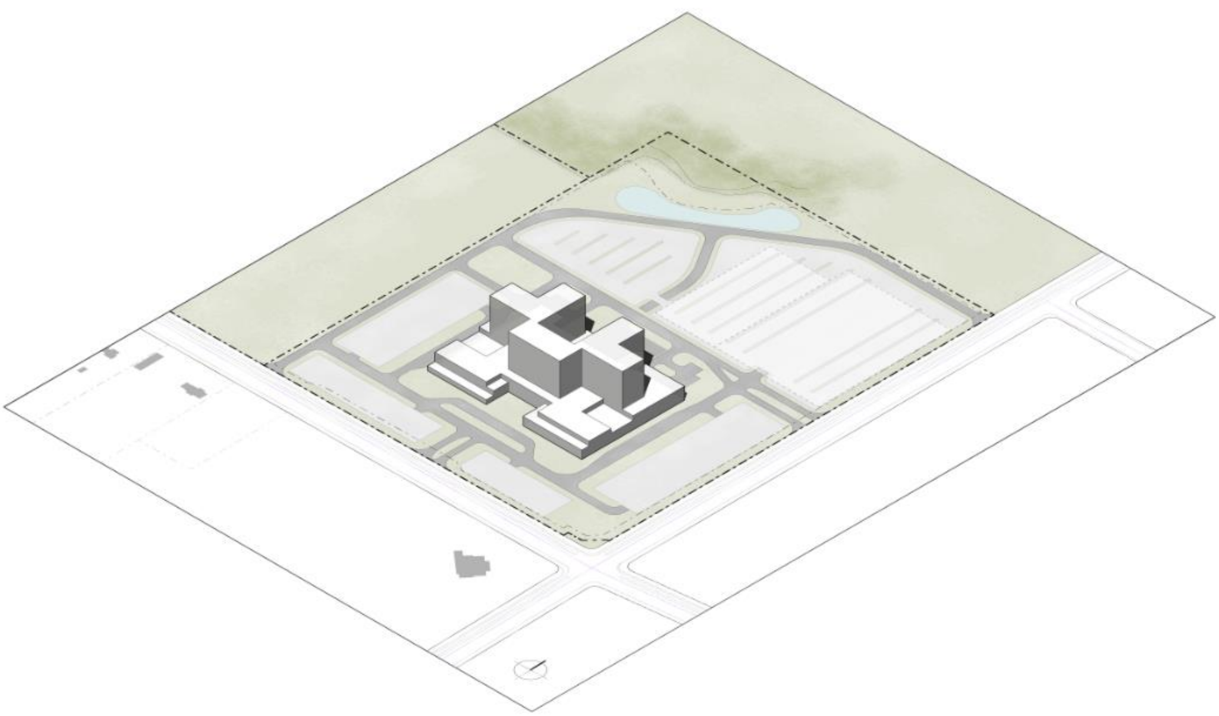
NIAGARA HEALTH
REPORT NUMBER: 191-07593-00

ENVIRONMENTAL PLAN
SOUTH NIAGARA HOSPITAL

CONFIDENTIAL



ENVIRONMENTAL PLAN

SOUTH NIAGARA HOSPITAL

NIAGARA HEALTH

99% DRAFT REPORT
CONFIDENTIAL

PROJECT NO.: 191-07593-00
DATE: OCTOBER 29, 2019

WSP
2300 YONGE STREET
SUITE 2300
TORONTO, ON, CANADA M4P 1E4

T: +1 416 487-5256
F: +1 416 487-9766
WSP.COM

SIGNATURES

PREPARED BY

Carolyn Johanson, C.Tech, LEED AP BD+C
Technical Lead

Date: October 29, 2019

APPROVED[1] BY

Juhee Oh, M.Arch., EcoDistricts AP
Project Manager

Date: October 29, 2019

WSP Canada Inc. prepared this report solely for the use of the intended recipient, NIAGARA HEALTH, in accordance with the professional services agreement. The intended recipient is solely responsible for the disclosure of any information contained in this report. The content and opinions contained in the present report are based on the observations and/or information available to WSP Canada Inc. at the time of preparation. If a third party makes use of, relies on, or makes decisions in accordance with this report, said third party is solely responsible for such use, reliance or decisions. WSP Canada Inc. does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this report. This limitations statement is considered an integral part of this report.

The original of this digital file will be conserved by WSP Canada Inc. for a period of not less than 10 years. As the digital file transmitted to the intended recipient is no longer under the control of WSP Canada Inc., its integrity cannot be assured. As such, WSP Canada Inc. does not guarantee any modifications made to this digital file subsequent to its transmission to the intended recipient.

[1] Approval of this document is an administrative function indicating readiness for release and does not impart legal liability on to the Approver for any technical content contained herein. Technical accuracy and fit-for-purpose of this content is obtained through the review process. The Approver shall ensure the applicable review process has occurred prior to signing the document.

CONTRIBUTORS

CLIENT

Project Manager, S. Niagara Hospital Project	Izabela Cawricz
Director, Capital Planning & Biomedical Engineering	Amir Gill
Director, EVS, Parking & Security	Bobby Alexander
Director, ICT	Jeff Wilson
Manager, Engineering Services	Alain Boucher
Sr. Procurement Coordinator	David Weir
Technical Engineering Specialist	Marisha Pluta
Manager, Complex Care, Recreation & Allied Health	Susan Reinhart
Emergency Physician	Dr. Shira Brown
Senior Registered Technologist, Laboratory	Vicki Lanigan
Logistics and Strategic Sourcing	Kyle Gauthier
Orthopedic Tech, Ambulatory Care	Bobby Gale
President, Enerlife Consulting Inc.	Ian Jarvis
Enerlife Consulting Inc.	Katia Osokine
Patient Partner	John Storm
Patient Partner	Daislyn Vidal
Sr. Design Manager, Redevelopment	Ben Embir
Chief Planning Officer	Cliff Harvey

WSP

Project Manager	Juhee Oh
Sustainability Technical Lead	Carolyn Johanson
Energy Technical Lead	Antoni Paleshi

Energy Analyst	David Rulff
Sustainability Analyst	Tiphany Monplaisir
Project Coordinator	Chelsey DiManno
Engagement Coordinator	Advait Mohole
Mechanical/Electrical Specialist	Kevin Cassidy

SUBCONSULTANTS

Architect, HOK	Debbie Wadworth
Landscape Architect, HOK	Alison Lumby
Costing Consultant, AW Hooker	Glenn Hultzer

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

FORWARD

PROLOGUE

Niagara Health (NH) is developing plans for the new South Niagara Hospital project, an 117,000 square meter facility to be located at the intersection of Lyons Creek/Biggar Road and Montrose Road in the City of Niagara. Currently in Stage 3 of the Ministry of Health and Long-Term Care's design approval process, the project will follow a design-build-finance-maintain (DBFM) procurement model. This Environmental Plan will serve as a control document to guide further stages of planning, design, implementation, and operations for the new hospital, ensuring in particular that exceptional environmental practices and performance are encoded into contract and procurement documents. The plan defines specific metrics and evaluation criteria developed through a collaborative approach with NH stakeholders to measure performance at every stage of the project across the eight overarching environmental requirements listed in Figure 1.

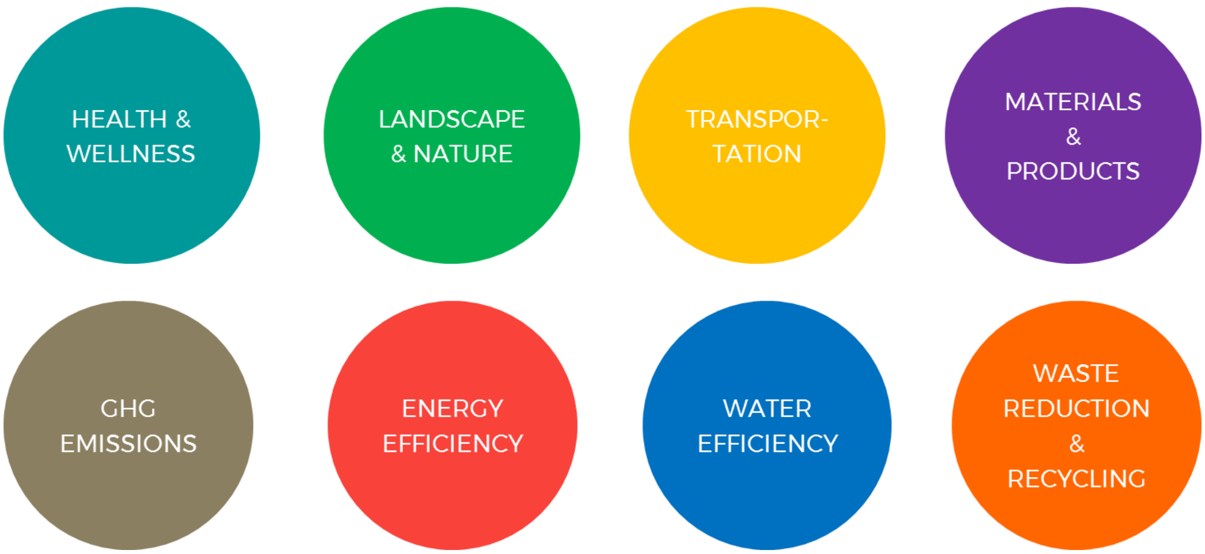


Figure 1: NH Environmental Requirements

Where appropriate, evaluation metrics and tools from the LEED, WELL and Zero Carbon Building Standards have been combined with project-specific criteria to customize the environmental evaluation matrix. This plan explores a range of potential performance outcomes for the new hospital within each area of focus outlined in Figure 1 above, weighed against high-level costing and qualitative analysis of constraints, co-benefits, and implementation risks. Where feasible, design strategies and performance outcomes from other design reports, particularly the Campus Master Plan, are integrated into this analysis. Based on a cost-benefit analysis of some 60 sustainability measures, a recommended set of performance targets and design strategies have been developed, including:

- A central plant consisting of a geo-exchange field for heating and cooling as well as a biomass-fueled combined heat and power system which will provide renewable base load and first-stage backup power while serving all of the supplementary heating requirements. On-site photovoltaics supplying 5% of total building energy consumption will further contribute to achievement of the following targets:
    - GHG intensity of 13-17 $kgCO_2e/m^2$
    - Total energy use intensity (including on-site generation) of 325-375 kWh/m^2
    - Thermal energy demand intensity of 65-75 kWh/m^2 for heating and 115-125 kWh/m^2 for cooling
    - On site renewable electricity generation of 20-25%
    - A significant extension of passive and active survivability, estimated at double and quadruple the typical 72 hours, respectively.
- Promotion of health and wellness through WELL Gold certification (potentially the first hospital in the world to be certified under this rating system) and inclusion of specific measures such as at-grade food and healing gardens, a visible main staircase, and active transportation infrastructure such as e-bike charging stations and staff locker/shower facilities.
- A mandatory water use intensity performance target similar in structure to the pain-share/gain-share model employed for mandatory energy intensity targets. Exemplary water management strategies to achieve and

maintain a water use intensity of 1.2 m^3/m^2 include water-efficient medical process equipment, water submetering, and inclusion of a rainwater cistern to serve 100% of the site's irrigation needs with reclaimed water.

[redacted]

GUIDE TO DESIGN REPORT AND STAGE 3 HANDOFF

The approach employed within this report is intended to support the Planning, Design and Compliance (PDC) team employed to complete Stage 3 of the planning process as they prepare an illustrative design, project agreement (PA), project-specific output specification (PSOS) and a request for proposal (RFP) that encompass NH's vision of sustainable performance. Ultimately, this Environmental Plan has been developed to support proponents to deliver robust, cost-effective bids that achieve the desired performance targets without prescriptively imposing design features and measures. Recommended measures are identified as a starting point to support identified performance targets and shape the high-level initial costing exercise.

As NH moves into the next phase of development, the core approaches developed here will be further tested and refined by the PDC through the illustrative design process, including several rounds of capital cost and return on investment (ROI) analysis. This report endeavors to provide sufficient detail to repeat and refine the evaluation exercise to further strengthen implementation of the hospital's sustainable vision and clarify associated procurement impacts. Further technical exploration required during Stage 3 includes:

- Completion of a detailed carbon neutral study to determine appropriate Mandatory Energy Targets, particularly TEDI, passive/active survivability and %-renewable energy metrics, as these have not been well-characterized by previous hospital projects.
- Establishment of a water modeling process that can be repeated by the proponents that predicts facility water usage patterns and process water requirements with reasonable accuracy to support testing of a water pain-share/gain-share process and set an appropriate additional cost for water beyond utility rates.

As with the other Design Reports, this document has been developed using a Design Thinking Process. Summarized in Figure 2, Design Thinking seeks to balance critical thinking and analysis, creative thinking and scenario planning in order to develop solutions that are both novel and well-informed.

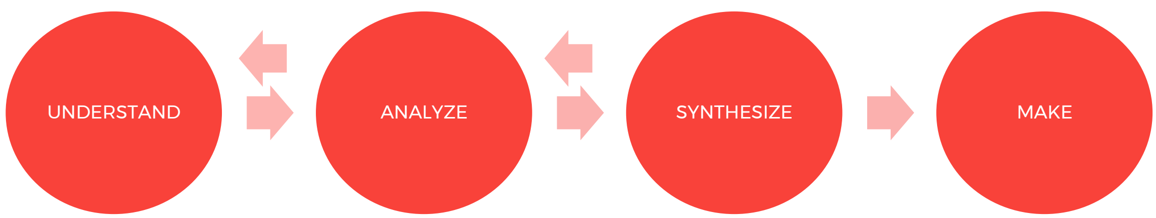


Figure 2: Design Thinking Process

Following this structure, the report is organized into three parts and twelve sections. The purpose and contents of each section are described in the following tables, as is a summary of how each section should be integrated into the Stage 3 MOHLTC submission. Direct links to individual sub-sections are included in column 1 where appropriate.

Table 1: Environmental Plan Section Overview and Stage 3 Handoff

PART 1: SECTIONS	UNDERSTAND CONTENT	STAGE 3 HANDOFF
SECTION 1 BACKGROUND	Contains general information about the project, NH's environmental goals, green building certification systems and the meetings and documents incorporated into this report. This material provides context for the analysis and recommendations contained in later sections.	Informs the background documentation of the PA and RFP.
SECTION 2 RESEARCH Health & Wellness GHG Emissions Energy Efficiency Water Efficiency Landscape & Nature Transportation Materials & Products Waste Reduction & Recycling	Provides a broad overview of sustainability trends in hospital design, operations, and performance; innovation drivers; and policy and regulatory context, organized according to NH' eight environmental requirements. This section includes four detailed hospital case studies from recently built Canadian and international hospitals and multiple hospital-specific examples of best practices. The strategic insight derived from this industry research informs potential areas of excellence for the new hospital design examined in the following section.	Provides general context for the best practices and performance outcomes recommended for the illustrative design.

PART 2: SECTIONS	ANALYZE CONTENT	STAGE 3 HANDOFF
SECTION 3 OPPORTUNITIES & CONSTRAINTS Health & Wellness GHG Emissions Energy Efficiency Water Efficiency Landscape & Nature Transportation Materials & Products Waste Reduction & Recycling	Identifies a large number of potential priorities for each of NH's eight environmental requirements. Available credits in the LEED and WELL building standards and project-specific performance requirements are identified and their benefits and limitations are assessed. Feedback from stakeholder engagement sessions is summarized and used to divide each credit or opportunity into those that should be encoded in the PSOS, dismissed, or championed by NH as additional operational practices. Next steps that are a priority for NH but fall outside of Project Co's responsibility are further summarized in the conclusion of Section 12.	Recommended credits for LEED and WELL are summarized in scorecards contained in Appendices B and C. Certification strategies are to be confirmed in Stage 3 and final scorecards incorporated into the PSOS.
SECTION 4 KEY EVALUATION CRITERIA	Summarizes the key evaluation criteria that will be used to evaluate the design options contained the remainder of the report. Evaluation criteria are linked to specific project stages as follows: — **Design:** Criteria that can be evaluated based on design drawings and specifications, as well as through construction submittals for materials and construction waste. Project Co will be fully responsible for meeting these performance requirements. — **Maintain:** Criteria for which Project Co. is involved during the operations of the facility (such as maintaining system performance or conducting ongoing testing), but which are not linked to mandatory targets or thresholds. — **Operate:** Criteria with the highest level of responsibility for Project Co., which will be encoded as formal contractual performance requirements with associated penalties or 'pain-share/gain-share' terms.	Specifies the criteria to be used to evaluate the design and operating plans of the DBFM proponents, to be incorporated into the RFP and high-level performance criteria within the PSOS. Operate criteria will become mandatory performance targets associated with contractual penalties.

PART 3: SECTIONS	SYNTHESIS CONTENT	STAGE 3 HANDOFF
SECTION 5 VISION & GUIDING PRINCIPLES	Summarizes the project's sustainability vision and guiding principles, as outlined by NH in the statement of work for this Environmental Plan.	To be incorporated into the RFP, and Part 1 Section 1 Core Objectives of the PSOS.
SECTION 6 DESIGN OPTIONS ANALYSIS Minimum Maximum	Describes and provides key evaluation outcomes (including capital costs) for more than 60 specific design measures, which are grouped into a minimum and maximum design option. The minimum design incorporates elements outlined in NH's Stage 2 submission, including the mechanical and electrical design brief. The maximum design option explores all potential features that align with NH's vision and priorities for the project, regardless of cost. These measures are further detailed in Appendix A.	Frames the design features and performance outcomes used to generate the recommended option for the illustrative design.
SECTION 7 RECOMMENDED DESIGN OPTION	Identifies the design measures from the minimum and maximum options which are recommended for inclusion in Stage 3 based on capital costs, lifecycle costs, and performance results. This section includes an extensive qualitative and performance benchmarking analysis to document the full benefits of the recommended option, including mitigation of future risks and alignment with stakeholder feedback.	Describes all design elements to be further developed and evaluated during Stage 3.
SECTION 8 DESIGN GUIDELINES	Organizes specific contractual requirements for the recommended option according to typical PSOS subsections to facilitate direct incorporation into contract documents.	Content to be updated based on Stage 3 design development, then directly incorporated into PSOS.
SECTION 9 EVALUATION TOOLS & PROCESS	Summarizes evaluation tools and processes that NH will rely on to validate that their design intent and priorities are met throughout the life of the hospital. Specifically, these tools will allow for design, construction and operating-phase verification of facility performance.	Tools to be incorporated into specific PA schedules such as Schedule 36 and Schedule 10.
SECTION 10 IMPLEMENTATION PLAN	Outlines specific technical analyses and certification steps required to implement the recommended design, including key schedule milestones and enabling works.	Outlines all technical work to be completed during Stage 3.
SECTION 11 CAPITAL & LIFECYCLE COSTS	Presents capital costs of all three design options to facilitate comparison, as well as lifecycle costs for the recommended option to summarize its business case and ROI.	Provides a starting point for the evolving illustrative design and ROI exercise.
SECTION 12 CONCLUSION	Lists key recommendations and lessons learned during the development of this report for review by the Planning, Design and Compliance (PDC) team, as well as next steps for NH post-construction.	General recommendations for PDC team.

Comprehensive implementation of NH's environmental vision will require effort well beyond the project contract and construction phase, mandating re-evaluation of facility maintenance and hospital operations practices. These next steps, identified during the stakeholder engagement process, are captured in this plan for future reference. Key operations processes to be developed by NH's include procurement strategies to reduce material lifecycle impacts and waste production, outreach and programming initiatives that promote engagement with the site's healing and food gardens, ongoing promotion of active transportation opportunities, and specific health-related policies and testing procedures required to establish and maintain WELL certification. Formalizing these processes into ongoing operations practices will embed sustainability into the fundamental day-to-day decision-making of the hospital community, ensuring that NH's environmental vision is realized long after the initial design process is complete.

PART 1 | UNDERSTAND

© TOM ARBAN PHOTOGRAPHY

1 BACKGROUND

The following section summarizes relevant background material, regional data and organizational precedent which provide context for the analysis and recommendations within this report. This context includes general site conditions and fundamental project characteristics, the sustainability goals defined by Niagara Health System (NH), existing green building benchmarking and certification systems, and design documents reviewed during report production. Applicable government regulations and sustainability policies that also frame the project are included in **Section 2, Research**.

1.1 PROJECT AND SITE DESCRIPTION

The site of the new South Niagara hospital, a 20-ha greenfield, is located at the intersection of Lyons Creek/Biggar Road and Montrose Road in the City of Niagara Falls, Ontario. Positioned on the south end of the 330-ha redevelopment zone of the Grand Niagara Secondary Plan Area, the hospital is intended to anchor future growth of an environmentally sustainable, healthy and complete community that provide livable neighbourhoods, green space, and efficient transit options. The new hospital will replace NH's existing Fort Erie, Niagara Falls, Port Colborne and Welland hospitals.

NH's March 2019 Ministry of Health and Long-Term Care (MOHLTC) Stage 2 submission proposed a 130,000 m^2 hospital comprised of five interconnected buildings. Updated blocking and stacking plans, as shown in Figure 3 below, now define an 116,910 m^2 five-storey facility. Within the site boundary, the building footprint occupies approximately 20% of the total site area, parking and hardscape 65%, and green space 15%, including a protected wetland along the northwest boundary. The potential for a woodland in the southeast corner is also detailed in the Campus Master Plan report currently under development, but does not appear in the current plan below.

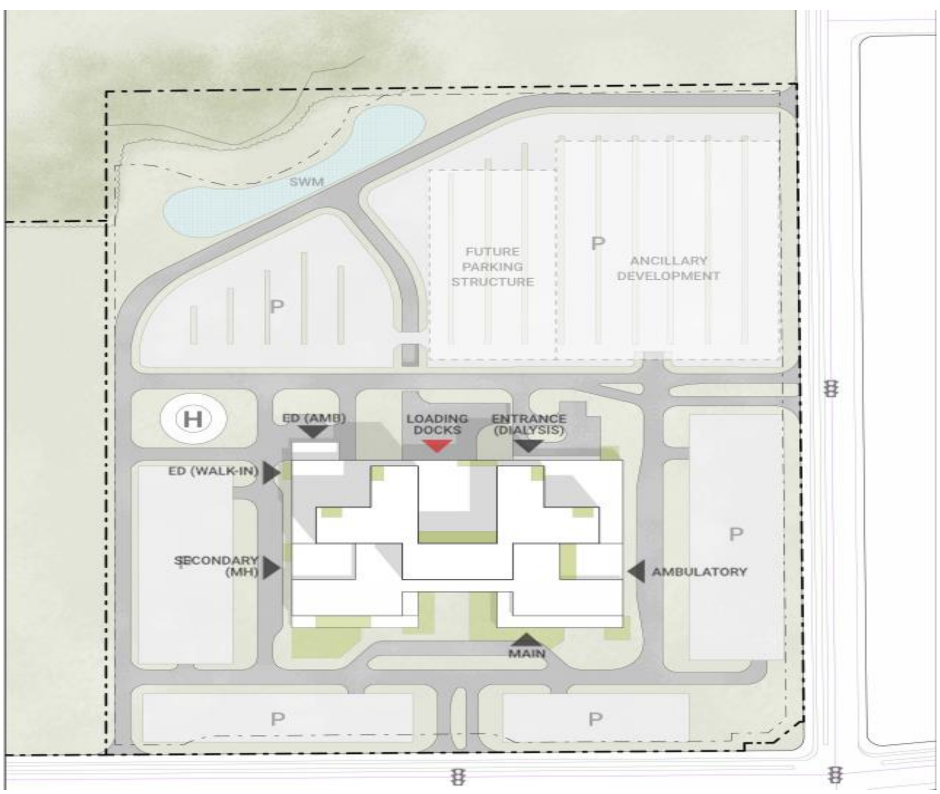


Figure 3: South Niagara Hospital – Updated Site Plan

The hospital is anticipated to accommodate 2400 staff and 550 beds. Major components of the Stage 2 design relevant to NH's environmental goals include efficient heating, ventilation, and air conditioning equipment, LED lighting, water-conserving plumbing fixtures, and an indoor green wall to improve indoor air quality. The exterior site design is envisioned to include a variety of healing and therapeutic gardens, walking paths, and bicycle storage infrastructure that is well-connected to planned regional bicycle and pedestrian networks.

At time of the production of this report, NH continues to actively revisit the blocking and stacking plan and parking requirements for the new hospital to reclaim additional site area for green space. Other changes are expected as a result of the analysis and recommendations under development within seven additional design plans, particularly the Campus Master Plan. Detailed energy analysis to inform decision-making is also being performed through the Savings-By-Design program, described in **Section 6.2**.

1.2 PROJECT SUSTAINABILITY GOALS

NH has identified eight environmental requirements which will guide the design and operational requirements encoded in the Project-Specific Output Specification (PSOS) developed in Stage 3, serving as the control document for the Design Build Finance Maintain (DBFM) process. These environmental requirements, summarized in Figure 4 below, include typical green building concerns such as energy, water and waste, as well as emerging considerations such as carbon emissions, health and wellness, and access to and integration with nature. This holistic approach to sustainability necessitates detailed exploration of NH' priorities and project-specific opportunities and constraints to develop performance targets and design recommendations that fully embrace its broad vision.

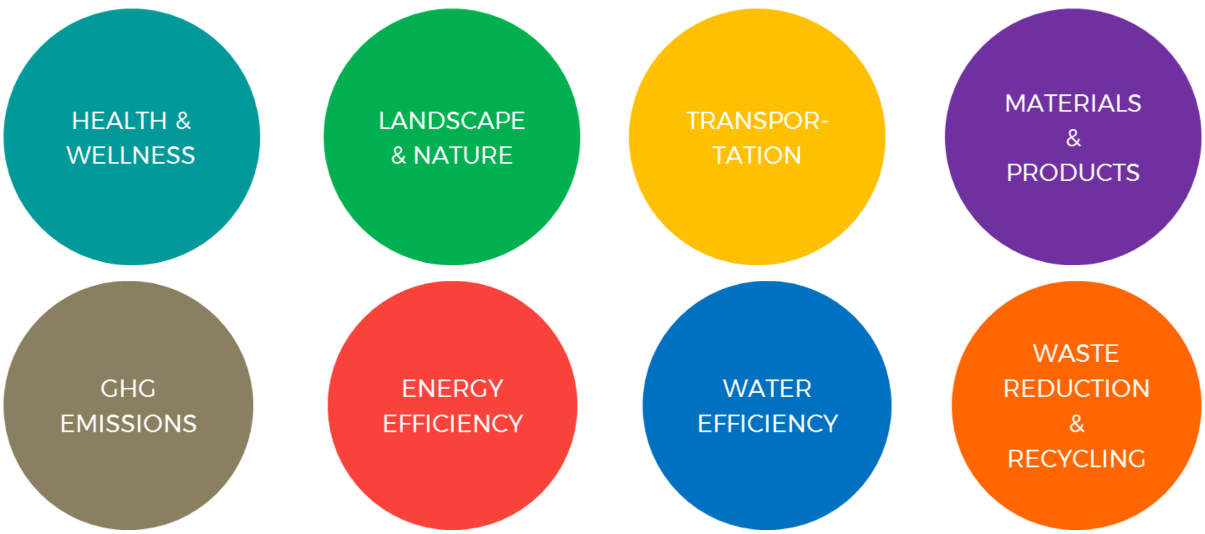


Figure 4: NH Environmental Requirements

Green building certification through the LEED and WELL rating systems, described in the next section, form one small part of the sustainability goals for the new hospital. The redevelopment team intends to leverage the evaluation tools and processes of these certification systems to guide design decision-making and identification of typical best practices for sustainability. Certification is not a sufficient goal in itself, however, and NH intends each of these environmental requirements to shape unique operational practices and ongoing performance monitoring throughout the life of the hospital.

1.3 GREEN BUILDING RATING SYSTEMS

A number of green building rating systems have been incorporated into this report, including the LEED (Leadership in Energy and Environmental Design) Standard, the WELL Building Standard, the Canada Green Building Council's (CaGBC) Zero Carbon Building (ZCB) Standard, and the Canadian Coalition for Green Health Care's Green Hospital Scorecard.

LEED is the most widely used green building certification system in the world. The LEED v4 Building Design + Construction: Healthcare (BD+C) rating system includes customized credits and adjusted requirements specific to hospital projects. Infrastructure Ontario typically mandates projects to certify to a minimum of LEED Silver, which requires achievement of 15 prerequisites and at least 50 points from available credits. Credits are organized across the nine categories shown in Figure 5. As implied by the 'Design + Construction' title, this version of LEED does not address operational requirements or performance.

LEED Facts

for LEED BD+C: Healthcare (v4)

Certification awarded	
Certified	
Integrative process credits	1
Location & transportation	18
Sustainable sites	9
Water efficiency	11
Energy & atmosphere	35
Material & resources	19
Indoor environmental quality	16
Regional priority credits	4
Innovation	6

Figure 5: LEED Facts

LEED v4, which came into effect in October 2016, increased the stringency of many design requirements compared to previous LEED standards (versions 2009 and 1.0). Currently, there are no Canadian hospitals certified under the v4 standard, although 30 hospitals in the design or construction phase are registered for certification. Due to market reaction to several challenging new requirements in LEED v4, the LEED v4.1 beta was released in January 2019 with the goal of increasing achievability of certification and better balancing sustainable building leadership with market expansion. By the time the new hospital is officially registered for certification, it is expected that v4 and the v4.1 beta will have been integrated into a single system.

In addition to LEED, NH intends the South Niagara Hospital to be the first hospital in the world certified under the WELL Building Standard. Similar to LEED, WELL offers certification levels ranging from Silver to Platinum, requiring achievement of 23 preconditions and a certain number of the available 94 optimizations. Optimizations in the WELL v2 standard are arrayed across ten concepts, as shown in Figure 6. Many WELL features align with or overlap LEED credits, such as those for indoor environmental quality within the Air, Light, Thermal Comfort and Sound concepts. Currently only eight hospital projects are registered to pursue WELL certification; of these, the new MetroHealth Systems hospital in Cleveland, Ohio is the furthest into the process. Construction of MetroHealth began in April 2019 and is scheduled for completion in 2022. Additional information about this project is provided in **Section 2.2.1**.

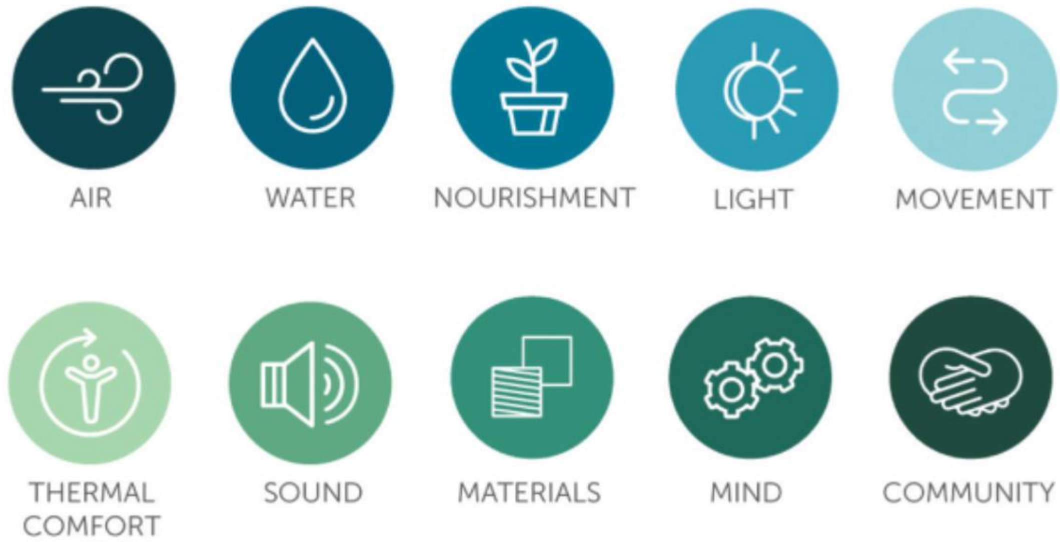


Figure 6: WELL v2 Certification Concepts

Unlike LEED BD+C, WELL features incorporate requirements for both building design and operations. Operational features may include organizational policies, ongoing performance testing and procurement standards for food. As such, the WELL certification process includes additional steps compared to LEED, including performance verification once design and construction is complete. Performance verification is completed every three years thereafter to maintain certification. This process is summarized in Figure 7 below.

Figure 7: WELL certification process

Although NH is not intending to pursue certification under CaGBC's relatively recent Zero Carbon Building (ZCB) Standard, it provides a useful framework and set of metrics for evaluating the environmental impacts of energy use and fuel selection that extend beyond total building efficiency or utility costs. High level requirements of the ZCB Standard are outlined in Table 2 below.

Table 2: Requirements of the ZCB Standard

	ZCB-Design (new construction)
Demonstrate Zero Carbon Balance	✓
Provide Zero Carbon Transition Plan*	✓
Install Minimum 5% Onsite Renewable Energy	✓
Achieve Thermal Energy Demand Intensity Target	✓
Report Energy Use Intensity	✓
Report Peak Demand	✓
Report Embodied Carbon	✓

Finally, the Green Hospital Scorecard, administered by the Canadian Coalition for Green Healthcare since 2013, provides a benchmarking tool and performance data for operating Canadian hospitals. Participants report energy use, GHG emissions, water consumption, waste generation and diversion, as well as corporate environmental commitments on an annual basis and receive a score relative to their peers. Benchmarking data from the Scorecard (among other sources) is provided throughout this report as a reference for typical operating performance of existing hospitals.

1.4 BACKGROUND MATERIALS

Materials reviewed during the production of this report include:

1. Environmental Design Report Stakeholder List
2. Kick-off Meeting Agenda
3. WELL v2 Scorecard
4. Stage 2 MOHLC Submission, including functional program, mechanical and electrical design briefs, parking study, retail food study, and budget.
5. Niagara Health Visioning Session Report
6. What to expect at an Enbridge Savings By Design
7. Savings By Design Niagara Health-Agenda
8. Grand Niagara Secondary Plan
9. Campus Plan Dashboard
10. City of Niagara Minutes
11. Design Vision
12. Design Opportunities Worksheet
13. Design Program Framework
14. NH Waste Audits
15. Savings By Design Hospital Benchmarking

1.5 STAKEHOLDER INTERVIEWS

Stakeholder input was also solicited and reviewed throughout the development process of this report. The following meetings were held to collect information and feedback from NH's executive team, operations staff, and other interested employees. This important feedback included lessons learned from past NH development projects, input on key sustainability priorities, and feedback on design options and measures.

DATE	TOPIC	PARTICANT GROUP(S)
June 14, 2019	Kick-Off Meeting	WSP, NH Redevelopment Team
June 19, 2019	**UNDERSTAND:** Savings By Design Workshop	RWDI, Enerlife, Enbridge, WSP
July 4, 2019	**UNDERSTAND:** Local Programs and Niagara Secondary Plan	City of Niagara, Region of Niagara, WSP
July 10, 2019	**UNDERSTAND:** Hospital Research	WSP (Presenter)
July 10, 2019	**UNDERSTAND:** Hospital Research (Condensed Form)	WSP (Presenter), NH Redevelopment Team
July 30, 2019	**ANALYZE:** LEED and WELL Rating System, NH Priorities	WSP (Presenter), All NH Stakeholders
August 9, 2019	**SYNTHESIS:** Evaluation Criteria and Design Options, GHG, Energy, Water, Waste	WSP (Presenter), All NH Stakeholders
August 16, 2019	**SYNTHESIS:** Evaluation Criteria and Design Options, Health, Landscape, Transportation, Materials	WSP (Presenter), All NH Stakeholders
September 10, 2019	Infrastructure Ontario Integration	WSP, NH Redevelopment Team
October 2, 2019	**MAKE:** Final Presentation	WSP (Presenter), all NH Stakeholders

Material and feedback gathered at each session has been interwoven throughout this report. For a detailed summary of participants in each session, please refer to Appendix D.

2 RESEARCH

The following section comprehensively describes sustainable design practices incorporated into recently-built hospitals in Canada and abroad. Research is summarized as strategic insights for each of NH's eight environmental focus areas, identifying best practices and lessons learned that will frame and inform design of the South Niagara Hospital. Information on operations strategies verified performance results is also provided where possible to identify potential gaps between design intent and real-world performance, as well as innovations that may not translate into intended outcomes. Government policies and regulations which define the basic regulatory context for the hospital's future sustainability requirements are also outlined. Throughout, relevant data from specific hospitals is provided in informative sidebars and detailed case studies. The intent of this section is to showcase local and international precedent within the healthcare sector to inform NH's sense of the possible.

2.1 POLICIES & REGULATIONS

NIAGARA SECONDARY PLAN (2018)

E L T

The Grand Niagara Secondary Plan sets specific land use, transportation, servicing, and environmental protection policy for the 330-ha area which includes the new hospital site. It incorporates recommended design principles to guide future projects, such as protection of natural features, use of Low Impact Design (LID) techniques for stormwater management, and promotion of active transportation and public transit. The Secondary Plan encourages projects to adopt the LEED Standard (or equivalent alternatives), to maximize passive and active solar energy, and incorporate opportunities for local food production. Through this plan, the City seeks to leverage the economic impact of the new hospital to encourage employment and commercial growth throughout the development area.

The Secondary Plan appendices include detailed mapping of zoning, Environmental Protection Areas, planned bicycle and pedestrian network and pathways, and stormwater servicing. A provincially-significant wetland is identified at the northwest corner of the new hospital site. Specific content from the Secondary Plan is included throughout the strategic insight sections.

HIGHLIGHTS

- The Secondary Plan encourages **LID techniques** for stormwater management, **LEED-compliant design**, **active transportation** and **local food production**.
- Protections for the **provincially-significant wetland** on the hospital site will be required.

ONTARIO BUILDING CODE UPDATE (2019)

E W T

The OBC has typically had limited impact on performance requirements for hospital projects as hospitals designed and funded by MOHLTC are required to perform beyond the 2019 code update.

An important change, however, is a new a focus on accounting for thermal bridging more accurately in enclosures to more accurately determine energy performance and improve durability of envelope design.

HIGHLIGHTS

- **Energy requirements are further strengthened**, but remain behind current best practices within the hospital sector
- **Improved enclosure modeling** requirements will result in more accurate energy models.

ONTARIO ENVIRONMENT PLAN (2018)

G E W

The *Preserving and Protecting Our Environment for Future Generations: A Made-in-Ontario Environment Plan*, released in late 2018, is designed to protect Ontario's air, land and water; address litter and reduce waste; support reduction of greenhouse gas emissions (GHG); and help communities and families prepare for climate change.

The Plan includes a commitment to update government policies such as the Building Code, Municipal Disaster Recovery Assistance program, and land use planning policies and laws to increase community resilience to climate change. It also defines a target of achieving a 30% reduction in provincial GHG emissions from 2005 levels by 2030. The building sector is identified as contributing 22% of the planned reduction. Private investment in clean technology solutions is one mechanism to achieve this goal, and will be encouraged through development of an emissions reduction fund. The Ontario Carbon Trust will also fund investments in cost-effective projects in the transportation, industry, residential, business, and municipal sectors. Integration of emerging smart grid technologies and distributed resources to make best use of Ontario's energy resources is also a priority.

HIGHLIGHTS

- The province aims to achieve a **30% reduction in GHG emissions** by 2030.
- 3R Regulations will be amended to **include food and organic waste** and increase resource recovery across the **IC&I sector**.
- Targets will be established for **municipalities, multi-residential buildings, business, schools, and hospitals** to recover **70% of their food and organic waste by 2025.**
- **Bans on single use** and **food waste disposal in landfill** to be enacted by 2021-22.

To ensure that waste is properly recycled, recovered and disposed, the province will consult on amendments to the 3Rs Regulations aimed at increasing resource recovery across the Industrial, Commercial and Institutional (IC&I) sector through improved management of food and organic waste. Building-specific diversion thresholds will also be considered, and would account for sector, facility size, volume of food and organic waste generated and geographic population levels. Most stringently, a food and organic waste landfill disposal ban will be considered, with phase-in anticipated by 2022. This will include a target for municipalities, multi-residential buildings, business, schools, and hospitals to recover 70% of their food and organic waste by 2025. Supporting actions include defining consistent rules for compostable products and packaging and developing best practices for safe food donation.

A plastics strategy is also proposed in the Plan, to reduce plastic waste and limit micro-plastic pollution in waterways. The province may ban single use plastics as early as 2021. Federal commitment will be sought to implement national standards that address recyclability and labelling for plastic products and packaging to reduce the cost of recycling, including making producers responsible for recycling costs associated with the waste generated from their products.

WASTE-FREE ONTARIO ACT (2016)

W

The *Waste-Free Ontario Act* consists of two parts: The *Resource Recovery and Circular Economy Act* and the *Waste Diversion Transition Act*. The Act primarily impacts municipal recycling and recovery programs, including transitioning municipal programs to a full producer responsibility model. In this model, the cost to collect and recover recyclable materials is borne by producers, rather than local governments, encouraging manufacturers to lower their recovery costs by selecting easier to recycle materials and packaging. Blue box programs will also be standardized across the province. Both regulatory changes aim to promote a circular economy in which waste is repositioned as a resource and materials are reclaimed and

HIGHLIGHTS

- **Producers** will become fully **responsible for the costs of recycling** their products and packaging.
- The province aims to achieve a series of interim waste diversion targets including **50% diversion by 2030.**
- **Disposal of food waste in landfill** is likely to be **banned by 2022**.

reprocessed to create further value, rather than disposed in landfill. Discussions and plans for this transition are in early stages as of mid-2019. The *Waste-Free Ontario Act* also mandated development of the *Strategy for a Waste-Free Ontario*, which was approved in 2017 and continues to be reviewed, refined and updated under the new provincial government.

The Strategy outlines specific objectives, actions and milestones towards the aim of a zero-waste Ontario. Interim diversion goals have been set at 30% by 2020, 50% by 2030, and 80% by 2050. The Strategy will be regularly reviewed and updated as progress reports are issued.

These regulations are expected to impact the hospital sector in two ways: disposal of food waste in landfill is likely to be banned by 2022, and single-use plastics and packaging may become more expensive under the full producer responsibility pricing system.

2.2 HOSPITAL RESEARCH & STRATEGIC INSIGHT

The following section summarizes a significant volume of research into the hospital sector in Canada and internationally. To best inform the remainder of the report, information has been organized according to NH' eight environmental requirements.

Detailed case studies of four hospitals – one American, and three Canadian – provide concrete and specific sources for the insights outlined in this section. Other relevant hospital sources are summarized in informative sidebars. The first case study, from the iconic **Dell Children's Hospital** in Austin, Texas, showcases the measurable health and wellness outcomes that result from attention to design elements such as indoor air quality, lighting quality, and access to nature. The second case study, from **Sechelt Hospital** in Sechelt, British Columbia, demonstrates Vancouver Coastal Health's (VCH) commitment to GHG emissions reduction by designing the first newly built carbon neutral hospital in North America. VCH has continued to push the boundaries of sustainability by achieving carbon neutrality across all of its hospitals for two consecutive years through procurement of renewable energy credits (RECs). The third case study, from **Humber River Hospital** in Toronto, Ontario, showcases energy efficiency in both design and performance. At the time of completion, Humber River established itself as the most energy efficient hospital in North America (a title that may be passed to the newly-opened **Peel Memorial Hospital** once performance data for both hospitals is available for 2019). Finally, **Michael Garron** Hospital, currently under construction in Toronto, Ontario, is also targeting certification under LEED BD+C v4 for Healthcare, with a focus on material selection and durability.

CASE STUDY | DELL CHILDREN'S MEDICAL CENTRE

DESCRIPTION

- 1st LEED Platinum Health Care Facility (86 LEED v2009 credits awarded)
- Owner: Seton Family of Hospitals
- Pediatric care facility completed in 2007 with expansion in 2014

Image Source : https://www.wsp.com/en-CA/insights/moving-from-sustainability-to-wellness-in-health-care

From its inception, Dell Children's Medical Centre was envisioned as a forward-thinking, innovative hospital facility rooted in a sustainable environment. The complex's first building was the first in the world to achieve LEED Platinum certification under LEED for New Construction v2009, and a recent expansion, completed in 2014, was the first to achieve LEED Platinum certification under the healthcare-specific version of LEED v2009. Through sustainable and occupant health-focused design, Dell Children's has been able to reduce operating costs while fostering a healthier, happier environment for staff and patients.

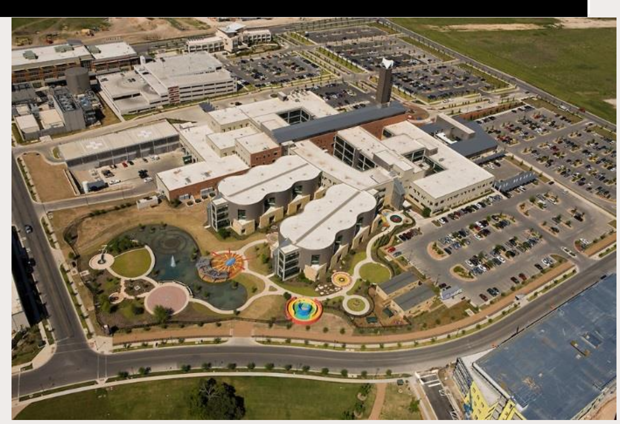
HIGHLIGHTS

- [redacted]
- [redacted]
- [redacted]
- [redacted]

DESIGN STAGE

With sustainability and premium care at the forefront of Dell's vision, it was clear that energy use must be minimized without sacrificing occupant comfort. Mechanical systems therefore included an on-site combined heat and power plant (owned and operated by Austin Energy) to boost efficient energy generation and recycle waste products. The hospital also incorporated renewable energy features such as a 36-kW solar photovoltaic array and a rooftop solar hot water collection system. Other features included individual lighting controls for 96% of occupants, occupancy sensors and daylight harvesting, and carbon dioxide monitoring in high occupancy areas to control outdoor air supply.

