Bahen Centre for Information Technology

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For:
Terri Boake
ARCH 366 – Environmental Building Design

March 17th, 2004

Location: 40 St. George Street
Client: University of Toronto
Architect: Diamond and Schmitt Architects Incorporated
Mechanical: Keen Engineering
Landscape: Ian Gray & Associates/Diamond and Schmitt Architects Incorporated
Area: above grade 37,000 m2; below grade 10,500m2
Height: 3 storey podium with 8 storey tower
Budget: $108 Million
Completion: April 2002
Awards:
OAA Architectural Excellence Award - 2003
City of Toronto Architecture and Urban Design Award - 2003

Introduction

The Bahen Centre for Information Technology, located at the corner of St. George Street and Russell Street, was designed and built for the University of Toronto, by Diamond and Schmitt Architects Incorporated. The Bahen Centre was designed and built to a budget of $108,000,000 and completed in April 2002. The area encompassed is 37,000 m2 above grade, and 10,500 m2 below grade.

The University of Toronto wanted to incorporate environmental design aspects into the new building. The green agenda was inspired by the computer science faculty and its need for large amounts of energy that are required to cool and power the computers. This forced the architects to figure out ways to design the Bahen Centre using different devices so that the energy costs of the building could be reduced. Other areas of design to help make the building energy efficient and environmentally conscious involve site conservation, building form and orientation, energy and water conservation, material selection, indoor air quality, and other factors.

The Bahen Centre is designed to accommodate teaching and research in computer science, electrical engineering, engineering science, mechanical and industrial engineering. In addition specialist research institutes will focus in technology, innovation and research in partnership with industry to facilitate technology transfer. Because of the complexity and scale of the project the building is intended to achieve a high level of flexibility in program, configuration and servicing. In this sense, the concept is that of a high tech loft space. A structural bay size of 9 meters squared is used throughout. All power, data communication, heating, ventilation and air conditioning are delivered through an accessible floor with concrete tiles. Coffered cast concrete vaults, which accommodate direct and indirect lighting and acoustic absorption to dampen room noise thus form ceilings. These features will allow the building to be easily adapted for new uses as the University sees fit in the future.

The site that was available for this building is located in the middle of the University block, replacing an existing parking lot, between six existing buildings. The structural and servicing system forms the armature of a building shaped around the many constraints of the mid block site. A full storey arcade bisects the building from St. George Street to Huron Street and provides access to all lecture and seminar rooms. The arcade provides mid block pedestrian connections through this large block. A circular public stair, at the crossroads of the plan, surrounds a tower of shared meeting rooms that links all eight levels. This stair has a glass cylinder around it that is sky lit and is a lantern of light drawing daylight deep into the building.

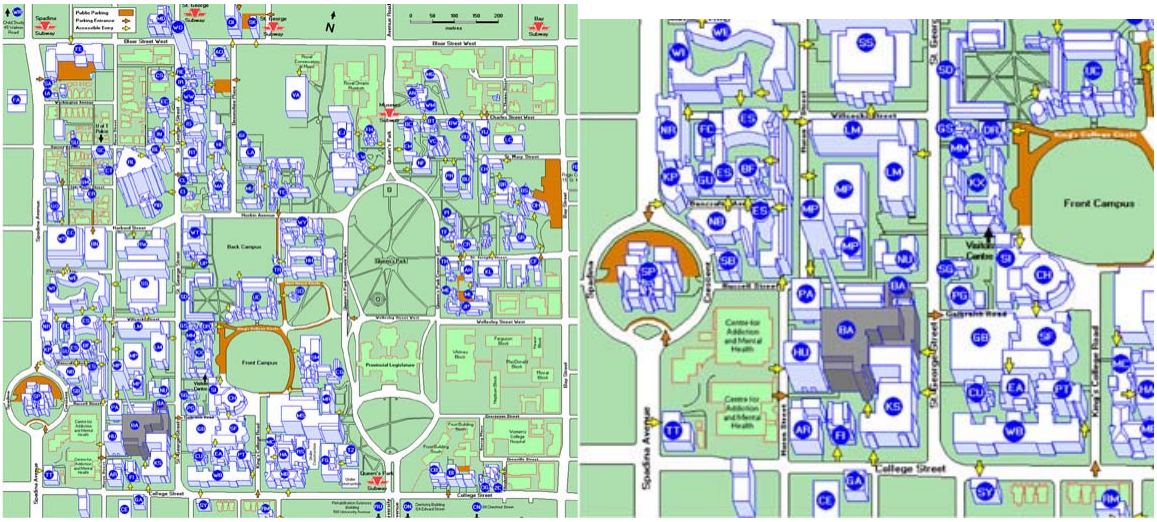
At the south a new landscaped quadrangle is created. This quad is enclosed by existing buildings to the east, south and west and is overlooked by a two storey interior court and café of the Bahen Centre. It is landscaped with a grove of trees and large pool of water. At the seventh and eighth floors there are exterior courtyards that face west and provide a welcome exterior terrace in the midst of research Centres.

