HUMBER RIVER HOSPITAL
A MODEL FOR SUSTAINABLE HEALTHCARE DESIGN
The most energy efficient, fully-digital acute care hospital in North America, Humber River Hospital's (HRH) built environment is revolutionizing sustainable healthcare design. Incorporating digital integration and interoperability to reduce operating costs and carbon footprint, the 1.8M square foot facility was design-built by PCL Constructors Canada Inc. (Toronto) in just 43.5 months, boasting an unprecedented annual EUI target of 348 ekWh/m², which is 47 per cent lower than the Energy Star Portfolio Manager Canada target for hospitals, with 100 per cent fresh air. The build incorporates Information, Communications and Automation Technology (ICAT) infrastructure, first-in-Canada use of Automated Guided Vehicles (AGVs), one of the world’s largest dynamic glass installations, and incorporation of sustainable offsite manufacturing techniques.

In collaboration with an expert team of partners, PCL, as part of the Plenary Health Partnerships team, design-built HRH’s vision for a building that maximizes technology, lean design, and environmental planning, as characterized by the hospital’s three guiding principles: lean, green, and digital.

- **Lean**—Maximize clinical design efficiency to enable high-quality, cost-effective care.
- **Green**—Minimize the environmental impact of the new facility wherever possible.
- **Digital**—Develop an affordable, fully integrated and interoperable digital hospital, using the best possible technology to support the delivery of compassionate, respectful, patient-centred care.

The project team’s technical expertise, combined with user group, stakeholder, and community engagement input were of paramount importance to achieving HRH’s environmental vision and overall project success.
The team was challenged to meet unprecedented targets for energy efficiency, including 15 points for the LEED Canada-NC 2009 Credit EA – Credit 1: Optimize Energy Performance, a first for an acute care hospital in Canada. Not only were these targets 40.1 per cent better than ASHRAE 90.1-2007 standards, the hospital specified 100 per cent fresh-air circulation, well above CSA-Z317 standards.

Commissioned building systems demonstrate unprecedented targets for energy efficiency, with a resulting energy model predicting an annual EUI of 348 ekWh/m2, 47 per cent lower than the Energy Star Portfolio Manager Canada target for hospitals.

The building meets the City of Toronto’s Green Standard (TGS) Tier 1 requirements. The hospital’s state-of-the-art heating, ventilation and air-conditioning (HVAC) system pumps 100 per cent fresh air throughout the building. Adding to increased energy savings are automated climate and lighting controls, condensing boilers, high-efficiency chillers, variable-speed drives and pumps throughout, heat-recovery chillers to provide low-temperature heating, efficient duct design to reduce static pressures, exhaust-air heat recovery, a high-performance building envelope that includes increased insulation levels in the roof and walls, and an energy-efficient lighting design that includes LEDs and provides a building average lighting power density of 0.75W/ft².

A result of steadfast determination, the team secured 17 points for LEED® Canada-NC 2009 Optimized Energy, and surpassed the project’s intended LEED® Silver classification to achieve LEED® Canada NC v2009 Gold certification.

Among the innovative design features that make this project stand out and demonstrate how technology and green building go hand-in-hand is the use of dynamic glass as a response to solar control. Like transition sunglasses for a building, this innovation allowed for downsizing of HVAC infrastructure, while maintaining patient privacy.

With the ability to change its shading throughout the day according to patients’ preference or the sun, the feature uses less energy, and supports infection prevention and control at a time when hospitals are moving away from curtains as an infection-control measure. At almost 26,000 square feet, it is one of the largest installations of electrochromic windows in the world.

To support occupant engagement, the hospital is armed with fully converged ICAT infrastructure, complete with an industry-leading middleware solution that integrates building automation and clinical care into a common network. This approach simplifies the ability of systems to share digital information; enabling patients, staff and visitors with ease of access to information when and where they need it, allowing people to be mobile and connected. The device agnostic software system is a user-friendly platform that provides solutions at the users’ finger tips to their mobile devices and computers - a true revolution for smart hospitals of the future.

These systems enable hospital-defined use cases and workflows to extend across multiple digital platforms to simplify the end users’ day-to-day life. By providing on-the-go information from
statically located patients to dynamically moving nurses and doctors, information, alerts and communication processes are boundless and available at the fingertips of all users no matter where they were located in the facility. The building’s high-performance design incorporates multiple metering systems integrated into a common platform, enabling the building operator to have a seamless method of analyzing actual energy usage to continue the ongoing improvement of energy optimization and hence reduce utility consumption.