[redacted]



Water efficiency was addressed through dual and low flush fixtures, low flow showers and automatic sensors, which save 1.3 million gallons of water annually.

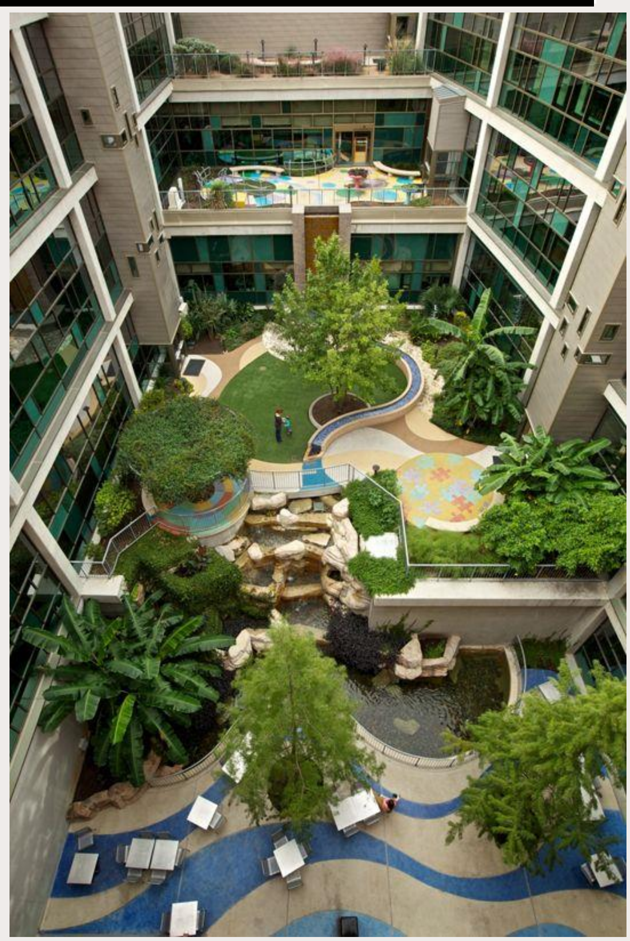
Finally, Dell Children's embraces the healing benefits of nature through indoor courtyards and local materials which reflect and celebrate the surrounding community. The hospital's expansion also includes an outdoor labyrinth, reflecting pond and sensory garden to make best use of limited available outdoor space.

OPERATIONS STAGE

Dell provides an enhanced working environment for staff and improved care for patients. Upon completion of the hospital, an outside research firm was hired to conduct a study of 1,900 hospital employees over a two-year period to comprehensively measure employee engagement, health and well-being, turnover, injuries, and perceived indoor air quality. The results were compared to two Seton's existing Texas hospitals as well as Dell's original investment in sustainability.

[redacted]

Perceived indoor air quality at Dell Children's was also 14% higher, mostly attributed to the indoor courtyards located throughout the facility. While originally included in the design as a daylighting measure, these courtyards have the added benefit of creating a sense of being outside anywhere in the facility.,



[redacted]

[redacted]f.

2.2.1 HEALTH & WELLNESS

HEALTH & WELLNESS

KEY STRATEGIC INSIGHTS

- LEED, WELL, and EcoDistricts have been used as frameworks to support health & well-being of patients, staff and communities.
- Common design strategies include occupant controllability, ergonomics, air quality monitoring, active commuter support, physical activity promotion and access to green space.
- Emerging concerns include healthy food programs for patients and staff, integration of nature and community engagement.
- Designing for physical and mental wellness has operational benefits such as improved employee productively and retention, increased patient satisfaction, and reduced operating costs.

INDUSTRY TRANSFORMATION AND POLICY TRENDS

With the rapid growth of the wellness industry, there is an increasing demand to design buildings that positively impact occupants' health, productivity and happiness. Sustainability for buildings is no longer solely focused on energy and water efficiency as industry recognizes that occupant productivity, satisfaction and health must be an equal or greater concern.

Buildings that are designed for wellness increase an employer's ability to attract and retain the best employees. Healthy, happy employees are also more productive and less likely to take time off for sickness or to quit their jobs. According to the Mental Health Commission of Canada, 1 in 5 Canadians experience a mental illness or addiction problem in any given year, and psychological health problems cost the Canadian economy $51 billion per year, $20 billion of which results from work-related causes. Studies have shown that healthcare employees experience a relatively high depression and anxiety rate due to shift work, long hours and stressful situations. Integrating health and wellness as a hospital design priority presents an opportunity to reduce employee absenteeism and burnout and reduce treatment errors, while improving employee productivity and patient satisfaction.

To respond to these trends, a number of certification programs have been developed to benchmark building health and wellness features and programs, including WELL, Fitwel, Reset, EcoDistricts and the Living Building Challenge. More established green building standards such as LEED and BREEAM are also expanding to include a fuller suite of occupant wellness criteria beyond indoor environmental quality.

Much as LEED has provided for the last 15 years, these wellness standards provide a framework to inform the design process, and an accomplishment to boast when certification is achieved. WELL certification has gained notable traction since it was introduced in 2014, with 3,543 projects currently registered across 55 countries. This includes 71 projects in Canada, and eight healthcare projects internationally. One notable registered healthcare project is the **MetroHealth Systems Hospital** in Cleveland, Ohio, profiled on the following page. Although healthcare accounts for a small percentage of WELL registered buildings, this is likely due to a relatively rigorous and expensive certification process rather than a lack of attention to occupant wellness in the healthcare industry. Many new and existing hospitals are testing new approaches to design and operations to improve the health and wellness of patients, staff and hospital visitors, including healing gardens, operable windows, fresh and local food options, and community engagement programs.

[redacted]

STRATEGIC INSIGHTS

- New hospital will be **LEED certified**, the first **EcoDistrict** anchored by a health care system in the US. It is also being designed to meet the **WELL Building Standard**.
- During the Design stage the transformation team included 26 local firms, with 10 being **minority-or women-owned businesses**
- **Active transportation** options include bicycle, carpooling program, EV charging stations,
- **Carbon neutral target** established for buildings, infrastructure, and transportation
- **"Hospital in a park"** – 25 acres of dedicated green space within the 52-acre main campus

Image Source : https://www.cleveland.com/cuyahoga-county/2018/03/metrohealth_committed_to_developing_its_neighborhood_as_well_as_its_campus.html

Features that improve occupant health and wellness can be linked to many other environmental considerations, particularly landscape and nature, transit and active commuting, and sustainable and healthy materials. Despite these many positive synergies, building features that promote occupant wellness also have the potential to negatively impact energy and/or water efficiency. For instance, increased outdoor air rates or insufficient controls for natural ventilation can negatively impact energy use, and extensive landscaping may have high water requirements. Careful attention to the balance between conserving resources for the benefit of the environment and enhancing occupant health and wellness must therefore be maintained for a truly sustainable facility.

DESIGN PHASE BEST PRACTICES & LESSONS LEARNED

Key design strategies to increase occupant health and wellness include universal (accessible) design, enhanced indoor environmental quality, landscape design and spaces of respite.

Universal design involves creating an environment that is accessible to and useable for all people, regardless of age, size or disability. The overall design and architecture of the hospital must be accessible to a diverse community and supportive of an inviting and comfortable culture for patients, staff and visitors. Hospitals can incorporate universal design principles through accessibility planning, inclusive design, wayfinding/signage and technology to facilitating independent and intuitive use of the facility. For example, **St. Olav's Hospital** in Norway was designed not just to accommodate, but to welcome and encourage a wide range of people and abilities by focusing on patient's needs. The hospital has received international praise for its innovative architecture that brings nature, the city, employees and patients together in an unconventional way.

Enhanced indoor environmental quality that addresses indoor air quality, thermal, visual, and acoustic comfort, and individual occupant controls provides another set of design strategies. For instance, **Humber River Hospital** in Toronto created a digital, lift-free and patient-focused environment to facilitate safe and efficient workflow throughout the hospital. Individual control over work environments includes lighting control, sound control and furniture ergonomics, and extensive smart glass installation adjusts automatically to prevent overheating and glare. The hospital is oriented to maximize views to nature while minimizing solar heat gain. Other recent hospital builds, such as **Sechelt Hospital** in British Columbia, include operable windows in patient rooms to enhance occupant connection to nature and allow for natural ventilation.

Integrating landscaped elements and features into the hospital's exterior and interior design also influences occupant wellness by drawing on the therapeutic benefits of nature. This approach has been well established in recent hospital designs through healing gardens, interactive vegetation, and maximizing views to landscaped areas. Hospitals in denser urban locations offering limited landscaping opportunities have incorporated natural materials, colours, patterns and textures into their interiors to mimic naturalized spaces, an approach known as biophilic design. Other hospitals have taken a bolder approach to integrating landscape and nature. The **NG Teng Fong General Hospital** in Singapore is designed to create the feeling of a hospital without walls. Its facade includes custom external shading devices such as sliding sunscreens and light shelves to maintain access to daylight in all patient rooms. Vertical gardens containing native vegetation and densely planted low roofs provide views of greenery.

Finally, indoor and outdoor places of respite dedicated to relaxation and contemplation provide relief from fatigue and mental stress, common symptoms in a healthcare environment. Several recent hospital projects have also acknowledged their role in fostering public health through exterior spaces designed for, and with, the surrounding community. **Sechelt Hospital** in British Columbia included First Nations Elders as consultants in the hospital's design process, in acknowledgement that hospital's land was a gift from the Shishalh First Nations people. The Elders input reinforced the hospital's connections to nature, particularly through plant selections and fenestration design. **Michael Garron Hospital** in Toronto also incorporated plants for smudging ceremonies in its landscape, including sage, cedar and tobacco, three sisters-corn, squash and beans, together with medicinal plants such as Lavender and Centrosema. Its site includes a community garden designed to provide relaxation and recreation for patients, families and staff and to be used for special events by the neighbourhood. The site also incorporates a dedicated staff courtyard, a roof terrace for Adult Mental Health that accommodates dining, group activities, horticultural therapy and physical activity, and a separate roof terrace intended for casual use by staff, patients, families and visitors.

OPERATIONS PHASE BEST PRACTICES & LESSONS LEARNED

Once built, ongoing programming and wellness-specific policies and programs can extend the impact of these design features. Programs focusing on ergonomics program, air quality monitoring, or active commuter support ensure that the building is used as intended. More general programs such as employee recognition programs, attendance programs, wellness challenges, physical activity promotion and employee satisfaction programs provide additional support.

Many of the wellness initiatives benefitting hospital staff also benefit patients and visitors. However, some hospitals have chosen to implement additional programs that target specific users. For instance, the **Children's Hospital of Eastern Ontario** (CHEO) aims to provide nourishing, healthy food for patients and staff with their hospital motto, "Happy staff, happy patients." It is the first hospital in the country to model patient food after hotel room service, which has increased patient satisfaction from 30% to 98% while decreasing costs due to reduced food waste. [redacted]

DESCRIPTION
Location: Ottawa, Ontario

160 bed pediatric hospital built in 1974

1st hospital in the country to model patient food after hotel room service.

STRATEGIC INSIGHTS

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

[redacted]/

DESCRIPTION

Location: Arizona, United States

World-class inpatient, outpatient, trauma, emergency and urgent care to children and families in Arizona

One of 10 largest hospitals in the U.S.A

90th percentile for employee satisfaction

STRATEGIC INSIGHT

- Recognized by Becker's 150 Top Places to Work and Phoenix Business Journal's Valley Healthiest Employers in 2018
- Implemented an employee satisfaction program, regular feedback including monthly breakfasts with CEO and annual employee surveys
- Well-being Program "Vitality," offers employees Apple Watches, on-site farmers market, company-funded life insurance and disability
- Create a community in which residents and faculty look out for one another through the Resident Wellness Program which includes class lunches, retreats, house staff meetings, intern appreciation night, holiday parties, graduation, intern week vacation, focus days, community sports leagues, etc.
- Resident Wellness Program provides employee discounts to local fitness centers and an employee assistance program available 24/7 which allows residents to speak with clinician who can triage concerns.
- The demand of residency can be challenging at times to provide the best care to patients and families.

Image Photo Credit on image : ®Blake Marvin-HKS,Inc.

Food gardens offer another avenue to connect patients, staff, and the public. The **University Health Network** in Toronto created a wheelchair accessible, community food garden through collaborative effort involving staff, patients and community organizations. The garden is used to grow herbs, leafy vegetables, tomatoes, peppers and beets, and is maintained by volunteers. Harvested food is used to teach cancer survivors how to cook healthy meals through a partnership with ELLICSR.

General wellbeing programs can encourage both physical and mental health. To encourage employee fitness, the **Phoenix Children's Hospital** in Arizona offers employees Apple Watches, and employee discounts to local fitness centers. Staff are rewarded with gift cards for keeping regular fitness activities and staying on track with fitness goals. Additional employee benefits offered include an on-site pharmacy, flexible spending accounts, company-funded life insurance and a 24/7 employee assistance program. As a result of these efforts, this hospital scores in the 90th percentile for employee satisfaction.

HOSPITAL PERFORMANCE BENCHMARKING

There is limited Canadian industry data on hospital health and wellness outcomes, employee satisfaction, workplace error rates, staff turnover, sick days, or patient satisfaction and recovery rates. In the absence of comparative data, NH-specific benchmarks could be explored in the future, examining differences in these outcomes between NH's current hospital facilities and the new South Niagara Hospital once constructed. A sketch of this potential approach can be found in the **Dell Children's Medical Centre** case study at the beginning of this section.

WELL performance testing, required to complete initial certification and to maintain certification every three years following, may also provide a useful source of building-level data. These tests monitor whether thresholds for air quality, acoustics, water quality, lighting quality and circadian lighting parameters, and comfort conditions related to temperature, mean radiant temperature and humidity have been met to verify that the indoor environment meets qualitative standards for human health and well-being.

CASE STUDY | SECHELT HOSPITAL

DESCRIPTION

- 5,300 m^2 Acute Care Facility Acute Care Facility
- Owner: Vancouver Coastal Health Authority
- Built in 1963, renovation completed in 2013
- LEED NC 1.0 Gold
- North America's first newly built carbon-neutral hospital

Image Source : http://www.vch.ca/about-us/development-projects/sechelt-hospital

In 2014, Hospital News Magazine proclaimed St. Mary's Hospital (now named Sechelt Hospital) one of the greenest hospitals in North America and recognized the hospital for "causing health" rather than merely coping with disease. Originally built in 1963, Sechelt's 5,300-square metre expansion and renovation project was completed in 2013. The project included new emergency and radiology departments, intensive care rooms, a labour and delivery unit and two floors of single-occupancy inpatient rooms. The building incorporated indigenous design features in honour of the hospital's land that was gifted by the Shishalh First Nations people. The hospital pushed the boundary of health-centric design by constructing only single-occupancy inpatient rooms, providing operable windows in all clinical and inpatient areas and incorporating point-of-care stations at each inpatient bedroom. In addition to its LEED NC 1.0 Gold certification, the project was the first healthcare facility in Canada designed to achieve net zero carbon emissions.

DESIGN STAGE

Carbon emissions were first reduced through a focus on energy efficiency. Sechelt achieved 5 points for LEED credit EAc1 Optimize Energy Performance, reflecting 36% annual energy cost savings compared to a reference design, and an overall energy use that is 40% than other LEED Gold certified hospitals. Envelope performance was maximized through high efficiency glass and fenestration framing, and wall and roofs that incorporate two to three times more insulation than required by code. Other energy conservation measures include reduced interior lighting power density, exhaust air heat recovery using high efficiency water to water heat pumps and a high-mass hydronic radiant floor slab. A VAV reheat system provides space heating and cooling.

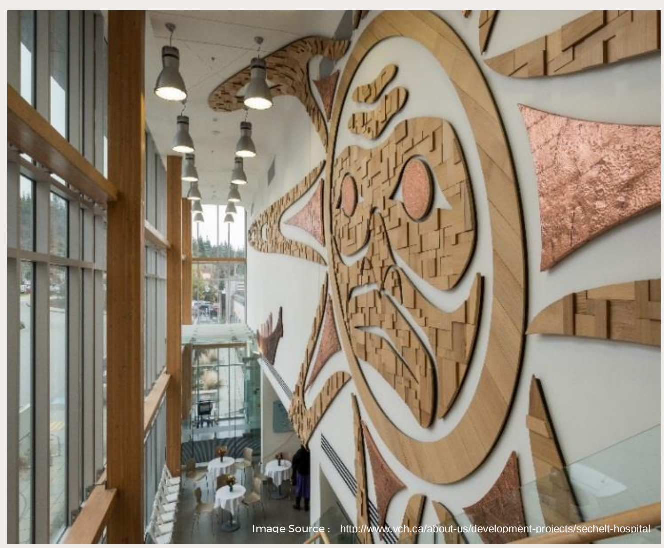


Image Source : http://www.vch.ca/about-us/development-projects/sechelt-hospital

Renewable energy further offsets energy use. A 19-kW solar photovoltaic (PV) array supplies electricity and is the largest solar PV system for this type of building in British Columbia. A geo-exchange system comprised of twenty-five 250-feet deep boreholes provides zero-carbon energy for heating and cooling.

Strategies to reduce carbon emissions from transportation are also incorporated into the design. Bicycle travel to and from the hospital is encouraged through bike racks and shower facilities, and 14 alternative fuel vehicle charging stations promote use of electric vehicles.

HIGHLIGHTS

ENERGY EFFICIENCY

- 36% annual energy cost savings from LEED baseline (5 pts)
- 40% energy savings compared to other LEED Gold hospitals
- Passive strategies
- High efficiency glass & framing fenestration
- High-performing building envelope
- 19-kW solar PV array
- Geo-exchange system: 125 boreholes, each 250-ft. deep

WATER EFFICIENCY

- No irrigation required
- Native & adaptive plants
- Water efficient fixtures
- 30.65% water use reduction compared to LEED baseline

GHG EMISSIONS

- VCH purchases carbon offsets annually for all of its facilities
- VCH organizes commuting campaigns and carpool programs to reduce emissions from employee travel.

Water efficiency was also a key concern for the hospital design. The need for landscape irrigation was eliminated through the selection of native and adaptive plants to replace lawns, and through the use of curb cuts to drain storm water into infiltration gardens. In addition, the project's 275-square metre green roof was designed to retain moisture by using sedum tiles with integrated fleece mats, which also serve to reduce storm water run-off. Water efficient fixtures including dual flush water closets (4.8 LPF/6.0 LPF), 5.7 LPM lavatory and kitchen faucets and showers were installed. Together, these fixtures resulted in a 30% interior water use reduction compared to the LEED baseline.

To support patient's mental health, Sechelt is designed with 100% single occupancy and same-handed rooms with large, operable windows that both maximise infection control and provide a connection to nature. Patients and staff are provided with control over the ventilation, lighting and temperature in their spaces. On-site respite gardens promote healing by offering immersive natural spaces.

OPERATIONS STAGE

Vancouver Coastal Health (VHC) has achieved carbon neutrality across all of its hospitals for two consecutive years, including at Sechelt. Low energy designs and retrofit projects are paired with purchase of carbon offsets to address remaining energy use.

VCH also offers programs to reduce carbon emissions from transportation. In 2011, it launched a "Cut the Carbon Community" program, including extensive promotion of sustainable transportation options. Through its "Green+Leaders" program, VCH continues to encourage staff to walk, bike or take public transit to work. A carpooling program in partnership with the Jack Bell Foundation connects employees of VCH who are interested in sharing rides with other nearby employees.

Image Source : https://www.andrewlatreille.com/portfolio/sechelt-hospital-perkinswill-canada-farrow-partnership-architects-inc/

2.2.2 GHG EMISSIONS

GHG EMISSIONS MITIGATION

KEY STRATEGIC INSIGHTS

- Existing hospitals are beginning to identify long-term GHG reduction targets, including achieving net zero carbon emissions through purchase of renewable energy credits and carbon offsets in the operations stage. Recapture of high global warming potential anaethetic gases is also increasing common.
- Addressing potential increase in carbon taxes is an important component of lifecycle costing exercises during design.
- Current Infrastructure Ontario Project Agreement requirements (such as Halton Courthouse) include refined EUI targets, GHG Intensity targets, TEDI, and whole building enclosure performance metrics. These metrics are enforced in the design/construction phase only, however, and no penalties exist for non-compliance. Infrastructure Ontario's acceptance of environmental life-cycle assessment targets to minimize embodied carbon of construction materials is in the exploratory phase.
- Carbon inventories of the hospital sector show that impacts from ongoing procurement significantly exceed those from energy use.

INDUSTRY TRANSFORMATION AND POLICY TRENDS

Human-caused climate change is widely recognized as the most significant global crisis of modern time. The United Nation's Intergovernmental Panel on Climate Change (IPCC) 2018 special report titled *Global Warming of 1.5 °C* outlines the impacts of rising atmospheric CO_2 levels, including extreme weather, rising sea levels, diminishing Arctic sea ice, coral bleaching, and loss of ecosystems. Limiting global temperature rise to 1.5°C will only be possible through deep emission reductions: a 50% reduction by 2030 from 1990 levels and zero net GHG emissions by 2050. (Fig. 9). This updated trajectory, more stringent than the previous Paris Accord targets designed to limit warming to 2.0°C, is summarized in Figure 8.

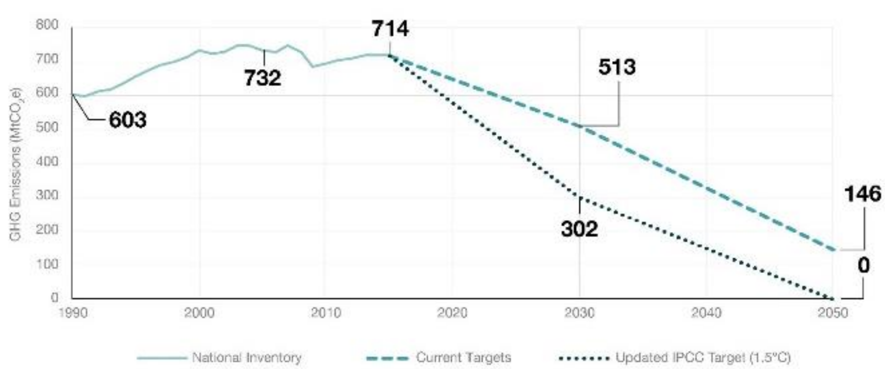


Figure 8: Updated Targets to below 1.5° C

Based on this report, the federal government has recently updated its previous commitment to achieve an 80% reduction of 2005 carbon emissions by 2050 to a target of net zero carbon by 2050. Provincially, the Ontario Environmental Plan targets a 30% reduction below 2005 levels by 2030. Many municipalities are also establishing local reduction targets in line with, or beyond, these federal and provincial goals. The City of Niagara has not yet formalized a carbon reduction target or strategy but is currently working to develop a Climate Change Action Plan. Based on these policy drivers, analysis of carbon emissions for the new hospital is recommended as key environmental consideration.

Financially, carbon emissions must also become a consideration. Carbon pricing is a key strategy to achieve federal carbon reduction targets; under the *Greenhouse Gas Pollution Pricing Act (2018)*, energy producers and distributors must apply an escalating charge for emissions associated with energy use. In Ontario, carbon pricing began in April 2019 at $20 per tonne. Per Figure 9, this price will increase by $10 per year to reach $50 per tonne by 2022. The federal pricing strategy after 2022 has not yet been determined, however, the Parliamentary Budget Officer has recently released a report (*Closing the Gap: Carbon Pricing for the Paris Target*) that estimates that the carbon price would need to more than double to $102 per tonne by 2030 to achieve the previous 80% reduction goal. Forecasted pricing to achieve net zero carbon by 2050 have not yet been assessed. Lifecycle costing exercises for building design options should reflect the federal backstop price as a minimum, as the Net Present Value (NPV) of capital maintenance and operating costs can be significantly impacted by the assumptions made for utility costs reflective of an escalating cost of carbon.

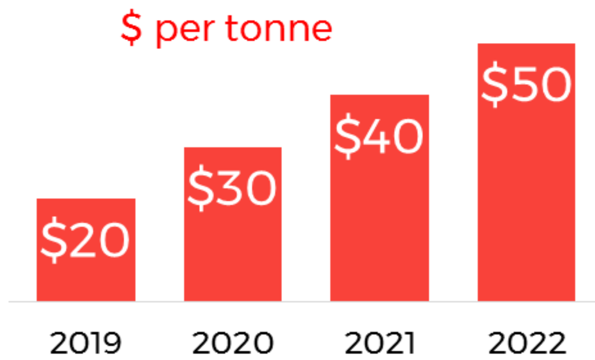


Figure 9: Federal Backstop Carbon Pricing Strategy ($/tonne eCO2)

In response to this increased focus on carbon emissions from the building sector, the latest version of LEED – version 4.1 – includes an updated energy performance credit which awards points based on a combination of carbon emissions reduction and energy cost reduction. Previous versions of LEED awarded points based on energy cost reduction alone. As this rating system was released in early 2019, only the most recently IO projects (e.g. Halton Regional Courthouse) have pursued this new credit points option.

In addition to this updated LEED credit, the Zero Carbon Building (ZCB) Program provides a framework through which Canadian buildings can demonstrate carbon neutrality. It includes a requirement to model a zero-carbon balance, in which operating emissions are balanced by procurement of renewable energy credits and carbon offsets. To ensure buildings using the standard are designed to be highly efficient, thresholds for thermal energy demand intensity (TEDI) are set for each climate zone, requiring high performance envelope and ventilation system designs. In addition, onsite renewable energy systems for new builds must be capable of providing a minimum of 5% building energy consumption. Primarily aimed at commercial and institutional buildings, there are currently no hospital projects registered under the ZCB program.

The full lifecycle carbon impact of buildings is not limited to operating energy. The embodied carbon of building materials and products is also a concern for designers, particularly for those focused on high performance buildings. As shown in Figure 10 below, a building's initial carbon impacts result from production of its building materials (orange line). Impacts from operating energy accrue over time (shown in blue). In typical buildings, embodied carbon impacts are outweighed by those from operating energy over a 50-year lifecycle (depicted in the solid blue line); however, as buildings become more energy efficient their material impacts may outweigh emissions from energy use (blue dotted line) over more than 30 years combined. Although not typically addressed, accounting for these initial embodied emissions provides perspective on potential areas of focus to mitigate environmental damage.

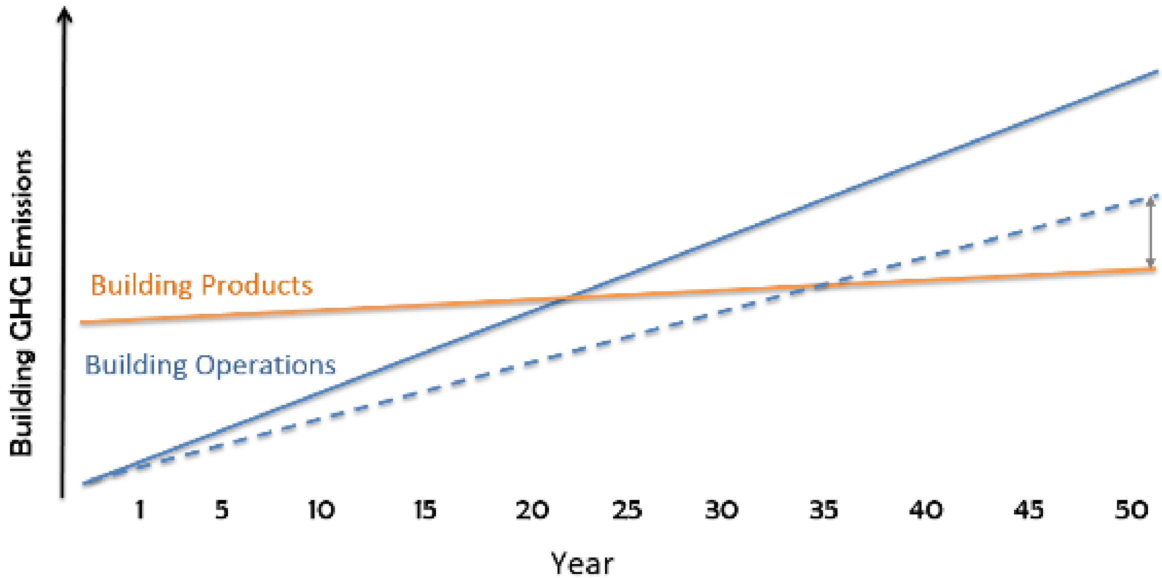


Figure 10: GHG Emissions Over Building Lifecycle

Life Cycle Analysis (LCA) is the technique used to fully quantify environmental impacts throughout the supply chain of a product, from material extraction to manufacture, distribution, use and final disposal or recycling. For buildings, LCA evaluates a full 60 or 100-year lifecycle with a focus on evaluating structural design options to reduce emissions from carbon-intensive materials such as concrete and steel. LEED credit MRc1 outlines specific requirements for this analysis; embodied carbon must also be reported for ZCB certification and is now mandatory for all Vancouver new builds under a recent rezoning bylaw. LCA can also be applied to individual products, as discussed in **Section 2.2.7**, Materials & Products. Fundamentally, LCA supports decision-making that properly balances design choices across discplines. For example, adding heavy insulation may significantly reduce operations phase emissions, but depending on the type and amount of insulation, the embodied impacts may actually increase the overall carbon emissions of the building.

Finally, post-construction, carbon impacts from employee travel and procurement are also significant, particularly in the healthcare sector with its high staffing requirements and purchase of billions of dollars of goods and services every year. Carbon footprinting processes to account for these operational elements are in their infancy in Canada, but have been explored by the National Health System in the U.K. for several years. Results from this carbon footprinting assessment are discussed in the Operations Phase Best Practices below.

Each of the strategies described above are contributor to a process known as climate change mitigation -- that is, reducing emissions of CO_2 to limit the magnitude and speed of global climate change. The building sector is also beginning to develop strategies to improve climate change resilience, which focuses on design and operations strategies that lessen the impact of expected changes such as extreme weather or sudden unavailability of municipal infrastructure. New Canadian resilience guidelines for buildings are under development and are expected to be incorporated into the 2025 update of the National Building Code. Until then, the Canadian Coalition for Green Healthcare offers the Health Care Climate Change Resiliency Toolkit and a mentoring program to identify climate risks and implementation strategies to address them. Potential climate impacts in the Niagara Region have been outlined in the 2012 report *Adapting to Climate Change: Challenges for Niagara* commissioned by the Niagara Regional Council.

DESCRIPTION
Location: Surrey, British Columbia

Design is fully embraced with principles to reduce embodied carbon and sustainable source materials through the incorporation of wood design.

Many hospitals in B.C. are using wood for its versatility, durability, and environmental benefits.

STRATEGIC INSIGHTS

- The two-storey base of the Critical Care Tower is clad in a wood composite panel system that continues into the interior of the hospital atrium.
- Wood was used in structural and decorative components to achieve a warm, comforting, and natural facility design to connect patients and occupants to nature and improve the overall patient experience.
- Wood products and finishes used for millwork, interior walls, and acoustic paneling were used to help control air-borne contaminants and provide a level of humidity control.
- Building Codes currently limit the use of heavy timber structure in large and tall buildings and therefore a code analysis was performed to address this at the hospital.
- LCA studies have consistently shown that wood products yield clear environmental advantages over other buildings materials in terms of energy, air and water pollution, and greenhouse gas emissions.

Image Source: © 2014 Ed White Photographics

DESIGN PHASE BEST PRACTICES & LESSONS LEARNED

Designing buildings to emit less carbon demands a new focus on selection of energy sources (and their associated emission factors), rather than only energy efficiency or energy cost. Natural gas heating, while inexpensive, emits two to four times as much carbon per unit of delivered energy as Ontario's electricity grid. Low carbon buildings therefore must find ways to switch from fossil fuel heating and process energy towards electrically-driven geo-exchange, combined heat and power systems, and, in some cases, biomass and on-site electricity generation through photovoltaics (PV).

As discussed in the previous case study, **Sechelt Hospital** in British Columbia leverages B.C.'s nearly carbon-neutral electricity grid by providing primary heat from an electrically-driven geo-exchange heat pump. Backup natural gas boilers are used to boost temperatures only on the coldest days. To reduce the size of the required borehole field, the hospital was designed with a high-performance envelope and passive design elements such solar shading and operable windows for natural ventilation. A PV array generates a portion of the hospital's energy on site. Annual carbon emissions are low, and Vancouver Coastal Health procures renewable energy credits and carbon offsets for its entire organization to achieve a zero-carbon balance. Although not carbon neutral, the recently opened **Peel Memorial Hospital** in Brampton similarly features a geo-exchange field as well as heat pump chillers capable of storing excess heat in the borehole loop.

To address government carbon reduction commitments, Infrastructure Ontario is beginning to incorporate new mandatory energy targets into DBFM project agreements which consider carbon in addition to energy use or energy cost. The agreements for the refurbishment of **MacDonald Block** (currently beginning design) and the new construction **Halton Regional Courthouse** (currently in pursuit) include thresholds for energy use, thermal energy performance and carbon emissions. Incorporating these targets into project agreements ensures that fuel selection will be appropriately considered at the design stage. The ultimate success of these new targets is not yet clear, as these design-construction targets will not be enforced in the operations phase.

Beyond energy use, GHG emissions from refrigerants are also a concern. A well-established regulatory framework for refrigerants is already in place and unfolding; Canadian regulations phase out use of HCFCs (such as R-123) for new equipment as of January 1, 2020. Similar phase-outs for HFCs (e.g. R-410A) will occur over the next two decades, with phase-out for chillers beginning in 2025. HCFCs, while highly efficient, have moderate to high global warming potential when released to atmosphere through leakage. Newer refrigerants such as R-1233zd have very low impacts but may also result in slightly reduced equipment performance.

Inhaled anaesthetics are also recognized greenhouses gases with significant global warming impacts. As these gases are not metabolized, they are released to atmosphere largely unchanged after being exhaled. A readily available solution for recapture of these gases is manufactured in southern Ontario. Recapture systems have been retrofit into several hospitals and included in new hospital design, including at the **NH St. Catharines Site**. For reference, the relative impact of various refrigerants and anesthetic gases is summarized in Table 3 on the following page.[1]*Source: https://academic.oup.com/bjaed/article/15/4/173/305822*

Table 3: Impacts of Refrigerants and Anesthetic Gases

GAS	GLOBAL WARMING POTENTIAL (100 YEAR)[1]	OZONE DEPLETION POTENTIAL
R-123	77	0.06
R-1233zd	6	0.00024
Desflurane	2540	0
N20	310	0
Isoflurane	510	0.01
Sevoflurane	130	0

[1]*Source: https://academic.oup.com/bjaed/article/15/4/173/305822*

Finally, hospitals such as **Surrey Memorial Hospital's Critical Care Tower** have addressed carbon emissions from production of construction materials through the use of wood structural elements where feasible. Replacing concrete and steel with renewable wood materials reduces embodied energy and carbon and encourages investment in the carbon storage capacity of forests in line with B.C.'s 2009 *Wood First Act.* As industry knowledge of LCA practices develops, establishment of specific targets and thresholds for embodied carbon intensity for various building types is likely to become an industry norm.

OPERATIONS PHASE BEST PRACTICES & LESSONS LEARNED

Since 2013, public agencies in Ontario have been required to report annual energy use and carbon emissions to the Ministry of Energy, Northern Development and Mines, and to develop five-year conservation and demand management plans to reduce energy use and emissions. These inventories provide basic tracking of emissions resulting from energy use, but do not address refrigerants, anesthetic gases, or procurement. Figure 11 below summarizes a more complete approach to operating greenhouse gas accounting, taken from the **United Kingdom**

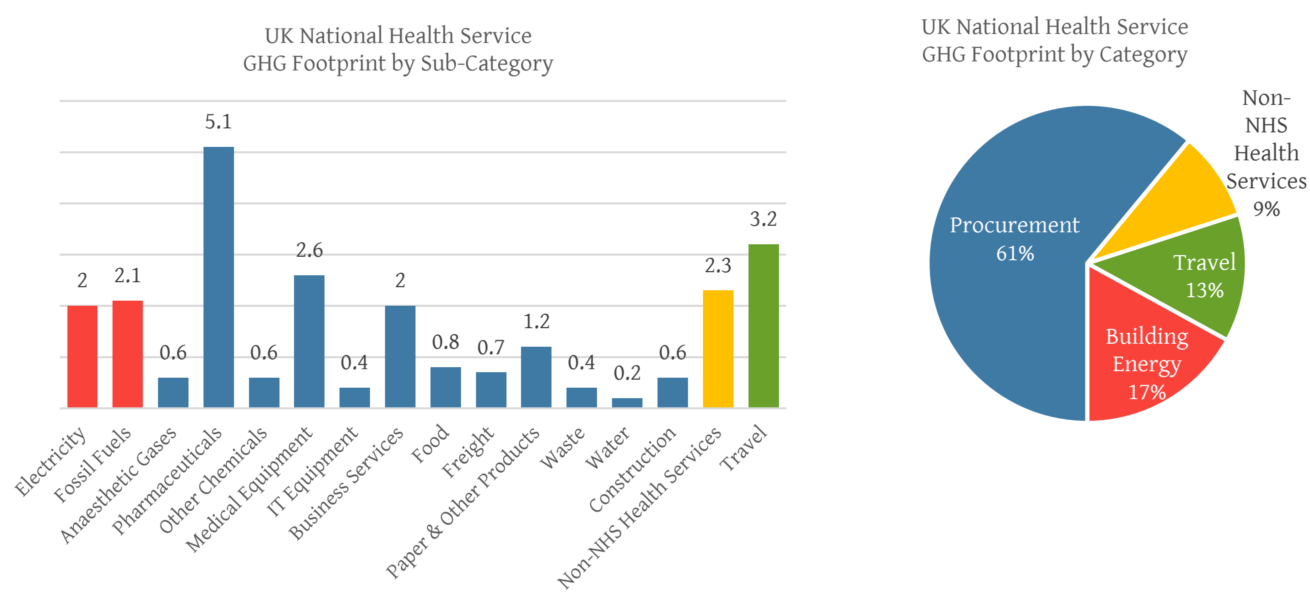


Figure 11: UK NHS GHG Footprint

National Health System (UK NHS)'s annual carbon footprinting inventory. This analysis of emissions from the UK's entire national public healthcare sector includes not only building energy use, but also procurement, waste, travel and other healthcare services. Based on the 2012 data presented in Figure 11, annual emissions from procurement (shown in blue) are 3.5 times higher than emissions from building energy (shown in red). Impacts from pharmaceutical procurement are particularly high, as they are calculated based on total dollars spent on drugs times the emission intensity of the entire pharmaceutical sector, including R&D. UK NHS plans to conduct this full carbon footprint analysis every 4 years, and has committed to reduce its GHG emissions 60% by 2050.

North American healthcare organizations such as Vancouver Coastal Health Authority also beginning to extend their GHG inventories to address operating emissions from operations, not just energy. **MetroHealth Community District**, in Cleveland Ohio, is also targeting carbon neutrality as a part of its bid for EcoDistricts certification. Currently under construction, the entire district of 585 acres has committed to eliminate, sequester, and/or offset carbon emissions from energy as well as water, solid waste and transportation. As mentioned in a previous case study, MetroHealth is also targeted WELL certification for excellence in health and wellness.

HOSPITAL PERFORMANCE BENCHMARKING

The cross-province survey of utility consumption data for Ontario public sector buildings (OBPS 2016) referenced above indicates that the operating carbon emission intensity of Niagara Health's existing hospitals is below the 2016 Ontario hospital 2016 average of 89 kg CO_2e/m^2, as shown in Figure 12. Two newly built hospitals **-- Humber River Hospital** (profiled on the following page) and **Peel Memorial Hospital** -- have reduced emissions by nearly 50% from this average, indicating that additional continual performance improvements are achievable even for large hospital facilities. Note that data for Peel Memorial reflects its 2017 emissions as the facility opened to the public in early 2017.

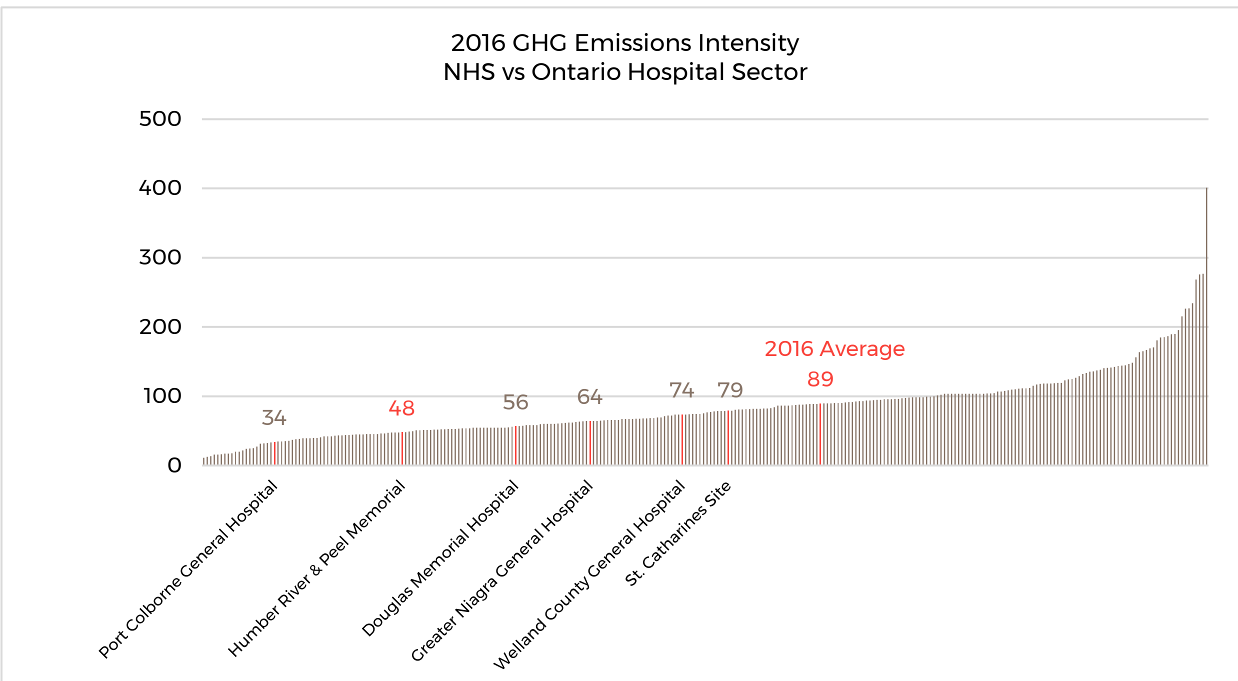


Figure 12: GHGI (kgCO2e/m²) Comparison of Ontario Hospitals

CASE STUDY | HUMBER RIVER HOSPITAL

[redacted]

Image Source : https://www.toronto.com/community-story/7272527-toronto-s-humber-river-hospital-is-leed-gold-certified/

Humber River Hospital in Toronto, Ontario, is a 1.8 million ft^2 acute care hospital designed according to three core principles: "Lean, Green and Digital". The facility is North America's first fully digital hospital, integrating the latest technologies and promoting adaptive and flexible design. At the time of completion, Humber River established itself as the most energy efficient hospital in North America. In addition to energy efficiency, other environmental highlights include noteworthy accomplishments in water efficiency, health and wellbeing, waste reduction and recycling, and landscape design.

HIGHLIGHTS

ENERGY EFFICIENCY

- 17 points achieved for LEED EAc1
- Achieved 27% lower than targeted EUI and 56% lower total EUI than equivalent acute care hospitals in ONMaximized passive solar heating/cooling
- Greywater heat reclaim
- Infrastructure for future PV

WATER EFFICIENCY

- Rainwater harvesting
- 2 points achieved for LEED WEc3
- Low flow fixtures are tailored to each area of use

DESIGN STAGE

Early in Humber's design, the project team established key sustainability priorities including minimizing energy use through innovation, detailed energy modelling and continual performance monitoring through energy submetering and measurement and verification.

The hospital achieved a 30% energy savings and 17% energy cost savings compared to the LEED baseline, achieving 17 EAc1 points and surpassing its mandated target of 15 points. Measures included modulating high efficiency boilers combined with a smaller steam boiler, variable speed drive pumps and fans, increased insulation levels in walls and roofs, high performance windows and efficient lighting design. The building's 26,000 ft^2 View Dynamic Glass (smart glass) installation — one of the largest electrochromic glass installations in the world — lowers energy use while increasing access to natural light and views. The smart glass automatically optimizes interior environmental quality through built-in solar heat gain and glare controls. Greywater from sinks and showers is circulated through heat exchangers before being discharged from the facility. Electrical infrastructure for future photovoltaic (PV) installation on the parkades is also incorporated into the design, as on-site renewable energy was deemed too expensive during initial construction.

The project's Sustainable Design Requirements addressed water efficiency though mandatory achievement of four points for both LEED credit WEc3: Water Use Reduction and WEc1 Water Efficient Landscaping, requiring at least a 40% reduction of fixture water use an 100% elimination of potable water for irrigation. Although high-efficiency water fixtures are installed where possible, the design was adjusted to use higher flow fixtures in procedural use or mental health areas. Reducing indoor water use through supply of non-potable water to flush fixtures was also not feasible due to infection risk; as such, the original 4-point WEc3 target was revised in a subsequent addendum to a 2-point target for a minimum water savings for 30%. Non-potable rainwater is collected for exterior irrigation use only, serving the site's low maintenance, drought-tolerant plants from two underground cisterns. Public areas located further away from the building are planted with even hardier species and are not irrigated. All stormwater is infiltrated on site to prevent discharge into municipal sewers during storm events, including the use of bio-swales along large open areas.

