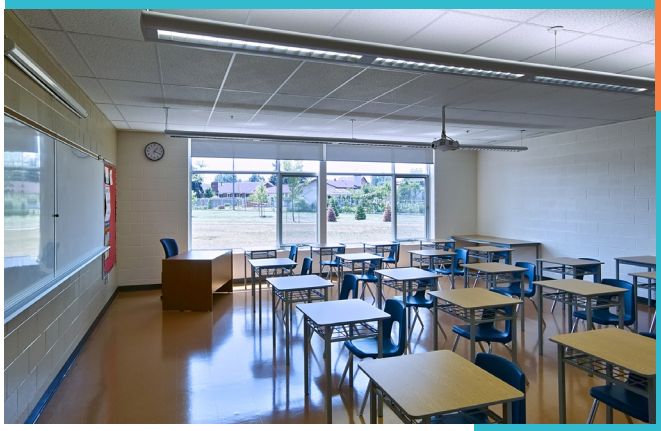
ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA

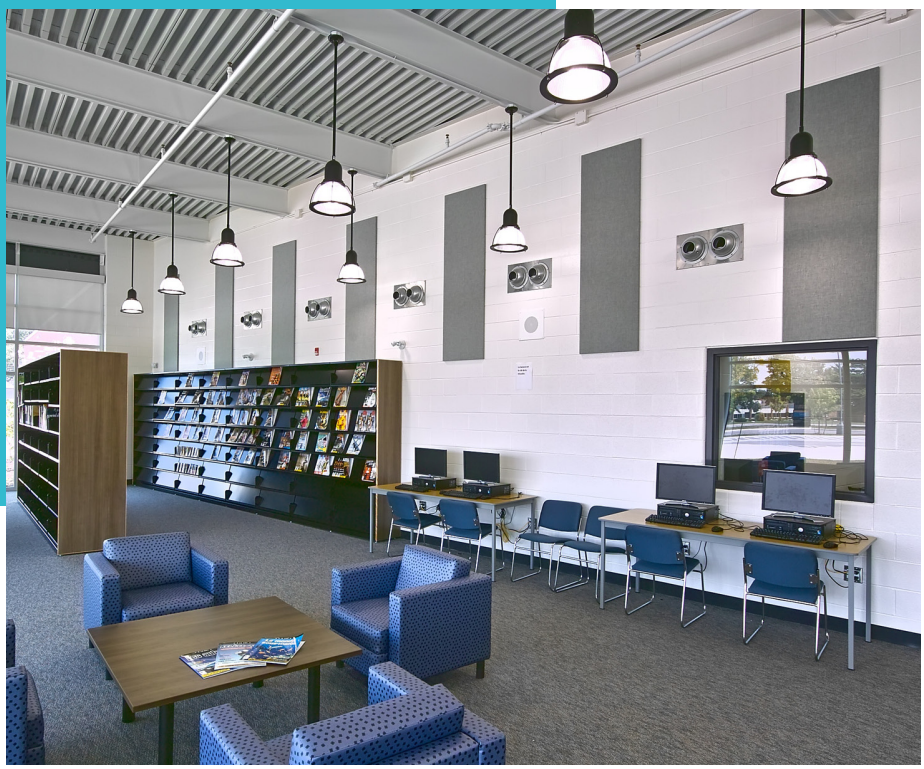
ASSOCIATION DES FIRMES D'INGÉNIEURS-CONSEILS | CANADA

École secondaire Michel-Gratton

Canadian Consulting Engineering Awards 2012

Submission Category – Buildings





MMM GROUP

ENERMODAL ENGINEERING

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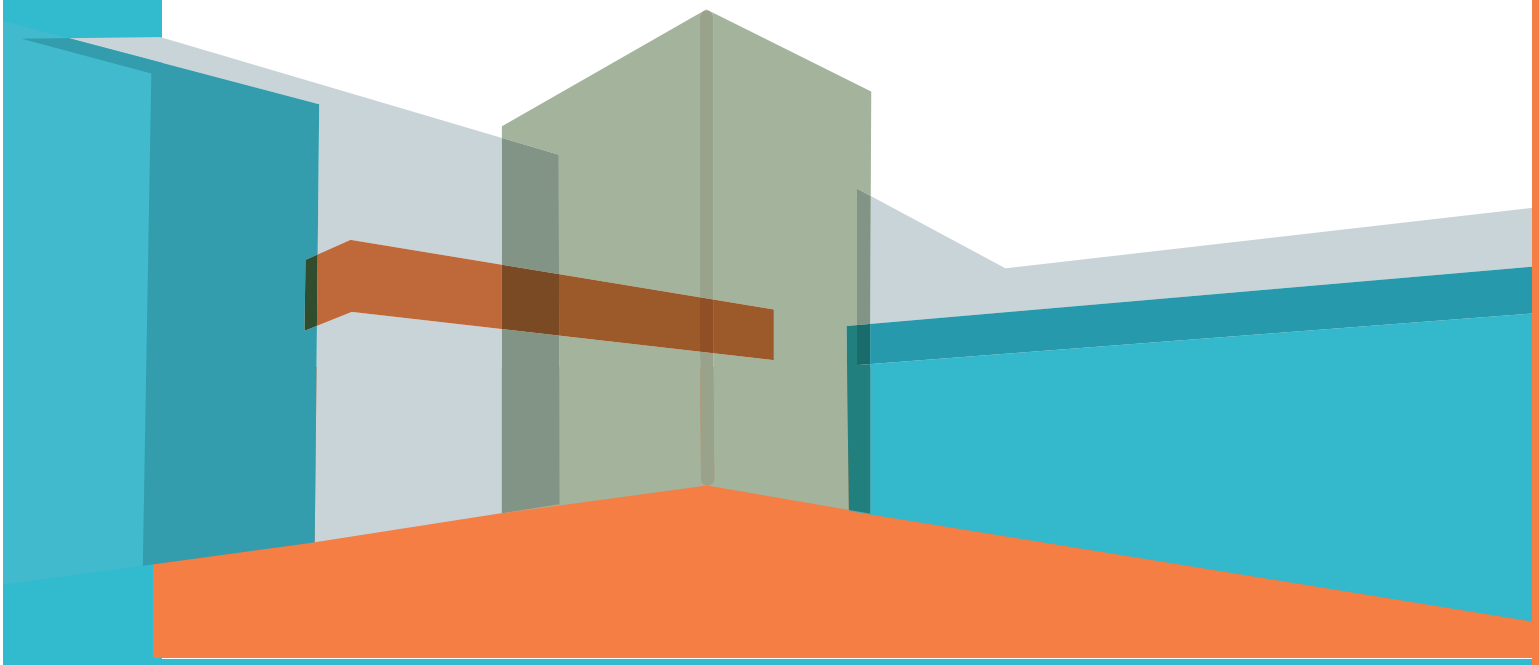
École secondaire Michel-Gratton

Project Highlights



École secondaire Michel-Gratton

Project Highlights

École secondaire Michel-Gratton is one of the most energy-efficient schools in Ontario, designed to use 51% less energy than a conventional school, and to achieve a remarkable 87% indoor water savings.

A LEED Gold candidate, École secondaire Michel-Gratton is far from a traditional school design. This design is highly tailored to the needs of the school, while looking for every possible opportunity to create a high-performance, energy-efficient building within budget. This design exemplifies technical innovation and performance excellence for schools across the country, and is part of a progression of energy-efficient LEED certified schools built by this school board. Furthermore, this landmark school design was completed on time and on budget.

Located in Windsor, Ontario this secondary school features ground source heat pumps and a horizontally bored ground heat exchanger to provide radiant floor heating for classrooms, ventilation conditioning, and cooling for select spaces. The building also features an efficient ventilation system in the form of a dedicated outdoor air system with heat recovery and variable refrigerant flow (VRF) heat pumps for spaces with special requirements.

