Water Resource Management: Macdonald Campus

Baseline Study and Conservation Initiatives

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Executive Summary

McGill is constantly working towards reducing its impact on the environment. The aim of this study is to investigate the water consumption of Macdonald Campus in order to determine and categorize the baseline consumption. This was performed by auditing buildings by walkthroughs and stakeholder interviews. For the purpose of this study, water consumption has been broken down into five categories: Operational, Hygiene, Landscaping, Food Services, and Research & Academia. The results show that the total annual water consumption of the campus is 110,143 m^3. Operations consume most water, with 44% of the total consumption of the audited buildings, followed by the Research and Academia with 31%, and Hygiene with 20%. Landscaping represents 5% and Food Services is almost negligible as the only cafeteria on campus sells pre-cooked meals only. Residences consume 3,932 m^3 of water. Best efforts were made to minimize uncertainties, but in order to validate the assumptions and results of this study, it is suggested to install water meters and compare readings to estimated values presented in this document. Recommendations proposed are twofold:direct and indirect. Direct recommendations include operational changes and indirect recommendations concern behavioural change. These water conservation initiatives should be prioritised according to the monetary investment needed against the water conserved.

Some of the main conservation initiatives presented in this paper are: replacing once-through water-cooled systems, continuing to enforce the University's policy to install low-flow fixtures when renovating washrooms, building a synthetic tennis court, upgrading the reverse osmosis unit at the powerhouse, building a pit to dispose and reuse the Zamboni's ice at the Glenfinnan arena, promoting better landscaping practices, installing additional cisterns at the Horticulture Centre, carrying out a residence water reduction contest, prompting researchers to propose conservation initiatives adapted to the reality of laboratories

The total conservation potential of the Macdonald Campus based on all of the recommendations is 29% of the total consumption.

1. Introduction

Echoing the Ministry of Education's mandate to reduce on-campus water consumption by 10% by 2017 and 20% by 2020, McGill has recently committed itself to reducing water consumption on campus. One of the most significant challenges McGill will have to deal with is that there is very little information on water consumption on campus, which makes it hard to estimate the impact of any potential water conservation initiative. The goals of this study are to establish a consumption baseline for Macdonald campus, to develop a water conservation strategy, and to calculate potential savings.

Along with this baseline, a breakdown of water consumption per type of usage and per building is necessary to draft a solid water conservation strategy and prioritize interventions and investment.

Buildings to be audited were prioritized, and 22 were chosen for the study. A full list of these buildings can be found in Appendix 1. The audit itself consisted of the study of floor plans to identify water installations, a walkthrough of the buildings, and interviewing stakeholders to identify their consumption patterns. It should be noted that almost all of the main on campus were audited.

While Facilities Operations and Development will work toward reducing the water consumption of mechanical equipment and other fixtures, we also need to work toward raising awareness on water conservation. Several initiatives are already under way on campus ("Water Is Life" exhibit, water refill stations, policy on bottled water, etc.). Other initiatives can be put in place to tackle water used in labs, for landscaping, to clean the buildings, at the powerhouse, etc. The strategy could also identify areas of interventions more fit to grassroots initiatives (water conservation in labs for example).

2. Methodology

For the purpose of this study, water consumption was divided into five categories: Hygiene, Food Services, Operational, Landscaping, and Research & Academia. Hygiene comprises toilets, urinals, bathroom sinks, drinking fountains, kitchen sinks in office environments, and showers. Food Services consists of kitchen sinks in cafeterias, as well as coffee and tea consumption. Operational comprises cooling towers, once-through water-cooled equipment (compressors, vacuum pump, and growth chambers), the arena's Zamboni, boilers, and maintenance sinks. Landscaping consists of water used in watering the various flowers, plants, trees and irrigating the fields. Research & Academia encompasses all water-consuming research and projects. The steps to determine the annual water consumption are 1) identifying the water-consuming installations or equipment, 2) determining the unitary use, and 3) estimating how many times and how long it is used in a year. With this information, it is possible to calculate annual consumptions for the installations and equipment on campus. Detailed calculations can be found in the spreadsheets appended to this report.

Note: the sections below give a brief overview of the methods and assumptions used to estimate water consumption. For more details on how calculations were performed, please refer to Appendix 2 and to the '2012 Water Audit Calculations Macdonald Campus' Excel spreadsheet.

2.1. Hygiene

Identifying Installations and Equipment

Floor plans were used to identify the following installations: toilets, urinals, bathroom sinks, drinking fountains, kitchen sinks, showers, and laundry machines. Information was confirmed during walkthroughs of the buildings, and the installations were grouped according to the following criteria: fixture (wall or floor), tap volumetric flow (normal or reduced), activation (manual, detector, or automatic), and age (0 to 10 years, 10 to 25 years, and over 25 years).

Determining Unitary Water Use

Using *CAN-AQUA International: Services professionels en mécanique du bâtiment, Guide de sélection pour appareils sanitaires*[1] and the *U.S. Environmental Protection Agency (EPA) volumetric flow standards*[2], the flow of each type of installation was estimated. CAN-AQUA provided information on the flow rates of washroom fixtures currently on the market and the EPA standards provided information on flow according to age. Some of the fixtures located on campus have the flow printed on them, and so these were noted during the walkthroughs.

Estimating the Frequency and Duration of Use per Year

The amount of times an installation is used is proportional to the amount of people in the building. To estimate this, the McGill Fact Book[3] was used to compile information on the total number of employees, graduate students and undergraduate students at Macdonald Campus. Next, the assumption was made that the population density is constant all across campus. Therefore, the number of people in a building is proportional to the gross area of the building. The number of people in a building was calculated by cross multiplying the total number of people on campus with the area of the building and divided by the total area of the campus. See Appendix 2 for an example. Full-time or part-time status, vacation time, and enrollment by semester are variables taken into account in these calculations.

The Leadership in Energy and Environmental Design (LEED) framework provides standard frequencies at which employees and students use hygiene installations. The values differ for women and men. Using LEED fixture use rates[4], the number of people in a building and gender ratios supplied by the McGill Fact Book for employees and by Statistics Canada[5] for university students, the total number of uses per year for each of the hygiene installations was found.

The same procedure was used for campus residences, but the population density was based on the number of students staying in the residences.

Calculating Annual Consumption

The number of uses per year is known as well as the unitary consumption of the installations. The result of the multiplication of these two values equals the annual consumption. This method is used for toilets, urinals, bathroom sinks, showers and laundry machines.

The consumption of the drinking fountains is also calculated differently. The average volume of water drunk per person per day[6,7] was found. To correct for the fact that not all a person's water drinking consumption occurs on campus, the total water drinking consumption was then multiplied by a factor which takes into account how much time the person spends on campus in a day. This water consumption, assumed to be taken exclusively from drinking water fountains, was divided among the buildings in the same manner as the other installations, i.e., pro rata the number of occupants per building.

