A case study assessment of the energy consumption of LEED certified academic buildings in Ontario:

Is LEED certification necessarily better?

by

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A thesis

presented to the University of Waterloo

in fulfillment of the

thesis requirement for the degree of

Master of Environmental Studies

in

Sustainability Management

Waterloo, Ontario, Canada, 2015

Author's Declaration

Abstract

With “commercial and institutional buildings account[ing] for 12% of Canada’s secondary energy use and 11% of [the] national greenhouse gas emissions” (National Resources Canada, 2014), the energy consumption of Canada’s non-residential buildings plays a large role in both climate change and overall energy usage. Making these buildings more energy efficient provides opportunity to reduce both Canadian energy use and the overall effects of climate change from building construction and operation. The LEED New Construction v1 rating system stresses the importance of a building’s energy efficiency by designating 25% of its points towards energy reduction opportunities providing clear indication of the CaGBC’s belief in the potential for LEED certified buildings to reduce overall energy consumption in new buildings.

As LEED certified buildings have been constructed for over a decade in Canada, there are opportunities to assess how these buildings are performing from an energy perspective in comparison to provincial averages. This study looks at LEED certified academic buildings in Ontario and evaluates their energy intensity in comparison to provincial survey averages, broad public sector data made available by the Green Energy Act, campus-wide energy intensities, and additionally assesses their actual energy performance in comparison to the modelled energy results submitted for final LEED certification.

The results of this research show that the studied LEED certified academic buildings on average perform better than both their provincial average and campus-wide energy intensities. The energy modelled results provided for LEED certification on each building under-predicts the energy intensity of the building anywhere from 2 – 44%. Additionally, the results of this research demonstrate the need for better energy surveys and energy benchmarking practices across Ontario. The study aims to aid academic decision-makers in setting reasonable benchmarks for energy intensity targets and to provide recommendations for national benchmarking authorities, the CaGBC and USGBC, as well as energy modelling professionals.

Keywords: CaGBC, USGBC, LEED, energy intensity, energy modeling, academic institution, energy efficiency, benchmarks, Green Energy Act, BPS data

Acknowledgements

Firstly, I would like to thank Professor Geoffrey Lewis for his on-going support, wisdom, amazing sense of humour, friendship, and endless guidance throughout this process. Without you my head would have exploded countless times and my experience at the University of Waterloo would not have been the same.

Secondly, a very large thank you to my committee member Professor Paul Parker for aiding in strengthening this research and pushing for more answers. A very large thank you to my reader, Dr. John Straube, for taking the time to go through my thesis and for providing constructive insight. Your knowledge and expertise on building performance has been highly regarded and discussed in our household for years. Thank you to all of the SEED faculty and my fellow SUSM colleagues for your broad knowledge, expertise and drive for a sustainable future. My depth of intellect has been significantly impacted by my time spent in the sustainability management program.

Thirdly, thank you to all of the contributors to my data collection (there are a lot of you). I could not have completed this research and case studies without all of the wisdom, expertise and data provided by countless energy professionals and academic institutions.

Lastly, thank you to the following people/groups/frivolities which made this thesis possible:

Chris Hadlock for your support, editing, and constant knowledge/input · My family for supporting me every step of the way with this thesis · University of Waterloo · Katherine MacLean for all of her hard work behind the scenes of the SUSM program · all forms of caffeine · CaGBC & USGBC · EQuest/EE4 · Microsoft Office · DropBox · Randy Van Straaten for your LEED and M&V help · my body & mind for making it through these past two years · MMM - specifically Antoni Paleshi, Victor Halder, & Arash Ghorayshi for your unparalleled knowledge · Holly Samuelson for your energy modeling expertise · study participants - Western University, McMaster University, Algonquin College & Lakehead University for the valuable information you provided · my Lenovo for surviving my thesis without avail · my friends and colleagues for trying to make this world better one research project at a time.

Dedication

I dedicate my thesis to the most important companions in my life:

my husband Chris for his love, support, and understanding through these past two years;

my family, friends, and extended family for their on-going support;

and my lovable fur-babies – Casey and Bailey.

Without your endless support throughout this crazy journey this thesis wouldn’t have been written and my thirst for knowledge quenched (for now...). May there be many more of these exciting turns in the future so that we can continue to grow and learn together.

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List of Abbreviations and Acronyms

ASHRAE – American Society of Heating, Refrigerating, and Air-Conditioning Engineers

CaGBC – Canada Green Building Council

CBECS – Commercial Building Energy Consumption Survey

CDD – Cooling degree day

CES 2003 – Consumption of Energy Survey for Universities, Colleges and Hospitals 2003

CIBEUS 2000 – Commercial and Institutional Building Energy Use Survey 2000

CICES 2005 – 2005 Commercial and Institutional Consumption of Energy Survey

CICES 2008 – 2008 Commercial and Institutional Consumption of Energy Survey

EAp2/EAc1 – LEED Energy and Atmosphere Prerequisite 2/Credit 1 – Energy Optimization

EAc5 – LEED Energy and Atmosphere Credit 5 – Measurement & Verification

ECMs – Energy conservation measures

ekWh – equivalent kilowatt hours

EO – Executive Order

FIT – Feed-in-Tariff program

GFA – gross floor area

GHG – Greenhouse gas

HDD – Heating degree day

HEI – high energy intense

HPNC – High Performance New Construction program

IESO – Independent electricity system operator

IPMVP – International Performance Measurement and Verification Protocol Volume 1

LEED - Leadership in Energy and Environmental Design

LEED NC v1 - LEED Canada for New Construction and Major Renovations version 1.0

MEI – medium energy intense

M&V – Measurement and verification

NBI – New Buildings Institute

NRCan – Natural Resources Canada

OBC – Ontario Building Code

SCIEU 2009 – Survey of Commercial and Institutional Energy Use 2009

USGBC – U.S. Green Building Council

Chapter 1: Introduction

1.1 Research Background

1.1.1 Defining Sustainability for Buildings

For the past 30 years the notion of sustainability has been discussed and debated worldwide. In the 1980s the characterization of the term “sustainability” really began to take form and in 1987 *Our Common Future,* more commonly known as *The Brundtland Report,* was released defining sustainable development [as] “development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 41). With the world population increasing, as well as a rise in the population density of cities, the sustainable development of buildings became an important issue in the late 20th century. We now know the significance of buildings in the context of environmental impact, as “buildings generate up to 35 percent of all greenhouse gases, 35 percent of landfill waste, and 80 percent of all water consumed. It [is] clear that making buildings greener [can] have a significant impact on larger environmental goals” (CaGBC, 2013). From the 1980s to the late 1990s, there was no prescribed standard of what made a building sustainable (as distinct from more energy efficient) nor were there mandated construction practices which alleviated some of the environmental burdens associated with development.

In 1993 the U.S. Green Building Council (USGBC) was established by Rick Fedrizzi, David Gottfried, and Mike Italiano “to promote sustainability in the building and construction industry” (USGBC, 2014). Once the USGBC was formed, discussions with over sixty (60) firms and non-profit organizations surrounding a sustainable construction industry began and ultimately led to the development of a new green building rating system. The Leadership in Energy and Environmental Design (LEED®) program was created by the USGBC in 2000 to precipitate change in the construction industry by providing guidance on how to implement green building practices, within the framework of a green rating system.

1.1.2 Canadian LEED Rating System

In the early 2000s, various US LEED rating systems were established for specific building types and different construction processes. In 2004, the “first LEED rating system adapted for Canada-wide use was [launched,] the LEED Canada for New Construction and Major Renovations version 1.0” (CaGBC, 2010, p. xiv), abbreviated as LEED NC v1. The Canadian rating system, which was an adaptation of the US rating system, was changed to reflect Canada’s climate, regulation, and building codes. LEED NC v1 will be used throughout this study as it is the most-often used green rating system in the Canadian construction industry due to its applicability to almost all project-types seeking certification. The LEED NC v1 rating system allows owners, architects, engineers, and other building professionals to register their new buildings with the Canada Green Building Council (CaGBC) and throughout the design and construction process they can aim to achieve up to 70 LEED points in six (6) categories (see Table 1 below and Appendix A: LEED Rating System Categories and Points for a full listing of credits and categories). The more points the building attains, the higher its certification level and, in theory, the more sustainable the building.

Table 1: LEED Points Distribution Table

CREDIT CATEGORY	AVAILABLE POINTS	% OF POINTS
Sustainable Sites	14	20%
Water Efficiency	5	7%
Energy and Atmosphere (Optimize Energy Performance)	17 (10)	24% (14%)
Materials and Resources	14	20%
Indoor Environmental Quality	15	21%
Innovation in Design	5	7%
TOTAL	**70**	**100%**[1]

[1] The sum total of the percentages for each credit category sums to 99% due to rounding.

A simple depiction of the entire LEED certification process for LEED NC v1 is shown in Figure 1 below. The first step is for the building owner and team to decide to pursue LEED certification in the early stages of the project. Throughout the design phase a pathway to achieve LEED is created and LEED credits are documented through both the construction documentation and construction phases. After construction is completed a final LEED submission package is sent to the CaGBC for review and auditing. Once the building has satisfactorily passed through the CaGBC audit LEED certification can be awarded to the building. Some credits, such as measurement and verification or thermal comfort, are evaluated for at least one (1) year post-occupancy.

Figure 1: LEED Certification Process

1.1.3 Energy Efficiency

Starting with the energy crisis in the 1970s, energy has become a leading concern worldwide. In 1975 the province of Ontario released the first Ontario Building Code (OBC) to define the minimum construction and energy efficiency requirements of new buildings. "The purpose of the [OBC] is to set minimum standards for construction to minimize the risk to the health and safety of the occupants of a building and to provide for the barrier-free accessibility into a building and the energy efficiency of that building" (OBOA, 2014). Since the inception of the OBC in 1975 there have been five (5) new editions – 1983, 1986, 1990, 2006, and 2012. In each new edition of the OBC, the prescribed energy efficiency standards have become more stringent - greater amounts of insulation are prescribed in the roof, floor and walls of the new buildings, improved window performance, smaller window-to-wall ratios, higher mechanical equipment efficiencies, reduced lighting allowances, and more airtight construction. The impact of reducing building energy consumption is significant as "buildings [in developed countries such as Canada] account for 20-40% of total energy use. Besides the depletion of non-renewable energy sources, this energy use contributes greenhouse gases to the atmosphere, with consequent detrimental effects" (Newsham et al., 2009, p. 897).

The LEED NC v1 rating system, aligned with the OBC, stresses the importance of a building's energy efficiency. Per the LEED Points Distribution Table (Table 1: LEED Points Distribution Table), approximately 25% (17 out of 70 points in the LEED NC v1 rating system) are in the energy and atmosphere category, of which energy optimization (energy modelling) is 14% of the total points. In the subsequent version of the rating system, LEED NC v2009, there is even more importance given to the energy and atmosphere category - 32% of the points, of which energy optimization is 17% of the total points. There is also the potential of earning even more energy points should the project decide to apply for innovation in design credits or regional priority credits attributed to energy savings. With “commercial and institutional buildings account[ing] for 12% of Canada's secondary energy use and 11% of [the] national greenhouse gas emissions” (National Resources Canada, 2014), the energy consumption of Canada's non-residential buildings plays a large role in both climate change and overall energy usage. Making these buildings more energy efficient provides opportunity to reduce both Canadian energy use and the overall effects of climate change from building construction and operation. The USGBC and CaGBC decision that approximately 20-25% of the LEED rating system should be designated towards energy reduction opportunities provides clear indication of their belief in the potential for LEED certified buildings to reduce overall energy consumption in new buildings.

1.1.4 Documentation Practices for Building Energy Performance

In Ontario, the current practice in documenting energy efficiency compliance for both building code (OBC) and green rating systems falls to the energy modeller who creates computer simulations of the building based on either the design drawings (for building code compliance) or the construction drawings and shop drawing submittals (for LEED compliance). These models reflect the intended building performance, not the actual ‘as built’ building performance. None of the current practices make it mandatory to complete a ‘post-occupancy’ energy model or update the model based on the actual energy use of the building post-construction (with the exception of the LEED M&V credit, EAc5). It is common knowledge that during the construction process alternative materials are used, designs are changed, and systems such as lighting or heating and ventilation equipment do not operate as they should due to less than perfect building commissioning and verification. All of these things can drastically change the energy consumption of a building and, were they incorporated in the model, would change the simulated model results, and the LEED points achieved, as well as the ability of a building to meet code. In other words, past and current LEED rating systems award points based on designed building operation, not actual building performance.

In order to meet the definition (and the intention) of sustainable development, actual building performance is what counts. Anticipated building performance as documented by energy models should not be the key metric for energy performance points or building code compliance – instead energy models should be used as a good preliminary estimate of how many LEED points a building could receive or give an indication of whether a building could meet building code. There should be some form of accountability after the building has been constructed to truly see how the building performs in its environment in order for a building rating to be a valid sustainability metric. Updating the energy model based on a post-occupancy analysis offers many advantages including helping the energy modeling professionals create more accurate building simulations going forward, ensuring that LEED energy points are awarded for actual energy performance, and ensuring that a building's passing or failing grade for building code is justified.

1.1.5 Measuring Building Performance

To do a post-occupancy analysis of a building in order to determine the actual building performance, a process called measurement and verification (M&V) is used. Energy and water meters are added to the building to measure the actual amount of energy and water used. A single energy or water meter can suffice to determine the overall energy and water consumption of an entire building, but ideally separate meters are installed for different end uses such as lighting loads, plug loads, or process loads. By providing additional metering there is an enhanced ability to identify and troubleshoot potential building issues. If multiple meters are used, the data from these meters are typically uploaded to a server and analyzed by an M&V consultant on a regular basis – monthly, quarterly, or annually. The M&V consultant has the ability and responsibility to identify any possible issues in the building's performance. Single meter data can also provide some insight on how the building is performing, but the ability to identify or troubleshoot issues within the building is significantly reduced.

The energy usage or energy intensity (energy per unit of floor area) data for a given building can be benchmarked by comparing them to energy performance databases, such as Natural Resources Canada and Statistics Canada's energy surveys. In the field of sustainability and energy efficiency consulting, it is common practice to compare post-occupancy data of new buildings to these energy surveys as a benchmarking procedure, though in academia this practice is frowned upon as the surveys provide energy intensity averages of the entire building stock and not equivalent (new) buildings. In this way, one can determine how a building is performing in comparison to other similar buildings in Canada. The M&V data can also be used to generate what is known as a calibrated simulation. A calibrated simulation is a computer model of the building that reflects actual weather conditions, building design, usage, mechanical schedules, lighting schedules and process loads. This type of simulation provides far more accurate results than a typical LEED energy model as real data (post-occupancy) are used to calibrate the model. With the calibrated simulation, energy conservation measures (ECMs) can be modeled to show the building owner how much energy or cost savings were (or could be) achieved by implementing different measures or by making slight changes to the building's current operating parameters.

1.2 Motivations

As a practitioner of sustainability and energy efficiency, I found a literature gap on the energy benefits associated with LEED certified buildings in Canada. It is particularly difficult to convince clients to pursue a green rating system that has no substantiated evidence of energy performance benefits and so I decided to assess the potential benefits for academic institutions to achieve LEED certification. Additionally, as a LEED practitioner, I have observed the disconnect between LEED certification during construction and actual building operation once the building has been handed over to the owners. There is a risk to the CaGBC and USGBC that, if this disconnect continues, the current perception of LEED as a valid and advantageous green building label will become discredited.

LEED certified “buildings [are supposed to] create a healthier working environment for staff and tenants, through better air ventilation and more natural daylight. [They should] reduce waste, conserve energy, decrease water consumption, and drive innovation” (CaGBC, 2013). In order to ensure that these buildings are performing as they are intended, there need to be better metrics and processes in place to prove that there is, in fact, a measurable environmental benefit resulting from the LEED certification process. However, there seems to be a large divide between the benefit of energy efficiency and sustainability metrics associated with a building design and the actual operation and ownership of a building.

Green rating systems, such as LEED, provide sustainability benchmarks for buildings, but cannot be seen as absolute indicators of sustainability. “For many years it was commonly assumed that a LEED-certified building saved energy, though little performance data were available to confirm this assertion” (Scofield, 2013, p. 517). With the LEED Rating System having existed as part of building construction practices for over 10 years now, building data are available to determine how well these buildings are actually performing in comparison to other buildings. By analysing actual building energy data from various LEED certified buildings, more conclusive and evidence-based decisions can be made by clients to determine whether LEED sustainability metrics should be implemented into their designs.

The energy use of a building estimated during the design and construction phase for LEED certification and documentation does not accurately reflect the actual usage of a building post-occupancy. Unaware of the difference between a calibrated simulation and the LEED compliance simulation, building owners are likely to think that the energy consumption estimates documented for LEED credits EAp2 and EAc1 will be reflected in their actual consumption. However, evidence indicates this is not usually the case – the actual consumption is usually much higher than the simulation results and the savings in the energy models are comparisons to a baseline standard. Hence, there seems to be a misunderstanding of the predicted or modeled energy usage that results from a computer model during the LEED process – results that owners and operators then compare to actual consumption. One of the goals of this study is to identify the potential discrepancies between modeled energy use and actual energy use to raise awareness to the fact that there are usually large differences between the two (2) values.

While there is current academic literature on the energy performance of LEED certified buildings in the United States (Newsham et al. (2009); Scofield (2009); Kleinhenz et al. (2012); Menassa et al. (2012); Oates and Sullivan (2012); Scofield (2013)), there are current gaps in the knowledge surrounding building performance in both academic buildings as well as LEED certified buildings in Canada. Building type, geographical location, and climate play a role in the energy usage of buildings and a study within Ontario for academic buildings is needed so that universities and colleges can make educated decisions as to whether LEED certification is necessary or beneficial to meeting internal energy performance goals. For this reason, an additional goal of this study is to assess the performance of academic institutions in Ontario in order to help fill this knowledge gap.

1.3 Objectives

The main objective of this study is to determine the actual energy intensity of LEED certified academic buildings in Ontario and compare their energy performance to the average energy performance of Ontario academic buildings, current energy surveys, and modeled energy consumption. The results will aid academic institutions by identifying issues with the current energy benchmarking and LEED processes. Academic buildings were selected based on my experience in and with post-secondary buildings at various institutions across Ontario and as it was the largest classification of building types for universities and colleges. There have been many difficulties and issues faced by practitioners and occupants in this type of facility that need to be addressed through research. Some recommendations to remediate the issues identified in this research will be provided.

This objective will be achieved by answering the following questions:

1. Do LEED certified academic buildings in Ontario have lower energy intensities than the average Ontario academic building?
2. Are government energy surveys and Broad Public Sector data useful tools as metrics of comparison for the energy intensity of academic buildings?

3. How accurate is the energy modelling for LEED certification in comparison to actual building energy usage?

By identifying issues within the current benchmarking and LEED certification processes it is the author’s intention to provide recommendations to the Ministry of Energy, Natural Resources Canada and Statistics Canada, the CaGBC and USGBC, energy modellers, and academic decision makers.

1.4 Thesis Organization

The remainder of this thesis is organized into the following sections:

Chapter 2: Literature Review assesses, summarizes, and critiques previous studies and published documents that have been completed on similar topics related to this research.

Chapter 3: Methods discusses the data used in this research and the analysis methods used. It also discusses limitations to the study.

Chapter 4: Results and Discussion summarizes the results of the study and discusses the relevance, importance, and applicability of the analysis in detail.

Chapter 5: Conclusions and Recommendations present conclusions and next steps for further research.

Chapter 2: Literature Review

Academic institutions are increasingly faced with the decision as to whether or not they should utilize green rating systems, such as LEED, to guide the development and construction of new buildings on campus. The decision to pursue a green rating system is made through careful review of internal policies, institution goals, and marketing advantage. While there have been a number of studies (Newsham et al. (2009); Scofield (2009); Kleinhenz et al. (2012); Menassa et al. (2012); Oates and Sullivan (2012); Scofield (2013)) that have posed the question *how energy efficient are LEED certified buildings?,* the results are contradictory and are not specifically relevant to the geographic location, climatic conditions, and building types proposed in this research as all of these factors contribute to the energy usage of the associated buildings. As each of the aforementioned factors can have a great effect on energy use, this research aims to fill a knowledge gap by supplying decision makers at academic institutions in Ontario with new information that will allow meaningful decisions to be made in regards to the pursuit of LEED certification of their buildings.

This chapter summarizes previous academic research on the topic of energy performance of LEED certified buildings, discusses the current energy benchmarks available nationally, and reviews findings from previous research on the accuracy of building energy models.

2.1 Energy Performance of LEED Certified Buildings

Many buildings that have been designed and certified using the LEED NC v1 rating system have been occupied and in use for several years. Actual measured data from these buildings can be used to determine if LEED buildings consume less energy than their non-LEED equivalents and national/regional averages. Over the past five (5) years, various researchers have published papers on their findings surrounding the actual building energy use of LEED certified buildings.

Newsham et al. (2009) re-examined data supplied by the New Buildings Institute (NBI) and US Green Building Council (USGBC) on 100 LEED certified commercial and institutional buildings located in the United States. Their findings showed that “on average, LEED buildings used 18-39% less energy per floor area than their conventional counterparts” (Newsham et al., 2009, p. 897). These results align well with the intent of the LEED rating system to lower building energy usage and therefore minimize carbon emissions. “However, [it was also concluded in this study that] 28-35% of LEED buildings [actually] used more energy than their conventional counterparts” (Newsham et al., 2009, p. 897) demonstrating that not all LEED certified buildings are high performance structures in operation.

Given the point structure of the LEED certification process, it is implied that the more LEED points a building achieves and the higher the level of certification (certified, silver, gold or platinum), the more sustainable the building. Newsham et al. (2009) found that “the measured energy performance of LEED buildings had little correlation with certification level of the building, or the number of energy credits achieved by the building at design time” (p. 897). This implies that the pursuit of higher levels of certification (usually at larger capital costs from personal experience) is not necessary in order to achieve better energy performance.

While one of the primary intents of the LEED rating system is to reduce energy use, the conclusions of this study illustrate that while the LEED rating system aims to provide more sustainable and energy efficient buildings, not all will be performing as desired. In general, the outlook seems positive in that LEED buildings were shown on average to use less energy than their non-LEED equivalents, yet in some specific cases the LEED buildings actually consumed far more energy. “While this might not be a problem for society, it is clearly a problem for the owner/operators of these individual buildings, who are not realising the energy performance that they (presumably) expected” (Newsham et al., 2009, p. 903) and also paid to achieve.

Scofield (2009) further analysed the study and results produced by Newsham et al. (2009) as well as the raw data provided by the NBI. While the results of Newsham’s study showed that LEED certified buildings in general used less energy than their counterparts, Scofield (2009) points out that the Newsham’s (2009) study only looked at on-site energy use, and not source energy. Source (or primary) energy includes off-site energy generation and transmission, which should be included when determining greenhouse gas (GHG) emissions associated with building operation. In order to get a true reflection of GHG emissions associated with building operation one would need to consider source energy use (Scofield, 2009).

Scofield’s (2009) results, similar to those of Newsham et al. (2009), show that “LEED buildings use, on average, less site energy than comparable non-LEED buildings” (p. 1387) and finds that the energy savings amount to 10-17%. Yet, when “focusing on source energy, which accounts both for energy used on-site and the off-site losses associated with the generation and distribution of electric energy, ... LEED certified commercial buildings, on average, show no significant primary energy savings over comparable non-LEED buildings" (Scofield, 2009, p. 1387). Scofield (2009) demonstrated that the overall energy savings of the LEED certified office buildings in Newsham et al.'s (2009) study could be minimized due to the source energy consumption calculation included in his study as well as using a different method to calculate the energy intensity of each building (equal weighting versus gross square footage method). The source energy calculations completed in his study utilized the US electric generation mix and distribution efficiency. Scofield's conclusions show that "LEED-certification, on average, is not lowering source energy consumption and, accordingly, is not delivering reduction in greenhouse gas emission associated with building operation" (Scofield, 2009, p. 1387). Scofield goes on to state that "[t]he majority of LEED-certified offices are using less energy (site or source) than comparable non-LEED offices (on an individual basis)... Collectively, however, because a relatively few large buildings dominate energy consumption, LEED offices (in total) are not using less energy (in particular, source energy) than their non-LEED counterparts" (Scofield, 2009, pg. 1390).

The difference between site and source energy use could have a large impact when performing a GHG emission analysis for building energy use, but for the sake of this thesis where decision-making for academic institutions is the focus, only energy usage at the building or campus level (i.e. site energy) will be considered. Additionally, this research analyses the energy usage of academic buildings located in Ontario and therefore would utilize the same or a relatively similar energy mix for all buildings studied. Upstream considerations, such as power generation fuel sources and transmission losses would also be useful in determining GHG emissions related to the energy usage of buildings and should be considered in future research in minimizing the impact of academic campuses on climate change.

In October 2008 the U.S. Department of the Navy imposed strict requirements that all new buildings constructed for the US Navy and the US Marine Corps obtain at least LEED Silver certification in order to satisfy Executive Order (EO) 13423. This order “mandates that all government departments reduce energy consumption by 30% by 2015” (Menassa et al., 2012, p. 46) when compared to baseline building performance per ASHRAE Standard 90.1-2004. Menassa et al. (2012) compared all 11 LEED-certified US Navy buildings with other Navy and Marine Corps “non-certified buildings of comparable size, usage, and location” (p. 46) as well as similar buildings from the Commercial Building Energy Consumption Survey (CBECS) database compiled by the United States Energy Information Administration of the Department of Energy. Their findings showed that “7 of 11 LEED-certified buildings have electric energy savings when compared to their non-LEED counterparts” (Menassa et al., 2012, p. 49). However, only 2 of the 11 buildings actually met the EO 13423 mandate of reducing energy consumption by 30% (Menassa et al., 2012). Furthermore, when comparing the LEED-certified US Navy buildings to the CBECS database, the findings showed “little to no savings, with a majority of the US [Navy] LEED-certified buildings consuming more electricity [per square foot] than the national average” (Menassa et al., 2012, p. 51). Menassa et al. (2012) pointed out that “the data shows that energy savings are not closely related to the number of points received in the Energy and Atmosphere section, [particularly EAp2 and EAc1] of the LEED certification process” (p. 52).

These results demonstrate that LEED certified US Navy buildings are not producing the desired energy savings when compared to similar US average building energy consumption.

Oates and Sullivan (2012) compared the energy consumption of 25 (out of the 53 total) LEED certified buildings in Arizona to both the national database (CBECS) as well as the energy model results documented for LEED certification. The “analysis of the LEED NC sample returned mixed results. On average, Arizona’s LEED New Construction (NC) medium energy intense (MEI) buildings performed better than the national average [(13% more efficient),] yet worse [(4% less efficient)] than buildings located in similar climates” (Oates & Sullivan, 2012, p. 742). Furthermore, “Arizona’s high energy intense (HEI) structures [laboratory spaces] performed considerably lower than national average [(35% less efficient)] and lower than buildings in similar climates [(12% worse)]” (Oates & Sullivan, 2012, p. 742). Again, the results of this study indicate that LEED certified buildings in Arizona are consuming more energy than similar buildings in the same climate and in some cases, consume more energy than the national average.

Kleinhenz et al. (2012) point out that other studies have shown that “15% of [the] LEED certified buildings [in the US] were actually performing in the bottom 30% of the comparable national building stock [(CBECS)] on an energy-per-sq-ft basis” (p. 28) and that “certified buildings are not living up to the label” (p. 28). As such, they decided to use their professional experience with various LEED certified projects in Ohio to determine why LEED certified buildings were underperforming in regards to energy efficiency. Their case studies indicated that many of the discrepancies were due to less efficient system designs and human error from the mechanical designers, energy modellers and LEED reviewers. The poor building performance often was due to “poor technical understanding or inattention by building owners and designers” (Kleinhenz et al., 2012, p. 28). Many designers tended to use old design practices with inefficient equipment or did not have adequate insight on how building mechanical systems actually work (Kleinhenz et al., 2012).

The “inefficienc[ies] outfoxi[ing] energy efficiency programs” (Kleinhenz et al., 2012, p. 29) such as LEED often stem from issues with the energy modellers and LEED reviewers on a project. Early versions of energy modelling software, such as EE4 (Natural Resources Canada, 2008), contained default plug loads for various space types which modellers tended to use rather than selecting values that more accurately reflected the actual building (Hadlock, personal communication, September 2013 – June 2015). “Building designers and energy modellers cannot rely solely on [reference guides and codes] and must use their own expert judgement [where] accurate energy modeling takes years of experience and advanced understanding of building energy systems and thermodynamics” (Kleinhenz et al., 2012, p. 29). Unfortunately, there are no minimum experience requirements for energy modellers documenting compliance for LEED certification and “it is virtually impossible for an organization, such as the USGBC [and the CaGBC], to fully inspect each energy model” (Kleinhenz et al., 2012, p. 29). Although third party reviews are part of the LEED certification process, it is virtually impossible to review all of the inputs to the model as the number of inputs is very large and model interactions are often complex. Furthermore, the achievement of LEED energy credits is determined strictly by the performance of the energy model and not the actual performance of the building, meaning “measurement and verification is not required and nobody is held accountable for actually delivering promised energy savings” (Kleinhenz et al., 2012, p. 29). All of these factors certainly contribute to answering the question of why LEED certified buildings in the US are performing in the bottom 30% when compared to the national building stock as well as why poor energy efficiency projects are being rewarded with energy efficiency credits for LEED certification. Errors made during the modelling process can result in significant inflation of modelled savings. As a result, buildings with poor energy savings may still receive a large number of LEED energy points. An example of this would be a model where the fan schedule in the baseline case had the fans in the building running continuously whereas in reality they were only in use for an eight (8) to ten (10) hour period. Catching this mistake in a third-party review would reduce the overall energy savings results for the building by over 20%, with significant effects to the overall achievement of LEED points.

Scofield (2013) analyzed data from 953 office buildings in New York City (NYC), 21 of which were LEED certified, in order to determine how the energy performance of LEED-certified buildings compared to their non-LEED counterparts. Usually data from LEED-certified buildings are compared to the CBECS national database to draw an energy comparison, whereas this study used “NYC benchmarking data [with] measured data for hundreds of similar office buildings for the same year and geographical region” (Scofield, 2013, p. 519). NYC’s local law 84 makes it mandatory for commercial building owners to upload their building energy data into ENERGY STAR’s Portfolio Manager; it was these data that were used by Scofield. By comparing similar building spaces in the same geographical regions over the same period of time, the comparisons have higher validity due to very similar weather patterns (the same heating and cooling degree days). The study showed that "with regard to energy consumption and GHG emission the LEED-certified buildings, collectively, showed no savings as compared with non-LEED buildings. The subset of the LEED buildings certified at the *Gold* level outperformed other NYC office buildings by 20%. In contrast LEED *Silver* and *Certified* office buildings underperformed other NYC buildings" (Scofield, 2013, p. 517).

From the research reviewed here, there are mixed results when analysing the energy performance of both LEED certified and non-LEED certified buildings. Early studies (Newsham et al. (2009), Scofield (2009)) show that LEED certification correlates with slightly improved site-energy performance, but also that some LEED certified buildings are actually performing worse than their non-LEED counterparts during operation and from a source-energy perspective. Recent study results (Scofield (2012), Oates & Sullivan (2012)) find that LEED certified buildings are not demonstrating increased energy efficiencies over similar non-LEED buildings. Additionally, the literature (Menassa et. al (2012), Oates & Sullivan (2012)) shows that there is little to no correlation between LEED certification level and overall building energy performance (with the exception of Scofield (2013) who found that LEED Gold buildings outperformed the national benchmarks while LEED Certified and Silver buildings performed worse). Kleinhenz et al. (2012) pointed out that many of the energy discrepancies of these buildings are due to less efficient system designs and human error from the mechanical designers, energy modellers and LEED reviewers.

2.2 Current Energy Benchmarks

All previous studies on LEED certified building energy performance have analysed building stock in the United States with most comparing their energy usage to the US CBECS. In Canada, Statistics Canada and Natural Resources Canada have been collecting national benchmarking data since 2000. Currently, there are five (5) relevant - both temporally and building type - energy surveys that provide the average annual energy intensity values for various building usage types to compare against the energy usage of LEED certified academic buildings in Ontario.

In 2000, Natural Resources Canada and Statistics Canada collected the energy intensity of commercial and institutional buildings in Canada to create the Commercial and Institutional Building Energy Use Survey 2000 (CIBEUS 2000). “The survey involved collecting information on [the] building characteristics, occupancy characteristics, energy efficiency characteristics, [and the] energy consumption” (Natural Resources Canada, 2002, p. i) of 137,039 buildings nationwide. The results break down the energy intensity of the surveyed buildings based on various building characteristics such as geographic region, occupancy, and energy efficiency features. The intent of the survey was to “strengthen and expand Canada’s commitment to energy efficiency in order to help address the challenges of climate change – by providing detailed information on the commercial sector that can be used to assess how well Canada is fulfilling its commitment to reducing greenhouse gas emissions” (Natural Resources Canada, 2002, p. i). The results showed that in 2000 the annual average site energy intensity for all educational buildings across Canada was 0.94 GJ/m^2. Ontario educational buildings performed slightly better than the national average and were found to have an average annual energy intensity of 0.93 GJ/m^2. As this was the first energy survey of its kind in Canada, the energy intensities were aggregated and did not differentiate between specific academic building types. As mentioned in Chapter 1, the building type, geographical location, and climate play a role in the energy usage of buildings. An elementary school, high school and higher education facility will have very different occupancy, mechanical system schedules, and space types resulting in very different energy loads. Universities and colleges, for example, may have lab spaces that utilize powerful and high energy demand machinery whereas an elementary school would not. Ideally, national surveys and benchmarking tools should break out different academic space types to provide more appropriate metrics for academic institutions to use for decision-making.

In 2004, Natural Resources Canada and Statistics Canada completed the 2003 Consumption of Energy Survey for Universities, Colleges, and Hospitals (CES 2003). The survey's purpose "was to gather 2003 energy consumption data for universities, colleges and hospitals [nationwide.]The data gathered through this survey [would] deepen [the government's] understanding of the various aspects of energy consumption in these sectors" (Natural Resources Canada, 2005, p. 1). The CES 2003 survey assessed and analysed energy data from 123 university campuses, 228 college campuses and 729 hospital complexes. The results of the survey were broken down by building sector and energy source as well as region and can be used "to calculate energy intensity for energy use per square metre, per student or per bed" (Natural Resources Canada, 2005, p. 2) as well as to provide a snapshot of the national and provincial energy intensity averages for academic institutions and hospitals at that time. The results of this survey showed that the average energy intensity in Canada was 2.04 GJ/m^2 for universities and 1.48 GJ/m^2 for colleges. Regionally, the energy intensity in Ontario was 2.19 GJ/m^2 for universities and 1.35 GJ/m^2 for colleges. The results of the CES 2003 study provided a more accurate comparison for the energy intensities of universities and colleges over the previous CIBEUS 2000, due to the aggregation of all academic institution types in CIBEUS.

In 2007 Natural Resources Canada and Statistics Canada completed the 2005 Commercial and Institutional Consumption of Energy Survey (CICES 2005) which surveyed 440,863 commercial and institutional buildings across Canada. The CICES 2005 study had a "scope [that] was increased to cover a much broader cross section of the commercial and institutional sector" (Natural Resources Canada, 2007, p. 2) than the previous CES survey. "This [CICES 2005] survey gathered data on the energy consumption and energy intensity of businesses and institutions...[as well as the] age of the establishments; the energy sources used for space heating, space cooling and water heating; establishment spending on energy consumption; and the use of auxiliary equipment" (Natural Resources Canada, 2007, p. 5). The results of this study provided the energy consumption and energy use intensities per sector, by region, by energy source, floor area, and establishment age. The energy intensity in Canada was found to be 1.42 GJ/m^2 for community colleges and CEGEPs (pre-university colleges in Quebec), and 2.59 GJ/m^2 for universities. In Ontario the energy intensity was found to be 1.55 GJ/m^2 for community colleges, and 3.12 GJ/m^2 for universities. It is interesting to note that the average energy intensity for academic institutional buildings is higher in 2005 than in the previous studies (2000 and 2003). This elevation in energy intensity may be due to actual energy usage increasing or different survey methods being used by NRCan and Statistics Canada. No information could be found to determine the actual reasoning and NRCan did not respond for comment.

The 2008 Commercial & Institutional Consumption of Energy Survey (CICES 2008) was completed by Statistics Canada and Natural Resources Canada to “improve [the Government of Canada’s] understanding on how and where energy is used, which in turn helps to identify energy efficiency opportunities and progress towards a more energy efficient economy” (Natural Resources Canada, 2011, p. I). In 2008 Statistics Canada surveyed 469,118 establishments for their building type, floor area, energy consumption, energy intensity, building age, and energy sources used for various types of heating and cooling. The CICES 2008 survey found that the energy intensity of community colleges and CEGEPs in Canada was 1.32 GJ/m^2 and universities 1.70 GJ/m^2. When analysed by region, community colleges in Ontario had an energy intensity of 0.95 GJ/m^2 while universities in Ontario averaged 1.24 GJ/m^2. The results of this study showed drastic improvements in building energy performance in 2008 when compared to previous studies conducted nationally. It was not stated why such drastic improvements were demonstrated, but one (1) assumption that can be made is that these savings were attributed to government, independent electricity system operator (IESO), power authority and public utility energy incentives (such as the High Performance New Construction (HPNC) or the Feed-in-Tariff (FIT) programs) for building retrofits and new buildings being constructed with more energy efficient equipment. Some additional improvements in the survey results may be due to changes in survey method and larger sample sizes, but no additional information could be confirmed by NRCan.

The most recent survey completed by Statistics Canada and Natural Resources Canada was the Survey of Commercial and Institutional Energy Use – Buildings 2009 (SCIEU 2009) completed in 2012. The SCIEU 2009 collected energy results from 482,266 commercial and institutional buildings nationwide. "The objective of the building-based component of the SCIEU [was] to establish baseline energy consumption figures against which new policies and programs geared toward energy efficiency in [commercial and institutional] buildings [could] be measured" (Natural Resources Canada, 2012, p. I). It is important to note that in the SCIEU 2009 both colleges and universities were aggregated into the 'other' building category which also included entertainment, leisure and recreation buildings (arenas), as well as shopping centres. The results showed that buildings categorized as 'other' in Canada had an energy intensity of 1.01 GJ/m^2. Regionally, in the Great Lakes climate zone, which includes Ontario, the buildings in the 'other' category had an energy intensity of 0.97 GJ/m^2. The results of this 2009 assessment would therefore not accurately reflect the energy use intensity values specific to colleges and universities as they are aggregated with other building types.

The Ontario Green Energy Act was created in 2009 "to expand renewable energy generation, encourage energy conservation and promote the creation of clean energy jobs" (Ministry of Energy, 2015). In 2012, *Regulation 397/11 Energy Conservation and Demand Management Plans* under the Green Energy Act was enforced which mandated that all "public agencies, starting in July 1, 2013, [had] to report annually to the Ministry of Energy on their energy use and greenhouse gas (GHG) emissions and publish the reports on their websites” (Ministry of Energy, 2015). The public agencies in Ontario required to provide annual reporting includes facilities such as colleges and universities. The data (BPS 2012) provided by all public agencies are published by the Ministry of Energy on their *Energy use and greenhouse gas emissions for the Broader Public Sector* webpage. This publicly available data provides valuable insight into how universities and colleges in Ontario are performing from an energy intensity perspective. From the BPS 2012 data, the university and college buildings throughout Ontario were assessed to determine the average energy intensities. First the BPS 2012 data were filtered by sector name “post-secondary educational institute” which listed only universities and colleges. The data was then sorted and separated by subsector name “university” or “college”. A review of the data was completed and easily identifiable incorrect entries were removed from the data set (i.e., duplicates, negative energy, extremely excessive/impossible energy values). All of the reported values for energy consumption sources (electricity, natural gas, fuel oil 1 & 2, fuel oil 4 & 6, propane, coal, wood, district heating, and district cooling) were converted from their reported units into GJ and then summed to determine the total energy used. The total energy consumption of the university buildings was divided by the total GFA of the university buildings, and similarly the total energy consumption of the college buildings was divided by the total GFA of the college buildings. The calculated average energy intensity of colleges and universities was found to be 1.49 GJ/m^2 (1.65 GJ/m^2 for universities and 1.15 GJ/m^2 for colleges).

Over the course of a decade the Government of Canada, through both Natural Resources Canada and Statistics Canada, has played a large role in researching the energy usage of its commercial and institutional building stock. The five (5) surveys that were completed provide an indication of how the average building (for various building types) in Canada was performing from an energy perspective. The variation in energy intensity values and aggregation categories provided by each government study does hint at the complexity associated with accurately quantifying building energy. This is yet another reason why additional studies, such as this one, can help provide insight where information is lacking specificity. Additionally, the publicly available energy data published due to the Green Energy Act provides another possible standard of comparison for universities and colleges to assess their buildings against.

2.3 The Accuracy of Building Energy Models

To identify the discrepancies between actual building energy consumption and energy consumption predicted by energy models, previous research on the accuracy of building energy models is reviewed and summarized in this section.