The traditional square school does not have as much daylighting potential as a more extended, open footprint such as the V-shaped design at École secondaire Michel-Gratton. In addition, good engineering practice of optimizing building orientation (minimizing the east and west exposures) helped reduce solar cooling loads and solar glare. Two inexpensive energy-saving strategies at this school are daylighting sensors that turn off lights when natural daylight permits, and occupancy sensors that turn lights off when a space is unoccupied.

École secondaire Michel-Gratton features displacement ventilation with floor-level supply of conditioned 100% outside air. Ventilation air is supplied low, and rises through the occupied zone, eventually being exhausted from the ceiling. This allows a reduction in the volume of outdoor air that must be brought into the building, since nearly all of the ventilation air is reaching the occupants. Ventilation air is supplied by dedicated outside air units, not by the heating and cooling system. These ventilation units pre-condition incoming air using heat and moisture recovered from outgoing exhaust to significantly reduce the energy cost to condition outside air.

Achieving an energy efficient design and meeting the Conseil scolaire Viamonde's requirements for high indoor air quality required building on lessons from previous buildings. Rather than simply sizing air handlers for ventilation, heating, and cooling, the team's approach was to separate heating and cooling from the ventilation system. Separating these systems resulted in more efficient heating and cooling and ventilation systems, compared to conventional schools that often

Project Highlights

rely on one (often oversized) single air handling system to perform both tasks. This increases the complexity at the design stage, but still results in a functional design that is not complicated to operate. Using displacement ventilation requires more spatial coordination between mechanical designers and architects, but has the obvious benefits as described above.