Integrated Bedside Terminals (IBT) help connect patients with their care and social network. Provided in patient rooms and select outpatient areas, the IBT allows patient and care team access to electronic medical records at the bedside, and enables the patient to control room temperature and window shading, access to TV and internet, and communication with staff. The handset features a built-in scanner for reading barcodes and provides access to the Nurse Call system.

Innovations include smart bed technology; robotic technology for certain surgical procedures; automated laboratory processing; and bedside computer screens that allow patients to control their environments and communicate with physicians.

The hospital includes first-in-Canada use of AGVs. Programmed to move custom-built carts to carry food, linens, medication, and general supplies throughout the hospital. AGVs are capable of calling elevators, opening doors, picking up loaded carts, and determining timing of each delivery based on their location, priority level of the call and time of day. Sneaker time for staff searching for equipment and supplies is reduced using Radio-frequency identification (RFID) technology on equipment, and delivering 75 per cent of supplies and medicine by automation.

**REDUCING EMBODIED ENERGY THROUGH OFFSITE MANUFACTURING**

To further the hospital’s lean and green philosophy, PCL’s agile thinking led to a solution that reduced critical path of the 43.5-month schedule through utilization of virtual construction technology and offsite manufacturing techniques to prefabricate and install 360 patient washrooms and 14 telecommunications/data rooms.

Fabrication of the modules in PCL’s in-house manufacturing facility generated less waste, created fewer site disturbances, and decreased the overall embodied energy of the project. Embodied energy is the sum of all energy needed to produce a product, as if that energy were incorporated or “embodied” into the product itself. Reducing embodied energy therefore reduces a building’s carbon footprint, which is the sum of all greenhouse gases emitted during the full life cycle of a product.

Design for Manufacture and Assembly (DFMA) seeks to reduce materials used onsite, labour and overhead costs by employing factory processes to build elements that can efficiently manufactured offsite, shipped to the construction site with just-in-time delivery, and installed in an organized and systematic way.
HRH serves a catchment area of more than 850,000 people in the northwest Greater Toronto Area. With 656 beds, 3,300 staff, approximately 700 physicians, and 400 volunteers, the ability of the facility to promote the wellness of occupants through immersion in the natural environment is a major priority.

The Aspen Grove glass installations on the north and south façades are a striking design feature that recall a colourful woodland scene representative of the way the hospital harmonizes with the local community. More than 38 per cent of the project’s total site area includes vegetated open space, incorporating pedestrian-oriented hardscape and landscape features within the campus environment, including outdoor furnishing, benches, group seating arrangements, and shelters to encourage interaction between people. It also provides open spaces with native adaptive vegetation and walking paths that allow for transition between public and private spaces accessible by patients, staff, and the general community. Garden roofs within mental-health inpatient areas provide additional access to natural landscapes and promote optimal healing.

Plants were chosen strategically to ensure minimal water demands. All irrigation is provided by a rainwater harvesting system that collects rainwater from the roofs and directs it to two on-site cisterns, to be redistributed to irrigation if required. This system is expected to save approximately 450,000 liters of potable water each year.

The use of low-emitting materials helps protect occupants from harmful volatile organic compounds and improves indoor air quality. Functional parameters, such as proper sight lines for staff to monitor patients, and places of respite for staff and patients alike, both within and outside of the facility, promote a balanced healing process and a high-quality work environment.

Low-flow plumbing fixtures were incorporated into the building design, resulting in a 33 per cent reduction in potable water use compared to the LEED baseline. In addition, while the site features a number of pedestrian-oriented landscaped areas, the plants selected for the environs were chosen to ensure minimal water demands. All irrigation is provided by a rainwater harvesting system that collects rainwater from the roofs and directs it to two on-site cisterns, to be redistributed to irrigation if required. This system is expected to save approximately 450,000 liters of potable water each year.

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To grow the built environment sustainably, attention was paid not only to creating an efficient building but also to drastically limiting waste during construction; this resulted in 96 per cent of construction waste being diverted from landfill. In addition to being paperless, green practices during the build included the use of low-volatile organic compound materials for adhesives and sealants, paints and coating, and carpets.

The project team was committed to educating subtrades on how to make waste diversion a priority in their daily routines. They used the hospital’s loading docks as an efficient layout area to separate waste streams, sorting concrete, metal, wood, drywall, insulation, and paper and cardboard products into separate bins. A bin full of one presorted material was then taken directly to the final recycling station rather than traveling to a transfer station for secondary sorting, which is far less cost-effective and results in lower diversion rates. Before bringing a waste-management partner on board, PCL committed to understanding where they would take the project’s waste, as well as the capacity and location of their facilities.