2.2. Food Services

Identifying Installations and Equipment

Food Services water consumption comprises kitchen sinks as well as coffee and tea machines. Floor plans were used to identify the location of Food Services sell points. It was identified that the only location on campus is the Link's café. During the walkthroughs, the manager of the cafeteria was interviewed. There is only one kitchen sink used by that cafeteria, and no water is used for preparing meals as all of the meals are pre-cooked.

Determining Unitary Water Use

The CAN-AQUA guide and EPA flow standards were used to determine the consumption of the kitchen sinks.

For coffee and tea machines, the consumption of these beverages had to be determined. Statistics Canada[8] provided values for annual consumption of coffee and tea per person.

Estimating the Number of Uses/Duration of Use per Year

The use of kitchen sink in the cafeteria and consumption of coffee and tea is proportional to the number of people in the building.

For the kitchen sinks, the LEED fixture use rates provided values for the number of uses per person.

Calculating Annual Consumption

The number of uses of kitchen sinks is divided between Hygiene (for the sinks located in offices) and Food Services (for the sink located in the cafeteria). The resulting number of uses multiplied by the unitary consumption equals the annual consumption.

For coffee and tea consumption, the assumption was made that consumption of these products is constant throughout the entire duration of the day. Therefore, the quantity consumed on campus is proportional to the time people spend on campus. By multiplying the total consumptions by the fraction of time spent on campus gives the estimate of coffee and tea consumption. These two products are assumed to be pure water when doing calculations.

2.3. Operational

Identifying Installations and Equipment

This category comprises cooling towers, once-through water cooled-equipment (compressors, vacuum pumps, and growth chambers), the arena's Zamboni, tennis court, boilers, reverse osmosis unit, and maintenance sinks.

Determining Unitary Water Use

Water consumption of compressors, vacuum pumps, and growth chambers was obtained by collecting information from the specification plate on the equipment and then contacting the manufacturer or researching on the internet.

Water consumption of the Zamboni and the tennis court was provided by Macdonald Campus Athletics staff based on the number of times the Zamboni is used in a day, number of times its tires are washed, and the number of times the tennis court is watered.

Make-up water for the boiler is metered and was provided by facilities. Chemicals are added to the cooling tower for a particular amount of water. The amount of chemicals added is known, which in turn gives the total amount of make-up water used for the cooling towers. For the reverse osmosis unit, there is a meter on the outlet; it was assumed that efficiency of the unit is 25%, and the metered data was then multiplied by four to give the total consumption.

For the maintenance sinks, all the custodial employees filled out a questionnaire which provided the basis to estimate their consumption.

Estimating the Frequency and Duration of Use per Year

The once-through water-cooled equipment runs all year. They do not function constantly at full capacity , therefore, assumptions were made to correct consumption values. It was assumed that they run at full capacity 50% of the time and at 75% capacity 50% of the time.

For the Zamboni, the number of times the machine is used in a day, which differs on the weekend was taken into account. This was then multiplied by the amount of water used each time for laying the ice and washing the tires. As for the tennis court, the number of times the court is watered in a day was multiplied with the amount of water used each time and the flow rate of the hose.

Monthly readings are available for make-up water for the boilers, make-up water for the cooling towers, and the water used by the reverse osmosis unit.

For the maintenance sinks, this information was obtained based on the questionnaire filled out by the employees.

Calculating Annual Consumption

For the once-through water cooled-equipment, the minutary consumption is known and can be converted to annual consumption, taking into account the variation in capacity.

For the Zamboni and the tennis court, the daily consumption was calculated and multiplied with the number of days the Zamboni and the tennis court are used through the year.

For custodial, the individual water consumption of each employee for each day was multiplied with the number of days they work and then the consumption of all the employees was added to obtain the annual consumption.

2.4. Landscaping

Identifying Installations and Equipment

A meeting was organized with Peter Knox and Jeanne Page to discuss this subject. They provided information on their tasks and tools at their disposal. Peter provided information on McEwen irrigation field and Jeanne on other irrigation systems and watering practices. Irrigation of the McEwen field accounts for most of the water consumption in the Landscaping category. Water is also used to irrigate gardens outside Barton, Laird hall Centennial Centre, Harrison House, and Brace Centre, as well as to water the summer pots and pots in the Summerby Greenhouse.

Determining Unitary Water Use

Detail on the flow rate of the sprinklers of the McEwen field was provided by Peter Knox.

The amount of water used per minute by the irrigation systems of Barton, Laird Hall and Centennial Centre was obtained from the manufacturer.

For water used to water the summer pots, the Summerby Greenhouse, Harrison House and the Brace Centre, the flow rate of the hose was calculated using the bucket-and-stop-watch method.

Estimating the Frequency and Duration of Use per Year

Jeanne Page gave information on the time the irrigation systems at Barton, Laird and Centennial Centre are used in a day. She also gave information about the number of times and minutes she waters summer pots and other gardens using the standard garden hose.

Calculating Annual Consumption

The total consumption of the McEwen field can be found by multiplying the flow rate of each sprinkler with the number of sprinklers, the duration for which the sprinklers are used, and the number of times the irrigation system is used in a year. The annual consumption was divided evenly among the buildings.

The total consumption of irrigation systems in other buildings was calculated by multiplying the unitary consumption of each system with the duration for which it is used each time, and the number of times it is used in a year.

For places where the hose is used, the flow rate of the hose was multiplied with the duration for which it is used each time and the number of times it is used in a year.

2.5. Research & Academia

Identifying Installations and Equipment

The first step in determining the water consumption of this category was to identify the buildings where research is carried out. Research was then divided into two broad sectors:

1) *Laboratory research* includes research and teaching laboratories. This type of research mainly takes place in Raymond, Macdonald Stewart, Nutrition Barn, Powerhouse and Parasitology.

2) *Independent research units* whose consumption and usage patterns are remarkably different from laboratory research. These include the Cattle Complex, Dietetics Laboratory in Centennial Centre, Horticulture Services LODS Research Centre, Plant Research Facility, Powerhouse and Raymond Greenhouse.

For Laboratory research, the next step was to contact department chairs and schedule meetings to gather information about the number of students in a lab, water-consuming activities of each lab, number of research teaching labs. After interviewing chairs of all the departments on campus, it was determined that it would be easier to audit one typical research lab and one typical teaching lab and to multiply the results with the number of labs in each building. Research equipment and water-consuming activities identified include water used for reagents/ media preparation, washing dishware/glassware, and autoclaves.

For independent research units, the consumption activities at each type of research unit were identified. The consumption of the Cattle Complex includes milk-washing systems, feed water requirement, floor washing, the laundry machine and drinking water for the cattle. The Dietetics laboratory uses water for dishwashers, ovens, the laundry machine, work stations and the steam jacket kettle. The water consumption of the Horticulture Services Building is for the greenhouse, field irrigation, orchard spraying and compressors. It should be noted that the horticulture centre has a rainwater harvesting system and the water used from this was subtracted from the overall consumption as we are concerned about water used from the City. The LODS Research Centre uses water to irrigate the fields. Usage at Plant Research Facility is for growth chambers and to water the benches. The Raymond Greenhouse consumption consists of water used for the benches. Research at the powerhouse takes place in the old Pilot Plant which houses an autoclave and a retort.