Another principle of efficient ventilation is to vary the ventilation rate according to need. Rather than always ventilating a classroom at the fully occupied rate, the design of this school includes occupancy sensors which reduce ventilation to a setback level when a classroom is empty, and increase it when someone enters the room. For large spaces like the cafeteria, sensors monitor the CO_2 level in the space as an indication of the number of occupants, and adjust the ventilation level accordingly.

École secondaire Michel-Gratton is designed to achieve a 51% reduction in energy cost relative to the Model National Energy Code for Buildings. Several technologies offer an alternative to conventional school mechanical systems, and provide better comfort and control with 'right-sizing' to actual loads. The design of this school includes the following:

- ground source heat pumps with a horizontally bored ground heat exchanger
- variable refrigerant flow, air-source heat pumps condition rooms that have special requirements, e.g. computer room, administration offices
- radiant-heated floors

VRF heating and cooling systems – a new technology in Canada – are well-suited for schools, as they are compact, modular, simple to install, and available in a variety of terminal units, offering extensive temperature control by zone. VRF systems consist of an outdoor air source heat pump connected by refrigerant piping to multiple indoor fan coil or water heating units throughout the building.

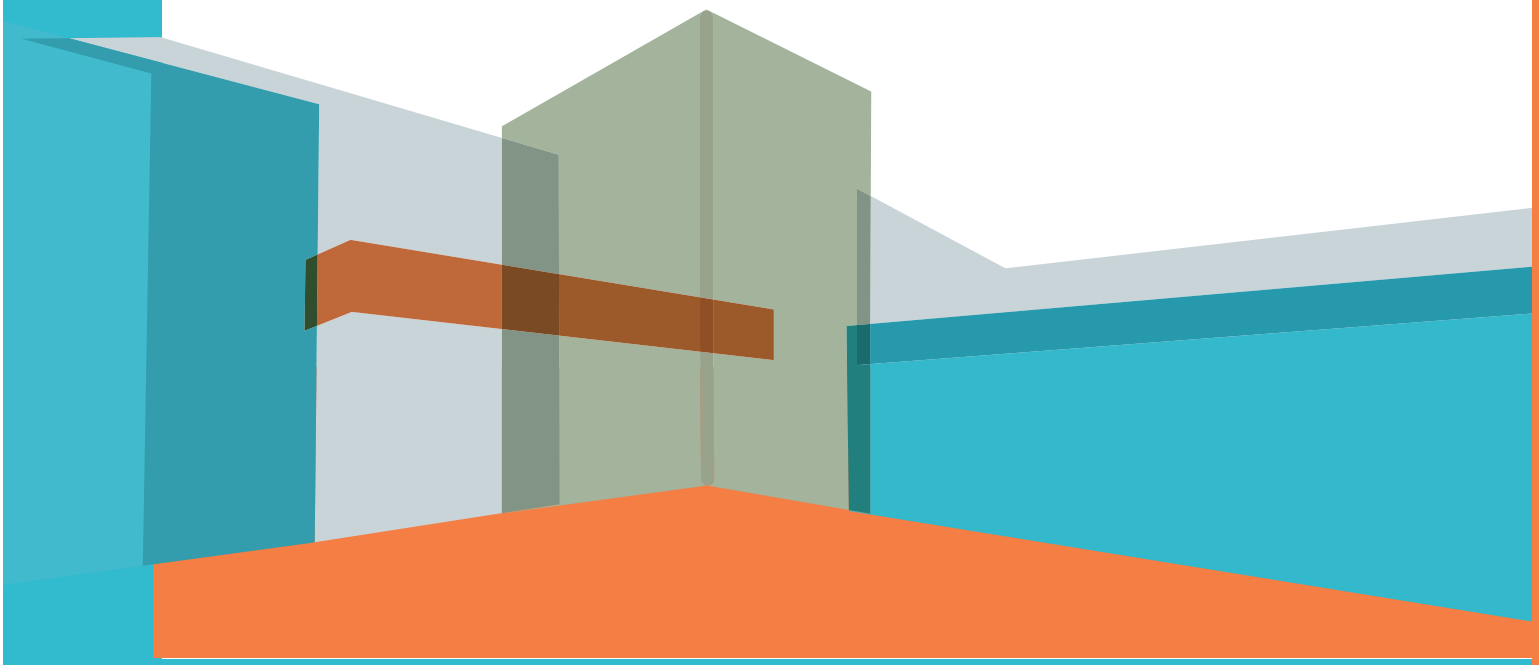
École secondaire Michel-Gratton was designed and built to achieve an 87% reduction in indoor water use supplied by the city, which represents a savings of over 2.8 million litres of potable water each year.

École secondaire Michel-Gratton has low-flow lavatory faucets, shower heads and kitchenette faucets, and low flush volume toilets and urinals. Toilets and urinals use only rainwater. The school's large, flat roof is well-suited for collecting rainwater, which is sent to a two-compartment, 22,000 litre tank with inlet strainers, an overflow weir in the tank, and a submersible pump.