An existing driveway, between the Fields Institute and the Koffler Centre for Student Services, extending south to College Street was transformed into a pedestrian walk, lined with trees and bordered by a rivulet of water flowing from the quadrangle pool, in a balustrade at waist height. This walk forms an entry off College Street.

Along St. George Street the built form steps down to three stories in height to match the cornice of the Koffler Centre. This wing enveloped a designated historic Victorian house in a small courtyard opening off the street. The retention of this house was mandated. Rather than stop the building south of the house a pavilion emulating the proportional system of the house was extended to the north with a translucent glass link forming a backdrop to the Victorian building.

Sustainable Sites

The site for the Bahen Centre was an above ground parking lot in the middle of a University block. The site was not used to its full potential, so it was chosen for the new building. This provided much more usable space and a much larger underground parking facility. The density of the surrounding area was also increased by the addition of the Bahen Centre. A row of old Victorian townhouses where demolished in order for the Bahen to be built but the University kept one of the heritage houses and incorporated it into the design of the building using it as a grad student facilities building.

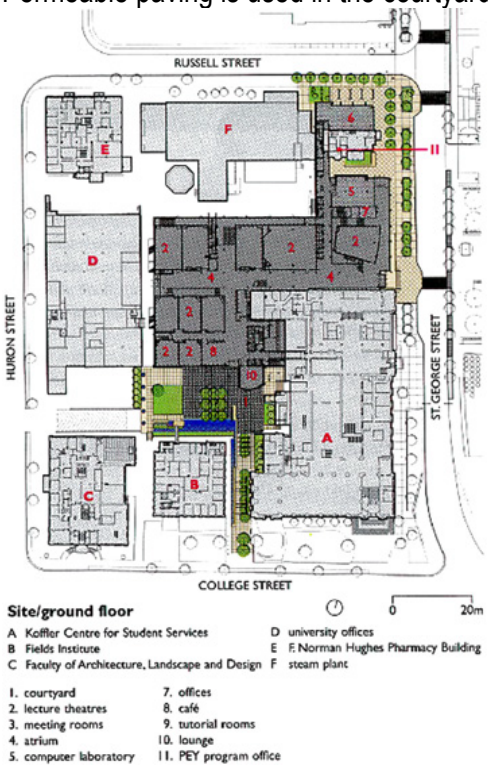


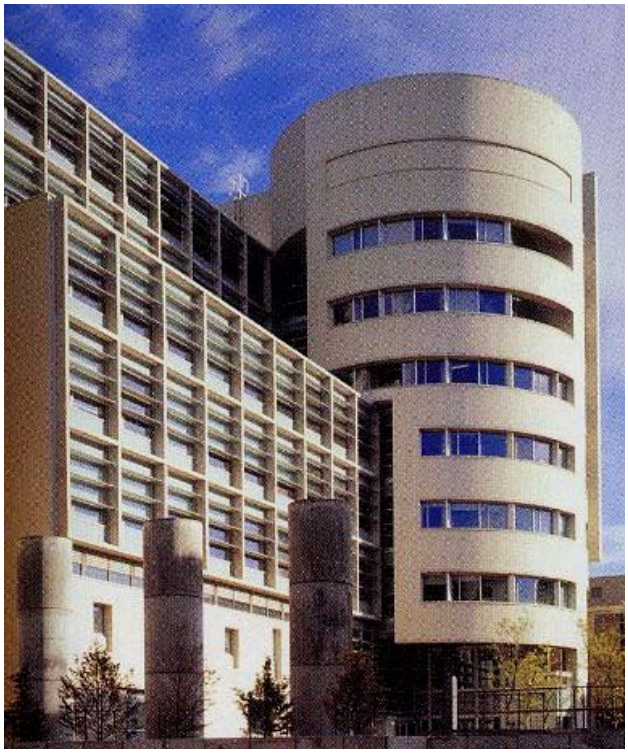
For the Brownfield site requirement, we do not believe that the Bahen Centre qualifies for this. The site was a parking lot beforehand but we believe the contamination to be too minimal to be considered a Brownfield site.