With elevated energy prices and an increased awareness of energy uses, the field of energy simulation has radically increased in the past decade (Ahmad & Culp, 2006). “Today energy codes and green building standards promote the widespread use of building energy simulation during the building design” (Samuelson et al., 2014, p. 1). These simulations (energy models) are used to demonstrate compliance with prerequisites and/or credits in green building standards, such as LEED, as well as for Ontario Building Code compliance. Energy models are used in comparison against baseline standards rather than providing an absolute prediction of the building's energy consumption (Samuelson et al, 2014), as the project-specific models that are generated are generally poor predictors of the actual energy usage of buildings (Turner & Frankel, 2008).

Several studies (Ahmad & Culp, 2006; Turner & Frankel, 2008; Stoppel & Leite, 2013; Samuelson et al., 2014) have found that, on average, there are large discrepancies between actual building performance and design model results. The predicted energy use intensities (EUI) for the simulated buildings in these studies were found to deviate from the actual measured energy use intensities by large amounts, ranging from 14% to 41%. "The comparisons between modeled and actual consumption can be complicated for several reasons: the building as actually built can differ dramatically from the one modeled at the design stage" (Diamond, 2011, p. 8); there can be differences in occupancy patterns, number or type of installed equipment (notably laboratory equipment or computers), lack of proper commissioning, usage change, or even poor initial modeling. Further analysis by Stoppel & Frankel (2013) point out that the larger discrepancies between actual energy use and predicted energy modelling results appear when over-estimating heating energy, building occupancy, and daily water consumption. All of these factors can "make this comparison [between modeled and actual consumption] difficult to interpret" (Diamond, 2011, p. 8).

"The LEED program[, in particular,] awards energy performance points [for LEED credits EAp2 and EAc1] on the basis of predicted energy cost savings [of only regulated energy loads] compared to a modeled code baseline building" (Turner & Frankel, 2008, p. 3). The "non-regulated loads including plug loads, exterior lighting, garage ventilation, elevators (vertical transportation), and process loads" (CaGBC, 2004, p. 177) were not included in the proposed or reference building for a LEED v1 energy model nor were they captured in the energy savings calculations. The resulting difference between actual and modeled energy performance could be significant in the calculation of LEED points. To put this into perspective, on a LEED v1 project, one (1) point is awarded for every 5% of energy savings when compared to the ASHRAE 90.1-1999 baselines. If researchers are seeing deviations between actual and modeled energy results between 14% and 41% for a LEED v1 project, then buildings could be either losing or falsely achieving anywhere from 3 to 8 LEED points based on these discrepancies (assuming the baseline model is accurate). This large deviation in number of points could make the difference between achieving and not achieving LEED certification or reaching a higher level of certification. It is also important to note that the LEED energy credits EAp2 and EAc1 "are awarded based on simulated cost of only the regulated energy components, not the whole-building energy cost [and therefore] modeled results must be interpreted with care when comparing them to actual energy bills" (Diamond, 2011, p. 4).

"As energy prices increase, the interest in saving energy has [also] increased. Simulation provides a mechanism to determine where savings opportunities exist or energy inefficiency occurs in a building" (Ahmad & Culp, 2006, p. 1142). As such, academic institutions have taken a keen interest in determining how to implement energy savings on campus by performing energy audits and determining energy conservation measures (ECMs) that could be implemented. Ahmad and Culp's (2006) analysis looking at energy simulation results of academic buildings in 1999 and 2004 in the United States found discrepancies between predicted energy usage and actual building energy usage of ±30%. Even more alarming, when looking at individual building components, such as chilled water or hot water, discrepancies exceeding ±90% were found (Ahmad & Culp, 2006).

By including a calibration step in energy modelling, where the modeling process "included inputting actual weather data, adding unregulated loads, revising process loads (often with submetered data), and updating a minimal number of other inputs" (Samuelson et al., 2014, p. 1) the deviation from actual measured energy use can be reduced to a conservative 7% under-prediction (Samuelson et al., 2014). The majority of the discrepancy between the predicted energy usage and actual energy usage was corrected when process loads were updated, missing unregulated loads were added, and the actual weather data were included in the energy models (Samuelson et al., 2014).

Previous published research on the accuracy of energy modelling has analyzed LEED NC v1 energy models and techniques. It is important to note that although process loads were not required to be accounted for in the v1 LEED energy models, newer versions of LEED (Version 2009 and the newest Version 4) do take into account process loads, likely reducing the difference between modeled and actual energy consumption.

In summary, the current academic literature demonstrates that LEED certified buildings can demonstrate improved energy performance when only site energy is analyzed, but the savings demonstrated have been minimal. Additionally, there is little support to demonstrate that higher levels of LEED certification lead to better overall building energy performance. Energy practitioners (Kleinhenz et al. (2012)) found that many of the errors stem from human error in the design, construction, energy modelling, and building operation processes. Study results varied depending on the type of building, geographical location, and the benchmark used to draw the comparison. While many LEED-certified buildings are performing better than the CBECS building stock in the United States, there is little research to show how LEED certified buildings are performing in comparison to the Canadian building energy intensity averages for specific building types and geographical locations. There is a need for building-type specific comparisons in different geographical locations in order for new buildings to set realistic and sustainable energy targets.

Five (5) national surveys on commercial and institutional energy usage have been completed by Natural Resources Canada and Statistic Canada over the past decade. These five (5) studies provide average building energy intensity data to assess how academic institutions are performing from an energy perspective. Given that each of the studies have different aggregating categories, some are more relevant than others for particular building types. Additionally, the published broad public sector data made available by the Green Energy Act can also be used for comparison by academic institutions. This will be discussed further in Chapter 4**.**

Existing literature on energy modelling has shown that energy models are poor predictors of the actual energy usage of buildings due to modelling inaccuracies. On average there are discrepancies between actual and modeled energy usage ranging from 14% to 41% due to various circumstances. The poor predictions of energy models can be improved through the experience of the energy modeller, using M&V data from a building and performing a calibrated simulation.

The outcome of this literature review demonstrates that there are contradictory results as to whether or not LEED certified buildings are more energy efficient than their non-LEED counterparts. While the previous research demonstrates that US LEED certified buildings do on average perform slightly better from a site energy perspective than US national benchmarking data, previous studies are not applicable to the geographic location, climatic conditions, and building types proposed in this research. As each of the aforementioned factors can have an effect on energy use, this research aims to fill a knowledge gap by supplying decision makers at academic institutions in Ontario with new information that will allow meaningful decisions to be made in regards to the pursuit of LEED certification on their buildings.

Chapter 3: Methods

In this chapter the methods used for conducting this study will be discussed. This includes an overview of the case study approach as well as the criteria methods used to select the appropriate research data.

3.1 Case Study Approach

Case studies were used for this research as "the case study is the most flexible of all research designs, allowing the researcher to retain the holistic characteristics of real-life events while investigating empirical events" (Schell, 1992, p. 2). It allows researchers to "investigate[] a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used" (Yin, 1984, p. 23). When studying building performance, it is impossible to remove a structure from its physical boundaries and purpose as a functioning facility and, as such, buildings need to be studied within the context of their intended purpose, location, and operating conditions.

This research analyzes measurement and verification data from LEED certified academic buildings located in Ontario. For each building, these data were compared with modeled (predicted) performance, to provincial average building energy intensities set forth by the Natural Resources Canada and Statistics Canada energy surveys, average energy intensities from the BPS 2012 data, and to campus-specific energy intensities. Utility data, campus energy data and the energy simulation results for each of the buildings participating in this study were obtained directly from the owners and operators of each of the academic institutions.

3.2 Data and Selection Criteria

The CaGBC maintains a directory of project profiles on their website which allows professionals to view buildings that have either been LEED certified or are in the process of obtaining certification. The CaGBC database was used to select several similar LEED certified buildings for comparison purposes. It should be noted that in order to perform an “apples-to-apples” comparison of energy consumption across various buildings, certain key variables, known to have a large impact on energy consumption, must be consistent from one (1) building to the next. Those key variables were: climatic region, building size, building type, and occupancy schedule. By selecting buildings whose key variables are similar, fair comparisons can be made; additionally, this process provides an opportunity to draw conclusions based on other outside factors such as occupancy patterns, mechanical schedules, lighting loads, and process loads.

Figure 2 (below) is a conceptual flowchart summarizing the data selection process used for this study. Each step is discussed in detail below.

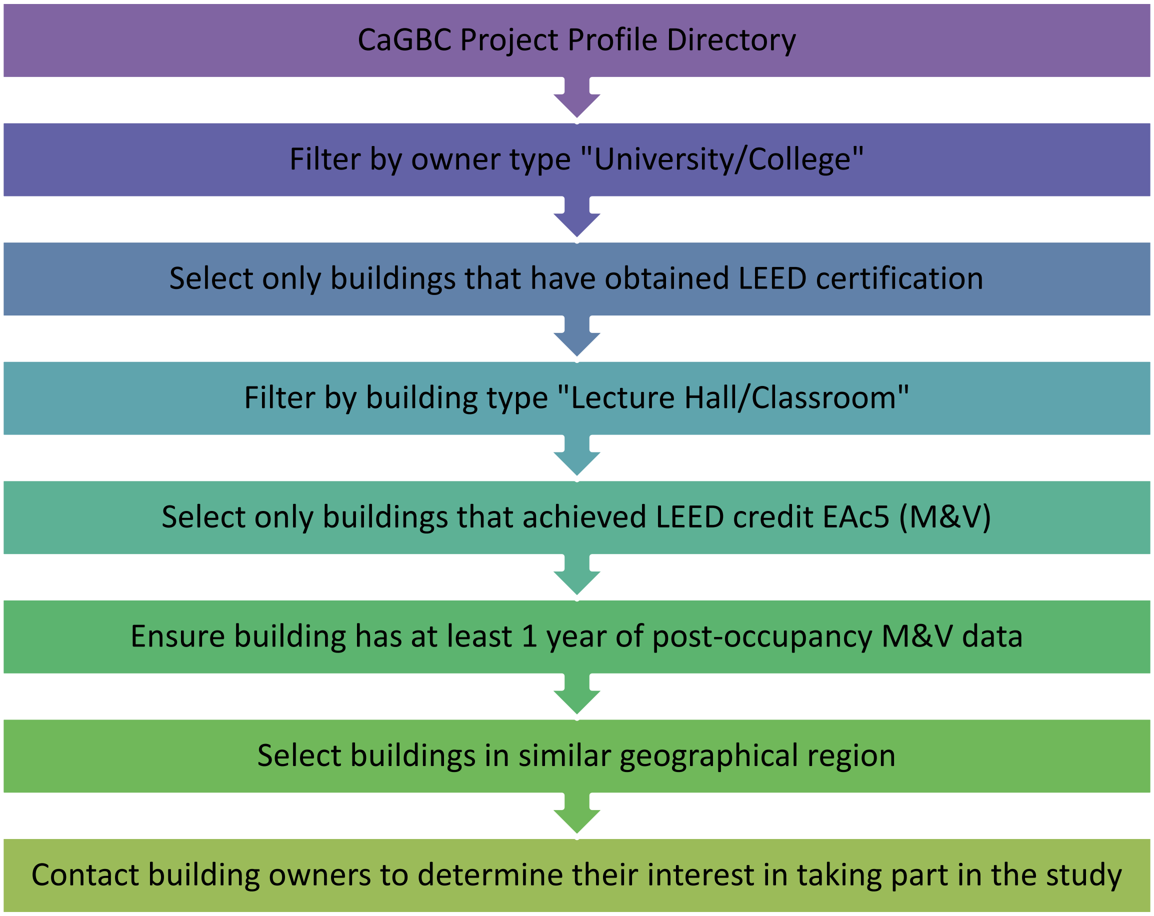


Figure 2: Flowchart Summarizing Data Selection process

As of February 2015, the CaGBC's project profile directory lists 1,840 buildings in Ontario. As this study aims to assess the energy efficiency of LEED certified academic buildings, the results were filtered to only include buildings with owner type "University/College", reducing the total number of potential research candidates to 112. Buildings that have already obtained LEED certification are of interest in this research as post-occupancy operational data should be accessible for some of these buildings. By using this selection criterion 59 of the possible 112 buildings were eligible – with the rest having been registered with the CaGBC but still under construction or currently going through the certification process.

It is important to select a specific project type to ensure a fair comparison between buildings as the energy usage of different types of academic spaces will greatly differ. For example, academic laboratories have significantly different hourly schedules, much higher water and energy loads for equipment and very different occupancy than a typical lecture hall/ classroom type structure. Of particular interest to the author, due to professional and educational experiences, were 'lecture hall/classroom' building types that fall under the "University/College" owner group. Additionally, the 'lecture hall/classroom' category has the largest number of LEED certified academic buildings (25 out of 59) in the "University/College" grouping. This classification reflects typical mixed-use academic buildings in which there would be staff offices, student work spaces, as well as lecture halls/theatres for student learning. Other academic buildings certified that fell into the 'University/College" ownership category included spaces like libraries, sports facilities, hospitals/clinics, residences, community centres, and laboratory spaces which would have varying process loads and very different schedules for each building. To minimize the energy usage differences due to building use type, the 'lecture hall/classroom' category was selected and a total of 25 buildings (out of the 59 LEED certified buildings) were assessed.

For each building certified with the CaGBC a project profile and LEED Scorecard is created. The profile describes key features of the building, whereas the scorecard provides a breakdown of the credits achieved for LEED certification. Examples of project profiles and LEED Scorecards are provided in Appendix B: CaGBC Project Profiles, LEED Scorecards, and CaGBC Building Selection Table. Each of the project profiles and LEED Scorecards for the 25 'lecture hall/classroom' buildings were reviewed to determine which had achieved the LEED M&V credit EAc5. The intent of the LEED M&V credit is to “provide for the accountability and optimization of building energy and water consumption performance over time” (CaGBC, 2004, p. 242). Metering equipment must therefore be installed to measure various energy end uses including: lighting systems and controls, motor loads, variable frequency drive operation, chiller energy, cooling loads, boiler energy, economizing control, air and ventilation equipment energy, process energy systems, water use, and irrigation systems (CaGBC, 2004, p. 242). Another requirement for the LEED M&V credit is that an M&V plan following the International Performance Measurement and Verification Protocol Volume 1 (IPMVP) options B, C or D must be created, requiring the M&V consultant to monitor the aforementioned building loads for at least one (1) year post-occupancy. This monitoring process aids in identifying and remediating any performance issues that may be occurring in the building, with the goal of reducing the building’s water and energy use to the designed/intended performance goals. Selecting projects that have achieved the LEED M&V credit should have ensured (which was not always the case) that energy data for at least a one (1) year period after LEED certification were readily accessible. Ideally, the information presented in the M&V reports could be utilized in this research.

After careful review of the CaGBC project profiles, it was determined that 10 of the 25 buildings achieved the LEED EAc5 credit. Upon further analysis, one (1) of the ten (10) buildings had been certified in December 2014 and would therefore not have a full year of post-occupancy energy data available for this research. This building was therefore removed from consideration. After this selection criterion was applied, nine (9) possible buildings were available for assessment. A table showing the potential buildings for use in this study with selection criteria is shown in Appendix B: CaGBC Project Profiles, LEED Scorecards, and CaGBC Building Selection Table**.**

Lastly, this study aims to analyze the energy usage of academic buildings within close proximity to one another, as geographical and climatic differences can impact the energy performance of a building depending on the building type. Buildings located in Ontario were selected to minimize the impact of weather differences. Additionally, the average heating degree days (HDD) and cooling degree days (CDD) over a five (5) year period for each of the proposed locations were compared to ensure that the proposed buildings had similar weather conditions. It should be noted that the weather in Sudbury, Ontario was considerably different (approximately 800 more HDD and 110 less CDD than the average of the nine (9) buildings) than southern Ontario where the other eight (8) academic buildings were located and that this could lead to elevated energy usage. In order to evaluate potential differences in energy usage between northern and southern Ontario, the energy intensities for both northern and southern Ontario academic institutions were created and compared. The results from this analysis were contrary to what was expected – the energy intensity of the northern academic institutions was less than (1.02 GJ/m^2) that of the southern academic institutions (1.23 GJ/m^2). Upon further assessment, these results could be skewed due to low participation in the northern province as the reporting was not mandated until 2013 and poor data quality (numerous entries for northern Ontario were missing or out of the ordinary). After discussions with energy professionals, they would expect to see larger energy intensities in the northern climates. This assessment, unfortunately, provided inconclusive evidence as to how much the energy intensity would differ between warmer and cooler climates in Ontario and the affect it may have on the results of this research.

Owners of the nine (9) candidate buildings were contacted via email and telephone to determine their interest in participating in this research. They were asked if they were willing to provide the completed LEED EAc1 letter template, any M&V reports, campus-wide energy usage data, and building specific energy usage data for a one (1) year period after the building achieved LEED certification. Considerable effort went into convincing building owners to participate in this research. Two (2) of the building owners did not respond after countless emails and phone calls. One (1) building owner could not provide the data requested because after three (3) years of certification their M&V data was still reporting incorrectly and therefore information on the building's energy usage could not be quantified. Another building owner hesitated to provide the data requested because they felt it would require too much effort on their behalf to find the LEED records and additionally felt that it would most likely cost money to get the information from their LEED consultants. After significant consultation, they provided the information requested and participated in this research. As a practitioner in this field of sustainability and energy efficiency, there seems to be a negative stigma associated with the process of LEED certification and, as such, it was difficult to convince owners to participate in this research. Much of the data collected were a result of professional ties within industry and the provision of aid to owners in providing the information requested.

Of the nine (9) buildings eligible for the research, only four (4) academic institutions – McMaster University in Hamilton, Lakehead University in Orillia, Western University in London, and Algonquin College in Ottawa - responded favourably and could provide the requested information. As Western University had two (2) eligible buildings take part in the research, a total of five (5) buildings comprised the study, as shown in Table 2 below:

Table 2: Buildings Selected for Research

Academic Institution	Building	Location	Size (m^2)	Certification Level	Usage Type
Western University	Claudette MacKay-Lassonde Pavilion	London, ON	3703	Gold	Lecture hall, offices, lab spaces, common use spaces
	Stevenson Lawson Hall	London, ON	11714	Silver	Offices, classrooms, common use spaces
Lakehead University (Orillia Campus)	Simcoe Hall	Orillia, ON	6083	Platinum	Classrooms, lecture halls, lab spaces, office spaces
McMaster University	Ron Joyce Centre	Burlington, ON	9624	Gold	Classrooms, lecture halls, meeting rooms, auditorium
Algonquin College	Algonquin Centre for Construction Excellence (ACCE)	Ottawa, ON	18460	Platinum	Lab spaces, transportation hub, lecture halls, cafeteria, workshops, offices

Each of the buildings, although all listed as “lecture hall/classrooms” type, have very different mixes of building use. In order to identify potential differences between the buildings studied an estimated breakdown of the floor area attributed to different space types was requested from each building owner. Four (4) of the building owners provided estimates of the floor area breakdowns (these estimates do not completely agree with the documented floor areas noted in Table 2). A summary of each building is shown in Table 3 below.

Table 3: Space Type Areas (and percentage of GFA) for Case Study Buildings

Academic Institution	Building	Classroom (m^2)	Lab (m^2)	Offices (m^2)	Common Use (m^2)	Other (m^2)
Western University	Claudette MacKay-Lassonde Pavilion	0 (0%)	1211 (30%)	1160 (29%)	0 (0%)	1679 (41%)
	Stevenson Lawson Hall	705 (7%)	116 (1%)	4626 (47%)	269 (3%)	4146 (42%)
Lakehead University (Orillia Campus)	Simcoe Hall	1308 (20%)	330 (5%)	923 (14%)	713 (11%)	3262 (50%)
McMaster University	Ron Joyce Centre	957 (11%)	0 (0%)	1720 (20%)	1394 (17%)	4363 (52%)
Algonquin College	Algonquin Centre for Construction Excellence (ACCE)	N/A	N/A	N/A	N/A	N/A

With the M&V data in-hand for the five (5) participating buildings, the annual energy usage and energy intensity of each building could be calculated. The data from the M&V reports from each university were used to calculate the annual energy consumption (by energy source) for each building. The annual consumption for electricity, natural gas, chilled water, and steam was calculated and converted to gigajoules (GJ) to allow for building-to-building and building-to-benchmark comparisons. The total annual energy usage for each building was then determined by summing the total GJs for each energy source. It should be noted that the data from the M&V reports was specific to site energy only; source energy, such as the energy utilized to create steam and chilled water at the central plant (applicable to the Western University buildings), are not captured in this research as there was insufficient information to do so.

After determining the actual annual energy consumption for each building, the energy intensities for each building were calculated by dividing the total building energy (in this case annual energy usage in GJ) by the building's gross floor area (GFA). It should be noted that the data provided for the Algonquin College ACCE building was presented by the owners in the form of an energy intensity value in equivalent kilowatt hours per square foot (ekWh/ft^2). This means that the building owners provided one (1) energy value for their building by converting the energy usage for both electricity and gas consumption of the ACCE into kWh and dividing it by the area of the building instead of providing separate energy end use loads. The provided energy intensity value was then converted from ekWh/ft^2 to GJ/m^2.

The calculated building-specific energy intensity could then be compared to both the average provincial energy intensity set forth by Natural Resources Canada and Statistics Canada, and the campus-specific energy intensities. The intent is that the comparisons between the provincial average energy intensities, BPS 2012 data, and campus-specific energy intensities should provide an indication of how LEED certified academic buildings within the same region are performing in comparison to other academic buildings.

The average annual energy intensity for each campus was either provided directly by the universities/colleges studied or determined from the "Energy use and greenhouse gas emissions for the Broader Public Sector" (BPS 2012) spreadsheet published by the Ministry of Energy. This BPS 2012 spreadsheet includes the annual energy usage categorized by energy source for public buildings in Ontario as mandated by the Green Energy Act, 2009. The campus-wide energy intensities (by energy source) for McMaster University and Lakehead University were determined using the information presented in the BPS 2012 document. The energy consumed by each energy source was converted to GJ and then the energy intensity was calculated by dividing the GJ by the total campus GFA. Similarly, Western University provided their raw BPS 2012 data which was then converted to GJ. The energy intensity was calculated by dividing the total annual energy in GJ by Western University's total campus GFA.

As an additional outcome of the research, this study aims to identify discrepancies between the LEED energy model results documented in the LEED EAc1 letter templates and the measured actual building energy usage. Energy usage depends greatly on a large number of variables, including quantity of occupants as well as building schedules - the hours that the building remains open and in use. What is presented in the energy model is information presented by the owner, architect and designers in the construction drawings and shop drawings for the project. The energy modeller is responsible for trying to accurately simulate how this building will be operated to determine anticipated energy usage. With any energy model, there is possibility for the energy modeller's assumptions to be erroneous due to unknown changes to the building usage, changes to the occupancy, or misinformation presented by the design team in regards to building envelope, mechanical and electrical systems. Ideally, there should not be large variances between the predicted modeled energy consumption and actual building energy usage; however, numerous studies have shown that there usually are, as described in the literature review. The magnitude of the discrepancies found in this research will be identified and recommendations to the CaGBC and USGBC, as well as LEED energy modellers will be provided based on the results from the analysis.

3.3 Limitations

Limitations remain in this study despite the many efforts made to reduce them. For example, this research compares building-specific energy intensities to the university and college average energy intensities presented in Natural Resource Canada and Statistics Canada's national and provincial energy surveys (CIBEUS 2000, CES 2003, CICES 2005, CICES 2008, and SCIEU 2009). Since the Statistics Canada data are averaged by province (with the exception of SCIEU 2009), the comparison will only provide an estimate of how academic buildings in a specific region of Ontario are performing in comparison to energy intensity averages for all of Ontario. The validity of the comparison is somewhat weakened due to the fact that the benchmarks do not have location specific data. A better "apples-to-apples" comparison would compare the data set to non-LEED equivalent buildings of similar vintage in the same towns or regions. Efforts have been made to provide comparisons between campus-specific and building-specific energy intensities to increase validity.

An analysis was completed using the BPS 2012 data with the intention to demonstrate the energy intensity differences between northern and southern Ontario, but the results demonstrated were not considered to be normal due to low participation and poor data quality. Ratio based weather normalization of the HDD could have been used to normalize the effect of climate on energy data. This type of weather normalization divides the total energy consumption (or energy intensity) by the number of HDD. Unfortunately, this type of normalization does not provide an accurate basis for comparison as only a portion of the total building energy usage is dependent on weather. In order to accurately normalize for weather, sub-metering would be required for end uses such as lighting, plug loads, and process loads (any loads that are not dependent on weather) in order to calculate the fraction of the total energy used for heating. The heating energy for each building would be divided by the total HDD and then the non-heating/non-weather dependent end uses would be analyzed separately. This level of detail in building data is not provided in the provincial benchmarks by NRCan and Statistics Canada nor the BPS data.

To further demonstrate the variability between normalizing by HDD using the ratio based and weather dependent methods, both quantities were calculated and compared. Ratio based normalization was completed on all five (5) case study buildings and the weather dependent method was completed on four (4) of the buildings (the ACCE did not provide energy source data). The weather dependent consumption method results ranged from 7% to 60% of the values obtained in the ratio based normalization method demonstrating that in most of the buildings the energy required for heating is much lower than the base loads.

Additionally, the aim of this study is not to compare the buildings to one another, but to compare the case study buildings to the provincial average, which does not take into account HDD.

As this study only compares LEED certified university and college buildings with “lecture hall/classroom” designation located in Ontario, and several owners declined to participate in this study, the sample size for this work was small and of unknown representativeness. Further studies would need to be completed for other geographical regions and building usage types as these variables could lead to different energy usage results, and may not be comparable to lecture/classroom buildings. Additionally, the goal of this research was to determine whether LEED certified academic buildings perform better from an energy perspective than their non-LEED counterparts. As only five (5) buildings took part in the study there was not enough data to draw such specific conclusions. As more buildings achieve certification and can provide M&V data, additional buildings can be compared to answer the question with more certainty, as long as data are also available from equivalent type and vintage non-LEED buildings.

From a temporal perspective, these buildings presented annual energy usage data from varying years. Discrepancies between annual weather data could affect the energy usage of a building as there would be different heating and cooling loads associated. Normalizing by HDD and CDD is a possibility if you were comparing each of the buildings to one another, but, again, in this research the author is comparing the buildings to available provincial average energy intensities which do not provide data that could be normalized. Ideally the utility and water usage data from all of the buildings in the data set would be for the same time period.

This research only assesses LEED NC v1 buildings (and the associated modeling guidelines) to quantify the difference between the model predicted energy data and the actual energy data. Changes have been made to the modeling guidelines in the LEED Reference Guide v2009 (which followed LEED v1) that have made it mandatory for energy models to include an estimate for process loads – something that was not required in LEED NC v1. Therefore, energy modelled results for energy usage should be more reflective of actual energy usage in LEED NC Version 2009 and LEED NC Version 4 (to be released in Canada in 2016) than for LEED NC v1 buildings.

This study will provide recommendations for reducing the discrepancies between energy modelled results and actual building usage based on the results of this study and the author's experience as a LEED practitioner. The recommendations will focus on the modeling process in general and will not go into specific details for each the five (5) case study buildings (as a calibrated simulation or M&V report would).

Due to the scope of this research - comparing actual energy intensity of buildings to provincial energy intensity averages as well as to the modelled energy intensity - life cycle emissions associated with energy use will not be calculated. It would be interesting in future research to investigate both the site and source level energy usage of these LEED certified buildings.

Chapter 4: Results & Discussion

Using the methods and techniques described in Chapter 3, the M&V data as well as the modeled energy use from McMaster University, Western University, Lakehead University, and Algonquin College were evaluated and compared to the existing Canadian energy surveys and campus-wide energy intensities. The results of each of these comparisons are discussed below.

4.1 Annual Building Energy Consumption and Energy Intensity

Energy use by source, total energy consumption, GFA, and the energy intensity of each building included in this study are summarized in Table 4 below.

Table 4: Annual Energy Consumption & Energy Intensity

	Building				
	Claudette MacKay Lassonde Pavilion	Stevenson-Lawson Hall	Simcoe Hall	Ron Joyce Centre	ACCE
Electricity (GJ)	4673	6768	6826	3855	-
Natural Gas (GJ)	0	0	527	2211	-
Chilled Water (GJ)	794	1686	0	0	-
Steam (GJ)	8328	2899	0	0	-
Total Actual Energy Usage (GJ)	**13795**	**11352**	**7350**	**6066**	15876*
Gross Floor Area (m^2)	3703	11714	6083	9624	18460
Actual Energy Intensity (GJ/m^2)	**3.73**	**0.97**	**1.21**	**0.63**	**0.86**

* This value was calculated by multiplying the AEI by the GFA as the energy usage was not provided

While it may be tempting to use the data from Table 4 above to simply compare the energy usage or energy intensity of each building to draw the conclusion that one (1) is outperforming the rest, this may result in an unfair comparison. Although these buildings have been pre-selected for this study due to similarities in building type, location and time period, it is important to consider key (energy-affecting) variables such as climatic region, building size, building type, process loads, and occupancy schedules as outlined in Chapter 1 and Chapter 3. To illustrate this point, when comparing the actual energy usage of the buildings in this research, the Stevenson-Lawson Hall consumes far more (almost twice as much) energy than Simcoe Hall, however the energy intensity of the Stevenson-Lawson Hall is far less. As indicated by this example, assessing the energy consumption of these five (5) buildings without taking into context their GFAs would be an unfair comparison. When the energy intensity of the buildings was compared, it was determined that the Claudette MacKay Lassonde Pavilion consumed far more energy than the rest of the buildings in this study. This building had the highest annual energy usage and the smallest gross floor area, resulting in an energy intensity of almost four (4) times greater (3.73 GJ/m^2) than the average of the other buildings (0.89 GJ/m^2).

Although the central focus of this study is to determine how LEED buildings are performing, the data will inevitably raise the question of why some buildings perform better than others. In regards to the significantly higher energy intensity of the Claudette MacKay Lassonde Pavilion compared to the other four (4) buildings in this study, it was observed that this building "houses collaborative learning, graduate student educational facilities and office spaces for professors.

Two floors of the building house engineering laboratories for leading-edge environmental research" (Enermodal Engineering, 2014, Executive Summary). It is well understood that laboratory spaces with energy-intensive equipment can greatly increase the process-related internal loads and thus overall energy consumption of a building. This is one (1) likely reason why the actual energy intensity of the Claudette MacKay Lassonde Pavilion was much greater than that of the other buildings being studied. This observation highlights the inequity of comparing academic buildings with extremely large process loads, such as engineering laboratory spaces, to academic buildings used predominately for office spaces/lecture halls. Table 2 and Table 3 identify the different uses of each of the buildings analyzed in this study.

4.2 How LEED certified buildings compare to existing Canadian energy benchmarks

Currently, there are five (5) relevant energy surveys available in Canada which provide the average energy intensity of all buildings studied per building type – the CIBEUS 2000, CES 2003, CICES 2005, CICES 2008 and SCIEU 2009. As discussed in detail in Chapter 2, each survey was conducted by Natural Resources Canada and Statistics Canada to provide national, regional and building usage specific energy intensities to "establish baseline energy consumption figures" (Natural Resources Canada, 2012, p. I) against which commercial and institutional buildings are often compared.

The energy intensities for each of the buildings participating in this study were compared to all five (5) energy surveys to further categorize their overall energy performance. A summary of the building energy intensities as well as each survey's average energy intensity is shown in Table 5 below.

Table 5: Building & Benchmark Energy Intensities

	Building				
	Claudette MacKay Lassonde Pavilion	Stevenson-Lawson Hall	Simcoe Hall	Ron Joyce Centre	ACCE
Actual Energy Intensity (GJ/m^2)	3.73	0.97	1.21	0.63	0.86
CIBEUS 2000 (GJ/m^2)	0.93 (universities & colleges)				
CES 2003 (GJ/m^2)	2.19 (universities); 1.35 (colleges)				
CICES 2005 (GJ/m^2)	3.12 (universities); 1.55 (colleges)				
CICES 2008 (GJ/m^2)	1.24 (universities); 0.95 (colleges)				
SCIEU 2009 (GJ/m^2)	0.97 (universities & colleges)				
BPS 2012 (GJ/m^2)	1.65 (universities); 1.15 (colleges)				

The results show that the actual energy intensity values of LEED certified academic buildings are on average lower than the provincial average, but in some cases the buildings are performing much worse. The energy intensity of the Claudette MacKay Lassonde Pavilion is higher than every provincial energy average from 2000 to 2009 as well as the BPS 2012 average. The energy intensity of Stevenson-Lawson Hall is lower than the energy intensity targets of all of the averages except for one (1) – CIBEUS 2000. The energy intensity of Simcoe

Hall is less than the energy intensity of four (4) averages (CES 2003, CICES 2005, CICES 2008, BPS 2012), but higher than the remaining two (2) averages (CIBEUS 2000, SCIEU 2009). Both the Ron Joyce Centre and the ACCE have energy intensities far below all six (6) of the energy intensity averages.

While there are currently five (5) Canadian surveys, there are no guidelines as to which should be used. This should raise a question for academic institutions – *which survey average should be used for an energy intensity comparison?* After evaluating the categorization criteria for each study, one realizes that this is a tough question to answer as each of the surveys use different data groupings.

CIBEUS 2000 data is 15 years old and aggregates all educational-type buildings across Ontario. Given its age, it may not be the most temporally relevant comparison for current building projects nor an accurate average for buildings with strong energy/climate correlations as the data are Ontario-wide.

The CES 2003 survey is over 10 years old, but does look at specific academic building types – colleges, universities, and CEGEPS - across Canada. Although this survey is slightly more temporally relevant than the previous survey, the CES 2003 survey still only provides provincial energy intensity averages, rather than more localized climatic regions. These data may therefore be applicable for academic buildings in Ontario whose energy is not strongly affected by weather.

Similar to the CES 2003 data, both the CICES 2005 and CICES 2008 surveys provide energy intensity averages for universities and colleges across Ontario. These surveys provide more temporally relevant data than the two (2) previous surveys as they are both less than 10 years old. CICES 2005 and CICES 2008 also both provide provincial-level data and are not region specific. There is large variability between the energy intensity values for the CICES 2005 (3.12 GJ/m^2) and CICES 2008 (1.24 GJ/m^2) surveys. This may be due to the fact that more universities provided data for their buildings in the CICES 2008 survey, but the exact reasoning could not be obtained from NRCan.

The SCIEU 2009 survey is the most temporally relevant survey completed, but unlike the rest of the surveys conducted, it aggregates colleges and universities into an “other” category which includes “entertainment, leisure and recreation buildings (arenas), [and] shopping centres” (NRCan, 2012, p. 115). The SCIEU 2009 characterizes the building data using different climate zones instead of aggregating the data by province. All of the buildings analyzed in this study fall into the “Great Lakes/St. Lawrence” climate zone. While the addition of more climate zones is valuable for buildings whose energy use is strongly affected by climate, by aggregating many building types into one category, the relevance of the data is significantly diminished. Table 6 contains a summary of several attributes of the NRCan building energy surveys.

Table 6: Summary of NRCan Surveys

Survey	Temporal Relevance	Building Category By Usage Type	Provincial Data	Regional Sensitivity
CIBEUS 2000			X	
CES 2003		X	X	
CICES 2005	X	X	X	
CICES 2008	X	X	X	
SCIEU 2009	X			X

In discussions with energy practitioners and from the author's personal experience none of these surveys are very useful – the climate regions, temporal data, or building use types all vary, as do the results from one study to the next. Having evaluated the energy surveys, one can conclude that they do not seem to provide a clear energy average or benchmark (as used in the industry to mean a comparison value) necessary for an "apples-to-apples" comparison for academic buildings in Ontario.

Out of all the different categorization factors used by the study, the one (1) factor expected to have the greatest impact on energy intensity for academic buildings is the building usage type; an average that references the same building type as the one being studied is imperative. Climate can also play a role in the energy intensity of a building but this may not prove to be a large factor in lecture/hall buildings as per the BPS 2012 data analysis performed. As the majority of the current surveys are separated primarily by province and the HDDs and CDDs days across Ontario do not fluctuate drastically (with the exception of extreme northern buildings), the energy intensity associated with climate should be similar in the averages provided. A large concern for future energy benchmarks and energy surveys for academic buildings is the fluctuation in process loads depending on what mix of uses it houses. Process loads can drastically change the energy usage of a space and have not been captured in any of the surveys to date.

Although none of the current energy surveys are very accurate for academic buildings to use as for apples-to-apples energy intensity comparison, there needs to be some basis of comparison for energy usage in order for building owners to determine a baseline energy standard for new buildings or retrofits. Some campuses use the government energy surveys, others use their campus-wide energy intensity, and some hire energy consultants to determine a suitable energy intensity. The government energy surveys as well as the future published BPS data should be used as a preliminary starting point for new buildings, then utilizing internal campus-wide energy intensities, and, if the budget allows, an energy consultant can be hired to make recommendations based on similar buildings and new technologies.

Based on the aforementioned observations, if a single NRCan energy survey needed to be selected for the basis of comparison, the CICES 2008 data would be the survey of choice. This survey provides energy intensity averages for both colleges and universities provincially and has temporally relevant data. Furthermore, in discussions with building energy professionals, the energy intensities for academic buildings from this survey are considered to be more realistic than the intensity values from the other surveys.

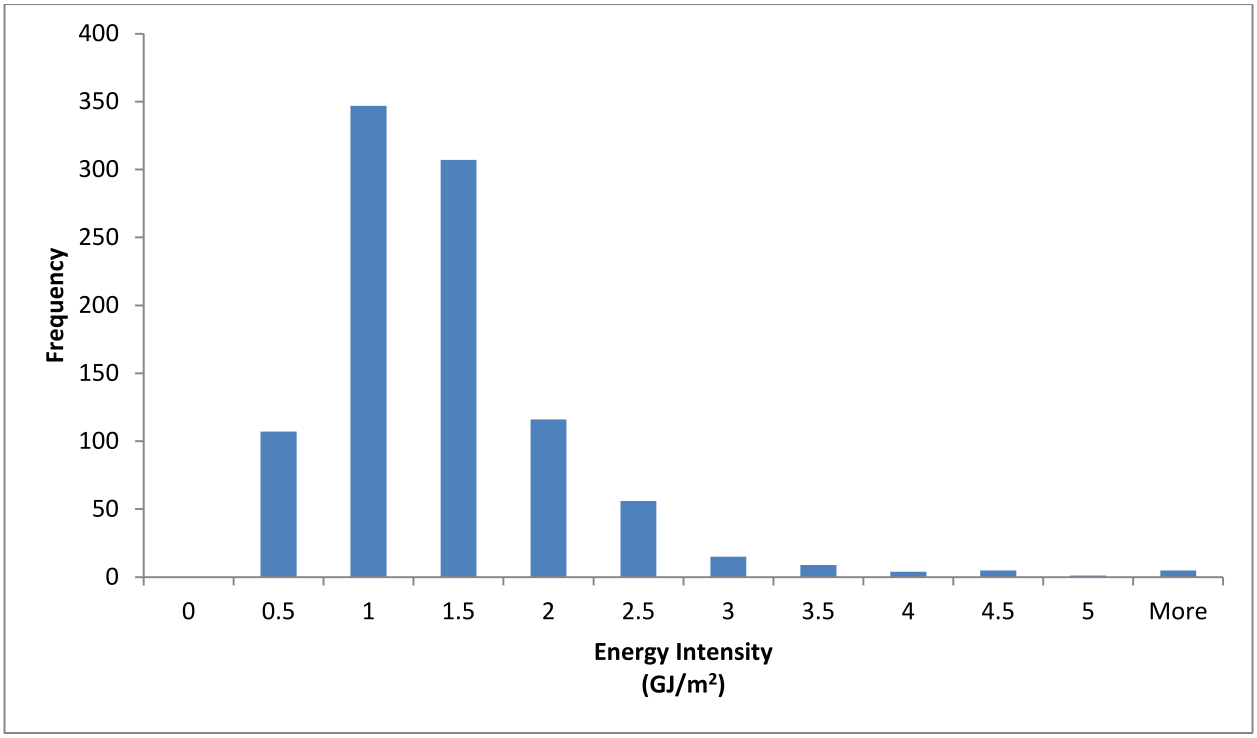
The Ontario public building data (BPS data) provided due to the implementation of the Green Energy Act has created an opportunity to generate a new provincial or even regionally specific average. The current BPS 2012 data were analyzed to determine how the case study buildings performed in comparison to other universities and colleges throughout Ontario. The data statistics and frequency trends of BPS 2012 are shown in Figure 3 and Table 7 below:

Table 7: BPS 2012 Data Results

	Min (GJ/m^2)	Median (GJ/m^2)	Mean (GJ/m^2)	Max (GJ/m^2)	Standard Deviation
BPS 2012	0.01	1.04	1.49*	14.34	1.00

*The mean is calculated using the GFA method – sum the total energy of all buildings and divide by the total GFA. This is consistent with the provincial energy surveys by NRCan.

Figure 3: Histogram of BPS 2012 Data



Approximately one (1) quarter (22%) of the buildings/campuses that provided information for BPS 2012 had energy intensities between 0.75 and 1.0 GJ/m^2. The majority (67%) had building energy intensities between 0.51 and 1.5 GJ/m^2. Four (4) out of five (5) of the buildings considered in this research – Stevenson Lawson Hall, Simcoe Hall, Ron Joyce Centre and the ACCE – perform within this range of energy intensity. The Claudette MacKay Lassonde Pavilion, with a much higher energy intensity of 3.73 GJ/m^2, performs similarly to the highest intensity 0.4% of the BPS 2012 buildings. This analysis show that the case study buildings used in this research perform similarly to other colleges and university buildings across Ontario.