As one of the most energy-efficient schools in Canada, École secondaire Michel-Gratton raises the bar for the design and construction industry. The combination of superior indoor health and wellness conditions, combined with an innovative, tailored approach to M/E design, makes this school a landmark project.

École secondaire Michel-Gratton

Full Project Description



ÉCOLE SECONDAIRE MICHEL-GRATTON is one of the MOST ENERGY-EFFICIENT SCHOOLS IN ONTARIO, designed to use 51% LESS ENERGY THAN A CONVENTIONAL SCHOOL, and to achieve A REMARKABLE 87% INDOOR WATER SAVINGS.

Located in Windsor, this secondary school features ground source heat pumps and a horizontally bored ground heat exchanger to provide radiant floor heating for classrooms, ventilation conditioning, and cooling for select spaces.

The building also features an efficient ventilation system in the form of a dedicated outdoor air system with heat recovery and variable refrigerant flow (VRF) heat pumps for spaces with special requirements.

This landmark school design was COMPLETED ON TIME AND ON BUDGET.

École secondaire Michel-Gratton

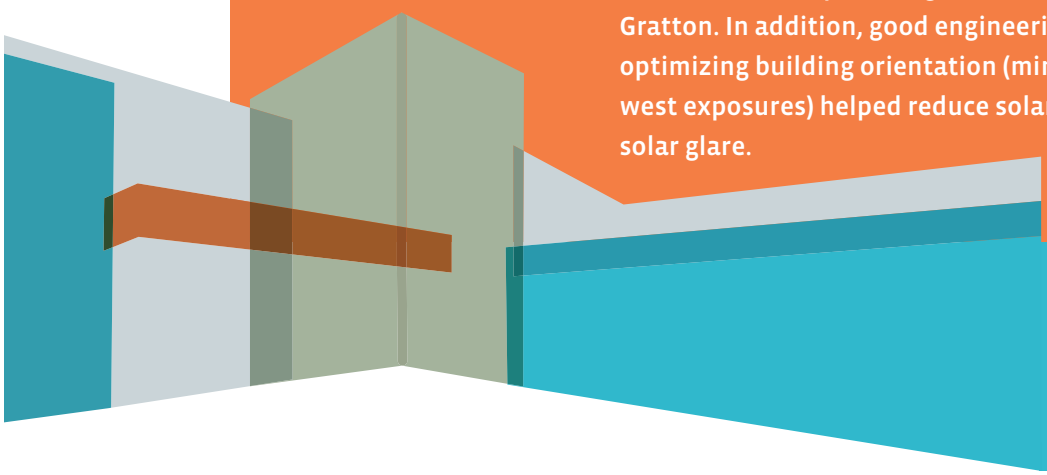
OBJECTIVE	SOLUTION	ACHIEVEMENT
Create a high performance, energy- and water-efficient school to provide a goal and benchmark for other school boards looking to create sustainable schools	• A dedicated Enermodal energy modeller created an 'energy shopping list' at the design stage to allow the design team to make informed decisions about which efficiency upgrades would have the biggest energy and savings payoffs • Created a custom mechanical and electrical design tailored to meet the needs of the building without oversizing equipment • Modified the conventional school plan to improve daylighting • Made investments in areas such as the building envelope to achieve HVAC system downsizing savings and reduce long term utility costs	• **51% energy savings compared with a conventional school designed to Model National Energy Code for Buildings (MNECB)** • **87% indoor water savings** • **One of the most energy-efficient schools in Ontario**
Create a 'living classroom' to inspire today's students to be tomorrow's sustainability and green building leaders	• Conseil scolaire Viamonde developed a green building education plan to educate students on the features of the school and their benefits	• **Students have access to an intranet website in order to access information that can be tied into the curriculum**
Meet the modest design and construction budget and ambitious time line	• Carefully selected design and technology upgrades that were not only innovative, but also financially practical with realistic payback periods	• **Mechanical and electrical costs totalled 28% of the total budget as expected by the owner, and on par with conventional school projects undertaken by the school board** • **The mechanical and electrical design, and the project as a whole, were on budget**