Determining Unitary Water Use

For the laboratory usage, information about reagents, media preparation, and autoclaves was given by students. To calculate the amount of water used to wash dishware/glassware, Can-AQUA guide and the EPA standards were used to determine the lab sink minutary consumption.

For details on the independent research units, please refer the Excel spreadsheet.

Calculating Annual Consumption

For all information regading annual consumption, please refer the Excel spreadsheet.

3. Findings

For the full list of water-consuming installations and related material, refer to Appendix 2 and to the *2012 Water Audit Calculations Macdonald Campus* Excel spreadsheet.

Category (Unit)	Hygiene (m^3/year)	Food Services (m^3/year)	Operational (m^3/year)	Landscaping (m^3/year)	Research & Academia (m^3/year)	Total (m^3/year)
22 buildings audited	21,924	15	48,388	5,492	34,323	110,143

Table 1 - Annual Consumption by Category

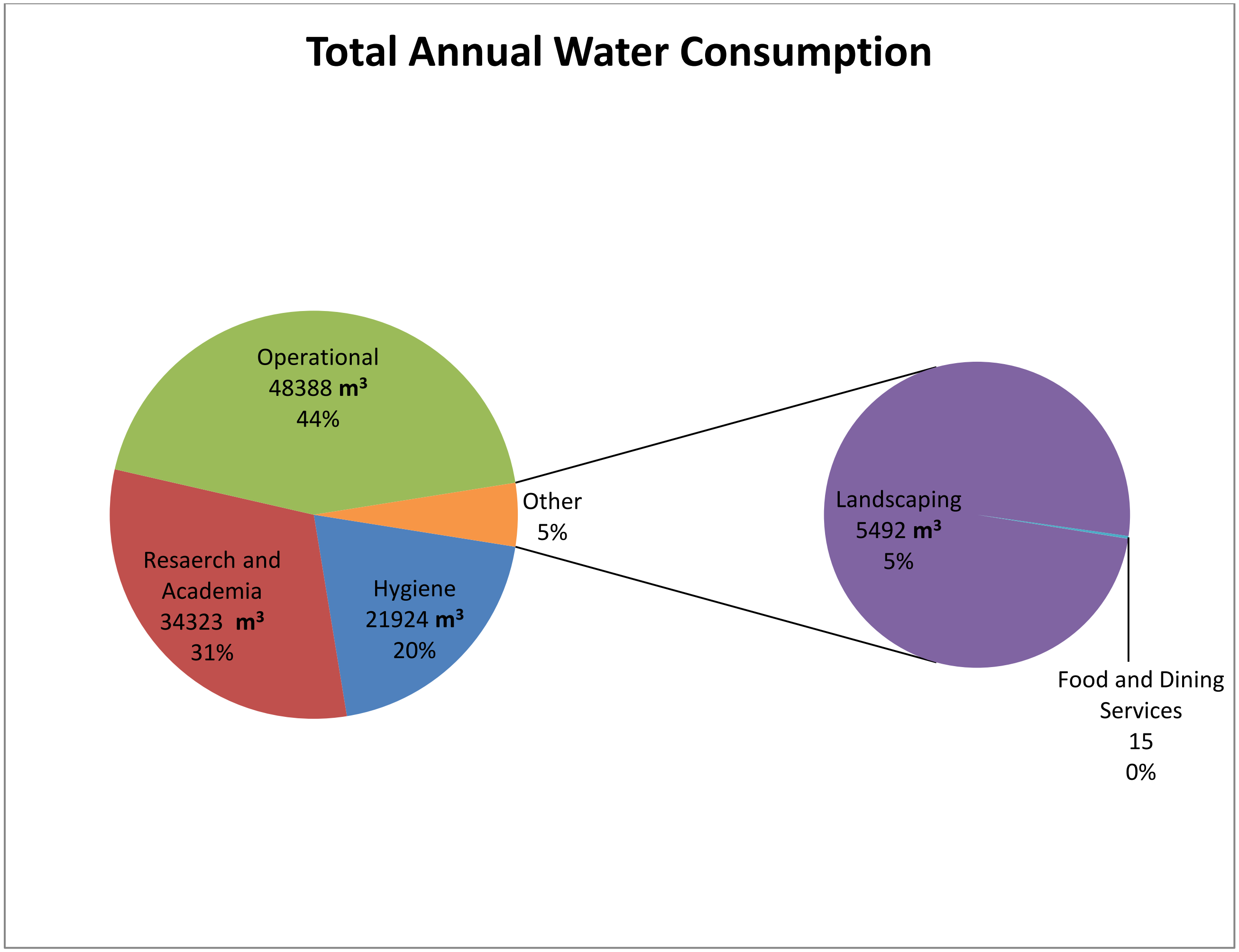

Figure 1 - Overall Water Consumption Divided Into Five Main Categories for the 22 Buildings Audited