The access to public transit is a great benefit to a university building. The Bahen Centre is located within two city blocks of the Queens Park subway station. It is also on the 506-streetcar route, which travels along College Street. There are also bike paths along the streets close to the school, specifically St. George Street. The building provides bike racks and storage, as well as, showering and changing facilities. The building, as far as we know, does not provide specific car pool parking spots or an alternative fueling station for eco-friendly vehicles.

The Bahen Centre uses both pervious paving and storm water collection. The on-site storm water system is designed to reduce the loads on the city system compared to the original use of the land. The storm water management system consists of full roof water storage, a small south facing roof garden and a major educational rain cycle demonstration that includes several

six-meter high storage cylinders, pond and rill spilling to College Street. The original plan had five water cisterns but with some cost cutting only three were built. The planted courtyard exists with the rain cycle demonstration on a south facing student plaza to be used as a year round student amenity space. The plaza is designed to buffer winds to provide a microclimate for year round use. Permeable paving is used in the courtyards to reduce storm water runoff.





The heat islands formed by the site were reduced immensely with the addition of the Bahen Centre. The removal of the parking lot and relocation of the new parking areas below ground helped to dissipate the heat island effect. The addition of roof top gardens, courtyard planting also helped by providing shaded areas.

Water Efficiency

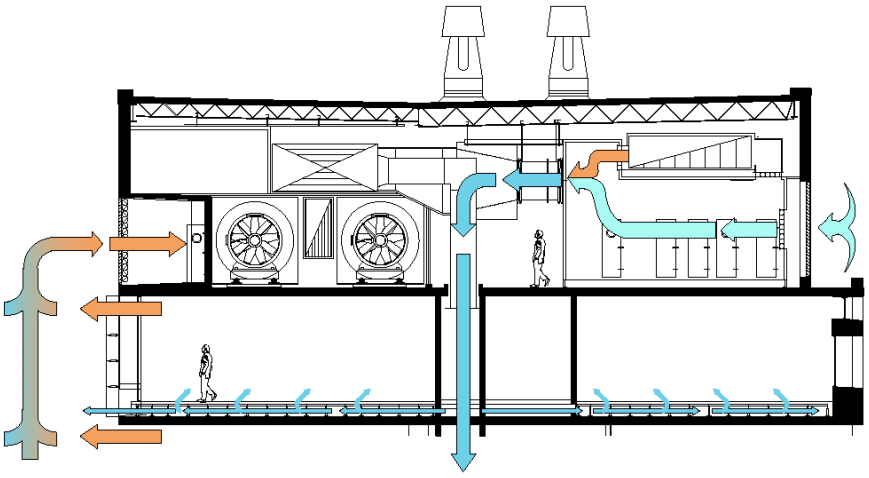
Site irrigation and landscape watering is provided from the rain cycle demonstration storage cylinders. This provides a 100% diversion from potable water, and eliminates any reliance on municipal water for irrigation. The majority of the rainwater evaporates from the roofs, reflecting pool, and planting rather then exiting into the City storm water sewers. The use of water is also reduced through the usage of low flow fixtures throughout the whole building.

Energy and Atmosphere

The Bahen Centre is heated from the waste chimney heat from adjacent, central steam plant for the campus. The heat exchanger on the chimneystack provides over 90% of the calculated building capacity for ventilation air, building heat loss, domestic hot water, and underground parking ramp heating. The NRCan energy software model predicts an annual energy use of 53% of the new Model National Energy Code of Canada. The secondary hot water overhead radiant panel heating system is installed to offset heat loss and increase thermal comfort.