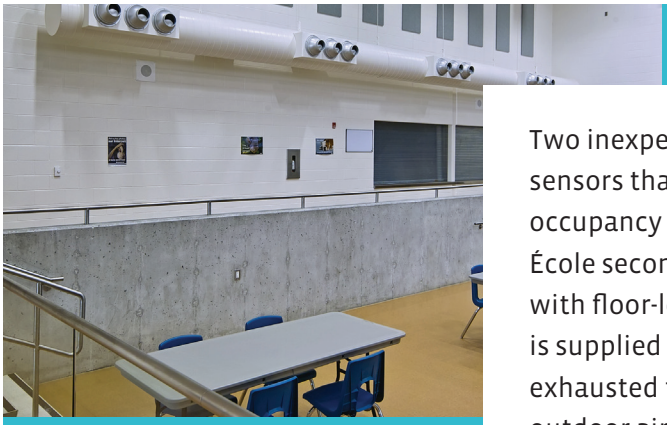
OBJECTIVE	SOLUTION	ACHIEVEMENT
Make use of innovative technologies in a landmark design that pushes the boundaries of typical school M/E design	• Used a first-of-its-kind mechanical system that combined the heating and cooling power of ground source heat pumps with supplemental heating from variable refrigerant flow heat pumps (a new technology in Canada) • A simple rainwater cistern design that reduces consumption of city water • Heat recovery on ventilation systems • Ventilation decoupled from heating and cooling systems for best possible efficiency • Energy-efficient lighting with occupancy sensors • Occupancy sensors for lighting and set back ventilation in classrooms when no one is present	• **Rather than simply adding unusual technologies to a conventional building design, the M/E team created a high performance building that includes innovative, yet proven, technologies to create a 'Green Building that Works'** • **Despite an innovative design, the building is easy to operate, and meets the desired comfort and needs of the occupants and owner**
Create a healthy, comfortable indoor environment for students, teachers, and staff	• An innovative ventilation system that not only saves energy, but creates a healthy, more comfortable indoor environment • 100% outdoor air is provided to all spaces • Ventilation is demand-controlled by occupancy or CO_2 sensors in rooms with variable occupancy to save energy during unoccupied times, and to provide enough ventilation during times of full occupancy • Radiant floor heating to provide comfortable, effective heating • Supply diffusers low on classroom walls provide displacement ventilation • Low-emitting materials were used throughout the school	• **The client has received positive feedback from the building operator and building occupants on the design of the building from a comfort and ease of operation perspective**
Achieve at least LEED Silver certification to join several other LEED certified schools for this school board	• The energy- and water-efficiency of the building helped it to achieve a significant number of LEED points	• **A LEED Canada NC Gold candidate, submitted with 41 points in mid-2011 (39 points are required for Gold)**

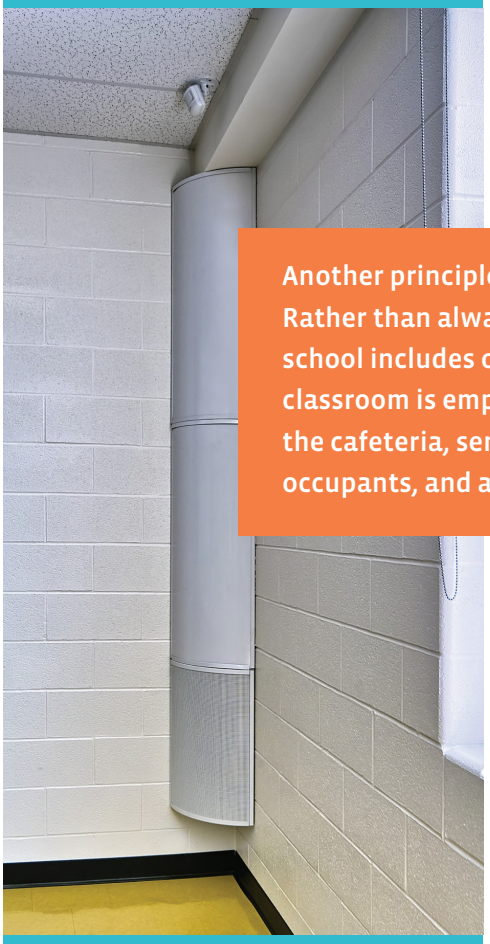
Technical Excellence and Innovation

École secondaire Michel-Gratton is far from a traditional school design. This design is highly tailored to the needs of the school, while looking for every possible opportunity to create a high-performance, energy-efficient building within budget. This design exemplifies technical innovation and performance excellence for schools across the country, and is part of a progression of energy-efficient LEED certified schools built by this school board.

The traditional square school does not have as much daylighting potential as a more extended, open footprint such as the V-shaped design at École secondaire Michel-Gratton. In addition, good engineering practice of optimizing building orientation (minimizing the east and west exposures) helped reduce solar cooling loads and solar glare.







Two inexpensive energy-saving strategies at this school are daylighting sensors that turn off lights when natural daylight permits, and occupancy sensors that turn lights off when a space is unoccupied. École secondaire Michel-Gratton features displacement ventilation with floor-level supply of conditioned 100% outside air. Ventilation air is supplied low, and rises through the occupied zone, eventually being exhausted from the ceiling. This allows a reduction in the volume of outdoor air that must be brought into the building, since nearly all of the ventilation air is reaching the occupants. Ventilation air is supplied by dedicated outside air units, not by the heating and cooling system. These ventilation units pre-condition incoming air using heat and moisture recovered from outgoing exhaust to significantly reduce the energy cost to condition outside air.