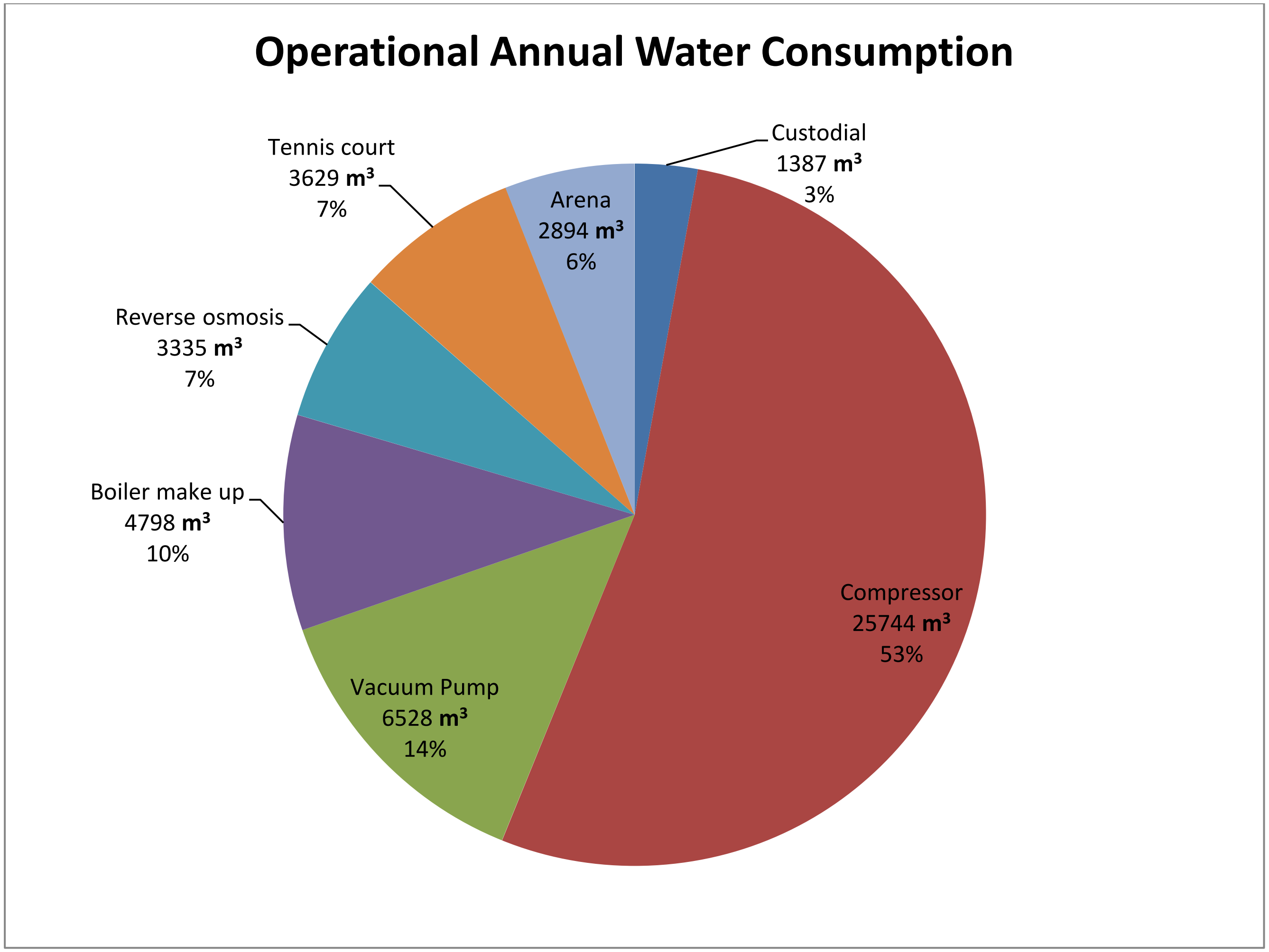

Figure 2 - Detailed Water Consumption in the Operational Category for the 22 Buildings Audited

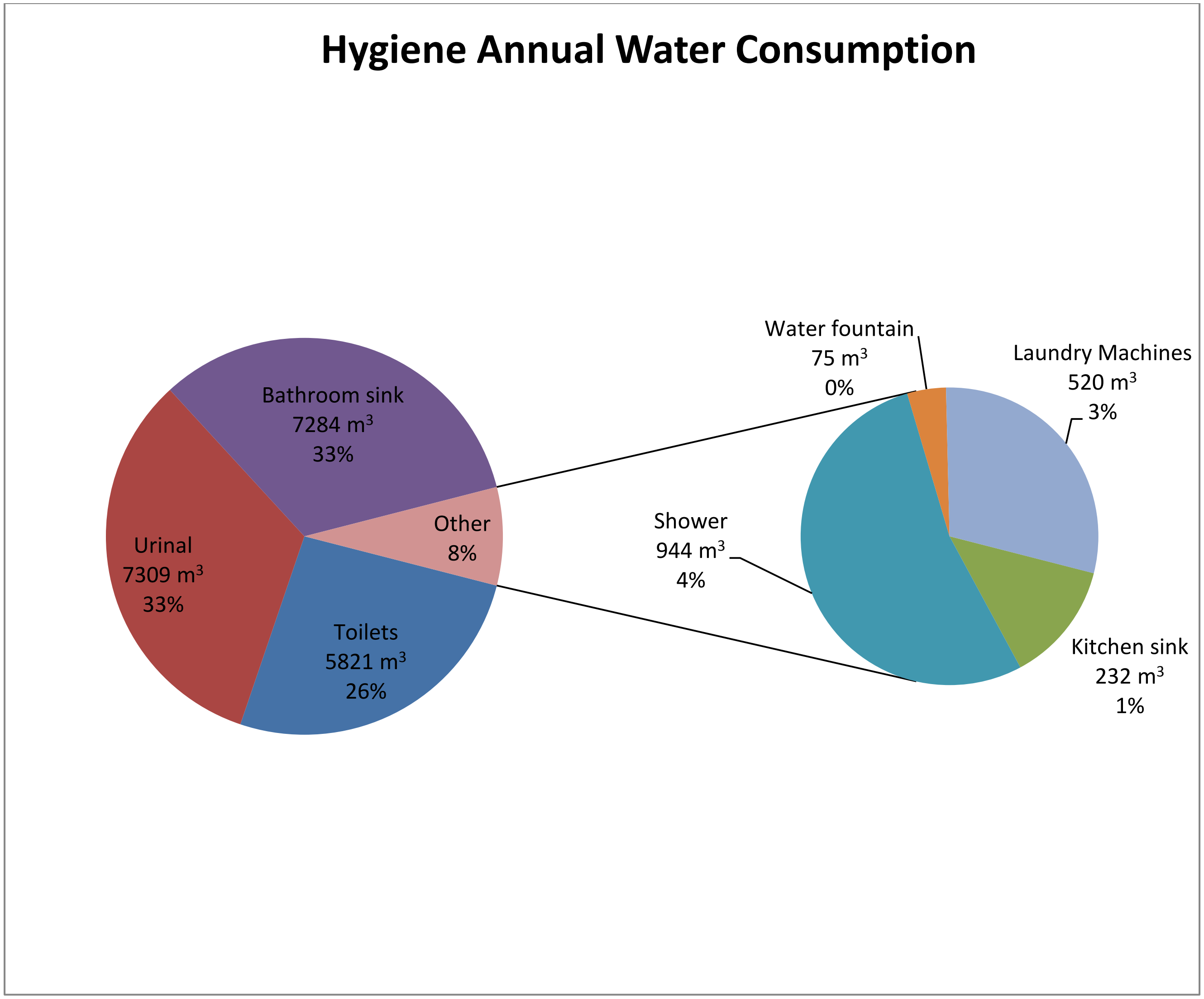

Figure 3 - Detailed Water Consumption in the Hygiene Category for the 22 Buildings Audited