Humber's site is designed to be functional and comfortable as well as water efficient. Healthy connections between the hospital, community and regional parkways are promoted through flexible landscape design, the creation of exterior "landmarks", green roofs installed on 50% of the available roof and the use of native or edible vegetation. A microclimate study revealed areas within the landscape requiring location-specific design strategies to mitigate discomfort from extremes of climate and weather.

HIGHLIGHTS

LANDSCAPE & NATURE

- Community and regional parkway connections
- 100% non-potable water for irrigation
- Native/edible vegetation to support biodiversity that can be interacted with

HEALTH & WELLNESS

- Individual control of lighting and workstation configuration
- Tint-controlled patient windows

WASTE REDUCTION & RECYCLING

- 96% of construction waste diverted
- TransVac automated waste & linen collection system

Waste reduction and recycling strategies reflect Humber's lean and green sustainable design principles. More than 95% of construction waste was diverted from landfill. TransVac's automated technology separately collects waste, recyclables and soiled linen throughout the facility and deposits them in the loading doc. The TransVac system establishes a dedicated pathway for waste, reducing exposure to airborne diseases and frees up hospital resources to be re-directed into patient care. Humber is also designed to be a paper-light facility through efficient automation of about 75% of back-of-the-hospital functions including pharmacy, laundry and food delivery. However, its digitalization also meant high equipment costs and extensive staff training requirements in the operations stage.

Humber's design also prioritizes an environment of wellness for hospital employees, patients and users, with goals of improving staff performance, staff retention, patient experience, and reducing healing times and reducing workplace error. To achieve these outcomes, indoor environmental quality strategies such as individual control over work environments (lighting, furniture ergonomics, acoustics) and patient room windows, "lift-free" design in patient care spaces and access to natural light, views and outdoor spaces are employed.

OPERATIONS STAGE

An extensive measurement and verification (M&V) exercise was completed on the post-construction facility in 2017 to determine if the project's energy goals had been met. This process revealed that natural gas consumption was only 46% less than the baseline, rather than the modeled 70%. Similarly, electricity consumption was 9% less than the baseline, rather than 13%. Overall, Humber River uses 28% more energy than its intended design performance, indicating that there is further potential to reduce the hospital's energy consumption.

Potential reasons for this over consumption include low boiler efficiency, simultaneous heating and cooling and unreliable submeter data. Steps have now been taken to better align operational performance with the project's mandatory energy target. Recently implemented measures include decreasing fan power by 6% by rescheduling air handling units to slow down at night, recommissioning submeters, adjusting the chiller sequence to avoid false loading and installing a smaller steam boiler to improve energy efficiency.

Image Source: https://greenbuildingnews.com/2017/06/27/humber-river-hospital-toronto-earns-leed-gold-status/

2.2.3 ENERGY EFFICIENCY

ENERGY EFFICIENCY

KEY STRATEGIC INSIGHTS

- Energy conservation is already captured in most Infrastructure Ontario DBFM design and operating requirements, including operating phase energy targets (pain-share/gain-share model)
- Previous provincial incentive programs for energy efficient design have been largely phased out
- Load reduction for both heating and process loads are key considerations for hospital facilities
- Humber River Hospital represents a milestone in design and operational performance for new Ontario hospitals, despite its performance gap between design EUI and operating EUI

DESCRIPTION
Location: Brampton, Ontario

Geothermal field provides approximately 85% of the building's heating and cooling.

LEED Gold Certified

STRATEGIC INSIGHTS

- A large geothermal field, located below the south parking lot, provides approximately 85% of the building's heating and cooling loads.
- The geothermal field incorporates over 100 boreholes which extend approximately 600 feet below the surface.
- An innovative energy metering system was installed to track building performance.
- More than 90% of modulating and condensing boilers and water heaters are efficient.

INDUSTRY TRANSFORMATION AND POLICY TRENDS

Canadian hospitals have the second-highest energy intensity (measured as energy use per unit of floor area) of all commercial and institutional building types. Energy bills for large hospitals represent a multi-million dollar annual operating expense. To control these costs, the majority of Infrastructure Ontario's DBFM hospital project agreements incorporate both design phase energy performance targets (typically called minimum energy targets or METs) and energy performance guarantees (typically called pain-share/gain-share or PS/GS) requirements. IO has developed and refined the MET process over many projects. Targets are initially established during the pursuit phases based on detailed energy modeling, formalized during financial close and award, potentially refined during design development through a formal variation process and then calibrated once again post-construction. Project teams are motivated to achieve the final agreed upon target, as they are forced to take an annual financial penalty which scales relative to the cost of energy for natural gas and electricity if the MET has not been achieved. If energy prices go up, so too does the penalty.

LEED has also historically focused on operational energy cost reduction. Project Agreements have typically mandated a certain number of LEED points based on this energy cost reduction model. As previously discussed in **Section 2.2.2**, LEED is now testing carbon reduction as an alternate metric for its energy efficiency credit, and IO is piloting this new metric on at least two current projects.

In addition to energy consumption and cost, incentive programs such as Ontario's High-Performance New Construction (HPNC) program have encouraged a specific focus on electricity demand reduction due to the large electrical process and facility loads of hospitals. As these programs were phased out in early 2019 without a clear replacement, this financial driver for load reduction has now been lost. Remaining design stage incentive opportunities (such as Savings by Design) are useful for supporting integrated design, but provide small financial incentives for energy efficiency compared to HPNC.

Finally, the recently released ZCB program is encouraging detailed attention to envelope thermal performance as a major driver of energy use, as discussed below.

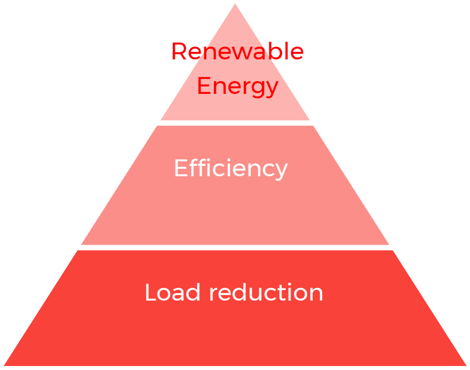


Figure 13: Energy Reduction Foundation

DESIGN PHASE BEST PRACTICES & LESSONS LEARNED

Figure 13 summarizes the relative impact of various design strategies on energy consumption. Energy efficient buildings must first reduce underlying loads; that is, ventilation, heating and cooling requirements as well as lighting and equipment. Once loads are established, active building systems such chillers, boilers and lighting systems are put in place to serve those loads. Smaller loads enable more efficient equipment and control strategies. Finally, the highest levels of energy performance are achieved by offsetting the remaining energy requirement with on-site renewable energy generation rather than purchased energy.

As mentioned above, the ZCB program has encouraged a new focus on thermal energy demand intensity (TEDI) as a key metric for evaluating the base energy load of buildings. TEDI summarizes the heating or cooling energy required to serve envelope energy loss and ventilation requirements. It is primarily influenced by building envelope performance (including insulation, windows and thermal bridging), ventilation heat recovery effectiveness and envelope airtightness. As shown in Figure 14, the cooling thermal energy demand intensity (TEDI-c) for most hospitals is larger than heating thermal energy demand intensity (TEDI-h).

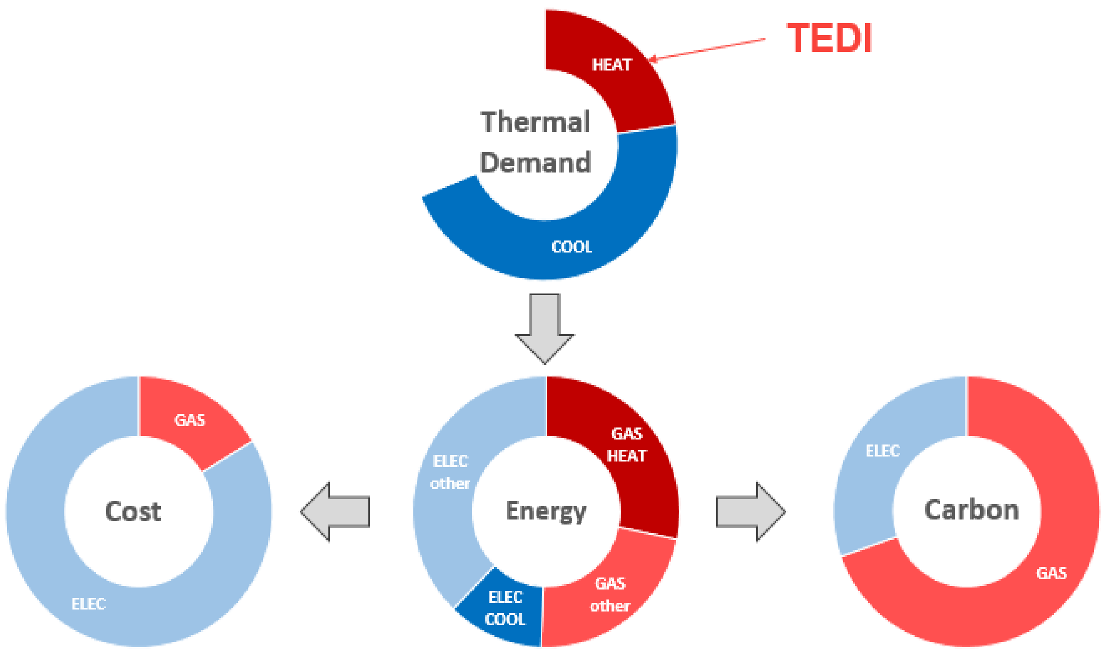


Figure 14: Comparison of Thermal Demand, Energy, GHG Emissions and Energy Cost for a typical hospital

Based on typical loads, heating and cooling together represent slightly less than half of the total energy used in hospitals. Once other loads such as medical and imaging equipment, commercial kitchens, and other process energy are included, a typical hospital's total combined energy use is split roughly equally between natural gas and electricity, as shown in Figure 14. Although heating demand is lower than cooling, the reduced efficiency of gas-fired boilers (about 85-95% efficient) compared to electrically-driven chillers (about 300-600% efficient) increases natural gas consumption. Because the price of electricity in Ontario is around five times more than the cost of natural gas, electricity costs significantly outweigh natural gas costs, typically encouraging a focus on electricity reduction measures per the defunct High-Performance New Construction Program. Electricity costs are further inflated as most large hospitals are Class A facilities subject to global adjustment charges, which more prominently factor peak demand into their rate structure.

Variability in typical hospital energy performance is shown in Figure 15, which details an illustrative energy end use breakdown derived from actual **Humber River Hospital** metered data. Additional loads are included based on average values for acute care hospitals from the Commercial Building Energy Consumption Survey (CBECS) dataset. Ranges of performance for each end use are also shown. Heating energy variance is typically a result of ventilation system design (such as outdoor air fraction and use of heat recovery), operating schedules, and operational issues requiring further commissioning. Variance in process energy is typically a result of IT design including number of servers, or energy source such as electrical versus natural gas steam generation or sterilization. From Figure 15, it is clear that reducing process loads is key to addressing the half of hospital energy consumed by this equipment.

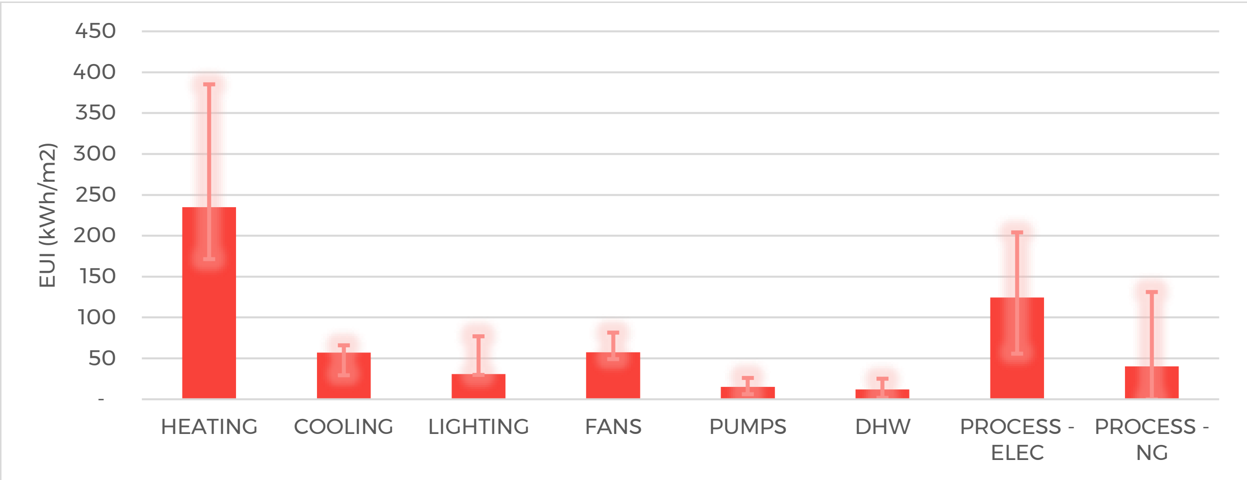


Figure 15: Illustrative Baseline End-use (Typical Ontario Acute Care)

Due to the lack of incentives for large renewable energy installations in Ontario recent hospital projects such as **Peel Memorial** and **Humber River** have not included on-site generation infrastructure. Although hospitals typically have large rooftop areas suitable for equally large PV arrays, their overall electricity use is high enough that on-site generation can only address a small fraction of the building's energy need. As electricity prices rise and the cost of PV modules decline, renewable energy may become financially viable in the recent future. As was decided for **Humber River**, a solar-ready design with additional structural loading capacity and electrical servicing needs for PV provides flexibility for the future. Biomass from responsibly managed forests offers another potential renewable energy source that is being considered for low carbon new builds and retrofits, although not yet in the hospital sector.

OPERATIONS PHASE BEST PRACTICES & LESSONS LEARNED

In the operations phase, the gap between design performance targets and actual hospital performance is a significant concern. The core function of Mandatory Energy Targets and pain-share/gains-hare agreements are to drive project teams to close that gap by attaching financial incentives to measurable performance tracking. For **Humber River**, extensive measurement and verification in the facility management (FM) stage led to implementation of several energy conservation measures despite the fact that the facility had only recently opened, as discussed in the previous case study. This result is a testament to the benefits of the PS/GS process (and especially the pain-share part).

This performance gap between modeled and actual performance is likely to widen as METs become stricter and more emphasis is placed on process/user-driven systems such as sterilization and kitchen operation. As operating parameters for this equipment are difficult to predict, the accuracy of modelling results for total energy use for the facility decreases. Even if not attached to contract PS/GS terms, continuous review of submeter and system data is important to support ongoing commissioning processes and maintain performance.

HOSPITAL PERFORMANCE BENCHMARKING

Based on the data from the Ontario public sector buildings energy use survey (OBPS 2016) previously referenced in **Section 2.2.2,** existing Ontario hospitals largely fall within or below the energy use intensity ranges identified by EnergyStar, IBPSA, Architecture 2030 and various other prominent benchmarking datasets. Survey results are summarized in Figure 16. It is clear that Ontario hospitals are already performing well, and progressively strict operational targets are demanding construction and operation of even more efficient buildings.

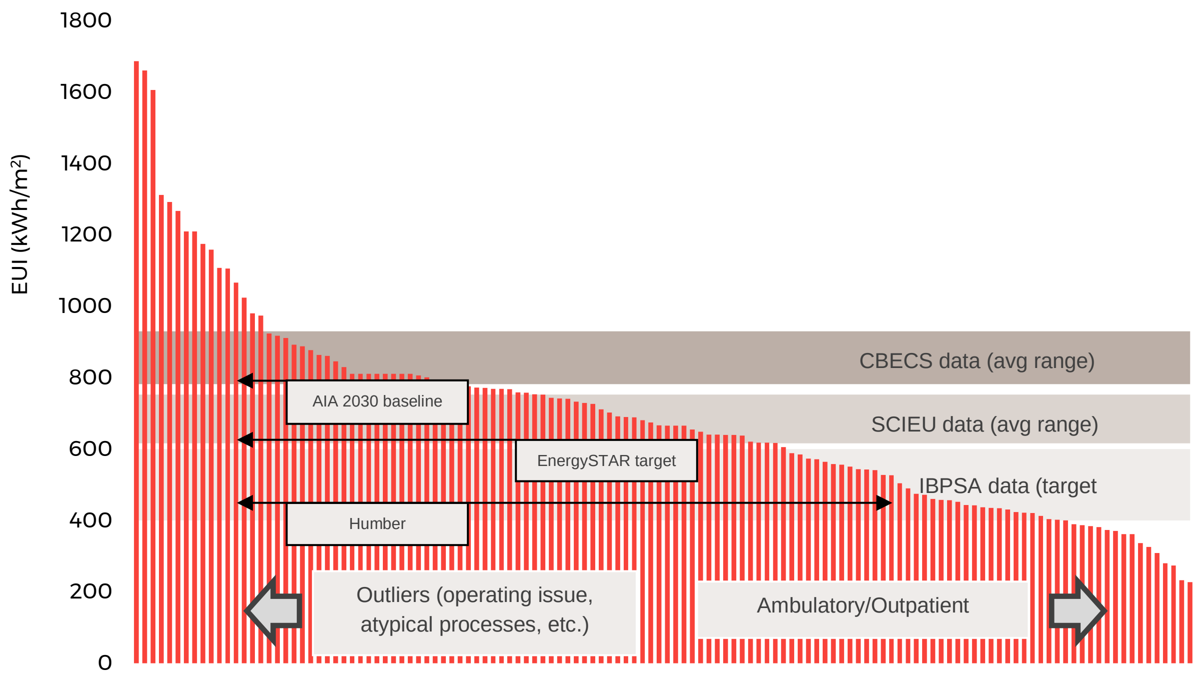


Figure 16: Hospital Energy Benchmarks (including all facilities labelled as "hospital" in the OBPS 2016 database)

Compared to ambulatory/outpatient facilities, full-service acute care hospitals have demanding building program factors and process equipment needs that make it difficult to achieve low energy use intensities compared to healthcare facilities of other types; however, the strong performance of **Humber River Hospital** clearly indicates advanced targets are achievable using currently available technology and construction practices. Figure 17 focuses on acute care hospitals similar to the planned Niagara Health Services facility in size and building program, also including calibrated model results for Humber River. Even with its early operational issues included, Humber is at least 100 kWh/m² more efficient than most other facilities in the same class of recently-built DBFM facilities.

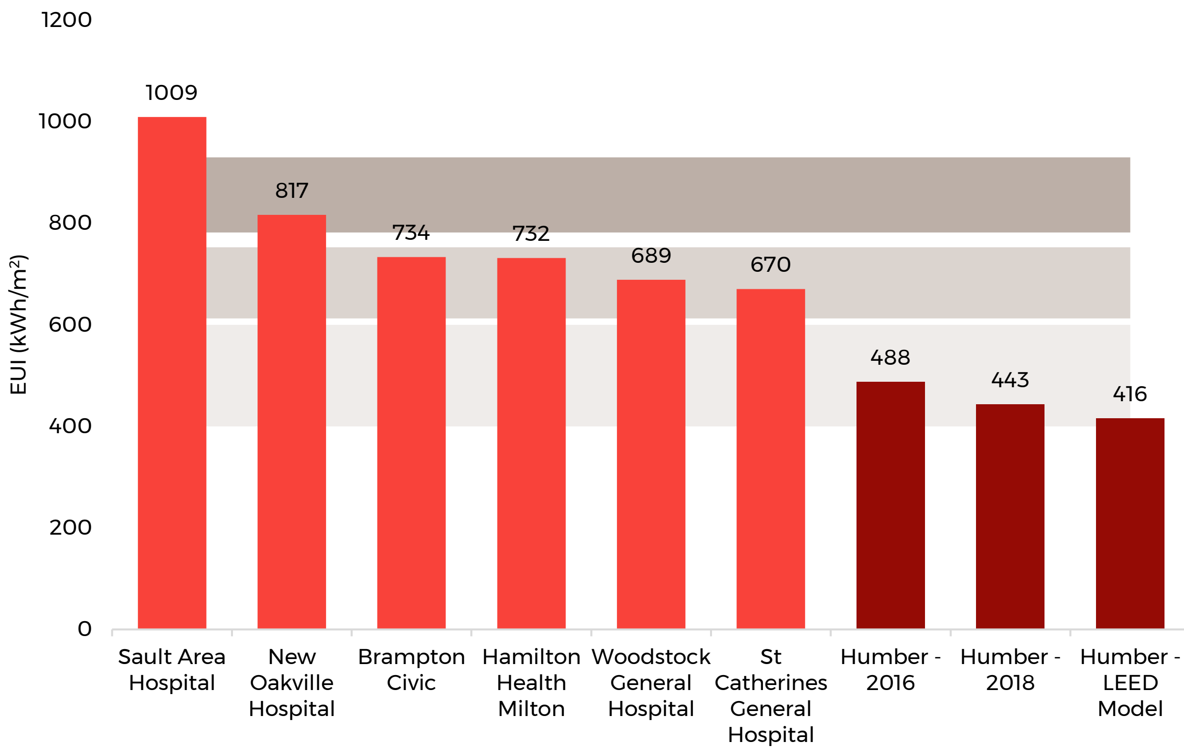


Figure 17: Energy Use Intensity of Selected Acute Care Hospitals (kWh/m^2)

2.2.4 WATER EFFICIENCY

WATER EFFICIENCY

KEY STRATEGIC INSIGHTS

— Sewer overflows are a significant concern in the Niagara region, encouraging a focus on wastewater reduction and stormwater management.

— Hospital water reduction efforts have typically focused on system design features for plumbing fixtures and landscaping. Rainwater harvesting for irrigation use is also a feature of several newer hospitals.

— Post-construction performance verification or mandatory water use intensity targets is not yet common in Infrastructure Ontario DBFM projects.

INDUSTRY TRANSFORMATION AND POLICY TRENDS

Canada is a nation rich in water resources, containing 8% of the world's renewable freshwater. Although water is abundantly available in most regions of the country, including Niagara, excessive water use remains a concern due to the strain placed on municipal infrastructure, particularly for wastewater treatment. As a result, water efficient design practices for plumbing fixtures and landscape design are typical components of green building rating systems such as LEED. LEED BD+C v4 for Healthcare now also mandates water efficient medical and laboratory equipment as a minimum requirement for certification.

In Niagara, sewage overflows during high rain events are of particular concern. In 2017, Niagara Region discharged 834 million litres of sewage into the hydro canal and Niagara River. Efforts to reduce the frequency and volume of these events are ongoing, as the Region examines stormwater management practices, wastewater treatment capacity and the effect that climate change has on rainfall patterns, particularly storm intensity. Planned wastewater servicing for the Grand Niagara Secondary Plan Region is shown in Figure 18. Hospitals are often one of the largest users and

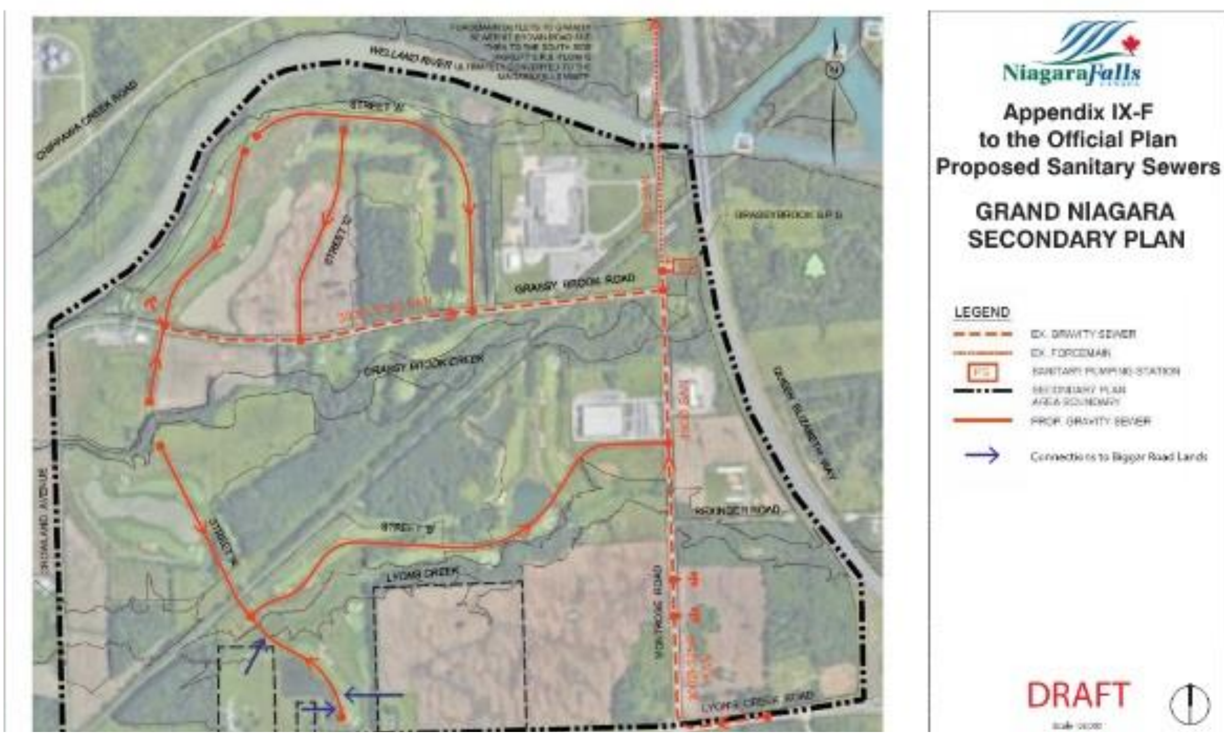


Figure 18: Planned Wastewater Servicing for the Grand Niagara Secondary Plan

thus disposers of water in a community; the South Niagara hospital will certainly be one of the largest users within this development boundary.

Water quality and its impact on human health is another area of concern distinct from water consumption or stormwater management. Water quality considerations for hospitals can include drinking water properties, wastewater pH levels and pharmaceutical micro-contamination, and pollution of stormwater with vehicle fluids, road salt, and other chemicals. The latter is addressed in **Section 2.2.5** as a landscape design consideration. Although Niagara's municipal regulations outline acceptable pH range for wastewater discharge and minimum potable water quality properties, these minimums do not fully address the more specific wellness concerns such as drinking water taste quality included within the WELL Building Standard.

DESIGN PHASE BEST PRACTICES & LESSONS LEARNED

As shown in Figure 19, the three largest end uses for water in hospitals are plumbing fixtures, cooling and heating equipment, and medical process equipment. Typical design stage water conservation measures for hospitals have therefore focused on specifying low-flow and sensor-enabled plumbing fixtures to reduce the largest of these end uses. Ultra-low flow fixtures are now readily available in the market, with significantly improved efficacy compared to earlier versions. Water efficient medical process equipment such as reverse-osmosis water purifiers and sterilizers and commercial cooking and dishwashing equipment has also become available.

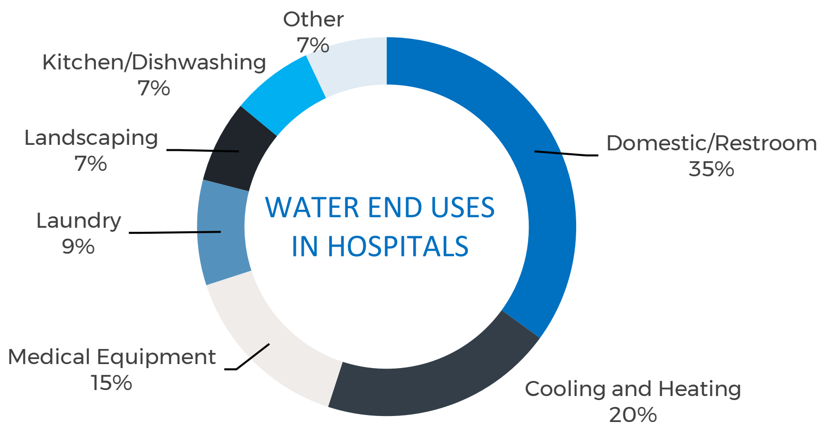


Figure 19: Proportion of water use for various activities within the hospital

Figure 20 provides a summary of the design indoor water use reduction for plumbing fixtures installed at several new hospitals, compared to the LEED baseline. Reductions for this credit are primarily achieved through the specification of low flow water fixtures. Per the results below, new hospitals average a 33% reduction, lower than the 40% reduction achieved by most commercial office new builds. This is due to the need for higher flow water fixtures in specific patient care areas. For example, **Humber River Hospital** found ultra low flow fixtures or dual flush designs were not appropriate in mental health care areas.

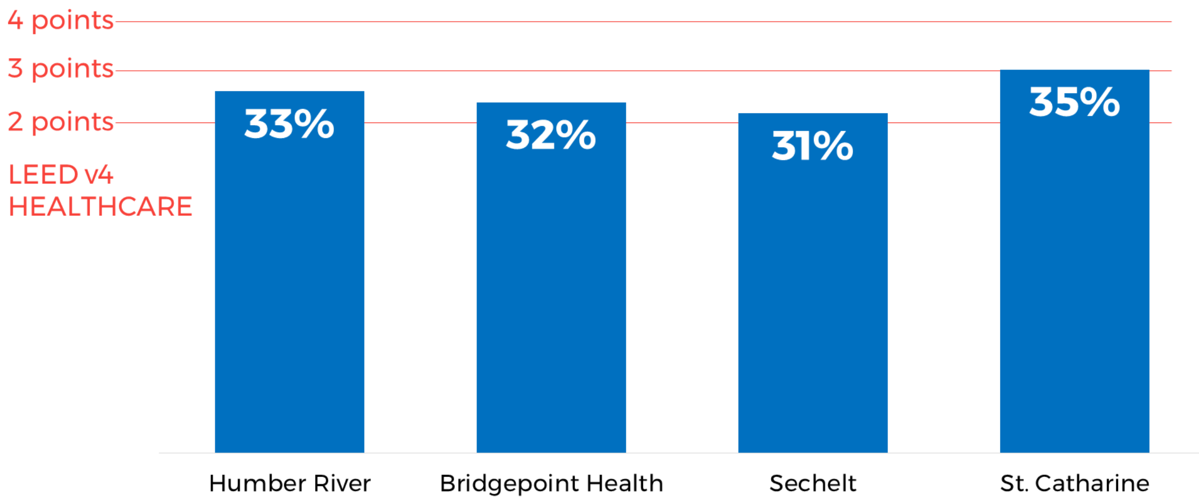


Figure 20: LEED Indoor Water Use Reduction

To reduce water use for cooling and heating, cooling towers are typically equipped with makeup water meters, conductivity controllers and chemical treatment systems to increase cycles of concentration. Potable water use can be further reduced by supplying towers with reclaimed water from condensate reclaim or harvested rainwater. Highly efficient hospitals such as **Peel Memorial Hospital** and **Sechelt Hospital** have completely eliminated cooling towers from their design by rejecting heat to ground through geo-exchange loops, rather than to air. Removing cooling tower equipment has the further benefit of eliminating the single biggest potential source of Legionella infection.

Although many buildings have sought to eliminate irrigation requirements for landscape through selection of drought-tolerant shrubs and replacement of water-intensive lawns with meadow grasses & native bulb and seed mix, this approach carries the risk of reduced lushness during the summer months. Technologies such as drip irrigation and weather-responsive controllers offer one design strategy to reduce landscape water consumption. Rainwater collection for irrigation use is also being employed to promote plant health without increasing water demand. Located along the rain-heavy BC shoreline, curb cuts drain storm water from paved areas into infiltration gardens provide low-cost rainwater collection pathways at **Sechelt Hospital**. In the drier Toronto region, **Humber River Hospital** employs a rainwater cistern to irrigate green space and gardens. Rainwater collection has the further benefit of reducing stormwater flows during intense rain events, which are likely to become more frequent due to changing climate. As hospitals increasingly focus on access to nature as a significant driver of well-being for staff and patients (as discussed in **Sections 2.2.1** and **2.2.5**), non-irrigated landscape designs may not provide sufficiently diverse and flourishing outdoor environments.

Although other potential sources or uses of reclaimed water are often explored in ultra-green buildings, the majority of these strategies are not suitable in a hospital facility. Due to the high microbial levels in water discharged from hospital sinks and showers, and a need to maintain an environment with low contamination risk, greywater collection and reuse in flush fixtures is not recommended in healthcare facilities. Circulation of non-potable rainwater (even if treated) in the hospital interior is also not recommended for this reason. Although the **Perth Children's Hospital** in Perth, Australia was originally designed with a greywater collection, treatment and reuse system, this infrastructure was ultimately removed before the hospital opened due to infection control concerns.

OPERATIONS PHASE BEST PRACTICES & LESSONS LEARNED

Water reduction efforts in hospitals have largely focused on design features and less on post-construction performance verification. Newer hospitals such as **Michael Garron Hospital** have mandated installation of hospital-wide submeters to allow monitoring of water use data at the sub-system level and to identify leaks more quickly. This data will not be used to confirm that intended design performance has been achieved, however. If controlling water use (and resulting water cost) one day reaches the level of importance of controlling energy use and cost, mandatory water targets in the operations phase, tied to similar pain-share/gain-share clauses attached to mandatory energy targets, may emerge as a strategy to ensure DBFM projects achieve intended design efficiencies. Infrastructure Ontario's openness to such Project Agreement terms for water is discussed later in this report.

Beyond restructuring contract terms, important water management strategies include ongoing calibration of automated sensors and controls on flow and flush fixtures, regularly inspecting for leaks, and reviewing water meter data for irregularities.

HOSPITAL PERFORMANCE BENCHMARKING

Operating water use intensity varies widely across hospitals based on their age, amount of process equipment, and annual patient-hours. Figure 21 provides a comparison of the water use intensity on a floor area basis for NH's existing hospitals compared to the average water use intensity for acute care facilities from the 2016 Green Hospital Scorecard (outlined in **Section 1.3**). NH's hospitals have significantly lower water use intensity than the Scorecard average, and the new hospital can be expected to perform at or below the intensity of the **St. Catharine** and **Greater Niagara General** sites.

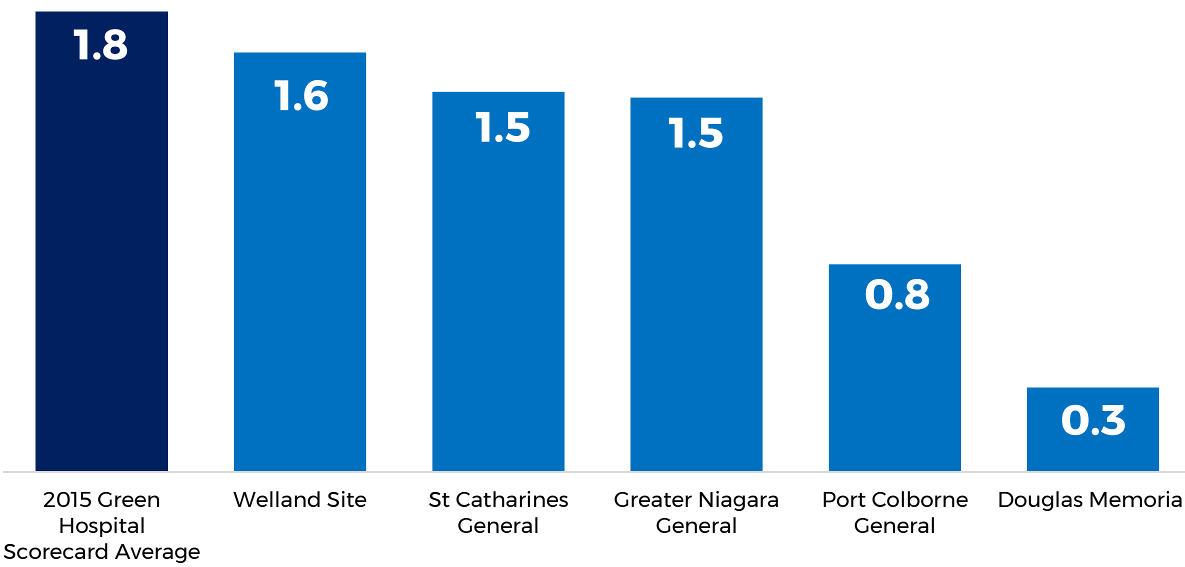


Figure 21: Operating Water Use Intensity (m^3/m^2)

CASE STUDY | MICHAEL GARRON HOSPITAL

Michael Garron Hospital

Location: Toronto, Ontario

DESCRIPTION

- 550,000 ft^2 Acute & Complex Care Addition
- Under Construction
- Project Type: DBF
- Targeting LEED BD+C v4 for Healthcare Silver

Image Source : http://www.quinndesign.ca/michael-garron-hospital

Michael Garron Hospital, formerly known as Toronto East General Hospital, is an acute and complex care hospital division of the Toronto East Network. Since it opened in 1929, the hospital has undergone several redevelopments and is currently adding an extension to replace several outdated hospital wings with an 8-storey, 550,000 square feet patient tower. The tower will include two levels of outpatient care clinics and six stories of inpatient beds.

Construction of the extension began in April 2018 and is expected to be completed in 2021. The project's sustainable design features demonstrate a commitment to an environment of wellness, durability, quality, safety, and performance and includes a focus on energy efficiency, sustainable materials, transportation and landscape. The hospital is targeting a minimum of LEED BD+C v4 for Healthcare Silver certification.

HIGHLIGHTS

ENERGY EFFICIENCY

- Minimum 6 points for EAc1
- Energy target of 444 ekWh/m^2
- Envelope & Ongoing Commissioning

MATERIALS & PRODUCTS

- Mandatory envelope commissioning to ensure project is designed and constructed for a 100-year lifespan
- DBF contract increased the focus on durability considerations in design
- Recommended LEED credits include PBT Source Reduction, Furniture & Medical Furnishings, Low Mercury Lighting.

DESIGN STAGE

A mandatory energy target has been established to drive operational energy savings, although achievement is not tied to pain-share/gain-share terms under the projects DBF contract structure. The extension is mandated to achieve a design annual energy use intensity of no greater than 1.6 GJ/m^2/yr (or 444 ekWh/m^2/yr). Based on this energy target, the project must achieve a minimum of 6 points for LEED v4 credit EA Optimize Energy Performance, reflecting a 12% reduction in energy cost compared to the LEED baseline. Detailed energy simulation requirements to verify the hospital's design performance have been extensively documented in the project specific output specifications (PSOS).

The importance of commissioning during every stage of the project including design, construction and occupancy is also recognized in the PSOS. LEED credit EA Enhanced Commissioning is mandated for a minimum 5 points, requiring the project to commission mechanical, electrical, plumbing and renewable energy systems, as well as the thermal envelope.

The DBF contract also focuses on material durability considerations by defining a 100-year lifespan for the New Patient Care Tower, LEED credit EA Enhanced Commissioning, Option 2 Envelope Commissioning is mandated to ensure detailed review of enclosure design details and review of contractor material submittals is completed, and envelope performance is tested for air and water infiltration. All exterior materials are required to be high quality, durable, institutional-grade architectural components that reduce noise and vibration and withstand damage from weather, vandalism and impact from vehicles.

Although not mandatory, the project is also expected to pursue one or more of the new LEED v4 materials credits requiring documentation of extended producer responsibility supports, raw material sources, chemical ingredients, and lifecycle impacts. Recommended LEED credits include those that promote reduction of persistent bioaccumulative and toxic (PBT) chemicals such as lead, cadmium and copper, selection of furniture and medical furnishings that contain minimal chemical content and/or meet specific environmental criteria (materials reuse, recycled content, environmental product declarations, etc.), and low mercury lighting. Energy efficient and/or reused or recycled materials will be chosen along with natural materials such as clay, brick, stone, glass and wood. Conversely, materials such as precast concrete panels, stucco, metal siding, embossed face brick panels, vinyl, and EIFS (Exterior Insulation Finish Systems) are not permitted.

The project also recognizes landscape as an integral part of the healing process, requiring the site to be designed for the benefit of patients, their families, hospital staff, and the surrounding community. Key landscape design features include accessible outdoor spaces, a community garden, rooftop terraces and green roofs, and a dedicated staff courtyard. Plants for smudging ceremonies are specified including sage, cedar and tobacco, together with medicinal plants such as Lavender and Centrosema. The 3,400-m^2 community Coxwell Garden is composed of a series of outdoor rooms inspired by the Music Garden in Toronto and Bryant Park in NYC, and is intended to be used for special public events. On the south side, the Event Lawn and Terrace provides fixed chess/checker tables, space for an outdoor ping pong table and shaded sitting areas for dining. To the north, the Great Lawn supports community events including concerts and performances, the east side of the garden includes a junior play area with playground elements for children. A roof terrace on Level 5 is designated for Adult Mental Health and will accommodate dining, group activities, horticultural therapy and physical activity. The Level 4 roof terrace is dedicated for casual use by staff, patients and visitors. Green roofing systems used on the roof terraces and other roofs follow the City of Toronto Green Roof By-Law and the roof structures were designed for storm water retention without reuse.

HIGHLIGHTS

LANDSCAPE & NATURE

- Community garden
- Staff courtyard
- Rooftop terrace for mental health program
- Plants for smudging ceremonies
- Green roofs per Toronto Green Standard
- Stormwater capture without reuse

TRANSPORTATION

- 10 EV chargers (per floor of parking) out of 407 stalls
- Secure bike cages with card access

Parking at the NPCT is provided by a new four-storey below-grade parking garage. The garage includes charging stations for electric vehicles, one of which is an accessible space, on each level of parking. To provide for future expansion of charging infrastructure, the parking garage also includes strategically placed knockout panels on each level. More than 100 staff bicycle parking spaces are supplied on the first level of the parking structure. For enhanced security and accessibility, bicycle storage rooms can be accessed without crossing vehicular traffic corridors and include secure metal cages, card access-controlled doors and 100% security camera coverage. An additional 150 visitor bicycle parking spaces are provided in a publicly accessible location at-grade or on the first parking level.

Image Source: http://www.pmalarch.ca/projects/strategies/michael-garron-hospital/#h3Image_6

2.2.5 LANDSCAPE & NATURE

LANDSCAPE & NATURE

KEY STRATEGIC INSIGHTS

- Inclusive and accessible site design enable users of all abilities to access and engage with nature. Many recently designed hospitals include therapeutic and food gardens as a key design feature.
- Increasing year-round access to natural daylight – inside and outside the building – can be facilitated by innovative building footprint designs.
- Plant selection should prioritize drought-tolerant, hardy species that require limited application of pesticides and herbicides, and serve community needs such as Indigenous healing ceremonies or comfort shading.

INDUSTRY TRANSFORMATION AND POLICY TRENDS

In the healthcare sector, hospital planners have fully embraced the link between human well-being and access to natural environments. Most recent hospital projects incorporate exterior spaces for therapeutic and restorative gardens and several apply biophilic design principles to interior spaces, mimicking natural environments with material selection and interior vegetation.

Use of low impact development (LID) techniques to better treat and infiltrate stormwater runoff within landscaped areas is also an increasing priority, as climate change alters rainfall patterns and risks of flood and drought increase. Densification of cities also makes stormwater design a critical area of focus. The Grand Niagara Secondary Plan notes that naturalized stormwater management facilities will be key features within the newly developed community surrounding the South Niagara Hospital. These retention ponds will contribute to the appearance and ambience of the neighbourhood while achieving functional objectives related to flow moderation and water quality.

CONSTRUCTION PHASE BEST PRACTICES & LESSONS LEARNED

Access to landscape and nature is mostly easily maintained by designing sites with a reasonable ratio of soft landscaping to hardscape (particularly parking). Hospitals such as **Metro Health Systems** have reduced their parking footprints by including above ground and underground parking garage structures. Vertically stacked massing strategies for patient care buildings also preserve site area for human-centred uses.

Landscaped areas specific to healthcare uses are known as either therapeutic gardens or healing gardens. “Healing gardens” (or restorative garden) include any landscape – wild or designed, large or small -- that facilitates human health and well-being. “Therapeutic gardens” are natural spaces designed for specific physical, occupational, horticultural and other therapies. Restorative gardens increase connection to green space physically and visually, allowing

DESCRIPTION

Location: Indianapolis, Indiana

315-bed, 11-storey hospital opened in 2013, situated on a 15-ha site within the Indiana University – Purdue campus.

STRATEGIC INSIGHTS

- Indiana’s first LEED Gold project
- Network of linked outdoor spaces linked provide more than the “standard” isolated healing garden.
- Integration of vegetation and art
- Non-rhythmic sensory stimuli to trigger relaxation response
- Produces about two tons of produce and honey annually from its 460 m^2 rooftop gardens, called the Sky Farm, contributing to the hospitals’ 40% local food target.

Image Source: https://www.bsalifestructures.com/project/sidney-lois-eskenazi-hospital

DESCRIPTION

Location: Liverpool, England

100-year-old hospital was demolished and replaced with new facility in 2015

270 bed Children's Hospital including major trauma centre

World's first hospital built in a park. Site includes a CHP plant fueled by both natural gas and biodiesel to reduce carbon

STRATEGIC INSIGHTS

- One of the world's largest most technologically innovative children's hospitals
- 75% of patients have a single room with a window that can be opened out into the park
- Digital aquarium was installed in surgery waiting room to help deal with patient anxiety
- Previous hospital demolished and reclaimed as parkland for children's health park
- By connecting the hospital and the park, children in the hospital can see the activity or be part of it
- Accident and emergency, surgery departments are all on the lower floors leading into an atrium, full of visually engaging elements for children, including an indoor treehouse in the hospital atrium
- Each floor has an outdoor balcony overlooking the park
- Grass of the park continues over the hospital roof in three main sections creating valleys and hills

Image Source: http://healthcare.wsp-pb.com/portfolio/alder-hey-children-health-park/

users to experience varied site and water elements beyond the standard man-made landscape of lawn, shrubs and broadly-spaced trees.