Quality of the BPS 2012 data is poor. There are missing or invalid entries, variation between reported units, buildings/facilities that did not take part, and minimal data quality assessment (duplicate entries were removed). Additionally, there is no mention as to what the Ministry of Energy will do to assure data quality or whether there are plans to utilize these data beyond publishing them.

Academic decision makers can use these publicly available data in conjunction with the government energy surveys when constructing new buildings and setting their own internal campus energy targets, but with caution. Both NRCan and the Ministry of Energy need to make changes to their programs (consistency, methodology, and data quality) to create better energy surveys for academic institutions. If academic decision makers choose to use these values for comparison, it is recommended that more than one (1) data source be used. For example, the average of the 2012 energy data for all 'Post-Secondary Educational Institute' buildings (including both universities and colleges) was found to be 1.49 GJ/m^2. Dividing this further showed the average energy intensity for universities in Ontario was 1.65 GJ/m^2 and for colleges in Ontario was 1.15 GJ/m^2. Comparing the BPS data with the provincial energy surveys and then to the energy performance of similar buildings on campus will give academic decision makers an indication of the range of energy intensities that new buildings should have. While the provincial and BPS 2012 averages are recommended to use as a starting point for setting internal energy targets, these averages are a snapshot of how academic buildings are currently performing. It is recommended that future buildings push the envelope and strive to construct and operate buildings that have better energy intensities than the current working averages and realised energy intensity of similar campus buildings.

4.3 How dataset buildings compare to campus-specific energy performance

The aim of this research was also to show how LEED certified academic buildings were performing in comparison to their campus-specific energy intensities. For each of the studied buildings, annual average energy intensity values were calculated in Table 4.

The results for both the building specific energy intensity and campus-wide energy intensity in units of GJ/m^2 are shown in Table 8 below.

Table 8: Energy Intensities Compared to Campus-wide Energy Intensities

	Building/Campus				
	Claudette MacKay Lassonde Pavilion (Western)	Stevenson-Lawson Hall (Western)	Simcoe Hall (Lakehead)	Ron Joyce Centre (McMaster)	ACCE (Algonquin)
Building Energy Intensity (GJ/m^2)	3.73	0.97	1.21	0.63	0.86
Campus-wide Energy Intensity (GJ/m^2)	1.91	1.91	1.16	1.77	1.14

The results indicate that three (3) of the five (5) buildings in this research consume less energy than their associated campus-wide average. The actual energy intensity of the Claudette MacKay Lassonde Pavilion at 3.73 GJ/m^2 grossly exceeded the Western University campus-wide energy intensity value of 1.91 GJ/m^2. Similarly the energy performance of Simcoe Hall exceeded Lakehead University's campus-wide energy intensity by a small margin of 0.05 GJ/m^2. Stevenson-Lawson Hall, the Ron Joyce Centre, and the ACCE all performed much better than their associated campus-wide energy intensities.

At Western University in London, Ontario 12 out of the 90 buildings on campus are either LEED certified or in the process of applying for LEED certification. From the information provided there is no way to accurately separate the energy usage for the LEED and non-LEED buildings. Therefore, based only on the number of LEED versus non-LEED buildings, approximately 87% of the buildings would be considered non-LEED equivalents for comparison purposes. From the results shown above the Claudette MacKay Lassonde Pavilion performs far worse (consuming almost twice as much as the WU campus-wide energy intensity) than its LEED and non-LEED campus counterparts. On the other hand, Stevenson-Lawson Hall performs much better (consuming almost half as much as the WU wide energy intensity) than both its LEED and non-LEED campus counterparts. In so far as examining whether LEED buildings are performing better than non-LEED buildings, the data for these two (2) buildings present conflicting results. Based solely on the results of the two (2) aforementioned LEED buildings at Western University, it cannot be concluded with certainty that LEED buildings are performing better in comparison to other buildings on campus. It is recommended that future LEED buildings be monitored for energy performance in order to help understand how LEED buildings are performing at this campus.

At McMaster University, the Ron Joyce Centre is consuming only 36% of the campus-wide energy intensity of 1.77 GJ/m^2. Approximately 25% (12 out of the 48 buildings) of the building stock at McMaster University are LEED certified due to their sustainable building policy which "states that every new building on campus will have a minimum of Leadership in Energy and Environmental Design (LEED) Silver Certification. The return on the LEED investment includes financial and energy savings and increased efficiency in utilities and other operating costs over the building's lifespan" (McMaster, 2011). With McMaster's performance of the Ron Joyce Centre and through discussions with their energy department, LEED buildings on this campus are out-performing the non-LEED buildings at this campus.

Simcoe Hall at Lakehead University in Orillia saw slightly elevated actual energy intensity (at 104%) in comparison with its campus-wide energy intensity. All three (3) buildings currently constructed the Lakehead University campus in Orillia are LEED certified and therefore a comparison between LEED and non-LEED buildings cannot be made.

The ACCE building at Algonquin College is outperforming the campus-wide energy intensity by 31%. The ACCE building is one (1) of two (2) LEED certified buildings at the Algonquin College Woodroffe Campus and as such it is fair to say that this LEED certified building is outperforming the rest of the non-LEED buildings on campus. Additionally, in 2014 the Physical Resources team at Algonquin College published a "Post Occupancy and Thermal Comfort Analysis: ACCE Building – Final Report" document which demonstrated the energy intensity comparisons between the LEED and non-LEED buildings. The average energy intensity for both of the LEED certified buildings on campus are 32% better than the non-LEED campus-wide energy intensity in the same year.

4.4 How dataset building actual energy intensity compared to the LEED energy models

Another aim of this research was to show how LEED certified academic buildings were performing in comparison to the modelled energy consumption (energy numbers provided for final LEED certification). Each of the universities in this study provided their final LEED Letter Template for the Energy and Atmosphere Credit 1: Optimize Energy Performance (EAc1) which summarizes the final energy modeling results submitted to the CaGBC. The EAc1 Letter Template lists the building's modeled energy usage broken out by end use (e.g. lighting or fans) and energy source (e.g. electricity or gas). The energy usage values from the LEED EAc1 Letter Templates were converted to GJ and then divided by the corresponding building's GFA to calculate the modelled energy intensity. The modelled energy intensities were then compared to the actual energy intensity of each building. The results are shown below in Table 9 below.

Table 9: Annual Energy Intensity and Modelled Energy Intensity

	Building				
	Claudette MacKay Lassonde Pavilion	Stevenson-Lawson Hall	Simcoe Hall	Ron Joyce Centre	ACCE
Actual Energy Intensity (AEI) (GJ/m^2)	3.73	0.97	1.21	0.63	0.86
Modelled Energy Intensity (MEI) (GJ/m^2)	2.10	0.74	0.68	0.62	0.55
Discrepancy: 100% - (MEI/AEI)	44%	24%	44%	2%	35%

The results demonstrate that all of the modelled energy intensities were lower than the actual building energy intensities. As mentioned in Chapter 2, the predicted energy use intensities (EUI) for the simulated buildings often deviate from the actual measured energy use by large amounts, ranging from 14% to 41%. The modelled energy intensities of the buildings in this study deviated from actual energy intensities in the best case by 2% (for the Ron Joyce Centre) to the worst case of 44% (for both Simcoe Hall and the Claudette MacKay Lassonde Pavilion). The findings of this research are in agreement with current academic research where the modelled energy use of buildings do not in general reflect the actual energy usage of a building (models typically under predict actual energy use).

4.5 How does this research affect academic building owners and operators?

It is a common misconception that a LEED energy model accurately reflects the future energy usage of a building. Owners and operators generally think that the modeled energy savings documented on the EAc1 Letter Template will equate to realized energy savings demonstrated on utility bills. Research has shown this is not often the case. The documentation for LEED EAc1 requires a computer simulated model to be compared to a similar baseline building which meets the requirements and guidelines outlined by the CaGBC (and their reference modeling standards). As such, a percentage of savings can be determined by comparing these two (2) values – proposed building to reference building (baseline). The percent savings calculated in this process does not accurately demonstrate cost savings realized by an owner. From personal experience, this information typically does not seem to be properly conveyed to the owners and operators of a building who tend to expect a significant decrease to their overall energy consumption based on the modeled savings.

This study demonstrates the energy savings associated with LEED certification of academic buildings. Four (4) out of the five (5) buildings studied in this research on average perform better than the five (5) energy surveys from NRCan and Statistics Canada as well as the BPS 2012 energy intensity average. Similarly, three (3) out of the five (5) buildings performed better than their campus-wide energy intensity values.

In general, this research demonstrates that in aggregate, the group of LEED certified academic buildings selected for this study do perform better from an energy perspective than the average provincial energy data for academic buildings in Ontario. However, each building studied in this research had higher (ranging from 2% to 44%) actual energy intensities compared to the modelled energy intensities.

Chapter 5: Conclusions and Recommendations

Based on the results presented in Chapter 4, the goal of this chapter is to draw conclusions and provide final recommendations to NRCan and Statistics Canada, the CaGBC and USGBC, the energy modelling community, and academic campus decision makers.

5.1 Conclusions

The results of this study demonstrate that these five (5) case study LEED certified academic buildings do, in fact, on average have overall lower energy intensities compared to the provincial energy intensity averages for academic buildings in Ontario. While the goal of this study was to determine if LEED buildings performed better than non-LEED buildings, there were not enough case study buildings (or appropriate non-LEED building data) available to definitively answer this question.

At Western University, the Claudette MacKay Lassonde Pavilion performed anywhere from 16% to 75% worse than the provincial average energy intensities. Stevenson-Lawson Hall, on the other hand, ranged from 4% worse than one (1) average (CIBEUS 2000) to 69% better than another (CICES 2005). At Lakehead University, Simcoe Hall performed 23% worse when compared to CIBEUS 2000 and up to 61% better than three (3) of the provincial averages. The Ron Joyce Centre at McMaster University performed anywhere from 32% to 80% better than the provincial averages. Lastly, the ACCE building at Algonquin College performed between 8% and 45% better than the provincial averages.

This research demonstrates that there is a diverse and sometimes conflicting range of provincial energy intensity data provided by NRCan and Statistics Canada which makes it impossible for academic institutions to make educated and useful decisions on energy intensities of campus buildings. Without guidance on which energy survey to use, it is extremely difficult to determine how an academic building is performing in comparison to its provincial counterparts. By publishing inconsistent data with changing aggregation categories including both building types and location, NRCan and Statistics Canada are creating confusion about how a building is actually performing as practitioners could use different surveys to portray the building's energy performance. This leads to inconsistencies in reporting relative building performance and can lead to gamesmanship.

The annual public reporting mandated for public buildings in Ontario due to the Green Energy Act has provided practitioners with data for other potential comparison, but the quality of these data at present is poor. The data quality and measurement needs to be standardized in order for these data to be used. Currently, public institutions provide metrics such as GFA and energy data in varying units which makes it nearly impossible to analyze thousands of entries of inconsistent data. Additionally, there appears to be issues with some of the data that public institutions are reporting as some entries are absent or unexpectedly low, if not impossible, values. Some form of quality assurance needs to take place to ensure that institutions are accurately reporting the performance of their buildings and some form of accountability needs to be put into place. There is no value in reporting such data, should it be inaccurate and unusable by others.

On average, the buildings in this research do perform better from an energy perspective than the campus-wide energy intensities. The results of this study show demonstrate that 60% (three (3) out of the five (5)) buildings perform better than their associated campus-wide energy intensity. The Claudette MacKay Lassonde Pavilion performed 49% worse than the campus-wide energy intensity at Western University while the Stevenson-Lawson Hall performed 49% better. Simcoe Hall performed 4% worse than the campus-wide energy intensity at Lakehead University and the Ron Joyce Centre performed 64% better than the campus-wide energy intensity at McMaster University. The ACCE building performed 31% better than the campus-wide energy intensity at Algonquin College. These results demonstrate that these LEED buildings do in-fact aid in decreasing the overall energy usage of buildings on campus.

Each building studied in this research had higher actual energy intensities (ranging from 2% to 44%) when compared to the modelled energy intensities for LEED certification. These findings seem to be consistent with current academic literature (discussed in Chapter 2) which lists deviations from the actual measured energy use on average ranges from 14% to 41%. The energy model for the Ron Joyce Centre was the most accurate simulation with a 2% discrepancy between the modeled and actual energy intensity. The discrepancy between the actual energy intensity and modelled energy intensity for Stevenson-Lawson Hall was 24% and the ACCE building was 35%. The discrepancies were much larger for both the Claudette MacKay Lassonde Pavilion and Simcoe Hall at 44%. These large discrepancies demonstrate that the energy model created for LEED demonstration purposes is not an accurate reflection of how a building will be performing from an energy perspective. In order to achieve points in a rating system, buildings should be rewarded based on actual energy savings and as such if these models are not an accurate reflection of the building they should not be solely used to demonstrate compliance.

5.2 Recommendations

Based on the conclusions of this study, and as an experienced LEED practitioner, recommendations to NRCan and Statistics Canada, the CaGBC and USGBC, LEED energy modellers and academic campus decisions makers will be provided in this section. The goal of these recommendations is to improve the overall process of integrating LEED buildings into academic campuses and also to improve the predicted performance of LEED energy models for these associated buildings.

5.2.1 Recommendations for the Ministry of Energy, NRCan and Statistics Canada

The results of this study demonstrate the need for NRCan and Statistics Canada to provide more relevant energy surveys for academic buildings. The existing energy intensity surveys relevant to academic buildings provide multiple years of data with varying building-type categories, building ages, and geographical catchment areas; as a result, the studies do not provide a good basis of comparison for academic buildings to use as a metric of comparison. As outlined in Chapter 4, geographic location can have an impact on the energy use (and therefore the energy intensity) of a building although the attempt in this study to demonstrate the actual difference in Ontario academic buildings was unsuccessful. Through discussion with various energy professionals, provincial data should provide valid climatic information for utilization in an energy benchmark (instead of using location specific benchmarks), but more location specific data would be ideal. The SCIEU 2009, the most recent survey, does categorize the buildings in their study by climatic region, which is an improvement over the previous studies and should provide a better benchmark for buildings. It is therefore recommended that going forward the commercial and institutional surveys should continue this climatic categorization.

Unfortunately, the SCIEU 2009 survey aggregates academic buildings into an 'other' category along with recreational buildings and shopping centres. This severely dilutes the validity and usefulness of this information to academic decision makers. It is therefore recommended that future surveys conducted by NRCan and Statistics Canada break down the 'other' category specifically for each building use type - universities, colleges, and CEGEPs - as did the CICES 2005 and CICES 2008 surveys. By using relevant climatic regions and breaking down the 'other' category into building usage types, this would allow for academic institutions to make better decisions regarding their energy intensity targets and use this information as a baseline metric against which to compare.

Another drawback of the current energy surveys is the lack of building age data for the different building types. While some of the surveys (CIBEUS 2000, CICES 2005, and CICES 2008) have reported the average energy intensity value of buildings for various years of construction, without building type information these averages are of minimal use. It is not very useful to compare a new academic building against the average academic building in Ontario when existing buildings are of varying ages which means different construction quality and building performance. The ideal benchmark would have geographical, building use type, and age criteria for the most useful comparison as a new building should aim to be better than the current state of construction, not the average over the past 100 years.

It should also be noted that there is no differentiation in the benchmarks between academic facilities which utilize high process load spaces such as laboratories and those that do not. It is recommended that future studies separate high process load buildings such as engineering lab facilities versus lower load buildings such as classrooms. Process loads play a large role in increased energy usage and therefore benchmarks need to somehow incorporate these differences.

In addition, it is recommended that a user's guide be provided to help guide those using the surveys to ensure fair 'apples-to-apples' comparisons can be made.

The annual reporting that is mandated due to the Green Energy Act needs to be standardized and upheld. Currently public institutions are reporting data in varying units, inconsistent entries, and skewed values. There needs to be some sort of data quality check in place to ensure that all data reported is accurate. Should the quality of this data be improved, it could be used by researchers to create new energy intensity comparisons (provincial averages, geographically relevant, superior performance target, etcetera) for various building types.

5.2.2 Recommendations for the CaGBC and USGBC

The results of this study demonstrate that these specific LEED certified academic buildings have, on average, lower energy intensities when compared to the average energy intensity of academic buildings in Ontario. While in aggregate there seem to be energy benefits in obtaining LEED certification, there are still LEED certified buildings that are performing significantly worse than the provincial average. The LEED rating system is a certification which boasts that a building will “save money and resources and have a positive impact on the health of occupants, while promoting renewable, clean energy” (USGBC, 2015). Yet, in some instances, it has been shown that buildings that have received certification are, in fact, performing worse than the provincial averages as well as the campus-wide energy intensity. There needs to be some form of accountability and enforcement put into place by the CaGBC and USGBC to ensure these buildings operate and perform as intended.

Additionally, there are obvious issues with the achievement and documentation of LEED energy points. The current academic literature and the results of this study show that there are discrepancies between the LEED energy model and actual energy use ranging anywhere from 2% in the most accurate models to 44% in the least accurate models. Personal experience with energy modelling and M&V data has shown model discrepancies in some instances much larger than 44%. While it is understood within the energy modelling community that LEED models are not necessarily predictive of actual energy use, but rather demonstrate relative savings compared to a baseline building. In this paradigm however, the model provides very little benefit other than documenting LEED energy points. As a result, there is little benefit to the owners of such buildings when the results shown do not reflect their actual buildings. There is currently no reconciliation between the demonstrated savings for LEED certification and the actual usage of the building post-occupancy. If the energy models are significantly different than actual usage it is the author's personal opinion that a building should not be awarded LEED points for theoretical and not realizable savings. Instead, one (1) recommendation would be to implement a one (1) year period of post-occupancy analysis whereby the M&V data is used to calibrate the simulation and provide updated energy savings to document and award LEED points. Within the current LEED paradigm, there are tangible rewards and therefore pressure to demonstrate a high percentage of savings in order to gain a large number of energy-related LEED points. There is nothing in place to ensure the model accurately reflects the true building operation. This disconnect, which is inherent to the process, requires an additional level of energy accountability which should be mandated through the CaGBC and USGBC (such as financial or point related impacts for inaccuracies).

This research has demonstrated that obtaining information from building owners and operators post-LEED certification is an extremely difficult process and that often times these individuals had negative feelings towards the LEED process. Building owners refused to take part in this study for various reasons, but one particularly problematic issue was the unsuccessful implementation of plans and systems necessary for the LEED M&V credit. This may be due to improper metre sizing, a lack of following through with the M&V plans, data not correctly being reported from the M&V consultant/host server to the building owner, or even a change of operating staff. Whatever the reason, M&V is an extremely useful tool that should be utilized by building owners and operators, but its value is often unrealised (even when owners have paid the additional costs associated). Energy modelling and performance based incentives are being utilized more in the industry, and CaGBC and USGBC should ensure that the M&V requirements are properly completed before granting this credit. Placing accountability on the actual performance of a building will reduce some of the negative feelings attributed to LEED.

From both professional experience and through trying to obtain data from universities in this research it was found that often there is a disconnect between the LEED certification process and the operation of the building – there is no physical hand-off of the LEED documentation, M&V plans, commissioning plans, etcetera to the owners and operators of the building. When someone then requests this additional information about the building – the owner frequently has no idea where to look and often requesting this data from the LEED consultant results in additional costs. There should be a way for building owners to request data from the CaGBC, or else the implementation of a program similar to LEED Online (in the US) where the uploaded documents (including energy information in the EnergyStar Portfolio Manager) are centrally stored and accessible by future users.

As a practitioner in this field of sustainability and energy efficiency, the negative stigma associated with the process of LEED certification and the hand-off to building owners and operators is concerning and could drastically impact the future of the LEED program in Canada.

5.2.3 Recommendations for the LEED energy modeller

As mentioned in the previous section (recommendations for the CaGBC and USGBC), there needs to be increased accountability for the results of LEED energy models. Through discussions with energy modeling professionals, there appears to be a perception that LEED models do not need to be as accurate as models for other applications, for example Ontario Building Code (OBC) and Public – Private Partnerships (P3) projects, where reflecting actual building energy usage is deemed more important. It is the author’s opinion that it is the duty of the modeller to ensure that each model is as accurate as possible (within the confines and rules of the regulating program), and that modellers are exercising their due diligence to provide the owner with a simulation that attempts to reflect actual building operation. “There are many reasons why buildings do not perform as modeled, for example, change in design and construction, as well as operation and maintenance issues that can all affect the energy use of the actual building” (Diamond, 2011, pg. 2). While there is no way to simulate a building 100% accurately, there are ways to ensure the energy model is more reflective of reality – calibrated simulations, M&V, checking all shop drawings, discussing operating conditions with the owner and designers. One large systematic obstacle for the energy modeling community is that after a project achieves certification, there is no follow up on the project - unless the project is pursuing the M&V credit. This lack of feedback promulgates the disconnect between the theoretical model and the actual building operation – whereby the actual building operation is in no way connected to the modeling procedure. It is therefore recommended to the CaGBC and USGBC to provide more compelling incentives to increase the accuracy of the energy models and place a higher level of accountability on energy modellers. For their part, professional energy modellers need to raise their level of accountability in order to provide the best model possible for their clients and to help raise the stature of the LEED program.

5.2.4 Recommendations for academic campus decision makers

Gains achieved with energy efficiency can help provide savings in order to achieve better financial paybacks as it relates to LEED certification. While LEED is perceived by some to be an expensive process, this study has shown that these case study LEED certified academic buildings are achieving energy savings when compared to both provincial average and campus-wide energy intensities. It has been observed, however, that not all LEED certified buildings are performing as intended nor as well as the modeled energy predictions. It is the author's opinion there is great potential for a LEED building to perform much better from an energy perspective than non-LEED equivalent buildings, but it is the responsibility of the designers, the commissioning agents, M&V consultants and operators to ensure the building is designed and operated to its full potential to ensure these savings are achieved.

Often on new LEED projects key decision makers, staff committees, designers, and LEED consultants take part during the design and certification phases. But, unfortunately, many times operators of the building are left out of these design discussions and are not told how the building would ideally be operated to maintain energy efficiencies. It is recommended that the building operators are brought into the design discussions early in the process to create synergies between how operators would like to run the building at the campus and implementing new technologies or systems that would aid in energy efficiency. In the author's professional experience that too often these discussions do not occur and the operation teams do not agree with the new technologies implemented. This leads to many headaches associated with the operation and maintenance of the new building and an overall negative feeling by operation staff towards the entire LEED system. It is possible for a building to achieve LEED certification, but with M&V systems that are unable to provide data because the building is not working as designed (i.e., metres are sized incorrectly and are not reporting valid or accurate data). When the building operation staff and owners of the building are aware of the M&V process and have ideas of how the M&V data will be used in the future (through post-occupancy analysis or to provide to researchers), then it is more likely there will be follow ups to ensure that all systems are constructed properly within warranty periods.

Commissioning as well as M&V are also very important steps that should take part in the construction and maintenance of new buildings. Commissioning helps to ensure that all systems are running properly and as designed; whereas, M&V helps to ensure that systems are running effectively or aids in troubleshooting issues that arise. Both of these steps aid in ensuring that the new building is running as smoothly as possible while giving operators feedback on items that require improvement. If these two (2) steps happened on each and every new building the quality and efficiency of new buildings would be significantly increased.

Academic decision makers also need to understand that the savings calculated by the LEED energy model do not equate to the overall energy savings that will be realized. While most energy modellers attempt to accurately model a building, there will always be differences in construction materials used, occupant usage, and how the building is operated, which will result in discrepancies. To reduce the discrepancies, it is recommended to include the building operators in the design process in order to provide a better understanding of how the building will actually be operated; this is of benefit to the energy modeller and LEED consultant and will help ensure the energy model is as accurate as possible. It is also critical that energy modellers receive better information on equipment that consumes a large amount of energy – such as laboratory equipment and server rooms. These loads, along with their anticipated operating schedules, need to be conveyed to the energy modeller. By providing better information relating to these large sources of energy usage, the models will more accurately reflect the building.

Energy intensity comparisons such as energy surveys and the BPS data (specific to building use type and geographical location) should become part of the design process. Relevant comparisons should be discussed with designers and considerations should be made in regards to achieving better energy intensity values for the new buildings. Due to recent legislation (Green Energy Act (Ministry of Energy, 2015)), each Ontario academic campus now has its own published annual average energy intensity comparison which could be used for benchmarking and goal setting. For buildings pursuing LEED certification, it is recommended that academic campus decision makers require that new buildings achieve significantly lower energy intensities than non-LEED equivalent buildings of the same building type, age, and climatic region. The government supplied energy surveys as well as the specific campus-wide energy intensity provide some indication of how the average academic building is performing, but are not a good indication of how a new LEED building should perform. In order to uphold the principles of the program, a new LEED building should provide superior environmental (including energy) and human health advantages in comparison to non-LEED equivalent buildings – this should be the responsibility of the entire design team and building operators as well as the academic decision makers.

5.3 Recommendations for future research

Due to a limited sample size, this research was limited to the study of only a handful of LEED NC v1 certified academic buildings in Ontario. Future research, when more LEED academic buildings are certified and have M&V data available, is recommended to build upon this research. It would also be of interest to determine how LEED v2009 and LEED v4 buildings are performing in comparison to the provincial energy surveys, campus-wide energy intensities, and the LEED energy models.

It is also recommended that future research be conducted on the quality of energy surveys and potential energy benchmarking across Canada. Ideally, a framework will be created and implemented by the government to create an accurate academic energy benchmark which also accounts for process loads of different building types.

Additional research is also needed to determine how energy models can better reflect actual building energy use. There is currently very little academic literature addressing topics related to energy modelling which is problematic as it is becoming a large industry with very little guidance and expertise. It is therefore recommended that more energy professionals share their knowledge and experience through publications in order to decrease the variability between modeled energy and true energy usage.

References

Ahmad, M. & Culp, C. (2006). Uncalibrated Building Energy Simulation Modeling Results. *HVAC&R Research, 12(4),* 1141-1155.

Canada Green Building Council (2004). *LEED Green Building Rating System Reference Package for New Construction and Major Renovations LEED Canada-NC Version 1*. Ottawa: Canada Green Building Council.

Canada Green Building Council (2010). *LEED Canada Reference Guide for Green Building Design and Construction 2009*. Ottawa: Canada Green Building Council.

Canada Green Building Council (2013). *Going green with LEED.* Retrieved from http://www.cagbc.org/Content/NavigationMenu/Programs/LEED/GoingGreenwithLEED/default.htm (May 11, 2014).

Diamond, Rick (2011). Evaluating the energy performance of the first generation of LEED-certified commercial buildings. Lawrence Berkeley National Laboratory: Lawrence Berkeley National Laboratory. Paper LBNL-59853. Retrieved from: http://escholarship.org/uc/item/498009ks

Government of Ontario (2014). *Energy use and greenhouse gas emissions for the Broader Public Sector*. Retrieved from: http://www.ontario.ca/data/energy-use-and-greenhouse-gas-emissions-broader-public-sector (May 14, 2014).

Kleinhenz, P., Seryak, J., Schreier, C., Sever, F., & Raffio, G. (2012). How The Culture of Inefficiency Is Outfoxing LEED®, ASHRAE, And Efficiency Programs. *Engineered Systems*, *29*(10), 28-34

McMaster University (2011). *Sustainability at McMaster.* Retrieved from: http://mcmaster.ca/sustainability/energy.html (July 15, 2015).

Menassa, C., Mangasarian, S., El Asmar, M., and Kirar, C. (2012). “Energy Consumption Evaluation of U.S. Navy LEED-Certified Buildings.” *J. Perform. Constr. Facil.*, 26(1), 46–53.

Ministry of Energy (2015). *Green Energy Act.* Retrieved from: http://www.energy.gov.on.ca/en/green-energy-act/ (July 15, 2015).

Ministry of Energy (2015). *Conservation for Public Agencies.* Retrieved from: http://www.energy.gov.on.ca/en/green-energy-act/conservation-for-public-agencies/ (August 7, 2015).

Natural Resources Canada (2014). *Buildings.* Retrieved from http://www.nrcan.gc.ca/energy/efficiency/buildings/4261 (May 11, 2014).

Natural Resources Canada (2002). *Survey 2000: Commercial and Institutional Building Energy Use Detailed Statistical Report.* Ottawa, ON: Natural Resources Canada.

Natural Resources Canada (2005). *2003 Consumption of Energy Survey for Universities, Colleges and Hospitals.* Ottawa, ON: Natural Resources Canada.

Natural Resources Canada (2007). *2005 Commercial and Institutional Consumption of Energy Survey: Summary Report.* Ottawa, ON: Natural Resources Canada.

Natural Resources Canada (2008). *EE4 v1.7 (computer software).* Ottawa, ON: Natural Resources Canada.

Natural Resources Canada (2011). *2008 Commercial & Institutional Consumption of Energy Survey: Summary Report.* Ottawa, ON: Natural Resources Canada.

Natural Resources Canada (2012). *Survey of Commercial and Institutional Energy Use – Buildings 2009.* Ottawa, ON: Natural Resources Canada.

Newsham, G. R., Mancini, S., & Birt, B. J. (2009). Do LEED-certified buildings save energy? yes, but…. *Energy & Buildings, 41*(8), 897-905.

Oates, D. and Sullivan, K. (2012). "Postoccupancy Energy Consumption Survey of Arizona's LEED New Construction Population." *J. Constr. Eng. Manage.*, 138(6), 742–750.

Ontario Building Officials Association (OBOA) (2014). *Build it by the book*. Retrieved from http://www.oboa.on.ca/ps/BuildingCode2014.pdf (May 27, 2014).

Samuelson, H.W. et al (2014). Post-Occupancy Evaluation and Partial-Calibration of 18 Design-Phase Energy Models. *2014 ASHRAE/IBPSA-USA Building Simulation Conference (Atlanta, GA),* 1-9.

Schell, C. (1992). *The Value of the Case Study as a Research Strategy*. Manchester Business School, UK.

Scofield, J. H. (2009). Do LEED-certified buildings save energy? not really…. *Energy & Buildings, 41*(12), 1386-1390.

Scofield, J. H. (2013). Efficacy of LEED-certification in reducing energy consumption and greenhouse gas emission for large New York City office buildings. *Energy & Buildings, 67*(1), 517-524.

Stoppel, C. & Leite, F. (2013). Evaluating building energy model performance of LEED buildings: identifying potential sources of error through aggregate analysis. *Energy & Buildings, 65 (2013),* 185-196.

Turner, C. & Frankel, M. (2008). *Energy Performance of LEED for New Construction Buildings*. Washington, DC.

United States Green Building Council (2014). *USGBC History.* Retrieved from http://www.usgbc.org/about/history (May 12, 2014).

United States Green Building Council (2014). *USGBC LEED.* Retrieved from http://www.usgbc.org/leed (May 15, 2015).

World Commission on Environment and Development (WCED). (1987). *Our common future*. Oxford: Oxford University Press.

Yin, R. (1984). *Case Study Research: Design and Methods*. Newbury Park, Sage Publications.

Appendix A: LEED Rating System Categories and Points

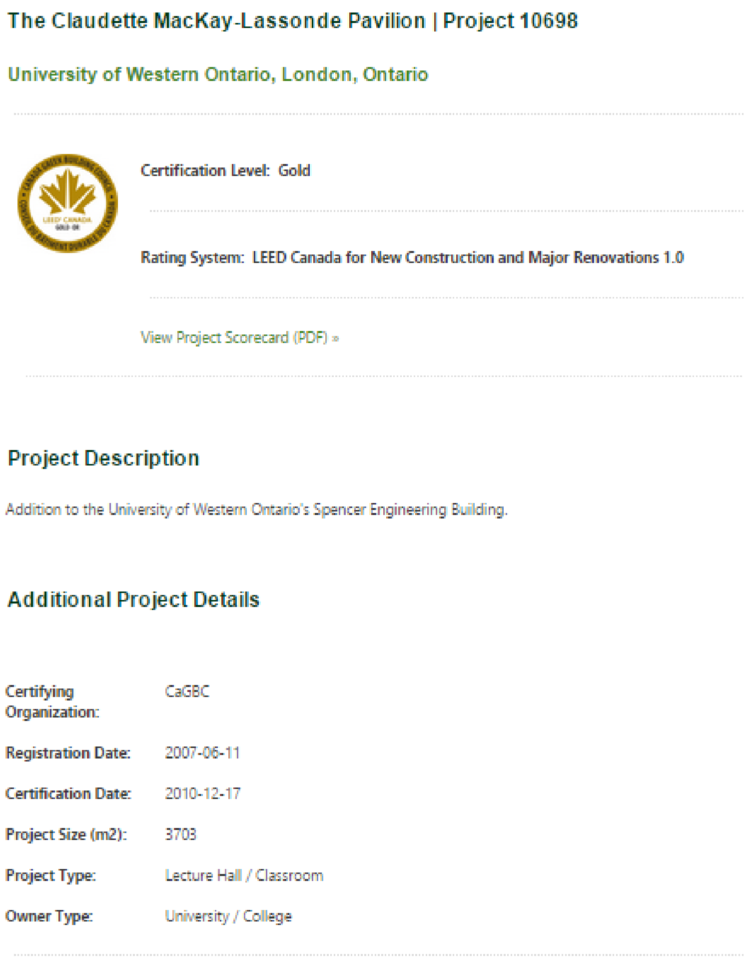
LEED CREDIT	POINTS
Sustainable Sites (14 Points)	
SSp1: Erosion and Sedimentation Control	None
SSc1: Site Selection	1
SSc2: Development Density	1
SSc3: Redevelopment of a Contaminated Site	1
SSc4: Alternative Transportation	
SSc4.1: Public Transportation Access	1
SSc4.2: Bicycle Storage and Change Rooms	1
SSc4.3: Alterative Fuel Vehicles	1
SSc4.4: Parking Capacity	1
SSc5: Reduced Site Disturbance	
SSc5.1: Protect or Restore Open Space	1
SSc5.2: Development Footprint	1
SSc6: Stormwater Management	
SSc6.1: Rate and Quantity	1
SSc6.2: Treatment	1
SSc7: Heat Island Effect	
SSc7.1: Non-Roof	1
SSc7.2: Roof	1
SSc8: Light Pollution Reduction	1
Water Efficiency (5 Points)	
WEc1: Water Efficient Landscaping	
WEc1.1: Reduce by 50%	1
WEc1.2: No Potable Use or No Irrigation	1
WEc2: Innovative Wastewater Technologies	1
WEc3: Water Use Reduction	
WEc3.1: 20% Reduction	1
WEc3.2: 30% Reduction	1
Energy and Atmosphere (17 Points)	
EAp1: Fundamental Building Systems Commissioning	None
EAp2: Minimum Energy Performance	None
EAp3: CFC Reduction in HVAC&R Equipment & Elimination of Halons	None
EAc1: Optimize Energy Performance	1-10
EAc2: Renewable Energy	1-3
EAc3: Best Practice Commissioning	1
EAc4: Elimination of HCFCs	1
EAc5: Measurement and Verification	1
EAc6: Green Power	1

Materials and Resources (14 Points)	
MRp1: Storage and Collection of Recyclables	None
MRc1: Building Reuse	
MRc1.1: Maintain 75% Existing Walls, Floors and Roof	1
MRc1.2: Maintain 95% Existing Walls, Floors and Roof	1
MRc1.3: Maintain 50% of Interior Non-Structural Elements	1
MRc2: Construction Waste Management	
MRc2.1: Divert 50% from Landfill	1
MRc2.2: Divert 75% from Landfill	1
MRc3: Materials Reuse	
MRc3.1: 5% Salvaged Materials	1
MRc3.2: 10% Salvaged Materials	1
MRc4: Recycled Content	
MRc4.1: 7.5% (post consumer + ½ post-industrial)	1
MRc4.2: 15% (post consumer + ½ post-industrial)	1
MRc5: Regional Materials	
MRc5.1: 10% Manufactured Regionally	1
MRc5.2: 20% Manufactured Regionally	1
MRc6: Rapidly Renewable Materials	1
MRc7: Certified Wood	1
MRc8: Durable Building	1
Indoor Environmental Quality (15 Points)	
EQp1: Minimum IAQ Performance	None
EQp2: Environmental Tobacco Smoke (ETS) Control	None
EQc1: Carbon Dioxide (CO2) Monitoring	1
EQc2: Increase Ventilation Effectiveness	1
EQc3: Construction IAQ Management Plan	
EQc3.1: During Construction	1
EQc3.2: Before Construction	1
EQc4: Low Emitting Materials	
EQc4.1: Adhesives and Sealants	1
EQc4.2: Paints and Coatings	1
EQc4.3: Carpets	1
EQc4.4: Composite Wood	1
EQc5: Indoor Chemical and Pollutant Source Control	1
EQc6: Controllability of Systems	
EQc6.1: Perimeter Zones	1
EQc6.2: Non-Perimeter Zones	1
EQc7: Thermal Comfort	
EQc7.1: Comply with ASHRAE Standard 55-2004	1
EQc7.2: Permanent Monitoring System	1
EQc8: Daylight and Views	
EQc8.1: Daylight 75% of Spaces	1
EQc8.2: Views for 90% of Spaces	1

Innovation and Design Process (5 Points)	
IDc1: Innovation Credits	1-4
IDc2: LEED Accredited Professional	1
TOTAL	**70**

*Adapted from the LEED Green Building Rating System Reference Package for New Construction and Major Renovations LEED Canada-NC Version 1 (2004), p. 28-30

Appendix B: CaGBC Project Profiles, LEED Scorecards, and CaGBC Building Selection Table



The Claudette MacKay-Lassonde Pavilion | Project 10698

University of Western Ontario, London, Ontario

Certification Level: Gold

Rating System: LEED Canada for New Construction and Major Renovations 1.0

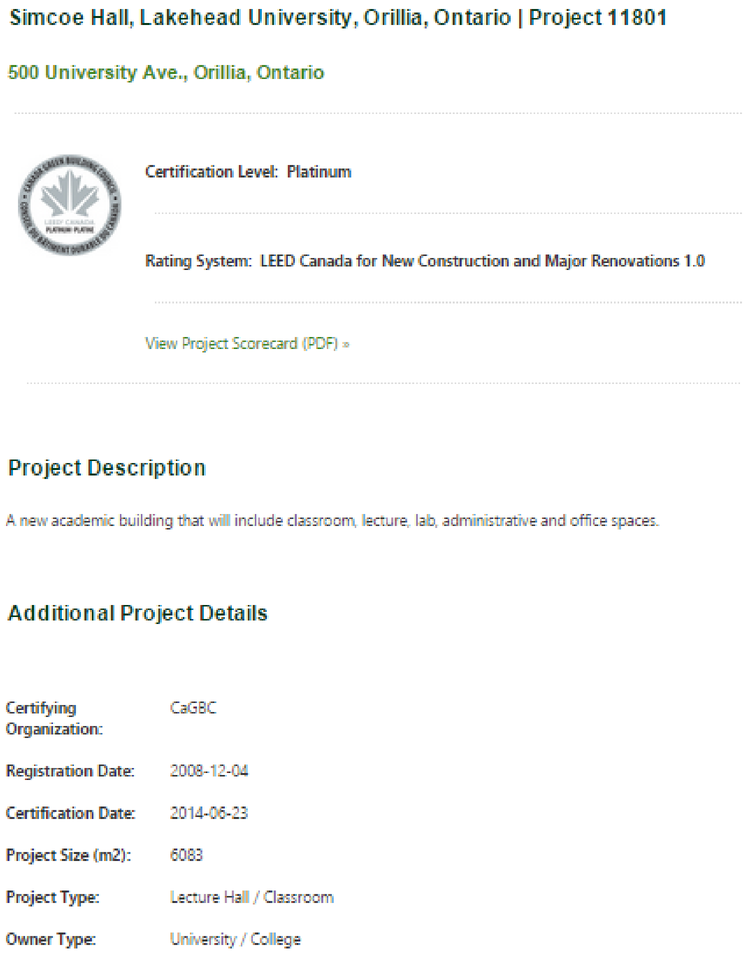
View Project Scorecard (PDF) »

Project Description

Addition to the University of Western Ontario's Spencer Engineering Building.

Additional Project Details

Certifying Organization:	CaGBC
Registration Date:	2007-06-11
Certification Date:	2010-12-17
Project Size (m2):	3703
Project Type:	Lecture Hall / Classroom
Owner Type:	University / College



Simcoe Hall, Lakehead University, Orillia, Ontario | Project 11801

500 University Ave., Orillia, Ontario

Certification Level: Platinum

Rating System: LEED Canada for New Construction and Major Renovations 1.0

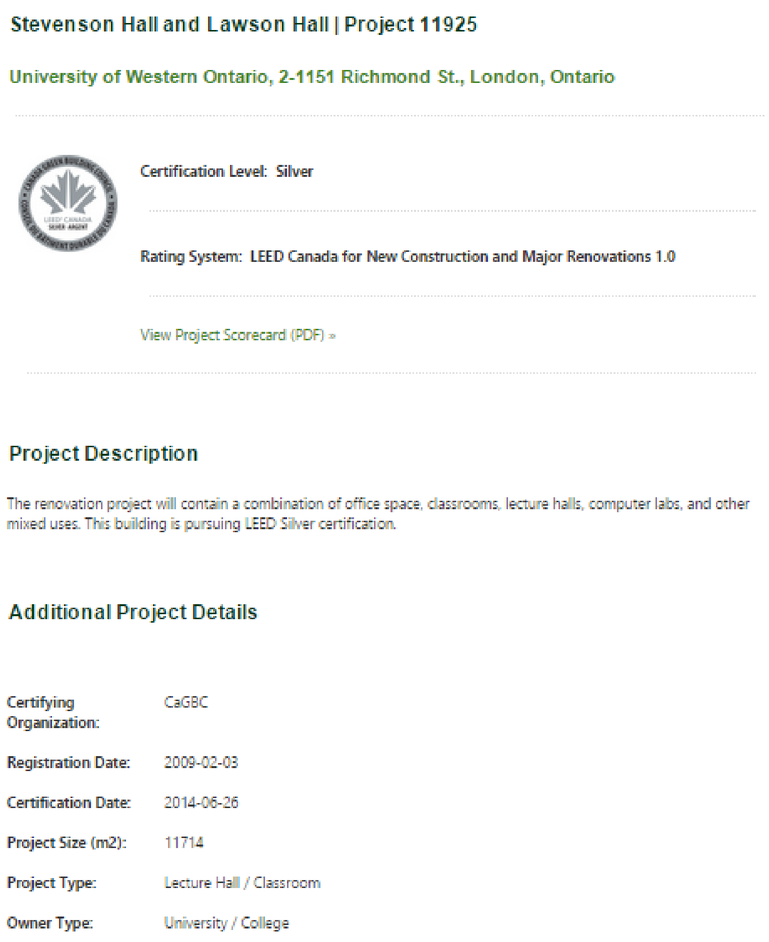
View Project Scorecard (PDF) »

Project Description

A new academic building that will include classroom, lecture, lab, administrative and office spaces.