Each room and exposure is individually thermostatically controlled to minimize energy usage. The building contains a 375mm raised floor system for voice, power, and data wiring, and an underfloor medium pressure, variable air volume air-conditioning system. The raised floor system contains electrical floor outlet boxes for connections to voice, power, and data, and high induction swirl diffusers for displacement ventilation. Stratified hot air from occupants and computers is returned at high level resulting in minimum fan energy and maximum heat transfer efficiency. Individual floor heat/cool zones in the north, south, east, and west of the building control to maximize energy conservation. High efficiency motors are used on all fans, pumps, resulting in energy consumption that is 60-70% of ASHRAE 90.1.

The building allows maximum use of natural ventilation in all spaces through the use of operable windows and doors on shoulder seasons to reduce the reliance on building heating and cooling systems. Air-to-air heat exchangers are used for the pre-heating of fresh air for the building. While maximum day lighting is used to reduce reliance on artificial illumination systems.



The exterior wall design on the south side of the building is equipped with a multi-louvered shading system that provides significant reduction of summer heat gain and mechanical refrigeration capacity. The shading reduces the chiller plant requirement by 100 tons resulting in an $800,000 capital saving and a $60,000 - $90,000 annual electricity charge reduction.

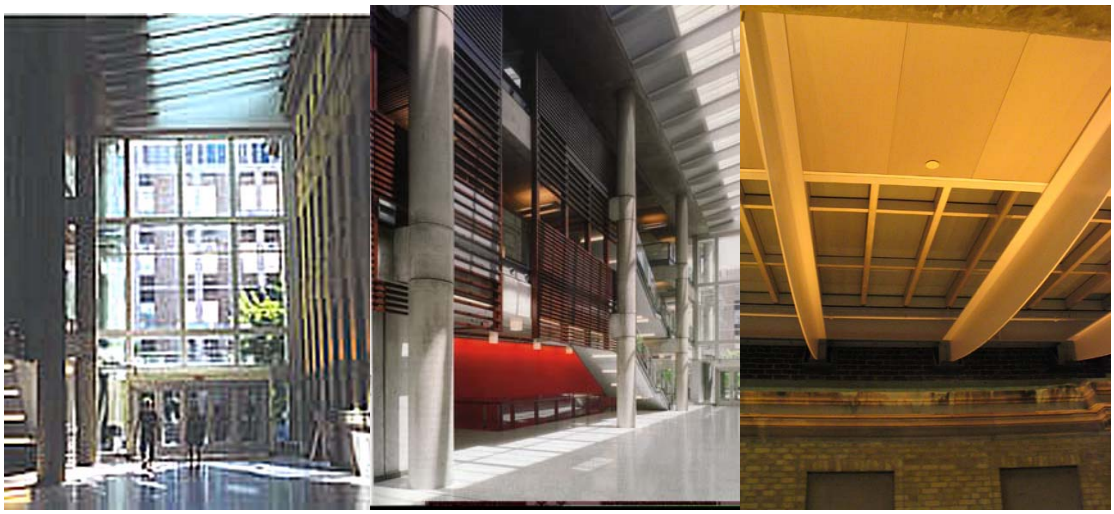
The building includes a maximum use of equipment for dual purpose to minimize the use of embodied energy. The building return air fans are used for smoke exhaust under fire/smoke mode. All refrigerants are non-ozone depleting and fire suppression systems are non-halon. The building also incorporates a maximum use of materials and components to reduce requirements for supplemental heating and cooling, such as exposed concrete floors in some areas and operable windows.

The building envelope uses a glazing system, where 95% of the glazing in windows, curtain walls, and skylights are PPG Solarban 60 SolarControl Low E glass, to minimize cooling and maximize day lighting. The skylights are also fritted 55% to further reduce solar heat gain.

Mechanical air handling systems have been combined in a header arrangement to provide complete operational flexibility and nine stages of air capacity for optimum efficiency. The building also houses a 5,000 tonne central cooling plant that distributes chilled water to two of the University Campus blocks.

Materials and Resources

The Bahen Centre incorporated a Victorian house into two walls of the main building. It also added the north exterior face of the Koffler building as a feature wall in its main atrium space. This design moved further to join the two buildings. The rest of the site, since it was parking lot, was just torn up and removed.