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Several technologies offer an alternative to conventional school mechanical systems, and may provide better comfort and control with 'right-sizing' to actual loads. The design of this school includes the following:

- ground source heat pumps with a horizontally bored ground heat exchanger
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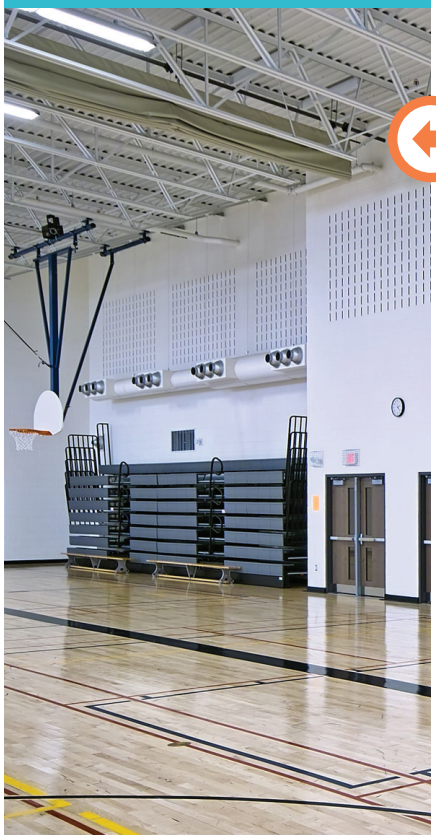
École secondaire Michel-Gratton

Lighting Design

Space Type	Average W/m²	ASHRAE 90.1-2007 (W/m²)
Office - Open	8	12
Office - Private	8.5	12
Corridors Serving Classrooms	5	5
Classrooms – Science	13.5	15
Classroom – General	12.6	15
Gymnasium	10.2	15
Library	13.3	14-15 (Reading/Stack Average)



Classroom lighting utilizes suspended direct/indirect fixtures arranged in three rows. The row of lights adjacent to the windows is controlled by a dedicated daylight sensor that switches off the window side row of lights when there is sufficient daylight; all rows are on occupancy control.

Gymnasium lighting is by tandem 4' long T5HO fixtures totalling eight lamps each. Each half gym is controlled independently, and uses occupancy sensors to keep lights off during long periods of inactivity.

Administrative office and corridor spaces use a highly optically efficient recessed 2x4' fixture with two 32W T8 lamps each. Spaces near windows have the same on/off daylight control as classrooms, and occupancy control throughout.

The library has a glass curtain wall on two sides, and uses pendent fixtures with two 42W compact fluorescent lamps. The lighting is divided into three zones, and is turned on/off by a multi-zone daylight controller. As the daylight begins to penetrate further into the space, the controller turns off more zones of lighting.

Project Complexity

Schools are a natural fit for green design. Although school boards are often strapped with limited construction budgets, there is significant public interest in achieving healthy, productive learning environments and decreasing school operating costs. In addition to budget constraints, creating sustainable schools can be hampered by tight design and construction schedules, diverse stakeholders, and rigid, or out-dated, building standards.

Achieving an energy-efficient design and meeting the Conseil scolaire Viamonde's requirements for high indoor air quality required building on lessons from previous buildings. Rather than simply sizing air handlers for ventilation, heating, and cooling, the team's approach was to separate heating and cooling from the ventilation system. Separating these systems resulted in more efficient heating and cooling and ventilation systems, compared to conventional schools that often rely on one (often oversized) single air handling system to perform both tasks. This increases the complexity at the design stage, but still results in a functional design that is not complicated to operate. Using displacement ventilation requires more spatial coordination between mechanical designers and architects, but has the benefits of improving indoor air quality and decreasing fan energy.

École secondaire Michel-Gratton has low-flow lavatory faucets, shower heads and kitchenette faucets, and "low-flow" toilets and urinals. Toilets and urinals use only rainwater. The school's large, flat roof is well-suited for collecting rainwater ,which is sent to a two-compartment, 22,000-litre tank with inlet strainers, an overflow weir in the tank, and a submersible pump.

Environmental Benefits

Conseil scolaire Viamonde is committed to the principles of green building, and has embraced the LEED certification program, applying for LEED Gold certification for École secondaire Michel-Gratton.

École secondaire Michel-Gratton was designed and built to achieve an 87% reduction in indoor water use supplied by the city, which represents a savings of over 2.8 million litres of potable water each year.