Additional Project Details

Certifying Organization:	CaGBC
Registration Date:	2008-12-04
Certification Date:	2014-06-23
Project Size (m2):	6083
Project Type:	Lecture Hall / Classroom
Owner Type:	University / College



Stevenson Hall and Lawson Hall | Project 11925

University of Western Ontario, 2-1151 Richmond St., London, Ontario

Certification Level: Silver

Rating System: LEED Canada for New Construction and Major Renovations 1.0

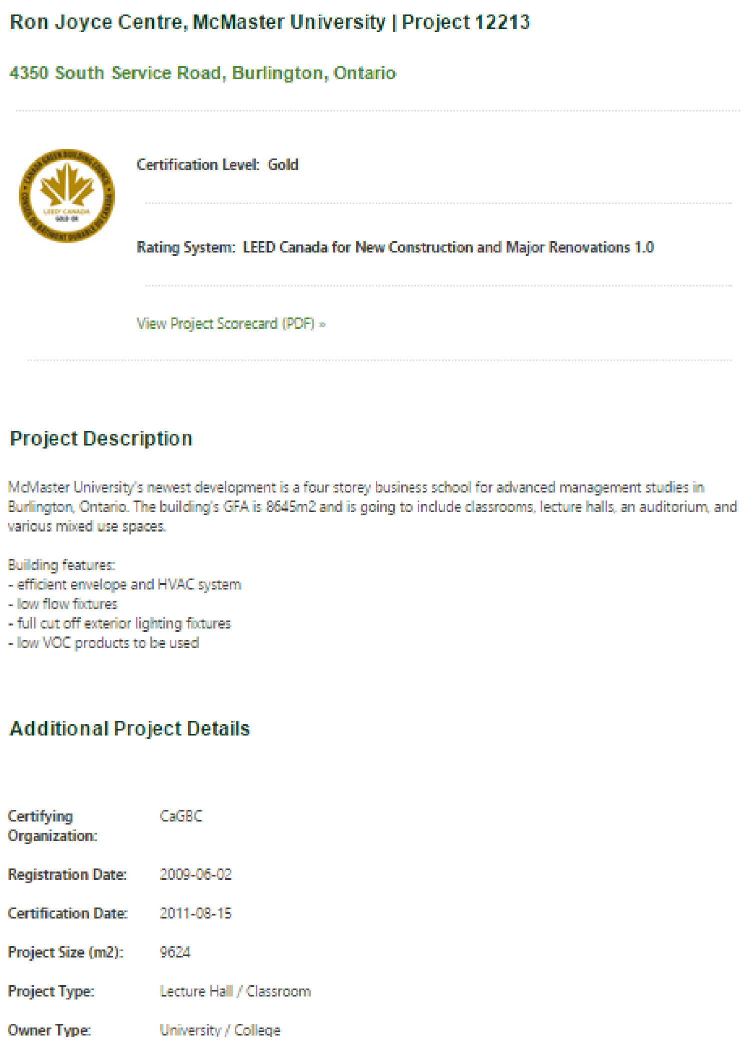
View Project Scorecard (PDF) »

Project Description

The renovation project will contain a combination of office space, classrooms, lecture halls, computer labs, and other mixed uses. This building is pursuing LEED Silver certification.

Additional Project Details

Certifying Organization:	CaGBC
Registration Date:	2009-02-03
Certification Date:	2014-06-26
Project Size (m2):	11714
Project Type:	Lecture Hall / Classroom
Owner Type:	University / College



Ron Joyce Centre, McMaster University | Project 12213

4350 South Service Road, Burlington, Ontario

Certification Level: Gold

Rating System: LEED Canada for New Construction and Major Renovations 1.0

View Project Scorecard (PDF) »

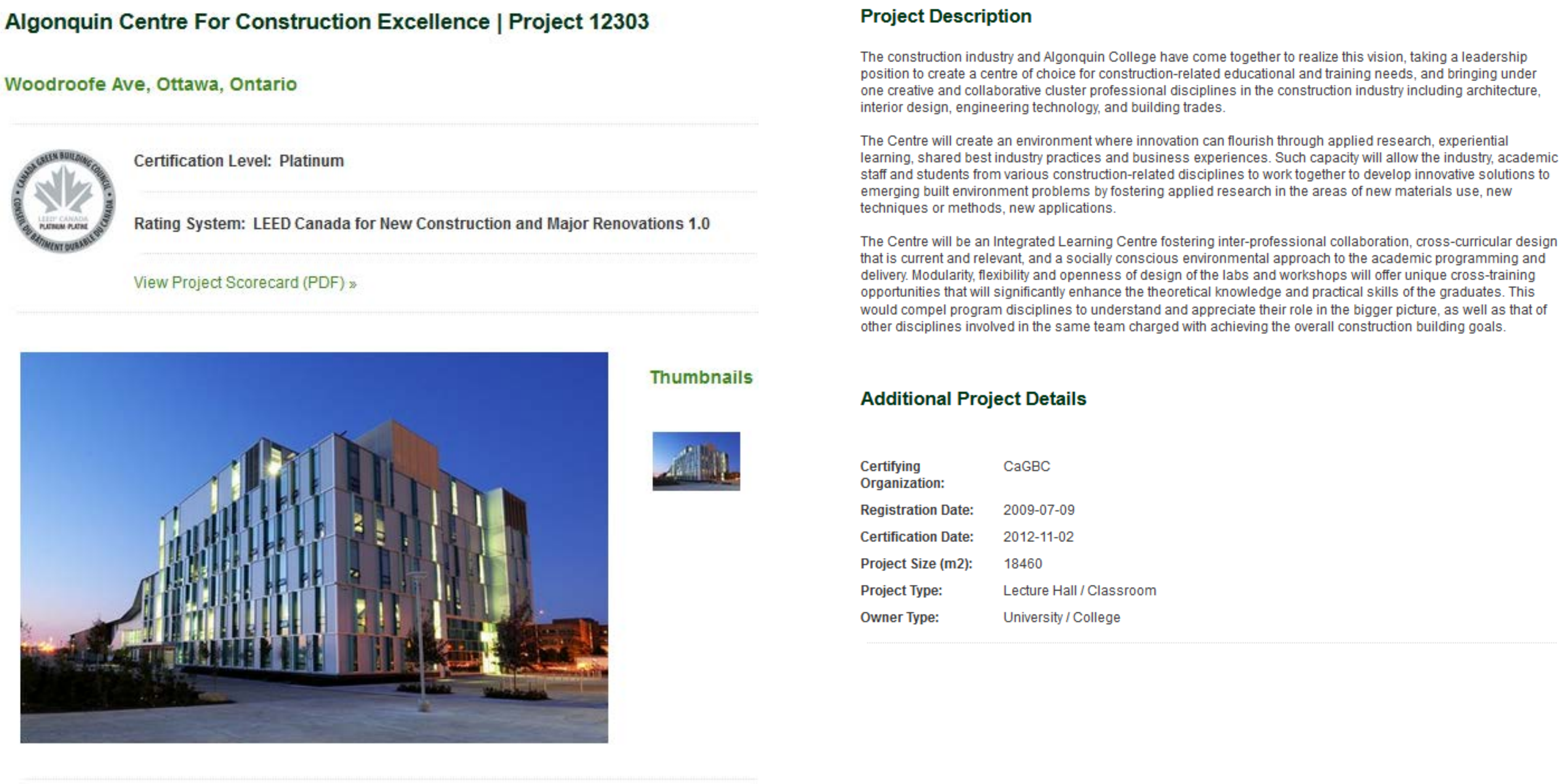
Project Description

McMaster University's newest development is a four storey business school for advanced management studies in Burlington, Ontario. The building's GFA is 8645m2 and is going to include classrooms, lecture halls, an auditorium, and various mixed use spaces.

Building features:
- efficient envelope and HVAC system
- low flow fixtures
- full cut off exterior lighting fixtures
- low VOC products to be used

Additional Project Details

Certifying Organization:	CaGBC
Registration Date:	2009-06-02
Certification Date:	2011-08-15
Project Size (m2):	9624
Project Type:	Lecture Hall / Classroom
Owner Type:	University / College



Algonquin Centre For Construction Excellence | Project 12303

Woodroofe Ave, Ottawa, Ontario

Certification Level: Platinum

Rating System: LEED Canada for New Construction and Major Renovations 1.0

View Project Scorecard (PDF) »

Thumbnails

Project Description

The construction industry and Algonquin College have come together to realize this vision, taking a leadership position to create a centre of choice for construction-related educational and training needs, and bringing under one creative and collaborative cluster professional disciplines in the construction industry including architecture, interior design, engineering technology, and building trades.

The Centre will create an environment where innovation can flourish through applied research, experiential learning, shared best industry practices and business experiences. Such capacity will allow the industry, academic staff and students from various construction-related disciplines to work together to develop innovative solutions to emerging built environment problems by fostering applied research in the areas of new materials use, new techniques or methods, new applications.

The Centre will be an Integrated Learning Centre fostering inter-professional collaboration, cross-curricular design that is current and relevant, and a socially conscious environmental approach to the academic programming and delivery. Modularity, flexibility and openness of design of the labs and workshops will offer unique cross-training opportunities that will significantly enhance the theoretical knowledge and practical skills of the graduates. This would compel program disciplines to understand and appreciate their role in the bigger picture, as well as that of other disciplines involved in the same team charged with achieving the overall construction building goals.

Additional Project Details

Certifying Organization:	CaGBC
Registration Date:	2009-07-09
Certification Date:	2012-11-02
Project Size (m2):	18460
Project Type:	Lecture Hall / Classroom
Owner Type:	University / College

Building with purpose

LEED® Canada - NC 1.0
GREEN BUILDING RATING SYSTEM

Claudette MacKay-Lassonde Pavilion
Spencer Engineering Addition
CaGBC Project # 10698
December 17, 2010

41 Points Achieved *Gold Rating Achieved* Possible Points: 70

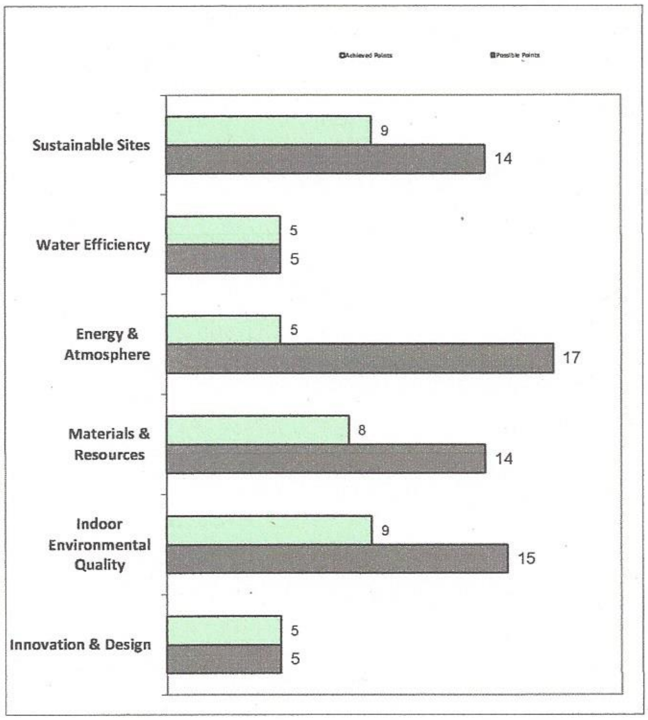
Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

9 Sustainable Sites Possible Points 14

Y	Prereq 1	Erosion & Sedimentation Control	Required
1	Credit 1	Site Selection	1
	Credit 2	Development Density	1
	Credit 3	Redevelopment of Contaminated Site	1
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, 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
	Credit 5.2	Reduced Site Disturbance, Development Footprint	1
1	Credit 6.1	Stormwater Management, Rate and Quantity	1
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



5 Energy & Atmosphere Possible Points 17

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
3	Credit 1	Optimize Energy Performance	1 to 10
	Credit 2.1	Renewable Energy, 5%	1
	Credit 2.2	Renewable Energy, 10%	1
	Credit 2.3	Renewable Energy, 20%	1
1	Credit 3	Best Practice Commissioning	1
	Credit 4	Ozone Protection	1
1	Credit 5	Measurement & Verification	1
	Credit 6	Green Power	1

8 Materials & Resources Possible Points 14

Y	Prereq 1	Storage & Collection of Recyclables	Required
	Credit 1.1	Building Reuse: Maintain 75% of Existing Walls, Floors, & Roof	1
	Credit 1.2	Building Reuse: Maintain 95% of Existing Walls, Floors, & 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
	Credit 3.1	Resource Reuse: 5%	1
	Credit 3.2	Resource Reuse: 10%	1
1	Credit 4.1	Recycled Content: 7.5% (post-consumer + ½ post-industrial)	1
1	Credit 4.2	Recycled Content: 15% (post-consumer + ½ post-industrial)	1
1	Credit 5.1	Regional Materials: 10% Extracted & Manufactured Regionally	1
1	Credit 5.2	Regional Materials: 20% Extracted & Manufactured Regionally	1
	Credit 6	Rapidly Renewable Materials	1
1	Credit 7	Certified Wood	1
1	Credit 8	Durable Building	1

9 Indoor Environmental Quality Possible Points 15

Y	Prereq 1	Minimum IAQ Performance	Required
Y	Prereq 2	Environmental Tobacco Smoke (ETS) Control	Required
1	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
	Credit 4.1	Low-Emitting Materials: Adhesives & Sealants	1
1	Credit 4.2	Low-Emitting Materials: Paints and Coating	1
1	Credit 4.3	Low-Emitting Materials: Carpet	1
1	Credit 4.4	Low-Emitting Materials: Composite Wood & Laminate Adhesives	1
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 90% of Spaces	1

5 Innovation & Design Process Possible Points 5

1	Credit 1.1	Innovation in Design:	Green Housekeeping Program	1
1	Credit 1.2	Innovation in Design:	Exemplary Performance: Regional Materials	1
1	Credit 1.3	Innovation in Design:	Reduced Low Mercury Lighting	1
1	Credit 1.4	Innovation in Design:	Exemplary Performance: Water Use Reduction	1
1	Credit 2	LEED® Accredited Professional		1

Building with purpose

LEED® Canada - NC 1.0

GREEN BUILDING RATING SYSTEM

Simcoe Hall, Lakehead University,
Orillia, Ontario
CaGBC Project # 11801
June 23, 2014

52	Points Achieved	*Platinum Rating Achieved*	Possible Points: 70

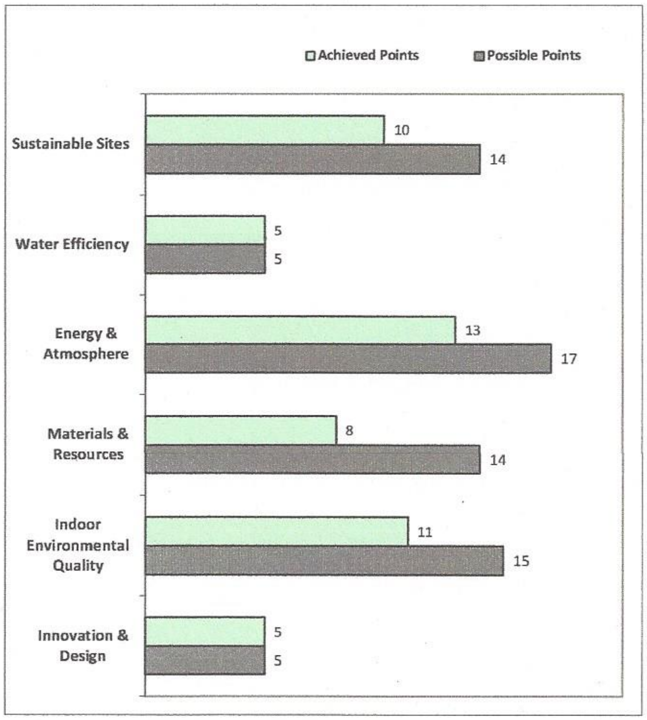
Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

10 Sustainable Sites — Possible Points 14

Y	Prereq 1	Erosion & Sedimentation Control	Required
1	Credit 1	Site Selection	1
	Credit 2	Development Density	1
	Credit 3	Redevelopment of Contaminated Site	1
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, 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
1	Credit 6.1	Stormwater Management, Rate and Quantity	1
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



13 Energy & Atmosphere — Possible Points 17

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
10	Credit 1	Optimize Energy Performance	1 to 10
	Credit 2.1	Renewable Energy, 5%	1
	Credit 2.2	Renewable Energy, 10%	1
	Credit 2.3	Renewable Energy, 20%	1
1	Credit 3	Best Practice Commissioning	1
1	Credit 4	Ozone Protection	1
1	Credit 5	Measurement & Verification	1
	Credit 6	Green Power	1

8 Materials & Resources — Possible Points 14

Y	Prereq 1	Storage & Collection of Recyclables	Required
	Credit 1.1	Building Reuse: Maintain 75% of Existing Walls, Floors, & Roof	1
	Credit 1.2	Building Reuse: Maintain 95% of Existing Walls, Floors, & 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
	Credit 3.1	Resource Reuse: 5%	1
	Credit 3.2	Resource Reuse: 10%	1
1	Credit 4.1	Recycled Content: 7.5% (post-consumer + ½ post-industrial)	1
1	Credit 4.2	Recycled Content: 15% (post-consumer + ½ post-industrial)	1
1	Credit 5.1	Regional Materials: 10% Extracted & Manufactured Regionally	1
1	Credit 5.2	Regional Materials: 20% Extracted & Manufactured Regionally	1
	Credit 6	Rapidly Renewable Materials	1
1	Credit 7	Certified Wood	1
1	Credit 8	Durable Building	1

11 Indoor Environmental Quality — Possible Points 15

Y	Prereq 1	Minimum IAQ Performance	Required
Y	Prereq 2	Environmental Tobacco Smoke (ETS) Control	Required
1	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 Coating	1
1	Credit 4.3	Low-Emitting Materials: Carpet	1
1	Credit 4.4	Low-Emitting Materials: Composite Wood & Laminate Adhesives	1
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
1	Credit 8.2	Daylight & Views: Views 90% of Spaces	1

5 Innovation & Design Process — Possible Points 5

1	Credit 1.1	Innovation in Design:	Exemplary Performance: Water Use Reduction	1
1	Credit 1.2	Innovation in Design:	Exemplary Performance: Recycled Content	1
1	Credit 1.3	Innovation in Design:	Exemplary Performance: Regional Materials	1
1	Credit 1.4	Innovation in Design:	Green Education Program	1
1	Credit 2	LEED® Accredited Professional		1

Building with purpose

L E E D® Canada - NC 1.0

GREEN BUILDING RATING SYSTEM

Stevenson Hall and Lawson Hall

CaGBC Project # 11925

June 26, 2014

35 Points Achieved *Silver Rating Achieved* Possible Points: 70

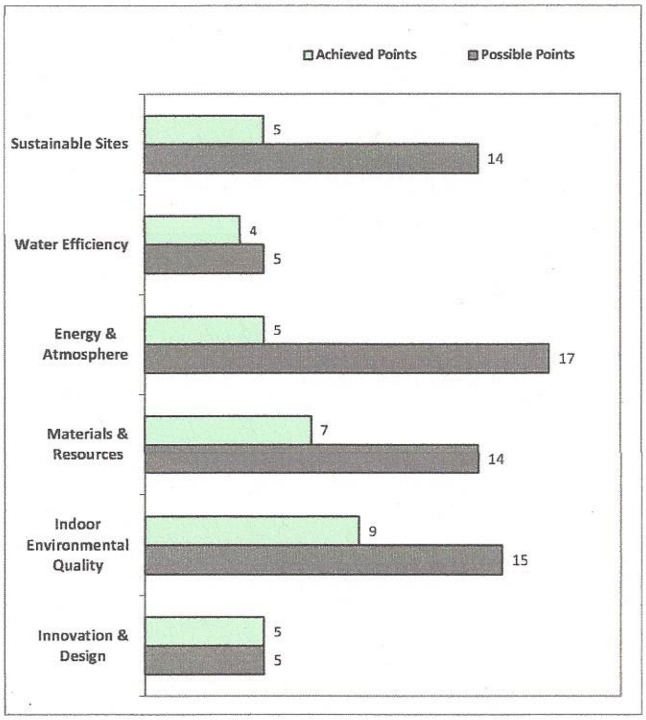
Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

5 Sustainable Sites Possible Points 14

Y	Prereq 1	Erosion & Sedimentation Control	Required
1	Credit 1	Site Selection	1
1	Credit 2	Development Density	1
	Credit 3	Redevelopment of Contaminated Site	1
1	Credit 4.1	Alternative Transportation, Public Transportation Access	1
	Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1
	Credit 4.3	Alternative Transportation, 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
	Credit 7.1	Heat Island Effect, Non-Roof	1
	Credit 7.2	Heat Island Effect, Roof	1
	Credit 8	Light Pollution Reduction	1

4 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
	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



5 Energy & Atmosphere Possible Points 17

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
4	Credit 1	Optimize Energy Performance	1 to 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
	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	Required
1	Credit 1.1	Building Reuse: Maintain 75% of Existing Walls, Floors, & Roof	1
1	Credit 1.2	Building Reuse: Maintain 95% of Existing Walls, Floors, & 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
	Credit 3.1	Resource Reuse: 5%	1
	Credit 3.2	Resource Reuse: 10%	1
1	Credit 4.1	Recycled Content: 7.5% (post-consumer + ½ post-industrial)	1
	Credit 4.2	Recycled Content: 15% (post-consumer + ½ post-industrial)	1
1	Credit 5.1	Regional Materials: 10% Extracted & Manufactured Regionally	1
1	Credit 5.2	Regional Materials: 20% Extracted & Manufactured Regionally	1
	Credit 6	Rapidly Renewable Materials	1
	Credit 7	Certified Wood	1
	Credit 8	Durable Building	1

9 Indoor Environmental Quality Possible Points 15

Y	Prereq 1	Minimum IAQ Performance	Required
Y	Prereq 2	Environmental Tobacco Smoke (ETS) Control	Required
1	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 Coating	1
1	Credit 4.3	Low-Emitting Materials: Carpet	1
1	Credit 4.4	Low-Emitting Materials: Composite Wood & 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 90% of Spaces	1

5 Innovation & Design Process Possible Points 5

1	Credit 1.1	Innovation in Design:	Green Housekeeping Program	1
1	Credit 1.2	Innovation in Design:	Exemplary Performance: Water Use Reduction	1
1	Credit 1.3	Innovation in Design:	Sustainable Purchasing: Reduced Mercury in Lamps	1
1	Credit 1.4	Innovation in Design:	Green Education Program	1
1	Credit 2	LEED® Accredited Professional		1

LEED® Canada - NC 1.0
GREEN BUILDING RATING SYSTEM

Building with purpose

Ron Joyce Centre, McMaster University
CaGBC Project # 12213
August 15, 2011

43 Points Achieved *Gold Rating Achieved* Possible Points: 70

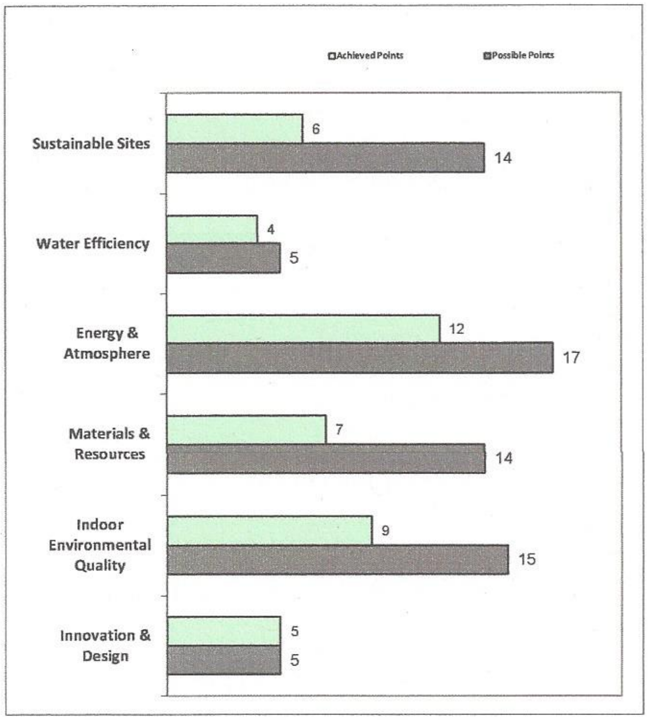
Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

6 Sustainable Sites — Possible Points 14

Y	Prereq 1	Erosion & Sedimentation Control	Required
1	Credit 1	Site Selection	1
	Credit 2	Development Density	1
	Credit 3	Redevelopment of Contaminated Site	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, Alternative Fuel Vehicles	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
1	Credit 6.2	Stormwater Management, Treatment	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

4 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
	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



12 Energy & Atmosphere — Possible Points 17

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
8	Credit 1	Optimize Energy Performance	1 to 10
	Credit 2.1	Renewable Energy, 5%	1
	Credit 2.2	Renewable Energy, 10%	1
	Credit 2.3	Renewable Energy, 20%	1
1	Credit 3	Best Practice Commissioning	1
1	Credit 4	Ozone Protection	1
1	Credit 5	Measurement & Verification	1
1	Credit 6	Green Power	1

7 Materials & Resources — Possible Points 14

Y	Prereq 1	Storage & Collection of Recyclables	Required
	Credit 1.1	Building Reuse: Maintain 75% of Existing Walls, Floors, & Roof	1
	Credit 1.2	Building Reuse: Maintain 95% of Existing Walls, Floors, & 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
	Credit 3.1	Resource Reuse: 5%	1
	Credit 3.2	Resource Reuse: 10%	1
1	Credit 4.1	Recycled Content: 7.5% (post-consumer + ½ post-industrial)	1
1	Credit 4.2	Recycled Content: 15% (post-consumer + ½ post-industrial)	1
1	Credit 5.1	Regional Materials: 10% Extracted & Manufactured Regionally	1
1	Credit 5.2	Regional Materials: 20% Extracted & Manufactured Regionally	1
	Credit 6	Rapidly Renewable Materials	1
1	Credit 7	Certified Wood	1
	Credit 8	Durable Building	1

9 Indoor Environmental Quality — Possible Points 15

Y	Prereq 1	Minimum IAQ Performance	Required
Y	Prereq 2	Environmental Tobacco Smoke (ETS) Control	Required
1	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 Coating	1
1	Credit 4.3	Low-Emitting Materials: Carpet	1
1	Credit 4.4	Low-Emitting Materials: Composite Wood & 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 90% of Spaces	1

5 Innovation & Design Process — Possible Points 5

1	Credit 1.1	Innovation in Design:	Exceptional Performance - Water Use Reduction	1
1	Credit 1.2	Innovation in Design:	Green Cleaning	1
1	Credit 1.3	Innovation in Design:	Exceptional Performance - Recycled Content	1
1	Credit 1.4	Innovation in Design:	Scent Free Policy	1
1	Credit 2	LEED® Accredited Professional		1

Building with purpose

LEED® Canada - NC 1.0

GREEN BUILDING RATING SYSTEM

Algonquin Centre For Construction Excellence

CaGBC Project # 12303

November 2, 2012

52 Points Achieved — *Platinum Rating Achieved* — Possible Points: 70

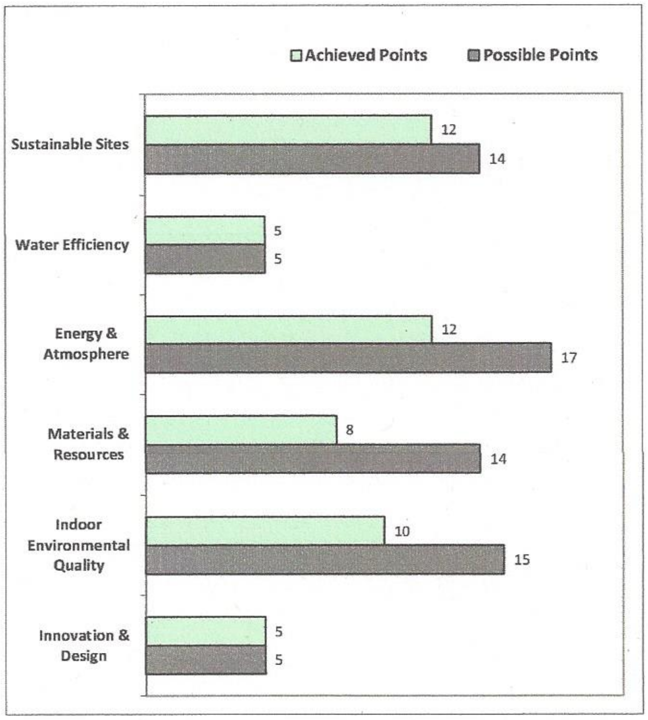
Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

12 Sustainable Sites — Possible Points 14

Y	Prereq 1	Erosion & Sedimentation Control	Required
1	Credit 1	Site Selection	1
1	Credit 2	Development Density	1
	Credit 3	Redevelopment of Contaminated Site	1
1	Credit 4.1	Alternative Transportation, Public Transportation Access	1
1	Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1
1	Credit 4.3	Alternative Transportation, Alternative Fuel Vehicles	1
1	Credit 4.4	Alternative Transportation, Parking Capacity	1
1	Credit 5.1	Reduced Site Disturbance, Protect or Restore Open Space	1
	Credit 5.2	Reduced Site Disturbance, Development Footprint	1
1	Credit 6.1	Stormwater Management, Rate and Quantity	1
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



12 Energy & Atmosphere — Possible Points 17

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
9	Credit 1	Optimize Energy Performance	1 to 10
	Credit 2.1	Renewable Energy, 5%	1
	Credit 2.2	Renewable Energy, 10%	1
	Credit 2.3	Renewable Energy, 20%	1
1	Credit 3	Best Practice Commissioning	1
1	Credit 4	Ozone Protection	1
1	Credit 5	Measurement & Verification	1
	Credit 6	Green Power	1

8 Materials & Resources — Possible Points 14

Y	Prereq 1	Storage & Collection of Recyclables	Required
	Credit 1.1	Building Reuse: Maintain 75% of Existing Walls, Floors, & Roof	1
	Credit 1.2	Building Reuse: Maintain 95% of Existing Walls, Floors, & 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
	Credit 3.1	Resource Reuse: 5%	1
	Credit 3.2	Resource Reuse: 10%	1
1	Credit 4.1	Recycled Content: 7.5% (post-consumer + ½ post-industrial)	1
1	Credit 4.2	Recycled Content: 15% (post-consumer + ½ post-industrial)	1
1	Credit 5.1	Regional Materials: 10% Extracted & Manufactured Regionally	1
1	Credit 5.2	Regional Materials: 20% Extracted & Manufactured Regionally	1
	Credit 6	Rapidly Renewable Materials	1
1	Credit 7	Certified Wood	1
1	Credit 8	Durable Building	1

10 Indoor Environmental Quality — Possible Points 15

Y	Prereq 1	Minimum IAQ Performance	Required
Y	Prereq 2	Environmental Tobacco Smoke (ETS) Control	Required
1	Credit 1	Carbon Dioxide (CO_2) Monitoring	1
	Credit 2	Ventilation Effectiveness	1
1	Credit 3.1	Construction IAQ Management Plan: During Construction	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 Coating	1
1	Credit 4.3	Low-Emitting Materials: Carpet	1
1	Credit 4.4	Low-Emitting Materials: Composite Wood & Laminate Adhesives	1
1	Credit 5	Indoor Chemical & Pollutant Source Control	1
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
	Credit 7.2	Thermal Comfort: Monitoring	1
1	Credit 8.1	Daylight & Views: Daylight 75% of Spaces	1
	Credit 8.2	Daylight & Views: Views 90% of Spaces	1

5 Innovation & Design Process — Possible Points 5

1	Credit 1.1	Innovation in Design: Green Education Program	1
1	Credit 1.2	Innovation in Design: Green Cleaning Program	1
1	Credit 1.3	Innovation in Design: Exceptional Performance: Regional Materials	1
1	Credit 1.4	Innovation in Design: Exceptional Performance: Water Use Reduction	1
1	Credit 2	LEED® Accredited Professional	1

CaGBC Building Selection Table

project_nu	project_name	project_cit	registration_date	certification_date	certificatio	version	project_size	project_type	owner_type	M&V?
~~10058~~	~~Burke Science Building~~	~~Hamilton~~	~~2004-11-16~~	~~2010-05-10~~	~~Silver~~	~~1~~	~~14578~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~10369~~	~~Brock University Plaza 2006~~	~~St. Catheri~~	~~2006-07-20~~	~~2007-07-24~~	~~Silver~~	~~1~~	~~7880~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~10411~~	~~Centre for Healthy Communities~~	~~Brampton~~	~~2006-10-20~~	~~2010-10-21~~	~~Silver~~	~~1~~	~~7958~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~10440~~	~~Medical Education Building~~	~~Windsor~~	~~2006-11-02~~	~~2014-02-18~~	~~Silver~~	~~1~~	~~5675~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~11519~~	~~Brock University International Centre~~	~~St Catherin~~	~~2008-08-01~~	~~2012-09-27~~	~~Silver~~	~~1~~	~~1377~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~11941~~	~~Sheridan College J-Wing Davis Campus~~	~~Brampton~~	~~2010-04-22~~	~~2013-09-18~~	~~Certified~~	~~1~~	~~6503~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~12328~~	~~Rotman School of Management South Building~~	~~Toronto~~	~~2009-06-19~~	~~2014-10-10~~	~~Gold~~	~~1~~	~~14364~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~12335~~	~~Essar Convergence Centre~~	~~Sault Ste M~~	~~2009-09-10~~	~~2013-01-30~~	~~Gold~~	~~1~~	~~4033~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~12418~~	~~UTM Instructional Centre~~	~~Mississaug~~	~~2009-12-04~~	~~2012-07-19~~	~~Silver~~	~~1~~	~~13035~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~12467~~	~~Cambridge Campus - Phase 1~~	~~Cambridge~~	~~2009-11-05~~	~~2014-12-12~~	~~Silver~~	~~1~~	~~25822~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~12592~~	~~Library and Academic Facility~~	~~Scarborou~~	~~2009-10-20~~	~~2013-05-04~~	~~Gold~~	~~1~~	~~10022~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~12753~~	~~Georgian College Health & Wellness Building~~	~~Barrie~~	~~2009-12-18~~	~~2012-11-02~~	~~Silver~~	~~1~~	~~15627~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~13162~~	~~Centre for Biodiversity Genomics - Building 135~~	~~Guelph~~	~~2010-03-18~~	~~2014-06-20~~	~~Silver~~	~~1~~	~~3502~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~13235~~	~~Algonquin College - Perth Campus~~	~~Perth~~	~~2010-04-08~~	~~2013-02-21~~	~~Gold~~	~~1~~	~~3893~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
~~13310~~	~~Seneca College - Newnham Campus Building A~~	~~Toronto~~	~~2010-04-15~~	~~2014-10-06~~	~~Gold~~	~~1~~	~~13716~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~N~~
10555	Engineering Technology Building	Hamilton	2007-02-09	2010-11-02	Gold	1	11671	Lecture Hall / Classroom	University / College	Y
10698	The Claudette MacKay-Lassonde Pavilion	London	2007-06-11	2010-12-17	Gold	1	3703	Lecture Hall / Classroom	University / College	Y
11801	Simcoe Hall, Lakehead University, Orillia, Ontario	Orillia	2008-12-04	2014-06-23	Platinum	1	6083	Lecture Hall / Classroom	University / College	Y
11925	Stevenson Hall and Lawson Hall	London	2009-02-03	2014-06-26	Silver	1	11714	Lecture Hall / Classroom	University / College	Y
12213	Ron Joyce Centre, McMaster University	Burlington	2009-06-02	2011-08-15	Gold	1	9624	Lecture Hall / Classroom	University / College	Y
12303	Algonquin Centre For Construction Excellence	Ottawa	2009-07-09	2012-11-02	Platinum	1	18460	Lecture Hall / Classroom	University / College	Y
12463	Mohawk College E-Learning Centre	Hamilton	2009-08-17	2012-08-24	Gold	1	4522	Lecture Hall / Classroom	University / College	Y
12776	University of Waterloo Environment 3 Building	Waterloo	2009-11-30	2012-11-30	Platinum	1	5644	Lecture Hall / Classroom	University / College	Y
~~13014~~	~~George Brown College Waterfront Campus~~	~~Toronto~~	~~2009-12-16~~	~~2014-12-17~~	~~Gold~~	~~1~~	~~32122~~	~~Lecture Hall / Classroom~~	~~University / College~~	~~Y~~
13859	Xstrata Nickel Sustainable Energy Centre	Sudbury	2010-10-19	2012-11-30	Gold	2009	2145	Lecture Hall / Classroom	University / College	Y

Appendix C: Calculations

Discrepancies

		Building				
	Comparison	Claudette MacKay Lassonde Pavilion	Stevenson-Lawson Hall	Simcoe Hall	Ron Joyce Centre	ACCE
Energy Intensities	AEI & MEI	44%	24%	44%	2%	35%
	AEI & Campus-Wide	49%	49%	4%	64%	31%
	AEI & CIBEUS 2000	75%	4%	23%	32%	8%
	AEI & CES 2003	41%	56%	45%	71%	36%
	AEI & CICES 2005	16%	69%	61%	80%	45%
	AEI & CICES 2008	67%	22%	3%	49%	10%
	AEI & SCIEU 2009	74%	0%	20%	35%	11%
	MEI & CIBEUS 2000	56%	21%	27%	34%	40%
	MEI & CES 2003	4%	66%	69%	72%	59%
	MEI & CICES 2005	33%	76%	78%	80%	64%
	MEI & CICES 2008	41%	40%	45%	50%	42%
	MEI & SCIEU 2009	54%	24%	30%	36%	43%

🟥 Actual/Modelled building performing worse than

⬛ Acutal/Modelled building performing better than

Energy Intensities

	Building				
	Claudette MacKay Lassonde Pavilion	Stevenson-Lawson Hall	Simcoe Hall	Ron Joyce Centre	ACCE
Actual Energy Intensity (GJ/m2)	3.73	0.97	1.21	0.63	0.86
Modelled Energy Intensity (GJ/m2)	2.10	0.74	0.68	0.62	0.55
CIBEUS 2000 (GJ/m2)	0.93	0.93	0.93	0.93	0.93
CES 2003 (GJ/m2)	2.19	2.19	2.19	2.19	1.35
CICES 2005 (GJ/m2)	3.12	3.12	3.12	3.12	1.55
CICES 2008 (GJ/m2)	1.24	1.24	1.24	1.24	0.95
SCIEU 2009 (GJ/m2)	0.97	0.97	0.97	0.97	0.97
UWO Energy Intensity Campus-wide 2012 (GJ/m2)	1.91	1.91	1.91	1.91	1.91
McMaster Energy Intensity Campus-wide 2012 (GJ/m2)	1.77	1.77	1.77	1.77	1.77
Lakehead Energy Intensity Campus-wide 2012 (GJ/m2)	1.16	1.16	1.16	1.16	1.16
Algonquin College Eergy Intensity Campus-wide (GJ/m2)	1.24	1.24	1.24	1.24	1.24

Energy Usage

	Building				
	Claudette MacKay Lassonde Pavilion	Stevenson-Lawson Hall	Simcoe Hall	Ron Joyce Centre	ACCE
Electricty (GJ)	4673	6768	6826	3855	-
Natural Gas (GJ)	0	0	527	2211	-
Chilled Water (GJ)	794	1686	0	0	-
Steam (GJ)	8328	2899	0	0	-
Total Actual Energy Usage (GJ)	13795	11352	7350	6066	-
Area (m2)	3703	11714	6083	9624	18460
Modelled Energy Usage (GJ)	7763	6926	4128	5945	9340
CIBEUS 2000 Energy Usage (GJ)	3443.79	10894.02	5657.19	8950.32	
CES 2003 Energy Usage (GJ)	8109.57	25653.66	13321.77	21076.56	
CICES 2005 Energy Usage (GJ)	11553.36	36547.68	18978.96	30026.88	
CICES 2008 Energy Usage (GJ)	4591.72	14525.36	7542.92	11933.76	
SCIEU 2009 Energy Usage (GJ)	3591.91	11362.58	5900.51	9335.28	