Recycled steel is used in the structure, and the Terrazzo floor incorporates recycled materials. Wood, primarily maple, used in the Bahen Centre is grown and harvested locally within Ontario. It is unknown whether the wood is certified or not. Fly ash concrete was tried and determined to be unreliable visually. It produced a streaky finish and was too dark a concrete for what the spaces required. It also took to long to form up in winter and the cold temperatures were causing irregularities on the face of the concrete. Regular concrete was used instead, however recyclable forms were used which incorporated recyclable corrugated steel.

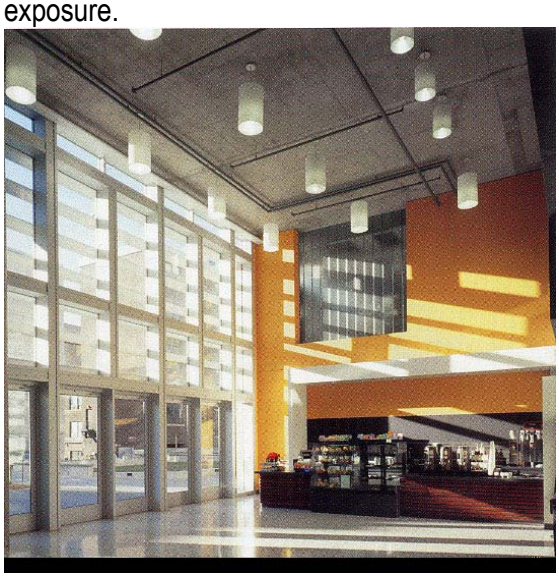
The carpet was supplied by Interface, who incorporates recycled materials into their product and allows for the carpet to be recycled after its use. The carpet can come in rolls or 2'x2' tiles. Interface uses a patterning technique called biomimcry, which allows for the tiles to be randomly placed forming an organic pattern. The carpet tile system and their patterning technique make worn tile replacement in high traffic areas easier and cheaper for the clients. Interface will come free of charge to dispose of the worn tiles. The tiles are taken back and are either reused or recycled.

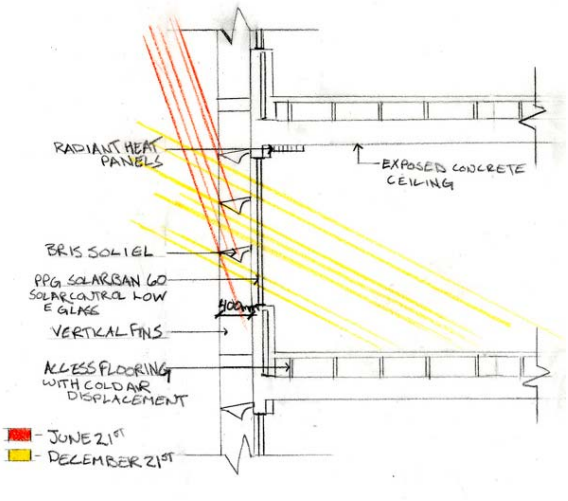
Indoor Environmental Quality

Maximum day lighting is used to reduce reliance on artificial illumination systems. The building is located with five-meter clearances from the new building envelope to the existing building. This clearance allows daylight into the perimeter offices and classrooms. A full height central atrium provides day lighting to the interior of the floor plate with a maximum distance of 25m to daylight. Floor-to-ceiling glass partitions and the glazed stair allow light to penetrate into space that would not otherwise have access to daylight. The atrium will ultimately connect to College Street at the south, St. George Street to the east and Huron Street to the west as a major student walkway for the campus.

The atrium is also used for the building's air-conditioning and return air duct under normal operation as a smoke exhaust chimney under fire/smoke mode. The full south exposure is equipped with a multi-louvered shading system providing significant reduction of summer heat gain and mechanical refrigeration capacity. The east connection to both St. George Street and the