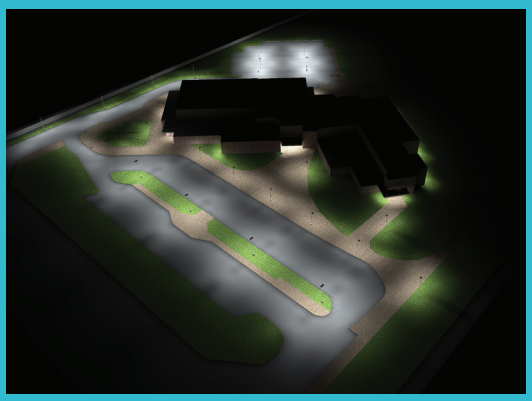
Outdoors, planting drought-tolerant species eliminated the need for a permanent irrigation system. Rainwater collected in an underground cistern is available to help establish landscape plantings during the startup years.

École secondaire Michel-Gratton is designed to achieve a 51% reduction in energy cost relative to the Model National Energy Code for Buildings. Energy conservation measures include the following:

- Heat recovery ventilators on numerous HVAC systems
- Demand control ventilation (occupancy sensors and CO_2) on some HVAC systems
- Increased insulation levels in walls and roofs
- High-performance windows
- Efficient lighting design and extensive use of occupancy sensors
- Ground source heat pump providing heating and cooling
- Radiant floors for heating
- Condensing domestic hot water heater and boilers

In terms of material savings, a recycling area is provided in the shipping/receiving area where waste can be collected, separated and stored. During construction, the project's Construction Waste Management Program successfully diverted 87% of the construction debris from landfill. Also, a significant portion of the school is constructed from recycled and regional materials.

Social and Economic Benefits



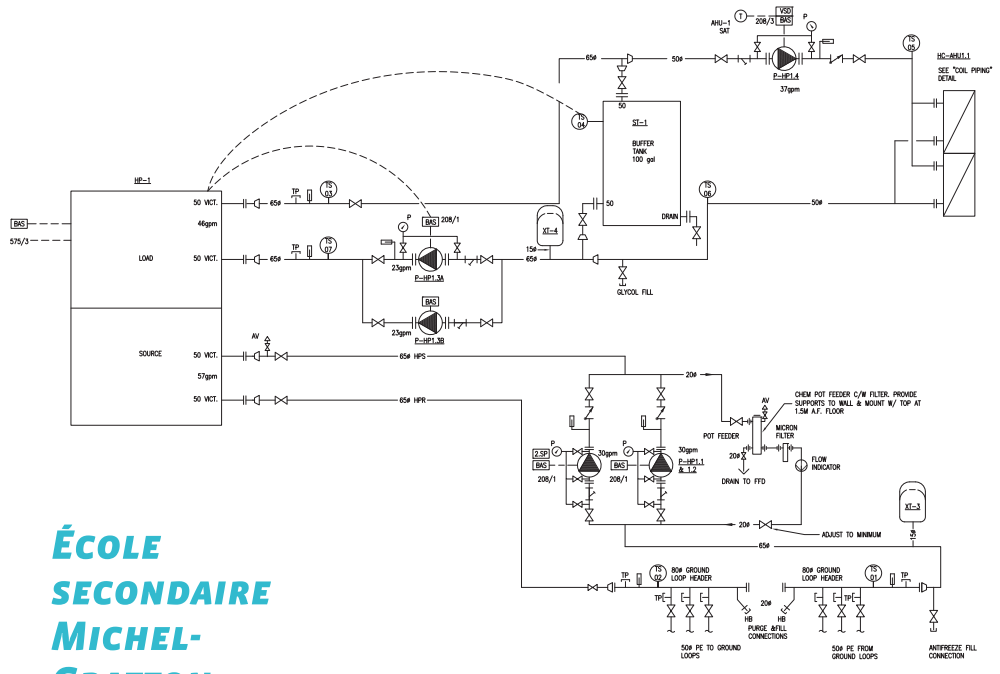
A rendering of the site lighting simulation used to optimize lighting design and ensure no light trespasses on adjacent property and there is no light pollution of the night sky.

The construction team implemented an indoor air quality management plan during construction. This initiative improved the air quality for the construction team and for building occupants. The building was tested for contaminants prior to students occupying the facility.

A Green Housekeeping Program has been implemented at this facility, focusing on green cleaning techniques, and using only Green Seal certified cleaning products.

A Green Education Plan has been created which includes holding building tours for students and members of the public, posting signage throughout the school highlighting building features, educational literature regarding green building, and an internal website for the students containing information on green building technologies, and animations demonstrating how these technologies work.