Organization Name	**Subsector Name**	**Operation Name**	**Operation Type**
Algonquin College	College	ACOV	Library
Algonquin College	College	ACOV	Administrative offices and related facilities
Algonquin College	College	Advanced Technology Centre	Library
Algonquin College	College	Advanced Technology Centre	Administrative offices and related facilities
Algonquin College	College	Algonquin Centre for Construction Excellence	Library
Algonquin College	College	Algonquin Centre for Construction Excellence	Administrative offices and related facilities
Algonquin College	College	Algonquin Heritage Institute	Library
Algonquin College	College	Algonquin Heritage Institute	Administrative offices and related facilities
Algonquin College	College	Animal Health Care Centre	Library
Algonquin College	College	Animal Health Care Centre	Administrative offices and related facilities
Algonquin College	College	Building A	Library
Algonquin College	College	Building A	Administrative offices and related facilities
Algonquin College	College	Building B	Library
Algonquin College	College	Building B	Administrative offices and related facilities
Algonquin College	College	Building C	Library
Algonquin College	College	Building C	Administrative offices and related facilities
Algonquin College	College	Building D	Administrative offices and related facilities
Algonquin College	College	Building E	Administrative offices and related facilities
Algonquin College	College	Building F	Administrative offices and related facilities
Algonquin College	College	Building J	Library
Algonquin College	College	Building J	Administrative offices and related facilities
Algonquin College	College	Building M	Administrative offices and related facilities
Algonquin College	College	Building N	Library
Algonquin College	College	Building N	Administrative offices and related facilities
Algonquin College	College	Early Learning Centre	Administrative offices and related facilities
Algonquin College	College	Philip Killeen Hospitality Centre	Library
Algonquin College	College	Philip Killeen Hospitality Centre	Administrative offices and related facilities
Algonquin College	College	Physical Resources	Administrative offices and related facilities
Algonquin College	College	Police and Public Safety Institute	Library
Algonquin College	College	Police and Public Safety Institute	Administrative offices and related facilities
Algonquin College	College	Residence - Phase 1	Administrative offices and related facilities
Algonquin College	College	Residence - Phase 2	Administrative offices and related facilities
Algonquin College	College	Residence - Phase 3	Administrative offices and related facilities
Algonquin College	College	Thunderdome Soccer Facility	Administrative offices and related facilities
Algonquin College	College	Transportation Technology Centre	Library
Algonquin College	College	Transportation Technology Centre	Administrative offices and related facilities
Algonquin College	College	Thunderdome Soccer Facility	Classrooms and related facilities
Algonquin College	College	Thunderdome Soccer Facility	Student recreational facilities and athletic facilities
Algonquin College	College	Animal Health Care Centre	Laboratories
Algonquin College	College	Animal Health Care Centre	Classrooms and related facilities
Algonquin College	College	ACOV	Laboratories
Algonquin College	College	ACOV	Student recreational facilities and athletic facilities
Algonquin College	College	ACOV	Classrooms and related facilities
Algonquin College	College	Advanced Technology Centre	Laboratories
Algonquin College	College	Advanced Technology Centre	Classrooms and related facilities
Algonquin College	College	Building C	Laboratories
Algonquin College	College	Building B	Classrooms and related facilities
Algonquin College	College	Philip Killeen Hospitality Centre	Laboratories
Algonquin College	College	Philip Killeen Hospitality Centre	Classrooms and related facilities
Algonquin College	College	Building D	Classrooms and related facilities
Algonquin College	College	Building A	Laboratories
Algonquin College	College	Building M	Laboratories
Algonquin College	College	Building M	Classrooms and related facilities
Algonquin College	College	Building B	Laboratories
Algonquin College	College	Building A	Classrooms and related facilities
Algonquin College	College	Building A	Student recreational facilities and athletic facilities
Algonquin College	College	Building C	Classrooms and related facilities
Algonquin College	College	Early Learning Centre	Classrooms and related facilities
Algonquin College	College	Algonquin Heritage Institute	Classrooms and related facilities
Algonquin College	College	Algonquin Heritage Institute	Laboratories
Algonquin College	College	Algonquin Heritage Institute	Student recreational facilities and athletic facilities
Algonquin College	College	Building F	Laboratories
Algonquin College	College	Physical Resources	Classrooms and related facilities
Algonquin College	College	Building F	Classrooms and related facilities
Algonquin College	College	Building N	Laboratories
Algonquin College	College	Transportation Technology Centre	Laboratories
Algonquin College	College	Police and Public Safety Institute	Laboratories
Algonquin College	College	Transportation Technology Centre	Classrooms and related facilities
Algonquin College	College	Police and Public Safety Institute	Classrooms and related facilities
Algonquin College	College	Building N	Classrooms and related facilities
Algonquin College	College	Algonquin Centre for Construction Excellence	Classrooms and related facilities
Algonquin College	College	Algonquin Centre for Construction Excellence	Laboratories
Algonquin College	College	Residence - Phase 3	Classrooms and related facilities
Algonquin College	College	Residence - Phase 3	Student residences
Algonquin College	College	Building J	Laboratories
Algonquin College	College	Building J	Classrooms and related facilities
Algonquin College	College	Residence - Phase 2	Student residences
Algonquin College	College	Residence - Phase 1	Student residences
Centennial College	College	Ashtonbee Campus	Administrative offices and related facilities
Centennial College	College	Centre of Creative Communication	Administrative offices and related facilities
Centennial College	College	George Bennet Building	Administrative offices and related facilities
Centennial College	College	Morningside Campus	Administrative offices and related facilities
Centennial College	College	Progress A Block	Administrative offices and related facilities
Centennial College	College	Progress AWC (Student Building)	Administrative offices and related facilities
Centennial College	College	Progress Campus (Main Building)	Administrative offices and related facilities
Centennial College	College	Progress CCSAI (Student Building)	Administrative offices and related facilities
Centennial College	College	Progress Library and Academic Facility	Library
Centennial College	College	Progress Library and Academic Facility	Administrative offices and related facilities
Centennial College	College	East York Daycare	Classrooms and related facilities
Centennial College	college	George Bennet Building	Laboratories
Centennial College	College	George Bennet Building	Classrooms and related facilities
Centennial College	College	Progress A Block	Laboratories
Centennial College	College	Progress A Block	Classrooms and related facilities
Centennial College	College	Progress CCSAI (Student Building)	Student recreational facilities and athletic facilities
Centennial College	College	Progress AWC (Student Building)	Student recreational facilities and athletic facilities
Centennial College	College	Morningside Campus	Classrooms and related facilities
Centennial College	College	Morningside Campus	Laboratories
Centennial College	College	Morningside Campus	Student recreational facilities and athletic facilities
Centennial College	College	Progress Student Residence	Laboratories
Centennial College	College	Progress Student Residence	Student residences
Centennial College	College	Centre of Creative Communication	Student recreational facilities and athletic facilities
Centennial College	College	Centre of Creative Communication	Laboratories
Centennial College	College	Centre of Creative Communication	Classrooms and related facilities
Centennial College	College	Ashtonbee Campus	Laboratories

City	GFA (SQM)	Electricity (GJ)	Natural Gas (GJ)	Fuel Oil 1&2 (GJ)	Fuel Oil 4 &6 (GJ)	Propane (GJ)	Coal (GJ)	Wood (GJ)	District Heating (GJ)	District Cooling (GJ)	EI (GJ/m2)
Pembroke	325.3358	378.8725752	1.222842908	0	0	0	0	0	0	0	1.168317222
Pembroke	1098.4496	1279.208832	1146.875955	0	0	0	0	0	0	0	2.208644609
Ottawa	447.0237423	347.1848809	261.8801468	0	0	0	0	0	0	0	1.362489215
Ottawa	3452.166284	2681.154996	2022.384333	0	0	0	0	0	0	0	1.362489215
Ottawa	707.8146868	476.6278228	129.5183507	0	0	0	0	0	0	0	0.856362809
Ottawa	5285.646412	3559.245363	967.185647	0	0	0	0	0	0	0	0.856362809
Perth	250.5112225	133.3344276	177.20323	0	0	0	0	0	0	0	1.239615752
Perth	1063.993032	566.3095666	752.6329564	0	0	0	0	0	0	0	1.239615752
Ottawa	65.78692856	59.90020441	113.8296077	0	0	0	0	0	0	0	2.640795307
Ottawa	427.1412134	388.9199048	739.0726066	0	0	0	0	0	0	0	2.640795307
Ottawa	101.9806911	59.66877094	69.10726173	0	0	0	0	0	0	0	1.262749166
Ottawa	7379.039252	4317.466355	5000.409305	0	0	0	0	0	0	0	1.262749166
Ottawa	152.5535415	89.25888052	103.3779768	0	0	0	0	0	0	0	1.262749166
Ottawa	6089.156235	3562.757465	4126.319492	0	0	0	0	0	0	0	1.262749166
Ottawa	776.1995058	454.1533304	525.9919481	0	0	0	0	0	0	0	1.262749166
Ottawa	8842.886377	5173.961422	5992.385975	0	0	0	0	0	0	0	1.262749166
Ottawa	1138.638734	666.2160554	771.5990556	0	0	0	0	0	0	0	1.262749166
Ottawa	6845.2436	5471.84228	2884.699033	0	0	0	0	0	0	0	1.220780706
Ottawa	315.0273773	251.8215893	132.7577547	0	0	0	0	0	0	0	1.220780706
Ottawa	88.89538422	34.12099939	34.08564334	0	0	0	0	0	0	0	0.767268665
Ottawa	2311.538884	887.2453564	886.3259961	0	0	0	0	0	0	0	0.767268665
Ottawa	274.1534675	160.4068405	185.780222	0	0	0	0	0	0	0	1.262749166
Ottawa	32.8568591	22.26127455	14.68449229	0	0	0	0	0	0	0	1.124446093
Ottawa	1189.630737	806.0020703	531.6735644	0	0	0	0	0	0	0	1.124446093
Ottawa	1484.974572	868.8567081	1006.293694	0	0	0	0	0	0	0	1.262749166
Ottawa	112.0592057	65.56569682	75.9369717	0	0	0	0	0	0	0	1.262749166
Ottawa	1766.367104	1033.499116	1196.979472	0	0	0	0	0	0	0	1.262749166
Ottawa	1260.11689	1007.292257	531.034129	0	0	0	0	0	0	0	1.220780706
Ottawa	281.0001008	190.384004	125.5854615	0	0	0	0	0	0	0	1.124446093
Ottawa	2530.056477	1714.171209	1130.740912	0	0	0	0	0	0	0	1.124446093
Ottawa	1604.948342	470.6533461	674.0591142	0	0	0	0	0	0	0	0.713239442
Ottawa	1470.301327	431.1679206	617.5089778	0	0	0	0	0	0	0	0.713239442
Ottawa	1601.712873	738.4823028	524.4870745	0	0	0	0	0	0	0	0.788511723
Ottawa	174.1313729	317.8640785	2178.723667	0	0	0	0	0	0	0	14.33738047
Ottawa	109.7496278	74.35788643	49.04965381	0	0	0	0	0	0	0	1.124446093
Ottawa	522.5558422	354.0435511	233.5423241	0	0	0	0	0	0	0	1.124446093
Ottawa	157.1862065	286.9319172	1966.70653	0	0	0	0	0	0	0	14.33738047
Ottawa	196.3170477	358.3624043	2456.309802	0	0	0	0	0	0	0	14.33738047
Ottawa	282.5833103	257.2972842	488.9473954	0	0	0	0	0	0	0	2.640795307
Ottawa	166.2106092	151.3378066	287.5903902	0	0	0	0	0	0	0	2.640795307
Pembroke	1100.9579	1282.129894	1149.494837	0	0	0	0	0	0	0	2.208644609
Pembroke	707.1548	823.5231417	738.330495	0	0	0	0	0	0	0	2.208644609
Pembroke	1664.6751	1938.611558	1738.064128	0	0	0	0	0	0	0	2.208644609
Ottawa	3576.570396	2777.774533	2095.264058	0	0	0	0	0	0	0	1.362489215
Ottawa	4170.52274	3239.072791	2443.219462	0	0	0	0	0	0	0	1.362489215
Ottawa	1229.552467	719.4095637	833.2067885	0	0	0	0	0	0	0	1.262749166
Ottawa	11383.81313	6660.654389	7714.246143	0	0	0	0	0	0	0	1.262749166
Ottawa	2370.090238	1386.736743	1606.092728	0	0	0	0	0	0	0	1.262749166
Ottawa	2096.762161	1226.812838	1420.871832	0	0	0	0	0	0	0	1.262749166
Ottawa	2743.139136	1605.007173	1858.889483	0	0	0	0	0	0	0	1.262749166
Ottawa	3281.570588	1920.042721	2223.757801	0	0	0	0	0	0	0	1.262749166
Ottawa	808.8779775	473.2734621	548.1365293	0	0	0	0	0	0	0	1.262749166
Ottawa	248.1974914	145.2200323	168.1911429	0	0	0	0	0	0	0	1.262749166
Ottawa	1462.374434	855.6333966	990.9787005	0	0	0	0	0	0	0	1.262749166
Ottawa	8479.507337	4961.348813	5746.142003	0	0	0	0	0	0	0	1.262749166
Ottawa	3502.009127	2049.021027	2373.138078	0	0	0	0	0	0	0	1.262749166
Ottawa	6446.40501	3771.783263	4368.409287	0	0	0	0	0	0	0	1.262749166
Ottawa	164.6189548	96.3183383	111.5541096	0	0	0	0	0	0	0	1.262749166
Perth	1282.477092	682.5975589	907.181247	0	0	0	0	0	0	0	1.239615752
Perth	1223.879781	651.4091799	865.7314759	0	0	0	0	0	0	0	1.239615752
Perth	101.8553996	54.21246705	72.04909073	0	0	0	0	0	0	0	1.239615752
Ottawa	723.4798848	578.3238776	304.8864067	0	0	0	0	0	0	0	1.220780706
Ottawa	109.6700435	87.66630026	46.21677283	0	0	0	0	0	0	0	1.220780706
Ottawa	269.3532084	215.3112964	113.5099034	0	0	0	0	0	0	0	1.220780706
Ottawa	1699.638163	1151.543782	759.6077104	0	0	0	0	0	0	0	1.124446093
Ottawa	2284.122887	1547.545569	1020.827488	0	0	0	0	0	0	0	1.124446093
Ottawa	2227.461345	1509.156077	995.5041308	0	0	0	0	0	0	0	1.124446093
Ottawa	313.7426477	212.5678294	140.2188651	0	0	0	0	0	0	0	1.124446093
Ottawa	3625.304485	2456.226818	1620.232646	0	0	0	0	0	0	0	1.124446093
Ottawa	1761.445295	1193.419529	787.2307507	0	0	0	0	0	0	0	1.124446093
Ottawa	8387.772817	5648.153352	1534.82334	0	0	0	0	0	0	0	0.856362809
Ottawa	5388.032825	3628.190263	985.9206627	0	0	0	0	0	0	0	0.856362809
Ottawa	196.1005262	90.41368811	64.21387566	0	0	0	0	0	0	0	0.788511723
Ottawa	9524.764745	4391.467609	3118.92105	0	0	0	0	0	0	0	0.788511723
Ottawa	1538.568189	590.5535444	589.941615	0	0	0	0	0	0	0	0.767268665
Ottawa	1969.579777	755.9900998	755.2067456	0	0	0	0	0	0	0	0.767268665
Ottawa	9123.712135	2675.541345	3831.850011	0	0	0	0	0	0	0	0.713239442
Ottawa	9262.963448	2716.376988	3890.333897	0	0	0	0	0	0	0	0.713239442
Toronto	4794.416644	2081.199105	2396.939064	0	0	0	0	0	0	0	0.934031917
Toronto	2133.230185	1606.464167	637.7778505	0	0	0	0	0	0	0	1.052039313
Toronto	217.383213	94.36346109	358.1458663	0	0	0	0	0	0	0	2.081620384
Toronto	5079.763639	3612.431411	2673.02696	0	0	0	0	0	0	0	1.237352526
Toronto	2758.106242	2484.902238	1393.351019	0	0	0	0	0	0	0	1.406129031
Toronto	285.58389	165.8005962	195.5745416	0	0	0	0	0	0	0	1.265390488
Toronto	11194.12671	6498.941108	2726.915245	0	0	0	0	0	0	0	0.82416937
Toronto	1948.535695	1131.255618	1334.402915	0	0	0	0	0	0	0	1.265390488
Toronto	3438.857933	1996.487602	837.7137732	0	0	0	0	0	0	0	0.82416937
Toronto	2412.833173	1400.811435	587.7717605	0	0	0	0	0	0	0	0.82416937
Toronto	429.4767	531.5688	427.5	0	0	0	0	0	0	0	2.233110201
Toronto	4261.468853	1849.852823	7020.907608	0	0	0	0	0	0	0	2.081620384
Toronto	807.530463	350.5393465	1330.432526	0	0	0	0	0	0	0	2.081620384
Toronto	2815.114327	2536.263392	1422.150589	0	0	0	0	0	0	0	1.406129031
Toronto	2821.871873	2542.35157	1425.564392	0	0	0	0	0	0	0	1.406129031
Toronto	1813.914305	1053.098875	1242.211032	0	0	0	0	0	0	0	1.265390488
Toronto	4025.57996	2337.119078	2756.811511	0	0	0	0	0	0	0	1.265390488
Toronto	6568.845662	4671.379633	3456.598141	0	0	0	0	0	0	0	1.237352526
Toronto	6480.093647	4608.26438	3409.895864	0	0	0	0	0	0	0	1.237352526
Toronto	3468.599868	2466.665775	1825.215034	0	0	0	0	0	0	0	1.237352526
Toronto	4519.831185	2026.249693	2760.541921	0	0	0	0	0	0	0	1.059064248
Toronto	10601.22312	4752.550307	6474.826079	0	0	0	0	0	0	0	1.059064248
Toronto	1748.819275	1316.977193	522.8494355	0	0	0	0	0	0	0	1.052039313
Toronto	3598.504725	2709.913322	1075.855116	0	0	0	0	0	0	0	1.052039313
Toronto	2427.416615	1828.00611	725.7315979	0	0	0	0	0	0	0	1.052039313
Toronto	10059.69136	4366.792088	5029.280722	0	0	0	0	0	0	0	0.934031917

Centennial College	College	Ashtonbee Campus	Student recreational facilities and athletic facilities
Centennial College	College	Ashtonbee Campus	Classrooms and related facilities
Centennial College	College	Progress Campus (Main Building)	Laboratories
Centennial College	College	Progress Library and Academic Facility	Classrooms and related facilities
Centennial College	College	Progress Campus (Main Building)	Classrooms and related facilities
Conestoga College	College	Doon - Automation Tooling	Administrative offices and related facilities
Conestoga College	College	Doon - Early Childhood Education	Administrative offices and related facilities
Conestoga College	College	Doon - Employee Services	Administrative offices and related facilities
Conestoga College	College	Doon - Industrial Skills	Administrative offices and related facilities
Conestoga College	College	Doon - Recreational Centre	Administrative offices and related facilities
Conestoga College	College	Doon - Service/Power House	Administrative offices and related facilities
Conestoga College	College	Doon - Student Services	Library
Conestoga College	College	Doon - Student Services	Administrative offices and related facilities
Conestoga College	College	Doon - Wood Working	Administrative offices and related facilities
Conestoga College	College	Doon Main Building	Library
Conestoga College	College	Doon Main Building	Administrative offices and related facilities
Conestoga College	College	Guelph Campus	Library
Conestoga College	College	Guelph Campus	Administrative offices and related facilities
Conestoga College	College	Ingersoll Campus	Administrative offices and related facilities
Conestoga College	College	South Campus	Library
Conestoga College	College	South Campus	Administrative offices and related facilities
Conestoga College	College	Waterloo Campus main Building	Library
Conestoga College	College	Waterloo Campus main Building	Administrative offices and related facilities
Conestoga College	College	Waterloo Campus Masonry Centre	Administrative offices and related facilities
Conestoga College	College	Waterloo Campus Roofing Centre	Administrative offices and related facilities
Conestoga College	College	Doon - Service/Power House	Classrooms and related facilities
Conestoga College	College	Doon - Recreational Centre	Classrooms and related facilities
Conestoga College	College	Doon Main Building	Laboratories
Conestoga College	College	Doon Main Building	Classrooms and related facilities
Conestoga College	College	Doon - Recreational Centre	Student recreational facilities and athletic facilities
Conestoga College	College	Doon - Employee Services	Classrooms and related facilities
Conestoga College	College	Doon - Industrial Skills	Laboratories
Conestoga College	College	Doon Main Building	Student recreational facilities and athletic facilities
Conestoga College	College	Doon - Industrial Skills	Classrooms and related facilities
Conestoga College	College	Doon - Early Childhood Education	Classrooms and related facilities
Conestoga College	College	Doon - Student Services	Classrooms and related facilities
Conestoga College	College	Doon - Student Services	Laboratories
Conestoga College	College	Doon - Wood Working	Laboratories
Conestoga College	College	Doon - Wood Working	Classrooms and related facilities
Conestoga College	College	Waterloo Campus Marsland Building	Laboratories
Conestoga College	College	Waterloo Campus main Building	Laboratories
Conestoga College	College	Waterloo Campus main Building	Classrooms and related facilities
Conestoga College	College	Waterloo Campus Masonry Centre	Laboratories
Conestoga College	College	Waterloo Campus Masonry Centre	Classrooms and related facilities
Conestoga College	College	Doon - Automation Tooling	Classrooms and related facilities
Conestoga College	College	Doon - Automation Tooling	Laboratories
Conestoga College	College	Ingersoll Campus	Classrooms and related facilities
Conestoga College	College	Ingersoll Campus	Laboratories
Conestoga College	College	Waterloo Campus Roofing Centre	Laboratories
Conestoga College	College	Waterloo Campus Roofing Centre	Classrooms and related facilities
Conestoga College	College	Guelph Campus	Laboratories
Conestoga College	College	Guelph Campus	Classrooms and related facilities
Conestoga College	College	South Campus	Classrooms and related facilities
Conestoga College	College	South Campus	Laboratories
Durham College & University of Ontario Institute of Technology	College	Campus Corners	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Campus Recreation Wellness Centre	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	J Buildings	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	LIB - Library	Library
Durham College & University of Ontario Institute of Technology	College	Simcoe Building	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Student Services Building	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Whitby Campus	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - A Wing	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - B Wing	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - C Wing	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - D Wing	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - F&G Wing	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - H Wing	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - I Wing	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - JW Wing	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - L Wing	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - SW Wing	Administrative offices and related facilities
Durham College & University of Ontario Institute of Technology	College	Tennis Centre	Student recreational facilities and athletic facilities
Durham College & University of Ontario Institute of Technology	College	Campus Ice Centre	Student recreational facilities and athletic facilities
Durham College & University of Ontario Institute of Technology	College	Willey - C Wing	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Campus Recreation Wellness Centre	Student recreational facilities and athletic facilities
Durham College & University of Ontario Institute of Technology	College	Willey - B Wing	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - SW Wing	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - I Wing	Laboratories
Durham College & University of Ontario Institute of Technology	College	Willey - A Wing	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - D Wing	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - SW Wing	Laboratories
Durham College & University of Ontario Institute of Technology	College	Willey - A Wing	Laboratories
Durham College & University of Ontario Institute of Technology	College	Willey - F&G Wing	Student recreational facilities and athletic facilities
Durham College & University of Ontario Institute of Technology	College	Willey - L Wing	Laboratories
Durham College & University of Ontario Institute of Technology	College	Willey - B Wing	Laboratories
Durham College & University of Ontario Institute of Technology	College	Willey - JW Wing	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - L Wing	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - F&G Wing	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - F&G Wing	Laboratories
Durham College & University of Ontario Institute of Technology	College	Willey - I Wing	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - C Wing	Laboratories
Durham College & University of Ontario Institute of Technology	College	Willey - JW Wing	Laboratories
Durham College & University of Ontario Institute of Technology	college	Willey - D Wing	Laboratories
Durham College & University of Ontario Institute of Technology	college	Student Centre	Student recreational facilities and athletic facilities
Durham College & University of Ontario Institute of Technology	College	Simcoe Building	Laboratories
Durham College & University of Ontario Institute of Technology	College	Simcoe Building	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	J Buildings	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - H Wing	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Willey - H Wing	Laboratories
Durham College & University of Ontario Institute of Technology	College	Student Services Building	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Whitby Campus	Classrooms and related facilities
Durham College & University of Ontario Institute of Technology	College	Whitby Campus	Laboratories
Durham College & University of Ontario Institute of Technology	College	Whitby Campus	Student recreational facilities and athletic facilities
Fanshawe College	College	London - Cuddy Court Warehouse	Administrative offices and related facilities
Fanshawe College	College	London - Nelson Plaza	Administrative offices and related facilities
Fanshawe College	College	London - Residence R1	Administrative offices and related facilities
Fanshawe College	College	London - Residence R2	Administrative offices and related facilities

Toronto	3882.554836	1685.370766	1941.059371	0	0	0	0	0	0	0	0.934031917
Toronto	6522.570314	2831.37001	3260.918844	0	0	0	0	0	0	0	0.934031917
Toronto	11103.87529	6446.544107	2704.929789	0	0	0	0	0	0	0	0.82416937
Toronto	3883.588813	2254.683696	946.0512477	0	0	0	0	0	0	0	0.82416937
Toronto	11385.04829	6609.783885	2773.424184	0	0	0	0	0	0	0	0.82416937
Kitchener	1436.4198	633.99312	616.8176603	0	0	0	0	0	0	0	0.870783583
Kitchener	911.5348	402.32448	807.4451371	0	0	0	0	0	0	0	1.327178751
Kitchener	1093.433	482.60916	1766.832361	0	0	0	0	0	0	0	2.057228492
Kitchener	53.5104	23.6178	86.46520307	0	0	0	0	0	0	0	2.057226316
Kitchener	1707.2233	753.5178	2758.630272	0	0	0	0	0	0	0	2.057228291
Kitchener	598.5547	264.1842	967.1793461	0	0	0	0	0	0	0	2.057228096
Kitchener	46.1713	20.37852	24.46414535	0	0	0	0	0	0	0	0.971223798
Kitchener	3079.2634	1359.09612	1631.566522	0	0	0	0	0	0	0	0.971226639
Kitchener	792.8086	349.92216	398.0102589	0	0	0	0	0	0	0	0.943395946
Kitchener	3593.7436	1586.17224	5806.97902	0	0	0	0	0	0	0	2.057228362
Kitchener	22804.2559	10065.12552	36848.43726	0	0	0	0	0	0	0	2.057228396
Guelph	96.2444	27.2196	39.77129454	0	0	0	0	0	0	0	0.696049791
Guelph	2180.7346	616.75344	901.1499692	0	0	0	0	0	0	0	0.696051417
Ingersoll	140.29758	63.95508	54.05826245	0	0	0	0	0	0	0	0.841164491
Cambridge	1131.95863	331.98372	289.6700151	0	0	0	0	0	0	0	0.549184147
Cambridge	7902.9101	2317.77576	2022.358661	0	0	0	0	0	0	0	0.549181803
Waterloo	25.4546	8.42364	15.1812077	0	0	0	0	0	0	0	0.927331315
Waterloo	4217.9387	1395.80784	2515.592603	0	0	0	0	0	0	0	0.927325104
Waterloo	384.1415	127.12068	223.0128249	0	0	0	0	0	0	0	0.911470135
Waterloo	292.60713	96.82992	109.247619	0	0	0	0	0	0	0	0.704280648
Kitchener	80.5443	35.55	130.1481442	0	0	0	0	0	0	0	2.057229924
Kitchener	1099.5644	485.31528	1776.739832	0	0	0	0	0	0	0	2.057228401
Kitchener	9688.1694	4276.07208	15654.70515	0	0	0	0	0	0	0	2.0572284
Kitchener	23933.0838	10563.35652	38672.46275	0	0	0	0	0	0	0	2.057228382
Kitchener	6755.5022	2981.67912	10915.93166	0	0	0	0	0	0	0	2.05722837
Kitchener	207.8173	91.7244	335.8032279	0	0	0	0	0	0	0	2.057228286
Kitchener	241.3542	106.52652	389.994093	0	0	0	0	0	0	0	2.057227979
Kitchener	155.7004	68.72148	251.5897228	0	0	0	0	0	0	0	2.057227874
Kitchener	77.107	34.0326	124.5939558	0	0	0	0	0	0	0	2.057226397
Kitchener	343.0797	151.42536	303.9028629	0	0	0	0	0	0	0	1.327179145
Kitchener	751.4681	331.67592	398.1699632	0	0	0	0	0	0	0	0.9712267
Kitchener	46.2642	20.41956	24.51336898	0	0	0	0	0	0	0	0.971224597
Kitchener	3728.4486	1645.62732	1871.776861	0	0	0	0	0	0	0	0.943396184
Kitchener	945.1646	417.16764	474.4968801	0	0	0	0	0	0	0	0.943396018
Waterloo	1393.5	461.13948	832.96	0	0	0	0	0	0	0	0.928668446
Waterloo	4010.9575	1327.31352	2392.14833	0	0	0	0	0	0	0	0.927325171
Waterloo	4535.4709	1500.88644	2704.969859	0	0	0	0	0	0	0	0.927325165
Waterloo	571.9853	189.2826	332.0652873	0	0	0	0	0	0	0	0.91147078
Waterloo	130.4316	43.16256	75.72188782	0	0	0	0	0	0	0	0.911469673
Kitchener	1259.4453	555.88212	540.8224693	0	0	0	0	0	0	0	0.87078382
Kitchener	3202.4488	1413.4662	1375.17387	0	0	0	0	0	0	0	0.870783655
Ingersoll	348.08701	158.68008	134.1245984	0	0	0	0	0	0	0	0.841182434
Ingersoll	800.97451	365.13288	308.6291391	0	0	0	0	0	0	0	0.841177854
Waterloo	1054.3221	348.89832	393.6410542	0	0	0	0	0	0	0	0.704281333
Waterloo	137.81715	45.6066	51.4553268	0	0	0	0	0	0	0	0.704280467
Guelph	6450.7902	1824.40692	2665.674856	0	0	0	0	0	0	0	0.696051435
Guelph	3741.4546	1058.15484	1546.089881	0	0	0	0	0	0	0	0.696051402
Cambridge	7860.74279	2305.40976	2011.568895	0	0	0	0	0	0	0	0.549182026
Cambridge	9828.46698	2882.50632	2515.110429	0	0	0	0	0	0	0	0.549181959
Oshawa	1752.8372	668.4552	459.686	0	0	0	0	0	0	0	0.643608659
Oshawa	516.174696	554.386212	418.8098697	0	0	0	0	0	0	0	1.8854006
Oshawa	956.968474	1027.812132	212.2573794	0	0	0	0	0	0	0	1.295831101
Oshawa	3122.623546	3353.787864	898.32	0	0	0	0	0	0	0	1.36171005
Oshawa	2885.205519	3098.7945	1423.738631	0	0	0	0	0	0	0	1.567490808
Oshawa	3157.997079	1727.969112	1507.67746	0	0	0	0	0	0	0	1.024588209
Whitby	5058.634463	2670.456528	2508.914302	0	0	0	0	0	0	0	1.023867383
Oshawa	2100.206093	2255.682636	1704.050595	0	0	0	0	0	0	0	1.88540222
Oshawa	1992.396572	2139.891372	1616.576321	0	0	0	0	0	0	0	1.885401604
Oshawa	1024.097085	1099.91016	830.9247561	0	0	0	0	0	0	0	1.885402219
Oshawa	1123.936715	1207.140156	911.9314313	0	0	0	0	0	0	0	1.885401161
Oshawa	2234.919454	2400.36822	1813.353014	0	0	0	0	0	0	0	1.885401833
Oshawa	1480.646703	1590.25734	256.3587916	0	0	0	0	0	0	0	1.247168638
Oshawa	108.607532	116.647416	88.12103366	0	0	0	0	0	0	0	1.88539824
Oshawa	1089.460596	1170.112644	883.9590666	0	0	0	0	0	0	0	1.885402481
Oshawa	585.682476	629.03988	475.2068222	0	0	0	0	0	0	0	1.885401642
Oshawa	1930.021654	2072.899368	1565.96736	0	0	0	0	0	0	0	1.885402022
Oshawa	1910.7672	2052.216	2657.682	0	0	0	0	0	0	0	2.464925083
Oshawa	3914.94535	4666.5648	4589.089	0	0	0	0	0	0	0	2.364184675
Oshawa	3471.348779	4190.13	2816.558434	0	0	0	0	0	0	0	2.018434009
Oshawa	3602.964854	4331.4912	2923.348363	0	0	0	0	0	0	0	2.013574891
Oshawa	4404.475397	5192.334	3573.671719	0	0	0	0	0	0	0	1.990249673
Oshawa	4682.071745	5490.4824	3798.905847	0	0	0	0	0	0	0	1.984033725
Oshawa	162.412425	174.43602	131.7773257	0	0	0	0	0	0	0	1.885405908
Oshawa	2409.487844	2587.860216	1954.993428	0	0	0	0	0	0	0	1.885402184
Oshawa	361.692215	388.467972	293.4672957	0	0	0	0	0	0	0	1.885402116
Oshawa	1239.51825	1331.278668	1005.711614	0	0	0	0	0	0	0	1.885402076
Oshawa	1579.289781	1696.203144	1281.393013	0	0	0	0	0	0	0	1.885402029
Oshawa	2262.926017	2430.448128	1836.076805	0	0	0	0	0	0	0	1.885401865
Oshawa	1184.71654	1272.419892	961.2468722	0	0	0	0	0	0	0	1.885401857
Oshawa	719.39902	772.655328	583.7007921	0	0	0	0	0	0	0	1.885401679
Oshawa	862.481742	926.330256	699.7941904	0	0	0	0	0	0	0	1.885401589
Oshawa	2289.920899	2459.441052	1857.979446	0	0	0	0	0	0	0	1.885401587
Oshawa	1620.142556	1740.079692	1314.539457	0	0	0	0	0	0	0	1.885401465
Oshawa	399.555468	429.13404	324.18839	0	0	0	0	0	0	0	1.885401378
Oshawa	907.718468	974.915496	736.4978136	0	0	0	0	0	0	0	1.885401003
Oshawa	567.946937	609.99102	460.8164149	0	0	0	0	0	0	0	1.885400493
Oshawa	170.384174	182.997324	138.2449245	0	0	0	0	0	0	0	1.885399571
Oshawa	168.391469	180.85698	136.6280245	0	0	0	0	0	0	0	1.88539839
Oshawa	907.0756	953.19846	735.946	0	0	0	0	0	0	0	1.862187077
Oshawa	153.994756	165.395052	75.99062464	0	0	0	0	0	0	0	1.567492835
Oshawa	3037.600537	3262.471164	1498.939743	0	0	0	0	0	0	0	1.567490804
Oshawa	556.98195	598.214592	123.5395614	0	0	0	0	0	0	0	1.295830419
Oshawa	1940.981996	2084.671116	336.0611882	0	0	0	0	0	0	0	1.247168861
Oshawa	2214.991475	2378.965032	383.5030912	0	0	0	0	0	0	0	1.247168738
Oshawa	892.470791	488.335536	426.0796466	0	0	0	0	0	0	0	1.024588358
Whitby	9019.204861	4761.244296	4473.225379	0	0	0	0	0	0	0	1.023867383
Whitby	8239.530463	4349.653596	4086.532787	0	0	0	0	0	0	0	1.02386737
Whitby	36.099082	19.0566	17.90381248	0	0	0	0	0	0	0	1.023860177
London	4222.885625	1287.376848	1532.865174	0	0	0	0	0	0	0	0.667847125
London	185.7687418	181.2532683	128.9889128	0	0	0	0	0	0	0	1.670045122
London	81.41669257	25.08986394	21.33735274	0	0	0	0	0	0	0	0.570241989
London	7.014124636	2.351184119	1.520779702	0	0	0	0	0	0	0	0.552023812

Fanshawe College	College	London Campus - A Building	Library
Fanshawe College	College	London Campus - A Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - B Building	Library
Fanshawe College	College	London Campus - B Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - C Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - D Building	Library
Fanshawe College	College	London Campus - D Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - E Building	Library
Fanshawe College	College	London Campus - E Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - F Building	Library
Fanshawe College	College	London Campus - F Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - G Building	Library
Fanshawe College	College	London Campus - G Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - H Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - J Building	Library
Fanshawe College	College	London Campus - J Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - K Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - L Building	Library
Fanshawe College	College	London Campus - L Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - M Building	Library
Fanshawe College	College	London Campus - M Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - N Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - Student Centre	Administrative offices and related facilities
Fanshawe College	College	London Campus - Student Union Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - T Building	Library
Fanshawe College	College	London Campus - T Building	Administrative offices and related facilities
Fanshawe College	College	London Campus - Z Building	Library
Fanshawe College	College	London Campus - Z Building	Administrative offices and related facilities
Fanshawe College	College	London Downtown Campus - CDPA	Library
Fanshawe College	College	London Downtown Campus - CDPA	Administrative offices and related facilities
Fanshawe College	College	Simcoe - JNA Delhi	Administrative offices and related facilities
Fanshawe College	College	Simcoe Campus	Library
Fanshawe College	College	Simcoe Campus	Administrative offices and related facilities
Fanshawe College	College	St. Thomas Campus	Library
Fanshawe College	College	St. Thomas Campus	Administrative offices and related facilities
Fanshawe College	College	Woodstock Campus	Library
Fanshawe College	College	Woodstock Campus	Administrative offices and related facilities
Fanshawe College	College	London Campus - N Building	Laboratories
Fanshawe College	College	London Campus - N Building	Classrooms and related facilities
Fanshawe College	College	London Campus - Student Union Building	Classrooms and related facilities
Fanshawe College	College	St. Thomas Campus	Classrooms and related facilities
Fanshawe College	College	St. Thomas Campus	Laboratories
Fanshawe College	College	London Campus - D Building	Classrooms and related facilities
Fanshawe College	College	London Campus - D Building	Laboratories
Fanshawe College	College	Woodstock Campus	Laboratories
Fanshawe College	College	Woodstock Campus	Classrooms and related facilities
Fanshawe College	College	London Campus - A Building	Laboratories
Fanshawe College	College	London Campus - A Building	Classrooms and related facilities
Fanshawe College	College	London Campus - M Building	Laboratories
Fanshawe College	College	London Campus - M Building	Classrooms and related facilities
Fanshawe College	College	London Campus - F Building	Classrooms and related facilities
Fanshawe College	College	London Campus - F Building	Laboratories
Fanshawe College	College	Simcoe Campus	Classrooms and related facilities
Fanshawe College	College	Simcoe Campus	Laboratories
Fanshawe College	College	London Campus - H Building	Classrooms and related facilities
Fanshawe College	College	London Campus - H Building	Laboratories
Fanshawe College	College	London Campus - K Building	Laboratories
Fanshawe College	College	London Campus - K Building	Classrooms and related facilities
Fanshawe College	College	London Campus - Student Centre	Classrooms and related facilities
Fanshawe College	College	London Campus - T Building	Laboratories
Fanshawe College	College	London Campus - T Building	Classrooms and related facilities
Fanshawe College	College	London Campus - Z Building	Classrooms and related facilities
Fanshawe College	College	London Campus - Z Building	Laboratories
Fanshawe College	College	London Campus - J Building	Classrooms and related facilities
Fanshawe College	College	London Campus - J Building	Student recreational facilities and athletic facilities
Fanshawe College	College	London Campus - J Building	Laboratories
Fanshawe College	College	London Campus - E Building	Classrooms and related facilities
Fanshawe College	College	London Campus - E Building	Laboratories
Fanshawe College	College	London Campus - G Building	Laboratories
Fanshawe College	College	London Campus - G Building	Classrooms and related facilities
Fanshawe College	College	London Campus - B Building	Classrooms and related facilities
Fanshawe College	College	London Campus - B Building	Laboratories
Fanshawe College	College	London Downtown Campus - CDPA	Laboratories
Fanshawe College	College	London Downtown Campus - CDPA	Classrooms and related facilities
Fanshawe College	College	Strathroy - A.M (Mac) Cuddy Gardens	Laboratories
Fanshawe College	College	London - Residence R3	Student residences
Fanshawe College	College	London - Residence R1	Student residences
Fanshawe College	College	London - Residence R1	Classrooms and related facilities
Fanshawe College	College	London - Residence R2	Student residences
Fanshawe College	College	London - Citi Plaza	Classrooms and related facilities
Fanshawe College	College	London Campus - L Building	Classrooms and related facilities
Fanshawe College	College	London Campus - L Building	Laboratories
Fanshawe College	College	London Campus - C Building	Laboratories
Fanshawe College	College	London Campus - C Building	Classrooms and related facilities
Fanshawe College	College	London - Residence R4	Student residences
George Brown College	College	Casa Loma Campus	Administrative offices and related facilities
George Brown College	College	St. James Campus	Classrooms and related facilities
George Brown College	College	St. James Campus	Classrooms and related facilities
George Brown College	college	Casa Loma Campus	Classrooms and related facilities
George Brown College	College	Casa Loma Campus	Classrooms and related facilities
George Brown College	College	Casa Loma Campus	Classrooms and related facilities
George Brown College	College	St. James Campus	Classrooms and related facilities
George Brown College	College	Casa Loma Campus	Classrooms and related facilities
George Brown College	College	St. James Campus	Classrooms and related facilities
George Brown College	College	Waterfront Campus	Classrooms and related facilities
George Brown College	College	St. James Campus	Classrooms and related facilities
George Brown College	College	St. James Campus	Classrooms and related facilities
Humber College	College	Skilled Trades Centre	Classrooms and related facilities
Humber College	College	Humber Arts and Media Studios	Classrooms and related facilities
Humber College	College	North Campus	Classrooms and related facilities
Humber College	College	North Residences	Student residences
Humber College	College	Lakeshore Campus West	Classrooms and related facilities
Humber College	College	Criminal Justice Centre	Classrooms and related facilities
Humber College	College	Lakeshore Campus East	Classrooms and related facilities
Humber College	College	Lakeshore Residence	Student residences
Humber College	College	Fashion Insitute	Classrooms and related facilities
Loyalist College	College	Employment Ontario - Belleville	Administrative offices and related facilities