Views to nature can also provide wayfinding opportunities. The **Sidney & Lois Eskenazi Hospital** was designed along a linked network of outdoor spaces which serve as visual markers that allow patients and staff to locate themselves in relation to various courtyards. Each outdoor space also has high integration of local materials and vegetation, public art and seating areas to promote prolonged contact with nature. An entire façade of the hospital's seven storey parking structure is used to display the art piece "May/September" which appears to dynamically shift as users change position, replicating the kinetic experience of leaves moving in the wind. The rooftop terrace Sky Farm is used to grow vegetables for hospital use, and includes pollinator plants to encourage honey production in the garden's beehive boxes.

Michael Garron Hospital also effectively incorporates landscape elements for healing and community use despite its limited site area. At-grade outdoor space is largely dedicated to publicly-accessible uses. Additional outdoor areas are integrated into the project through rooftop terraces designed for specific needs, such as a secure area for adult mental health programming and a separate terrace for use by staff and visitors. Garden space is used to grow plants for smudging ceremonies as well as medicinal plants. Stringent City of Toronto stormwater management requirements are met through a combination of rooftop storage (utilizing control flow roof drains), multiple stormwater cisterns to limit the 100-year storm event release rate, as well as an oil-grit separator. Site area limitations and the project's urban location constrained opportunities for low impact development measures such as swales and rain gardens.

Access to nature from interior spaces is also increasingly important in hospital design. Views of nature – even in form of photographs – have been shown to reduce patient stress and facilitate healing. Ample daylight and views to green space and sky contribute to improved mood of patients and staff, shorter average hospital stays and post-operative recovery times, and reduced requirements for pain medication. Floorplates for both the **NG Teng Fong General** and **Alder Hey Children's Hospital** were laid out to allow the majority of patient beds to be placed beside individual operable windows, permitting views to the outdoors, daylight, and ventilation. Where direct access or views to nature are not feasible, biophilic design elements can mimic natural patterns, colors, light qualities, and multi-sensory experience through features such as fountains or plants, with the aim of replicating the key beneficial features and qualities of natural spaces. **Alder Hey** incorporates an indoor aquarium in its surgery waiting room to reduce patient stress, while vegetation growing up the façade of **NG Teng Fong** provides views to nature despite its urban setting.

DESCRIPTION
Location: Jurong East, Singapore

Newly built 1.84 m ft² hospital opened in 2015

700 bed facility includes an outpatient clinic, community hospital and acute care general hospital

Designed to "create a hospital without walls"

STRATEGIC INSIGHTS

- Vertical gardens use native vegetation to restore the ecological benefits on-site – densely planted low roofs for view of greenery for patients and staff
- Any patient can have outdoor views, daylight, air with single patient layout
- Designed to be very thermally comfortable without air conditioning
- Air passes over only one patient bed before leaving the building
- Singapore's Ministry of Health objective was to create a hospital without walls – a healthcare facility for and of the community it serves.

Image Source: HOK Presentation

OPERATIONS PHASE BEST PRACTICES & LESSONS LEARNED

Once designed, gardens and outdoor spaces require operational and programming support to achieve their intended outcomes. This can include therapeutic and educational programming, food harvesting, coordination of volunteer gardeners and ongoing fundraising to support garden expansion if required. **University Heath Network** and **Children Hospital of East Ontario** (CHEO) use their food gardens for therapeutic and educational programs that improve the health and wellness of their patients. At CHEO, this includes wheelchair accessible garden spaces with elevated plant beds, integration of harvested food into eating disorder support services and engaging community volunteers to plant, maintain and harvest food garden areas. Garden coordinators oversee the project and work with the hospital and the City to gain support.

Other general operations and maintenance considerations for landscape include selection and application of pesticides, herbicides, de-icers and other chemicals. Chloride-based de-icers harm surrounding landscape, in addition to damaging interior floors and exterior concrete and metal. Environmentally preferred de-icers such as beet juice are now commonly used to reduce these impacts, including by the City of Toronto. In addition, environmental and health hazardous from commercial pesticides and herbicides can be minimized by either creating a pest management plan based on Chapter 3 of the San Francisco Environment Code Integrated Pest Management (IPM) program or using pesticides with a Hazard Tier ranking of 3 (least hazardous).

HOSPITAL PERFORMANCE BENCHMARKING

Specific performance data related to landscape design is not typically monitored by healthcare or other facilities. In a healthcare environment, a link between inclusion of natural elements and user satisfaction rates; staff mental health, turnover, and sick days; or patient satisfaction and recovery rates could reasonably be assumed. In the absence of comparative data, NH-specific benchmarks could be explored to measure these outcomes, as discussed in **Sections 2.2.1** and **Section 3.2**.

2.2.6 TRANSPORTATION

TRANSPO-
RTATION

KEY STRATEGIC INSIGHTS

- Flexible and adaptive parking structure designs respond to an expected trend of decreasing car ownership.
- Current design features for active and low carbon transportation include secure bicycle parking, shower rooms and changing facilities; EV charging stalls; and fully accessible public transportation stop(s) including shelter, raised curbs, seating, and lighting.
- Shuttle services, car pool programs, subsidized transit pass costs and increasing parking fees further encourage staff to select alternative modes of transportation.

INDUSTRY TRANSFORMATION AND POLICY TRENDS

The transportation sector is the second-largest CO_2 emitter in Canada. Emissions from road transportation alone account for more than 20% of Canada's annual emissions, more than either electricity production or buildings. Throughout 2017, the Government of Canada worked with provinces and territories to develop a Canada-wide strategy for zero emission vehicles (ZEVs) and has already invested over $180 million in charging stations and other alternative refueling infrastructure. Demand for low carbon and active modes of transportation are increasing due to increased focus on the environmental impacts of CO_2 as well as demographic and economic trends such as aging population, rising fuel prices, increasing urbanization, increasing health concerns, new technologies, and changing consumer preferences.

Niagara Region's Transportation Master Plan provides a strategic vision to meet local transportation needs through to 2041, including pedestrian cycling infrastructure and complete streets design, proactive planning for demand-responsive and conventional transit, and continued development of an integrated network of roadways and highways. Specific infrastructure surrounding the new hospital site is detailed in the Grand Niagara Secondary Plan, including pedestrian and bicycle path systems that link with other pathway systems in the City. These plans are summarized in Figure 22.

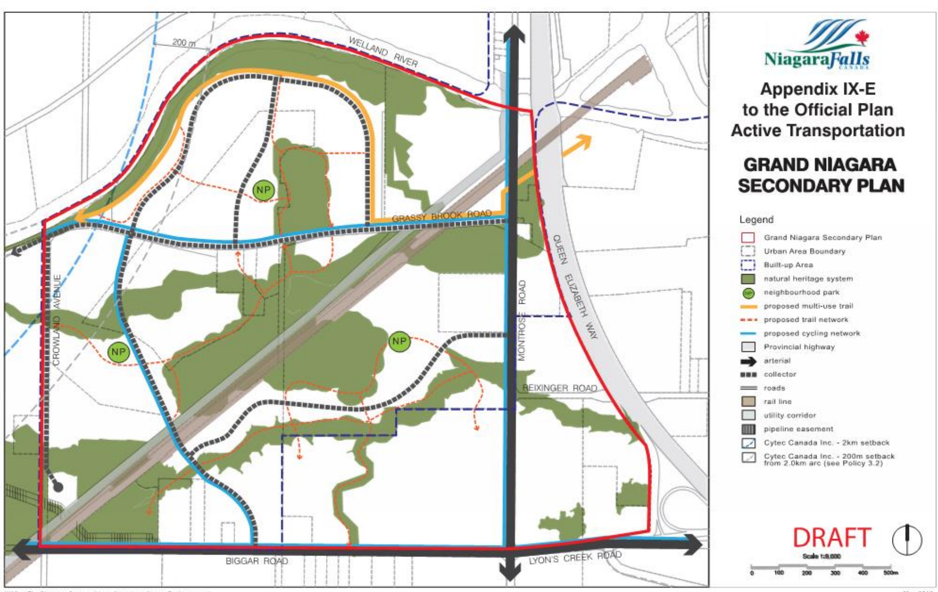


Figure 22: Grand Niagara Secondary Plan

Currently, six inter-municipal transit service providers operate in Niagara including Niagara Region Transit, Niagara Specialized Transit, GO Transit, VIA Rail, Greyhound and Coach Canada. In addition, Uber began to service the Niagara region in 2016 and as of 2017, there were more than 50 electric vehicle charging stations throughout the region. The City of Niagara has confirmed that public transit service will be extended to the new hospital site prior to its opening, regardless of the status of surrounding development.

The growth of virtual medicine and other technology innovations should be considered as an opportunity to reduce patient trips for follow-up appointments. One such model is provided by the **Renfrew County Paramedic Service**, which delivers health care in rural eastern Ontario using drones to deliver defibrillators and other equipment in medical emergencies as well as digital monitoring of chronically ill patients. Paramedics have been empowered to conduct routine home visits to extend the time that patients are able to remain in their homes and reduce strain on other local medical services.

Finally, emerging technologies such as autonomous vehicles may substantially transform existing public and private transit systems, reducing need for on-site parking and increasing demand for both shared and flexible transportation options that are less reliant on individual car ownership and single occupant trips. In light of this transportation evolution, Transport Canada has launched the Program to Advance Connectivity and Automation in the Transportation System, which is intended to help Canadian jurisdictions prepare for the issues that will arise with the introduction of connected and automated vehicles.

CONSTRUCTION PHASE BEST PRACTICES & LESSONS LEARNED

Due to the critical and on-demand function hospitals play in their communities, traditional transportation planning practices are not easily shifted. Certain recently designed and built hospitals have taken small steps to proactively influence commuting patterns, particularly of hospital staff, and to reduce the overall site area dedicated to surface parking. Rebates and incentives offered in Ontario to encourage the switch to electric vehicles (EVs) and the installation of electric vehicle chargers has created an increased demand for EV infrastructure, which has become an obvious consideration due to its minimal disruption of existing commuting patterns. Other potential measures include preferred parking for car share and electric vehicles, reducing the number of parking spaces provided, and thoughtful parking structure design including underground parking. All of these strategies have been employed in the design of the under-construction **Michael Garron Hospital** in Toronto.

Although car transportation is likely to dominate for at least another decade, autonomous vehicles, ride-sharing and enhanced public transit are likely to result in a decline in car ownership, especially in urban areas. Smaller communities may find it increasingly challenging to manage current parking needs in the face of future demand uncertainty. Not yet common in the healthcare sector, adaptive design options for parking structures ensure that these buildings can more easily be repurposed in the future if required. This includes structural designs that allow straightforward conversion into office space or provision of electrical infrastructure that allows at-grade lots to be covered in a canopy of solar photovoltaic (PV) panels in the future. Solar-covered parking serves multiple purposes: producing renewable energy (which can be directly used for EVs parked underneath), lowering electricity costs, reducing heat island effect, providing shade for cars on extremely hot days, and generating an ongoing stream of revenue from user fees. Examples of solar parking include **Southern Arizona VA Health Care System** in Tuscon, Arizona, **St. Peter's University Hospital** in New Brunswick, New Jersey, and **Mohawk College's Fennell Campus** in Hamilton, Ontario.

More typical transportation design strategies include careful attention to planning of transit stops, designated drop-off locations and bicycle infrastructure. Fully accessible and conveniently located public transportation stops that include shelter, raised curbs, seating, lighting and real-time information systems (SMART technologies) can increase transit ease of use. Planning for an increased volume of patient and visitor drop-offs to accommodate growing use of ridesharing services is also warranted. Finally, enhanced bicycle infrastructure such as covered and locked exterior enclosures, changerooms and lockers, wayfinding, emergency call stations, flexible and impact-reducing surface treatments, and efficient and safe connections to surrounding bike lanes encourages staff to consider active transportation rather than car-based travel.

OPERATIONS PHASE BEST PRACTICES & LESSONS LEARNED

DESCRIPTION
Location: Toronto, Ontario

Healthcare and medical research organization comprised of four hospitals of varying ages.

Motto is "UHN: Committed to Patient and Planet Centered Care".

STRATEGIC INSIGHT

- Smart Commute Gold & Games Champion Workplace award in 2016
- TTC VIP program
- Bicycle User Group
- Bike parking zones
- Carpool matching program to connect staff

Image Source: http://hcr-moves.com/project/university-health-network/

Operational strategies can be used to further influence the commuting patterns of hospital staff. For example, **University Health Network** has implemented a number of clean commuting programs including a bicycle user group, bike parking zones, a transit VIP program and a carpool matching program. **The Markham Stoufville Hospital** has dedicated bike-to-work days, an in-house carpooling program and priority parking for high occupancy vehicles. Guaranteed ride home programs further encourage staff to consider active transportation, providing a sense of security should an emergency arise or when staff are working late. Free or discounted transit passes for staff also decrease single occupant vehicle trips.

Hospitals are also considering shuttle services and “park and ride” schemes for patients and staff. **Vancouver Coastal Health** offers a dedicated shuttle service between eight hospital worksites, allowing staff to easily change location during the day without driving. Shuttle buses can also transport staff and visitors between external transit hubs and the hospital.

Although not a popular option with hospital users, increasing costs for parking passes can effectively reduce single-occupant vehicle trips. Studies suggest that a 10% increase in parking cost will decrease single occupant vehicle trips by 1-3%, and reductions of up to 15% are possible with even higher cost increases.

HOSPITAL PERFORMANCE BENCHMARKING

Although many hospitals, including NH’s sites, periodically complete transportation demand management plans, aggregated results from multiple hospitals are not readily available. NH should consider developing a performance management plan to improve access to and availability of high-quality, timely and accessible transportation information for its sites. Informal commuter surveys may also provide an ongoing data source to quantify single occupant vehicle trips. This information will assist to inform context-specific transportation strategies and long-term planning for the future hospital site.

2.2.7 MATERIALS & PRODUCTS

MATERIALS & PRODUCTS

KEY STRATEGIC INSIGHTS

- Selection of sustainable materials requires examination of both human health impacts and lifecycle environmental impacts
- Transparency in the market place is increasing through Health Product Declarations (HPDs) and Environmental Product Declarations (EPDs)
- Impacts of operations phase procurement is not yet tracked by Canadian hospitals, despite the fact that annual GHG emissions from ongoing procurement are likely significantly higher than those from energy.

INDUSTRY TRANSFORMATION AND POLICY TRENDS

Current sustainability trends for material and product selection address two major areas of focus: human health and lifecycle environmental impacts. Several product certification systems exist to recognize materials that offer reduced concentrations of volatile organic compounds (VOCs), Persistent Bioaccumulative and Toxic (PBT) compounds and other chemical contaminants harmful to human health and the environment. The LEED and WELL rating systems also include several credits that promote selection of products and materials that are less hazardous to building occupants. The Living Building Challenge certification system has also identified a "Red List" of 22 prohibited materials representing the worst-in-class products used in the building industry. While complying with the Red List remains extremely challenging even for typical commercial projects, the existence of the List highlights the need not only to reward low-emitting products, but also to identify and avoid harmful ones.

Although not adopted in LEED BD+C v4, the Red List has encouraged the green building industry to transition from a material-source approach to one that enables product transparency and disclosure. Previous versions of LEED identified sustainable materials based on VOC levels, regional and recycled content, rapidly renewable content or Forest Stewardship Council (FSC) certification for wood products. In LEED BD+C v4, sustainable materials are those that transparently disclose their environmental impacts, raw material sources, and material ingredients, allowing designers to select environmentally preferred products based on available data. WELL v2 imposes more stringent requirements, including preconditions that limit or restrict outright the use of materials that contain asbestos, mercury and lead. As manufacturers adjust to new requirements for transparency and product-specific impact assessments contained in Environmental Product Declarations (EPDs) and Health Product Declarations (HPDs), many building projects find product availability to achieve these available material credits can be quite limited.

Both LEED BD+C v4 and WELL v2 also include credits to reward selection of materials that demonstrate reduction in embodied energy and other environmental impacts associated with the extraction, processing, transport, and disposal of building materials. These credits are designed to support a life-cycle approach that promotes resource efficiency and attention to material end of life, including disposal and reclaim options. This shift links initial material selection decisions to eventual waste outcomes, transforming the traditional linear view of material streams into a circular one.

CONSTRUCTION PHASE BEST PRACTICES & LESSONS LEARNED

Complying with current materials and products credits will require extensive planning during the design stage and tracking during construction. Low-emitting material credits are usually targeted by Infrastructure Ontario hospital projects, as the health impacts of installed materials are especially critical in a healthcare environment. Regarding material transparency, it is unclear whether sufficient appropriately documented products will be readily available in the market to achieve various LEED v4 materials credits as well as demanding healthcare specifications for infection control, durability, and safety. **Michael Garron Hospital** is one recent IO project that aims to achieve several of LEED's new material credits, including PBT (Persistent Bioaccumulative and Toxic) Source Reduction, Furniture & Medical Furnishings and Low-Mercury Lighting.

To ensure its building is designed and constructed for a 100-year lifespan, **Michael Garron's** PSOS also mandates commissioning of its envelope to verify the enclosure's airtightness, thermal performance, and resistance to water leakage. Tendered under a Design-Build-Finance (DBF) contract rather than Design-Build-Finance-Maintain (DBFM) contract, an increased design focus on durability was warranted, as the proponent team will not be responsible for ongoing facility maintenance. In healthcare facilities, more durable materials and products allow for longer maintenance and replacement cycles, reducing disruption to building operations and decreasing whole-life costs for the building.

OPERATIONS PHASE BEST PRACTICES & LESSONS LEARNED

Continued consideration of health impacts from materials procured during the operations phase (such as paints, coatings and lamps) is not yet common in DBFM contract terms, although healthcare organizations may adopt purchasing policies for their existing hospitals. The construction-only focus of LEED, which has traditionally been the only rating system applied to IO's projects, offers little in the way of guidance for future procurement decisions. To maintain the original project intent established during design and construction, low-emitting paints and coatings, low-mercury lamps, and other materials with reduced negative human health impacts should also be selected during the maintenance phase.

Environmental impacts from material procurement can be significant, as previously discussed in **Section 2.2.2**. Based on the UK National Health Service's data, annual GHG emissions from purchasing of materials such as pharmaceuticals and medical equipment can outstrip emissions from energy by as much as three times. As this complete carbon footprinting process is in its infancy, particularly in Canada, it appears that no Canadian hospitals are assessing carbon emissions resulting from their ongoing procurement processes.

HOSPITAL PERFORMANCE BENCHMARKING

Although no formal performance monitoring processes for outcomes resulting from material selection exist, the testing processes required by WELL may offer a useful starting point. WELL's air quality testing parameters include carbon monoxide, ozone, particulate matter, formaldehyde, volatile organic compounds, nitrogen dioxide and radon. Presence of these pollutants would result in part from material selection.

2.2.8 WASTE REDUCTION & RECYCLING

WASTE REDUCTION & RECYCLING

KEY STRATEGIC INSIGHTS

— Wide ranging legal and policy changes related to waste management are expected in Ontario over the next 5-10 years.

— Waste is primarily an operational concern unrelated to PSOS contract terms. Improvements in waste reduction and diversion are largely driven by user engagement and procurement decisions.

— Due to the high volume of food waste in inpatient facilities, composting and working with food providers is a key waste management strategy.

INDUSTRY TRANSFORMATION AND POLICY TRENDS

The waste sector in Ontario is facing a major structural change. In its Ontario Environment Plan, the Province has proposed an amendment to the 3Rs Regulations to substantially increase resource recovery, largely by addressing organic and plastic waste. By 2025, the Province hopes to recover 70% of food and organic waste through sector-specific targets for municipalities, multi-residential buildings, business, schools, and hospitals. The Plan also proposes banning food waste disposal in landfill by 2021 to encourage rapid adoption of municipal composting practices and programs. Green bin collection systems will therefore be expanded, and clear rules for compostable products and packaging materials will be developed. Food waste reduction opportunities in institutional and commercial operations will also be explored.

Plastic waste, through the proliferation of single-use plastics, packaging materials and micro-plastics, is also addressed in the Plan. In line with recent Federal commitments, the Province has indicated that a ban on single use plastic items may be instituted as early as early as 2021. A broader plastics strategy to reduce plastic waste and limit micro-plastics will also be developed. These commitments are refocusing industry effort on the reduction component of the 3Rs, rather than an exclusive focus on recycling/diversion which has more typically dominated conversations about waste. Similar to energy, eliminating waste has greater environmental benefit than reprocessing, which requires significant energy, transportation and water inputs. Reduced global appetite for North American recyclables can also mean that blue box items are not recycled as intended. A recent report from Environment and Climate Change Canada estimates that Canada recycles just 9 per cent of its plastics, with the majority of this material sent to landfill or incinerated.

Ultimately, proposed regulatory amendments aim to make producers responsible for waste generated from their products and packaging, promoting development of a circular economy in which waste is repositioned as a material resource.

CONSTRUCTION PHASE BEST PRACTICES & LESSONS LEARNED

Construction waste diversion targets are common for most major infrastructure projects. The majority of recent projects in urban Ontario locations have demonstrated an extremely high proportion of construction waste diversion from landfill, easily exceeding established targets. For example, **Bridgepoint Hospital** in Toronto achieved 98% diversion of construction waste from landfill, while NH's **St. Catharines Site** achieved 85% diversion.

Where access to diversion facilities is limited, modular construction can be employed to improve material efficiency, reduce construction waste and lesson impacts from transportation of contractor staff to site during construction. Although **Humber River Hospital** easily exceeded its diversion target, reporting 96% construction waste diversion, its construction team also opted to incorporate 360 modular washrooms and telecommunications rooms which had been prefabricated in a controlled factory environment to speed construction time and reduce project costs. Prefabrication of additional hospital elements, particularly for facilities that serve rural and remote locations, is likely for future builds.

Other recent innovations include automated pneumatic waste collection systems and smart waste bin receptacles. **Humber River Hospital** implemented TransVac's automated waste collection technology which separately directs waste, recyclables and soiled linen from each ward to a central collection point in the loading dock. Establishing dedicated pathways for individual waste streams reduces exposure to airborne diseases and frees up hospital resources to be re-directed into patient care. Standalone interactive waste bins can also assist users to more quickly and effectively sort waste into divertible and non-divertible streams. Some bin designs incorporate scanners and screens to provide immediate feedback on the cost and landfill savings that result from recycling or composting specific materials. As no case studies for use of this technology in a hospital setting could be sourced, limited pilots of various systems available in the market may be warranted as a first step. Pilots would be particularly effective in existing hospitals where pre- and post-pilot waste audit data could be directly compared to inform a cost-benefit analysis for wide-scale deployment.

OPERATIONS PHASE BEST PRACTICES & LESSONS LEARNED

New options to divert hospital-specific waste streams are emerging in the Canadian market. The **Ottawa Hospital** now recycles not only typical waste streams, but also clean materials generated in operating rooms, and donates surplus supplies. Styrofoam food containers have been replaced with biodegradable versions. The **Grand River Hospital** in Kitchener-Waterloo has recently implemented a recycling program for single use medical devices such as compression sleeves, laparoscopic sealers, ultrasonic scalpers, and trocars, to reduce the estimated 20-30% of hospital waste generated by operating room procedures.

Increased attention to procurement decisions and programming to shift the behavior of hospital users is also needed. Paperless operations models, vendor take-back programs for packaging materials, requirements for retail food providers to supply compostable packaging, and encouragement for staff to select reusable beverage containers can all help to support ongoing efforts to reduce waste.

More significant shifts in operating practices are also being tested. For instance, **the Children's Hospital of Eastern Ontario** has nearly eliminated food waste from its facility by transforming its meal delivery to a model that emulates hotel room style food service. Providing greater control to patients over the type and timing of meals (particularly children, who often have highly specific food preferences when ill) ensures that nearly all delivered food is eaten, compared to the 50% or greater plate waste in hospitals with more typical food service models. CHEO's on-demand food service has positively contributed to patient satisfaction as well, as discussed in **Section 2.2.1**.

HOSPITAL PERFORMANCE BENCHMARKING

Based on waste audits completed in 2019, three of NH's existing hospitals exceed the average waste production benchmark identified in the Green Hospital Scorecard; however, they also exceed the Scorecard's benchmark diversion rate. In short, NH's hospitals both generate and divert more waste than average. Waste audit data is summarized in Figure 23.

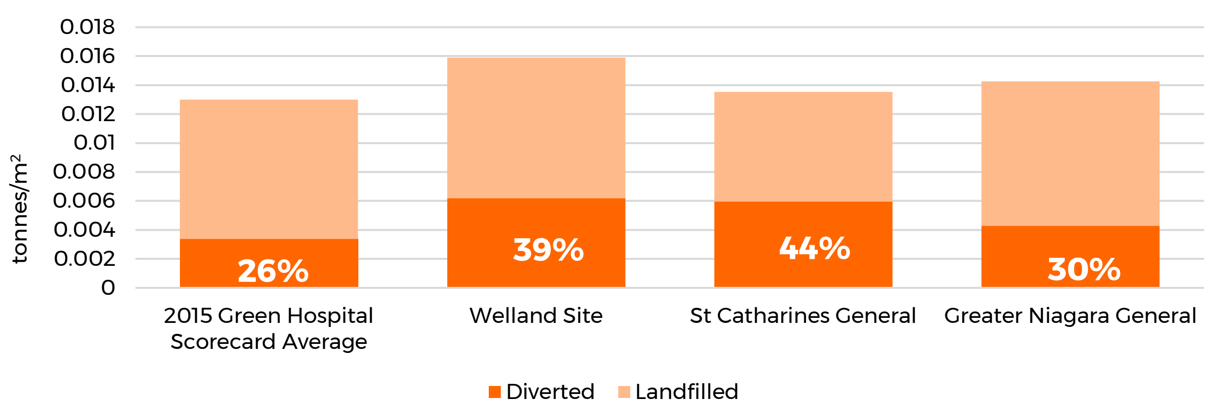


Figure 23: Operating Waste Intensity and Diversion Rates

The four largest waste categories identified in NH's 2019 audits are diapers, paper towels, fine paper and cardboard, and organics. Waste distribution by site and category is summarized in Figure 24. Together, these four categories represent slightly more than half of all waste generated at these sites. Due to infection risk, there are no diversion opportunities for diapers or paper towels, nor is reduced use of these materials likely. Replacement of paper towels with hand dryers in a hospital environment is not recommended due to airborne contamination risk. Diversion of paper and cardboard by NH is already high, exceeding 95%. Reduction opportunities may be available, however, particularly for fine paper. Notably, although the St Catharine Site was designed to by 80% paperless, it shows the highest overall production of fine paper waste at 22% of total waste, compared to 2-5% at GNG and Welland. Based on discussion with NH, ICAT systems that will reduce reliance on paper were not yet operational at the time of this audit. Opportunities to reduce and divert organics are therefore the most likely strategy to improve performance, as only 63% of this waste stream is currently diverted.

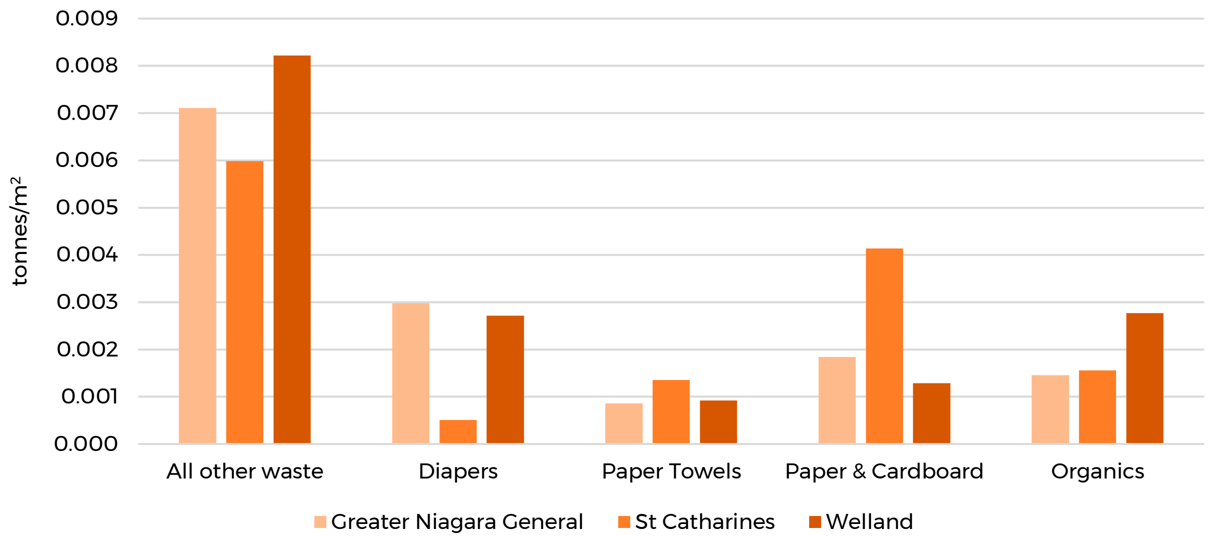


Figure 24: NH's Top Four Waste Categories

2.3 CONCLUSION | PART 1

The strategic insights described in this section encourage a re-evaluation of the relationship between NH's eight environmental requirements. Rather than individual categories, these areas of focus can be grouped as either important outcomes to be supported by hospital design and operations, or necessary components of that design. The most important of these outcome is health and wellness – of people, and of ecosystems, with carbon as a primary metric. The remaining six environmental requirements support these two outcomes. This reorganization is shown in Figure 25.

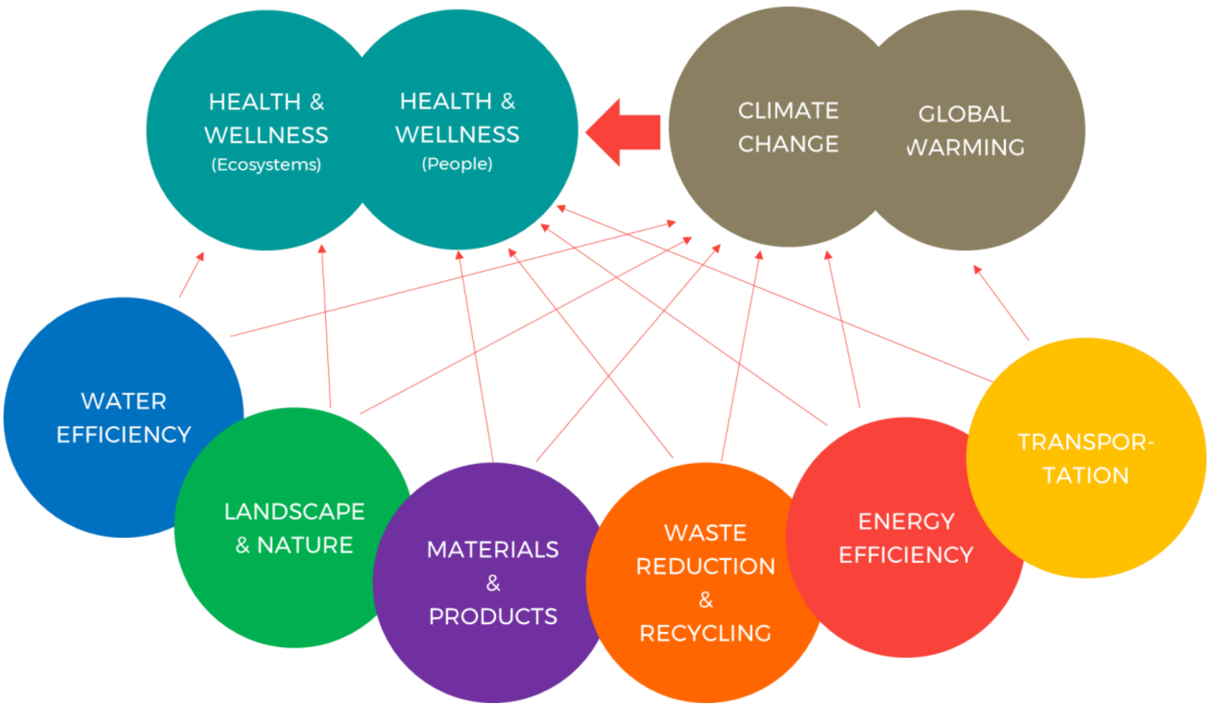


Figure 25: Reorganization of NH Environmental Requirements

This reorganization reminds us to remain cognizant of the tension that exists in sustainability theory between the need to promote human and social advancement with the broader landscape, socio-economic and climate-related impacts of development. As carbon impacts result from nearly all of the six subcategories shown in Figure 25, performance metrics for GHG emissions in the remainder of this report will be distributed across these individual areas, rather than as a discrete category.

PART 2 | ANALYSIS

3 OPPORTUNITIES AND CONSTRAINTS

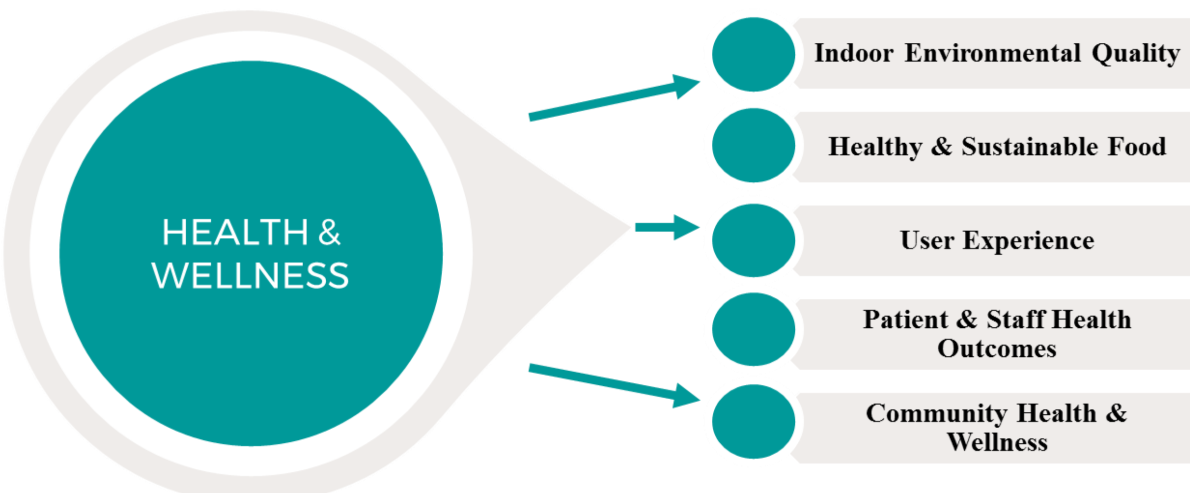
3.1 INTRODUCTION

The following section divides each of NH's eight environmental requirements into potential areas of focus. Presented and discussed by stakeholders through multiple engagement sessions, opportunities and constraints for each focus areas were explored to determine its level of importance to NH. In some cases, this exploration involved outlining related credits from LEED, WELL and ZCB, which provide detailed evaluation criteria for determining performance/success, as well as exploring NH-specific evaluation criteria not pre-determined by these rating systems.

Through these engagement sessions, a consolidated list of evaluation criteria for determining the performance of the design options in Section 5, as well as later stages of hospital design, was developed. As discussed in Section 2.3, many key environmental outcomes can only be measured once the hospital is operational. These ideas have been marked as out of scope for the purpose of this report and captured in more detail as 'Next Steps' for NH within each category. These criteria do not appear in the final evaluation table in Section 4.

3.2 HEALTH & WELLNESS

OVERVIEW



As mentioned in **Section 2.2.1**, there is an increasing demand to design buildings that positively impact occupants' health, productivity and happiness. NH identified health and wellness of patients and family as a guiding principle to ensure that the creation of indoor and external environments improve patient health outcomes and contribute substantively to family and community well-being. Indoor environmental quality factors such as thermal comfort, air quality and lighting design have typically been considered during design, however design intent has not always translated to operational success. Emerging concerns such as ergonomics, controllability, universal accessibility examine how to adapt spaces to users with varying needs, an important consideration for NH's focus on senior care and mental health. Access to health and sustainable food in a hospital context is increasingly important, as demonstrated by the local food commitments and room-service style delivery model of the **Children's Hospital of Eastern Ontario (CHEO)** and hospital food revolution of the **Scarborough Hospital** (refer to **Section 2.2.1**).

The potential to link design choices to staff health outcomes, as assessed by the **Dell Children's Medical Centre**, is also a key concern, as are opportunities to leverage the hospital to support community well-being through inclusion of public event space, use of local materials, and expanding volunteering opportunities.

Throughout the Health and Wellness category, opportunities to support NH' pursuit of WELL Building certification are identified. This certification will provide ultimate confirmation of NH' commitment to the health of its staff. Standard provides a comprehensive framework for mental health support through the Mind concept, which promotes mental health through stress management programs, substance use and addiction treatment services, sleep support, opportunities for restoration and design strategies such as access to indoor nature.

Features that improve occupant health and wellness link to many other environmental considerations, particularly landscape and nature, transit and commuting, and sustainable materials. Opportunities and constraints related to access to nature, healing gardens, active transportation, and low-emitting materials are more directly linked to these other focus areas and are not duplicated as Health and Wellness considerations despite this overlap.

OPPORTUNITIES & CONSTRAINTS

INDOOR ENVIRONMENTAL QUALITY

Indoor environmental quality addresses design and operations practices to maintain good indoor air quality and thermal, visual, and acoustic comfort. Directly linked to better productivity and health for staff and occupants, this is a typical green building concern which is extensively covered by both the LEED and WELL certification programs. Requirements overlap between the two systems, streamlining implementation.

Through the engagement sessions, this performance category was noted to be a mandatory area for NH stakeholders. Engagement session results indicated that 92% of participants were interested in performance requirements for indoor environmental quality.

The stakeholders noted that this objective aligns with the staff's core efforts to keep the space clean and comfortable for the patients. Further monitoring and enabling additional control for comfort was seen as valuable. Stakeholders agreed that management practices should align to better assess the indoor environment quality through a sensors and regular monitoring. This would enable a better performance-based approach to satisfaction instead of relying on an approach based on regulations.

OPPORTUNITIES	CONSTRAINTS
— Requirements that support this category are thoroughly available under both LEED and WELL rating systems, which mandatory and optional criteria address air quality, lighting quality, thermal comfort and acoustic performance — Increased air quality awareness for staff and occupants — Potential positive impact on other sustainable priorities (e.g. GHG mitigation) — High quality indoor air is linked to better productivity and health	— Strategies such as increased ventilation may pose a potential negative impact on other sustainable priorities (e.g. energy efficiency) — High efficiency filtration systems and indoor air quality monitors can be costly

LEED V4 BD+C: HEALTHCARE	WELL V2
— **EQ Prerequisite**: Minimum Indoor Air Quality Performance: — **EQ Prerequisite**: Environmental Tobacco Smoke Control — **EQ Prerequisite**: Minimum Acoustic Performance — 9 more credits are available under the Indoor Environmental Quality category	**AIR** — **A01** Fundamental Air Quality — **A02** Smoke-Free Environment — **A03** Ventilation Effectiveness — **A04** Construction Pollution management — 10 Features are available under the concept of Air, which aims to provide high levels of indoor air quality through diverse strategies that include source elimination or reduction, active and passive building design and operation strategies and human behavior interventions. **LIGHT** — **L01** Light Exposure and Education — **L02** Visual Lighting Design — 6 Features are available under the concept of Light, which aims to create lighting environments that are optimal for visual, mental and biological health. **THERMAL COMFORT** — **T01** Thermal Performance — 6 Features are available under the concept of Thermal Comfort, which aims to promote human productivity and ensure a maximum level of thermal comfort among all building users through improved HVAC system design and control and by meeting individual thermal preferences. **SOUND** — **S01** Sound Mapping — 5 Features are available under the concept of Sound, which aims to bolster occupant health and well-being through the identification and mitigation of acoustical comfort parameters that shape occupant experiences.

HEALTHY & SUSTAINABLE FOOD

Healthy and sustainable food is an emerging hospital trend focused on opportunities to provide nourishing, healthy food options through on-site accessible gardens, local food procurement, and innovative food service programs. As mentioned in **Section 2.2.1**, The **Children's Hospital of Eastern Ontario** (CHEO) increased patient satisfaction from 30% to 98% through implementing a healthy and sustainable patient food service program modelled after hotel room service. **CHEO**'s success indicates the importance of providing healthy and sustainable food options on-site to benefit both patients and visitors. The goal for this environmental outcome is to create food environments where the healthiest choice is the easiest choice to encourage healthy eating patterns and increase nutritional awareness.

For NH to achieve WELL certification for the new hospital, mandatory requirements related to availability and visibility of fruit and vegetables, as well as nutritional transparency. Additional credits that focus on refined & artificial ingredients, food advertising, portion size, nutrition education, special diets, and responsible food sourcing are optional certification credits that can be explored. LEED does not address health and sustainable food.

Through the engagement sessions, this performance category was noted to be a recommended priority area for NH. Engagement session results indicated that 58% of participants were interested in performance requirements for healthy & sustainable food. The stakeholders recognize the potential benefit of a different service model, but the approach to food service has already been mostly decided and imbedded in the planning of both the St. Catharine and South Niagara facilities. If the alternative model were to go ahead, it would require a financial and operating partnership (e.g. Niagara College) or a substantial revisit of the budgeting process. NH Executive team were interested in the ideal of a trial/small-scale program for a target group at the South Niagara Hospital.

ITS will play a strong role in implementing the dietary planning and dietary needs analysis/communication approach. Questions arose about the capability of the existing systems to offer the functionality required.

OPPORTUNITIES	CONSTRAINTS
— Encourage heathy eating patterns for patients, visitors and staff — Create food environments that nudge users towards healthier choices — Increased access to healthier foods and beverages — Increased nutritional awareness — Opportunity to partner with Niagara college on expansion of their culinary programs	— Level of responsibility on retailers — Requirements applicable to food prepared outside of hospital — Hospital food budget may be limited — The current kitchen in St. Catharine and the one planed for South Niagara Hospital will not have a full kitchen where a service model like CHEO would be feasible
LEED V4 BD+C: HEALTHCARE	**WELL V2**
— Healthy and sustainable food is not addressed in LEED.	**NOURISHMENT** — **N01** Fruits and Vegetables — **N02** Nutritional Transparency — 11 Features are available under the concept of Nourishment, which requires the availability of fruits and vegetables and nutritional transparency and encourages the creation of food environments where the healthiest choice is the easiest choice

USER EXPERIENCE

User Experience captures design elements that adapt spaces to users of various needs through ergonomics, controllability, and universal accessibility. These elements enhance the perception of the hospital environment as inclusive, healthy, attractive and enjoyable for all people, regardless of age, size, or disability. This personalization enhances occupant comfort and well-being, improves productivity and employee engagement, and demonstrates commitment to health and safety.

Both LEED and WELL address user experience and focus on the hospital's ease of use and occupant comfort. LEED requirements primarily focus on quality views and bi-annual occupant comfort surveys, where as WELL's requirements are a bit more stringent. WELL requires annual occupant comfort surveys and also addresses accessibility, universal design, wayfinding, occupant controllability, and visual & physical ergonomics.

Through the engagement sessions, this performance category was noted to be a recommended priority area for NH. Engagement session results indicated that 58% of participants were interested in performance requirements for user experience.

Stakeholders would like the new hospital to recognize different focuses that are required for staff vs patient/visitors. While currently there are constraints on feature stairs from operational efficiency goals (e.g. porter movement, supplies transportation, etc.), the participants were interested in a design that promotes stair use to staff and visitors.

As part of the user experience, the option of operable windows was discussed. While participants agreed that operable windows would provide a great user experience for the patients, it may pose operational challenges including further investigation required on how it may impact the goal for energy efficiency.

OPPORTUNITIES	CONSTRAINTS
— Accessibility and universal design foster an inclusive environment — Support occupant comfort and well-being — Help prevent workplace injury and associated costs — Improved productivity and employee engagement — Demonstrated commitment to health and safety — Controllability of lighting and temperature can enhance user experience	— Additional planning required in early stage design — Additional costs associated with employing a Universal Design and Wayfinding Consultant — Additional costs associated with designing to meet all accessibility laws and to integrate universal design principles — Ergonomics implementation may require customization
LEED V4 BD+C: HEALTHCARE	**WELL V2**
— **EQ credit:** Interior Lighting	— **V02** Visual and Physical Ergonomics (Pre-condition) — **C03** Occupant Survey (Pre-condition) — **C13** Accessibility and Universal Design (option)

PATIENT & STAFF HEALTH OUTCOMES

The exploration of patient and staff health outcomes captured the ultimate impact that the hospital's design and operation is intended to support: improving the physical, mental and emotional health of patients and staff. Healthy, happy employees are more productive and less likely to take time off for sickness or to quit their jobs. Mental health in particular is becoming an increasing concern for employees, as depression and anxiety are two of the most common mental disorders that affect an employee's productivity [2].

LEED and WELL both address patient and staff health outcomes through active building design which encompasses promoting stair use through visible stairs, wayfinding, and aesthetic design; providing an on-site exercise facility and equipment; and providing active facades that include windows, murals and biophilic elements. WELL also addresses health outcomes that are more specific to staff such as, mental health promotion & support, stress support, restorative opportunities, substance use and education, community immunity, occupant health promotions and support, and new parent support. Staff specific credits are not a requirement in LEED.

Once operational, the impacts of these design strategies can be monitored through factors such as employee turnover rate, patient satisfaction, occupant comfort, particularly in comparison to NH' other facilities.

Through the engagement sessions, this performance category was noted to be a recommended priority area for NH. Engagement session results indicated that 50% of participants were interested in performance requirements for patient and staff health outcomes. There was a general desire to learn lessons and assess performance both before and after the project for South Niagara and as compared to other NH sites, especially St. Catharines. Majority of the stakeholders from the facility management and staff indicated that learning from experience and developing benchmarking approaches that are reproducible across all sites is important and worth exploring.

OPPORTUNITIES	CONSTRAINTS
— Promote mental and physical health through policies, programs & design — Foster active living — Healthier, happier staff translate to decreased absences and employee turnover — Current policies and programs within NH align very well with the WELL Requirements	— Additional costs associated employee benefits, training, etc. may be required.