As one of the ***MOST ENERGY-EFFICIENT SCHOOLS IN CANADA****, École secondaire Michel-Gratton* ***RAISES THE BAR FOR THE DESIGN AND CONSTRUCTION INDUSTRY****. The combination of* ***SUPERIOR INDOOR HEALTH AND WELLNESS*** *conditions, and an* ***INNOVATIVE, TAILORED APPROACH TO M/E DESIGN****, makes this school a* ***LANDMARK PROJECT****.*



ÉCOLE SECONDAIRE MICHEL-GRATTON

Schematic of the heat pump that serves 100% outdoor air ventilation

École secondaire Michel-Gratton

LEED Scorecard

Total Project Score: 41 — Possible Points **70**

Certified 26 to 32 points **Silver** 33 to 38 points **Gold** 39 to 51 points **Platinum** 52 or more points

7 Sustainable Sites — Possible Points 14

Y	Prereq 1	**Erosion & Sedimentation Control**	
1	Credit 1	**Site Selection**	1
	Credit 2	**Development Density**	1
	Credit 3	**Redevelopment of Contaminated Sites**	1
	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
	Credit 4.3	**Alternative Transportation**, Hybrid and Alternative Fuel Vehicles	1
1	Credit 4.4	**Alternative Transportation**, Parking Capacity	1
	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
	Credit 6.1	**Stormwater Management**, Rate and Quantity	1
	Credit 6.2	**Stormwater Management**, Treatment	1
1	Credit 7.1	**Heat Island Effect**, Non-Roof	1
1	Credit 7.2	**Heat Island Effect**, Roof	1
1	Credit 8	**Light Pollution Reduction**	1

5 Water Efficiency — Possible Points 5

1	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
1	Credit 2	**Innovative Wastewater Technologies**	1
1	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

9 Energy & Atmosphere — Possible Points 17

Y	Prereq 1	**Fundamental Building Systems Commissioning**	
Y	Prereq 2	**Minimum Energy Performance**	
Y	Prereq 3	**CFC Reduction in HVAC&R Equipment and Elimination of Halons**	
7	Credit 1	**Optimize Energy Performance**	10
	Credit 2.1	**Renewable Energy**, 5%	1
	Credit 2.2	**Renewable Energy**, 10%	1
	Credit 2.3	**Renewable Energy**, 20%	1
	Credit 3	**Best Practice Commissioning**	1
1	Credit 4	**Ozone Protection**	1
1	Credit 5	**Measurement & Verification**	1
	Credit 6	**Green Power**	1

7 Materials & Resources — Possible Points 14

Y	Prereq 1	**Storage & Collection of Recyclables**	
	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors and Roof	1
	Credit 1.2	**Building Reuse**, Maintain 95% of Existing Walls, Floors and Roof	1
	Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-structural Elements	1
1	Credit 2.1	**Construction Waste Management**, Divert 50% From Landfill	1
1	Credit 2.2	**Construction Waste Management**, Divert 75% From Landfill	1
1	Credit 3.1	**Resource Reuse**, 5%	1
1	Credit 3.2	**Resource Reuse**, 10%	1
1	Credit 4.1	**Recycled Content**, 7.5% (post -consumer + 1/2 post-industrial)	1
1	Credit 4.2	**Recycled Content**, 15% (post -consumer + 1/2 post-industrial)	1
	Credit 5.1	**Regional Materials**, 10% Extracted and Manufactured Regionally	1
	Credit 5.2	**Regional Materials**, 20% Extracted and Manufactured Regionally	1
	Credit 6	**Rapidly Renewable Materials**	1
1	Credit 7	**Certified Wood**	1
	Credit 8	**Durable Building**	1

8 Indoor Environmental Quality — Possible Points 15

Y	Prereq 1	**Minimum IAQ Performance**	
Y	Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	
	Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
	Credit 2	**Ventilation Effectiveness**	1
1	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
1	Credit 3.2	**Construction IAQ Management Plan**, Testing Before Occupancy	1
1	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1	Credit 4.2	**Low-Emitting Materials**, Paints and Coatings	1
1	Credit 4.3	**Low-Emitting Materials**, Carpet	1
1	Credit 4.4	**Low-Emitting Materials**, Composite Wood and Laminate Adhesives	1
	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
	Credit 6.1	**Controllability of Systems**, Perimeter Spaces	1
	Credit 6.2	**Controllability of Systems**, Non-Perimeter Spaces	1
1	Credit 7.1	**Thermal Comfort**, Compliance with ASHRAE 55-2004	1
1	Credit 7.2	**Thermal Comfort**, Monitoring	1
	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

5 Innovation & Design Process — Possible Points 5

1	Credit 1.1	**Innovation in Design**: Exceptional Performance, Water Efficiency	1
1	Credit 1.2	**Innovation in Design**: Green Housekeeping	1
1	Credit 1.3	**Innovation in Design**: Exceptional Performance, Regional Content	1
1	Credit 1.4	**Innovation in Design**: Green Building Education	1
1	Credit 2	**LEED™ Accredited Professional**	1