London	291.742086	189.9264254	88.43182168	0	0	0	0	0	0	0	0.954124415
London	4148.127352	2700.463999	1257.365584	0	0	0	0	0	0	0	0.954124415
London	467.7920354	190.221881	122.0584161	0	0	0	0	0	0	0	0.667562236
London	4615.657131	1876.900236	1204.338159	0	0	0	0	0	0	0	0.667562236
London	3851.351308	1021.272147	590.8997943	0	0	0	0	0	0	0	0.418599035
London	39.43945385	26.42840429	26.71829597	0	0	0	0	0	0	0	1.347551629
London	8310.966467	5569.184165	5630.272233	0	0	0	0	0	0	0	1.347551629
London	16.81441335	12.22743158	0	0	0	0	0	0	0	0	0.727199417
London	3085.763631	2243.965513	0	0	0	0	0	0	0	0	0.727199417
London	752.8382215	508.355711	160.6257518	0	0	0	0	0	0	0	0.888612512
London	2721.288926	1837.556499	580.614888	0	0	0	0	0	0	0	0.888612512
London	40.61193802	26.45638581	2.17613889	0	0	0	0	0	0	0	0.705027292
London	827.6989011	539.1991255	44.35118971	0	0	0	0	0	0	0	0.705027292
London	1292.017226	893.4126065	222.1600609	0	0	0	0	0	0	0	0.863434825
London	26.17259052	13.93004785	5.83741268	0	0	0	0	0	0	0	0.755273365
London	1212.720054	645.4557246	270.4794321	0	0	0	0	0	0	0	0.755273365
London	991.9501188	507.6153755	335.5214103	0	0	0	0	0	0	0	0.849979016
London	2949.846432	1420.309883	0	0	0	0	0	0	0	0	0.481486042
London	443.8681659	213.7163263	0	0	0	0	0	0	0	0	0.481486042
London	116.0667284	87.57654153	23.05637331	0	0	0	0	0	0	0	0.95318371
London	1948.062558	1469.883607	386.9778891	0	0	0	0	0	0	0	0.95318371
London	29.54109606	47.83232592	81.02759687	0	0	0	0	0	0	0	4.362056252
London	1053.672222	654.389785	235.0102925	0	0	0	0	0	0	0	0.844095592
London	272.1628032	237.5218971	226.3966922	0	0	0	0	0	0	0	1.704562798
London	57.3317858	33.51384527	14.84880968	0	0	0	0	0	0	0	0.843557449
London	3080.275016	1800.604304	797.7846294	0	0	0	0	0	0	0	0.843557449
London	221.3461357	96.02538009	86.97494507	0	0	0	0	0	0	0	0.826760877
London	1854.706934	804.6173372	728.7817933	0	0	0	0	0	0	0	0.826760877
London	496.8047236	40.67698179	255.0606234	0	0	0	0	0	0	0	0.595279375
London	1318.071698	107.9200256	676.7008708	0	0	0	0	0	0	0	0.595279375
Delhi	102.19	6.154848	8.92571002	0	0	0	0	0	0	0	0.147573716
Simcoe	147.1242136	77.01048674	50.60214423	0	0	0	0	0	0	0	0.867380208
Simcoe	543.5559252	284.5181316	186.9515198	0	0	0	0	0	0	0	0.867380208
St. Thomas	127.6759078	82.56440115	113.9461944	0	0	0	0	0	0	0	1.539136075
St. Thomas	712.5588898	460.7916955	635.9333973	0	0	0	0	0	0	0	1.539136075
Woodstock	78.37497634	53.2363442	27.32225371	0	0	0	0	0	0	0	1.027861209
Woodstock	405.8094821	275.6468235	141.4690013	0	0	0	0	0	0	0	1.027861209
London	332.8885321	539.0061604	913.0723425	0	0	0	0	0	0	0	4.362056252
London	11.4519958	18.54283248	31.41141741	0	0	0	0	0	0	0	4.362056252
London	2030.988914	1772.484462	1689.463684	0	0	0	0	0	0	0	1.704562798
St. Thomas	1463.681943	946.5217457	1306.283935	0	0	0	0	0	0	0	1.539136075
St. Thomas	1888.838627	1221.458558	1685.721114	0	0	0	0	0	0	0	1.539136075
London	8293.201921	5557.28013	5618.237623	0	0	0	0	0	0	0	1.347551629
London	5587.584189	3744.243886	3785.314287	0	0	0	0	0	0	0	1.347551629
Woodstock	242.3302616	164.6032678	84.47860782	0	0	0	0	0	0	0	1.027861209
Woodstock	915.4082409	621.7927005	319.1199203	0	0	0	0	0	0	0	1.027861209
London	2607.419974	1697.451204	790.3518528	0	0	0	0	0	0	0	0.954124415
London	4185.425168	2724.745174	1268.671165	0	0	0	0	0	0	0	0.954124415
London	1878.203041	1417.172077	373.100466	0	0	0	0	0	0	0	0.95318371
London	4558.452445	3439.517123	905.5254913	0	0	0	0	0	0	0	0.95318371
London	4228.259572	2855.141835	902.142523	0	0	0	0	0	0	0	0.888612512
London	330.3232605	223.0515284	70.47785374	0	0	0	0	0	0	0	0.888612512
Simcoe	1144.932286	599.3017087	393.7898952	0	0	0	0	0	0	0	0.867380208
Simcoe	1116.199608	584.261917	383.9075306	0	0	0	0	0	0	0	0.867380208
London	3126.792053	2162.134824	537.6463245	0	0	0	0	0	0	0	0.863434825
London	2747.313708	1899.730631	472.3956989	0	0	0	0	0	0	0	0.863434825
London	71.18288734	36.42675917	24.07720136	0	0	0	0	0	0	0	0.849979016
London	178.9065499	91.5527039	60.51410933	0	0	0	0	0	0	0	0.849979016
London	3657.900847	2271.762414	815.8555675	0	0	0	0	0	0	0	0.844095592
London	2573.326054	1504.262426	666.4859343	0	0	0	0	0	0	0	0.843557449
London	4663.138611	2725.8824	1207.742909	0	0	0	0	0	0	0	0.843557449
London	4114.796214	1785.099474	1616.853051	0	0	0	0	0	0	0	0.826760877
London	7731.718839	3354.20918	3038.073465	0	0	0	0	0	0	0	0.826760877
London	1961.02726	1043.733273	437.3783857	0	0	0	0	0	0	0	0.755273365
London	5569.527527	2964.314322	1242.201477	0	0	0	0	0	0	0	0.755273365
London	375.8682497	200.0513742	83.83190363	0	0	0	0	0	0	0	0.755273365
London	1197.108738	870.5367759	0	0	0	0	0	0	0	0	0.727199417
London	294.8703758	214.4295653	0	0	0	0	0	0	0	0	0.727199417
London	511.611896	333.286279	27.41407078	0	0	0	0	0	0	0	0.705027292
London	1483.345378	966.3158057	79.48316975	0	0	0	0	0	0	0	0.705027292
London	8124.361084	3303.671569	2119.845082	0	0	0	0	0	0	0	0.667562236
London	5315.064611	2161.30569	1386.830725	0	0	0	0	0	0	0	0.667562236
London	2059.976784	168.6651397	1057.596552	0	0	0	0	0	0	0	0.595279375
London	1568.870337	128.4547169	805.4614363	0	0	0	0	0	0	0	0.595279375
Strathroy	603.9429	178.1302716	180.0846274	0	0	0	0	0	0	0	0.593127097
London	14388.94656	4786.021703	3613.423956	0	0	0	0	0	0	0	0.583742918
London	13274.79631	4090.842095	3479.00415	0	0	0	0	0	0	0	0.570241989
London	580.4647736	178.8795606	152.1258262	0	0	0	0	0	0	0	0.570241989
London	13200.04563	4424.748528	2861.990982	0	0	0	0	0	0	0	0.552023812
London	1538.146229	797.315868	0	0	0	0	0	0	0	0	0.518361553
London	366.6852951	176.5538513	0	0	0	0	0	0	0	0	0.481486042
London	38.54401368	18.55840458	0	0	0	0	0	0	0	0	0.481486042
London	2169.15458	575.1999693	332.8060445	0	0	0	0	0	0	0	0.418599035
London	752.0731906	199.429068	115.3880439	0	0	0	0	0	0	0	0.418599035
London	12506.6625	2137.931208	1985.9569	0	0	0	0	0	0	0	0.3297353
Toronto	2344.4244	1439.33058	420.204	0	0	0	0	0	0	0	0.79317319
Toronto	1672.2	2023.0164	2663.306	0	0	0	0	0	0	0	2.802489176
Toronto	17497.8079	19535.7384	26208.486	0	0	0	0	0	0	0	2.614283153
Toronto	8128.6571	10549.6344	4139.112	0	0	0	0	0	0	0	1.807032357
Toronto	5145.2665	2818.4256	2384.424	0	0	0	0	0	0	0	1.011191471
Toronto	33700.1253	17052.15323	15566.168	0	0	0	0	0	0	0	0.967899108
Toronto	39345.1009	23865.7284	10265.472	0	0	0	0	0	0	0	0.867482854
Toronto	10854.9934	5492.591173	3765.23	0	0	0	0	0	0	0	0.852862902
Toronto	1795.3854	506.304	315.438	0	0	0	0	0	0	0	0.457696715
Toronto	34328.408	10249.8624	4652.34	0	0	0	0	0	0	0	0.434107005
Toronto	650.3	177.9571008	0	0	0	0	0	0	0	0	0.273653853
Toronto	2773.1579	0	398.848	0	0	0	0	0	0	0	0.143824483
Toronto	8796.701	4975.4952	0	5373.2568	0	0	0	0	0	0	1.176435575
Toronto	5109.5	1952.568	0	3954.1856	0	0	0	0	0	0	1.156033584
Toronto	120325.009	62091.54	0	65767.2416	0	0	0	0	0	0	1.06261186
Toronto	27086.0169	11690.5284	0	16801.7192	0	0	0	0	0	0	1.05191722
Toronto	13594.7073	7002.4644	0	6068.8632	0	0	0	0	0	0	0.961501216
Toronto	1763.9852	904.2372	0	692.6964	0	0	0	0	0	0	0.905298752
Toronto	32464.5553	16368.7356	0	10504.0912	0	0	0	0	0	0	0.827758968
Toronto	15537.9895	4912.11	0	6068.8632	0	0	0	0	0	0	0.706717764
Toronto	1672.2	543.2544	0	342.6428	0	0	0	0	0	0	0.529779452
Belleville	369.6491	220.1076	135.128	0	0	0	0	0	0	0	0.961007615

Loyalist College	College	Kente Building	Library
Loyalist College	College	Kente Building	Administrative offices and related facilities
Loyalist College	College	Pioneer Building	Administrative offices and related facilities
Loyalist College	College	Satellite Campus - Bancroft	Administrative offices and related facilities
Loyalist College	College	Residence Complex	Student residences
Loyalist College	College	Satellite Campus - Bancroft	Laboratories
Loyalist College	College	Kente Building	Student recreational facilities and athletic facilities
Loyalist College	College	Kente Building	Classrooms and related facilities
Loyalist College	College	Kente Building	Laboratories
Loyalist College	College	Pioneer Building	Laboratories
Loyalist College	College	Pioneer Building	Classrooms and related facilities
Mohawk College	College	Fennell Conference House	Administrative offices and related facilities
Mohawk College	College	Fennell Shed	Administrative offices and related facilities
Mohawk College	College	Brantford Main Building	Classrooms and related facilities
Mohawk College	College	Stoney Creek 336 Leaside	Laboratories
Mohawk College	College	Fennell Main Building	Classrooms and related facilities
Mohawk College	College	Brantford West Building	Student recreational facilities and athletic facilities
Mohawk College	College	Stoney Creek Barton	Classrooms and related facilities
Mohawk College	College	Stoney Creek 330 Leaside	Laboratories
Mohawk College	College	David Braley Athletic and Recreation Centre	Student recreational facilities and athletic facilities
Seneca College	College	BT-Buttonville Campus	Library
Seneca College	College	BT-Buttonville Campus	Administrative offices and related facilities
Seneca College	College	JN-Jane Campus	Administrative offices and related facilities
Seneca College	College	KG-King Campus - Gatehouse	Administrative offices and related facilities
Seneca College	College	KG-King Campus - Horse Barn	Administrative offices and related facilities
Seneca College	College	KG-King Campus - Log Cabin	Administrative offices and related facilities
Seneca College	College	KG-King Campus - McCutcheon Island-Change Rooms	Administrative offices and related facilities
Seneca College	College	KG-King Campus - McCutcheon Island-Pavillion	Administrative offices and related facilities
Seneca College	College	KG-King Campus - McCutcheon Island-Rec Island Offices	Administrative offices and related facilities
Seneca College	College	KG-King Campus - McCutcheon Island-Rigging Shop	Administrative offices and related facilities
Seneca College	College	KG-King Campus - Sheep & Cow Barn	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Animal Health Building	Library
Seneca College	College	KG-King Campus -Animal Health Building	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Chalet 1	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Chalet 2	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Chalet 3	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Crime Lab	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Eaton Hall	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Equipment Garage	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Equipment Storage-Repair Shop	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Farm Office-Environmental Landscape Management	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Garriock Hall	Library
Seneca College	College	KG-King Campus -Garriock Hall	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Greenhouse	Administrative offices and related facilities
Seneca College	College	KG-King Campus -KOLTS Day Care	Administrative offices and related facilities
Seneca College	College	KG-King Campus -KW Building	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Law Lodge	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Main Electrical Storage Building	Administrative offices and related facilities
Seneca College	College	KG-King Campus -McCutcheon Island-Boat House	Administrative offices and related facilities
Seneca College	College	KG-King Campus -McCutcheon Island-Quartermaster Office	Administrative offices and related facilities
Seneca College	College	KG-King Campus -McCutcheon Island-Tank Storage	Administrative offices and related facilities
Seneca College	College	KG-King Campus -McCutcheon Island-Underwater Skills Store	Administrative offices and related facilities
Seneca College	College	KG-King Campus -Portables	Administrative offices and related facilities
Seneca College	College	KG-King Campus Residence	Administrative offices and related facilities
Seneca College	College	MK-Markham Campus	Library
Seneca College	College	MK-Markham Campus	Administrative offices and related facilities
Seneca College	College	NH- Newnham Campus - Maintenance Shop	Administrative offices and related facilities
Seneca College	College	NH-Newnham Campu - Building L	Administrative offices and related facilities
Seneca College	College	NH-Newnham Campus - Building A	Library
Seneca College	College	NH-Newnham Campus - Building A	Administrative offices and related facilities
Seneca College	College	NH-Newnham Campus - Building B	Library
Seneca College	College	NH-Newnham Campus - Building B	Administrative offices and related facilities
Seneca College	College	NH-Newnham Campus - Building C	Library
Seneca College	College	NH-Newnham Campus - Building C	Administrative offices and related facilities
Seneca College	College	NH-Newnham Campus - Building D	Library
Seneca College	College	NH-Newnham Campus - Building D	Administrative offices and related facilities
Seneca College	College	NH-Newnham Campus - Building E	Administrative offices and related facilities
Seneca College	College	NH-Newnham Campus - Building F	Administrative offices and related facilities
Seneca College	College	NH-Newnham Campus - Building G	Administrative offices and related facilities
Seneca College	College	NH-Newnham Campus - Building H	Administrative offices and related facilities
Seneca College	College	NH-Newnham Campus - Bus Garage	Administrative offices and related facilities
Seneca College	College	NH-Newnham Campus Residence	Administrative offices and related facilities
Seneca College	College	NM-Newmarket Campus	Library
Seneca College	College	NM-Newmarket Campus	Administrative offices and related facilities
Seneca College	College	SY-Seneca @ York-SEQ Building	Library
Seneca College	College	SY-Seneca @ York-SEQ Building	Administrative offices and related facilities
Seneca College	College	SY-Seneca @ York-TEL Building	Library
Seneca College	College	SY-Seneca @ York-TEL Building	Administrative offices and related facilities
Seneca College	College	VN-Vaughan Campus	Library
Seneca College	College	VN-Vaughan Campus	Administrative offices and related facilities
Seneca College	College	YG-Yorkgate Campus	Library
Seneca College	College	YG-Yorkgate Campus	Administrative offices and related facilities
Seneca College	College	KG-King Campus -KW Building	Classrooms and related facilities
Seneca College	College	KG-King Campus -KW Building	Laboratories
Seneca College	College	KG-King Campus -Greenhouse	Classrooms and related facilities
Seneca College	College	KG-King Campus -Greenhouse	Laboratories
Seneca College	College	VN-Vaughan Campus	Classrooms and related facilities
Seneca College	College	JN-Jane Campus	Classrooms and related facilities
Seneca College	College	JN-Jane Campus	Laboratories
Seneca College	College	MK-Markham Campus	Laboratories
Seneca College	College	MK-Markham Campus	Student recreational facilities and athletic facilities
Seneca College	College	MK-Markham Campus	Classrooms and related facilities
Seneca College	College	KG-King Campus -KOLTS Day Care	Classrooms and related facilities
Seneca College	College	KG-King Campus -KOLTS Day Care	Laboratories
Seneca College	College	BT-Buttonville Campus	Laboratories
Seneca College	College	BT-Buttonville Campus	Classrooms and related facilities
Seneca College	College	KG-King Campus -Animal Health Building	Laboratories
Seneca College	College	KG-King Campus -Animal Health Building	Classrooms and related facilities
Seneca College	College	KG-King Campus Residence	Student residences
Seneca College	College	NH-Newnham Campus - Building C	Classrooms and related facilities
Seneca College	College	NH-Newnham Campus - Building C	Laboratories
Seneca College	College	NH-Newnham Campus - Building D	Classrooms and related facilities
Seneca College	College	NH-Newnham Campus - Building D	Laboratories
Seneca College	College	NH-Newnham Campus - Building G	Student recreational facilities and athletic facilities
Seneca College	College	NH-Newnham Campus - Building G	Classrooms and related facilities
Seneca College	College	KG-King Campus -Portables	Classrooms and related facilities
Seneca College	College	KG-King Campus -Farm Office-Environmental Landscape Management	Classrooms and related facilities

Belleville	863.5984	383.19048	328.83376	0	0	0	0	0	0	0	0.824485363
Belleville	14527.5162	6705.8316	5754.606	0	0	0	0	0	0	0	0.857712869
Belleville	1876.16195	645.17724	247.85424	0	0	0	0	0	0	0	0.475988483
Bancroft	281.7657	181.29204	0	153.97392	0	0	0	0	0	0	1.189874992
Belleville	11034.7549	7963.92	8681.442	0	0	0	0	0	0	0	1.508448729
Bancroft	159.5093	120.86136	0	102.64928	0	0	0	0	0	0	1.401238925
Belleville	3175.1362	1915.95204	1644.1688	0	0	0	0	0	0	0	1.121249803
Belleville	9666.6166	4789.8792	4110.422	0	0	0	0	0	0	0	0.920725583
Belleville	11642.4138	5364.666	4603.6734	0	0	0	0	0	0	0	0.856208993
Belleville	1141.0907	394.27488	151.46648	0	0	0	0	0	0	0	0.478262911
Belleville	2202.98415	752.70672	289.16328	0	0	0	0	0	0	0	0.472935768
Hamilton	214.599	51.847488	1139.644662	0	0	0	0	0	0	0	5.552179414
Hamilton	1545.4844	128.83644	0	0	0	0	0	0	0	0	0.083363145
Brantford	9991.395	4724.37	7019.71242	0	0	0	0	0	0	0	1.175419691
Stoney Creek	4088.0645	1240.718544	2957.487864	0	0	0	0	0	0	0	1.026942312
Hamilton	74690.5781	46252.30907	28543.6164	0	0	0	0	0	0	0	1.001410451
Brantford	4070.5993	1846.225872	1512.597296	0	0	0	0	0	0	0	0.825142177
Stoney Creek	26872.47139	9339.428376	7091.777588	0	0	0	0	0	0	0	0.61145124
Stoney Creek	1455.4643	316.19682	32.564024	0	0	0	0	0	0	0	0.23962171
Hamilton	6967.5	60.16806	0	0	0	0	0	0	0	0	0.008635531
Markham	50.075887	38.50724188	21.06929138	0	0	0	0	0	0	0	1.189724972
Markham	657.206186	505.3769206	276.5176906	0	0	0	0	0	0	0	1.189724972
Toronto	358.99347	234.1196618	220.0067497	0	0	0	0	0	0	0	1.264999086
King City	494.580091	221.3609564	192.8718789	0	0	0	0	0	0	0	0.8375445
King City	66.4235	29.72940026	0	0	0	0	0	0	0	0	0.447573528
King City	142.137	63.6167586	176.2624243	0	0	0	0	0	0	0	1.687661783
King City	23.760104	10.63439358	0	0	0	0	0	0	0	0	0.447573528
King City	295.165596	130.7822192	0	0	0	0	0	0	0	0	0.443080837
King City	180.271521	80.68476072	26.57200987	0	0	0	0	0	0	0	0.59497346
King City	6.00134	2.686040919	0	0	0	0	0	0	0	0	0.447573528
King City	12.412369	5.555447789	0	0	0	0	0	0	0	0	0.447573528
King City	47.06314	21.06421563	30.86183537	0	0	0	0	0	0	0	1.103327381
King City	326.094793	145.9513971	213.8379168	0	0	0	0	0	0	0	1.103327381
King City	211.748828	135.3486638	0	0	0	0	0	0	0	0	0.639194394
King City	211.748828	135.3486638	0	0	0	0	0	0	0	0	0.639194394
King City	211.748828	135.3486638	0	0	0	0	0	0	0	0	0.639194394
King City	16.769379	7.505530128	0	0	0	0	0	0	0	0	0.447573528
King City	3807.931053	1042.588814	2025.333297	0	0	0	0	0	0	0	0.805666402
King City	139.028566	62.22550583	0	0	0	0	0	0	0	0	0.447573528
King City	68.5602	30.68573062	10.08036374	0	0	0	0	0	0	0	0.594602909
King City	613.512529	274.5919673	265.9802805	0	0	0	0	0	0	0	0.881110364
King City	1072.527713	480.0350128	405.5065397	0	0	0	0	0	0	0	0.825658435
King City	3848.445672	1722.462408	1455.039221	0	0	0	0	0	0	0	0.825658435
King City	277.806302	124.3387468	349.7217456	0	0	0	0	0	0	0	1.706442543
King City	544.507338	243.7070705	431.6629581	0	0	0	0	0	0	0	1.240332281
King City	82.441318	36.89855158	108.4004616	0	0	0	0	0	0	0	1.762453787
King City	346.286608	154.988719	0	0	0	0	0	0	0	0	0.447573528
King City	81.2875	36.38213319	0	0	0	0	0	0	0	0	0.447573528
King City	287.35828	128.6139593	0	0	0	0	0	0	0	0	0.447573528
King City	100.069093	44.78827703	0	0	0	0	0	0	0	0	0.447573528
King City	3.0657	1.372126166	0	0	0	0	0	0	0	0	0.447573528
King City	6.202933	2.776268609	0	0	0	0	0	0	0	0	0.447573528
King City	56.5761	25.3219647	26.37590772	0	0	0	0	0	0	0	0.913775824
King City	935.884819	418.8772706	608.020647	0	0	0	0	0	0	0	1.097248183
Markham	1761.703576	1261.848347	933.3421469	0	0	0	0	0	0	0	1.246061212
Markham	12109.47877	8673.607737	6415.54406	0	0	0	0	0	0	0	1.246061212
Toronto	383.038777	200.5170074	396.3299377	0	0	0	0	0	0	0	1.558189356
Toronto	83.811593	43.87453914	0	0	0	0	0	0	0	0	0.523490099
Toronto	384.128494	201.0874635	77.6856816	0	0	0	0	0	0	0	0.725728889
Toronto	6089.653527	3187.87333	1231.564157	0	0	0	0	0	0	0	0.725728889
Toronto	3373.795418	1766.148498	682.312301	0	0	0	0	0	0	0	0.725728889
Toronto	7006.426029	3667.794658	1416.971118	0	0	0	0	0	0	0	0.725728889
Toronto	44.059683	23.06480783	24.32717892	0	0	0	0	0	0	0	1.075631587
Toronto	2895.466324	1515.747953	1598.707084	0	0	0	0	0	0	0	1.075631587
Toronto	222.837372	116.653158	123.0377581	0	0	0	0	0	0	0	1.075631587
Toronto	5532.872241	2896.403839	3054.92831	0	0	0	0	0	0	0	1.075631587
Toronto	885.483782	463.541993	85.00188014	0	0	0	0	0	0	0	0.619484946
Toronto	222.197291	116.3180819	21.32979495	0	0	0	0	0	0	0	0.619484946
Toronto	1757.999653	920.2954129	769.2958008	0	0	0	0	0	0	0	0.961087342
Toronto	749.609171	392.4129794	360.5951336	0	0	0	0	0	0	0	1.004534285
Toronto	338.496014	177.199312	293.7511631	0	0	0	0	0	0	0	1.391302868
Toronto	5961.82034	2254.178962	2835.302327	0	0	0	0	0	0	0	0.853679078
Newmarket	32.27346	14.1584907	13.57998691	0	0	0	0	0	0	0	0.859482609
Newmarket	409.76332	179.7647403	172.4197071	0	0	0	0	0	0	0	0.859482609
Toronto	2522.301888	2001.727322	71.11993486	0	0	0	0	0	0	0	0.821807757
Toronto	7096.444271	5631.818481	200.0944679	0	0	0	0	0	0	0	0.821807757
Toronto	277.495087	156.7109322	0	0	0	0	0	0	0	0	0.564734078
Toronto	5279.622196	2981.582575	0	0	0	0	0	0	0	0	0.564734078
Vaughan	63.536168	34.50360123	47.43222747	0	0	0	0	0	0	0	1.289593491
Vaughan	390.322137	211.9661886	291.3906987	0	0	0	0	0	0	0	1.289593491
North York	116.398126	60.45452658	0	0	0	0	0	0	0	0	0.519377147
North York	569.078459	295.5663464	0	0	0	0	0	0	0	0	0.519377147
King City	185.933776	83.21903617	244.4806515	0	0	0	0	0	0	0	1.762453787
King City	365.622814	163.6430929	480.7502204	0	0	0	0	0	0	0	1.762453787
King City	111.617492	49.95703472	140.5118022	0	0	0	0	0	0	0	1.706442543
King City	561.588861	251.352308	706.966816	0	0	0	0	0	0	0	1.706442543
Vaughan	283.076519	153.7259743	211.3276621	0	0	0	0	0	0	0	1.289593491
Toronto	601.838715	392.4925888	368.8328357	0	0	0	0	0	0	0	1.264999086
Toronto	934.646462	609.5350803	572.7918401	0	0	0	0	0	0	0	1.264999086
Markham	1934.281119	1385.459771	1024.772906	0	0	0	0	0	0	0	1.246061212
Markham	237.20157	169.8994162	125.6682598	0	0	0	0	0	0	0	1.246061212
Markham	8160.262609	5844.918535	4323.268186	0	0	0	0	0	0	0	1.246061212
King City	170.168646	76.16298131	134.9026835	0	0	0	0	0	0	0	1.240332281
King City	38.60924	17.28047377	30.60781294	0	0	0	0	0	0	0	1.240332281
Markham	1663.542649	1279.227249	699.9309826	0	0	0	0	0	0	0	1.189724972
Markham	256.35755	197.1332467	107.8617323	0	0	0	0	0	0	0	1.189724972
King City	842.848256	377.2365678	552.700991	0	0	0	0	0	0	0	1.103327381
King City	810.649116	362.8250851	531.5862809	0	0	0	0	0	0	0	1.103327381
King City	6764.664927	3027.68495	4394.831353	0	0	0	0	0	0	0	1.097248183
Toronto	1450.435623	759.2886883	800.8456826	0	0	0	0	0	0	0	1.075631587
Toronto	1122.446599	587.5896816	619.749335	0	0	0	0	0	0	0	1.075631587
Toronto	6708.733553	3511.955594	3704.170124	0	0	0	0	0	0	0	1.075631587
Toronto	1730.880285	906.0986923	955.6908155	0	0	0	0	0	0	0	1.075631587
Toronto	5501.365206	2879.910218	2407.382245	0	0	0	0	0	0	0	0.961087342
Toronto	1409.80395	738.0184098	616.9263213	0	0	0	0	0	0	0	0.961087342
King City	735.89806	329.3684912	343.0773652	0	0	0	0	0	0	0	0.913775824
King City	43.342495	19.39895342	18.79056813	0	0	0	0	0	0	0	0.881110364

Seneca College	College	NM-Newmarket Campus	Laboratories
Seneca College	College	NM-Newmarket Campus	Classrooms and related facilities
Seneca College	College	NH-Newnham Campus Residence	Classrooms and related facilities
Seneca College	College	NH-Newnham Campus Residence	Student residences
Seneca College	College	KG-King Campus -Garriock Hall	Student recreational facilities and athletic facilities
Seneca College	College	KG-King Campus -Garriock Hall	Classrooms and related facilities
Seneca College	College	KG-King Campus -Garriock Hall	Laboratories
Seneca College	College	SY-Seneca @ York-SEQ Building	Student recreational facilities and athletic facilities
Seneca College	College	SY-Seneca @ York-SEQ Building	Classrooms and related facilities
Seneca College	College	SY-Seneca @ York-SEQ Building	Laboratories
Seneca College	College	KG-King Campus -Eaton Hall	Classrooms and related facilities
Seneca College	College	NH-Newnham Campus - Building A	Classrooms and related facilities
Seneca College	College	NH-Newnham Campus - Building A	Laboratories
Seneca College	College	NH-Newnham Campus - Building B	Classrooms and related facilities
Seneca College	College	NH-Newnham Campus - Building B	Laboratories
Seneca College	College	NH-Newnham Campus - Building E	Classrooms and related facilities
Seneca College	College	NH-Newnham Campus - Building F	Classrooms and related facilities
Seneca College	College	KG-King Campus - McCutcheon Island-Rec Island Offices	Classrooms and related facilities
Seneca College	College	SY-Seneca @ York-TEL Building	Laboratories
Seneca College	College	SY-Seneca @ York-TEL Building	Classrooms and related facilities
Seneca College	College	NH-Newnham Campu - Building L	Classrooms and related facilities
Seneca College	College	YG-Yorkgate Campus	Laboratories
Seneca College	College	YG-Yorkgate Campus	Classrooms and related facilities
Seneca College	College	KG-King Campus - Sheep & Cow Barn	Laboratories
Seneca College	College	KG-King Campus -McCutcheon Island-Boat House	Classrooms and related facilities
Seneca College	College	KG-King Campus - McCutcheon Island-Rigging Shop	Laboratories
Seneca College	College	KG-King Campus -Crime Lab	Classrooms and related facilities
Seneca College	College	KG-King Campus - Horse Barn	Laboratories
Seneca College	College	KG-King Campus -Law Lodge	Classrooms and related facilities
Seneca College	College	KG-King Campus -McCutcheon Island-Underwater Skills Store	Laboratories
Seneca College	College	KG-King-McCutcheon Island-Tank Storage	Laboratories
Seneca College	College	KG-King Campus -Crime Lab	Laboratories
Seneca College	College	KG-King Campus - McCutcheon Island- Pavillion	Classrooms and related facilities
Sir Sandford Fleming	College	Frost Facilities Shop	Administrative offices and related facilities
Sir Sandford Fleming	College	Frost Farmhouse	Administrative offices and related facilities
Sir Sandford Fleming	College	Frost Heavy Equipment	Administrative offices and related facilities
Sir Sandford Fleming	College	Frost Main Campus	Library
Sir Sandford Fleming	College	Frost Main Campus	Administrative offices and related facilities
Sir Sandford Fleming	College	Frost NR Law & Arboriculture	Administrative offices and related facilities
Sir Sandford Fleming	College	Frost Parnham RDB Training Centre	Administrative offices and related facilities
Sir Sandford Fleming	College	Haliburton Main Campus	Library
Sir Sandford Fleming	College	Haliburton Main Campus	Administrative offices and related facilities
Sir Sandford Fleming	College	McRae Campus	Administrative offices and related facilities
Sir Sandford Fleming	College	Sutherland Drive Shed	Administrative offices and related facilities
Sir Sandford Fleming	College	Sutherland Farmhouse	Administrative offices and related facilities
Sir Sandford Fleming	College	Sutherland Main Campus	Library
Sir Sandford Fleming	College	Sutherland Main Campus	Administrative offices and related facilities
Sir Sandford Fleming	College	Sutherland Main Campus	Classrooms and related facilities
Sir Sandford Fleming	College	Sutherland Main Campus	Laboratories
Sir Sandford Fleming	College	McRae Campus	Laboratories
Sir Sandford Fleming	College	McRae Campus	Classrooms and related facilities
Sir Sandford Fleming	College	Haliburton Main Campus	Laboratories
Sir Sandford Fleming	College	Haliburton Main Campus	Classrooms and related facilities
Sir Sandford Fleming	College	Frost Parnham RDB Training Centre	Classrooms and related facilities
Sir Sandford Fleming	College	Frost Parnham RDB Training Centre	Laboratories
Sir Sandford Fleming	College	Frost Main Campus	Classrooms and related facilities
Sir Sandford Fleming	College	Frost Main Campus	Laboratories
Sir Sandford Fleming	College	Frost Residence Building #1	Student residences
Sir Sandford Fleming	College	Frost Residence Building #2	Student residences
Sir Sandford Fleming	College	Sutherland Residence Building #1 Newfoundland House	Student residences
Sir Sandford Fleming	College	Haliburton Blacksmith	Laboratories
Sir Sandford Fleming	College	Frost NR Law & Arboriculture	Laboratories
Sir Sandford Fleming	College	Frost NR Law & Arboriculture	Classrooms and related facilities
Sir Sandford Fleming	College	Frost Heavy Equipment	Classrooms and related facilities
Sir Sandford Fleming	College	Frost Heavy Equipment	Laboratories
Sir Sandford Fleming	College	Sutherland Residence Building #3 Eastern House	Student residences
Sir Sandford Fleming	College	Sutherland Residence Building #5 Mountain House	Student residences
Sir Sandford Fleming	College	Sutherland Residence Building #6 Pacfic House	Student residences
Sir Sandford Fleming	College	Sutherland Residence Building #2 Atlanitc House	Student residences
Sir Sandford Fleming	College	Sutherland Residence Building #4 Central House	Student residences
Sir Sandford Fleming	College	Frost FieldHouse	Student recreational facilities and athletic facilities
Sir Sandford Fleming	College	Musem Portable	Classrooms and related facilities
St. Clair College	College	TD Student Centre	Other
St. Clair College	College	South Campus	Classrooms and related facilities
St. Clair College	College	Thames Campus (HealthPlex)	Student recreational facilities and athletic facilities
St. Clair College	College	Thames Campus (Main)	Classrooms and related facilities
St. Clair College	College	South Campus-FCEM	Laboratories
St. Clair College	College	SCCCA	Classrooms and related facilities
St. Clair College	College	MediaPlex	Laboratories
St. Clair College	College	South Campus	Student residences
St. Clair College	College	South Campus-CCIP	Laboratories
St. Clair College	College	South Campus-Truck & Coach	Laboratories
University of Western Ontario	College	Richard Ivey School of Business (New)	Laboratories
Nipissing University	University	Brantford Academic Building #2	Classrooms and related facilities
Nipissing University	University	Muskoka Academic Building	Classrooms and related facilities
Nipissing University	University	Brantford Academic Building	Classrooms and related facilities
Nipissing University	University	Muskoka Residence Building	Student residences
Queen's University	University	Campus Total	Classrooms and related facilities
Ryerson University	University	Ryerson University	Classrooms and related facilities
University of Western Ontario	University	Althouse College	Laboratories
University of Western Ontario	University	Spencer Hall	Classrooms and related facilities
University of Western Ontario	University	London Hall Residence	Student recreational facilities and athletic facilities
University of Western Ontario	University	Althouse College	Student recreational facilities and athletic facilities
University of Western Ontario	University	Essex Hall Residence	Student residences
University of Western Ontario	University	TD Waterhouse Stadium	Student recreational facilities and athletic facilities
University of Western Ontario	University	Ausable Hall Residence	Student residences
University of Western Ontario	University	Saugeen-Matiland Hall Residence	Student residences
University of Western Ontario	University	Althouse College	Classrooms and related facilities
University of Western Ontario	University	Beaver Hall Residence	Student residences
University of Western Ontario	University	London Hall Residence	Student residences
University of Western Ontario	University	Richard Ivey School of Business (New)	Student recreational facilities and athletic facilities
University of Western Ontario	University	Perth Hall Residence	Student recreational facilities and athletic facilities
University of Western Ontario	University	Bayfield Hall Residence	Student residences
University of Western Ontario	University	Richard Ivey School of Business (New)	Classrooms and related facilities
University of Western Ontario	University	Perth Hall Residence	Student residences
University of Western Ontario	University	Elborn College	Laboratories
University of Western Ontario	University	Elborn College	Student recreational facilities and athletic facilities