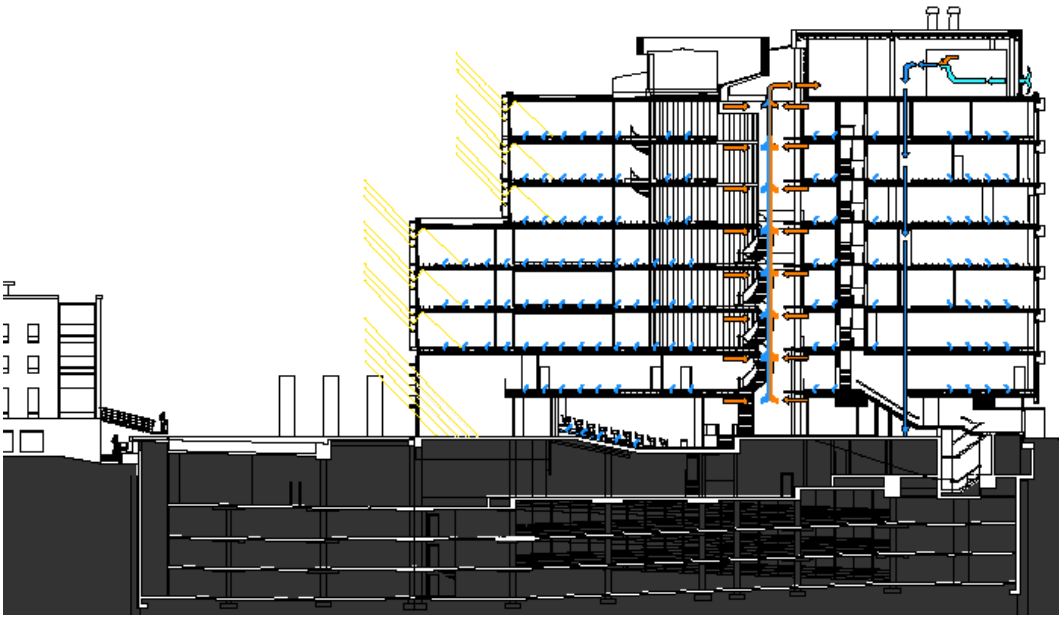
Koffler Student Centre is a four-storey atrium extension providing 16 meter high glazing on the east exposure.





Displacement ventilation from below the raised floor and high level exhaust throughout the building provides up to 50% improvement in indoor air quality. Displacement ventilation air system is also installed below high occupancy rate auditoriums on the ground floor level.

The HVAC system is designed with carbon dioxide monitoring sensors and integrates these sensors with the building automation system. The HVAC system and building to envelope are designed to optimize air change effectiveness. Air change effectiveness is optimized using plug flow ventilation from underfloor delivery and operable windows.



The choice of floor covering can have an impact on the indoor air quality. As mentioned above, Interface supplied all the carpet. Interface Flooring Systems is the only commercial carpet manufacturer that meets the requirements for the CRI Green Label Certification, State of

Washington Protocol, and consistently passes the GSA Antimicrobial test. Carpet that includes Intersept is guaranteed to maintain antimicrobial-preservative effectiveness for the life of the product and helps prevent odour-causing microorganisms that could escape into the air space, assuming proper maintenance. Interface Flooring Systems products also features a dense face construction of premium nylon and a moisture impermeable structured backing. Furthermore, Interface products are tested for VOC emissions and are all below established guidelines.

Innovation and Design Process

We awarded The Bahen Centre 2 points in innovative design. The smoke stack reclamation proved creative way to heat 90% of the building. Also the use of an interior urban site that may have been overlooked for development because of the close proximity of surrounding buildings added to the complexity of the project.

Diamond and Schmitt is in the process of training some of their employees to be LEED accredited professionals. One architect on the team is accredited now but we are unsure if she was during the design and construction of this building.

Conclusions

The Bahen Centre for Information Technology incorporated a complex program and a green agenda into a highly sophisticated building. The Bahen Centre scored a total of 42 points out of a possible 69 points. This gives Bahen Centre a pre-certification estimate of a LEED Gold rating. The most notable environmental design characteristics were in the water efficiency and indoor air quality categories. In these areas, the Bahen Centre truly excelled. Also notable was the category of Energy and atmosphere, where Bahen Centre achieved all 10 points available to optimizing energy performance.