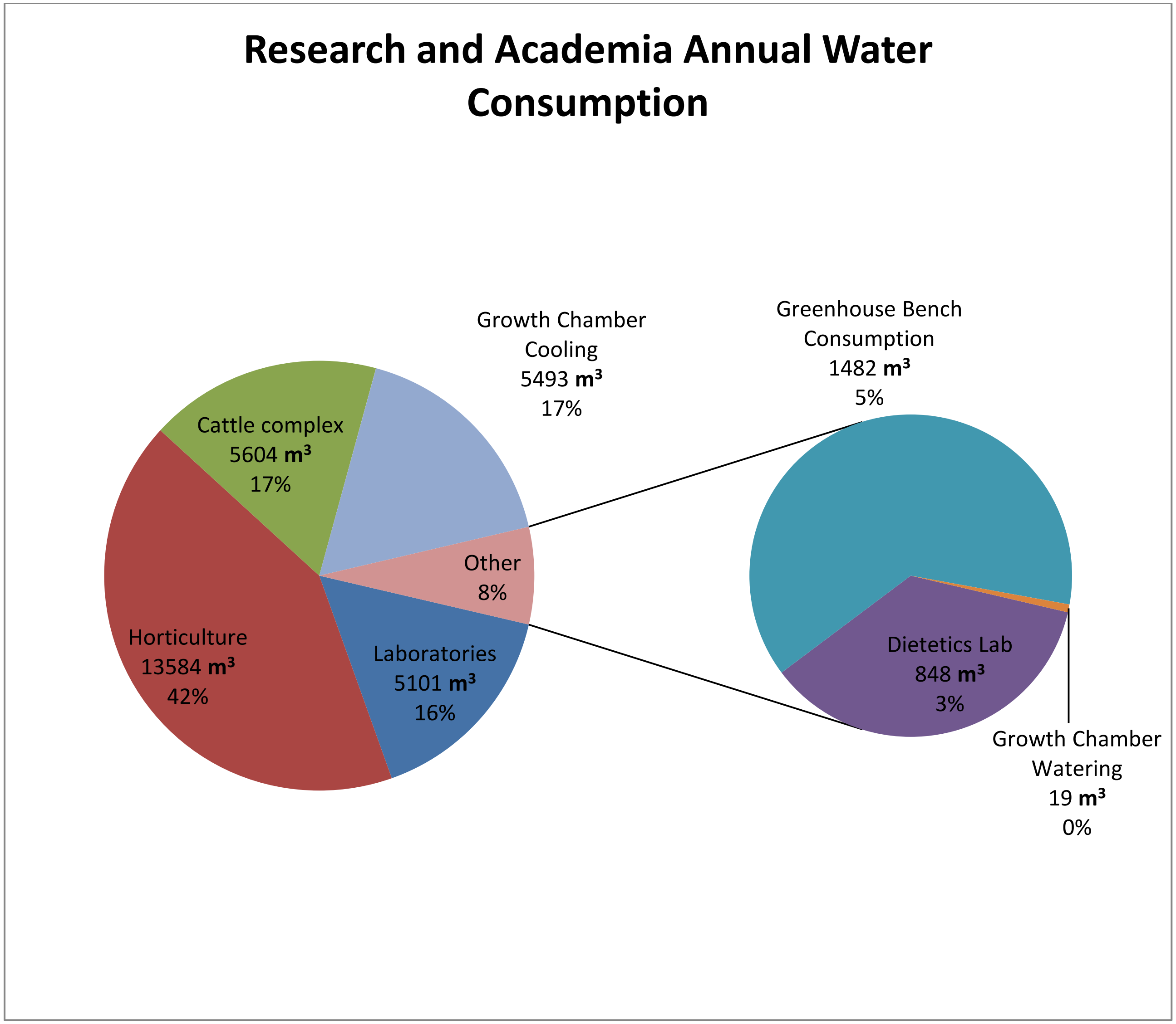

Figure 4 - Detailed Water Consumption in the Research & Academia Category for the 22 Buildings Audited

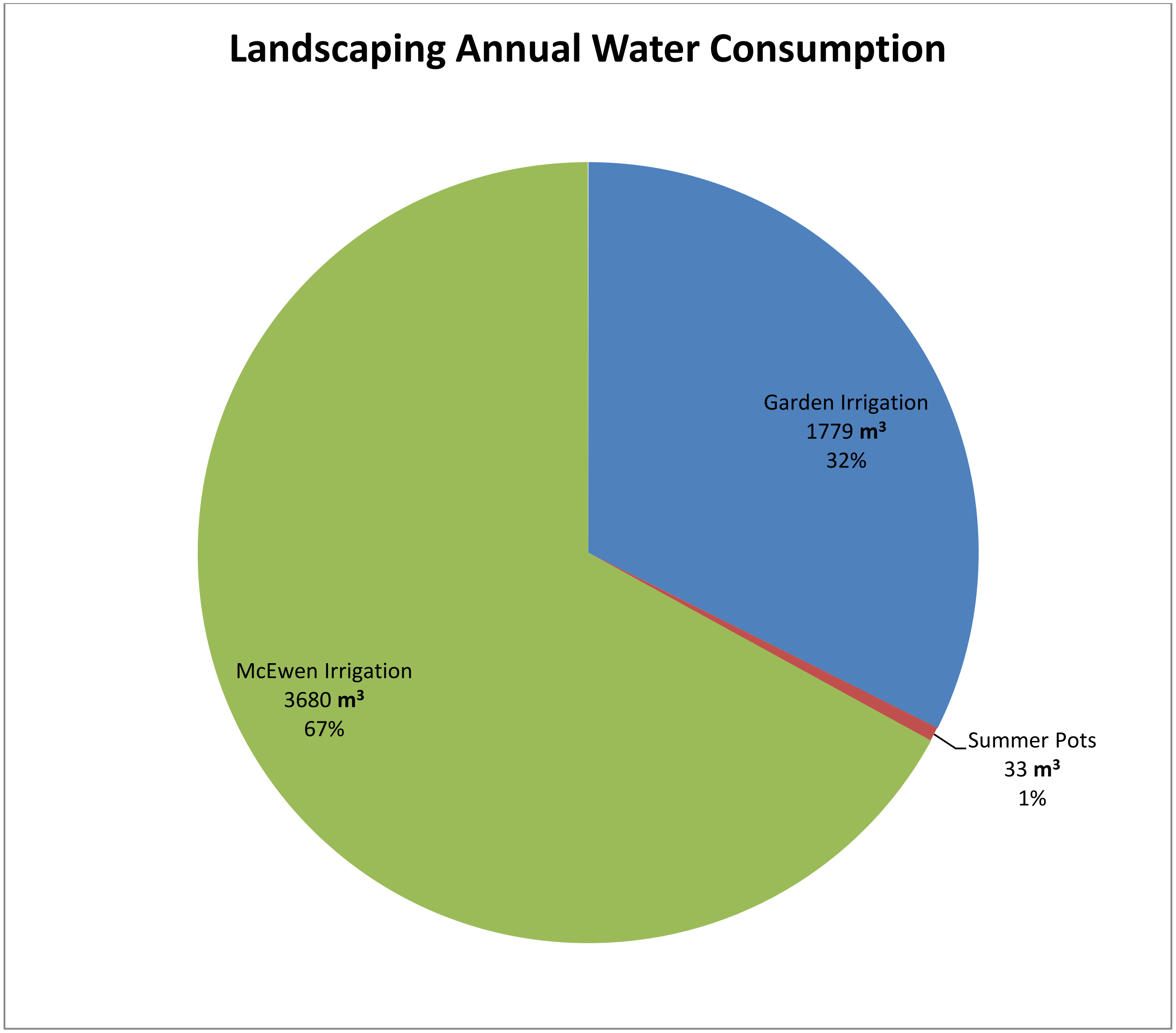

Figure 5 - Detailed Water Consumption in the Landscaping Category for the 22 Buildings Audited

4. Limitations of the Study

The most notable limitation to this study was the small number of water meters installed on campus. Only two meters are present; one of them installed on the main supply pipe in the powerhouse and the second one in Laird hall.