LEED V4 BD+C: HEALTHCARE	WELL V2
— Health outcomes are not addressed in LEED.	**MOVEMENT** — 10 Features are available under the concept of Movement, which aims to promote movement, physical activity and active living and discourages sedentary behaviours through environmental design strategies, programs and policies **MIND** — **M01** Mental Health Promotion — 13 Features are available under the concept of Mind, which aims to promote mental health through policy, program and design strategies that seek to address the diverse factors that influence cognitive and emotional well-being.

COMMUNITY HEALTH & WELLNESS

Many hospitals are acknowledging their role in community health and wellness beyond the direct provision medical services. Hospitals are creating spaces that are therapeutic for patients, visitors, staff, and the surrounding community. Outdoor areas, including community gardens, dedicated courtyards, and rooftop terraces, have been created at hospitals to provide places of respite. A focus on community health and wellness supports the health and well-being of the building community and facilitates collaborative design and development.

Well requirements for community health and wellness focus on the integration of culture and local attributes in design, providing designated space to community access and civic engagement. LEED does not address community health.

Through the engagement sessions, this performance category was noted to be an optional area for NH. Engagement session results indicated that 17% of participants were interested in performance requirements for community health and wellness. Stakeholders agreed that future programming such as community gardens or farmer's market could be incorporated to support community engagement.

As Niagara region has a focus on outdoor tourism, participants agreed that the hospital could align and enhance the goals of outdoor tourism and active living for the surrounding communities. Cycling and walking path integration were noted as being important to create a connection.

OPPORTUNITIES	CONSTRAINTS
— Increased staff engagement in health & wellness activities — Support community engagement through community gardens or farmer's market — Facilitates collaborative design and development	— High level of social organization — Costs associated with providing designated community spaces and allowing employees paid time off for volunteer opportunities

LEED V4 BD+C: HEALTHCARE	WELL V2
— Community health & wellness is not addressed by LEED.	— Features under the concept of Community aims to contribute to the surrounding community by offering flexible public space, programming that engages the local individuals. It aims to support integrated community through social equity, civic engagement and community access.

NH PRIORITIES FOR PSOS

Based on the engagement sessions with NH stakeholders, Indoor Environment Quality is a very high priority as it impacts the comforts of patients. While other performance categories will be out of scope for the project co., NH has noted the desire to further pursue these areas.

HEALTH & WELLNESS	STAGE	LEED	WELL	ZCB	METRIC	PRIORITY
WELL Certification	Design	-	Certify	-	level of certification	Mandatory
Acoustics	Design	EQc9	S01	-	background noise level & acoustical privacy	Recommended
Ventilation	Design	EQp1	A03	-	ventilation & monitoring	Mandatory
Air Quality Testing	Operate	-	A01	-	ongoing testing of particulate matter, inorganic & organic gases	Mandatory
Healthy & Sustainable Food	Out of Scope	-	N01 N02	-	WELL preconditions, # of WELL optimizations	Recommended
Accessible & Universal Design	Design	-	C13	-	accessibility codes & universal design features	Mandatory
Controllability	Design	EQc5 EQc6 EQc7	L04 L08 T04	-	% occupants with individual controls	Recommended
Visual & Physical Ergonomic	Design	-	V02	-	% employees with flexible workstations	Recommended
Occupant Comfort	Operate	INc Occupant Survey	C03	-	annual occupant survey results	Mandatory
Active Building Design	Design	INc Design for Active Occupants	V01 V03	-	# of active design features	Mandatory
Staff Wellness	Out of Scope	-	M01	-	WELL Preconditions & optimizations	Recommended
Community Design Features	Design	-	C02	-	# of design features	Optional
Community Engagement Programs	Out of Scope	-	C11 C16	-	# of engagement programs	Optional

NEXT STEPS | HEALTH & WELLNESS

Within this category, a number of important actions were discussed that are beyond the scope of the PSOS and Project Co's involvement in the new hospital. This work, if deemed a priority, will not be used to evaluate design options and will instead need to be implemented by NH. These next steps for Health & Wellness include:

DESIGN STAGE

— Healthy & sustainable food (food options, food service set-up, retailer agreements, advertising, portion sizes, food sourcing, education) that further supports features under WELL v2 certification should be explored

— Develop a partnership with Niagara College to support an alternative food service model, possibly serving both retail and patient food needs. The concept proposed, in the long term, would be to develop a *Food as Healthcare* program delivered out of the South Niagara facility and funded by the college and NH (and their respective ministries). At a minimum, a discussion of how to begin this partnership is desired in the early planning stages of the project. A fruitful relationship would extent into the operating and monitoring stages as well.

— Research on the relationship between health and wellness initiatives and general patient and staff health and wellness outcomes is essential to the long-term success of such actions. A partnership with researchers in this field needs to be established and fostered in the very short term so that the proper research methods can be put in place and data collection completed at existing facilities before the new facility opens. Brock and Brown University are also looking for topic areas for student's researches.

OPERATIONS STAGE

— Operational WELL preconditions and optimizations. See the WELL scorecard in Appendix C and the WELL Feasibility Study in Appendix D for a summary of all optimizations and preconditions for which NH will be responsible. Key steps include:
  — Quality testing for air, ventilation and balancing
  — Food related (Fruit & Vegetables, Nutritional Transparency)
  — Support staff health & wellness through internal policies & programs (mental health, stress, sleep, immunity, substance use, new parents) through WELL preconditions & optimizations

ADDITIONAL PERFORMANCE MONITORING

— Policies & programs related to staff health & wellness
— WELL Annual Performance Monitoring and Surveys
— Set health outcomes metrics for:
  — Employee turnover rate, patient satisfaction, occupant comfort
  — Employee absences
  — Patient recover rate

3.3 GHG EMISSIONS

OVERVIEW

As mentioned in **Section 2.2.2**, there is an increasing demand to design buildings that identify long-term GHG reduction targets, including net zero carbon. As a response to the Paris Agreement, and Global Warming Report published by the IPCC, the federal government has set a target to achieve 80% reduction from 2005 baseline by 2050. A provincial target of 30% below 2005 levels by 2030 has also been identified in the Made-In-Ontario Environmental Plan. In response to the industry focus on carbon from energy, many municipalities have created targets beyond federal and provincial goals, and standards/certification programs, such as LEED v4.1, are being updated to include language and metrics to track carbon emissions from energy.

NH identified greenhouse gas emissions mitigation including building materials, products used, and medical gas, as a guiding principle to develop, monitor, and report on a life-cycle emissions target, as well as develop a plan to reduce greenhouse gas emissions throughout the life of the building. Focusing on GHG emissions mitigation at a building level also showcases environmental leadership, a category identified as a key facility design theme for NH to assist in building a healthier Niagara.

Key design strategies for GHG reduction include using carbon as the key performance metric for the building energy system; selecting the right technology to reduce GHG emission from refrigerants and anaesthetic gases; and conducting a whole life cycle analysis. Using carbon as a metric, as explored by **Sechelt Hospital,** in British Columbia**,** enforces the importance of energy efficiency and considers the type of energy used. Recent P3 projects, such as **MacDonald Block** (currently beginning design) and **Halton Regional Courthouse** (currently in pursuit), have introduced Mandatory Energy Targets (METs) which focus on TEDI, EUI and GHGI. However, the success of these new targets at balancing cost is not yet clear. For the focus on anesthetic gas reduction, the **NH St. Catharines site** recently installed a readily available solution for re-capture that is manufactured in southern Ontario. Emerging concerns which focus on decreasing energy consumption as a means to decrease overall GHG emissions, puts a heavy focus on the operations phase of the building life cycle. For high-performance buildings, the embodied impacts are particularly important as the operations phase emissions will be very low, or even zero in the carbon neutral case. The right balance will need to be explored by NH to minimize both GHG emissions from operations and materials.

Hospital and healthcare organizations, such as the **UK National Health System (UK NHS),** have also started to include a target for their full carbon footprint from operation GHG emissions. The inventory from **UK NHS** indicates that emissions from procurement are 3.5 times higher than emissions from building energy.

As explored in Section 2.2.2**, Zero Carbon Building (ZCB) certification,** is Canada's first green building program to make carbon emissions a key indicator for building performance and provides a path for new and existing buildings to reach zero carbon. No hospital has yet registered for this certification, providing NH with the opportunity to be an environmental leader and showcase operational excellence within this environmental outcome to assist in developing an extraordinary future.

GHG result from environmental outcomes that are categorized within the six-related NH environmental requirements. Therefore, all six-related environmental requirements contribute at a varying scale towards GHG reduction and are explored within their applicable sections. Opportunities and constraints related to refrigerants, anesthetic gases, renewable energy, electric vehicle infrastructure, commuting GHG emissions, and embodied carbon of construction materials are more directly linked to these other focus areas, and are not duplicated.

OPPORTUNITIES & CONSTRAINTS

As stated in section 3.1, evaluation criteria for GHG emissions have been distributed according to the related implications among the six service-related areas of focus. Likewise, opportunities and constraints for each performance requirement can be found in the relevant sections.

NH PRIORITIES FOR PSOS

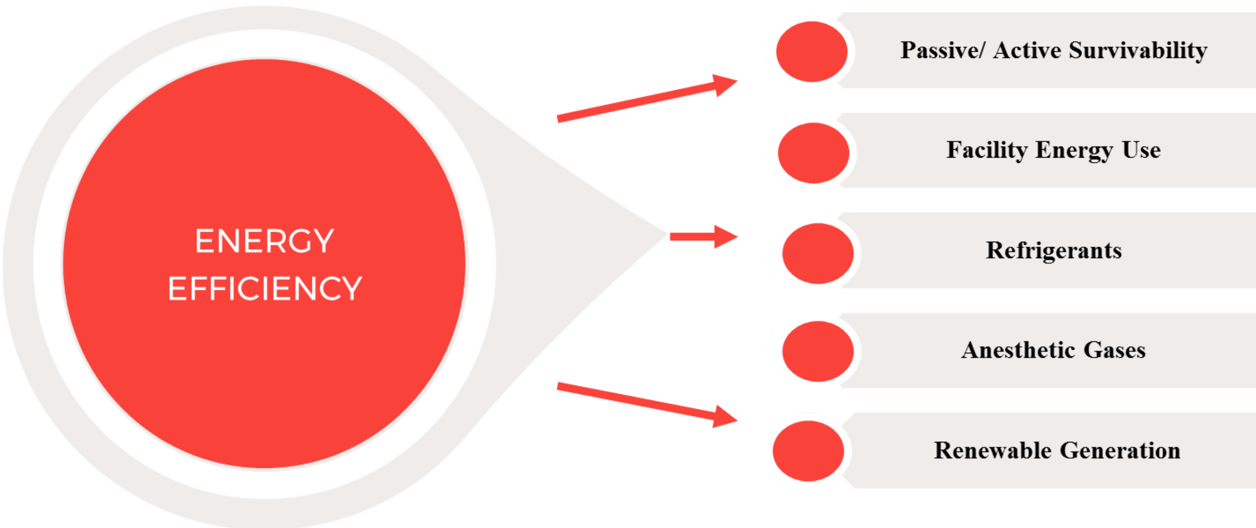
While outside the scope of project co., the stakeholders including the executive team were interested in the model set by UK NHS where the full carbon footprint, including procurement impacts, is being tracked and benchmarked to set future reductions. Project Co's involvement will be required in many of the activities required for this process, as outlined in the individual metrics and initiatives discussed below.

While all six service-related environmental requirements contribute at varying scale towards GHG reduction, the following performance requirements were specifically included under each section.

GHG EMISSIONS	STAGE	LEED	WELL	ZCB	METRIC	PRIORITY
GHG Emissions Intensity	See Energy					
Embodied Carbon	See Materials & Products					
Anaesthetic Gas	See Energy					
Refrigerants	See Energy					
Zero Carbon Building Certification	Design	-	-	Certify	Certification	Recommended

3.4 ENERGY EFFICIENCY

OVERVIEW



As mentioned in **Section 2.2.3**, energy conservation has historically been well-captured in the design and operations of hospitals within Ontario through design/construction phase energy performance targets and the energy performance guarantee process (i.e. pain-share/gain-share). NH identified energy efficiency and consumption including renewable energy, as a guiding principle to assist in developing an energy plan that will set ambitious targets for NH, reduce overall energy consumption, and implement renewable energy where appropriate. The guiding principle also indicates the need for continuous improvement on set targets through implementation and upgrades to systems as they become available. Environmental leadership has also been categorized by NH as an important design theme in the facility design program - energy efficiency being a key metric to assist with achieving environmental leadership within this design theme.

Full-service acute care hospitals with demanding program factors and process equipment make it difficult to achieve very low energy use, however **Humber River Hospital**, located in Ontario, was able to achieve 56% lower total EUI than equivalent acute care hospitals in Ontario. Project Co. at Humber is also motivated to achieve very strict energy targets, as an annual financial penalty which scales relative to the cost of energy for natural gas and electricity applies if targets are not met. Building on the successes of Humber and the pain-share/gain-share process is identified as an obvious path forward.

Low carbon facility energy systems operation five fundamental actions:

1. Reducing the underlying loads of the building, with particular focus on process loads (e.g. sterilization, ITS, etc.);
2. focusing on careful design, selection, and operations to increase efficiency, with special focus on ventilation delivery systems;
3. fuel switching, especially where it overlaps efficiency gains;
4. installing on-site renewable generation;
5. and offsetting the remaining energy requirement needs with outsourced renewable energy.

To achieve the highest levels of energy performance (including zero carbon on site), studies have shown that energy conservation needs to be balanced by on-site renewable energy generation from a variety of sources. Hospitals typically have large rooftop areas and have the potential to install PV arrays to reduce behind-the-meter electricity loads and contribute to on-site generation. **Humber River and Sechelt Hospital** explored the feasibility of on-site renewable energy in the facility design stage. **Humber River** deemed it to be largely too expensive but still put in place the electrical infrastructure during construction for future PV installations on the parkades. **Sechelt Hospital,** however found PV to be a feasible investment and installed a modest 19-kW PV array. PV will not be sufficient, however, to address all renewable energy needs on-site. Additional renewable energy sources, particularly for heating needs, should also be explored.

Passive and active survivability addresses how the hospital would function in the absence of grid-supplied power and is extremely important as the post-disaster function of hospitals requires some form of backup power to keep lights and equipment on in operating rooms and ventilation on in critical infection-control areas.

Regarding refrigerants and anesthetic gases, effective refrigeration equipment selection and maintenance and anesthetic gas recapture systems have both been demonstrated as successful and reasonably cost-effective activities at previous facilities (including the St. Catharines location). Given the high global warming potential of the fluids involved, these features should be a focus for NH. Leveraging previous experience and integration of refrigerants and anaesthetic gases into the overall facility GHG reporting and management protocols will improve outcomes over previous projects.

Throughout the Energy Efficiency category, opportunities to support NH' pursuit of WELL, LEED, and ZCB building certification are identified.

OPPORTUNITIES & CONSTRAINTS

PASSIVE/ ACTIVE SURVIVABILITY

Passive and active survivability addresses how the hospital would function in the absence of grid-supplied power. Active survivability refers to reducing all energy use and expanded back-up power reserves, while passive survivability typically means that areas do not require cooling/heating and therefore have a secondary state of survivability. The post-disaster function of hospitals makes fully passive modes of operation infeasible; some form of backup power with active systems will be required to keep lights and equipment on in operating rooms and ventilation on in critical infection-control areas. Maintaining some level of facility operation beyond the typical 72-hour period becomes a valuable resilience goal, which can be achieved through reducing thermal and electrical energy demand overall, prioritizing services to critical systems/areas, reducing setpoints and services where appropriate, and employing back-up power generation from multiple fuels.

To go beyond just thermal demand, a more robust metric of passive/active survivability including electricity demand, system readiness testing and back-up fuel diversity may be worth exploring further.

ZCB does include metrics for TEDI and light exposure. A simple TEDI metric would work to measure both passive and active survivability but would not address the two different states of service availability. There are currently few/no industry-specific reference points for enhanced targets in hospitals and therefore custom metrics and design guidelines may have to be created.

Through the engagement sessions, this performance category was noted to be a recommended priority area for NH. Engagement session results indicated that most participants were interested in performance requirements for passive/active survivability, though specific surveys were not conducted. Though stakeholders expressed interest in developing survivability metrics, understanding the associated costs would be required before setting specific targets, given the possibility of high capital costs being required that would only be supported/motivated by such a metric, as opposed to having an overlap with other key metrics (e.g. operational energy use).

OPPORTUNITIES	CONSTRAINTS
— Improved focus on conservation (limit the pipe so you limit the usage) — Clear process for determining success. — Improved resilience to disaster scenarios and extreme weather events	— Few/no industry-specific reference points for enhanced targets in hospitals. — Cost to achieve a specific active and/or passive target beyond typical may be high. — Operating uncertainty: How will resilience features be tested? What if performance doesn't match expectation?
LEED V4 BD+C: HEALTHCARE	**WELL V2**
— Passive/ Active survivability is not addressed by LEED.	— Passive/ Active survivability is not addressed by WELL.

ZCB
— Overlaps, in pat, with ZCB TEDI requirement for heating

FACILITY ENERGY USE

As discussed in **Section 2.2.3.**, the differences in energy cost and emissions rates for electricity and natural gas can lead to narrowly-focused targets causing one driving factor to dominate the design and operations decision-making. P3 projects are evolving to incorporate competing drivers of energy, emissions and thermal demand reduction, compared and analyzed in the context of life-cycle financial viability. Facility energy use addresses using less energy to deliver services and the associated GHG benefits. As discussed in previous engagement sessions, facility energy use can be tracked using a EUI or GHGI target approach. EUI is comparable to targets set for existing facilities and is less at the whim of grid performance. GHGI is more aligned with broader sustainability goals and changes mindset around fuel switching and grid impacts.

Both LEED and ZCB address facility energy use and the associated GHG emissions. Facility Energy Use is not addressed in the WELL certification program.

Through the engagement sessions, this performance category was noted to be a recommended priority area for NH. Engagement session results indicated that all participants were interested in performance requirements for facility energy use. Broad supported existed for extending lessons learned through the Greening Healthcare initiative and from existing sites (especially Humber Hospital) to target the lowest targets for facility energy use set to date for a hospital.

Desire to set targets in both energy and GHG emissions was also clear, as well as building on and using a thermal energy demand (TEDI) target for both heating and cooling energy requirements. The TEDI targets enhance efficiency by addressing conservation and load reduction while EUI and GHGI more appropriately address comparability to other facilities and the overall facility performance, respectively.

Augmenting the pain-share/gain-share process to address GHG emissions instead of just energy use / cost was also well-supported in stakeholder discussions, however the appropriate cost of carbon required to motivate action needs to be investigated further in the next phase of design.

OPPORTUNITIES	CONSTRAINTS
— Current IO Energy Matters painshare/gainshare process can achieve best in class Ontario energy performance targets — High thermal demands and process loads in hospitals present potential for significant savings using innovative strategies for energy sharing and fuel switching — Targets may be strongly aligned with recognized LEED and ZCB Standards	— Conventional Code compliance and PSOS requirements do not adequately address advanced resilience or emissions reduction targets — Acute care hospitals have very high process loads (e.g. sterilization, server loads, etc.) and demanding building program requirements (e.g. CSA ventilation, 24/7 operations, etc.)
LEED V4 BD+C: HEALTHCARE	**WELL V2**
— **EA Prerequisite:** Fundamental Commissioning and Verification — **EA Prerequisite:** Minimum Energy Performance — **EA Prerequisite:** Building-Level Energy Metering	— Facility Energy Use is not addressed by WELL.

ZCB
— No specific GHGI or EUI targets currently exist within the ZCB, though these requirements must be documented for submissions and affect the overall zero carbon balance. — It is also expected that similar targets will be introduced in the next version.

REFRIGERANTS

Refrigerants are the associated GHG and ozone depleting impacts of refrigeration, cooling and heat pump equipment. Refrigeration and climate control systems play a fundamental role in the preservation of treatments and preventative activities at hospitals and therefore refrigeration equipment maintenance, use and care is extremely important to ensue GHG mitigation and energy efficiency.

LEED requirements for refrigerants focus on enhanced and fundamental (the use of natural or low-impact) refrigeration management which is most easily achieved by systems with low refrigerant charge (i.e. chillers). LEED also provides an enhanced refrigerant management credit which requires use of no or low-impact refrigerants or calculation of refrigerant impact to comply. WELL does not address refrigerants, neither does the ZCB. However, given the importance of refrigerants to overall global warming impacts, changes to the ZCB could be anticipated in the future.

Through the engagement sessions, this performance category was noted to be a mandatory priority area for NH. Engagement session results indicated that all participants were interested in performance requirements for refrigerants, especially given that success in this area of focus has been achieved, in design, with relatively low cost on previous projects. The challenge put forward and generally agreed-to by stakeholders was to add an operational component (i.e. refrigerant management and tracking) to the list of guaranteed performance requirements for project co. to maintain.

OPPORTUNITIES	CONSTRAINTS
— Fundamental: No CFCs — Enhance: Use natural or low-impact refrigerants — Most easily achieved by systems with low refrigerant charge (i.e. chillers) — Walk-in refrigerators are included — Regulatory efforts to address HFCs are under way in Canada (i.e. implementation of the Kigali amendment begins in 2020)	— VRF systems typically don't comply. — Because of new regulations, the refrigeration industry is in transition. This reality may lead to limited product availability (though installation is not likely to occur for 4-5 years)

LEED V4 BD+C: HEALTHCARE	WELL V2
— **EA Prerequisite:** Fundamental Refrigerant Management — **EA Credit:** Enhanced Refrigerant Management	— Refrigerants are not addressed by WELL.

ZCB
— Future refrigerant leakage reporting, and mitigation/offsetting requirements are possible.

ANESTHETIC GASES

Similar to refrigerants, anesthetic gases are the associated GHG emissions from medical gases and contribute significantly when not managed. As mentioned in **section 3.3**, a system to capture and store anesthetic gases is available from a local manufacturer in Ontario and is being installed in recent developments, most notable **NH St. Catharines site.**

Through the engagement sessions, this performance category was noted to be a mandatory priority area for NH. Engagement session results indicated that all participants were interested in performance requirements for anesthetic gases, given that recapture technology had already been successfully implemented in the St. Catharines facility. As with refrigerants, including these gases in a GHG pain-share/gain-share system makes sense, but requires additional discussion and review in the next phase of design.

OPPORTUNITIES	CONSTRAINTS
— Readily available solutions for re-capture (manufactured in southern Ontario) that are being installed in recent developments, most notably at NH St. Catharines site.	— Options in the current market are limited.

LEED V4 BD+C: HEALTHCARE	WELL V2
— **EA Prerequisite**: Fundamental Refrigerant Management — **EA Credi**t: Enhanced Refrigerant Management	— Anesthetic gases are not addressed by WELL.

ZCB
— No anesthetic gas requirements are currently required for ZCB certification, though future requirements may include accounting for non-energy-related GHG emissions.

RENEWABLE GENERATION

Renewable generation addresses the buying and/or supplying renewable energy to thermal or electricity networks. As explored in **section 3.4**, in order to achieve the highest levels of energy performance, energy requirements need to be offset by on-site renewable energy generation. Hospitals typically have large rooftop areas and have the potential to install PV arrays to reduce behind-the-meter electricity loads and contribute to on-site generation. **Sechelt Hospital** explored the option of PV in their design stage and installed a 19-kW PV array, the largest solar PV system for this type of building in British Columbia.

The ZCB certification includes a requirement to model a zero-carbon balance, with highly efficient envelope and ventilation systems to meet a defined threshold for TEDI and onsite renewable energy systems capable of providing a minimum of 5% building energy consumption. While different sectors (commercial and institutional) have buildings certifying under the new ZCB framework, no hospital has registered yet. LEED certification provides renewable energy production and green power/carbon offset credits to increase the self-supply of renewable energy, technologies, and carbon mitigation projects. The requirements focus on the use of renewable energy systems or RECs to offset building energy costs. The WELL certification program does not address renewable generation.

Through the engagement sessions, this performance category was noted to be a recommended priority area for NH. Engagement session results indicated that participants were interested in performance requirements for renewable generation, based on a combination of GHG reduction and cost-effectiveness arguments. The desire to install a small amount of PV and to enable a site for future larger quantities was well supported. Through additional discussion of renewables (and fuel switching) it was identified that stakeholders are interested in exploring metrics of cost-effectiveness that integrate life-cycle cost savings with GHG reduction such as Life-cycle Cost per Tonne (LCC/tonne) in the next phase of design as part of a detailed carbon neutral study. If the metric is useful in that phase of work, then it may be applied to the pursuit process as well (similar to how NPV is currently included).

Support for certification under the ZCB was not universally supported by stakeholders, given the other venues of certification already pursued for the project (i.e. LEED, PA requirements) and the potentially high cost of purchasing the necessary RECs and offsets to achieve a carbon balance annually. That said, if significant action for on-site renewables is taken, if the standard was to grow in importance (especially for Hospital buildings) and if fees remained low, certification may be possible.

OPPORTUNITIES	CONSTRAINTS
— Achieve a zero-carbon facility (or better) on-site. — Demonstrate what is possible in terms of renewable energy generation and sharing in a properly-designed sub-urban facility. — Support electricity demand reduction and associated cost savings. — Community partnership and revenue opportunities.	— Cannot likely achieve full zero carbon on-site without biomass electricity generation (i.e. more expensive than PV). — Investment in renewables is typically the highest capital measure among energy-related actions of similar impact benefit. — Risks of guaranteeing energy delivery under contact with neighbouring facilities.
LEED V4 BD+C: HEALTHCARE	**WELL V2**
— **EA Credit:** Renewable energy production — **EA Credit:** Green power and carbon offsets	— Renewable generation is not addressed by WELL.

ZCB
— A minimum of 5% of renewable energy is required for ZCB certification

NH PRIORITIES FOR PSOS

Based on the engagement sessions with NH stakeholders, energy efficiency and carbon reduction strategies are a high priority for the new hospital. NH would like to set an example in its energy performance and carbon reduction against other hospitals.

ENERGY EFFICIENCY	STAGE	LEED	WELL	ZCB	METRIC	PRIORITY
Energy Cost and/or Carbon Reduction	Design	X			% Reduction vs NECB Baseline	Mandatory
Total Energy by Fuel	Design & Operate			X	MJ vs Target	Recommended
Energy Cost Budget	Design & Operate				$/year	Optional
GHG Emissions Intensity	Design & Operate			X	tCO_2e/m^2 vs Target	Recommended
Incremental Lifecycle Cost Per Tonne	Design & Operate				$/$tCO_2e$	Optional
On-Site Energy Generation	Design	X		X	% of Load	Recommended
Annual Carbon Balance Including RECs or Offsets	Out of Scope			X	tCO_2e	Optional
Ozone and Global Warming Impact - Refrigerants	Design	X			ODP & GWP	Mandatory
Ozone and Global Warming Impact – Anaesthetic Gases	Design				ODP & GWP	Mandatory
Indoor Design Conditions During Reduced Power	Design				# of hours Per Stage	Recommended
Heating and Cooling Demand Intensity	Design			X	TEDI-h/ TEDI-c	Recommended
Backup Power Availability	Design				% of Load Type of fuel	Recommended

NEXT STEPS | ENERGY EFFICIENCY

Within this category, a number of important actions were discussed that are beyond the scope of the PSOS and Project Co's involvement in the new hospital. This work, if deemed a priority, will not be used to evaluate design options and will instead need to be implemented by NH. These next steps for Energy Efficiency include:

DESIGN STAGE

— Zero Carbon Certification is available for both New Construction and Existing Building

OPERATIONS STAGE

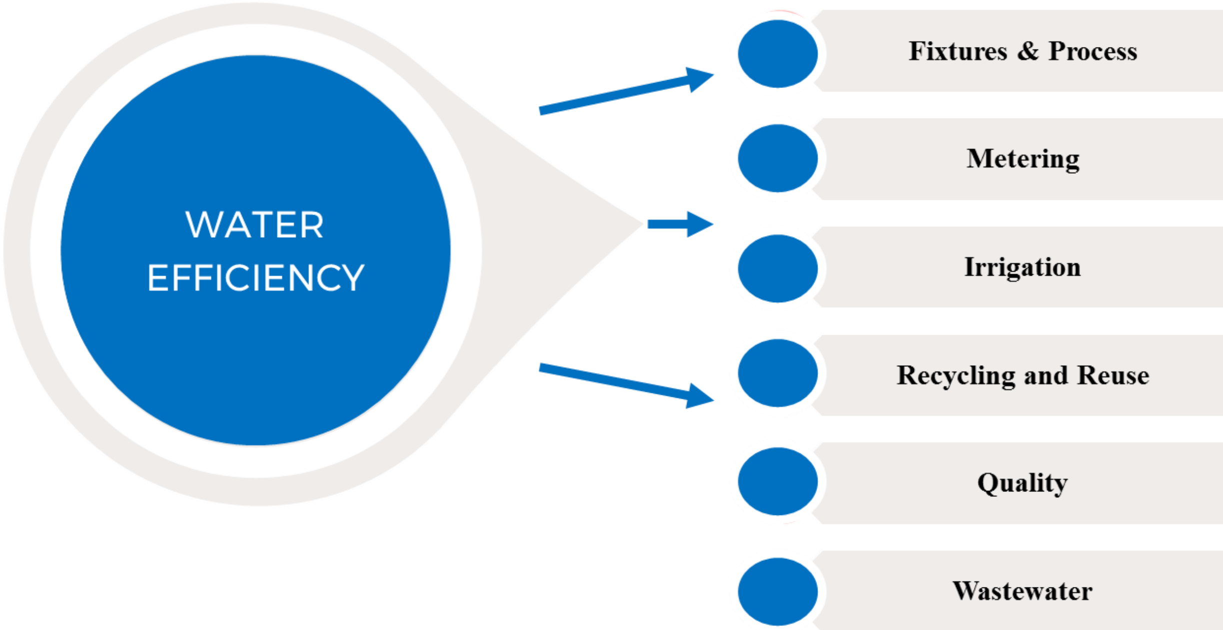
— Renewable Energy Certificate purchasing

ADDITIONAL PERFORMANCE MONITORING

— Annual Carbon Balance Including RECs or Offsets

3.5 WATER EFFICIENCY

OVERVIEW



As mentioned in **Section 2.2.4**, hospitals are often one of the largest users and thus disposers of water in a community. NH identified water efficiency, including recovery and recycling, as a guiding principle to establish and achieve a site-specific water use target and determine a plan to continuously improve targets through out the life of the building. Within a health care facility, a certain amount of water of a standardized quality is required to be used to meet hygiene standards. Therefore, the focus on water quality and treatment of wastewater is important for NH to achieve operational excellence, as well as accessibility and safety, in the facility design stage.

The largest use of water in hospitals comes from fixtures and processes, landscaping, cooling equipment and medical process laundry. As water reduction efforts have been focused on the system design features and quality of water at both consumption and discharge phases of water use, the **Green Hospital Scorecard,** is an important resource for use by NH. The **Green Hospital Scorecard** captures efficiency of water consumption within health care facilities in Canada and lists the average WUI which can be used as a performance benchmark target in the post-construction phase.

Although fixtures and processes are identified as one of the largest contributors to water use in a hospital, the use of high-efficiency water fixtures at **Humber River** were not the best solution for certain hospital applications and supplying non-potable water to interior fixtures was deemed as a potential infection risk. With the high concern of infection in hospitals, recycling and reuse of water has been more evident in outdoor spaces and hospitals are increasingly leveraging on-site cisterns to capture rainwater runoff and to use for landscaping purposes. At **Sechelt Hospital,** landscape irrigation was eliminated through the selection of native and adaptive plants and through the use of curb cuts to drain storm water into infiltration areas. The City of Niagara & the Region have also cited reducing sewage conveyance as a local priority. Therefore, reducing water use both indoor and outdoor, as well as focusing on wastewater treatment should be considered a high-priority to enable the hospital in supporting the local community.

Through out the Water Efficiency category, opportunities to support NH' pursuit of WELL Building certification and LEED are identified. Water is well regulated and governed resource across all levels of Canada's governance structure and therefore water efficiency receives greater focus with popular sustainability standards such as LEED. WELL does address water efficiency but focuses wholly on the availability and quality of drinking water including the often-ignored parameter of water taste.

Features that benefit from water efficiency link to many other environmental considerations, particularly landscape and nature. Opportunities and constraints related to stormwater management are more directly linked to these other focus areas and are not duplicated as Water Efficiency considerations despite this overlap.

OPPORTUNITIES & CONSTRAINTS

FIXTURES & PROCESS – INTERIOR FIXTURES & PROCESS EQUIPMENT

Interior fixtures and process equipment addresses design practices to reduce indoor water consumption through installation of interior fixtures. Hospitals, such as **Sechelt**, have typically achieved a 30-35% reduction installing water efficient fixtures including dual flush water closets, lavatory and kitchen faucets, and low-flow shower faucets. As identified in **Section 2.2.4,** most hospital's indoor water use reduction targets are not as aggressive as other sectors due to the need for higher flow water fixtures in specific patient care areas. As fixtures and processes are one of the largest consumers of water in a hospital, the goal for this environmental outcome is to reduce water use on-site to assist in achieving the site-specific water use target.

Directly linked to a decrease in water use, this is a typical green building concern which is extensively covered by in the LEED certification program through the indoor water use reduction requirement. This requirement focuses on reducing aggregate water consumption by 20% from the baseline for commercial fixtures, fittings and appliances. Fixture specific requirements are not covered in the WELL certification program.

Through the engagement sessions, this performance category was noted to be a mandatory area for NH stakeholders. Engagement session results indicated that 33% of participants were interested in performance requirements for fixtures and process. Participants in the session agreed that, though very important, potable water use reduction was as much about user engagement and operating practices as fixture selection, emphasizing the importance of ongoing monitoring discussed further in the next section.

OPPORTUNITIES	CONSTRAINTS
— Water Efficiency with WaterSense labelled fixtures, efficient process equipment such as dishwashers, ice machines and steamers, and enhanced cooling tower control. — Alternative water sources contribute to % reduction. — To achieve points, healthcare projects must address sterilizers and other lab equipment.	— Low-flow fixtures may not be desirable for all patient areas — Hospitals typically have achieved a 30 – 35% water reduction.
LEED V4 BD+C HEALTHCARE	**WELL V2**
— **WE credit:** Indoor Water Use Reduction	— Fixtures and Processes – Interior Fixtures & Process Equipment is not addressed by WELL.

FIXTURES & PROCESS – COOLING TOWERS

Interior fixtures and process equipment addresses design and operation practices to reduce indoor water consumption through installation of interior fixtures, in this case specifically cooling towers. Cooling towers use significant amounts of water and must be carefully managed and operated to reduce the risk of Legionella. Cooling towers, if provided on-site, should be designed to limit water use through chemical treatment systems or use of non-potable water. In the operations stage, a cooling tower management program will be required to ensure proper management and operation. A focus on cooling tower management and design supports the environmental leadership and operational excellence design themes and water efficiency vision of NH' guiding principles.

Cooling tower water use is covered through the LEED certification program and requires a one-time potable water analysis program to optimize cooling tower cycles. Control parameters that must be tested are provided within the certification requirements to control microbes, corrosion, and scale in the condenser water system. WELL does not address cooling tower requirements.

Through the engagement sessions, this performance category was noted to be a recommended area for NH stakeholders. Engagement session results indicated that 33% of participants were interested in performance requirements for fixtures and process. Though cooling tower make-up can be a significant source of water use, the technologies required to avoid significant loss (i.e. e.g. variable-speed fans and flows, a dry cooler for free-cooling winter and shoulder months, etc.) are all cost-effective and would likely be included in a baseline design.

OPPORTUNITIES	CONSTRAINTS
— LEED V4.1 allows projects without cooling towers or evaporative cooling to achieve this credit. — Or, design cooling towers to limit water use through chemical treatment systems or use of non-potable water	— Cooling tower systems must be carefully managed and operated to reduce Legionella risk.

LEED V4 BD+C HEALTHCARE	WELL V2
— **WE Prerequisite**: Indoor Water Use Reduction — **WE Credit:** Cooling Tower Water Use	— Fixtures and Process – Cooling Towers is not addressed by WELL.

WATER METERING

Water meters provide water use direct readings for buildings, and therefore support water management and assist in identifying atypical usage patterns, leaks and seasonal variations to determine cost savings and best practice. Water meters are an important water reduction effort and water management tool to consider in the design phase to track progress towards the site-specific water use target and assist in identifying areas for continuous improvement throughout the life of the building. Water meters are also often included as a mandatory credit for IO hospitals.

Standards such as LEED offer specific credits to reduce water use both indoor and outdoor by prescribing the use of water meters. For building-level water metering LEED certification requires the installation of permanent water meters that measure the total potable water use for the building and associated grounds, this also includes two or more water subsystems. Monthly and annual tracking is required. WELL does not address water metering.

Through the engagement sessions, this performance category was noted to be mandatory area for NH stakeholders. Engagement session results indicated that 58% of participants were interested in performance requirements for water metering. As the most important sub-category of focus, water metering represents the minimum requirement of a process of setting, maintaining and improving on an annual water budget. Similar to how energy conservation is carefully monitored to validate the pain-share/gain-share requirements, water metering with appropriate end-use breakdown will allow project co and/or NH staff to understand how potable water is used and work to reduce it, in partnership with staff and tenants.

OPPORTUNITIES	CONSTRAINTS
— Allows ongoing management of water including monitoring leaks, atypical usage patterns and seasonal variation. — Typically, not expensive to achieve. — Often included as a mandatory credit for IO projects, including the Michael Garron hospital.	— Requires consideration of piping design to minimize the number of meters required. — May be challenging to implement in a hospital environment with significant distributed process equipment.

LEED V4 BD+C HEALTHCARE	WELL V2
— **WE Prerequisite:** Building-Level Water Metering — **WE Credit:** Water Metering	— Water Metering is not addressed in WELL.

IRRIGATION

As mentioned in **section 2.2.4**, hospitals are increasingly leveraging on-site outdoor water management systems such as cisterns, infiltration systems, and drip irrigation to eliminate or reduce potable water use for irrigation purposes. An emerging trend to limit potable water use for irrigation purposes is the collection or use of rainwater. **Humber River**, designed their drip irrigation system to be fed by two underground cisterns supplied with roof run-off, while **Sechelt Hospital** explored the option of eliminating the need for irrigation by creating curb cuts to drain storm water into infiltration gardens. The focus on irrigation and outdoor water conservation should be a concern for NH, as outdoor water use is one of the largest contributors to water use at a hospital.

LEED requirements for outdoor water use focus on the reduction of water use by providing reduced or no irrigation on-site. Reduced irrigation explores plant species selection and irrigation system efficiency. WELL does not address irrigation.

Through the engagement sessions, this performance category was noted to be mandatory area for NH stakeholders. Engagement session results indicated that 25% of participants were interested in performance requirements for irrigation. Owing, in part, to the desire to achieve reduced potable water use *overall* and the overlap of technologies appropriate for the next category, measures specific to irrigation were not given the same focus. However, options such as a cistern and drought-tolerant species for most landscaping are already in the expected design, owing to the desire to achieve lower maintenance costs and strict storm-water control.

OPPORTUNITIES	CONSTRAINTS
— Eliminate or reduce potable water use for irrigation through plant selection, irrigation system design and/or use of non-potable water sources. — Food gardens can be excluded. — Rainwater collection supports stormwater management	— Rainwater-fed irrigation is costly but permits lusher landscaping. — Volume of water collected will be reduced by green roof areas.

LEED V4 BD+C HEALTHCARE	WELL V2
— **WE Credit:** Outdoor Water Use Reduction	— Irrigation is not addressed in WELL.

RECYCLING AND REUSE

Recycling and reuse of water addresses design and operations practices to reduce water consumption on-site through reuse or recycling methods such as cisterns, raingardens, graywater reuse, etc. Curb cuts, native and adaptive plants to replace lawns and create modern gardens, as examined at **Sechelt Hospital**, have also been emerging as a trend to addresses water recycling methods. Due to infection control, greywater reuse, has not been recommended in hospital environments.

Recycling and reuse contributes to both LEED Indoor and Outdoor Water Use Reduction credits but is not included as a separate credit with specific requirements. Rainwater management is also covered with LEED to manage on-site and annual increase in runoff volume focusing on the percentile of rainfall events. WELL does not address recycling and reuse.

Through the engagement sessions, this performance category was noted to be mandatory area for NH stakeholders. Engagement session results indicated that 50% of participants were interested in performance requirements for recycling and reuse. Participants generally supported the idea of a cistern as the main approach to enabling rain water to be reused for irrigation of food and healing gardens.

OPPORTUNITIES	CONSTRAINTS
— Offers water resource and financial savings — Treated wastewater can be reused for landscape irrigation and replenishing a ground water basin.	— Treated wastewater is typically not used for toilet flushing in the healthcare sector — Depending on the size of the water re-use requirement, cisterns can become costly.

LEED V4 BD+C HEALTHCARE	WELL V2
— **SS Credit:** Rainwater Management	— Recycling and Reuse is not addressed in WELL.

QUALITY

Quality addresses design and operations practices to maintain a healthy water quality that meets the Ontario drinking water quality standard. In Canada, the responsibility for ensuring safe drinking water is shared between provincial, federal, and municipal governments and is well-regulated. As a result of this, water quality has not been a large focus area for sustainability standards when compared to water use efficiency. However, ensuring healthy water quality in a hospital environment should be a concern for NH to eliminate transfer of infection or water-borne bacteria.

WELL sustainability standard focuses on water quality, specifically on the availability, consistency, and taste properties. WELL preconditions require annual testing for turbidity, coliforms, dissolved metals, organic pollutants, disinfectant by-products, herbicides, pesticides, fertilizer, and public water additives. LEED does not address water quality.

Through the engagement sessions, this performance category was noted to be a recommended area for NH stakeholders. Engagement session results indicated that 42% of participants were interested in performance requirements for quality. Discussion in sessions focused on quality issues that align with well, but also on taste and smell concerns for drinking water.

OPPORTUNITIES	CONSTRAINTS
— Drinking water quality will be monitored to limit the presence of sediment and water-borne bacteria levels in water — Continuous monitoring and testing will be required to maintain WELL certification — Analysis for risk of Legionella can help set up teams and response process to manage concerns	— Healthcare facilities are at higher risk for having Legionnaires' disease case and outbreaks than other type buildings as healthcare facilities can have large complex water systems that promote Legionella growth if not properly maintained

LEED V4 BD+C HEALTHCARE	WELL V2
— Quality is not addressed in LEED.	— **W01** Fundamental Water Quality — **W02** Water Contaminants — **W03** Legionella Control — 5 more Features are available under the concept of Water, which cover aspects of the quality, distribution and control of liquid water in the building system. It includes features that address the availability and contaminant thresholds of drinking water, as well as features targeting the management of water to avoid damage to building materials and environmental conditions.

WASTEWATER

Wastewater treatment and reducing sewage conveyance is a priority in the Niagara region due to a history of combined sewage overflows. Wastewater addresses design and operations practices to ensure the proper treatment and disposal of water that has been used on-site and conveyed from building plumbing systems. As noted in **section 2.2.4**, the South Niagara hospital will be one of the largest users and disposers of water within this development boundary and as such, the goal for this environmental outcome is to implement active water management and wastewater treatment practices to assist the region with their local priority.

LEED and WELL do not specifically address reduction of sewage or quality of wastewater discharged in the sustainability requirements. Therefore, separate contract language and design guidelines will be required.

Through the engagement sessions, this performance category was noted to be a recommended area for NH stakeholders. Engagement session results indicated that 42% of participants were interested in performance requirements for wastewater. Focus of the discussion centred mostly on measuring pH levels in the water which have a tendency to elevate beyond municipally-approved thresholds caused by stricter cleaning requirements that occur from time-to-time. Being good stewards and knowing when such exceedances have occurred is the main argument for installation additional testing systems.

OPPORTUNITIES	CONSTRAINTS
— NH currently gets warnings from the municipality on the pH level. Active management can neutralize pH level in the wastewater	— Full wastewater treatment can be costly

RELATED POLICIES/REQUIREMENTS
— Not addressed specifically in LEED or WELL.

NH PRIORITIES FOR PSOS

Based on the engagement sessions with NH stakeholders, understanding the water use intensity is a high priority. Metering will support the steps needed to allow ongoing management of water including monitoring leaks, atypical usage patterns and seasonal variation.