LEED Version 2.1 Registered Project Checklist

Bahen Centre for Information Technology
Toronto, Ontario, Canada

Yes	?	No			
7	**1**	**6**	**Sustainable Sites**		
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
Y			Credit 1	**Site Selection**	1
Y			Credit 2	**Urban Redevelopment**	1
		N	Credit 3	**Brownfield Redevelopment**	1
Y			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
Y			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		N	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
		N	Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	1
		N	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
		N	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
Y			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
Y			Credit 6.2	**Stormwater Management**, Treatment	1
Y			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
	?		Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
		N	Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
3		**2**	**Water Efficiency**		**5** Points
Y			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
Y			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		N	Credit 2	**Innovative Wastewater Technologies**	1
Y			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
		N	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
14	**2**	**1**	**Energy & Atmosphere**		**17** Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
Y			Credit 1	**Optimize Energy Performance**	1 to 10
Y			Credit 2.1	**Renewable Energy**, 5%	1
Y			Credit 2.2	**Renewable Energy**, 10%	1
Y			Credit 2.3	**Renewable Energy**, 20%	1
	?		Credit 3	**Additional Commissioning**	1
Y			Credit 4	**Ozone Depletion**	1
	?		Credit 5	**Measurement & Verification**	1
		N	Credit 6	**Green Power**	1

4	5	4	**Materials & Resources**	13 Points
Y			Prereq 1 **Storage & Collection of Recyclables**	Required
		N	Credit 1.1 **Building Reuse**, Maintain 75% of Existing Shell	1
		N	Credit 1.2 **Building Reuse**, Maintain 100% of Shell	1
		N	Credit 1.3 **Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
	?		Credit 2.1 **Construction Waste Management**, Divert 50%	1
	?		Credit 2.2 **Construction Waste Management**, Divert 75%	1
Y			Credit 3.1 **Resource Reuse**, Specify 5%	1
	?		Credit 3.2 **Resource Reuse**, Specify 10%	1
Y			Credit 4.1 **Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	1
	?		Credit 4.2 **Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	1
Y			Credit 5.1 **Local/Regional Materials**, 20% Manufactured Locally	1
Y			Credit 5.2 **Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
		N	Credit 6 **Rapidly Renewable Materials**	1
	?		Credit 7 **Certified Wood**	1
Yes	?	No		

12	2	1	**Indoor Environmental Quality**	15 Points
Y			Prereq 1 **Minimum IAQ Performance**	Required
Y			Prereq 2 **Environmental Tobacco Smoke** (ETS) **Control**	Required
Y			Credit 1 **Carbon Dioxide** (CO_2) **Monitoring**	1
Y			Credit 2 **Ventilation Effectiveness**	1
	?		Credit 3.1 **Construction IAQ Management Plan**, During Construction	1
Y			Credit 3.2 **Construction IAQ Management Plan**, Before Occupancy	1
Y			Credit 4.1 **Low-Emitting Materials**, Adhesives & Sealants	1
Y			Credit 4.2 **Low-Emitting Materials**, Paints	1
Y			Credit 4.3 **Low-Emitting Materials**, Carpet	1
Y			Credit 4.4 **Low-Emitting Materials**, Composite Wood & Agrifiber	1
Y			Credit 5 **Indoor Chemical & Pollutant Source Control**	1
Y			Credit 6.1 **Controllability of Systems**, Perimeter	1
	?		Credit 6.2 **Controllability of Systems**, Non-Perimeter	1
Y			Credit 7.1 **Thermal Comfort**, Comply with ASHRAE 55-1992	1
Y			Credit 7.2 **Thermal Comfort**, Permanent Monitoring System	1
Y			Credit 8.1 **Daylight & Views**, Daylight 75% of Spaces	1
		N	Credit 8.2 **Daylight & Views**, Views for 90% of Spaces	1
Yes	?	No		

2	1		**Innovation & Design Process**	5 Points
Y			Credit 1.1 **Innovation in Design**: Smoke Stack Reclemation	1
Y			Credit 1.2 **Innovation in Design**: Infill Site project	1
			Credit 1.3 **Innovation in Design**: Provide Specific Title	1
			Credit 1.4 **Innovation in Design**: Provide Specific Title	1
	?		Credit 2 **LEED™ Accredited Professional**	1
Yes	?	No		

42	11	14	**Project Totals** (pre-certification estimates)	69 Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

References

Thank you to Thom Pratt from Diamond and Schmitt architects

Polo, M. *Green Giant*. Canadian Architect, Vol. 48, Number 1, 2003, pp. 20-25.

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