The main uncertainty regarding Hygiene is the varying number of people in the buildings as people move around campus frequently and there is no way to estimate how many people are in each building.

Another key limitation was related to determining the Research & Academia water consumption. Estimation of only one typical research lab and one typical teaching lab was done, and its results were multiplied with the number of labs; however, activities differ significantly from one lab to another. Thus, in order to accurately determine the water consumption of labs, each lab should be audited or similar labs be grouped into categories.

5. Recommendations

5.1. Suggestions to Fine-Tune Baseline

B1: Install Water Flow Meters

The audits performed allowed to gather information then used to make assumptions about water consumption on Macdonald campus. To validate these assumptions and accurately determine the water consumption baseline, water meters should be installed. Metering will allow McGill University to track water consumption and confirm whether or not and to what extent its approach at reducing water consumption is successful.

B2: Further Investigate water consumption of individual laboratories

Identification of each lab can be done through FAMIS, and building walkthroughs can provide the contact information of the lab users as this is usually posted on the doors of the laboratories. Look into estimating the water consumption of each laboratory.

5.2. Water Conservation Recommendations

WC1: Upgradation of Vacuum Pump in Macdonald Stewart

The vacuum pump in Macdonald Stewart is water cooled and used by research labs. The campus needs to change this for a vacuum system which does not utilize water for cooling. There could be two possibilities: 1) switch to a vacuum pump which does not utilize water and 2) purchase individual electricity-powered vacuum units as in the Parasitology Building. It is necessary that the campus promotes and helps in purchasing the equipment. The estimated water saving are 6,528 m^3 annually.

WC2: Upgrade Compressor at the Power House

The process of upgrading the compressor to one that is air cooled has already been initiated by Facilities. The new compressor installed is air cooled and will generate annual savings of 5,048 m^3 .

WC3: Upgrade the Reverse Osmosis Unit at the Powerhouse

The efficiency of the reverse osmosis unit is estimated to approximately 25%. In recent years, some manufacturers have developed innovative reverse osmosis systems referred to as “zero-discharge” that discharge the backwash water into the water supply pipes instead of the drain as in traditional reverse osmosis systems. Upgrading this unit will save 2,501 m^3 of water annually. Alternatively, investigate if the discharged water can be re-used for landscaping.

WC4: Replace Clay Tennis Court with Synthetic surface

The tennis court has to be watered and rolled because it is made of clay. If the clay surface was replaced with a synthetic one, potential water savings would be 3,629 m^3 annually.

WC5: Eliminate Water Used for Washing Zamboni Tyres

As the Zamboni leaves the arena to dump the ice, its tires attract salt and debris. This has to be washed with hot water before the Zamboni can be used again. If the Zamboni does not leave the arena, then its tires need not being washed. This could be done by constructing a shed or a room or a pit inside the arena where this ice could be dumped. An added benefit of dumping the ice inside the pit is that the melted ice could be re-used to lay ice if passed through a filter inside the Zamboni. A detailed plan needs to be worked out before athletics is approached. The potential savings by not washing the tires is 1,399 m^3 annually.

WC6: Increase the Number of Cisterns at the Horticulture Center

The Horticulture Centre has a rain water harvesting system which was installed in 2010. There were three cisterns with a capacity of 3,500 gallons each installed as a part of this project. In my interviews with Mr. Mike Bleho (Horticulture Centre Supervisor), I realised that the water from these cisterns is used to water the plants in the greenhouse. He was open to the idea of irrigating fields using this rainwater, but the only problem was the lack of more cisterns. Dr. Mark Lefsrud (Co-supervisor of Water Collection System Project) informed me that the Horticulture Service Building could support nine cisterns. He welcomed the idea of installing new cisterns provided, funds are arranged. The project was previously funded by the Sustainability Project Fund in 2010. This avenue could be explored to obtain funds for six new cisterns. This would help irrigate the fields at the Horticulture Centre. Also, as the fields have drip irrigation, a pump with a filter (to remove algae) needs to be installed.

WC7: Growth Chamber Cooling alternatives

The growth chambers in Plant Research Facility are not connected to a closed loop system. One possibility is to have a closed loop system installed, which requires an investment of around $100,000. The same facility houses air-cooled chambers.

The second possibility is to use the water-cooled chambers only when the air-cooled chambers are fully occupied for experiments. This could be done by creating awareness among stakeholders about the presence of and difference between air-cooled and water-cooled chambers.

Another possibility is to completely restrict the use of water-cooled chambers at this facility. During discussions with supervisors of facilities, another avenue to explore was to move these chambers to the Raymond building and connect them to the closed loop system. The potential saving by addressing this recommendation is 5,493 m^3 annually.

WC8: Green House Bench Watering

During the walk through of the greenhouse and after interviewing Mr. Guy Rimmer it was identified that students' watering plants on benches is not the most efficient way of watering. This system must be replaced by an irrigation system similar to the one in the Plant Research Facility Building.

WC9: Low-Flow Bathroom Installations

Continue installing low-flow fixtures during bathroom renovations. A total of six urinal flush tanks in Barton, Parasitology, Stewart Athletics Complex, Centennial Centre, and Horticulture need to be replaced. These flush tanks flush as soon as they are full regardless of anyone using the urinal. The total savings that could be achieved by replacing these urinals is 8,223 m^3 annually.

It is also advisable to look into the use of greywater in toilets and bathrooms. However, the use of greywater in a building requires that greywater pipes and city (clean) water pipes be two separate networks. Besides, existing buildings were not designed to carry the extra load on the roof water cisterns would represent. Using greywater is, therefore, conceivable in the case of new developments only.

WC10: Change in Landscaping Practices

The McEwen field is irrigated by using sprinklers. Sometimes it so happens that the irrigation system is running at the same time as it is raining. Thus, the system needs to be properly managed. Mr. Peter Knox is looking at the possibility of installing a gauge which would automatically turn off the irrigation system if it is raining.

Using drought resistant landscaping would be efficient. The advantages include less water consumption and beautiful, environmentally responsible landscapes.

Another option is watering the floral landscape with rooftop runoffs from the building. A project similar to the rainwater harvesting at the Horticulture Centre should be explored. A small building like the Horticulture Services Building can accommodate nine cisterns. Thus, the potential of other buildings is enormous. Centennial Centre has a flat rooftop and a garden right next to it. This site should be explored for such a project.

WC11: Promote Researchers Involvement

Include researchers and lab users in the water consumption reduction effort. Research & Academia is responsible for approximately half of the total water consumption on the Macdonald Campus. Facilities Operations and Development are limited in the actions it can take to reduce research water consumption. Involving the researchers themselves and getting them to find lab specific water conservation measures should be pursued. During interviews, researchers were asked for suggestions and their responses were:

1. Leaking lab sink faucets need repair.

2. Consolidate de-ionized water production from individual labs to a central system: This has been carried out in Parasitology and should be replicated in Macdonald Stewart and Raymond.