WATER EFFICIENCY	STAGE	LEED	WELL	ZCB	METRIC	PRIORITY
Water Metering	Design	WEp3 WEc4	-	-	# of subsystems	Mandatory
Water Recycling and Reuse	Design	-	-	-	% irrigation from non-potable sources	Mandatory
Drinking Water Quality	Operate	-	W01 W02	-	ongoing testing of turbidity, coliforms, metals, organic pollutants, disinfectant by-products, herbicides, pesticides, fertilizers and water additives	Recommended
Wastewater pH Control	Operate	-	-	-	11>pH>6	Recommended
Irrigation System	Design	WEp1 WEc1	-	-	% outdoor water use reduction	Mandatory
Fixtures & Process Equipment	Design	WEp2 WEc2	-	-	% indoor water use reduction	Mandatory
Cooling Tower Water Treatment	Operate	WEc3	-	-	condenser water parameter concentrations & cooling tower cycles	Recommended
Operating Annual Water Use Intensity	Operate	-	-	-	m^3/m^2 or m^3/patient-hour	Optional

NEXT STEPS | WATER EFFICIENCY

Within this category, a number of important actions were discussed that are beyond the scope of the PSOS and Project Co's involvement in the new hospital. This work, if deemed a priority, will not be used to evaluate design options and will instead need to be implemented by NH. These next steps for Water Efficiency include:

DESIGN STAGE

– N/A

OPERATIONS STAGE

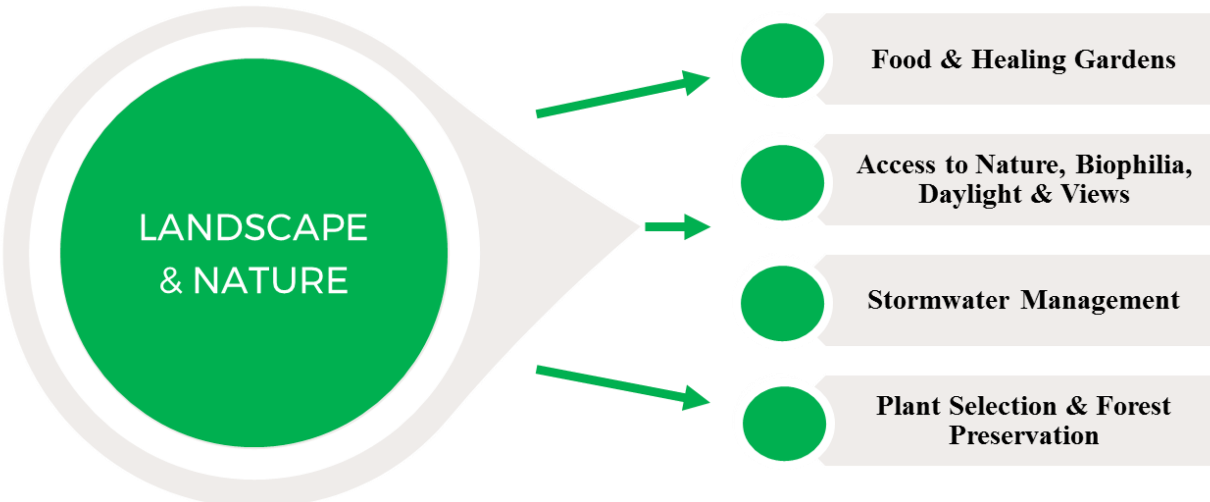
– N/A

ADDITIONAL PERFORMANCE MONITORING

– Water Use Intensity target may be difficult to include in the PA, will require discussions with IO

3.6 LANDSCAPE & NATURE

OVERVIEW



In the healthcare sector, hospital design has fully embraced the principles of wellbeing and the importance of landscape and nature. NH identified landscape and nature, including connection to health outcomes, as a guiding principle to create a beautiful, low maintenance site for the benefit of occupants, staff, and the community. Key design strategies for landscape and nature include reduction of parking to increase dedicated green space, use of therapeutic and healing gardens, and careful plant selection.

Access to healing or therapeutic gardens in the hospital context is increasingly important for human health and well-being, as demonstrated by the **University Health Network** and **Children Hospital of Eastern Ontario (CHEO).** The gardens and outdoor spaces require design involvement and further operational and management support, such as ongoing maintenance and upkeep, and operational support to accommodate group activities, horticulture therapy and physical activity. Community gardens are an emerging trend that enhance community connectedness through maintenance and upkeep. Hospital's have also used their community garden harvesting program to create a connection with various patients (cancer survivors, kids, patients suffering from eating disorders, etc.). The **Michael Garron Hospital** recognizes landscape as an integral part of the healing process and provides accessible outdoor spaces, a community garden, rooftop terraces and green roofs, and a dedicated staff courtyard.

Pollinator-friendly plants are also increasingly important to create pollinator friendly-spaces. **Hamilton General Hospital** recently added a pollinator garden at the **Hamilton Health Sciences** site to join a local and international movement focused on increasing these spaces. Emerging concerns such as ensuring non-invasive species are used, avoiding hybrids, planting in clusters and ensuring a variety of early, mid, and late flowering species, is an important concern in the design phase to improve the efficiency of pollination and to attract more pollinators.

As addressed by the **Grand Niagara Secondary Plan**, stormwater management facilities will be a key feature within the community contributing to the appearance and ambience of the neighbourhood. It is important for NH to address stormwater management practices to help minimize the impact of polluted runoff flowing into the water streams and lessen the stress that stormwater places on municipal infrastructure.

Through out the Landscape & Nature category, opportunities to support NH' pursuit of both WELL and LEED building certification are identified. The WELL certification provides a comprehensive framework for food production, restorative spaces, and access to nature through the Nourishment concept. The Nourishment concept focuses on the availability of food and encourages better eating habits and food culture. LEED addresses Landscape & Nature through Environmental Quality credits that focus on daylight, access to quality views, rainwater management and outdoor water use reduction.

Features that benefit from landscape and nature link to many other environmental considerations, particularly health and wellness, and water efficiency. Opportunities and constraints related to healthy and sustainable food, irrigation, and recycling and reuse, are more directly linked to these other focus areas and are not duplicated as a landscape and nature consideration despite this overlap.

OPPORTUNITIES & CONSTRAINTS

FOOD GARDEN (THERAPEUTIC GARDENS)

Food garden areas that support on-site food production and community connectedness, can serve as either a therapeutic garden or healing garden within the hospitals. A therapeutic food garden is a garden where physical, occupational, horticultural and other therapies take place to support on-site food production and provide restorative space. Providing therapeutic gardens or restorative spaces increase the staff, occupants, and visitor's connection to green space physically and visually. As explored with **Dell Children's Medical Centre** and **Michael Garron Hospital,** providing healing gardens and incorporating landscaped elements in external and internal design features improve occupant health and wellness.

Food production, specifically the provision of gardening space and planting support is addressed in the WELL certification program. This credit requires the provision of gardening space, training of garden management and maintenance individuals, and supplies needed to utilize the space. The food grown is also intended to be available to the occupants of the hospital. LEED does not address food gardens.

Through the engagement sessions, this performance category was noted to be a mandatory area for NH stakeholders. Engagement session results indicated that 75% of participants were interested in performance requirements for food gardens. Though stakeholders identified that NH works with third party food suppliers for most of their food needs, a food garden is a unifying concept that ties the nutritional, therapeutic and community connection goals for the new development together.

OPPORTUNITIES	CONSTRAINTS
— Engage staff, patients, visitors & community — Incorporate local, healthy foods into hospital setting — Distribution point for community-based agricultural programs — Educational opportunities — Reduce carbon footprint — Provide additional greenspace	— Space requirements — Gardening space management and maintenance can be time consuming and costly — High level of social organization — Pest control — May impact water efficiency goals negatively
LEED V4 BD + C HEALTHCARE	**WELL V2**
— Food Gardens are not addressed in LEED.	— **N12** Food Production: Provision of gardening space and planting support is worth 2 points towards WELL certification.

HEALING GARDEN (RESTORATIVE GARDENS)

A healing garden or restorative garden includes any landscape – wild or designed, large or small – that facilitates human health and well-being and increases connection to green space physically and visually. This connection is usually established in the design phase by providing site and water elements throughout the green space. It has been proven that views of nature have reduce patient stress and facilitate healing. Garden maintenance and planting support will be required in the operations stage.

Both LEED and WELL address healing gardens and focus on the hospital environments need for restorative spaces and places of respite. LEED provides two optional credits, direct exterior access and places of respite. Direct exterior access requires the hospital to provide direct access to an exterior courtyard, terrace, garden, or balcony for patients. Places of respite must be outdoors and provided to patients, staff, and visitors. The WELL standard requires projects to provide spaces that promote a restorative environment and encourage relief from mental fatigue and stress.

Through the engagement sessions, this performance category was noted to be a mandatory area for NH stakeholders. Engagement session results indicated that 75% of participants were interested in performance requirements for healing gardens. Just as food gardens are unifying, healing gardens are seen as a natural extension of practices already on-going within the facility, as part of the healing process, that should extend throughout the building and its immediate landscape. Significant effort was made during stakeholder engagement (and as part of broader planning efforts) to ensure sufficient space would be allocated to both purposes. Participants also noted security constraints that need to be carefully considered, especially as it relates to shading/trees and view angles.

OPPORTUNITIES	CONSTRAINTS
— Encourage relief from mental fatigue and stress — Encourage micro-breaks during the day for staff — Enhance patient experience and improves recovery rates — Boost employee wellbeing and effectiveness — Varied space types can be used to appeal to different users	— Space requirements — Gardening space management and maintenance can be time consuming and costly — High level of social organization — Pest control — May impact water efficiency goals negatively

LEED V4 BD+C HEALTHCARE	WELL V2
— **SS Credit:** Direct exterior access — **SS Credit**: Places of respite	— **M07** Restorative Spaces (Indoor & Outdoor)

ACCESS TO NATURE, BIOPHILIA, DAYLIGHT & VIEWS

Access to nature, biophilia, daylight and views, addresses design and operation practices to integrate connections between the interior and exterior environment of the hospital. As mentioned in **section 2.2.5**, access to nature from interior spaces, whether it be in the form interior biophilic interior design elements, outdoor green space, or even an image, is increasingly important within hospitals design. Ample daylight and views to green space and sky have been shown to enhance patient experience, boost staff productivity, improve recovery time and reduce requirements for pain medication. **Michael Garron Hospital**, provides a rooftop terrace designated for adult mental health, which reiterates the strong connection between improved mental health and access to nature.

Both LEED and WELL address access to nature and focus on the hospital's quality views, daylight, space layout, and restorative spaces. LEED requirements primarily focus on open space, direct exterior access and daylight, where as WELL's mandatory requirements focus predominately on providing direct and indirect connection. WELL also provides option credits which focus on enhanced access to nature, restorative space, and on-site pedestrian destinations.

Through the engagement sessions, this performance category was noted to be a recommended area for NH stakeholders. Engagement session results indicated that 50% of participants were interested in performance requirements for access to nature, biophilia, daylight and views. A natural extension and overlap exists with this focus area and IEQ requirements, which were also a high priority for stakeholders during health and wellness discussions. Combining the benefits of a comfortable and controllable space with one that provides the thrill of natural and personal connections is expected to be self-reinforcing.

OPPORTUNITIES	CONSTRAINTS
— Enhanced patient experience — Boost staff productivity — Encourage social interaction, passive recreation & physical activity — Support spatial orientation — Improved recovery times	— Additional maintenance costs for natural elements — Significant architectural involvement given open-ended requirements — High costs for UV sanitation required for water features — Glare control and comfort — Weather-related maintenance — Impact on envelope design

LEED V4 BD+C	WELL V2
— **EQ credit:** Daylight — **EQ credit**: Quality Views	— **M02** Access to Nature (Precondition): Integrate and encourage occupant access to nature within the building and project site through plants, water, light, views, natural materials/colours/patterns & space layout. — **M07** Restorative Spaces (Indoor & Outdoor) — **M09** Enhanced Access to Nature

STORMWATER MANAGEMENT

Stormwater management addresses design and operations practices to help minimize the impact of polluted runoff flowing into the water streams, and lessen the stress that stormwater places on municipal infrastructure. The **Grand Niagara Secondary Plan** addresses the importance of increased stormwater management and recommends design principles to guide future projects in use of Low Impact Design for stormwater management. Under natural conditions stormwater is treated by vegetation, therefore reiterating the value of on-site green space, gardens, and low-impact design. **Humber River's** success in implementing a system that infiltrates all stormwater on-site to prevent discharge into municipal sewers during storm events provides an innovative design measure to manage stormwater on-site.

LEED requirements for stormwater management focus on the management of on-site runoff from rainfall events using low impact development and green infrastructure. WELL does not address stormwater management. Considering that both certification standards are quite limited in addressing stormwater management, additional metrics as it pertains to adaption and resiliency may need to be explored.

Through the engagement sessions, this performance category was noted to be an optional area for NH stakeholders. Engagement session results indicated that 50% of participants were interested in performance requirements for stormwater management. Users identified the potential risks of the site as it relates to storm water. Anecdotal observations described a site that can become very wet, indicating the possibility of significant run-off from adjacent sites and watersheds combined with generally poor soil permeability. A geotechnical study of the site is underway which will help inform the specific challenges, but the stakeholders were nonetheless concerned that appropriate action be taken to address runoff and flooding.

OPPORTUNITIES	CONSTRAINTS
— On-site infiltration of 100% of runoff from rain event through low impact development (LID) and green infrastructure — Aligns with Niagara Secondary Plan recommendations — Adaptation and Mitigation — Essential action for climate change adaptation	— Soil conditions and water table will make implementation difficult — Permeable pavers, bioswale, oil/grit separators, green roofs and rainwater reclaim may be more viable strategies than infiltration trenches

LEED V4 BD+C	WELL V2
— **SS credit:** Rainwater Management	— Stormwater management is not addressed in WELL.

PLANT SELECTION & FOREST PRESERVATION

Plant selection and forest preservation is a typical concern for most new hospitals in the design and operations stage. The focus of this environmental outcome is to conserve existing natural areas and resources and restore previously disturbed site areas using native vegetation. As discussed in **section 2.2.5**, providing pollinator-friendly spaces which focus on inclusion of native/naturalized, non-invasive species is an international movement and emerging trend that has been implemented at **Hamilton General Hospital** at the **Hamilton Health Sciences** site. Native plant selection also provides a unique opportunity for NH to incorporate and display Niagara culture through out the site.

LEED requirements address plant selection and preservation but do not directly focus on forest preservation. Credit requirements focus on preserving greenspace from construction and restoring previously disturbed sit areas using native vegetation and outdoor water use reduction. WELL does not address plant selection and forest preservation.

Through the engagement sessions, this performance category was noted to be a mandatory area for NH stakeholders. Engagement session results indicated that 50% of participants were interested in performance requirements for plant selection & forest preservation. Those representing community/patient perspectives specifically tabled forest preservation as an important action to address both climate change adaptation and global warming mitigation. Security and cost challenges exist with retaining all existing forest and planting a significant number of trees, but the benefits of such approaches were acknowledged.

OPPORTUNITIES	CONSTRAINTS
— Preservation of greenfield site area — Restoration of previously disturbed site area — Trees support more carbon sequestration — Vegetated roof surfaces can contribute to site restoration — Reduction of landscape water requirement (LWR) — Opportunity to incorporate and display culture of Niagara — Lower cost, less maintenance associated with native plants	— High level of site planning required — Limited variety of native plants available — Native plants can be less visually impressive — Planting significant numbers of trees introduces additional security requirements

LEED V4 BD+C	WELL V2
— **WE credit**: Outdoor Water Use Reduction	— Plant selection is not addressed in WELL.

NH PRIORITIES FOR PSOS

Based on the engagement sessions with NH stakeholders, the provision of various gardens is a high priority. The current site plan includes ample landscaped space that could be dedicated for healing and food gardens. Plant selection, especially creating pollinator-friendly plants were also discussed as a high priority for the new hospital.

LANDSCAPE & NATURE	STAGE	LEED	WELL	ZCB	METRIC	PRIROITY
Healing Gardens	Design	SSc3 SSc7 SSc8	M07	-	garden space per occupant	Mandatory
Food Garden	Design & Operate	SSc3	N12	-	# of garden participants (staff, patients, community) OR garden space per occupant OR 30% of on-site food requirement	Mandatory
Indoor Restorative Space	Design	-	M07	-	indoor space per occupant	Recommended
Nature Integration	Design	-	M02 M09	-	# of direct & indirect natural design elements	Recommended
Daylight & Views	Design	EQc7 EQc8	L01 L05	-	% occupants with views, % area meeting daylight requirements	Recommended
Native / Drought-Tolerant Plants	Design	SSc2 WEp1	-	-	% landscape water use reduction	Mandatory
Pollinator-Friendly Plants	Design	-	-	-	dedicated coverage area	Mandatory
Rainwater Management	Design	SSc4	-	-	percentile rainfall event managed	Mandatory

NEXT STEPS | LANDSCAPE & NATURE

Within this category, a number of important actions were discussed that are beyond the scope of the PSOS and Project Co's involvement in the new hospital. This work, if deemed a priority, will not be used to evaluate design options and will instead need to be implemented by NH. These next steps for Landscape & Nature include:

DESIGN STAGE

- Programming of the food gardens and healing gardens for appropriate outdoor spaces should be determined. –
- The location and the appropriate size for the food garden should be analyzed. Currently NH is considering food gardens for Senior Wellness and Complex Care. The appropriate size and form for the food garden will be driven by the purpose of the food garden (e.g. elevated planting beds for the patients, or community gardens for therapeutic uses, etc.)

OPERATIONS STAGE

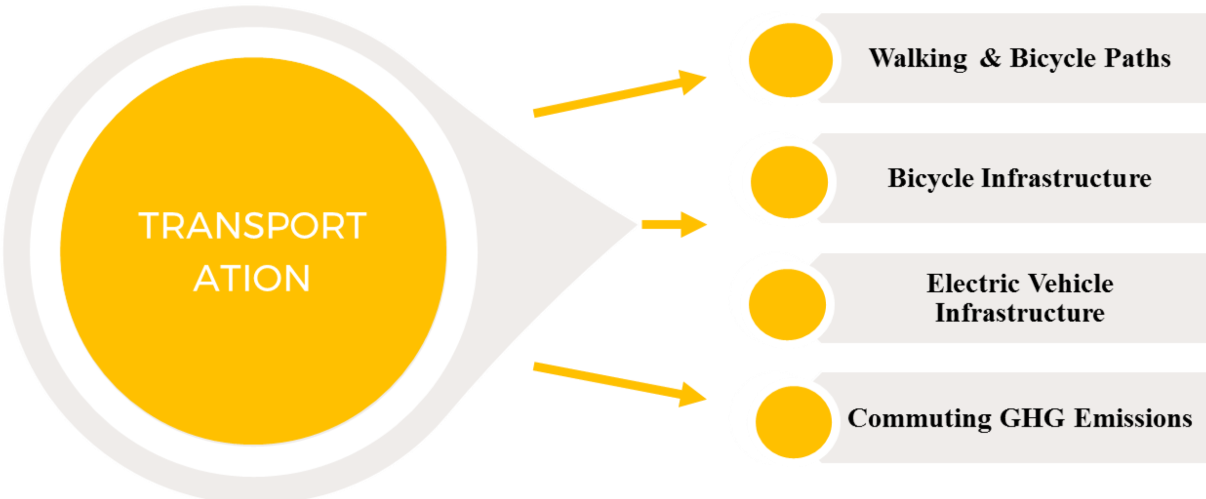
- If food gardens and/or healing gardens are included, continuous programming and monitoring will be required to ensure success of the intended use.

ADDITIONAL PERFORMANCE MONITORING

- Enhanced stormwater management strategies for climate change adaptation, possibly in partnership with *Niagara Adapts* (a recently-formed municipal government and Brock University partnership).

3.7 TRANSPORTATION

OVERVIEW



As mentioned in **Section 2.2.6**, transportation has been an important role to play in Canada's economic health and the day-to-day activities of the public. NH identified transportation as a guiding principle to develop a transportation network for staff, occupants, and visitors that is convenient, cost effective, and sustainable. The focus of this development was also to include transit, community, EV infrastructure, and parking within this development. Current demographics and economic trends are changing the consumer preference and demand from car transportation to alternative forms of transportation.

Recently designed and built hospitals acknowledge their role in supporting the evolution of transportation and are aiming to proactively influence clean commuting patterns of both hospital staff and visitors. There has been an increasing emphasis on sustainable transportation planning which presents an opportunity to address other planning objectives such as reducing commuting greenhouse gas emissions and improving health and wellness. During the design and construction phase, this commonly translates to reduced parking demand through preferred parking for car share and electric vehicles, and reducing parking provision and thoughtful parking structure design. Emerging trends have indicated that commuting patterns are changing and therefore hospital parking infrastructure design should be flexible to allow for repurposing of space in the future. A further flexible design consideration and emerging trend has focused on the inclusion of PV on covered parking areas. Incorporating solar PV infrastructure into parking design serves multiple purposes as it provides shade for cars and renewable on-site energy, as well as reduces heat island effect and electricity costs (if electricity is used on-site).

Operational strategies have been focused on influencing commuter patterns by leveraging bicycle networks, walking paths and transit, to encourage alternate modes of transportation. **Markham Stouffville Hospital,** a platinum Smart Commute designated hospital, offers bike-to-work days, an in-house carpooling program, and priority parking for high occupancy vehicles to encourage staff to choose alternative modes of transportation. Research has indicated that influencing commuter patterns in rural areas will likely require additional long-term planning and partnerships with other agencies.

Throughout the Transportation category, opportunities to support NH' pursuit of WELL and LEED building certification are identified. The LEED certification program provides a category on Location and Transportation which includes credits to encourage compact development, alternative transportation, and connection with amenities. The WELL certification provides a feature for sustainable transit and site planning through the Movement concept, which promotes movement and active living through environmental design strategies, policies and programs.

WALKING & BICYCLE PATHS

Walking and bicycle paths addresses design and operational elements to promote bicycling and alternative transportation use to reduce vehicle use and improve public health through recreational physical activity. These design elements assist to enhance the health and wellness perception and features of a hospital environment. The **University Health Network** in Toronto has implemented a number of operational strategies, which include the creation of a bicycle user group and bicycle parking zones, to promote bicycle path use and transportation.

Both LEED and WELL address walking and bicycle paths and focus on promoting alternative forms of transportation to reduce GHG from commuting and improve public health through recreational physical activity. LEED requirements primarily focus on ease of access to bicycle networks, and the design of on-site short-term and long-term bicycle storage facilities, and amenities such as shower and changing facilities. The WELL feature addresses this environmental outcome correspondingly through site planning and selection and requires projects to demonstrate that the project boundary is in a location that is pedestrian friendly and has proximate access to mass transit.

Through the engagement sessions, this performance category was noted to be a mandatory area for NH stakeholders. Engagement session results indicated that 67% of participants were interested in performance requirements for walking and bicycle paths. Paths were seen as a cost-effective way of integrating with broader community active transportation networks and local economic development actions already underway throughout the Niagara region. Identifying the appropriate partners for path design criteria and siting was identified as a gap by stakeholders.

OPPORTUNITIES	CONSTRAINTS
— Promote daily physical activity — Reduced carbon footprint — Synergies between LEED and WELL — Reduced vehicular traffic congestion — Niagara Region Secondary Plan shows bike routes that are accessible from the site	— Out of contract scope — Dependent on existing infrastructure
LEED V4 BD+C	**WELL V2**
— **LT credit:** Bicycle Facilities	— **V05** Site Planning and Selection

BICYCLE INFRASTRUCTURE

Providing bicycle infrastructure and amenities for active commuters is increasingly important to promote bicycle use and increase recreational activity. Many hospitals promote use of walking and bicycle paths by providing occupants and staff with on-site bicycle parking infrastructure, changing facilities that include showers, lockers, repair and water stations, as well as flexible and impact reducing surface treatments for user comfort. Lighting and wayfinding also play a vital role in user comfort, knowledge, and interest. Bicycle infrastructure addresses design stage practices to provide amenities and facilities for active commuters.

Both LEED and WELL address bicycle infrastructure and focus on promoting ease of access and quality of bicycle infrastructure to support cycling and walking to the workplace. LEED requirements primarily focus on ease of access to bicycle networks, and the design of on-site short-term and long-term bicycle storage facilities, and on-site amenities such as shower and changing facilities. The WELL feature addresses this environmental outcome correspondingly through site active commuter and occupant support, which requires projects to provide bicycle storage and facilities for active occupants.

Through the engagement sessions, this performance category was noted to be a mandatory area for NH stakeholders. Engagement session results indicated that 58% of participants were interested in performance requirements for bicycle infrastructure. Discussion in the sessions focused on ensuring the infrastructure, especially security infrastructure, would be appropriate for both regular (staff) users and casual (visitors/broader community) users. For example, indoor storage space was recommended for staff bicycles.

OPPORTUNITIES	CONSTRAINTS
— Contributes to improved health & well-being — Contributes to reduced GHG emissions — Synergies between LEED credits and WELL optimizations — Reduced congestion and single-vehicle use on site — Beyond the LEED and WELL requirement, charging stations for e-bikes will be needed for the new hospital — Through the engagement sessions, this performance category was noted to be a high-priority area for NH stakeholders.	— Bike storage security — Accessibility — Dependent on surrounding infrastructure

LEED V4 BD+C	WELL V2
— **LT credit:** Bicycle Facilities	— **V04** Active Commuter and Occupant Support

ELECTRIC VEHICLE INFRASTRUCTURE

Similarly, to what was noted above for bicycle infrastructure, providing electric vehicle infrastructure is increasingly important to not only promote the use of electric vehicles but to also assist in the Canada-wide strategy for an increase in zero emission vehicles, charging stations, and alternative refueling infrastructure. As rebates and incentives offered in Ontario are encouraging the switch to electric vehicles, an emerging need for electric vehicle chargers has created an increased demand for EV infrastructure. **Michael Garron Hospital** considered this emerging trend in the design of their new four-storey below-grade parking structure and provides one electric vehicle charging station for a minimum of 10 parking spaces, one of which is an accessible parking space on each floor.

LEED requirements for electric vehicle infrastructure focus on promoting alternatives to conventionally fueled automobiles through providing electric vehicle charging supply equipment and EV specific parking spaces on-site. WELL does not address electric vehicle infrastructure.

Through the engagement sessions, this performance category was noted to be an optional area for NH stakeholders. Engagement session results indicated that 33% of participants were interested in performance requirements for electric vehicle infrastructure. The perspective of stakeholders was mixed on this focus area. There was general agreement that the transition to EVs is accelerating and the priority area aligns with the City and Regional plans for electrification. The challenge is the number of spaces required to meet LEED requirements, given the size of parking and the medium-term (e.g. 10-15 years from now, or 5-10 years after construction) expectation that many EVs will be automated and not require parking spaces for charging, except possibly at night. The idea of providing night time storage space for automated vehicle providers as an eventual balance for lost parking revenues was briefly discussed, but more information is required. In the end, consensus exists around enabling a higher numbers of charging stations over time (i.e. being EV ready) and studying further the potential revenue impacts.

Beyond EV charging for cars, it was identified that E-bikes are also an important future need and infrastructure should be provided for this mixed mode alongside other cycling infrastructure.

OPPORTUNITIES	CONSTRAINTS
— Contributes to reduced GHG emissions. — Cost could be partially recovered in operations by imposing fee structure for EV charging.	— May implicate parking space calculations. — Capital cost for electrical charging points.

LEED V4 BD+C	WELL V2
— **LT Credit:** Green Vehicles	— Electric vehicle infrastructure is not addressed in WELL.

COMMUTING GHG EMISSIONS: SITE PLANNING

Commuting GHG emissions addresses design and operational elements to reduce greenhouse gas emissions, air pollution, and other environmental and public health harms associated with motor vehicle use. Recently designed and built hospitals acknowledge their role in supporting the evolution of transportation and are aiming to proactively influence clean commuting patterns of both hospital staff and visitors. **Sechelt Hospital,** a hospital that achieved carbon neutrality, launched a 'Cut the Carbon Community' program in 2011, that focused on commuting campaigns and carpool programs to reduce emissions from employee travel. This indicates the importance of addressing staff and occupant commuting and site planning in reducing GHG emissions.

Both LEED and WELL cover this environmental consideration quite extensively. LEED focuses on the surrounding density and diverse uses of the site, access to quality transit, and providing a reduced parking footprint. WELL requirements focus more solely on the on-site planning and selection aspects.

Through the engagement sessions, this performance category was noted to be a recommended area for NH stakeholders. Engagement session results indicated that 50% of participants were interested in performance requirements for commuting GHG emissions. The challenge identified with the current site is that (similar to the new St. Catharines site) significant parking will be required to accommodate users who currently take transit, walk and cycle a much shorter distance to the hospital. More broadly, transit in the Niagara Region is not seen as a main mode of transport for the average person. A broader shift away from single car driving is required, but many of the necessary actions are outside the control of NH. Broad consensus existed, however, in the ideas of (i) partnering with the Region and City to enable improved transit infrastructure and (ii) developing a long-term transportation demand management (TDM) strategy for South Niagara and other facilities within the NH network to make continual improvements of mode shift, especially for staff.

Another identified challenge with mode shift is the impact on parking revenues, which may be significant, since those revenues are needed, in part, to address the upfront cost of so significant parking infrastructure. The revenues also flow directly into NH coffers, which is important to cashflow. Addressing this concern through a broader and more robust TDM that looks into the medium term (as discussed in the EV section, above) and explores possible funding partnerships to lower upfront and on-going costs (e.g. FCM funding in partnership with the Region and City).

OPPORTUNITIES	CONSTRAINTS
— Proximity to diverse uses reduces GHG emissions — Increased access to transit reduces the need for single-car use — Reduced parking footprint can minimize environmental harm associated with parking facilities (car dependence, land consumption, rainwater runoff) — Current parking requirements can be designed for adaptation to accommodate future changes (e.g. autonomous vehicles)	— LEED credit and WELL feature achievement related to site selection are dependent on project location and surrounding site — Transportation Demand Plan is required to understand the various mode of transport for the hospital specifically to create a plan to reduce GHG emissions from transportation. — For reduced parking, increased level of planning required to determine feasibility.

LEED V4 BD+C	WELL V2
— **LT Credit:** Surrounding Density and Diverse Uses — **LT Credit:** Access to Quality Transit — **LT Credit:** Reduced Parking Footprint	— **V05** Site Planning and Selection

NH PRIORITIES FOR PSOS

Based on the engagement sessions with NH stakeholders, increasing walkability and the bicycle network is an important objective for the new hospital. Although this will be out of scope for the project co., the project can support this priority by providing infrastructure to promote the use of such networks.

TRANSPORTATION	STAGE	LEED	WELL	ZCB	METRIC	PRIORITY
Walkability & Bicycle Network	Out of Scope	INc Walkable Project Site	V05.3 V05.4	-	walk score, bike score, pedestrian friendly streets, proximity to bicycle network	Mandatory
Walking Trails	Design	-	V09.2	-	# of paths, # of connections	Mandatory
Bicycle Infrastructure	Design	LTc6	V04	-	# of short/long-terms bike parking spaces, # of showers	Mandatory
Commuting Patterns	Out of Scope	LTc4 LTc5 LTc7	V05.1 V05.2	-	proximity to diverse uses & mass transit	Recommended
Staff Transit	Operate	-	-	-	# of shuttles per day, # of users in carpool program	Recommended
Electric Vehicle Infrastructure	Design	LTc8	-	-	% of EV parking, # of EV charging points	Optional
E-Bikes	Design	-	-	-	# of e-bike chargers/ plugs	Mandatory

NEXT STEPS | TRANSPORTATION

Within this category, a number of important actions were discussed that are beyond the scope of the PSOS and Project Co's involvement in the new hospital. This work, if deemed a priority, will not be used to evaluate design options and will instead need to be implemented by NH. These next steps for Transportation include:

DESIGN STAGE

- An extensive, long-term Transportation Demand Management (TDM) Study to be conducted not only for South Niagara site, but also across the network. Key features of the study will include:
  - Investigation of current travel distance and mode split at each site broken down by different staffing areas, patients and visitors. This "user commuting" study will be based on survey instead of estimates and will form the baseline for updated surveys following construction of the new facility.
  - Quantitative analysis of options to enhance transit, promote carpooling and encourage active transportation will be developed through discussions with staff and other key stakeholders, including the City and Region.
  - An exploration of short and medium-term impacts to parking revenues associated with a significant reduction in single-car use will be paired with investigation into possible alternative funding and revenue streams including night-time charging for automated EVs and FCM funding for the studied GHG mitigation infrastructure.

- Actions that emerge from the TDM would apply broadly to the design, operations and broader performance monitoring of NH activities. There is a strong possibility that a dedicated staff or partially-dedicated staff will be required to manage these activities.
- Connecting with conservation authorities, local/regional cycling and walking enthusiasts and tourism promoters and with the adjacent golf course to discuss path development.

OPERATIONS STAGE

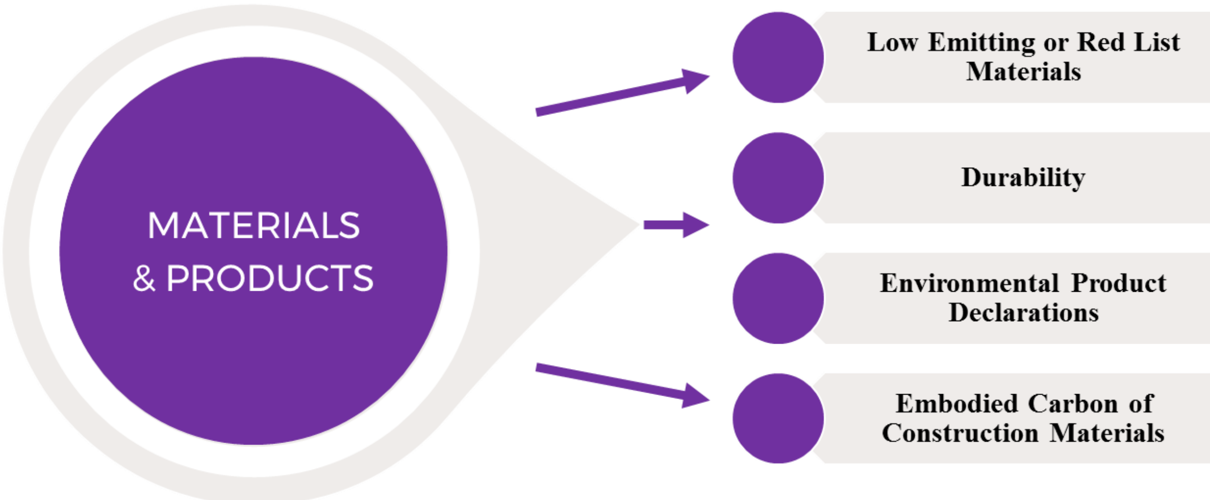
- N/A

ADDITIONAL PERFORMANCE MONITORING

- Identify appropriate staff to develop and manage on-going TDM services.

3.8 MATERIALS & PRODUCTS

OVERVIEW



As mentioned in **Section 2.2.7**, materials and product selection within the healthcare industry represents the focus that is occurring in general for the construction industry. NH identified sustainable materials and products as a guiding principle to ensure that the development of procurement standards and supply chain logistics focus on the right environmental decision to maximize use of sustainable products and materials by internal staff and on-site vendors. The current sustainability trends for materials and products focus on health impacts, life-cycle environmental impacts, and durability. Environmental certifications, such as the LEED rating system program, have followed this emerging trend and have recently changed focus for many credits included in the Material and Resource requirement section. This change in focus provides further transparency for product submittals through request for environmental product declarations, disclosure of raw materials, and material ingredient reporting for materials and products used on-site. In healthcare facilities, durability is also increasingly important to extend the maintenance cycles of a product and reduce disruption to building operations benefiting whole life cycle costs for the project.

Throughout the Materials and Products category, opportunities to support NH' pursuit of WELL and LEED building certifications are identified. The current LEED v4 BD+C and WELL v2 rating systems provide a series of requirements that focuses on minimizing the embodied energy and other impacts associated with the extraction, processing, transport, and disposal of building materials. The requirements are designed to support a life-cycle approach that improves performance and promotes resource efficiency.

Features that benefit from sustainable materials and product sourcing link to many other environmental considerations, particularly GHG emission mitigation. Opportunities and constraints related to embodied carbon of construction materials are more directly linked to this particular focus areas and are not duplicated in **section 3.1** despite this overlap.

LOW-EMITTING/RED LIST MATERIALS

Low-emitting/red list materials address design and operations practices to reduce concentrations of chemical contaminants that can damage air quality, human health, productivity and the environment. Hazards associated with substances is well understood and acknowledged within the construction and building industry and thus this is a typical green building concern which is extensively covered by both the LEED and WELL certification programs. Mandatory credits focusing on the PBT source reduction of mercury overlap between the two systems, streamlining implementation for this credit. The WELL certification program provides additional mandatory credits to reduce human exposure to hazardous building material ingredients. These mandatory restrictions focus on asbestos, lead, CCA restriction for wood, lead restriction for artificial turf, and plastic lumber material.

Through the engagement sessions, this performance category was noted to be a mandatory area for NH stakeholders. Engagement session results indicated that 33% of participants were interested in performance requirements for low-emitting/red list materials. Many of the straight-forward actions associated with materials hazardous to occupants – both during construction and operation - were seen as part of the baseline. Going beyond – for example including a broad requirement for HPDs and/or pursuing the Living Building Challenge red list – felt difficult to rationalize for several stakeholders, reflecting a lack of education and uptake in this area of focus in the market in general.

OPPORTUNITIES	CONSTRAINTS
— Improved air quality and productivity levels. — Synergies between LEED and WELL — Usually targeted by IO. — Reduces risk of installing materials with hazardous/ red list chemicals. — Option 1 aligns with WELL Feature X08 Hazardous Material Reduction — Co-benefits with LEED MR Building Product Disclosure & Optimization credits. — Specify and install lamps with low mercury content and long lamp life	— Potential higher cost when higher points are targeted (for 3 points, 5 product categories must be tracked — Requires coordination with operator – on-going purchasing policies and renovation policies. — Limited copper piping application

LEED V4 BD+C HEALTHCARE	WELL V2 PRECONDITIONS
— **MR Prerequisite:** PBT Source Reduction – Mercury — **MR Credit:** PBT Source Reduction – Mercury — **MR Credit:** PBT Source Reduction – Lead, Cadmium and Copper — **MR Credit:** Furniture and Medical Furnishings — **EQ credit:** Low-Emitting Materials	— **X01** Fundamental Material Precautions — **X02** Hazardous Material Abatement — **X03** Exterior Materials and Structures — **X11** Long-Term Emission Control — **X12** Short-Term Emission Control — **X13** Enhanced Material Precaution — **X14** Material Transparency

DURABILITY

Durability address design practices to reduce the long-term impact of the hospital and provide flexibility and ease for future adaptation and emerging hospital design trends. Durability and flexibility in design is increasingly important to increase the ease of adaptive use and service life of components over the life of the structure. As demonstrated in **section 2.2.5**, **Michael Garron Hospital** demonstrates a commitment to durability to ensure the hospital is designed and constructed for a 100-year lifespan. The New Patient Care Tower project was executed through a DBF contract, rather than a DBFM contract, which resulted in an increased focus on material durability considerations in the design phase reiterating this importance.

LEED requirements for durability focus on fundamental commissioning and verification. To further support the design, construction, and eventual operation of the hospital, LEED credit EA Enhanced Commissioning and MR credit: Design for Flexibility provide additional commissioning process activities and space strategies that can be mandated as part of the project's sustainability requirements. WELL does not address durability within the certification standard.

Through the engagement sessions, this performance category was noted to be a mandatory area for NHstakeholders. Engagement session results indicated that 75% of participants were interested in performance requirements for durability. Durability, and its sub-feature *maintainability*, were identified by operations stakeholder as key concerns. Of importance to the operations team is the disruption that premature failure and/or long repair timelines can cause. An example of a reasonably low-cost solution was to install Acrovyn (or similar products) throughout a broader part of the facility to avoid damage caused by gurneys/beds, carts and wheel chairs. Though damage is potentially minor or cosmetic, the impact on operations to repair the superficial damage can be significant. One of the challenges of setting durability requirements discussed is the balance of specifying specific products and approaches as compared to specifying performance requirements and allowing Project Co. to select the appropriate products. A system-by-system focus on durability and maintainability concerns was identified as important to the next phase of work.

OPPORTUNITIES	CONSTRAINTS
— Optimizes space use and aligns with NH Business Case and Spatial Requirements to allow for flexibility and adaptability. — Contributes to reduced GHG emissions and extended building life cycle. — Reduce operational maintenance cost	— May restrict design concept. — Requires extensive planning and tracking during design stage.

LEED V4 BD+C HEALTHCARE	WELL V2
— **EA Prerequisite:** Fundamental Commissioning and Verification — **EA Credit:** Enhanced Commissioning — **MR Credit:** Design for Flexibility	— Durability is not addressed in WELL.

ENVIRONMENTAL PRODUCT DECLARATIONS

Environmental Product Declarations address design and operations practices to encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically, and socially preferable life-cycle impacts. As discussed in **section 2.2.7**, the focus on material source for products is evolving from individual material characteristics to various features across lifecycle analysis to increase transparency in the market place. This is being achieved through disclosure of Health Product Declarations and Environmental Product Declarations.

LEED requirements for environmental product declarations focus on building product disclosure and optimization for Environmental Product Declarations, sourcing of raw materials, and material ingredients. The noted credits are optional for LEED certification and provide best practice options for selecting products that have verified improved environmental life-cycle impacts. WELL does not address environmental product declarations within the certification standard.

Through the engagement sessions, this performance category was noted to be a recommended area for NH stakeholders. Engagement session results indicated that 17% of participants were interested in performance requirements for environmental product declarations. The focus on EPDs for building products was not as important to stakeholders as the broader focus on whole-facility (i.e. construction and operations) GHG reductions. Given the results offered by the wholistic life-cycle analysis of UK NHS emissions, focusing on operational embodied impacts is much more critical than focusing on impacts embodied in construction activities. That said, stakeholders were supportive of the recommendation for a whole-facility LCA to be conducted, with as much effort placed on collecting EPDs as possible, given existing market limitations.

OPPORTUNITIES	CONSTRAINTS
— Contributes to supply chain optimization. — Co-benefits with NH Environmental. — Requirement to reduce GHG emissions. — Streamlined options available in LEED v4.1 – reduced threshold for Option 2.	— Supply chain limitations with regards to all options. May incur additional capital cost. — Requires extensive planning during design stage and tracking during construction.

LEED V4 BD+C HEALTHCARE	WELL V2 PRECONDITIONS
— **MR Credit:** Building Product Disclosure and Optimization – Environmental Product Declaration — **MR Credit:** Building Product Disclosure and Optimization – Souring of Raw Materials — **MR Credit:** Building Product Disclosure and Optimization – Material Ingredients	— Environmental Product Declarations are not addressed in WELL.

EMBODIED CARBON OF CONSTRUCTION MATERIAL

Embodied carbon of construction material addresses design practices to understand the sum impact of all the GHG emissions attributed to the materials throughout their life cycle and to encourage adaptive reuse and optimize environmental performance of products and materials. As discussed in **section 2.2.2**, Infrastructure Ontario's acceptance of lifecycle assessment targets to minimize embodied carbon of construction materials is currently unclear. Emerging concerns for designers of high-performance buildings have indicated the importance of accounting for initial embodied carbon emissions from production of its building materials and products, as the operation phase emissions will be very low for zero carbon buildings. An emerging trend has been the use of mass timber, versus concrete or steel, as the benefits are in the embodied carbon and not the operational emissions.

The current LEED v4 BD+C rating system provides a series of requirements that focuses on minimizing the embodied energy and other impacts associated with the extraction, processing, transport, and disposal of building materials. For embodied carbon of construction material, LEED provides an optional materials and resource credit that focuses on building life-cycle impact reduction and encourages adaptive reuse to optimize the performance of products and materials to demonstrate a reduction in material use. Life-cycle assessments during the initial project decision-making stage have also been recommended to demonstrate material use reduction.

Through the engagement sessions, this performance category was noted to be a dismissed area for NH stakeholders. Engagement session results indicated that 25% of participants were interested in performance requirements for embodied carbon of construction material. Commentary and perspectives for embodied carbon of construction align with the discussion in the EPDs section above. In general, data are limited, and other impact areas are likely to be more important to address. The focus for stakeholders was on completing a thorough inventory and impact assessment of construction activities to properly compare those impacts to other phases of development and in other domains, including energy use, transportation and especially operational embodied emissions.

OPPORTUNITIES	CONSTRAINTS
— More holistic analysis of building construction materials than "recycling" and "transport distance" — Analysis needed for hospitals which typically do not pursue these credits — Opportunity to demonstrate wood construction in unique market	— Focus is on a limited part of the full set of material-related impacts. — Data for broader analysis are limited (though increasingly available). — Significant deviation from standard practice may be required to achieve all credits.

LEED V4 BD+C HEALTHCARE	WELL V2
— **MR Credit:** Building Life-Cycle Impact Reduction	— Embodied carbon of construction material is not covered in WELL.

NH PRIORITIES FOR PSOS

Based on the engagement sessions, durability is a high priority for NH. More durable materials and products could allow the operators to extend the maintenance cycles, reducing disruption to building operations and benefiting whole-life costs for the projects.

MATERIALS & PRODUCTS	STAGE	LEED	WELL	ZCB	METRIC	PRIORITY
Durability	Design	MRc1 MRc8 EAc1	-	-	LEED credits	Mandatory
Low Emitting or Red List Materials	Design	MRp3 MRc4 MRc5 MRc6 MRc7 EQc2	X01 X02 X03 X11 X12 X13 X14	-	LEED prerequisite and credits	Recommended
Embodied Carbon of Construction Materials	Design	MRc1 MRc2 MRc3 MRc4	-	Embodied CO2	kgCO2e	Dismissed
Environmental Product Declarations	Design	MRc2 MRc7	-	-	LEED credits	Recommended

NEXT STEPS | MATERIALS

Within this category, a number of important actions were discussed that are beyond the scope of the PSOS and Project Co's involvement in the new hospital. This work, if deemed a priority, will not be used to evaluate design options and will instead need to be implemented by NH. These next steps for Materials & Products include:

DESIGN STAGE

— A research partnership for the LCA of construction impacts may be worthwhile, given the desire to be thorough in a market that is still growing. WSP has recommended working with the InfraGHG research group at the University of Toronto, whose focus is on holistic LCA analysis and tool development for the construction industry. Other partnerships may be available as well. Getting the research team involved before specifying LCA requirements for design and construction will offer a more complete investigation that aligns with the timeline of typical research activities.