The hospital employs a recycling and waste program and conducts frequent site tours and on-site conferences, to date having welcomed more than 100 health-care organizations from around the world, as well as local community and school groups interested in learning about its innovative sustainable features.
Greenguard certified furniture and materials reduce environmental impact.

Vegetated roof and reflective roofing materials reduce the heat island effect, with visible green roofs installed on 50 per cent of the roof space throughout the campus.

38 per cent of the project’s total site area is vegetated open space.

20 per cent of materials used to construct the facility contained recycled content, and 46 per cent were sourced regionally.
UNPRECEDENTED ENERGY EFFICIENCY TARGETS

It took an expert team to bring the hospital’s lean and green vision to fruition. Engineering a concept design in an eight-month bid period to achieve 100 per cent outside air and energy consumption 40 per cent below the MNECB (Model National Energy Code for Buildings) was a significant challenge that had never been done before in North America.

The result? In April 2017, the Canada Green Building Council validated that the project surpassed its intended LEED® Silver classification, attaining LEED® Canada NC v2009 Gold certification.

SHIFTS TO A LOW-Carbon ECONOMY IS POSSIBLE FOR ALL BUILDING TYPES

“One of the best things about this unprecedented environmental achievement is that it creates a new precedent, setting the stage for future, even-greener, building. As one of the most energy-efficient acute care hospitals in North America, Humber River Hospital is a strong example of how the shift to a low-carbon economy is possible for all building and project types. By committing to green building through LEED®, the patients, staff, and visitors of this hospital also benefit from a healthier indoor environment which will support patient care and recovery for years to come.”

— Thomas Mueller, president and CEO, Canada Green Building Council

“Surpassing the project’s intended LEED® Silver classification to achieve LEED® Gold is a testament to the entire collaborative team’s relentless pursuit of achieving unprecedented energy efficiency targets to reduce Humber River Hospital’s carbon footprint and create a facility that balances energy efficiency and innovative technology, enabling the hospital to focus on its core business of providing exemplary patient care,”

— PCL Toronto project director Bruce Macpherson
A SELECTION OF HUMBER RIVER HOSPITAL’S AWARDS

2016 Global Best Healthcare Project, Engineering News-Record

Excellence in Green Building: New Construction Institutional Award, Canada Green Building Council

Gold Medal, Modern Healthcare Design Awards

Innovation Award - New Construction Core & Shell, Canada Green Building Council - Greater Toronto Chapter

#22—Top 100: Canada’s Biggest Infrastructure Projects (2014), ReNew Canada magazine

Gold Award (Infrastructure), Canadian Council for Public-Private Partnerships

2013 Best Healthcare Project, North America, World Finance magazine—P3 Awards

2015 Best of the Best Award, Toronto Construction Association

Silver Award Innovation & Excellence—Project Finance, CCPPP

To top it all off, construction of this 1.8 million square foot environmental showpiece was delivered on time and on budget, with an impressive industry-leading safety record, including over five million hours worked without a lost time injury.
CONSTRUCTION HIGHLIGHTS

43.5 month schedule
Or about 5.5 NHL hockey seasons

$1.75 billion
Project Value
(NPV)

1.8 million ft²
That is equivalent to 32.25 football fields.

More than 29,500 loads excavated and hauled offsite

13,000 truckloads of concrete

More than 260 tons of structural steel framing installed

123,270 cubic metres of concrete poured
Or about 49 Olympic pools worth

That is equivalent to 32.25 football fields.
96% construction waste diverted from landfill

35% less water used

100% fresh air throughout the entire building

20,000 equivalent savings in tons of CO₂ due to green initiatives

An impressive safety record with over 5,000,000 hours worked without a lost time injury
Humber River Hospital was delivered under Infrastructure Ontario’s Alternative Financing and Procurement (AFP) delivery model in partnership with:

- Owner: Humber River Hospital
- Lead Sponsor and Financial Arranger: Plenary Group
- Design-Builder: PCL Constructors Canada Inc. (Toronto)
- Facilities Management: Johnson Controls
- Sustainability Consultant: MMM Group Limited
- Mechanical/Electrical Consultant: Smith + Andersen
- Structural Consultant: WSP Canada Inc./Halsall
- Mechanical Contractor: Modern Niagara Toronto Inc.
- Electrical Contractor: Plan Electric
- Civil Engineer: A.M. Candaras Associates Inc.
- Landscape Architect: Quinn Design Associates