WC13: Residence Water Use Reduction Contest

As Laird Hall is metered, its consumption can be monitored in real time. A contest should be organised to see if the residence can be water efficient. Readings should be compared on a monthly basis. If the readings from one month are lower than the readings from the next month breakfast or lunch for the residents could be organised to motivate the residents. Also, posters about the water consumption Increase or decrease should be put up on notice boards to keep the residents educated about their consumption patterns. Monetary incentives may increase motivation. A few suggestions are to wash only full loads of laundry and to turn off taps when not in use, e.g., while brushing teeth and shaving.

WC14: Identifying a "Change Agent"

There are various definitions about change agent. In my view, change agent is a person who has a clear vision for the project being carried out. This person should be knowledgeable and should lead by example. Most of the times this change agent has to be patient but persistent as projects that are not main stream could take time. Also, it always helps if this person is in authority. I would choose Mr. Denis Mondou, Director of Utilities & Energy Management, as my "Change Agent" for this project. He has the authority, vision, willingness to experiment and most importantly, he is knowledge and leads by example.

6. Water Conservation Potential

Recommendation	Conservation Potential
Vacuum Pump Upgrade at Macdonald Stewart	6,528 m^3
Compressor Upgrade at Powerhouse	5,048 m^3
Reverse Osmosis Unit Upgrade at Powerhouse	2,501 m^3
Synthetic Tennis Court Surface	3,629 m^3
Zamboni Tire Washing	1,399 m^3
Growth Chamber Cooling	5,493 m^3
Continuous Flush Urinal Replacement	8,223 m^3
TOTAL MACDONALD CAMPUS CONSUMPTION	**110,143 m^3**
TOTAL CONSERVATION POTENTIAL	**32,821 m^3**
TOTAL CONSERVATION POTENTIAL (%)	**29.79 (%)**

7. Monetary Investment Against Water Conserved

Conservation Measure	Monetary Investment	Water Conserved
Vacuum Pump Upgrade at Macdonald Stewart	$$	☆☆☆☆☆
Continuous Flush Urinal Replacement	$$	☆☆☆☆☆
Compressor Upgrade at Powerhouse	$$$$	☆☆☆☆
Increase Number of Cisterns at Horticulture Center	$$	☆☆☆
Reverse Osmosis Unit Upgrade at Powerhouse	$$$	☆☆☆
Synthetic Tennis Court Surface	$$$$$	☆☆☆
Zamboni Tire Washing - New Pit or Room	$$$	☆☆
Growth Chamber Cooling – Closed Loop	$$$$	☆☆☆☆
Growth Chamber Cooling – Awareness	$	☆☆☆
Greenhouse Bench Watering – Irrigation System	$$$$	☆
Change in Landscaping Practices	$	☆☆
Residence Water Reduction Contest	$	☆

Monetary Investment: $ = Very Low Investment; $$$$$ = Very High Investment

Water Conserved:☆ = Very Low Conservation;☆☆☆☆☆ = Very High Conservation

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Study Documents

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14. *LEED CERTIFICATION – Life Sciences Complex*, McGill University, last modified June 2007, 288 pages.

Appendix 1

List of Buildings Studied

Building Name	Building Name
Barton Building	Macdonald Stewart Building
Facilities Management Building	Nutrition Barn
Cattle Complex	Parasitology Building
Centennial Centre	Plant Research Facility
C.I.N.E Building	Power House
Glenfinnan Rink	Raymond Building
Harrison House	Raymond Greenhouse
Horticulture Services Building	Summerby Greenhouse
Laird Hall	Eco-Residence 1
LARU	Eco-Residence 2
LODS Research Centre	Stewart Athletics Complex

Appendix 2

Overview of Individual Excel Sheets:

List of Install. & Equip.:

Contains the quantity of each type of water installation and equipment present in each building. Short Abbreviations comprised of 1 or 2 letters and a number used to represent a specific type of equipment. This Tab also contains total consumption per building, total consumption per category and consumption per m^2 for each building and overall. Frequency of use for the hygiene category is based on the number of people in the building and the frequency of usage for certain installations from LEED. The sum of the undergrad students, grad students and employees of Macdonald Campus were divided into the buildings based on building area relative to the total area of the downtown campus.

Types of Equip. & Install.:

Contains details on each type of water equipment and installation. This sheet will name each type of installation or equipment with 1-2 letters and a number. These types are differentiated by: basic nature of installation (toilettes, sinks, water towers, etc.), fixture type (floor or wall), Low flow or normal flow, activation mechanism (manual, detection, automatic), Age (1-10, 10-25, 25+ years), consumption per minute or per use, frequency of use, and the total consumption per year. Floor plans were used to identify the location of installations, building walkthroughs supplied information on fixtures, low-flow normal-flow, activation and Age, unitary consumption found by walkthrough and research, frequency of use factor based on the number of people in the building and LEED fixture usage rates. Main categories of water installations and equipment:

> Sanitary: Anything to do with personal hygiene of building users. Toilets, washroom sinks, urinals, kitchen sinks, water fountains, showers and laundry machines.
>
> Food Services: Coffee machines and kitchen sinks.

Operational: Once-through water cooled equipment (compressors and vacuum pump, growth chambers), Zamboni, tennis court, boilers, reverse osmosis unit, and maintenance sinks.

Landscaping: McEwen field irrigation, irrigating gardens outside Barton, Laird hall and Centennial Center, Watering the summer pots, Summerby Greenhouse pots, Harrison House garden and Brace Center garden.

Research & Academia: Research Labs, Teaching Labs, Cattle Complex, Dietetics Laboratory in Centennial Centre, Horticulture Services Building, LODS Research Centre, Plant Research Facility, Power House and Raymond Greenhouse.

Emply. & Stud.:

This sheet contains the information on the number of employees and students at Macdonald Campus. Values for full time and part time employees, graduate students and full time and part time undergraduates were found in the McGill Fact Book for the winter, summer and fall semesters. Employees and These values were converted to Full Time Equivalent employees and students based on the number of hours spent working or studying per week and an estimate of the amount of time that an employee or student spends on the campus. These values were then multiplied by the number of days that the employees work or the students have class and exams per year.

Based on the amount of time spent on campus by the users and the LEED fixture use rates, the total amount of times the various installations are used on campus each year can be calculated and then distributed through the buildings based on building area relative to the overall area of the campus.

Variable Determination and Calculation Explanations

Number of People

The Number of People in Each building is Used as a Variable to Calculate water Consumption in the Hygiene category. This is how the number of people on the downtown campus was calculated.