OPERATIONS STAGE

– N/A

ADDITIONAL PERFORMANCE MONITORING

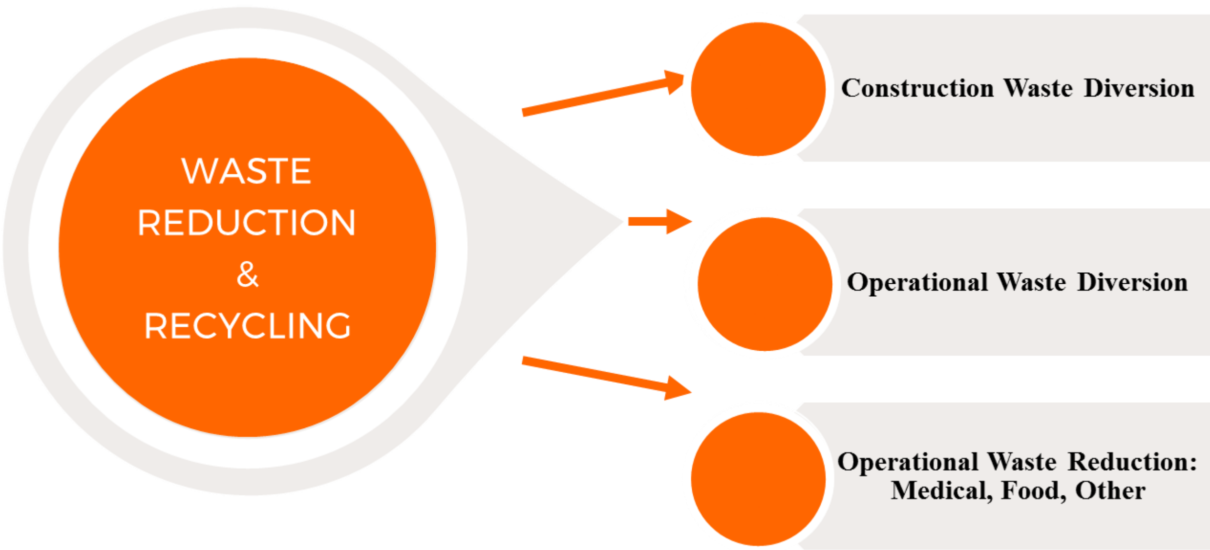
— Tracking of procurement life-cycle impacts

— WELL Annual Performance Monitoring and Surveys

— Identify appropriate staff to develop and manage on-going material impacts management services.

3.9 WASTE REDUCTION & RECYCLING

OVERVIEW



As mentioned in **Section 2.2.8**, wide ranging legal and policy changes will be enacted before hospital operations commence and should be accounted for at the design and planning stage. NH identified waste reduction and recycling as a guiding principle to ensure that the development of best practice targets for component of waste production and disposal were developed to reduce and divert medical and non-medical waste, and develop management practices and reporting practices to verify that best practice targets are met. The current sustainability trends indicate a focus on food and organic waste, as the provincial government has proposed an amendment to the 3Rs Regulation to include food and organic waste and increase resource recovery. Targets are to be established for municipalities, multi-residential buildings, business, schools, and hospitals to recover 70% of food and organic waste by 2025, thus mandating diversion from landfills.

The province has also proposed a plastic waste strategy to reduce plastic and limit micro-plastic pollution in waterways which indicates a plastic ban that may be instituted as early as 2021. The regulations proposed aim to make producers responsible for the waste generated from their products and packaging.

Advancements in construction technology have enabled construction projects to divert an extremely high proportion of waste from landfills, as witnessed at **Humber River Hospital** where construction waste diversion was noted to be at 96%. There however is an emerging focus on circular economy approaches to construction waste management which have led to the revamp of traditional linear material streams. As diversion at the construction and design stage is well recognized and achievable, emerging trends indicate the importance of smart waste bin receptacles to ensure segregation of waste, as well as engagement with suppliers to ensure regulatory compliance for procurement to go beyond the waste diversion range at the operations stage. Working with retail food providers will also be an important consideration to eliminate food waste from the hospital.

The current LEED v4 BD+C and WELL v2 rating systems do not address waste reduction and recycling in the operations stage. Custom metrics and design guidelines will need to be created to track and develop best practice guidelines for operational waste management and reduction. Construction and demolition waste management is a material and resource prerequisite for LEED v4 BD+C to reduce waste disposed of in landfills during the construction and demolition process.

Features that improve waste reduction and recycling link to many other environmental considerations, particularly materials and products. Opportunities and constraints related to embodied carbon of construction materials and low-emitting materials are more directly linked to materials and products and are not duplicated in this section despite this overlap.

CONSTRUCTION WASTE DIVERSION

Construction waste diversion addresses design strategies to reduce construction waste sent to landfill by implementing recycling and waste management practices. As discussed in **section 2.2.8**, construction projects are well aware of the requirements and processes for construction waste management, as advancements in construction technology have enabled projects to achieve extremely high proportion of waste from landfills. This metric is therefore well supported through the LEED certification standard.

The current LEED v4 BD+C rating system requires all projects to recycle and/or salvage nonhazardous construction and demolition materials to reduce construction and demolition waste disposed of in landfills. This credit is mandatory to receive LEED certification. WELL does not address construction waste diversion.

Through the engagement sessions, this performance category was noted to be a mandatory area for NH stakeholders. Engagement session results indicated that 25% of participants were interested in performance requirements for construction waste diversion. Stakeholders identified that this area of focus is already well supported by baseline construction practices. Additional focus beyond baseline may not be needed.

OPPORTUNITIES	CONSTRAINTS
— Hospitals have typically been able to achieve high construction waste diversion (85%+).	— No constraints to achieving high levels of construction diversion in urban areas.

LEED V4 BD+C	WELL V2
— **MR Prerequisite:** Construction and Demolition Waste Management Planning	— Construction waste diversion is not addressed in WELL.

OPERATIONAL WASTE DIVERSION

Operational waste diversion addresses design and operations strategies to reduce ongoing waste streams sent to landfill by implementing recycling and composting infrastructure and programs. As diversion at the construction and design stage is well recognized and achievable, emerging trends indicate the importance of smart waste bin receptacles to ensure segregation of waste, as well as engagement with suppliers to ensure regulatory compliance for procurement to go beyond the waste diversion range at the operations stage. Digital waste item recognition solutions have been explored to assist with waste segregation and therefore increase diversion. As policies are changing regarding food waste, discussion of organic waste diversion infrastructure must be incorporated at the design stage and operations stage to ensure food waste disposal is segregated throughout operations.

The current LEED v4 BD+C and WELL v2 rating systems do not provide preconditions for operational waste diversion in the operations stage. WELL provides a related credit that focuses on waste stream planning to address batteries, pesticides and mercury-containing equipment. As operational waste diversion is not a clear focus in either the LEED or WELL certification programs, metrics and design guidelines will need to be created to track and develop best practice guidelines for operational waste management and reduction.

Through the engagement sessions, this performance category was noted to be a mandatory area for NH stakeholders. Engagement session results indicated that 83% of participants were interested in performance requirements for construction waste diversion. Through a review of existing waste audits, stakeholders realized that existing diversion practices were exceeding 2015 Green Hospital benchmarks, but could still be improved. Except for increased fine paper waste caused by a delay in implementing electronic record-keeping, recent audit data showed that learning from successes at St. Catharines would be a good start for the baseline performance at the new South Niagara site. To go beyond in diversion efforts, concepts such as smart bins were well-received, though price was a concern. The Transvac solution from Humber Hospital, though seen as beneficial from a waste management perspective, was less desired by operations staff who were concerned that such a product would be used to motivate a cut in porter staffing which could be detrimental to effective operations. Overall, as with transportation impact assessment, it was identified that a more regular assessment of waste diversion activities, coupled with a sufficiently detailed waste auditing process, would be essential in making progress towards the desired diversion target of greater than 50%. Such a focus may also necessitate a partial or full-time staff member, especially if similar rigor was applied across all NH sites.

OPPORTUNITIES	CONSTRAINTS
— Province to amend the 3Rs Regulations to include food and organic waste and increase resource recovery across the IC&I sector. — Province to ban food waste disposal in landfill by 2022.	— Not covered by LEED or WELL. — Separate contract language will be required in the PSOS

RELATED POLICIES/REQUIREMENTS
— Not addressed under LEED or WELL rating systems

OPERATIONAL WASTE REDUCTION: MEDICAL, FOOD, OTHER

Operational waste reduction addresses design and operation strategies to reduce the total volume of ongoing waste, both diverted and sent to landfill, by changing procurement practices. As discussed in **section 2.2.8**, **CHEO** hospital was innovative in their approach to reducing food waste from its facility by providing patients with a choice of food options as well as smaller portions of higher quality food. CHEO modelled their kitchen and food services akin to a hotel room service which has decreased food waste significantly while also increasing patient satisfaction. **Humber River Hospital,** also explored the emerging trend of smart waste bin separation and provides a TransVac automated waste system to manage waste, recyclables and soiled linens on-site. **Humber River** also automated about 75% of its back-of-the-hospital functions including, pharmacy, laundry and food delivery [7]. The digitalization, however also came with high equipment costs and extensive staff training requirements in the operations stage.

The current LEED v4 BD+C and WELL v2 rating systems do not provide preconditions or optional credits for operational waste reduction. Metrics and design guidelines will therefore need to be created to track and develop best practice guidelines for operational waste management and reduction.

Through the engagement sessions, this performance category was noted to be a mandatory area for NHstakeholders. Engagement session results indicated that 33% of participants were interested in performance requirements for operational waste reduction. A focus on diversion was seen to be aligned strongly with a focus on reduction and efforts by NH operations to understand and address both activities would be intertwined. Reduction efforts would also be linked to procurement choices and the exploration of embodied impacts associated with procurement. One important set of relationships that will need to strengthen is with the food services provider across NH facilities. A review of food packaging and preparation practices for patient food may be an important source of waste reduction. Since the relationship with patient food provider is already embellished, negotiations and contract changes will be required. The work to define a proper contract with retail providers at the new site will be easier to establish, especially with feedback from existing suppliers.

OPPORTUNITIES	CONSTRAINTS
— Source reduction for operation (e.g. digital 'paperless' hospitals) — GNG Hospital had a waste intensity of 13 kg/m2 in 2012 — Food services can be designed to reduce food waste and reduce operation cost — On-site composting can support further waste reduction	— Not covered by LEED or WELL. — Separate contract language will be required in the PSOS — Administrative simplification will require technological support and training

RELATED POLICIES/REQUIREMENTS
— Not addressed under LEED or WELL rating systems

NH PRIORITIES FOR PSOS

Based on the engagement sessions with NH stakeholders, operational waste diversion is a very high priority. Operational waste reduction and construction waste should be considered.

WASTE REDUCTION & RECYCLING	STAGE	LEED	WELL	ZCB	METRIC	PRIORITY
Construction Waste Diversion	Design	MRc9	-	-	% Diverted	Mandatory
Recycling & Composting Infrastructure	Design	MRp1	-	-	Type	Mandatory
Food Waste Reduction	Operate	-	-	-	% Reduction	Mandatory
Food Packaging Reduction	Operate	-	-	-	% Reduction	Mandatory
Paper Waste Reduction	Operate	-	-	-	% Reduction	Mandatory
Waste Management Consultant	Operate	-	-	-	Yes/No	Recommended

NEXT STEPS | WASTE REDUCTION & RECYCLING

Within this category, a number of important actions were discussed that are beyond the scope of the PSOS and Project Co's involvement in the new hospital. This work, if deemed a priority, will not be used to evaluate design options and will instead need to be implemented by NH. These next steps for Health & Wellness include:

DESIGN STAGE

- Explore contract terms for existing food providers to reduce food waste and packaging waste
- Draft new contract terms for retail food providers to reduce food waste and packaging waste

OPERATIONS STAGE

- Waste audits will need to be determined whether this will be NH or Project Co responsibility
- Procurement strategy to reduce packaging and single use medical equipment
- Establish vendor takeback program for packaging
- Waste management consultant is recommended if this cannot be included in the Project Co.'s responsibility

ADDITIONAL PERFORMANCE MONITORING

- Identify appropriate staff to develop and manage on-going waste reduction/diversion services.

4 KEY EVALUATION CRITERIA

The following evaluation criteria matrix will be used to evaluate the opportunities that will form part of the Environmental Design Program. The final evaluation criteria are to be used as the basis for the Stage 3 RFP Evaluation Criteria and as a framework for decision making. The current draft includes a list of all potential evaluation criteria and the priority column notes the consensus collected from a series of the stakeholder engagement workshops. The evaluation criteria will be further finalized once costing information is received and the meeting with IO where NH and WSP will discuss the current PSOS requirements.

PERFORMANCE CRITERIA		STAGE	FINANCIAL CRITERIA
ALL	Level of LEED Certification Number of Mandatory LEED Points	Design Construction	Capital Cost Incremental 25 Year Lifecycle Cost
HEALTH & WELLNESS	Level of WELL Certification Number of Mandatory WELL Points	Design Operate	
GHG EMISSIONS	*Included Elsewhere*		
ENERGY EFFICIENCY	GHG Intensity Total Energy Use Intensity Thermal Energy Demand Intensity On Site Energy Generation # of Hours of Survivability	Design Operate	Annual Energy Cost Annual Carbon Cost
WATER EFFICIENCY	Water Use Intensity % Reclaimed Water for Irrigation	Design Operate	Annual Water Cost
LANDSCAPE & NATURE	Percentile Storm Event Food Garden Size	Design	
TRANSPORT ATION	Bicycle Infrastructure Active Transportation Connections and Pathways	Design	
MATERIALS & PRODUCTS	Embodied Carbon	Design	
WASTE REDUCTION & RECYCLING	Waste Diversion Infrastructure	Design	

PART 3 | SYNTHESIS

5 VISION AND GUIDING PRINCIPLES

To guide the development of this report, NH identified the following principles for each of the environmental requirements that will shape the design and operation of the New South Niagara Hospital:

ENVIRONMENTAL REQUIREMENT	GUIDING PRINCIPLE
Health and Wellness of Patients and Families	To create indoor and external environments which measurably improve patient health outcomes and contribute substantively to family and community well-being.
Greenhouse Gas Emissions Mitigation including building materials, products used, medical gases	To develop, monitor and report on a life-cycle emissions target and develop a plan to reduce greenhouse gas emissions throughout the life of the building.
Energy Efficiency and Consumption including renewable energy	To develop an energy plan which will allow NH to: — Set ambitious energy targets for energy efficiency; — Reduce overall energy consumption; — Implement renewable energy where appropriate; Continuously improve on set targets by implementing upgrades to systems as they become available.
Water Efficiency including recovery and recycling	To establish and achieve a site-specific water use target and determine plan to continuously improve targets throughout the life of the building.
Landscape & Nature including connection to health outcomes	To create a beautiful, low maintenance site for the benefit of patients, staff, families and the community.
Transportation including transit, commuting, EVs and parking	To develop a transportation network for getting people and products to and from the hospital with high convenience and least cost and environmental impacts.
Sustainable **Materials and Products** (building material, furniture and equipment)	To develop procurement standards and supply chain logistics to maximize use of sustainable products and materials by internal staff and onsite vendors; develop strategy to allow for right environmental decision.
Waste Reduction and Recycling	To set best practice targets for each component of waste production and disposal; set ambitious target to reduce and divert medical and non-medical waste; put in place management practices and reporting to verify that targets are met.

From these descriptions, and the engagement process previously described, it is clear that NH considers sustainability to be much more than achievement of a green building certification. Its vision acknowledges the need to develop new operational systems and processes that embed sustainability into the daily work of the hospital. These 'Next Steps' are identified throughout Section 3, and are summarized once again in Section 12, Conclusion.

The remaining sections of this report (6 through 11) therefore focus on developing a recommended design option to be captured in the upcoming DBFM contract, representing a design which best provides the necessary infrastructure, design features and occupant amenities to support these sustainable operations practices in the future.

6 DESIGN OPTIONS ANALYSIS

Three design options have been developed for the South Niagara Hospital, as summarized in Figure 26 below. The baseline design incorporates measures already identified in the project's Stage 2 submission. The second option, termed 'Maximum' includes all opportunities previously discussed in Section 3. These two options, defining the lower and upper bounds of cost and performance, are briefly described in Sections 6.1 and 6.2, respectively. Finally, the recommended option blends the baseline design with measures identified by NH as high priority or those with exceptional cost/benefit ratios. The recommended option is described and analyzed in Section 7. A full list of all measures explored for each design option is also included in Appendix A.

BASELINE

- Stage 2 submission architectural and site design
- Measures from electrical and mechanical design briefs, and Niagara Secondary Plan
- [redacted]

MAXIMUM

- Based on priorities identified during engagement with NH stakeholders
- Includes measures to maximize site and building potential across all environmental requirements
- [redacted]

RECOMMENDED

- Includes baseline design as well as measures with best cost/benefit ratio or identified as high priority
- Focuses on energy efficiency and health and wellness requirements
- [redacted]

Figure 26: Design Option Summary

The following sections summarize the measures, capital costs and performance results for the baseline and maximum options, per the key evaluation criteria presented in Section 4. The remainder of the report, beginning in Section 7, details the recommended option, including benchmarking analysis, PSOS considerations, implementation steps, and business case analysis. These sections have been designed for ease of handoff to the Stage 3 PDC team. LEED and WELL scorecards for this option are also included in Appendices B and C.

Due to the preliminary nature of the project's design, capital costs presented in the following sections combine estimates provided by an external cost consultant, AW Hooker, with approximations based on industry judgement. The costs presented should therefore be taken to be rough order-of-magnitude estimates suitable for comparative analysis only. This costing exercise should be reproduced and refined throughout later stages of design, as building features and design details are confirmed.

6.1 BASELINE DESIGN OPTION

	PERFORMANCE SUMMARY	STAGE	FINANCIAL SUMMARY
ALL	LEED BD+C v4 Healthcare **Silver** Certification **17** Mandatory Points, Including **10** for Energy	Design Construction	[redacted]
HEALTH & WELLNESS	WELL v2-**Ready** Design **23 of 23** WELL Preconditions	Design Operate	
GHG EMISSIONS	*Included Elsewhere*		
ENERGY EFFICIENCY	GHG Intensity: **50-70 kgCO_2e/m^2** Total Energy Use Intensity: **475-525 kWh/m^2** Thermal Energy Demand Intensity: Heating – **80-100 kWh/m^2** Cooling – **120-140 kWh/m^2** On Site Energy Generation: **0%** **72 Hours** of Active Survivability **144 Hours** of Passive Survivability	Design Operate	[redacted]
WATER EFFICIENCY	Water Use Intensity: **1.5 m^3/m^2** **0%** Reclaimed Water for Irrigation	Design Operate	[redacted]
LANDSCAPE & NATURE	Manage **80th Percentile** Storm Event No Food Garden	Design	
TRANSPORTATION	Bicycle Racks and EV Charging Stations, Carpool Parking Therapeutic Walking Path	Design	
MATERIALS & PRODUCTS	No Reduction in Embodied Carbon	Design	
WASTE REDUCTION & RECYCLING	Standard Waste Sorting Bins Refrigerated Compost Storage	Design	

As previously noted, the baseline design summarizes measures defined in the South Niagara Hospital Stage 2 submission, particularly the mechanical and electrical design briefs and transportation study. Requirements of the Greater Niagara Secondary Plan have also been extrapolated, and reasonable assumptions for targeted LEED points and resulting performance levels assumed to align this option's list of measures with IO's minimum LEED Silver target. Finally, to support NH's priority of achieving WELL certification, features required to support those WELL preconditions that impact building design have been included. Key design features of the baseline design therefore include:

- A facility energy design that meets or exceeds the features of Humber Hospital, specifically:
    - Window to wall ratio of 25-35%;
    - Whole-enclosure R-value of R-6;
    - High-performance design of lighting and domestic hot water systems;
    - High efficiency air filtration and exhaust air heat recovery on all ventilation air;
    - Occupancy-controlled ventilation in non-clinical areas;
    - Oversizing and redundancy in clinical area fan system sizes and ductwork;
    - Heat recovery chillers with appropriate low/mid-temperature loops; and,
    - Condensing boilers to serve the majority of the heating load; and,
    - Process/user-driven load reductions, especially for process steam and 24/7 cooling loads.
- Anesthetic gas recapture in operating theatres;
- Selection of refrigerants for all site equipment to comply with LEED credit requirements
- Water-conserving plumbing fixates and process equipment;
- Ergonomic, user-adjustable workstations;
- Living wall in entry foyer;
- Active facades for visual interest;
- No commercial kitchen equipment. Staff and visitors will be served by traditional retail food kiosks and patient meals by rethermed food prepared off site;
- 3,800 m^2 of therapeutic and healing gardens including a terrace dedicated to mental health services, and courtyards for spiritual care and general use;
- 240 EV charging stations to serve 10% of parking; and,
- Four public transit stops, with service planned to commence prior to the hospital's opening.

A more complete list of features is provided below. Additional technical details and individual measure costs are included in Appendix A.

BASELINE MEASURES		
HEALTH & WELLNESS	– Annual air quality design and testing – Accessible & universal design – Annual occupant comfort surveys – Community engagement program – Local design – Visual and physical ergonomics – Active facades – Policies and programs	[redacted]
LANDSCAPE & NATURE	– Green wall and green roof design – Outdoor labyrinth as direct extension of spiritual care area – Rooms designed to take advantage of views to landscape – Native/ drought-tolerant plant design – Public healing gardens featured in courtyard and entry area – Dedicated healing gardens for patient/ visitors and staff – LID/GI Strategies for 80th Percentile Rainfall Events	[redacted]
TRANSPORTATION	– Short and long-term bicycle parking – Shower and changing facilities – Secure pavilion for staff bicycle parking – Dedicated EV parking spots and EV charging stations – Dedicated carpool parking spots – Exterior therapeutic walking paths	[redacted]
MATERIALS & PRODUCTS	– Fundamental commissioning of mechanical and electrical systems – Use of low-emitting materials including interior paints and coatings; interior adhesives and sealants; flooring; composite wood; ceiling, walls, thermal and acoustic insulation; furniture; and exterior applied products. – Environmental product declarations including sourcing raw materials and focusing on material ingredients	[redacted]
GHG EMISSIONS	– *Included elsewhere.*	**N/A**
ENERGY EFFICIENCY	– Base (i.e. no cost) passive systems for building envelope design – Base space use and occupant comfort controls for internal loads – Base active systems for mechanical HVAC, but including full ventilation heat recovery and heat recovery chillers – Improvements in process-related systems – Anesthetic gas re-capture	[redacted]
WATER EFFICIENCY	– Water conserving fixtures, process, and lab equipment – Cooling tower water treatment system – Efficient irrigation system – Drought tolerant plants	[redacted]
WASTE REDUCTION & RECYCLING	– Construction waste diversion with a target of >85% – Recycling infrastructure including cardboard compacting and refrigerated organic waste storage – Paperless ICAT environment	[redacted]

ASSESSMENT

The baseline design, as implied by its title, incorporates typical green building measures and reasonable levels of performance compared to new hospitals in Ontario. As most of measures impacting energy performance have been assumed to be general mechanical requirements, rather than additional costs for sustainability, the identified budget for this option is only [redacted] Significant costs for this option include ergonomic workstations, stormwater management, and electric vehicle charging stations to serve 10% of parking.

A more detailed, comparative benchmarking assessment of the performance of all three design options is included in Section 7. A comparative capital cost summary is provided in Section 11.

6.2 MAXIMUM DESIGN OPTION

	PERFORMANCE SUMMARY	STAGE	FINANCIAL SUMMARY
ALL	LEED BD+C v4 Healthcare **Platinum** Certification **48** Mandatory Points, Including **20** for Energy	Design Construction	[redacted]
HEALTH & WELLNESS	WELL **Platinum** Certification **23 of 23** Preconditions **80+ of 100** Optimization Points	Design Operate	
GHG EMISSIONS	*Included Elsewhere*		
ENERGY EFFICIENCY	GHG Intensity: **15-20 kgCO2e/m^2** Total Energy Use Intensity: **300-350 kWh/m^2** Thermal Energy Demand Intensity: Heating - **60-70 kWh/m^2** Cooling – **90-100 kWh/m^2** On Site Energy Generation: **30-40%** (or higher) **3x the hours** of Active/ Passive Survivability	Design Operate	[redacted]
WATER EFFICIENCY	Water Use Intensity: **1.2 m^3/m^2** **100%** Reclaimed Water for Irrigation	Design Operate	[redacted]
LANDSCAPE & NATURE	Management of **98th Percentile** Storm Event **1600 m^2** At Grade + **800 m^2** Rooftop Food Gardens	Design	
TRANSPORTATION	Bicycle Racks and EV Charging Stations Carpool Parking and Shuttle Service Therapeutic Walking Path **Multiple Walking Trails**	Design	
MATERIALS & PRODUCTS	**10% Reduction** in Embodied Carbon	Design	
WASTE REDUCTION & RECYCLING	**Interactive Waste Sorting Bins** **Transvac Collection System** Refrigerated Compost Storage	Design	

The maximum design option includes features to fully realize the sustainable potential of the building and site across all of NH's environmental requirements. The list of measures for this option has been developed without consideration of cost, based on strategies employed at other cutting-edge hospitals and facilities identified in Section 2, Research. Additional measures identified during engagement sessions with NH are also included. The intention of the maximum option is to define the upper bound of sustainable performance achievable for the South Niagara Hospital and to provide a "shopping list" of potential features to evaluate for adoption into the recommended design. Key design features of the maximum option include:

— Triple-glazed windows and electrochromic glass façade;

- Mass timber structure;
- Geo-exchange plant for at least 50% of heating and cooling;
- A biomass combined heat and power plant for supplementary heating and full backup power (which doubles the size of the baseline back-up systems);
- On-site photovoltaics to supply 5% of energy consumption;
- A rainwater cistern to supply site irrigation;
- Transvac system to collect soiled linens and recyclables;
- Interactive, programmable waste sorting bins;
- Low emitting furniture and medical furnishings;
- A visible main staircase to promote physical activity;
- A commercial kitchen to support alternative food service models such as hotel-style room service, local food targets, and healthy food options;
- E-bike charging stations and staff locker/shower facilities;
- Designated spaces for community use;
- Rooftop and at-grade food gardens;
- Pollinator-friendly gardens and beehives; and,
- Multiple walking paths including connectivity to the multi-use trail located to the north of the hospital site.

The majority of baseline measures outlined for the previous option are also included in the maximum option, with significant upgrades and enhancements to envelope and energy system design, and stormwater management systems. A complete list of combined features is provided below. Additional technical details and individual measure costs are included in Appendix A.

	BASELINE MEASURES	MAXIMUM MEASURES
HEALTH & WELLNESS	[redacted] – Annual air quality design and testing – Accessible & universal design – Annual occupant comfort surveys – Community engagement program – Local design – Visual and physical ergonomics – Active facades – Policies and programs	[redacted] – Acoustic – WELL Platinum Certification – Enhanced air quality testing – Air quality monitoring and display – Alternate food service models – Electrochromatic glass in patient rooms – Visual and physical ergonomics – Aesthetic hallways & staircases – Allowance for volunteer activities – Designated community space – Annual contribution to registered charity
LANDSCAPE & NATURE	[redacted] – Green wall and green roof design – Outdoor labyrinth as direct extension of spiritual care area – Rooms designed to take advantage of views to landscape – Native/ drought-tolerant plant design – Public healing gardens featured in courtyard and entry area – Dedicated healing gardens for patient/ visitors and staff – LID/GI for 80th percentile rainfall events	[redacted] – 75% workstations with access to indoor plants and/or water features – Roof top food garden – At-grade food garden – Pollinator-friendly plants/beehives – Natural interior design – Indoor restorative space for patients/visitors – Natural elements to cover 25% of site area – LID/GI strategies for 98th percentile rainfall events
TRANSPORT ATION	[redacted] – Short & long-term bike parking – Shower/changing facilities – Secure pavilion for staff bike parking – Electrical vehicle charging stations – Dedicated carpool parking – Therapeutic walking paths	[redacted] – Extended EV charging stations – Bicycle user lockers/ maintenance tools – E-bike charging stations – Carpool program – Shuttle service – Multiple therapeutic walking paths

MATERIALS & PRODUCTS	[redacted] – Fundamental Commissioning – Low-emitting materials – Environmental product declarations – Sourcing of raw materials – Material ingredients	[redacted] – Extended service life for finishes – Mass timber design – Whole building life cycle assessment – Design for flexibility – Enhanced commissioning – Envelope commissioning – Furniture and medical furnishing
GHG EMISSIONS	– *Included Elsewhere*	– *Included Elsewhere*
ENERGY EFFICIENCY	[redacted] – Base passive system (building envelope) – Base space use and occupant comfort (internal loads) – Anesthetic gas re-capture – Base active system – Improvements in process related systems	[redacted] – Improved opaque enclosure and heat recovery systems for survivability and comfort – *Exterior shading integrated into façade + residual active systems (i.e. electrchromic glass) – Premium performance glazing and thermally broken framing – Dedicated outdoor air systems and occupant-based control of all ventilation – Geo-exchange central heat pumps sized to deliver ~60% of heating energy needs and ~90% of cooling needs – Biomass CHP system sized to match back-up power systems
WATER EFFICIENCY	[redacted] – Water conserving fixtures – Water conserving process equipment – Cooling tower water treatment system – Efficient irrigation system – Drought tolerant plants	[redacted] – Ongoing water quality testing – Rainwater harvesting – Cooling tower elimination – Water submetering – Wastewater monitoring system – Filtered water fountains – Ongoing drinking water taste quality testing
WASTE REDUCTION & RECYCLING	[redacted] – Construction waste diversion – Refrigerated compost storage – Recycling infrastructure including cardboard compacting – Paperless ICAT environment	[redacted] – Interactive sorting bins – Tracking of food waste and food packaging – Transvac System – Waste management consultant

In addition, to ensure the building achieves key performance targets for reduction of greenhouse gases, energy efficiency, and water efficiency during the contract's FM service period, mandatory targets for GHG intensity, thermal energy demand intensity, and water use intensity would be established, in addition to the more typical mandatory total energy use intensity target. Further discussion of these operational targets is provided in the analysis of the recommended design option, including a summary of initial discussion with IO of potential contract revisions.

ASSESSMENT

The maximum option offers a more substantial commitment to each of NH's environmental requirements, with an additional emphasis on climate change resilience. Specific areas of focus include enhancing passive survivability (i.e. the building's ability to withstand high summer temperatures in the absence of external energy supply), renewable energy generation, stormwater management and rainwater collection to limits flood risk and maintain lushness of landscape during droughts, and integrating local, healthy and sustainable ingredients into food service models for patients and staff.

[redacted]

[redacted]

A more detailed, comparative benchmarking assessment of the performance of all three design options is included in Section 7. A comparative capital cost summary is provided in Section 11.

7 RECOMMENDED DESIGN OPTION

	PERFORMANCE SUMMARY	STAGE	FINANCIAL SUMMARY
ALL	LEED BD+C v4 Healthcare **Gold** Certification **43** Mandatory Points, Including **16** for Energy	Design Construction	[redacted]
HEALTH & WELLNESS	WELL **Gold** Certification **23 of 23** Preconditions **60+ of 100** WELL Optimization Points	Design Operate	
GHG EMISSIONS	*Included Elsewhere*		
ENERGY EFFICIENCY	GHG Intensity: **18-23 $kgCO_2e/m^2$** Total Energy Use Intensity: **325-375 kWh/m^2** Thermal Energy Demand Intensity: Heating - **65-75 kWh/m^2** Cooling – **100-110 kWh/m^2** On Site Energy Generation: **20-25%** **2x the hours** of Active/Passive Survivability	Design Operate	[redacted]
WATER EFFICIENCY	Water Use Intensity: **1.2** m^3/m^2 **100%** Reclaimed Water for Irrigation	Design Operate	[redacted]
LANDSCAPE & NATURE	Management of **95th** Percentile Storm Event **1600 m^2** At Grade Food Garden	Design	
TRANSPORTATION	Bicycle Racks and EV Charging Stations Carpool Parking Therapeutic Walking Path **Multiple Walking Trails**	Design	
MATERIALS & PRODUCTS	**10% Reduction** of Embodied Carbon	Design	
WASTE REDUCTION & RECYCLING	**Interactive Sorting Bins** Refrigerated Compost Storage	Design	

The recommended design for the South Niagara Hospital incorporates those measures from the maximum option that best align with NH's priorities, as established in the stakeholder engagement process detailed in Section 3, or which are likely to enhance future performance outcomes at a reasonable additional capital cost. As with the previous option, the majority of measures defined for the baseline are also included in the recommended design. NH-specific priorities identified through engagement include GHG emissions reductions from building energy use, enhanced indoor environmental quality, healing and food gardens, and increased walkability and bikeability. As such, key measures adopted from the maximum option include:

- Geo-exchange plant for heating and cooling, including a biomass combined heat and power plant to serve supplementary heating requirements and provide partial (rather than full) backup power;
- On-site photovoltaics to supply 5% of energy consumption;
- A rainwater cistern to serve the site's irrigation system;
- A visible main staircase to promote physical activity;
- At grade food gardens;
- Pollinator-friendly gardens and beehives; and,
- E-bike charging stations and staff locker/shower facilities.

These measures will be further explored in the illustrative design to be developed during Stage 3. They are intended not to serve as a prescriptive design checklist or final design, but rather as a guide to inform the performance targets and desired outcomes to be encoded in the PSOS. Further discussion of the integration of these recommendations into Stage 3 is provided in Section 10. The complete combined list of recommended building features is provided below for reference, and additional technical details and individual measure costs are included in Appendix A.

	BASELINE MEASURES	RECOMMENDED MEASURES
HEALTH & WELLNESS	[redacted] – Annual air quality design and testing – Accessible & universal design – Annual occupant comfort surveys – Community engagement program – Local design – Visual and physical ergonomics – Active facades – Policies and programs	[redacted] – WELL Gold Certification – Enhanced air quality testing – Aesthetic hallways and staircases
LANDSCAPE & NATURE	[redacted] – Green wall and green roof design – Outdoor labyrinth as direct extension of spiritual care area – Rooms designed to take advantage of views to landscape – Native/ drought-tolerant plant design – Public healing gardens featured in courtyard and entry area – Dedicated healing gardens for patient/ visitors and staff – LID/GI strategies for 80th percentile rainfall events	[redacted] – At-grade food garden – Pollinator-friendly plants and beehives – Natural interior design – Indoor restorative space for patients/visitors – Natural elements to cover 25% of site area – LID/GI strategies for 95th percentile rainfall events
TRANSPORT ATION	[redacted] – Short & long-term bike parking – Shower/changing facilities – Secure pavilion for staff bike parking – Electrical vehicle charging stations – Dedicated carpool parking – Therapeutic walking paths	[redacted] – Bicycle user lockers/maintenance tools – E-bike charging stations – Carpool program – Shuttle services
MATERIALS & PRODUCTS	[redacted] – Fundamental Commissioning – Low-emitting materials – Environmental product declarations – Sourcing of raw materials – Material ingredients	[redacted] – Whole building life cycle assessment – Enhanced commissioning – Envelope commissioning
GHG EMISSIONS	– *Included Elsewhere*	– *Included Elsewhere*

ENERGY EFFICIENCY	[redacted] — Base passive system (building envelope) — Base space use and occupant comfort (internal loads) — Anesthetic gas re-capture — Base active system	[redacted] — Improved opaque enclosure and heat recovery — Dedicated outdoor air system and occupant-based control of ventilation for all systems — Optimal geo-exchange — Partial biomass CHP — On-site photovoltaics
WATER EFFICIENCY	[redacted] — Water conserving fixtures — Water conserving process equipment — Cooling tower water treatment system — Efficient irrigation system — Drought tolerant plants	[redacted] — Ongoing water quality testing — Rainwater harvesting — Cooling tower elimination — Water submetering — Filtered water fountains
WASTE REDUCTION & RECYCLING	[redacted] — Construction waste diversion — Refrigerated compost storage — Recycling infrastructure including cardboard compacting — Paperless ICAT environment	[redacted] — Interactive sorting bins — Tracking of food waste and food packaging — Waste management consultant

As with the maximum design option, mandatory FM service period performance targets for GHG intensity, thermal energy demand intensity, and water use intensity are recommended for inclusion in the PSOS, based on the target values identified in the performance evaluation summary for this option.

ASSESSMENT

[redacted]

Based on early discussions with the NH advisory team, one desired outcome for this Environmental Plan was to use preliminary Savings By Design energy model results and performance benchmarking of Humber River Hospital to help set realistic, but challenging energy performance goals. Figure 27 summarizes the performance of the Savings By Design exercise, include an Ontario Building Code-minimum model and a proposed design model -- against several existing Ontario hospitals taken from the energy benchmarking data included in Section 2.2.3.

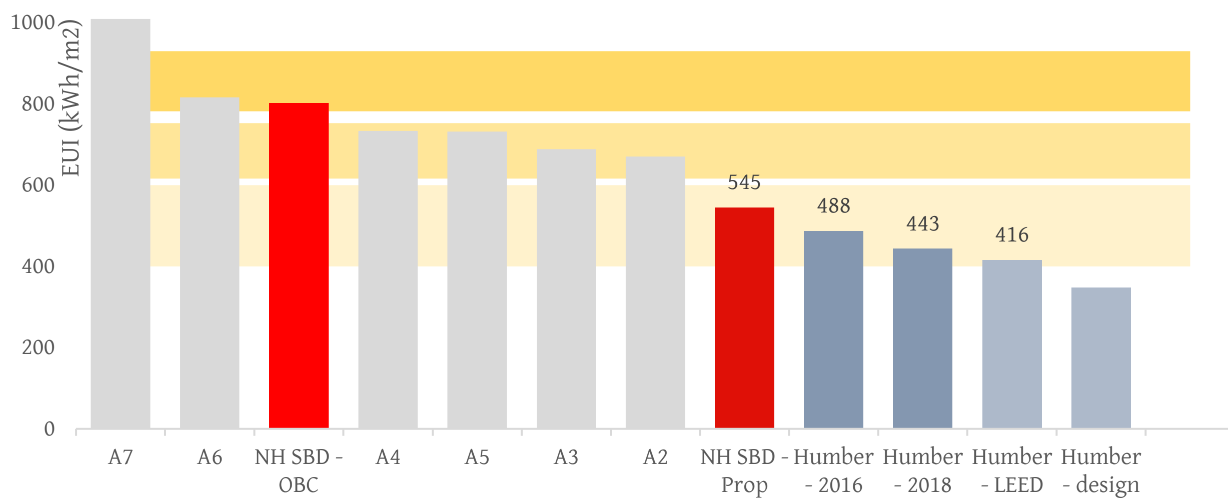


Figure 27: Energy Use Intensity (kWh/m2) Benchmarking

Figure 27 reveals three important challenges for establishing appropriate and realistic energy targets:

- ***Impact of Process Energy***. Though the types of mechanical and electrical systems included in the Savings By Design recommended design were similar to those of Humber, Humber's actual performance was better than the SBD model. Further investigation revealed that this gap was driven, in part, by process energy differences.
- ***Long-term trend towards modeled performance.*** Humber's early results were not aligned with its modeled target, but the results have been trending towards the final energy model results for the facility. This means that using a model to set the target (if realistic assumptions are included) can set an ideal performance target to motivate ongoing performance improvements if warranted.
- ***Benefit of 100% OA, redundant ventilation systems***. Humber's performance relative to the Savings By Design model is also driven by its universal use of 100% outdoor air redundant ventilation systems, resulting in very low fan power and increased heat recovery benefit.

The first two observations helped to establish the adjustment to be made to the Savings By Design proposed design to better align with the baseline option included in this report. Modeled result from Savings By Design are based on the Stage 2 facility design and systems approaches; however, a healthy (~10%) reduction in energy use was applied to establish the baseline total energy use range of 475-525 kWh/m² to account for process energy reductions in line with what seems to be possible from Humber-like systems (excluding ventilation).

The third observation, building on the extensive discussion surrounding ventilation efficiency at the SBD workshop, resulted in the most important non-fuel-switching measure proposed in the recommended and maximum designs: dedicated outdoor air systems with occupant-based control of ventilation. This approach, though similarly expensive as Humber's approach, does not require 100% outdoor air and will allow for much greater control of ventilation during active/passive survivability scenarios and during demand-response opportunities.

Beyond energy efficiency measures, it was clear from the stakeholder discussions that setting an aggressive GHG reduction target was also an important goal for the project. As depicted in Figure 28, efforts to save energy at most relevant Ontario acute care hospitals align with resulting reductions in GHG emissions. Red bars in the figure indicate energy intensity, while grey bars indicate GHG intensity. The Savings By Design models for the South Niagara Hospital in group four and five show a similar relationship. Only when applying the fuel switching and renewable generation options of the recommended option, in the form of geo-exchange, photovoltaics, and biomass (i.e. zero carbon) heating, are GHG emissions brought below the norms already associated with energy conservation actions.

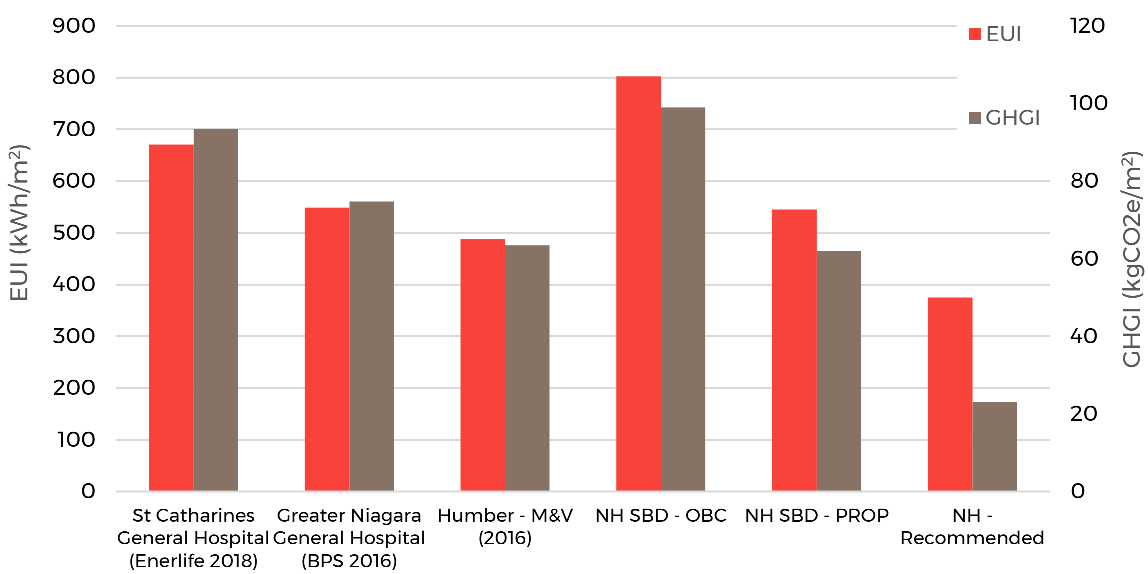


Figure 28: EUI vs GHGI performance benchmarking

The challenge with geo-exchange and biomass heating are primarily financial: they are expensive to install, and their fuel sources are more costly than natural gas. Although sizing a geo-exchange system to meet the balance of heating and cooling loads throughout the year can help to reduce the cost of the required borehole field, the two most effective ways to address the life-cycle cost implications of these technologies is to: (a) reduce heating and cooling loads as much as possible and (b) consider generating electricity on-site to cover some or all of the increased electricity costs. Appropriate measures to address these two strategies are therefore included in the recommended and maximum designs.

Reducing loads and increasing on-site renewable generation have the added benefit of improving passive and active survivability. Adding electricity generation capacity through a biomass CHP substantially improves active survivability assuming baseline back-up systems are retained and not downsized. Likewise, further investment in enclosure performance can reduce thermal energy demand and enable a longer period of passive survivability, particularly since a passive/emergency mode is likely to include a significant reduction in ventilation. The major differences between the recommended and maximum design are the size of their CHP systems and their envelope design, as dynamic view glass was not found to be sufficiently cost effective to recommend. The recommended option therefore focuses on the less risky and least costly path to very low GHG emissions.

The energy measures included in the recommended design significantly contribute to the LEED BD+C v4 Healthcare certification strategy for the project. Per Table 4 below, more than half of the mandatory LEED points for this project are associated with the Energy & Atmosphere category, with 16 (or more) coming specifically from the Optimize Energy Performance credit. As such, achievement of LEED Gold certification should easily result from implementing the measures most prioritized by NH, without additional cost beyond certification fees. A complete LEED scorecard for the recommended option is included in Appendix B.

Table 4: LEED Points per Category

LEED CATEGORY	MANDATORY	RECOMMENDED	OPTIONAL
Location & Transportation	1	3	5
Sustainable Sites	1	4	4
Water Efficiency	4	1	6
Energy & Atmosphere	24	5	6
Materials & Resources	5	12	2
Indoor Environmental Quality	5	8	3
Innovation	1	0	5
Regional Priority	2	1	1
TOTAL	**43**	**34**	**32**

[redacted]

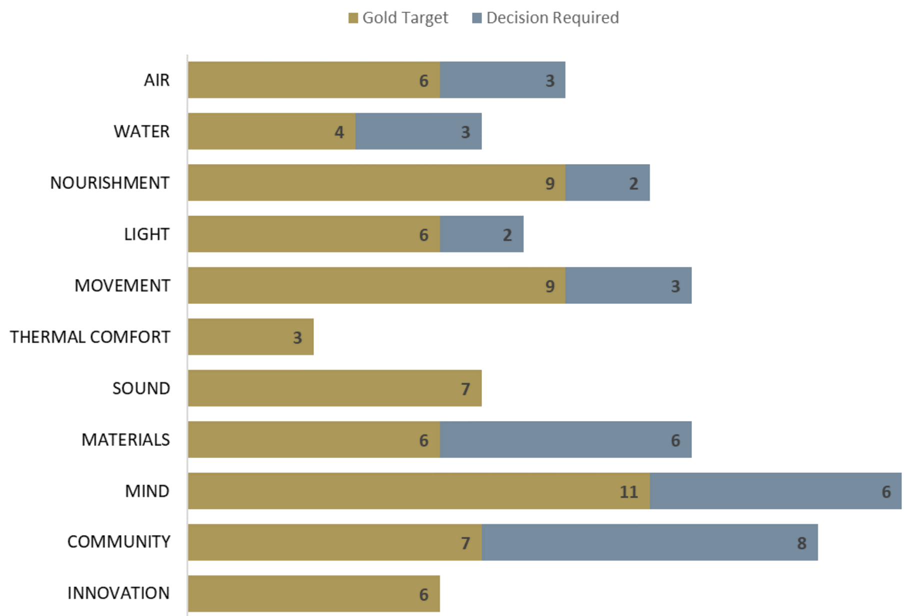


Figure 29: WELL v2 Scoring Summary

Further analysis of the lifecycle cost impacts and business case for the recommended option can be found in Section 11.