Newmarket	262.84197	115.3097805	110.5983217	0	0	0	0	0	0	0	0.859482609
Newmarket	340.374452	149.3235777	143.2223443	0	0	0	0	0	0	0	0.859482609
Toronto	750.06531	283.6015421	356.71352	0	0	0	0	0	0	0	0.853679078
Toronto	30014.43393	11348.53143	14274.16284	0	0	0	0	0	0	0	0.853679078
King City	645.656858	288.9789181	244.1131126	0	0	0	0	0	0	0	0.825658435
King City	6535.666427	2925.191283	2471.036828	0	0	0	0	0	0	0	0.825658435
King City	1003.398965	449.0948151	379.3700035	0	0	0	0	0	0	0	0.825658435
Toronto	1490.876851	1183.176741	42.03742027	0	0	0	0	0	0	0	0.821807757
Toronto	10044.69916	7971.586926	283.2247613	0	0	0	0	0	0	0	0.821807757
Toronto	4511.445102	3580.333887	127.2066929	0	0	0	0	0	0	0	0.821807757
King City	884.840914	242.2641655	470.6224301	0	0	0	0	0	0	0	0.805666402
Toronto	12104.50026	6336.586042	2447.999479	0	0	0	0	0	0	0	0.725728889
Toronto	4427.667882	2317.840299	895.4461923	0	0	0	0	0	0	0	0.725728889
Toronto	7147.089635	3741.430663	1445.418756	0	0	0	0	0	0	0	0.725728889
Toronto	711.392898	372.4071388	143.8712385	0	0	0	0	0	0	0	0.725728889
Toronto	1921.464635	1005.867713	184.4507036	0	0	0	0	0	0	0	0.619484946
Toronto	1340.551645	701.7655137	128.68605	0	0	0	0	0	0	0	0.619484946
King City	67.83558	30.36140989	9.998959853	0	0	0	0	0	0	0	0.59497346
Toronto	3430.373376	1937.248747	0	0	0	0	0	0	0	0	0.564734078
Toronto	4785.034673	2702.272146	0	0	0	0	0	0	0	0	0.564734078
Toronto	855.407407	447.7973084	0	0	0	0	0	0	0	0	0.523490099
North York	165.272816	85.83892362	0	0	0	0	0	0	0	0	0.519377147
North York	761.25976	395.3809222	0	0	0	0	0	0	0	0	0.519377147
King City	133.982238	59.966903	0	0	0	0	0	0	0	0	0.447573528
King City	19.21172	8.598657306	0	0	0	0	0	0	0	0	0.447573528
King City	89.80643	40.19498075	0	0	0	0	0	0	0	0	0.447573528
King City	41.973149	18.78607039	0	0	0	0	0	0	0	0	0.447573528
King City	1403.2545	628.0595678	0	0	0	0	0	0	0	0	0.447573528
King City	52.402103	23.45379413	0	0	0	0	0	0	0	0	0.447573528
King City	74.614493	33.3954719	0	0	0	0	0	0	0	0	0.447573528
King City	23.81027	10.65684656	0	0	0	0	0	0	0	0	0.447573528
King City	95.26895	42.6398601	0	0	0	0	0	0	0	0	0.447573528
King City	15.076741	6.680215017	0	0	0	0	0	0	0	0	0.443080837
Lindsay	156.256871	94.4078657	0	0	0	23.2852	0	0	0	0	0.753202499
Lindsay	486.1457	3.8988	95.874	0	0	0	0	0	0	0	0.2052323
Lindsay	87.74405	53.01353109	37.87429271	0	0	0	0	0	0	0	1.035828911
Lindsay	1197.9455	723.7792307	781.0645963	0	0	0	0	0	0	0	1.25618722
Lindsay	3359.8214	2029.949566	2190.615137	0	0	0	0	0	0	0	1.25618722
Lindsay	76.6425	46.30615474	33.95907602	0	0	0	0	0	0	0	1.047267909
Lindsay	67.3525	40.6932875	52.48477219	0	0	0	0	0	0	0	1.383438769
Haliburton	41.9908	21.99147954	0	0	0	43.27482439	0	0	0	0	1.554300083
Haliburton	422.2305	221.1311382	0	0	0	435.141763	0	0	0	0	1.554300083
Peterborough	693.2198	513.8318988	855.735842	0	0	0	0	0	0	0	1.975661602
Peterborough	703.1601	204.3864	263.53	0	0	0	0	0	0	0	0.665447883
Peterborough	260.12	75.6108	128.516	0	0	0	0	0	0	0	0.784740889
Peterborough	1905.379	2125.935174	2234.424792	0	0	0	0	0	0	0	2.288447582
Peterborough	6102.601	6809.004466	7156.478038	0	0	0	0	0	0	0	2.288447582
Peterborough	11052.313	12331.66785	12960.97111	0	0	0	0	0	0	0	2.288447582
Peterborough	5131.2386	5725.202507	6017.368061	0	0	0	0	0	0	0	2.288447582
Peterborough	1845.5514	1367.968976	2278.21606	0	0	0	0	0	0	0	1.975661602
Peterborough	1577.9994	1169.652725	1947.940098	0	0	0	0	0	0	0	1.975661602
Haliburton	734.0029	384.4130084	0	0	0	756.44776	0	0	0	0	1.554300083
Haliburton	1208.1645	632.7415738	0	0	0	1245.108609	0	0	0	0	1.554300083
Lindsay	541.2354	327.0056454	421.7603901	0	0	0	0	0	0	0	1.383438769
Lindsay	612.7684	370.2247232	477.5028378	0	0	0	0	0	0	0	1.383438769
Lindsay	6305.18803	3809.492286	4111.004335	0	0	0	0	0	0	0	1.25618722
Lindsay	4497.9393	2717.581932	2932.671932	0	0	0	0	0	0	0	1.25618722
Lindsay	1817.3098	1097.98909	1082.126	0	0	0	0	0	0	0	1.199638658
Lindsay	1817.3098	1097.98909	1063.658	0	0	0	0	0	0	0	1.189476384
Peterborough	2259.5138	1049.688	1629.934	0	0	0	0	0	0	0	1.185928583
Haliburton	832.0124	76.1004	0	0	0	857.4542638	0	0	0	0	1.122044171
Lindsay	357.665	216.0953888	158.4756881	0	0	0	0	0	0	0	1.047267909
Lindsay	274.5195	165.860227	121.6352359	0	0	0	0	0	0	0	1.047267909
Lindsay	301.2747	182.0252846	130.0437599	0	0	0	0	0	0	0	1.035828911
Lindsay	1758.6899	1062.571897	759.1299474	0	0	0	0	0	0	0	1.035828911
Peterborough	2209.7194	823.1112	1297.89	0	0	0	0	0	0	0	0.95985092
Peterborough	2240.8409	714.7152	1403.986	0	0	0	0	0	0	0	0.94549381
Peterborough	2240.8409	719.2116	1394.942	0	0	0	0	0	0	0	0.943464393
Peterborough	2240.8409	766.6092	1269.01	0	0	0	0	0	0	0	0.90841755
Peterborough	2240.8409	715.7124	1288.732	0	0	0	0	0	0	0	0.894505451
Lindsay	1585.9888	194.8284	919.03	0	0	0	0	0	0	0	0.702311643
Peterborough	204.38	111.33	0	0	0	0	0	0	0	0	0.544720618
Windsor	919.87722	234.4537872	374.622886	0	0	0	0	0	0	0	0.662128228
Windsor	91213.62346	57569.8675	70453.8088	3087.704	0	0	0	0	0	0	1.437410064
Chatham	5505.9972	3108.3552	3751.688168	0	0	0	0	0	0	0	1.245922059
Chatham	6955.83176	5970.114	2475.593562	0	0	0	0	0	0	0	1.214190891
Windsor	9906.99535	0.0036	10722.45141	0	0	0	0	0	0	0	1.082311501
Windsor	18164.5512	9681.19308	9106.093824	0	0	0	0	0	0	0	1.034283022
Windsor	1646.0951	1378.592964	321.50432	0	0	0	0	0	0	0	1.032806236
Windsor	13107.8184	4518.2016	5613.55	0	0	0	0	0	0	0	0.772954834
Windsor	2351.80066	0.0036	1201.162406	0	0	0	0	0	0	0	0.51074312
Windsor	743.2	0.0036	367.437732	0	0	0	0	0	0	0	0.494404376
London	54.76455	17.78200168	50.90431818	0	0	0	0	0	0	0	1.254211344
Brantford	1025.91328	491.1552	851.808	0	0	0	0	0	0	0	1.309041638
Bracebridge	1635.04	1063.38816	844.36	0	0	0	0	0	0	0	1.166789901
Brantford	1531.21496	476.57088	738.1424	0	0	0	0	0	0	0	0.793300295
Bracebridge	2153.1433	571.608	975.84	0	0	0	0	0	0	0	0.718692527
Kingston	674213.389	370376.0172	574003.07	1215.42164	701.675	0	0	0	0	0	1.403555906
Toronto	259408.3749	192878.4315	27011.10974	0	0	0	0	0	43204.81733	7002.186383	1.041202101
London	2043.60491	1258.731696	2144.373648	0	0	0	0	0	0	0	1.665246216
London	878.62033	658.2873683	777.5267063	0	0	0	0	0	0	0	1.634168964
London	106.50056	75.35782832	93.0885725	0	0	0	0	0	0	0	1.581648029
London	779.28236	452.2966428	770.531961	0	0	0	0	0	0	0	1.569172699
London	12718.98545	4939.325425	14388.63548	0	0	0	0	0	0	0	1.519614986
London	1518.10677	1156.440534	1005.491466	0	0	0	0	0	0	0	1.424097463
London	3252.5219	865.5213491	3729.928043	0	0	0	0	0	0	0	1.412888071
London	16408.28599	6648.934265	14368.72752	0	0	0	0	0	0	0	1.280917568
London	1948.17803	871.7640322	1485.13605	0	0	0	0	0	0	0	1.209797075
London	4045.67423	1185.916908	3688.450676	0	0	0	0	0	0	0	1.204834425
London	11136.67549	6003.912108	7416.556714	0	0	0	0	0	0	0	1.205069577
London	2247.21384	687.5714139	1968.302256	0	0	0	0	0	0	0	1.181851777
London	699.75067	738.2029876	0	0	0	0	0	0	0	0	1.054951455
London	15938.71365	3359.315431	12654.98867	0	0	0	0	0	0	0	1.004742569
London	3462.52235	816.7850566	2338.200566	0	0	0	0	0	0	0	0.911181302
London	9039.46728	7265.702152	0	0	0	0	0	0	0	0	0.80377548
London	2741.95279	1816.624713	363.8818912	0	0	0	0	0	0	0	0.795238566
London	171.70707	107.19776	21.47241715	0	0	0	0	0	0	0	0.749358644

University of Western Ontario	University	Museum of Ontario Archaeology	Classrooms and related facilities
University of Western Ontario	University	Fraunhofer Project Centre	Laboratories
University of Western Ontario	University	Lambton Hall Residence	Student residences
University of Western Ontario	University	Elborn College	Classrooms and related facilities
University of Western Ontario	University	The Insurance Research Lab for Better Homes	Laboratories
University of Western Ontario	University	Westminster Site 363	Laboratories
University of Western Ontario	University	Westminster Site 357	Laboratories
University of Western Ontario	University	Platts Lane Apartments	Student residences
Wilfrid Laurier University	University	Laurier University - Waterloo Campus	Classrooms and related facilities
Wilfrid Laurier University	University	Laurier University - Brantford Campus	Classrooms and related facilities
Wilfrid Laurier University	University	Laurier University - Kitchener Campus	Classrooms and related facilities
Guelph University	University	Guelph University	Classrooms and related facilities
McMaster University	University	McMaster University	Classrooms and related facilities
Nipissing University	University	Brantford Academic Building	Administrative offices and related facilities
Nipissing University	University	Brantford Academic Building #2	Administrative offices and related facilities
Nipissing University	University	Muskoka Academic Building	Administrative offices and related facilities
University of Western Ontario	University	Advanced Facility for Avian Research	Administrative offices and related facilities
University of Western Ontario	University	Althouse College	Library
University of Western Ontario	University	Althouse College	Administrative offices and related facilities
University of Western Ontario	University	Central Campus	Library
University of Western Ontario	University	Central Campus	Administrative offices and related facilities
University of Western Ontario	University	Elborn College	Library
University of Western Ontario	University	Elborn College	Administrative offices and related facilities
University of Western Ontario	University	Fraunhofer Project Centre	Administrative offices and related facilities
University of Western Ontario	University	Graphics Building	Administrative offices and related facilities
University of Western Ontario	University	Harold W Siebens Centre	Administrative offices and related facilities
University of Western Ontario	University	ICFAR / Environmental Sciences Western	Administrative offices and related facilities
University of Western Ontario	University	London Hall Residence	Administrative offices and related facilities
University of Western Ontario	University	Museum of Ontario Archaeology	Administrative offices and related facilities
University of Western Ontario	University	Richard Ivey School of Business (New)	Library
University of Western Ontario	University	Richard Ivey School of Business (New)	Administrative offices and related facilities
University of Western Ontario	University	Robarts Research Institute	Administrative offices and related facilities
University of Western Ontario	University	Saugeen-Matiland Hall Residence	Administrative offices and related facilities
University of Western Ontario	University	Spencer Hall	Administrative offices and related facilities
University of Western Ontario	University	Support Services Building	Administrative offices and related facilities
University of Western Ontario	University	TD Waterhouse Stadium	Administrative offices and related facilities
University of Western Ontario	University	The Insurance Research Lab for Better Homes	Administrative offices and related facilities
University of Western Ontario	University	Westminster Hall	Administrative offices and related facilities
University of Western Ontario	University	Westminster Site 357	Administrative offices and related facilities
University of Western Ontario	University	Westminster Site 363	Administrative offices and related facilities
University of Western Ontario	University	Westminster Site 367	Administrative offices and related facilities
University of Western Ontario	University	Advanced Facility for Avian Research	Laboratories
University of Western Ontario	University	Central Campus	Laboratories
University of Western Ontario	University	Harold W Siebens Centre	Laboratories
University of Western Ontario	University	Robarts Research Institute	Laboratories
University of Western Ontario	University	Support Services Building	Student recreational facilities and athletic facilities
University of Western Ontario	University	Central Campus	Student recreational facilities and athletic facilities
University of Western Ontario	University	Westminster Hall	Laboratories
University of Western Ontario	University	Westminster Hall	Student recreational facilities and athletic facilities
University of Western Ontario	University	ICFAR / Environmental Sciences Western	Laboratories
University of Western Ontario	University	Spencer Hall	Student recreational facilities and athletic facilities
University of Western Ontario	University	Central Campus	Classrooms and related facilities
University of Western Ontario	University	Essex Hall Residence	Student recreational facilities and athletic facilities
University of Western Ontario	University	Central Campus	Student residences
University of Western Ontario	University	Westminster Hall	Classrooms and related facilities
University of Western Ontario	University	Saugeen-Matiland Hall Residence	Student recreational facilities and athletic facilities
Fanshawe College		London - Nelson Plaza	Classrooms and related facilities
Loyalist College		Satellite Campus - Bancroft	Classrooms and related facilities
Seneca College		NH-Newnham Campus - Bus Garage	Laboratories
Seneca College		NH-Newnham Campus - Bus Garage	Classrooms and related facilities
Boreal College	College	London Campus	Administrative offices and related facilities
Boreal College	College	Windsor 1 Campus	Administrative offices and related facilities
Georgian College	College	Kempenfelt	Administrative offices and related facilities
Georgian College	College	Owen Sound Campus	Classrooms and related facilities
Georgian College	College	Barrie Campus	Classrooms and related facilities
Georgian College	College	Muskoka Campus	Classrooms and related facilities
Georgian College	College	Collingwood	Classrooms and related facilities
Georgian College	College	Orillia Campus	Classrooms and related facilities
Georgian College	College	Midland Campus	Classrooms and related facilities
Georgian College	College	Orangeville Campus	Classrooms and related facilities
Georgian College	College	Barrie Residence	Student residences
La Cite Collegiale	College	Main campus Ottawa	Classrooms and related facilities
La Cite Collegiale	College	Orléans Campus	Laboratories
Lambton College	College	Employment Learning Centre	Administrative offices and related facilities
Lambton College	College	Fire & Public Safety Centre of Excellence	Administrative offices and related facilities
Lambton College	College	Lambton INN	Library
Lambton College	College	Lambton INN	Administrative offices and related facilities
Lambton College	College	North Building	Library
Lambton College	College	North Building	Administrative offices and related facilities
Lambton College	College	Skilled Trades Training Centre	Administrative offices and related facilities
Lambton College	College	South Building	Library
Lambton College	College	South Building	Administrative offices and related facilities
Lambton College	College	Suncor Sustainability Centre	Library
Lambton College	College	Suncor Sustainability Centre	Administrative offices and related facilities
Lambton College	College	Sustainable Smart Home	Administrative offices and related facilities
Lambton College	College	Greenhouse	Laboratories
Lambton College	College	Suncor Sustainability Centre	Laboratories
Lambton College	college	South Building	Laboratories
Lambton College	college	South Building	Student recreational facilities and athletic facilities
Lambton College	college	South Building	Classrooms and related facilities
Lambton College	College	North Building	Classrooms and related facilities
Lambton College	College	Lambton INN	Laboratories
Lambton College	College	Lambton INN	Student residences
Lambton College	College	Lambton INN	Classrooms and related facilities
Lambton College	College	Hoophouse	Laboratories
Lambton College	College	Skilled Trades Training Centre	Classrooms and related facilities
Lambton College	College	Skilled Trades Training Centre	Laboratories
Lambton College	College	Sustainable Smart Home	Laboratories
Lambton College	College	Sustainable Smart Home	Classrooms and related facilities
Niagara College	College	Maid of the Mist Building	Administrative offices and related facilities
Niagara College	College	Niagara-on-the-Lake Main Building	Library
Niagara College	College	Niagara-on-the-Lake Main Building	Administrative offices and related facilities
Niagara College	College	Niagara-on-the-Lake Main Building and WVEC	Library
Niagara College	College	Niagara-on-the-Lake Main Building and WVEC	Administrative offices and related facilities
Niagara College	College	Niagara-on-the-Lake Residence Building	Library
Niagara College	College	Niagara-on-the-Lake Residence Building	Administrative offices and related facilities
Niagara College	College	Niagara-on-the-Lake Wine Visitor + Education Centre	Administrative offices and related facilities

London	1927.14547	501.895143	933.4754213	0	0	0	0	0	0	0	0.744816926
London	999.05589	198.5478791	538.4829105	0	0	0	0	0	0	0	0.737727285
London	9941.79569	1615.716102	5540.815264	0	0	0	0	0	0	0	0.719842933
London	1676.09251	806.7468995	161.5967158	0	0	0	0	0	0	0	0.577738764
London	443.89478	242.9312389	0	0	0	0	0	0	0	0	0.547272124
London	51.67098	27.34698316	0	0	0	0	0	0	0	0	0.529252264
London	70.43678	28.86938524	0	0	0	0	0	0	0	0	0.409862365
London	35040.24496	2607.620235	9971.26522	0	0	0	0	0	0	0	0.358983947
Waterloo	249789.7987	102292.9416	127432.278	0	0	0	0	0	0	0	0.919674145
Brantford	34601.8127	13985.6112	7029.696	0	0	0	0	0	0	0	0.607347002
Kitchener	3654.8718	1486.1232	697.11	0	0	0	0	0	0	0	0.597348777
Guelph	585440.936	389733.48	690469.5	0	0	0	0	0	0	0	1.845110093
Hamilton	404791.312	316482.8652	399223.934	0	0	0	0	0	0	0	1.768088341
Brantford	382.80374	119.14272	184.5356	0	0	0	0	0	0	0	0.793300295
Brantford	256.47832	122.7888	212.952	0	0	0	0	0	0	0	1.309041638
Bracebridge	408.76	265.84704	211.09	0	0	0	0	0	0	0	1.166789901
London	155.29164	104.2896789	223.468351	0	0	0	0	0	0	0	2.110596745
London	806.69715	322.7555519	549.8459303	0	0	0	0	0	0	0	1.081696498
London	2925.72757	931.8397432	1587.480951	0	0	0	0	0	0	0	0.861092031
London	25234.41771	13619.06881	31631.04994	2.351568009	0	0	0	0	0	0	1.793283714
London	65156.47406	27993.4127	65016.26856	6.071861129	0	0	0	0	0	0	1.427574995
London	1267.68553	545.5615397	109.2795685	0	0	0	0	0	0	0	0.516564316
London	2469.23555	845.9386745	169.4470864	0	0	0	0	0	0	0	0.411214621
London	11.36167	0.776177969	2.10507699	0	0	0	0	0	0	0	0.253594318
London	995.96232	448.4214725	758.1152397	0	0	0	0	0	0	0	1.211428071
London	1159.82863	1290.356512	16.45527586	0	0	0	0	0	0	0	1.126728341
Ilderton	628.43134	212.3418464	259.1006025	0	0	0	0	0	0	0	0.750189271
London	61.53696	23.89413688	29.51612517	0	0	0	0	0	0	0	0.867937936
London	269.45645	49.94869178	92.89963602	0	0	0	0	0	0	0	0.530135121
London	1279.86472	269.9430556	772.7626753	0	0	0	0	0	0	0	0.814699956
London	6995.02627	1174.46908	3362.138236	0	0	0	0	0	0	0	0.648547574
London	4876.80408	5152.092251	41.03128651	0	0	0	0	0	0	0	1.064862039
London	72.38768	21.12662038	45.6558359	0	0	0	0	0	0	0	0.922566606
London	1975.44418	1053.455211	1244.27355	0	0	0	0	0	0	0	1.163145375
London	8198.35997	9626.972212	2209.559122	0	0	0	0	0	0	0	1.44376819
London	309.01327	129.1745463	112.3135173	0	0	0	0	0	0	0	0.781481208
London	30.4712	8.623111449	0	0	0	0	0	0	0	0	0.282992184
London	2978.58767	1801.684084	2044.3863	0	0	0	0	0	0	0	1.291239611
London	75.59273	16.02098398	0	0	0	0	0	0	0	0	0.211938158
London	126.41832	34.59743114	0	0	0	0	0	0	0	0	0.273674189
London	184.99177	76.71061243	0	0	0	0	0	0	0	0	0.414670406
London	693.82365	1355.497374	2904.513334	0	0	0	0	0	0	0	6.13990415
London	71980.56433	89964.22582	208946.9522	6.707790698	0	0	0	0	0	0	4.152758298
London	2929.87091	9482.453159	120.9250165	0	0	0	0	0	0	0	3.277747884
London	5970.41359	18348.85913	146.130399	0	0	0	0	0	0	0	3.097773588
London	116.97968	250.3193011	57.45267391	0	0	0	0	0	0	0	2.630986638
London	33854.03273	26505.12494	61559.63689	3.154820582	0	0	0	0	0	0	2.601401061
London	919.14331	1075.178004	1220.013653	0	0	0	0	0	0	0	2.4970988
London	24.84146	27.38208695	31.07068765	0	0	0	0	0	0	0	2.353032978
Ilderton	1487.12462	1461.77808	1783.669058	0	0	0	0	0	0	0	2.182363935
London	798.07603	775.5624146	916.0444491	0	0	0	0	0	0	0	2.119606153
London	29055.32039	17538.27604	40733.62821	2.707633785	0	0	0	0	0	0	2.005643411
London	525.60033	267.8974138	780.4058047	0	0	0	0	0	0	0	1.994487367
London	33951.80998	20252.78049	47038.21678	3.163932337	0	0	0	0	0	0	1.9820493
London	93.40166	79.3753786	90.06791924	0	0	0	0	0	0	0	1.814135828
London	1407.18417	748.4063871	1617.34904	0	0	0	0	0	0	0	1.681198153
London	49.73647424	48.52753172	34.53462448	0	0	0	0	0	0	0	1.670045122
Bancroft	350.7904	302.1534	0	256.6232	0	0	0	0	0	0	1.592907332
Toronto	561.053757	293.706087	642.7288645	0	0	0	0	0	0	0	1.669064577
Toronto	22.237473	11.64109695	25.47468151	0	0	0	0	0	0	0	1.669064577
London	451	551.8836	0	0	0	0	0	0	0	0	1.223688692
Windsor	6131	3887.244	1388.178	0	0	0	0	0	0	0	0.860450497
Innisfil	1469	3645.5076	0	1085.641848	0	1985.979522	0	165.6	0	0	4.685315841
Owen Sound	9771	4909.446	7421.096	0	0	0	0	0	0	0	1.261952922
Barrie	74756.4442	52881.8472	39106.37	0	0	0	0	0	0	0	1.230505519
Bracebridge	1674	629.2044	1303.248	0	0	0	0	0	0	0	1.154392115
Collingwood	1923	1152.3096	1025.848	0	0	0	0	0	0	0	1.132687259
Orillia	12900	6315.6456	5785.196	0	0	0	0	0	0	0	0.938049736
Midland	6236	2796.066	1987.362	0	0	0	0	0	0	0	0.767066709
Orangeville	1046	487.2276	235.448	0	0	0	0	0	0	0	0.690894455
Barrie	17836.4284	5365.368	840.18	0	0	0	0	0	0	0	0.347914272
Ottawa	54090	36630.756	19545.946	0	0	0	0	0	0	0	1.038578332
Ottawa	5297	2601.1476	1541.508	0	0	0	0	0	0	0	0.782075816
Petrolia	340.0222965	39.906	168.188	0	0	0	0	0	0	0	0.612001043
Corunna	650.5016722	402.751116	662.05728	0	0	0	0	0	0	0	1.636903395
Sarnia	42.827945	23.67996303	19.00877487	0	0	0	0	0	0	0	0.99674962
Sarnia	1876.532887	1037.552219	832.8812226	0	0	0	0	0	0	0	0.99674962
Sarnia	124.0245262	43.00484847	92.41746741	0	0	0	0	0	0	0	1.091899482
Sarnia	4085.841695	1416.743997	3044.584432	0	0	0	0	0	0	0	1.091899482
Sarnia	351.0776663	99.0711	118.332	0	0	0	0	0	0	0	0.61924503
Sarnia	1424.19175	976.1823858	1108.203761	0	0	0	0	0	0	0	1.46355724
Sarnia	11145.85656	7639.693774	8672.905286	0	0	0	0	0	0	0	1.46355724
Sarnia	175.5852843	69.427584	280.95072	0	0	0	0	0	0	0	1.995487865
Sarnia	81.93979933	31.820976	128.76908	0	0	0	0	0	0	0	1.959854153
Sarnia	186.8264586	64.78108634	0	0	0	0	0	0	0	0	0.346744711
Sarnia	321.9063545	220.6439639	893.228	0	0	0	0	0	0	0	3.460236023
Sarnia	110.1820884	43.39224	175.5942	0	0	0	0	0	0	0	1.987495818
Sarnia	5694.444444	3903.137595	4431.007797	0	0	0	0	0	0	0	1.46355724
Sarnia	1126.62579	772.2220347	876.6592962	0	0	0	0	0	0	0	1.46355724
Sarnia	12575.43664	8619.569478	9785.30186	0	0	0	0	0	0	0	1.46355724
Sarnia	1477.424749	512.2892173	1100.910101	0	0	0	0	0	0	0	1.091899482
Sarnia	838.0713489	463.3773242	371.9699742	0	0	0	0	0	0	0	0.99674962
Sarnia	5880.34188	3251.29488	2609.933653	0	0	0	0	0	0	0	0.99674962
Sarnia	1859.903382	1028.357613	825.5003751	0	0	0	0	0	0	0	0.99674962
Sarnia	239.8736529	164.4163679	0	0	0	0	0	0	0	0	0.685429041
Sarnia	556.5774805	165.1185	197.22	0	0	0	0	0	0	0	0.651011787
Sarnia	1355.72278	396.2844	473.328	0	0	0	0	0	0	0	0.641438215
Sarnia	84.63396507	29.34637974	0	0	0	0	0	0	0	0	0.346744711
Sarnia	46.35823114	16.07447145	0	0	0	0	0	0	0	0	0.346744711
Niagara Falls	3355.6	1543.876704	976.14286	0	0	0	0	0	0	0	0.750989261
Niagara-on-the-Lake	1130.8	948.765996	0	0	0	0	0	0	0	0	0.839021928
Niagara-on-the-Lake	16615.3	13940.10796	0	0	0	0	0	0	0	0	0.838992251
Niagara-on-the-Lake	1130.8	0	950.67336	0	0	0	0	0	0	0	0.840708666
Niagara-on-the-Lake	16849.3	0	14165.5735	0	0	0	0	0	0	0	0.840721781
Niagara-on-the-Lake	104.6	38.757672	50.22612	0	0	0	0	0	0	0	0.850705468
Niagara-on-the-Lake	2413.9	894.752928	1159.51414	0	0	0	0	0	0	0	0.851015812
Niagara-on-the-Lake	234.9	246.542472	0	0	0	0	0	0	0	0	1.049563525

Niagara College	College	Welland Black Walnut Building	Administrative offices and related facilities
Niagara College	College	Welland Daycare Building	Administrative offices and related facilities
Niagara College	College	Welland MacKenzie Building	Administrative offices and related facilities
Niagara College	College	Welland Main Building	Library
Niagara College	College	Welland Main Building	Administrative offices and related facilities
Niagara College	College	Welland Main Building Voyageur Feed	Library
Niagara College	College	Welland Main Building Voyageur Feed	Administrative offices and related facilities
Niagara College	College	Welland Pavillion Building	Administrative offices and related facilities
Niagara College	College	Welland Residence Building	Library
Niagara College	College	Welland Residence Building	Administrative offices and related facilities
Niagara College	College	Welland Skills Building	Administrative offices and related facilities
Niagara College	College	Niagara-on-the-Lake Wine Visitor + Education Centre	Laboratories
Niagara College	College	Niagara-on-the-Lake Wine Visitor + Education Centre	Classrooms and related facilities
Niagara College	College	Niagara-on-the-Lake Residence Building	Student residences
Niagara College	College	Niagara-on-the-Lake Residence Building	Student recreational facilities and athletic facilities
Niagara College	College	Niagara-on-the-Lake Main Building and WVEC	Laboratories
Niagara College	College	Niagara-on-the-Lake Main Building and WVEC	Classrooms and related facilities
Niagara College	College	Niagara-on-the-Lake Main Building and WVEC	Student recreational facilities and athletic facilities
Niagara College	College	Niagara-on-the-Lake Main Building	Student recreational facilities and athletic facilities
Niagara College	College	Niagara-on-the-Lake Main Building	Laboratories
Niagara College	College	Niagara-on-the-Lake Main Building	Classrooms and related facilities
Niagara College	College	Maid of the Mist Building	Student recreational facilities and athletic facilities
Niagara College	College	Maid of the Mist Building	Classrooms and related facilities
Niagara College	College	Maid of the Mist Building	Laboratories
Niagara College	College	Welland Main Building	Laboratories
Niagara College	College	Welland Main Building	Classrooms and related facilities
Niagara College	College	Welland Main Building	Student recreational facilities and athletic facilities
Niagara College	College	Welland Main Building	Student residences
Niagara College	College	Welland Pavillion Building	Student recreational facilities and athletic facilities
Niagara College	College	Welland Residence Building	Student recreational facilities and athletic facilities
Niagara College	College	Welland Residence Building	Student residences
Niagara College	College	Welland Black Walnut Building	Laboratories
Niagara College	College	Welland Black Walnut Building	Classrooms and related facilities
Niagara College	College	Welland Daycare Building	Classrooms and related facilities
Niagara College	College	Welland Main Building Voyageur Feed	Classrooms and related facilities
Niagara College	College	Welland Main Building Voyageur Feed	Laboratories
Niagara College	College	Welland Main Building Voyageur Feed	Student recreational facilities and athletic facilities
Niagara College	College	Welland Skills Building	Student recreational facilities and athletic facilities
Niagara College	College	Welland Skills Building	Laboratories
Niagara College	College	Welland Skills Building	Classrooms and related facilities
Sheridan College	College	Davis - Miscellaneous	Administrative offices and related facilities
Sheridan College	College	Trafalgar - D wing	Administrative offices and related facilities
Sheridan College	College	Trafalgar - Miscellaneous	Administrative offices and related facilities
Sheridan College	college	Trafalgar - Annie Smith Building	Classrooms and related facilities
Sheridan College	College	Trafalgar - Student Centre	Student recreational facilities and athletic facilities
Sheridan College	College	Trafalgar - Residence	Student residences
Sheridan College	College	Trafalgar - HJK Wing	Classrooms and related facilities
Sheridan College	College	Trafalgar - Athletic Centre	Student recreational facilities and athletic facilities
Sheridan College	College	Trafalgar - B Wing	Classrooms and related facilities
Sheridan College	College	Trafalgar - A Wing	Classrooms and related facilities
Sheridan College	College	Trafalgar - E Wing	Classrooms and related facilities
Sheridan College	College	Trafalgar - SCAET	Classrooms and related facilities
Sheridan College	College	Trafalgar - C Wing	Classrooms and related facilities
Sheridan College	College	Trafalgar - G Wing	Classrooms and related facilities
Sheridan College	College	Trafalgar - AA Wing (SOCAD)	Classrooms and related facilities
Sheridan College	College	Davis - B Wing	Classrooms and related facilities
Sheridan College	College	Davis - C Wing	Classrooms and related facilities
Sheridan College	College	Davis - H Wing	Classrooms and related facilities
Sheridan College	College	Davis - Student Centre	Student recreational facilities and athletic facilities
Sheridan College	College	Davis - Residence	Student residences
Sheridan College	College	Davis - M Building	Classrooms and related facilities
Sheridan College	College	Davis - J Wing	Classrooms and related facilities
Sheridan College	College	Skills Training Centre	Classrooms and related facilities
Sheridan College	College	Hazel McCallion - South Building	Classrooms and related facilities
Sheridan College	College	Davis - C Wing Addition	Classrooms and related facilities
University of Ontario Institute of Technology	College	UOIT - Faculty of Education	Classrooms and related facilities
University of Waterloo	College	Waterloo Campus	Classrooms and related facilities
Brock University	University	East Campus-East Academic 2	Classrooms and related facilities
Brock University	University	Main Campus - John Decew	Classrooms and related facilities
Brock University	University	East Campus-East Academic 3	Classrooms and related facilities
Brock University	University	East Campus-International Centre	Classrooms and related facilities
Brock University	University	East Campus-East Academic 1	Classrooms and related facilities
Brock University	University	573 Glenridge	Classrooms and related facilities
Brock University	University	Main Campus - Mackenzie Chown - H Block	Classrooms and related facilities
Brock University	University	Main Campus - Plaza Building	Classrooms and related facilities
Brock University	University	Main Campus - Villages Residence	Student residences
Brock University	University	East Campus-Quarryview	Student residences
Brock University	University	Main Campus - South Block	Classrooms and related facilities
Carleton University	University	Carleton University	Classrooms and related facilities
Laurentian University	University	Laurentian University	Classrooms and related facilities
Trent University	University	Symons Campus	Classrooms and related facilities
Trent University	University	Oshawa Campus	Classrooms and related facilities
Trent University	University	Traill Campus	Classrooms and related facilities
University of Ontario Institute of Technology	University	UB - Business and IT	Classrooms and related facilities
University of Ontario Institute of Technology	University	Regent Theatre	Classrooms and related facilities
University of Ontario Institute of Technology	University	61 Charles	Classrooms and related facilities
University of Ottawa	University	Gendron	Laboratories
University of Ottawa	University	Stanton Residence	Student residences
University of Ottawa	University	University Centre	Student recreational facilities and athletic facilities
University of Ottawa	University	Perez Hall	Classrooms and related facilities
University of Ottawa	University	600 Peter Morand	Laboratories
University of Ottawa	University	ARTs	Classrooms and related facilities
University of Ottawa	University	100 Laurier	Classrooms and related facilities
University of Ottawa	University	Montpetit Hall	Student recreational facilities and athletic facilities
University of Ottawa	University	Residential Complex	Student residences
University of Ottawa	University	Fauteux	Classrooms and related facilities
University of Ottawa	University	200 Lees Campus	Classrooms and related facilities
University of Ottawa	University	Leblanc Residence	Student residences
University of Ottawa	University	Thompson Residence	Student residences
University of Ottawa	University	Hyman Soloway Residence	Student residences
University of Ottawa	University	SITE	Classrooms and related facilities
University of Ottawa	University	850 Peter Morand	Laboratories
University of Ottawa	University	Lamoureux	Classrooms and related facilities
University of Ottawa	University	Desmarais	Classrooms and related facilities
University of Ottawa	University	FSS	Classrooms and related facilities
University of Ottawa	University	Brooks Residence	Student residences
University of Ottawa	University	Vanier	Classrooms and related facilities

Welland	884.8	0	383.42	0	0	0	0	0	0	0	0.433340868
Welland	485.9	0	163.514	0	0	0	0	0	0	0	0.336517802
Welland	1762.3	2024.3664	66.96626	0	0	0	0	0	0	0	1.186706384
Welland	1332.5	757.1232	0	0	0	0	0	0	0	0	0.568197523
Welland	36348	20652.426	0	0	0	0	0	0	0	0	0.568186035
Welland	1289	0	427.88	0	0	0	0	0	0	0	0.331947246
Welland	30137.6	0	10003.386	0	0	0	0	0	0	0	0.331923776
Welland	372.5	0	182.97	0	0	0	0	0	0	0	0.491194631
Welland	43.5	0	20.938	0	0	0	0	0	0	0	0.481333333
Welland	2390	0	1150.944	0	0	0	0	0	0	0	0.481566527
Welland	2077.2	0	680.466	0	0	0	0	0	0	0	0.327588099
Niagara-on-the-Lake	532	558.417636	0	0	0	0	0	0	0	0	1.049657211
Niagara-on-the-Lake	39	40.918356	0	0	0	0	0	0	0	0	1.049188615
Niagara-on-the-Lake	3961.8	1468.531008	1903.07572	0	0	0	0	0	0	0	0.851029009
Niagara-on-the-Lake	176.1	65.27484	84.5899	0	0	0	0	0	0	0	0.85102067
Niagara-on-the-Lake	4596.2	0	3863.9274	0	0	0	0	0	0	0	0.840678691
Niagara-on-the-Lake	4577.8	0	3848.45532	0	0	0	0	0	0	0	0.840677906
Niagara-on-the-Lake	1971.3	0	1657.2028	0	0	0	0	0	0	0	0.840664942
Niagara-on-the-Lake	1971	1653.87798	0	0	0	0	0	0	0	0	0.839106027
Niagara-on-the-Lake	4064.2	3409.870788	0	0	0	0	0	0	0	0	0.839001719
Niagara-on-the-Lake	4538.8	3808.030824	0	0	0	0	0	0	0	0	0.83899507
Niagara Falls	23.4	10.788156	6.821	0	0	0	0	0	0	0	0.752528034
Niagara Falls	486.5	223.8462	141.53062	0	0	0	0	0	0	0	0.75103149
Niagara Falls	906.5	417.084012	263.7086	0	0	0	0	0	0	0	0.751012258
Welland	11302.5	6421.9428	0	0	0	0	0	0	0	0	0.568187817
Welland	5890.6	3346.956	0	0	0	0	0	0	0	0	0.568185923
Welland	5746	3264.7932	0	0	0	0	0	0	0	0	0.568185381
Welland	4238.5	2408.2524	0	0	0	0	0	0	0	0	0.568185065
Welland	434.7	0	213.484	0	0	0	0	0	0	0	0.49110651
Welland	144.2	0	69.464	0	0	0	0	0	0	0	0.481719834
Welland	4238.5	0	2041.132	0	0	0	0	0	0	0	0.481569423
Welland	414.2	0	179.474	0	0	0	0	0	0	0	0.433302752
Welland	93.9	0	40.66	0	0	0	0	0	0	0	0.433013845
Welland	344.6	0	115.938	0	0	0	0	0	0	0	0.336442252
Welland	5225.2	0	1734.396	0	0	0	0	0	0	0	0.331929113
Welland	6399.9	0	2124.276	0	0	0	0	0	0	0	0.331923311
Welland	5136.6	0	1704.946	0	0	0	0	0	0	0	0.331921115
Welland	30.5	0	9.994	0	0	0	0	0	0	0	0.327672131
Welland	4488.5	0	1470.41	0	0	0	0	0	0	0	0.327594965
Welland	226.9	0	74.328	0	0	0	0	0	0	0	0.327580432
Brampton	1241	787.7210868	708.9957175	0	0	0	0	0	0	0	1.206057054
Oakville	2682	2131.532958	1777.137484	0	0	0	0	0	0	0	1.457371529
Oakville	1334	1060.156016	883.8910924	0	0	0	0	0	0	0	1.457306678
Oakville	1191	946.7656086	789.3533361	0	0	0	0	0	0	0	1.457698526
Oakville	1605	1275.494439	1063.426662	0	0	0	0	0	0	0	1.457271714
Oakville	10796	8578.914475	7152.556767	0	0	0	0	0	0	0	1.457157396
Oakville	8331	6620.050894	5519.380099	0	0	0	0	0	0	0	1.457139718
Oakville	2908	2310.772482	1926.576072	0	0	0	0	0	0	0	1.457134991
Oakville	11923	9474.07859	7898.888038	0	0	0	0	0	0	0	1.457096924
Oakville	10550	8383.065028	6989.269874	0	0	0	0	0	0	0	1.457093356
Oakville	4287	3406.436822	2840.071761	0	0	0	0	0	0	0	1.457081545
Oakville	7897	6274.859784	5231.581565	0	0	0	0	0	0	0	1.457064879
Oakville	7244	5755.891969	4798.898995	0	0	0	0	0	0	0	1.457039062
Oakville	5464	4341.464752	3619.638963	0	0	0	0	0	0	0	1.457010197
Oakville	4497	3572.978983	2978.924091	0	0	0	0	0	0	0	1.456949761
Brampton	18037	11448.93251	10304.71858	0	0	0	0	0	0	0	1.206057054
Brampton	6721	4266.134911	3839.774551	0	0	0	0	0	0	0	1.206057054
Brampton	7957	5050.682262	4545.913718	0	0	0	0	0	0	0	1.206057054
Brampton	2090	1326.621331	1194.037913	0	0	0	0	0	0	0	1.206057054
Brampton	11166	7087.58554	6379.247527	0	0	0	0	0	0	0	1.206057054
Brampton	2125	1348.837477	1214.033763	0	0	0	0	0	0	0	1.206057054
Brampton	6502	4127.125307	3714.657659	0	0	0	0	0	0	0	1.206057054
Oakville	8175	5598.558	2938.388	0	0	0	0	0	0	0	1.04427474
Mississauga	14775	9088.3872	3224.11	0	0	0	0	0	0	0	0.833333144
Brampton	4352	1381.209577	1243.170573	0	0	0	0	0	0	0	0.603028527
Oshawa	2941	1923.6852	1110.93	0	0	0	0	0	0	0	1.031831078
Waterloo	581816	371602.8	488249.08	0	0	0	0	0	0	0	1.477875961
St Catharines	675	356.0688	426.816	0	0	0	0	0	0	0	1.159829333
St. Catharines	1604	1091.7	624.758	0	0	0	0	0	0	0	1.070110973
St Catharines	675	250.866	372.02	0	0	0	0	0	0	0	0.922794074
St Catharines	4280	2251.0584	1437.92	0	0	0	0	0	0	0	0.861910841
St Catharines	675	290.43	287.394	0	0	0	0	0	0	0	0.856035556
St. Catharines	2979	1960.7796	584.516	0	0	0	0	0	0	0	0.854412756
St Catharines	6600	0	5221.618	0	0	0	0	0	0	0	0.791154242
St Catharines	8011	0	4377.22	0	0	0	0	0	0	0	0.546401198
St Catharines	18195	0	8335.756	0	0	0	0	0	0	0	0.458134433
St Catharines	10773	1671.012	2979.238	0	0	0	0	0	0	0	0.431657848
St Catharines	7440	0	1988.008	0	0	0	0	0	0	0	0.267205376
Ottawa	442467.47	256436.6272	353689.066	0	288.66	0	0	0	0	0	1.379568883
Sudbury	169250	73152	133733	0	0	0	0	0	0	0	1.222363368
Peterborough	117700	80430.858	94145.418	177.4324	0	0	0	0	0	0	1.484738389
Oshawa	4571	2035.5912	3536.812	0	0	0	0	0	0	0	1.219077489
Peterborough	7414	2489.9148	1442.024	0	0	0	0	0	0	0	0.530339736
Oshawa	48947.19	61979.148	14824.636	0	0	0	0	0	0	0	1.569115285
Oshawa	1315.15	714.5208	596.904	0	0	0	0	0	0	0	0.997167471
Oshawa	7452	2320.3548	2239.378	0	0	0	0	0	0	0	0.611880408
Ottawa	4618.432	2190.38544	4425.214	17.66564	0	0	0	0	0	0	1.43625912
Ottawa	9207.9	3650.5908	9091.69	35.395688	0	0	0	0	0	0	1.387686279
Ottawa	15693	10636.8876	10580.207	37.813704	0	0	0	0	0	0	1.354419697
Ottawa	5183	5021.9352	1780.04958	7.105832	0	0	0	0	0	0	1.313735407
Ottawa	4457.3	2402.2008	3328.572	0	0	0	0	0	0	0	1.285704978
Ottawa	9034	4710.2868	6352.9008	25.360844	0	0	0	0	0	0	1.227424003
Ottawa	4321	1230.73272	4012.5378	16.018192	0	0	0	0	0	0	1.217146196
Ottawa	10874	5695.0848	6515.9702	26.011908	0	0	0	0	0	0	1.125351012
Ottawa	25216	10332.9108	17452.8262	65.384984	0	0	0	0	0	0	1.104501982
Ottawa	9131	4382.8308	5011.0448	20.00414316	0	0	0	0	0	0	1.030980149
Ottawa	21136.08	7942.4316	13562.2	0	0	0	0	0	0	0	1.017437084
Ottawa	3815	1164.52764	2536.728	0	0	0	0	0	0	0	0.970184965
Ottawa	12363	5145.5016	5749.9282	20.635004	0	0	0	0	0	0	0.882962453
Ottawa	8847	3437.3052	3690.522	0	0	0	0	0	0	0	0.805677314
Ottawa	17567	9487.746	3797.84958	13.971104	0	0	0	0	0	0	0.757076717
Ottawa	2320.07	826.8048	908.124	0	0	0	0	0	0	0	0.747791575
Ottawa	13895	5646.8124	2239.12644	8.938744	0	0	0	0	0	0	0.568181186
Ottawa	24845	10711.1376	2028.25	0	0	0	0	0	0	0	0.512754582
Ottawa	25741	7881.858	2299.94278	9.181244	0	0	0	0	0	0	0.395904667
Ottawa	25594	9633.6	0	0	0	0	0	0	0	0	0.376400719
Ottawa	13968.55	1805.00328	1149.97158	4.590816	0	0	0	0	0	0	0.211873507