ALIGNMENT WITH IO PRIORITIES

IO has agreed that priorities set for the South Niagara Hospital related to mandatory energy, carbon, and water targets align with their own objectives for hospital projects. However, it was noted that waste management initiatives will likely have to be led by the hospital instead of Project Co. As such, non-design measures for ongoing waste reduction have been captured as next steps for NH in Section 12: Conclusion, rather than under the implementation plan in Section 10.

Recommended design requirements that necessitate further coordination with IO are outlined in Section 8. IO's latest PSOS template includes mandatory energy targets, but not carbon or water performance. While it is this plan's recommendation to incorporate an appropriate additional cost of carbon into GHG-related pain-share/gain-share calculations that exceeds the current federal government backstop price, IO has noted that they can only legally enforce costs imposed by government and cannot use a predicted value. [redacted]

8 DESIGN GUIDELINES

The longest and most detailed section of the established Project Agreement for an IO-led alternative financing and procurement project is Schedule 15, the Output Specification (OS). It is within the OS that all of the program, design and operational requirements for the project are outlined. Many other sections of the Project Agreement, such as Schedule 36: Energy Matters, tie directly into the OS as well. To support the future PDC for the New South Niagara Hospital, the section below has been organized to align with the major sections of the OS. Each of the relevant outcomes from the sustainability pre-design work that has generated the recommended option have been translated into specific requirements to be addressed and refined the PA development process.

The starting point for the OS summary below has been taken from WSP's recent work on the Halton Regional Consolidated Courthouse. This version of the document has been significantly modified from its predecessor to be more performance-based and succinct. Many of the relevant sections and performance metrics contained within this environmental plan have already been included in this new version of the OS, with particular emphasis on changes to the Sustainability section to align with LEED BD+C v4 and include additional energy metrics consistent with those recommended as key performance metrics. Still, some new performance requirements will be needed in an NH-specific version of the OS. These additions are marked as New in the status columns of the tables below.

For completeness, comments and status (i.e. Not Applicable, Revised or New) are provided for all sections in the new OS. This structure gives the general reader sufficient information to understand where each requirement for the new hospital should be included, without duplicating the specifics already outlined for the recommended design.

8.1 PART I: DESIGN STATEMENT

Part 1 of the OS provides general guidance for project and site design, including certifications targeted as well as other extended sustainability requirements.

SECTION 1: CORE OBJECTIVES

The NH Redevelopment Team is currently finalizing the core objectives for the new hospital. Guiding principles for the NH's eight environmental requirements, as summarized in Section 5, should also be included in this section.

SECTION 2: PROJECT EXPRESSION

Section 2 is very specific to the architectural character and concept of the project. Consider adding guidelines to align the project design and architectural character with NH's environmental requirements and the architectural character of the building. Examples could include requirements clarifying how architectural design and space planning should allow for biophilic elements which contribute to occupant wellness, or a high-level goal to optimize building orientation and passive design elements to reduce energy demand and improve daylighting and views.

SECTION 3: SITE DEVELOPMENT

This section includes design / planning guidelines associated with the overall site. It includes information on zoning by-laws, urban design guidelines, site planning, transportation, site access and civil works. Although Section 3 does not contain a dedicated subsection for sustainability, consider adding design guidelines with respect to sustainable site selection, urban connectivity, alternative transportation, wellness-related site planning guidelines and other issues.

SECTION		REQUIREMENTS	STATUS
3.1	**General**	— Meet accessible and universal design requirement throughout the entire site. — OR refer to Section 4 requirements under WELL	NEW
3.2	**Planning Context**	— Not applicable for Environmental Plan.	N/A
3.3	**Site Planning**	— Provide local materials in entry areas and throughout the landscape — The building should be designed with active façade. — Healing gardens for public, patient/visitors, and staff are to be provided — Food garden in the complex care unit and senior wellness area are to be provided — Pollinator-friendly plants should be included where appropriate. — Provide therapeutic walking path throughout the site — OR refer to Section 4 requirements under LEED/WELL	New
3.4	**Transportation**	— Provide dedicated EV parking spaces and charging stations for 10% of dedicated spaces — Provide dedicated carpool parking for 5% of total parking space. — OR refer to Section 4 requirements under LEED/WELL	New
3.5	**Site Access**	— Provide short-term and long-term bicycle racks to meet LEED and WELL requirements — Provide E-bike charging stations for 10% bike storage capacity. — OR refer to Section 4 requirements under LEED/WELL	New
3.6	**Civil Works**	— LID / GI Strategies for 95th Percentile Rainfall Events — OR refer to Section 4 requirements under LEED/WELL	New

SECTION 4: KEY REQUIREMENTS

This section includes key project requirements. The main input for sustainability and wellness should be included here. A full PSOS would address multiple key requirements under this heading including but not limited to: indigenous engagement and reconciliation, accessibility, physical security, circulation systems, vertical transportation, acoustics and others.

SECTION		REQUIREMENTS	STATUS
4.1	**Sustainable Design**	**General** **Sustainable Design Approach** Provide description of overall sustainability design objectives with an emphasis on project-specific targets, e.g. wellness, GHG reduction, minimized water use, etc. **LEED® Design Requirements** LEED BD+C v4 Healthcare rating system should be used for Silver level certification Refer to the LEED scorecard in Appendix B listing prerequisites, mandatory credits (and no. of points) and optional credits. The scorecard should include comments addressing any project-specific applications that warrant specific considerations. **WELL Design Requirements** WELL v2 rating system should be used for Gold level certification. Refer to the WELL Scorecard in Appendix C listing preconditions, recommended features (an no. of points) and optional features. The scorecard should include comments addressing any project-specific applications that warrant specific considerations. The scorecard needs further development to determine mandatory features once NH finalizes the target level for WELL certification. **Energy and Water Requirements** Include overall performance-based Mandatory Energy/Water Targets (MEWTs) that are derived from the submitted Energy Performance Modeling Package: — TEDI-h, TEDI-c, TEUI, and GHGI target — Passive/active survivability targets (to be developed) — % on site renewable energy target — Annual anesthetic gas and refrigerant leakage targets — Potable water performance target **Structure and Envelope Building Materials Information** This is a separate section in the PSOS that focuses on structural and building envelope materials used during construction. Not applicable for Environmental Plan. This will be covered by LEED/WELL requirements.	Revised

SECTION 5: BUILDING ELEMENTS

This section covers architectural specifications for different building elements. It should provide high-level guidance on sustainability compliance. With that said, most of the specifications for materials and building elements will be governed by the sustainability strategies pursued for achievement of LEED, WELL and energy guidelines.

SECTION		REQUIREMENTS	STATUS
5.1	**Exterior Finishes**	— Extended service life for exterior finishes.	New
5.2	**Interior Finishes**	— Extended service life for interior finishes.	New
5.3	**Exterior Doors and Entrances**	— Not applicable for Environmental Plan. This will be covered by LEED/WELL requirements.	N/A
5.4	**Windows and Glazing**	— Not applicable for Environmental Plan. This will be covered by LEED/WELL requirements.	N/A
5.5	**Ceilings**	— Not applicable for Environmental Plan. This will be covered by LEED/WELL requirements.	N/A
5.6	**Access Flooring**	— Not applicable for Environmental Plan. This will be covered by LEED/WELL requirements.	N/A
5.7	**Stairs**	— Buildings must have at least one main stair that enables occupants to travel between the building entrance floor(s), occupant's own destination floor and common use floors. Locate a main staircase to be visible before an occupant visually encounters any motorized vertical circulation (elevator/escalator). — OR refer to Section 4 requirements under LEED/WELL	New
5.8	**Vehicle Circulation and Dimensions**	— Not applicable for Environmental Plan.	N/A
5.9	**Parking**	— Not applicable for Environmental Plan. This will be covered by LEED requirements.	N/A

8.2 PART II: PLANNING STATEMENT

Part II, the Planning Statement effectively constitutes a "Facility Program". The "program" is comprised of sections describing the overall hospital operational context, the individual component operational context, component planning criteria and a listing of all required program spaces.

SECTION 1: OPERATIONAL CONTEXT

This section includes information on occupant profiles such as occupant estimates, operational hours and provisions for parking, security, and other key spaces. The content of this section is mostly dictated by the project owner and is therefore project-specific. Whilst there isn't much verbiage on sustainability, clarification and linkage between Section 8.2.1 and the Energy Matters section (Schedule 36, discussed below) is essential to delivering a model which accurate represents expected facility performance. This need is especially great when targets have been set based on an illustrative design which follows the same operating parameters, but where the performance is measured in absolute terms (i.e. kWh/m²/year as opposed to %-savings vs. a reference case).

8.3 PART III: BUILDING STATEMENT

Part III offers the closest match to a traditional building construction specification of any part of the PA. Efforts have recently been made to reduce the length and detail of the section, to focus it more on performance statements than prescriptive requirements and/or system details.

SECTION 1: SPACE DATA

All spaces within the hospital should have a corresponding Space Data sheet which sets out the minimum physical requirements for each space in terms of surface finishes, ceiling height, acoustic performance, illumination levels, and so on. Sustainability performance requirements could be covered within space data sheets.

SECTION 2: BUILDING SYSTEMS

This section contains descriptions of system characteristics as an integrated whole, where best described in a single narrative rather than cumulatively through a number of elemental performance specification sections.

For energy-related features, the following sections are likely, depending on the final strategies chosen:

- Energy metering system requirements;
- A requirement to use geo-exchange for a specific fraction of the load as a minimum;
- A requirement to use a biomass CHP for a minimum fraction of the 24/7 backup and all supplementary heating requirements; and,
- Restrictions on refrigerants for chillers.

For Material-related features the following sections are likely, depending on the final strategies chosen:

- Qualities of any explicit finish choices that are mandated as part of extended durability goals.

For Water related features the following sections are likely, depending on the final strategies chosen:

- Water metering system requirements;
- Cistern and water re-use system qualities and expected system configurations (e.g. which systems are served by non-potable water); and,
- Filtered water fountain requirements.

SECTION 3: PERFORMANCE SPECIFICATIONS

For Energy-related features, the following sections are likely, depending on the final strategies chosen:

- Sole-sourced equipment requirements for anesthetic gases (e.g. Class1).

For waste-related features:

- Interactive sorting bins (e.g. EvoBin or Bin-e). This requirement can go to section 2, if a performance specification is not desired.

8.4 PART IV: FACILITY MANAGEMENT STATEMENT

The facility management statement details all the on-going requirements for the facility operator to manage, report on and service the spaces and systems required in the previous three sections.

SECTION 1: ENVIRONMENT AND SUSTAINABILITY SERVICES

This section should include information on sustainable FM practices include any specific LEED / WELL elements to be addressed during the FM service period. A sustainability reporting requirement that identifies the FM practices in place to maintain the environmental performance of the facility should be detailed. An example of potential requirements (adopted from the Halton Regional Courthouse PSOS) is provided for reference below:

- Provision of Environmental and Sustainability Services on a scheduled and demand basis to meet Output Specifications.
- Reasonable and competent supervision of the work at all times and of all Project Co staff performing services.
- Addressing provincial government priorities, principles and objectives on climate change.
- Prepare and provide annual sustainability reports reflective the GRI guidelines and any additional initiatives put forth by the Contracting Authority.
- Ensuing electronic-based platforms are available for Environmental and Sustainability requisitions.
- Scope of services includes:
  - Environmental Management System and Quality Monitoring to address;
  - Emissions management
    - GHG emission reduction
    - Halocarbons / ozone-depleting substance reduction
    - Hazardous materials handling and reduction
    - Recycling
    - Storage tanks management
    - Potable water quality management
    - Water conservation
    - IAQ management
    - Proactive mould growth prevention
    - Continuous hazardous gas monitoring
    - Sound pollution reduction
    - Occupant environmental awareness
  - Internal and external environment
  - Mould management

For the South Niagara Hospital, this list should also include performance testing requirements to achieve and maintain WELL v2 certification.

Note that two important goals listed above, namely GHG emissions reduction and water conservation are *further* addressed in the Schedule 36 discussion below and the appropriate interrelationship between the pain-share/gain-share requirements and operating requirements must be properly coordinated.

8.5 SCHEDULE 36

Though not part of the Schedule 15 OS, Schedule 36 of the project agreement should also be revised to incorporate new performance guarantees for GHGs and water. This would include addition of a water performance guarantee process, similar in structure to IO's energy pain-share/gain-share terms. A process for design stage modeling and annual adjustments based on actual annual water usage to a facility-wide potable water budget would need to be identified, tied to a pain-share/gain-share process with sufficiently high rate adjustment factors to incentivize effective ongoing management of water. Metering requirements to support an enhanced annual water measurement and verification process would also be required.

Secondly, the energy pain-share/gain-share process should be enhanced to address GHG reductions. This would include identifying an annual GHG target including emissions from building energy, anaesthetic gases and refrigerants. To standardize pursuit and annual reporting during the FM service period, a GHG emission factor table for all fuels supplied to the facility, medical gases and refrigerants should be developed. For grid electricity, a predicted annual emission factor can be used to standardize initial net present value (NPV) and LCC/tonne calculations. During operation, this predicted emission factor can be replaced with actual values as they become available from provincial or federal inventory reporting. Given that actual annual emission factors for electricity are not available for at least a year after the end of each calendar year, pain-share/gain-share adjustments may need to be reconciled (or perhaps even delayed) to the subsequent year. An appropriately escalating cost of carbon beyond existing costs imposed through utility rates should also be included in pain-share/gain-share terms.

9 EVALUATION TOOLS & PROCESS

Evaluation tools to verify that the South Niagara Hospital is designed and constructed in alignment with the recommendations of this Environmental Plan are outlined in the table below. Five of the seven are existing tools common in the building sector; lifecycle assessment and water modelling are likely to require a customized process as these tools are not yet standard in certification rating systems or previous DBFM project agreements. Further detail on the phasing of these processes is included in Section 10, Implementation Plan.

EVALUATION TOOL	STAGE	PROCESS
LEED v4 Healthcare Rating System	Design	Identify mandatory and recommended LEED credits in the PSOS, per the attached scorecard in Appendix B. Verify performance through a split design/construction review by CaGBC. Include penalty clauses if targeted certification level, mandatory credits or certification timeline (typically 1-year post-construction) are not met.
WELL v2 Building Rating System	Design & Operate	Identify mandatory and recommended WELL optimizations in PSOS, per the attached scorecard in Appendix C. Verify performance by submitting documentation and performance testing results to GBCI. Include penalty clauses if mandatory design-related preconditions and optimizations are not met. Consider including a penalty clause if initial performance test results are not compliant, and extending this clause to include non-compliance during ongoing performance testing required every 3 years to maintain certification.
Energy Modelling	Design & Operate	Use industry-standard energy modelling processes and tools to evaluate the benefits of a larger central combined heat and power system and finalize targets for energy performance, thermal energy demand, renewable power and annual GHG emissions. Develop an enhanced modeling-enabled financial evaluation of lifecycle cost, net present value, and associated pain-share/gain-share terms for energy and GHGs. Incorporate results into the combined lifecycle GHG assessment described below.
Lifecycle Assessment	Design, Construction & Operate	Use the process outlined in LEED credit Building Lifecycle Impact Reduction to develop an LCA of enclosure and structure embodied carbon. Performance will be further verified through the LEED certification process if this recommended credit is pursued.

		A customized process may also be developed that combines various sources of emissions (materials, energy transportation) into a single analysis, as described in Section 10.1.
Lifecycle Costing	Design	Reproduce lifecycle costing processes detailed in the Section 11 during the illustrative design and pursuit phases to evaluate the LCC per tonne of emissions reduction associated with individual energy measures.
Stormwater Modelling	Design	Use industry-standard stormwater modelling processes to verify that the site is designed to manage the targeted percentile storm event. Stormwater design will be further verified through achievement of the LEED v4 Rainwater Harvesting credit. Use the latest projections for rainfall data to ensure that the design accommodates increasingly intense rainfall patterns expected as a result of climate change. Rainwater cistern capacity calculations will further support the custom water modelling process below.
Water Modelling	Design & Operate	Develop a formalized modelling process for water use (including rainwater cistern calculations) to finalize targets for water performance and associated pain-share/gain-share) terms.

10 IMPLEMENTATION PLAN

The following section details the phasing of individual actions required in each of the remaining stages (3-6) of the DBFM procurement process and FM service period to design, construct and operate the New South Niagara Hospital in alignment with the recommended design included in this plan. Immediate work in Stage 3 will focus on exploring alternative design strategies and costing to refine performance requirements. Standard certification processes will then be followed through Stages 4-6, followed by ongoing performance monitoring during the FM service period. An overview of the implementation schedule is provided in Figure 30 below.

ACTIONS	STAGE 3	4	5	6	FM
Partnerships, City of Niagara Advocacy Fundraising Illustrative Design Carbon Neutral Study Illustrative Design Lifecycle Assessment Illustrative Design Stormwater Modelling Illustrative Water Modeling Refine LEED & WELL Performance Requirements Refine Waste Performance Requirements	•				
Revise Project Agreement Proponent Engagement		•			
Design & Construction Reviews			•		
Third-Party Commissioning Verification LEED & WELL Performance Testing, Review & Certification				•	
Pain-Share/Gain-Share Adjustments NH Next Steps					•

Figure 30: Implementation Overview

10.1 STAGE 3: FUNCTIONAL PROGRAM

Design/Contract Documents including PSOS (Q4 2019 to Q1 2021)

PARTNERSHIPS, CITY OF NIAGARA ADVOCACY

Join the research collaboration with Brock University and local municipalities know as *Niagara Adapts* to enhance organizational awareness of the most likely climate adaptation challenges to be faced by the development. Determine whether additional performance requirements or building features are required to support a resilient design. Also connect with conservation authorities, the City of Niagara and the adjacent golf course to discuss path connections to planned trail systems adjacent to the hospital site.

FUNDRAISING

Explore a partnership with Niagara College (or other local institutions) to develop a program for Food-As-Healthcare which – in its most elaborate form - could involve funding from the college flowing to the new hospital to construct a teaching kitchen for enhanced retail and patient food services. Kitchen services would be co-managed by the college and NH.

TRANSPORTATION DEMAND MANAGEMENT STUDY

Prepare an updated TDM study that includes both the new South Niagara Hospital site as well as the existing NH hospital network. The TDM study will confirm parking space requirements and further inform engagement with staff to best design a facility that enables alternatives to single-car driving. Key features of the study will include:

- Investigation of current travel distance and seasonal mode split at each site, broken down by staff category, patients and visitors. Staff travel distances will be collected through a direct survey rather than estimated data. This study can serve as a baseline for any ongoing commuting surveys conducted at the post-construction new facility.
- Quantitative analysis of options to enhance transit, promote carpooling and encourage active transportation developed through discussions with staff and other key stakeholders, including the City and Region. This quantification will include calculations of associated GHG emission for various transportation options to/from site.
- An exploration of short and medium-term impacts to parking revenues associated with a significant reduction in single-car use, paired with investigation into possible alternative funding and revenue models.

ILLUSTRATIVE DESIGN CARBON NEUTRAL STUDY

Detailed energy modelling will support a more robust lifecycle cost and lifecycle cost per tonne assessment of the measures recommended in this report, which will be used to confirm energy- and carbon-related design requirements and mandatory energy targets in the PSOS. The model is required especially to confirm appropriate TEDI, passive/active survivability and percent of site generated renewable energy targets, as these have not been well-characterized by previous IO hospital projects. The carbon study and energy model should include a detailed geothermal study incorporating data from a test borehole drilled on site to support plant design. The facility usage patterns, process energy inputs, and GHG emission factors for various fuels used in this model will be transferred into the PSOS to ensure that proponents use consistent inputs in their own energy models.

Modelling should also be used to support a business case for a larger central combined heat and power system that could eventually connect to adjacent facilities, will inform cooling tower water use targets for the water modeling process.

Based on this study, NH will determine whether Zero Carbon Building certification for the new hospital will be pursued to promote the project's progressive low-carbon goals. Additional design requirements to pursue ZCB status would be minimal, given the strong push towards very low GHG emissions during operations and the plan to include a lifecycle cost assessment for the construction phase of the project. At a minimum, an appropriate additional GHG emissions cost beyond what is likely to be imposed by government should be incorporated into GHG-related pain-share/gain-share contract terms to encourage proponents to meet mandatory carbon targets during the FM service period.

ILLUSTRATIVE DESIGN LIFECYCLE ASSESSMENT

Develop a comparative lifecycle assessment for various massing, enclosure and structural options to evaluate embodied carbon impacts per LEED credit Building Lifecycle Impact Reduction. Based on this quantification, determine whether an embodied carbon reduction target will be included in the PSOS, or whether proponents will only be required to report LCA results for their own designs during pursuit and construction. To support broader decision-making during this stage, a total facility lifecycle GHG inventory may be warranted, presenting emissions resulting from facility energy use, transportation and embodied materials in a common context to compare their relative impact. For instance, additional insulation may reduce emissions from energy but increase embodied emissions.

If additional thoroughness is of interest, a research partnership for the LCA of construction impacts may be worthwhile. The InfraGHG research group at the University of Toronto is working to develop holistic LCA processes for the construction industry, and other partnerships may be available as well.

ILLUSTRATIVE DESIGN STORMWATER MODELLING

Stage 3 stormwater modelling will confirm stormwater-related design requirements and mandatory percentile storm event to be managed by the civil design for the site. Projected rainfall data should be incorporated into the modelling to ensure that the design minimizes flood risk associated with increasingly intense rainfall patterns resulting from climate change. Cistern capacity and usage calculations should also be standardized. Transfer rainfall projections and cistern usage assumptions into the PSOS to ensure that proponents use consistent inputs in their own stormwater models.

ILLUSTRATIVE DESIGN WATER MODELLING

If water use intensity targets and pain-share/gain-share terms will be mandated in the PSOS, NH will need to establish a water modeling process that can be repeated by the proponents to combine hospital-specific fixture usage patterns, medical equipment process water use, irrigation demand, and other process requirements including cooling towers. As with carbon, an appropriate additional cost for water beyond utility rates will be required to encourage proponents to meet mandatory water targets during the FM service period.

REFINE LEED & WELL PERFORMANCE REQUIREMENTS

Based on results of the processes described above, establish desired certification levels and mandatory credits/point targets for LEED v4 BD+C Healthcare and WELL v2. Incorporate mandatory design requirements into the PSOS as outlined in Section 8.

For WELL, specific assessment of the location and the appropriate size for the food garden is required during Stage 3. Currently NH is considering food gardens to serve the Senior Wellness and Complex Care areas. To finalize the size and form requirements for the food garden (e.g. elevated planting beds for the patients, or community gardens for therapeutic uses, etc.), confirm the user groups and purpose of the garden. The current food garden area included in the recommended option aligns with the minimum size required for the WELL Food Production optimization, however additional garden space may be desired.

CONFIRM WASTE PERFORMANCE REQUIREMENTS

During stakeholder engagement, NH expressed a preference to include waste audits and a waste management consultant as proponent responsibilities. Although preliminary discussions with IO indicate that these operational measures to support ongoing waste reduction are likely to fall to NH, this should be confirmed during Stage 3. These measures have also been captured as next steps for NH in Section 12: Conclusion to ensure they are carried forward regardless of the final contract structure.

10.2 STAGE 4: PROCUREMENT

Tender and Approvals (Q2 2021 to Q3 2022)

REVISE PROJECT AGREEMENT

Incorporate the results of the investigations and illustrative design processes of Stage 3 into the project agreement following the structure defined in Section 8 of this plan. Particular focus on required updates to pain-share/gain-share procedures for GHG emissions and water in Schedule 36 is recommended, as previously outlined.

PROPONENT ENGAGEMENT

To ensure new performance guarantees and even newer and more robust sustainability requirements are well understood by proponent, additional engagement and review milestones will be required. This could include a pre-meeting with proponents to review core changes to Schedule 36 and Schedule 15 associated with performance-based verification for energy, carbon and water, and additional confidential meetings with individual proponents to discuss technical questions and concerns regarding updated modeling and metering requirements, mandatory targets and pain-share/gain-share procedure. Proponents should be expected to submit draft energy, carbon and water modelling results as well as a metering submission for review by the PDC prior to the full technical submission (e.g. as part of a final DPM) to allow sufficient time for ad-hoc follow up as required during the pre-evaluation period.

10.3 STAGE 5: IMPLEMENTATION

Early Works (Q2 2021 to Q3 2022) & Construction (Q4 2021 to Q2 2025)

DESIGN AND CONSTRUCTION REVIEWS

Check-in at appropriate design and construction milestones (e.g. 100%DD, 100%CD, substantial completion) to confirm that installed systems support the mandated energy, carbon and water targets, as well as mandatory LEED and WELL credits. Ensure that a design review is completed by the CaGBC to obtain third-party verification of achieved credits prior to the end of construction. Where deviation from the project agreement has occurred (without written variation) and targets are at risk, take immediate action.

10.4 STAGE 6: OPERATIONS

Move In Q3 2025 to Q2 2026

THIRD-PARTY COMMISSIONING VERIFICATION

Maintain vigilance in third-party commissioning during the initial operating period, especially for durability-, energy- and water-related requirements and any associated metering systems. Submetering systems are often neglected during building commissioning given their complexity and the degree of focus required to achieve the desired performance result. These systems also have performance requirements that straddle both sides of the design-build / operate divide, as both proper installation/calibration and proper programming are required for accurate measurements.

LEED & WELL PERFORMANCE TESTING, REVIEW & CERTIFICATION

Following construction completion, the proponent will submit construction stage credits for review by CaGBC. Confirm that the minimum LEED certification level and all mandatory credits have been achieved within the timelines allocated for certification. Leverage associated penalties if delays occur.

Ensure that the necessary performance testing to support NH's WELL certification application is completed. These tests include measurements of air quality, comfort parameters, acoustics, water quality and lighting quality.

10.5 FM SERVICE PERIOD

30 years (2026-2055)

PAIN-SHARE/GAIN-SHARE ADJUSTMENTS

Once facility operations have stabilized, complete final calibration of the mandatory energy, carbon and water targets outlined in Schedule 36 and begin enforcing pain-share/gain-share clauses. If necessary, provide appropriate flexibility and support for the first few years to allow proponents to adjust to new reporting structures and scopes. Communicate lessons learned during this process to IO to inform future DBFM projects, particularly hospital projects.

NH NEXT STEPS

NH will be responsible for implementing a number of policies, programs and research activities to fully integrate its environmental requirements into hospital operations. These next steps, which are outside the scope of the project agreement, are summarized in Section 12.

11 CAPITAL & LIFECYCLE COSTS

[redacted]

Table 5 below summarizes the capital costs associated with each environmental requirement in the three design options previously outlined.

Table 5: Capital Cost Comparison of Options

ENVIRONMENTAL REQUIREMENT	BASELINE CAPITAL	MAXIMUM CAPITAL	RECOMMENDED CAPITAL
Health & Wellness	[redacted]	[redacted]	[redacted]
GHG Emissions	N/A	N/A	N/A
Energy Efficiency	[redacted]	[redacted]	[redacted]
Water Efficiency	[redacted]	[redacted]	[redacted]
Landscape & Nature	[redacted]	[redacted]	[redacted]
Transportation	[redacted]	[redacted]	[redacted]
Materials & Products	[redacted]	[redacted]	[redacted]
Waste Reduction & Recycling	[redacted]	[redacted]	[redacted]
TOTAL CAPITAL	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]

Table 6: Design Option NPV

OPTION	25 YEAR ILCC NPV	CARBON-ONLY 25 YEAR ILCC NPV
Minimum	N/A	N/A
Maximum	[redacted]	[redacted]
Recommended	[redacted]	[redacted]

Assumptions used to quantify the NPV of each option are in line with other sustainability planning investment projects WSP has conducted in the past three years. Of particular note is the inclusion of a fixed cost of carbon at $50/tonne. The discount rate was set at 3%, reflecting a mix of funded and borrowed money. A higher discount rate may be achievable for other investment that achieve a similar result (e.g. power purchase agreements) but exploring such external opportunities was not in the scope of the study. A typical study period of 25 years was assumed and incorporated a minimum amount of replacement of equipment over this time. Maintenance costs were addressed where very relevant, but many of the alternate features and systems analyzed are expected to be similar in maintenance to the base building. Finally, utility rates were estimated as follows:

- Electricity: $150/MWh
- Natural Gas: $28/MWh
- Biomass: $91/MWh
- Water: $2.40/m^3
- An additional carbon cost of $50 was applied to electricity and natural gas.

As with the up-front capital comparison, the purpose of this LCC is comparative. Results are by nature incremental and are not intended to support an absolute estimate of lifecycle costs for the facility. Further work to estimate the illustrative lifecycle cost should be conducted during Stage 3 and inputs communicate to proponents to allow standardized LCC comparisons of individual designs.

Specific LCC estimates for the recommended option, grouped by environmental requirement, are summarized in Table 7. Additional detail is provided for individual measures in Appendix A. Table 7 also presents a capital costs split of 90%/10% as assumed in the Marshall & Murray Stage 2 costing report, which assigns these up-front costs to both IO and NH.

Table 7: LCC Inputs for Recommended Option

ENVIRONMENTAL REQUIREMENT	IO/MOH CAPITAL	NH CAPITAL	ANNUAL UTILITY COSTS	OTHER ANNUAL O+M COSTS	25 YEAR ILLC NPV
Health & Wellness	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
GHG Emissions	N/A	N/A	N/A	N/A	N/A
Energy Efficiency	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Water Efficiency	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Landscape & Nature	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Transportation	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Materials & Products	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Waste	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
TOTAL	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Significant measures in the recommended option worth discussion from an LCC perspective include geo-exchange, biomass CHP and WELL's operational requirements. As previously discussed, geo-exchange permits fuel switching to lower carbon electricity, but resulting utility costs for this more expensive energy source must be controlled through measures such as load reductions and CHP. Generating electricity at the same time as heat helps offset the cost of geo-exchange (and other sustainability measures) which have a negative life-cycle impact. Even with a perfect geo-exchange, high temperature heating is required for steam production. The challenge with biomass-fuelled CHP is its novelty in the Ontario hospital context (introducing a procurement and procedural risk) and the additional complexity it will add to the operations of the central plant (operational risk).

Currently results show possible merit in increasing the size of the CHP plant (as proposed for the maximum option) to include some thermal energy export. If further study verifies this assertion, then a partnership with adjacent land owners to seek out appropriate tenants may be warranted and produce financial benefit for the hospital in the long term. Though renewable energy export could help to replace the expected loss of parking revenues from the long-term automation of vehicles, opportunities for partnership with the Region and other future automated transportation providers to offer charging and storage infrastructure should also be explored now. The parking spaces and electrical infrastructure will be available; all that is needed is a willing partner. Helping to demonstrate the technology (e.g. being a pilot site) will help turn a likely loss into a potential win in the next decade.

[redacted]

12 CONCLUSION

This Environmental Plan is primarily intended to support the PDC team employed during Stage 3 of the South Niagara Hospital procurement to efficiently translate NH's sustainable vision into measurable performance requirements in the final output specification, and to thoroughly evaluate proponent bids. As NH moves into the next phase of development, the core approaches developed here will be further tested and refined through the illustrative design process. Key recommendations and lessons learned during the development of this report include:

- NH and IO's ongoing support of the new mandatory targets proposed for carbon and water. Not previously explored in any of IO's DBFM projects, these stringent contract amendments will be pivotal to maintain intended hospital performance beyond the design stage.
- The importance of achieving WELL v2 certification to demonstrate NH's commitment to the health and wellness of its patients -- and even more importantly, its staff.
- The design challenge that arises when balancing the significant anticipated parking demand of the hospital with NH's desire to showcase sustainable landscape and nature features such as low impact stormwater management infrastructure, therapeutic and healing gardens, and food gardens.
- The procurement challenge that arises in seeking to balance allocation of project resources to direct patient care areas with other potentially beneficial uses, such as commercial kitchen space to facilitate innovative and sustainable food service models for patients and staff. Although not deemed feasible at this particular project, the team engaged in this report continues to look to CHEO as a model for the potential hospital food revolution to come.

Stakeholder engagements also identified a number of next steps to fully integrate NH's environmental requirements into future hospital operations. Beyond the scope of the PSOS and proponent responsibility, these policies, programs and research activities programs will be led by NH to prepare for the new hospital's opening day as well as the 30 year operations period that follows.

HEALTH & WELLNESS

- Explore healthy and sustainable food options and service models that support targeted WELL v2 features, including retailer agreements, advertising, portion sizes, food sourcing, and education. Design and install appropriate signage to comply with WELL requirements.
- Implement other operational WELL preconditions and optimizations outlined in the WELL Feasibility Study in Appendix C, including development of policies and programs that support staff health and wellness (e.g. mental health, stress, sleep, immunity, substance use, and new parents).
- Contribute to research on the relationship between building design, health and wellness initiatives and general patient and staff health and wellness outcomes. A partnership with researchers in this field needs to be established and fostered in the very short term so that the proper research methods can be put in place and data collection completed at existing facilities before the new facility opens. Brock and Brown University are also seeking topics for student research projects.

ENERGY EFFICIENCY

- [redacted]

LANDSCAPE & NATURE

- Develop ongoing patient and community programs for food and healing gardens. Determine monitoring processes to ensure these spaces are used as intended. Explore fundraising opportunities to further develop these areas.

TRANSPORTATION

- Determine whether staff resources will be allocated to manage transportation demand management activities, such as carpool programs, commuter surveys, and bicycle support networks.

MATERIALS & PRODUCTS

- Consider partnering with other hospital management teams, procurement leadership at the Ministry of Health and possibly with the UK National Health Service to more thoroughly track lifecycle carbon impacts from ongoing so that action can be taken where it is most critical.

WASTE REDUCTION & RECYCLING

- Explore contract terms for existing and new food providers to reduce food waste and packaging waste
- Continue to perform waste audits across NH's hospital network if not included in scope for Project Co. Consider engaging a waste management consultant if this expertise is not provided by proponent teams.
- Develop a procurement strategy to reduce packaging and single use medical equipment, including identification of available vendor takeback programs.

It is clear that the redevelopment team of the South Niagara Hospital is committed to achieve world leadership in sustainable hospital operations. The research, opportunity evaluation, performance metrics and recommendations developed within this report provide a first step towards this goal. The innovations developed in this, and later stages of South Niagara project, will serve to inspire the hospitals of the future, and will meaningfully contribute to action required to mitigate our global environmental crisis.

BIBLIOGRAPHY

DOCUMENTS REFERENCED

- Design Vision + Program Diagram_v3. Niagara Health PowerPoint
- Modeling Report for Humber River Regional Hospital (2011)
- HRRH Energy vs Other Hospitals (2015)
- Pages from 2016-02-11 HRRH Energy Performance Report (2016)
- South Niagara Volume 1 – Stage 2 Submission (2019)
- WELL Scorecard 3115

HOSPITAL RESEARCH

ALDER HEY CHILDREN'S HOSPITAL

- The Guardian. (n.d.) Retrieved from: https://www.theguardian.com/sustainable-business/blog/alder-hey-hospital-childrens-health-park-design
- Sony. (n.d.) Digital aquarium has the power to calm young patients at Alder Hay. Retrieved from: https://pro.sony/en_CA/products/surgical-monitors/medical-digital-aquarium-young-patients-alder-hey
- WSP. (n.d.) Alder Hey Children's Health Park. Retrieved from: http://healthcare.wsp-pb.com/portfolio/alder-hey-children-health-park/?portfolioCats=39

BRIDGEPOINT HOSPITAL P3

- Canada Green Building Council. (n.d.) Bridgepoint Hospital/ Niagara Health System's St Catharines Site. Retrieved from: https://www.cagbc.org/Archives/EN/CaGBC_Green_Building_Case_Studies/Bridgepoint_Niagara.aspx
- Plenary. (n.d.) Bridgepoint Hospital. Retrieved from: https://plenarygroup.com/projects/north-america/bridgepoint-hospital/

CHEO

- CBC News. (2019). CHEO spreading the word about its kid-focused hospital menu. Retrieved from: https://www.cbc.ca/news/canada/ottawa/hospital-food-cheo-menu-children-recovery-choice-1.5144556
- Payne, E. (2018). CHEO's turkey dinners to go part of a revolution in hospital's food. Retrieved from: https://ottawacitizen.com/news/local-news/cheos-turkey-dinners-to-go-part-of-a-revolution-in-hospitals-food
- Ottawa Citizen. (2019). The hospital food revolution: How CHEO is joining the fight. Retrieved from: https://ottawacitizen.com/news/local-news/the-hospital-food-revolution-how-cheo-is-joining-the-fight
- The Canadian Coalition for Green Health Care. (2013) Taking a bit out of organic waste. Retrieved from: https://greenhealthcare.ca/wp-content/uploads/2017/07/CCGHC-Organic-Waste-Case-Study-June17-2013-FINAL.pdf

DELL CHILDREN MEDICAL CENTER OF CENTRAL TEXAS (3BT EXPANSION)

- WSP. (n.d.) Dell Children's Medical Center of Central Texas. Retrieved from: http://healthcare.wsp-pb.com/portfolio/dell-childrens-medical-center/

ENERGY STAR CERTIFIED HOSPITALS – KINGSTON GENERAL AND ST. JOHN'S REGIONAL HOSPITAL

- Natural Resources Canada. (2018) Heads Up: Building Energy Efficiency – Volume 2, Issue 3 (March). Retrieved from: https://www.nrcan.gc.ca/energy-efficiency/heads-building-energy-efficiency-newsletter/heads-building-energy-efficiency-archives/heads-building-energy-efficiency-volume-2-issue-3-march/17533

GRAND RIVER HOSPITAL

- Grand River Hospital. (n.d.) Recycling Single Use Devices in Canadian Hospitals. Retrieved from: http://greenhealthcare.ca/wp-content/uploads/2018/03/Recycling-Single-Use-Devices.pdf
- Grand River Hospital (n.d.) Retrieved from: http://www.grhosp.on.ca/about/achievements-and-excellence

HAMILTON HEALTH SCIENCES

- Green Health Care. (2016) Climate Change Resiliency Mentoring. Retrieved from: https://greenhealthcare.ca/mentoring/#toolkit
- Hamilton Health Sciences. (2018) 2017 Environmental Sustainability Report. Retrieved from: https://www.hamiltonhealthsciences.ca/wp-content/uploads/2018/12/PDF HHS_EnvironmentalReport_072718.pdf
- Infrastructure Ontario. (n.d.) Hamilton Health Sciences – Hamilton General Hospital. Retrieved from: https://www.infrastructureontario.ca/Hamilton-General-Hospital/

HUMBER RIVER

- Humber River Hospital 2017-2020 Strategic Plan Moving Forward Together (2018). Humber River Hospital. Retrieved from: https://www.hrh.ca/wp-content/uploads/2018/10/Strategic_Plan_2017-2020.pdf
- T. Greene [personal communication] Phone discussion on June 26, 2019.
- Master Plan Report (2009). Humber River Regional Hospital Infrastructure Ontario.
- Healthcare – View, Dynamic Glass (n.d.) Retrieved from: https://view.com/assets/pdfs/humber-river-hospital.pdf#zoom=100
- Kutscher, B. (2016) Inside North America's first all-digital hospital. Retrieved from: https://www.modernhealthcare.com/article/20160430/MAGAZINE/304309981/inside-north-america-s-first-all-digital-hospital

KATZ WOMENS HOSPITAL

- U.S. Green Building Council Chapter (n.d.) Katz Women's Hospital – LEED Platinum. Retrieved from: https://usgbc-li.org/project/katz-womens-hospital-leed-platinum
- Cision PR Web. (2019) Katz Women's Hospital at North Shore Earns LEED Platinum Green Building Certification for Second Time. Retrieved from: https://www.prweb.com/releases/2013/7/prweb10915532.htm
- Becker's Hospital Review. (2012) Katz Women's Hospital Becomes First NY Hospital to Receive LEED Platinum. Retrieved from: https://www.beckershospitalreview.com/news-analysis/katz-womens-hospital-becomes-first-ny-hospital-to-receive-leed-platinum.html

KEMPTVILLE DISTRICT HOSPITAL

- Kemptville District Hospital. (2019) Retrieved from: https://www.kdh.on.ca/news-releases/kdhs-sustainability-efforts-recognized-with-two-2017-ontario-green-health-care-awards/

MACKENZIE VAUGHAN

- T. Hussain [personal communication] Phone discussion, n.d.

MARKHAM VAUGHAN

- T. Greene [personal communication]. Phone discussion, n.d

MARKHAM STOUFVILLE HOSPITAL

- Wright. T (2019) Markham Stouffville hospital holds 6th annual greening and sustainability expo. Retrieved from: https://www.yorkregion.com/community-story/9335604-markham-stouffville-hospital-holds-6th-annual-greening-and-sustainability-expo/
- Markham Stouffville Hospital (n.d.) Retrieved from: https://www.msh.on.ca/about-us/accountability/greening-initiatives-and-energy-performance

MENTAL HEALTH HAMILTON

- T. Greene [personal communication]. Phone discussion, n.d

METRO HEALTH

– Jones, M. (2018) WELL Building Means a Healthy Building. Retrieved from: https://www.metrohealth.org/transformation/transformation-blog/well-building-means-a-healthy-building

MICHAEL GARRON

– Armstrong, S. [personal communication]. Phone discussion, n.d.

NIAGARA HEALTH SYSTEM ST. CATHERINE'S SITE P3

– Niagara Health. (n.d.) A Healthier Niagara. Retrieved from: https://www.niagarahealth.on.ca/files/ImagineAHealthierNiagaraDigitalSOURCENET.pdf

– Canada Green Building Council. (n.d.) Bridgepoint Hospital/ Niagara Health System's St Catharines Site. Retrieved from: https://www.cagbc.org/Archives/EN/CaGBC_Green_Building_Case_Studies/Bridgepoint_Niagara.aspx

NORTH BAY REGIONAL HEALTH CENTRE P3

– Plenary. (n.d.). Retrieved from: https://plenarygroup.com/projects/north-america/north-bay-regional-health-centre

OLIVIA-NEWTON JOHN CANCER AND WELLNESS CENTRE

– Green Building Council Australia. (n.d.) Olivia Newton -John Cancer & Wellness Centre. Retrieved from: https://new.gbca.org.au/showcase/projects/olivia-newton-john-cancer-wellness-centre/

PHOENIX CHILDREN'S HOSPITAL

– WSP. (n.d.) Designing for a better experience – high-performance hospitals. Retrieved from: http://cdn.wsp-pb.com/k68fr6/wsp-2017-high-perf-hosp-final.pdf

ROYAL ADELAIDE HOSPITAL

– Royal Adelaide Hospital. (n.d.) About the RAH. Retrieved from: https://www.rah.sa.gov.au/about/about-the-new-rah

– Sturman, Catherine. (2018) Royal Adelaide Hospital leads the way in sustainability. Retrieved from: https://www.healthcareglobal.com/hospitals/royal-adelaide-hospital-leads-way-sustainability

ST. JOSEPH'S HAMILTON

– T. Greene [personal communication]. Phone discussion, n.d.

ST. MARY'S HOSPITAL

– Canadian Interiors. (2014) A Look at B. C's Award-Winning St. Mary's Hospital. Retrieved from: https://www.canadianinteriors.com/2014/08/11/a-look-at-b-c-s-award-winning-st-marys-hospital/

– Green Care Community. (n.d.) Opening at St. Mary's Hospital in Sechelt, Sunshine Coast. Retrieved from: https://bcgreencare.ca/opening-st-marys-hospital-sechelt-sunshine-coast

– Mitham, P. (2016) B.C. hospitals get greener and leaner. Retrieved from: https://biv.com/article/2016/08/bc-hospitals-get-greener-and-leaner

UNIVERSITY HEALTH NETWORK

– Glauser, W., Petch, J., and Pendharkar, S. (2016) Are disposable hospital supplies trashing the environment. Retrieved from: https://healthydebate.ca/2016/08/topic/hospital-medical-waste

– Cuttler, M. (2019). How some doctors want to cut greenhouse gas emissions in the operating room. Retrieved from: https://www.cbc.ca/news/health/anaesthetic-greenhouse-gases-or-1.5170662

– University Health Network. (n.d.) Greening at UHN. Retrieved from: https://www.uhn.ca/corporate/AboutUHN/Greening_UHN/Pages/awards.aspx

– University Health Network. (n.d.) UHN Food Ecosystem. Retrieved from: https://greenhealthcare.ca/uhn-food-ecosystem/

– University Health Network. (2016) UHN's first wheelchair accessible garden blossoms at Toronto Rehab. Retrieved from: https://www.uhn.ca/corporate/News/Pages/UHN_first_wheelchair_accessible_garden_blossoms_at_Toronto_Rehab.aspx

– UHN’s 2019-23 Strategic Plan. (n.d.) A Healthier World. Retrieved from: https://www.uhn.ca/corporate/AboutUHN/Purpose_Performance/UHN_Strategic_Plan/Documents/Download_the_full_Strategic_Plan.pdf

VANCOUVER GENERAL HOSPITAL

– ScienceDaily. (2017) First study to measure the carbon footprint of surgery suggests where emissions reductions are possible. Retrieved from: https://www.sciencedaily.com/releases/2017/12/171208095904.htm