University of Toronto at Mississauga	University	University of Toronto Mississauga	Classrooms and related facilities
University of Waterloo	University	Kitchener Campus	Classrooms and related facilities
University of Waterloo	University	Cambridge Campus	Classrooms and related facilities
York University	University	Tatham Hall (379)	Student residences
York University	University	Sherman Health Science Research Centre (441)	Laboratories
York University	University	Petrie Science and Engineering Building (373)	Laboratories
York University	University	Vari Hall (381)	Classrooms and related facilities
York University	University	Winters Residence (374)	Student residences
York University	University	340 Assiniboine Road (400)	Student residences
York University	University	Vanier College (353)	Classrooms and related facilities
York University	University	McLaughlin College (378)	Classrooms and related facilities
York University	University	320 Assiniboine Road (403)	Student residences
York University	University	360 Assiniboine Road (401)	Student residences
York University	University	Stong Residence (389)	Student residences
York University	University	Hilliard Residence (321)	Student residences
York University	University	Joan and Martin Goldfarb Centre for Fine Arts (391)	Classrooms and related facilities
York University	University	Wood Residence (308)	Student residences
York University	University	380 Assiniboine Road (402)	Student residences
York University	University	Ignat Kaneff Building - Osgoode (384)	Classrooms and related facilities
York University	University	Norman Bethune Residence (410)	Student residences
York University	University	Curtis Lecture Halls (380)	Classrooms and related facilities
York University	University	Atkinson Residence (365)	Student residences
York University	University	Calumet Residence (390)	Student residences
York University	University	Vanier Residence (371)	Student residences
York University	University	Stadium Field House (397)	Student recreational facilities and athletic facilities
York University	University	Accolade Building West (413)	Classrooms and related facilities
York University	University	Tait McKenzie Physical Education Centre (361)(396)	Student recreational facilities and athletic facilities
York University	University	The Seymour Schulich Building (405)	Classrooms and related facilities
York University	University	Founders Residence (359)	Student residences
York University	University	Computer Science and Engineering Building (404)	Classrooms and related facilities
York University	University	Accolade Building East (412)	Classrooms and related facilities
York University	University	The Pond Road Residence (411)	Student residences
York University	University	Technology Enhanced Learning (483)	Classrooms and related facilities
Brock University	University	Main Campus - Alumni Greenhouse	Other
Brock University	University	Main Campus - Harrison Hall	Administrative offices and related facilities
Brock University	University	Main Campus - Kenmore	Administrative offices and related facilities
Brock University	University	Main Campus - Theal House	Administrative offices and related facilities
Brock University	University	Rodman Hall	Other
Brock University	University	Schmon Parkway (CPDC & ITS)	Administrative offices and related facilities
Brock University	University	Main Campus -cogen plant	Classrooms and related facilities
Brock University	University	Hamilton Campus	Classrooms and related facilities
Brock University	University	Main Campus-CFHBRC	Laboratories
Lakehead University	University	Orilia Campus	Classrooms and related facilities
University of Ontario Institute of Technology	University	Campus Corners	Administrative offices and related facilities
University of Ontario Institute of Technology	University	DTB - Bordessa Hall	Administrative offices and related facilities
University of Ontario Institute of Technology	University	ACE - Automotive Centre of Excellence	Laboratories
University of Ontario Institute of Technology	University	CERL - Clean Energy Research Centre	Laboratories
University of Ontario Institute of Technology	University	UP - Pavillion	Classrooms and related facilities
University of Ontario Institute of Technology	University	Campus Ice Centre	Student recreational facilities and athletic facilities
University of Ontario Institute of Technology	University	Tennis Centre	Student recreational facilities and athletic facilities
University of Ottawa	University	100 Marie Curie	Administrative offices and related facilities
University of Ottawa	University	129,139, 141 Louis-Pasteur	Administrative offices and related facilities
University of Ottawa	University	Academic Hall	Administrative offices and related facilities
University of Ottawa	University	Brooks Parking	Parking garage
University of Ottawa	University	Colonel By	Administrative offices and related facilities
University of Ottawa	University	Fauteux	Library
University of Ottawa	University	Hagen Hall	Administrative offices and related facilities
University of Ottawa	University	Montpetit Hall	Administrative offices and related facilities
University of Ottawa	University	Morisset Library	Library
University of Ottawa	University	Others/miscellaneous	Administrative offices and related facilities
University of Ottawa	University	Perez Parking	Parking garage
University of Ottawa	University	Tabaret Hall	Administrative offices and related facilities
University of Ottawa	University	Colonel By	Laboratories
University of Ottawa	University	Marion Hall	Laboratories
University of Ottawa	University	Careg	Laboratories
University of Ottawa	University	D'Iorio Hall	Laboratories
University of Ottawa	University	MacDonald & CUBE	Laboratories
University of Ottawa	University	Sports complex	Student recreational facilities and athletic facilities
University of Ottawa	University	Simard	Classrooms and related facilities
University of Ottawa	University	Roger Guindon Hall	Laboratories
University of Ottawa	University	Biosciences II	Laboratories
University of Ottawa	University	Marchand Residence	Student residences
University of Toronto	University	University of Toronto St George Campus	Classrooms and related facilities
University of Toronto at Scarborough	University	University of Toronto Scarborough	Classrooms and related facilities
University of Windsor	University	University of Windsor	Classrooms and related facilities
York University	University	190 Albany Road / Tennis Centre YUDC (443)	Administrative offices and related facilities
York University	University	Arboretum Lane Parking Garage - PSII (395)	Parking garage
York University	University	Atkinson College (364)	Administrative offices and related facilities
York University	University	Behavioural Science Building (358)	Administrative offices and related facilities
York University	University	Bennett Centre for Student Services - PSIII (408)	Administrative offices and related facilities
York University	University	Calumet College (347)	Administrative offices and related facilities
York University	University	Central Services (313)	Administrative offices and related facilities
York University	University	Central Square (382) (385)	Library
York University	University	Central Utilities Building (356)	Administrative offices and related facilities
York University	University	East Office Building (481)	Administrative offices and related facilities
York University	University	Executive Learning Centre (406)	Administrative offices and related facilities
York University	University	Founders College (352)	Administrative offices and related facilities
York University	University	Gatehouse (Cottage) (322)	Administrative offices and related facilities
York University	University	Glendon Hall (302)	Administrative offices and related facilities
York University	University	Greenhouse (323)	Administrative offices and related facilities
York University	University	Hart House (435)	Other
York University	University	Health, Nursing and Environmental Studies (387)	Administrative offices and related facilities
York University	University	Hoover House (436)	Other
York University	University	Kaneff Tower (485)	Administrative offices and related facilities
York University	University	Kinsmen Building (487)(587)	Administrative offices and related facilities
York University	University	Leslie Frost Library (307)	Library
York University	University	Norman Bethune College (393)	Administrative offices and related facilities
York University	University	Physical Resources Building (370)(363)	Administrative offices and related facilities
York University	University	Ross Building (372)	Administrative offices and related facilities
York University	University	Scott Library (369)	Library
York University	University	Steacie Science and Engineering Library (354)	Administrative offices and related facilities
York University	University	Stong College (386)	Administrative offices and related facilities
York University	University	Stong House (434)	Other
York University	University	Student Centre (388)	Administrative offices and related facilities
York University	University	Student Services Parking Garage PSIII (407)	Parking garage
York University	University	West Office Building (482)	Administrative offices and related facilities
York University	University	William Small Centre - PS2 Face Building (398)	Administrative offices and related facilities

Mississauga	185484	128967.9519	163514.532	0	0	43.35603	0	0	0	0	1.577094736
Kitchener	17912	10823.04	14075.2	0	0	0	0	0	0	0	1.390031264
Cambridge	7742	3688.2	3716.4	0	0	0	0	0	0	0	0.95641953
Toronto	6692.85	2671.272	0	0	0	0	0	0	7486.44	2141.294	1.837633594
Toronto	4102.69	4154.148	2260.658	0	0	0	0	0	0	0	1.563560981
Toronto	12895.7	9983.466	4.028	0	0	0	0	0	8726.888	3715.596	1.739337764
Toronto	11695.29	2986.0164	0	0	0	0	0	0	13410.93	3804.331	1.727300255
Toronto	6467.32	1789.47	0	0	0	0	0	0	7785.322	152.985	1.504143447
Toronto	9400.76	2519.2908	0	0	0	0	0	0	10505.6	3086.171	1.713804182
Toronto	6733.08	2781.432	0	0	0	0	0	0	6433.798	2270.564	1.705875172
Toronto	6568.62	2045.7072	0	0	0	0	0	0	6933.909	2063.561	1.681202018
Toronto	10877.53	3240.7056	0	0	0	0	0	0	11395.91	3587.867	1.675424715
Toronto	9364.6	2723.67	0	0	0	0	0	0	9844.844	3086.192	1.671689768
Toronto	6841.97	1990.8324	0	0	0	0	0	0	7202.776	2184.204	1.662943918
Toronto	5988.13	1501.9992	0	0	0	0	0	0	6995.96	0	1.419134054
Toronto	10675.39	4017.1248	14.212	0	0	0	0	0	9568.367	3302.55	1.583291458
Toronto	5361.24	928.134	0	0	0	0	0	0	6356.07	0	1.358678962
Toronto	11016.37	3217.086	0	0	0	0	0	0	10374.76	3611.941	1.561656607
Toronto	18750.01	8512.6968	0	0	0	0	0	0	14420.98	5514.862	1.517254593
Toronto	6536.69	2218.914	0	0	0	0	0	0	5589.148	2101.604	1.516006725
Toronto	9466.68	3309.0732	0	0	0	0	0	0	6662.399	3041.56	1.374614141
Toronto	11762.28	3424.4172	0	0	0	0	0	0	8252.67	3538.284	1.293573287
Toronto	5271.12	889.308	0	0	0	0	0	0	4176.325	1694.238	1.282435422
Toronto	6440.91	1023.8292	0	0	0	0	0	0	5105.102	2072.789	1.273379103
Toronto	1550.33	612.7164	847.248	0	0	0	0	0	0	0	0.941712023
Toronto	6511.3	2320.3368	0	0	0	0	0	0	3382.193	561.0048	0.961948397
Toronto	12505.5	4185.8136	81.32	0	0	0	0	0	6003.546	2728.051	1.039441094
Toronto	21802.69	9946.71	1646.122	0	0	0	0	0	4144.302	6719.483	1.02999295
Toronto	6394.64	1468.6488	0	0	0	0	0	0	3567.04	311.545	0.836205603
Toronto	8878.73	4095.3348	0	0	0	0	0	0	1029.074	4349.329	1.067014967
Toronto	22799.12	8327.0412	0	0	0	0	0	0	4430.079	5398.347	0.796323156
Toronto	12151.78	3552.0552	0	0	0	0	0	0	3238.882	2364.832	0.753450869
Toronto	32017.61	12439.368	520.106	0	0	0	0	0	2937.568	5804.381	0.677796469
St Catharines	243	0	339.796	0	0	0	0	0	0	0	1.398337449
St Catharines	546	0	82.992	0	0	0	0	0	0	0	0.152
St Catharines	529	0	261.592	0	0	0	0	0	0	0	0.494502836
St Catharines	259	0	29.754	0	0	0	0	0	0	0	0.114880309
St Catharines	2044	578.0088	967.86	0	0	0	0	0	0	0	0.75629589
Thorold	565	73.416204	36.29	0	0	0	0	0	0	0	0.194170273
St Catharines	136574	9915.066	424471.78	0	0	0	0	0	0	0	3.180596936
Hamilton	6728	3586.32	11194.382	0	0	0	0	0	0	0	2.196893876
St Catharines	16338	21349.2564	13489.962	0	0	0	0	0	0	0	2.132404113
Orillia	11247	11925.60876	7903.9525	0	0	0	0	0	0	0	1.763097827
Oshawa	4609.95	1619.6508	1160.672	0	0	0	0	0	0	0	0.603113439
Oshawa	3507.07	2072.2356	243.428	0	0	0	0	0	0	0	0.660284397
Oshawa	11827.05	23024.3544	12624.17	0	0	0	0	0	0	0	3.01415183
Oshawa	701.41	469.89	1631.2887	0	0	0	0	0	0	0	2.995649763
Oshawa	526.0223	329.4	950	0	0	0	0	0	0	0	2.432216277
Oshawa	7832	8008.4988	8256.032	0	0	0	0	0	0	0	2.076676558
Oshawa	3822	2369.9412	4147.32	0	0	0	0	0	0	0	1.705196546
Ottawa	3447.63	2746.0836	1781.31612	7.110876	0	0	0	0	0	0	1.31525442
Ottawa	4321	1674.05472	2301.51332	9.18784	0	0	0	0	0	0	0.922183726
Ottawa	3584	1404.35676	1945.03684	7.764656	0	0	0	0	0	0	0.936707103
Ottawa	11665	1155.708	596.676	0	0	0	0	0	0	0	0.150225804
Ottawa	6604.634	4613.652	20476.0416	81.740736	0	0	0	0	0	0	3.811177779
Ottawa	4890	2347.64496	2684.14596	10.715008	0	0	0	0	0	0	1.031187306
Ottawa	1599	626.553	867.77712	3.464064	0	0	0	0	0	0	0.936706807
Ottawa	7584	3971.9988	4544.5188	18.14177032	0	0	0	0	0	0	1.125350655
Ottawa	25662	11160.288	696.236	2.779244	0	0	0	0	0	0	0.4621348
Ottawa	25568	3403.6524	12270.846	0	0	0	0	0	0	0	0.613051408
Ottawa	6011	713.86164	2064.41802	8.24112	0	0	0	0	0	0	0.463570251
Ottawa	16567	6491.6244	8990.9102	35.89194	0	0	0	0	0	0	0.936707101
Ottawa	17780.37	12420.4392	55123.674	220.0543552	0	0	0	0	0	0	3.811178707
Ottawa	8915	9470.1168	20787.349	82.711124	0	0	0	0	0	0	3.40327279
Ottawa	5630.336	7704.1008	10639.715	42.417712	0	0	0	0	0	0	3.265565947
Ottawa	9274	13237.596	16316.136	65.134336	0	0	0	0	0	0	3.193753109
Ottawa	8562.9	6757.1208	15561.7372	62.12268	0	0	0	0	0	0	2.613715059
Ottawa	14950	16493.382	16226.95	0	0	0	0	0	0	0	2.18865097
Ottawa	10059.78	19427.5512	1868.28292	7.458136	0	0	0	0	0	0	2.117669796
Ottawa	51117	57321.972	26.866	0	0	0	0	0	42665	0	1.956567052
Ottawa	7642.301	7497.2484	7138.984	28.498988	0	0	0	0	0	0	1.918889532
Ottawa	8114.3	2458.66536	11282.7282	45.040592	0	0	0	0	0	0	1.699029387
Toronto	1379739	784281.9888	1602994.502	2125.675848	0	0	0	0	70344.80374	0	1.782762515
Toronto	129817	114014.808	118759.196	710.8936	0	0	0	0	0	0	1.798569506
Windsor	277861.6	117997.056	497842.94	0	0	0	0	0	494557.3	31197.3	4.108500764
Toronto	1421.66	587.682	565.136	0	0	0	0	0	0	0	0.810895713
Toronto	20466.74	917.5716	2.242	0	0	0	0	0	0	0	0.044941872
Toronto	9468.23	3117.6504	0	0	0	0	0	0	18772.75	3096.149	2.638988428
Toronto	8405.81	4305.6864	0	0	0	0	0	0	13172.71	2840.512	2.417245738
Toronto	9796.82	5556.0816	0	0	0	0	0	0	1143.638	1091.622	0.795292922
Toronto	3177.74	1664.7444	0	0	0	0	0	0	4560.18	1055.997	2.29122628
Toronto	1036.31	304.758	0	0	0	0	0	0	849	0	1.113332883
Toronto	10543.52	107.568	0	0	0	0	0	0	699.0134	201.3122	0.095593654
Toronto	999	484.6896	0	0	0	0	0	0	969	319.029	1.774493093
Toronto	3470.08	1270.5624	0	0	0	0	0	0	2565.867	1079.3	1.416604055
Toronto	6243.71	2679.8292	0	0	0	0	0	0	4166.813	2216.123	1.451503225
Toronto	8873.58	3128.6196	0	0	0	0	0	0	12507.42	2896.6	2.088518907
Toronto	154.7	24.0912	164.92	0	0	0	0	0	0	0	1.221791855
Toronto	2659.92	180.36	0	0	0	0	0	0	1893.94	0	0.779835484
Toronto	537.69	5.256	524.172	0	0	0	0	0	0	0	0.984634269
Toronto	304.28	31.2588	0	0	0	0	0	0	0	0	0.10273038
Toronto	15863.13	4844.4804	0	0	0	0	0	0	14911.9	5326.537	1.581208589
Toronto	328.18	15.264	0	0	0	0	0	0	0	0	0.046511061
Toronto	10719.04	5857.0452	4319.422	0	0	0	0	0	0	0	0.949382333
Toronto	2229.63	717.8364	0	0	0	0	0	0	2512.813	590.1891	1.713664823
Toronto	2883.46	1910.0988	0	0	0	0	0	0	4968.9	0	2.385675126
Toronto	5987.34	2272.0752	0	0	0	0	0	0	12177.14	2007.293	2.748550809
Toronto	4191.02	1077.0912	0	0	0	0	0	0	2153.266	708.9534	0.939940778
Toronto	29816.56	10452.5784	0	0	0	0	0	0	35153.27	9673.047	1.853966232
Toronto	22756.29	12847.5792	0	0	0	0	0	0	7444.06	7079.587	1.202798268
Toronto	7612.26	16812.324	0	0	0	0	0	0	5549.727	2428.417	3.256650193
Toronto	9815.28	4390.704	0	0	0	0	0	0	18420.92	3112.62	2.641212884
Toronto	478.39	46.656	0	0	0	0	0	0	0	0	0.097527122
Toronto	8587.15	7244.4348	0	0	0	0	0	0	1896.129	8847.61	2.094778104
Toronto	45682.36	4812.4116	0	0	0	0	0	0	0	0	0.105345074
Toronto	2938.86	732.9204	0	0	0	0	0	0	1908.6	933.0618	1.216315918
Toronto	4812.49	6834.366	0	0	0	0	0	0	4580.683	1910.829	2.769019364

York University	University	Winters College (368)	Administrative offices and related facilities
York University	University	York Hall (304)	Administrative offices and related facilities
York University	University	York Lanes (383) (450)	Administrative offices and related facilities
York University	University	York Lanes Parking Garage (394)	Parking garage
York University	University	York University Bookstore (203)	Administrative offices and related facilities
York University	University	Chemistry Building (367)	Laboratories
York University	University	Stedman Lecture Halls (362)	Classrooms and related facilities
York University	University	Leonard G. Lumbers Building (366)	Laboratories
York University	University	Centre for Film and Theatre (399)	Laboratories
York University	University	Farquharson Life Sciences Building (355)	Laboratories
York University	University	Life Sciences Building (429)	Laboratories
York University	University	Proctor Field House (309)	Student recreational facilities and athletic facilities
York University	University	Passy Gardens #2-18 (409)	Student residences
Lambton College		Fire & Public Safety Centre of Excellence	Classrooms and related facilities
Northern College	College	Haileybury Campus - Main Building	Library
Northern College	College	Haileybury Campus - Main Building	Administrative offices and related facilities
Northern College	College	Kirkland Lake Campus	Library
Northern College	College	Kirkland Lake Campus	Administrative offices and related facilities
Northern College	College	Moosonee Campus	Library
Northern College	College	Moosonee Campus	Administrative offices and related facilities
Northern College	College	Timmins Campus - Main Building	Library
Northern College	College	Timmins Campus - Main Building	Administrative offices and related facilities
Northern College	College	Haileybury Campus - Vet Sciences	Laboratories
Northern College	College	Timmins Campus - Residence	Student residences
Northern College	College	Moosonee Campus	Classrooms and related facilities
Northern College	College	Moosonee Campus	Laboratories
Northern College	College	Moosonee Campus	Student recreational facilities and athletic facilities
Northern College	College	Haileybury Campus - Main Building	Laboratories
Northern College	College	Haileybury Campus - Main Building	Classrooms and related facilities
Northern College	College	Haileybury Campus - Main Building	Student recreational facilities and athletic facilities
Northern College	College	Timmins Campus - Main Building	Classrooms and related facilities
Northern College	College	Timmins Campus - Main Building	Laboratories
Northern College	College	Timmins Campus - Main Building	Student recreational facilities and athletic facilities
Northern College	College	Kirkland Lake Campus	Classrooms and related facilities
Northern College	College	Kirkland Lake Campus	Student recreational facilities and athletic facilities
Northern College	College	Kirkland Lake Campus	Laboratories
Sault College	College	Hangar 2	Administrative offices and related facilities
Sault College	College	Main Campus	Library
Sault College	College	Main Campus	Administrative offices and related facilities
Sault College	College	Hangar 1	Laboratories
Sault College	College	Main Campus	Student recreational facilities and athletic facilities
Sault College	College	Main Campus	Classrooms and related facilities
Sault College	College	Main Campus	Laboratories
Sault College	College	Hangar 2	Classrooms and related facilities
Hearst University	University	Campus de Timmins	Laboratories
Hearst University	University	Campus de Timmins	Classrooms and related facilities
Hearst University	University	Campus de Hearst	Classrooms and related facilities
Nipissing University	University	Monastery	Classrooms and related facilities
Nipissing University	University	Chancellor's House Residence	Student residences
Nipissing University	University	Founder's House Residence	Student residences
Nipissing University	University	Governor's House Residence	Student residences
Nipissing University	University	Surtees Athletic Centre	Student recreational facilities and athletic facilities
Nipissing University	University	The Education Centre	Classrooms and related facilities
Nipissing University	University	The Education Centre	Laboratories
Nipissing University	University	Townhouse Residence Complex	Student residences
Nipissing University	University	The Education Centre	Student recreational facilities and athletic facilities
Hearst University	University	Campus de Hearst	Library
Hearst University	University	Campus de Hearst	Administrative offices and related facilities
Hearst University	University	Campus de Timmins	Library
Hearst University	University	Campus de Timmins	Administrative offices and related facilities
Nipissing University	University	Harris Learning Library	Library
Nipissing University	University	Harris Learning Library	Administrative offices and related facilities
Nipissing University	University	Monastery	Administrative offices and related facilities
Nipissing University	University	Surtees Athletic Centre	Administrative offices and related facilities
Nipissing University	University	The Education Centre	Administrative offices and related facilities
Boreal College	College	Options Emploi, Chelmsford	Administrative offices and related facilities
Boreal College	College	Options Emploi, Sudbury	Administrative offices and related facilities
Boreal College	College	Sudbury Campus - Electrical Plant	Administrative offices and related facilities
Boreal College	College	Sudbury Campus - Main Building	Administrative offices and related facilities
Boreal College	College	Timmins Campus	Administrative offices and related facilities
Boreal College	College	Sudbury Campus - Greenhouse	Laboratories
Boreal College	College	Sudbury Campus - Greenhouse Lab	Laboratories
Boreal College	College	Sudbury Campus - Trades Buildings 1	Classrooms and related facilities
Boreal College	College	Sudbury Campus - Trades Buildings 2	Classrooms and related facilities
Boreal College	College	Sudbury Campus - Residence 1	Student residences
Boreal College	College	Sudbury Campus - Residence 2	Student residences
Boreal College	College	Sudbury Campus - Collège Boréal (Sudbury)	Classrooms and related facilities
Boreal College	College	Sudbury Campus - Lecture Hall	Classrooms and related facilities
Cambrian College	College	Cambrian College - Enterprise Centre	Administrative offices and related facilities
Cambrian College	College	Cambrian College - Field House	Administrative offices and related facilities
Cambrian College	College	Cambrian College - Main	Library
Cambrian College	College	Cambrian College - Main	Administrative offices and related facilities
Cambrian College	College	Cambrian College - Old Daycare	Administrative offices and related facilities
Cambrian College	College	Record Centre	Administrative offices and related facilities
Cambrian College	College	Val Caron	Administrative offices and related facilities
Cambrian College	College	Cambrian College - Main	Classrooms and related facilities
Cambrian College	College	Cambrian College - Main	Student recreational facilities and athletic facilities
Cambrian College	College	Cambrian College - Main	Laboratories
Cambrian College	College	Cambrian College - Field House	Student recreational facilities and athletic facilities
Cambrian College	College	Cambrian College - Field House	Classrooms and related facilities
Cambrian College	College	Cambrian College - Residence	Student residences
Canadore College	College	Aviation	Administrative offices and related facilities
Canadore College	College	Commerce Court	Library
Canadore College	College	Commerce Court	Administrative offices and related facilities
Canadore College	College	Parry Sound	Administrative offices and related facilities
Canadore College	College	The Education Centre	Library
Canadore College	College	The Education Centre	Administrative offices and related facilities
Canadore College	College	The Education Centre	Laboratories
Canadore College	College	The Education Centre	Student recreational facilities and athletic facilities
Canadore College	College	The Education Centre	Student residences
Canadore College	College	The Education Centre	Classrooms and related facilities
Canadore College	College	Parry Sound	Classrooms and related facilities
Canadore College	College	Parry Sound	Laboratories
Canadore College	College	Aviation	Classrooms and related facilities
Canadore College	College	Aviation	Student recreational facilities and athletic facilities
Canadore College	College	Aviation	Laboratories
Canadore College	College	Commerce Court	Classrooms and related facilities

Toronto	6897.26	5707.3896	0	0	0	0	0	0	17026.69	2374.588	3.640382935
Toronto	19992.81	6584.454	0	0	0	0	0	0	14146.56	0	1.036923474
Toronto	10533.75	327.564	9273.672	0	0	0	0	0	0	4050.645	1.296013386
Toronto	6575.59	573.6564	0	0	0	0	0	0	0	0	0.087240293
Toronto	2482.49	1974.6324	0	0	0	0	0	0	0	1377.224	1.350199356
Toronto	9078.79	11384.0532	14.402	0	0	0	0	0	19301.82	3028.7	3.715139925
Toronto	2656.25	1256.9148	0	0	0	0	0	0	4526.783	899.7385	2.516117195
Toronto	6365.62	3693.672	9.766	0	0	0	0	0	10060.45	2063.561	2.486395512
Toronto	6211.76	2359.2636	0	0	0	0	0	0	10649.86	2104.845	2.433121788
Toronto	11117.44	8578.062	11.742	0	0	0	0	0	14398.58	3621.096	2.393489868
Toronto	15222.24	11365.164	0	0	0	0	0	0	19301.82	3028.7	2.213582495
Toronto	4634.23	2283.2208	0	0	0	0	0	0	7038.92	0	2.011583542
Toronto	18086.74	7437.978	0	0	0	0	0	0	22356.59	5234.117	1.936705288
Corunna	1751.672241	1088.919684	1790.00672	0	0	0	0	0	0	0	1.6435303
Haileybury	416.695518	122.45706	301.18876	0	0	0	0	0	0	0	1.01667957
Haileybury	900.590251	264.662424	650.9495	0	0	0	0	0	0	0	1.016679809
Kirkland Lake	728.544096	179.561844	442.03158	0	0	0	0	0	0	0	0.853199453
Kirkland Lake	2920.485223	719.80254	1771.95482	0	0	0	0	0	0	0	0.853199784
Moosonee	41.330281	10.898028	0	35.545068	0	0	0	0	0	0	1.123706272
Moosonee	1147.950436	302.691312	0	987.258628	0	0	0	0	0	0	1.123698288
Timmins	1429.00638	624.031128	627.86982	0	0	0	0	0	0	0	0.876063932
Timmins	4518.907759	1973.355984	1985.49544	0	0	0	0	0	0	0	0.876063782
Haileybury	864.45308	547.416	1454.032	0	0	0	0	0	0	0	2.315276614
Timmins	3234.75942	950.6304	3468.146	0	0	0	0	0	0	0	1.366029378
Moosonee	1285.94967	339.079068	0	1105.941232	0	0	0	0	0	0	1.123698955
Moosonee	1037.002753	273.436776	0	891.842056	0	0	0	0	0	0	1.12369888
Moosonee	1169.75964	308.441916	0	1006.014936	0	0	0	0	0	0	1.123698243
Haileybury	1866.720523	548.585316	1349.27132	0	0	0	0	0	0	0	1.016679579
Haileybury	3425.377214	1006.637904	2475.8729	0	0	0	0	0	0	0	1.016679503
Haileybury	1858.153285	546.06744	1343.07808	0	0	0	0	0	0	0	1.016679052
Timmins	9754.102388	4259.506752	4285.70954	0	0	0	0	0	0	0	0.87606383
Timmins	8499.385698	3711.585996	3734.41808	0	0	0	0	0	0	0	0.876063793
Timmins	2580.172085	1126.732068	1133.66312	0	0	0	0	0	0	0	0.876063733
Kirkland Lake	6800.600505	1676.121948	4126.14944	0	0	0	0	0	0	0	0.853199858
Kirkland Lake	2486.540962	612.849708	1508.6665	0	0	0	0	0	0	0	0.853199783
Kirkland Lake	3366.032694	829.615068	2042.28302	0	0	0	0	0	0	0	0.853199701
Sault Ste. Marie	1118.7947	358.8876	615.79	0	0	0	0	0	0	0	0.871185393
Sault Ste. Marie	1860.3225	893.9736	1274.254	0	0	0	0	0	0	0	1.165511679
Sault Ste. Marie	9638.2821	4631.6484	6601.778	0	0	0	0	0	0	0	1.165500894
Sault Ste. Marie	1171.2832	344.5308	1872.716	0	0	0	0	0	0	0	1.893006576
Sault Ste. Marie	3127.1069	1502.7228	2141.946	0	0	0	0	0	0	0	1.165508221
Sault Ste. Marie	11814.093	5677.2288	8092.138	0	0	0	0	0	0	0	1.165503505
Sault Ste. Marie	15460.6038	7429.5504	10589.802	0	0	0	0	0	0	0	1.165501208
Sault Ste. Marie	155.9791	50.0364	85.842	0	0	0	0	0	0	0	0.871132094
Timmins	73.99485	27.0936	71.11054	0	0	0	0	0	0	0	1.327175337
Timmins	1166.252665	427.0032	1120.79214	0	0	0	0	0	0	0	1.327152672
Hearst	3156.859054	449.676	1991.22546	0	0	0	0	0	0	0	0.773205714
North Bay	1045.125	244.4337	354.7395	0	0	0	0	0	0	0	0.573302906
North Bay	18334.744	3207.456	6622.64	0	0	0	0	0	0	0	0.536145801
North Bay	7775.9158	1340.262	0	0	0	0	0	0	0	0	0.172360663
North Bay	9847.4	437.9429076	208.2252572	0	0	0	0	0	0	0	0.065618149
North Bay	4180.5	185.9191589	88.39751484	0	0	0	0	0	0	0	0.065618149
North Bay	7680.7862	341.5872048	162.4117718	0	0	0	0	0	0	0	0.065618149
North Bay	7269.3321	323.2886281	153.711492	0	0	0	0	0	0	0	0.065618149
North Bay	3704.1088	164.7326378	78.32412693	0	0	0	0	0	0	0	0.065618149
North Bay	1097.2419	48.7975819	23.20140106	0	0	0	0	0	0	0	0.065618149
Hearst	1372.834395	197.9964	876.755	0	0	0	0	0	0	0	0.782870391
Hearst	892.342589	127.1088	562.85524	0	0	0	0	0	0	0	0.773205323
Timmins	153.17352	59.7708	156.887218	0	0	0	0	0	0	0	1.414461312
Timmins	228.055565	87.894	230.701002	0	0	0	0	0	0	0	1.397006041
North Bay	2211.33586	98.34462458	46.75914233	0	0	0	0	0	0	0	0.065618149
North Bay	390.23574	17.35493375	8.251613352	0	0	0	0	0	0	0	0.065618149
North Bay	348.375	81.4779	118.2465	0	0	0	0	0	0	0	0.573302906
North Bay	464.5	20.65768432	9.821946094	0	0	0	0	0	0	0	0.065618149
North Bay	8640.9077	384.2866383	182.7137344	0	0	0	0	0	0	0	0.065618149
Chelmsford	259	172.548	105.108	0	0	0	0	0	0	0	1.072030888
Sudbury	482	216.1332	283.404	0	0	0	0	0	0	0	1.036384232
Sudbury	417.1201	239.6722807	136.6070645	0	0	0	0	0	0	0	0.902088739
Sudbury	2183.295	1254.495694	715.0304311	0	0	0	0	0	0	0	0.902088873
Timmins	5158	5650.164	6590.948	0	0	0	0	0	0	0	2.373228383
Sudbury	446.0000001	256.2663638	617.795677	0	0	0	0	0	0	0	1.95978036
Sudbury	111	63.77929675	153.756323	0	0	0	0	0	0	0	1.959780359
Sudbury	2223	1277.309702	1244.838454	0	0	0	0	0	0	0	1.134569571
Sudbury	7301	4195.068881	4088.423546	0	0	0	0	0	0	0	1.134569569
Sudbury	2253	1294.547348	1000.882	0	0	0	0	0	0	0	1.018832378
Sudbury	1960	1126.192988	665.874	0	0	0	0	0	0	0	0.914319892
Sudbury	19649.65539	11290.46129	6435.273903	0	0	0	0	0	0	0	0.902088858
Sudbury	1137.93	653.8409335	372.672594	0	0	0	0	0	0	0	0.902088465
Sudbury	609.9084576	322.0128	422.218	0	0	0	0	0	0	0	1.220233612
Sudbury	22.26688715	11.7562107	10.18327743	0	0	0	0	0	0	0	0.985296597
Sudbury	3240.728032	1702.820968	2929.833391	0	0	0	0	0	0	0	1.42951038
Sudbury	21102.71	11088.29404	19078.25587	0	0	0	0	0	0	0	1.429510708
Sudbury	344.0199571	180.7632	311.03	0	0	0	0	0	0	0	1.42954846
Sudbury	538.837632	110.5668	264.594	0	0	0	0	0	0	0	0.696240904
Val Caron	276.2007379	144.7236	289.104	0	0	0	0	0	0	0	1.570696745
Sudbury	16038.8756	8427.530295	14500.20884	0	0	0	0	0	0	0	1.42951038
Sudbury	4142.719938	2176.767166	3745.293984	0	0	0	0	0	0	0	1.42951038
Sudbury	27082.85754	14230.52389	24484.70207	0	0	0	0	0	0	0	1.42951038
Sudbury	378.7930227	199.9907108	173.2327654	0	0	0	0	0	0	0	0.985296597
Sudbury	261.0600562	137.8314358	119.3901491	0	0	0	0	0	0	0	0.985296597
Sudbury	22936.18122	12109.554	4528.536	0	0	0	0	0	0	0	0.725408028
North Bay	240	68.65786812	111.1154567	0	0	0	0	0	0	0	0.74905552
North Bay	435	128.2369404	156.1693802	0	0	0	0	0	0	0	0.653807633
North Bay	502	147.9883772	180.2230548	0	0	0	0	0	0	0	0.653807633
Parry Sound	157	95.14144466	92.30813265	0	0	0	0	0	0	0	1.193946352
North Bay	2602	2125.141799	2426.845067	0	0	0	0	0	0	0	1.749418473
North Bay	22489	18367.53033	20975.1417	0	0	0	0	0	0	0	1.749418473
North Bay	4316	3525.02383	4025.466298	0	0	0	0	0	0	0	1.749418473
North Bay	874	713.8254929	815.1662522	0	0	0	0	0	0	0	1.749418473
North Bay	7866	6424.429436	7336.49627	0	0	0	0	0	0	0	1.749418473
North Bay	14753	12049.27631	13759.89441	0	0	0	0	0	0	0	1.749418473
Parry Sound	911	552.0627776	535.6223493	0	0	0	0	0	0	0	1.193946352
Parry Sound	289	175.1329777	169.9175181	0	0	0	0	0	0	0	1.193946352
North Bay	4015	1148.588919	1858.868995	0	0	0	0	0	0	0	0.74905552
North Bay	172	49.20480549	79.632744	0	0	0	0	0	0	0	0.74905552
North Bay	3444	985.2404076	1594.506804	0	0	0	0	0	0	0	0.74905552
North Bay	8037	2369.288022	2885.363927	0	0	0	0	0	0	0	0.653807633

Canadore College	College	Commerce Court	Laboratories
Canadore College	College	Commerce Court	Student recreational facilities and athletic facilities
Confederation College	College	Greenstone Building	Administrative offices and related facilities
Confederation College	College	Shuniah Building	Classrooms and related facilities
Confederation College	College	Conmee Building	Classrooms and related facilities
Confederation College	College	Aviation Centre of Excellence (ACE)	Classrooms and related facilities
Confederation College	College	Sibley Hall (Residence)	Student residences
Confederation College	College	Neebing Building	Student recreational facilities and athletic facilities
Confederation College	College	Lake of the Woods	Classrooms and related facilities
Confederation College	College	Dorion Building	Classrooms and related facilities
Confederation College	College	McIntyre Building	Classrooms and related facilities
Lakehead University	University	Thunder Bay Campus	Classrooms and related facilities

Energy Intensity (EI) = ∑energy sources (GJ)/ GFA (m2)
EI = (electricity + natural gas + fuel oil 1&2 + fuel oil 4&6 + propane + coal + wood + district heating + district cooling)/GFA
Total EI = average EI of all schools/buildings
Northern Ontario EI = average EI of all schools/buildings in Northern Ontario
Southern Ontario EI = average EI of all schools/buildings in Southern Ontario
College EI = average EI of all college owned buildings
Unitersity EI = average EI of all university owned buildings

Total EI
Northern Ontario EI
Southern Ontario EI
College EI
University EI

Electricity - kWh to GJ
Natural Gas - m3 to GJ
Fuel Oil 1&2 - L to GJ
Fuel Oil 4&6 - L to GJ
Propane - L to GJ
Coal (none used)
Wood - T to GJ

North Bay	6742	1987.525177	2420.445887	0	0	0	0	0	0	0	0.653807633
North Bay	869	256.1790832	311.9797503	0	0	0	0	0	0	0	0.653807633
Thunder Bay	527	439.9848	706.876	0	0	0	0	0	0	0	2.176206452
Thunder Bay	36112	28356.0984	20454.23264	0	0	0	0	0	0	0	1.351637435
Thunder Bay	430	540	0	0	0	0	0	0	0	0	1.255813953
Thunder Bay	5368	3636.3744	2528.51468	0	0	0	0	0	0	0	1.148451766
Thunder Bay	6844	3411.072	4328.4147	0	0	0	0	0	0	0	1.130842592
Thunder Bay	5782	2919.456	3569.73938	0	0	0	0	0	0	0	1.12230982
Kenora	1370	554.9256	652.43074	0	0	0	0	0	0	0	0.881282
Thunder Bay	7392	2967.84	1559.824	0	0	0	0	0	0	0	0.612508658
Thunder Bay	6969	2441.4552	1146.384	0	0	0	0	0	0	0	0.514828412
Thunder Bay	166539	76417.82532	148495.3261	0	0	0	0	0	0	0	1.350513402

1.20474076
1.015658732
1.227639968
1.162272309
1.317581582

= kWh x 0.0036
= m3 x 0.038
= L/1000 x 38.8
=L/1000 x 42.5
=L/1000 x 25.31

=T x 18

Histogram for 2012 BPS Data

Bin	*Frequency*
0	0
0.5	107
1	347
1.5	307
2	116
2.5	56
3	15
3.5	9
4	4
4.5	5
5	1
More	5