Undergrad Students were classified as full time and part time. The average full time student takes 15 credits per semester[9]. This comes to 15 hours of class time plus labs, tutorials, studying and assignments. We assumed it to come to 40 hours per week. For part time students, we assume that they took half the normal course load for 7.5 credits on average and 20 hours per week of school. From we know that part time students must have less than 12 credits[10]. Then we assumed that during the fall and winter semesters, students spend 75% of their time on campus while in the summer, we assumed that they spend 20 % of their time on campus. We assumed that during the two week Christmas break and for two weeks of stat holidays, no one was present on campus. We assumed an FTE is 40 hours per week. Then using the assumption of an average of 16 weeks per semester including exams, we multiply with the LEED frequency of usage to find how many times each installation is used.

For full time Grad Students and Full time employees, 40 hours/workweek is assumed and 100% of the time is spent on campus. For part time employees, 2/3 of full time hours is the assumption which gives 27 hours /week lunch time included. 40 hrs per week is considered FTE as with undergrad students, which reflects a 35 hour workweek with a one hour lunch break per day. For this group an average of 5 weeks is assumed as vacation and 2 more for Christmas break. For grad students, the remaining 45 working weeks are distributed evenly between winter summer and fall semesters.

McGill Fact Book provided the gender ratio for employees, 47% female/53% male, and the gender ratio from students, 57.6% women/42.4% men, was taken from Statistics Canada[11]. We then use the LEED frequency of usage to find how many times each installation is used.

Note: For students I considered students in Agriculture and Environmental sciences (study at Macdonald Campus) and the staff from MacDonald campus was calculated in such a way:

To estimate Macdonald Campus, take all Academic and Admin/Support staff from Faculty of Agriculture and Environmental Science + 20% of university-wide trades/services. Leave the rest for downtown campus. Email Correspondance , Conraud, Jerome. (Personal Communication, July 9th 2012)

We find that 211 are full time academic and admin/support staff from faculty of agriculture and another 90 are part time. Then from university wide trades and services. There are 399 full time and 43 part time. Following the equation, this makes 291 full time and 99 part time at mac campus for a total of 390.

The number of people on campus is then used to calculate the total number of uses for given installations. To calculate how many times an installation is used in each building, the population density on campus is assumed to be constant, therefore the number of uses in a building is proportional to the gross area of the building. The total number of people on campus is multiplied by the ratio of the building gross area over the total gross area of the downtown campus.

Consumption of water of Maintenance Sinks

A questionnaire was used and the details were directly included in the excel sheet.

Landscaping Consumption: McEwen Field Irrigation

Falcon 6504, number 12 nozzle is used on the field.

total number of nozzles: 46

Pipe pressure: 70psi

Flow rate: 50L/min this was taken from a spec sheet given to me by peter

Minutes per zone: 40

Number of times used in a year: 40

Landscaping Consumption: McEwen Field Irrigation

1. Centennial center garden

2. Mcdonald stewart garden

3. Laird Hall garden

4. Barton Garden

5. Brace center

6. Harrison house

7. Parking lot next to CC

USAGE

Complex 1: MS/Barton/parasitology

Usage period - May to October. Jenne said around 25 weeks

Days/week - 4

Hours/ day - 5 = 300mins

Flow rate - 38L/min (Obtained data from the supplier)

Method used - Irrigation

Centennial Center

Usage period - May to October. Jenne said around 25 weeks

Days/week - 4

Hours/ day - 1 hr = 60 mins

Flow rate - 38L/min

Method used - Irrigation

Laird Hall

Usage period - May to October. Jenne said around 25 weeks

Days/week - 4

Hours/ day - 45 mins

Flow rate - 38L/min

Method used - Irrigation

Brace Center

Usage period - May to October. Jenne said around 25 weeks

Days/week - 2

Hours/ day - 60 mins

Flow rate - 21L/min

Method used - Hose

Harrison House

Usage period - 5 times over summer

Hours/ day - 4 hr = 240 mins

Flow rate - 21L/min

Method used - Hose

CC parking lot

Usage period - 5 times over summer

Hours/ day - 2hr = 120 mins

Flow rate - 21L/min

Method used - Hose

Summerby Green House

Usage period - May to October. Jenne said around 25 weeks

Days/week - 2

Hours/ day - 30mins

Flow rate - 21L/min

Method used - Hose

Usage period - November to April. Jenne said around 27 weeks

Days/week - 3

Hours/ day - 30 mins

Flow rate - 21L/min

Method used - Hose

Summer Pots

Total number of pots - 52

Total weeks - 25

Days a week - 1

Water added - 25 Litre per pot

Method used - Bucket

Number of people in a building: Sample Calculation

5,000 people in a building of 300 m^3. Sum of all building areas of 15,000 m^3.

5,000 people * 300 m^3/15,000m^3= 100 people in the building

Arena:

1. Hose use to clean zamboni

The bucket and stop watch method was used to carry out this estimation. The bucket used had a capacity of 15 liters. This bucket filled up in 5 seconds. The flow rate is 3L per Second. Thus 180 Liters of water is used in one minute. This hose is used approximately for 3 minutes each time it is used which also means every time the zamboni is used. Thus 360 Liters (180L x 2min) of water is used in one cycle.

2. Hose used to clean bathrooms

This hose is used along with a spray gun. It is used once a week for approximately 7 minutes for 1 bathroom. There are 5 bathrooms in all. Same method mentioned above was used for the estimation of the flow rate. 20 Liters are used in a minute. Thus the flow rate is 0.33L per second. Thus 700 Liters (20L x 7min x 5 no of bathrooms) of water is used to clean the bathrooms every week.

3. Cleaning the arena floor

One bucket is used every day which has a capacity of 20 Liters. This 20 Liters of water is used daily to clean the arena.

4. Days of operation:

15th August to 15th April 35 weeks

5. Washing the ice

- This is done once a year.
- A standard garden hose is used for the entire day (Approximately 10 hours). This could take 1 or 2 days.
- This is done to remove all the ice from the surface.

6. Zamboni

- The information provided by Vince with respect to the zamboni was very accurate.
- The Zamboni is used 8 hours in a day for 5 days in a week.
- It is used for 34 hours on the weekend.
- The tank capacity of the zamboni is 130 gallons which is filled every hour. That means 34hrs x 130 gallons on the weekend.
- There is a garden hose which is used every hour for 5 minutes to wash the zamboni tires each time the zamboni is used. Thus it would be 5 mins x 34 on the weekend.

Stewart Athletic Complex:

1. Identify bathroom fixtures and water fountains
2. The main consumption of this complex is at the tennis court.
   - The tennis court is used from mid may to mid October. :24 weeks
   - It is watered 2 hours every day using a garden hose at full blast.
3. There is a washing machine which is used 5 times in a day

Dietetics Lab:

1. **Total hours and number of students**

- **Winter**: 7 labs – 4hrs each – 50 students in each lab. This is one weeks data.
  : Jan feb - 6 students on Monday Wednesday and Friday
  : March – 18 students on MWF and 25 students on Tue and Thu
- **Fall**: 4 labs- 4 hrs each – 30 students in each lab. Data for one week
- **Summer**: July and August lunch – Monday and Wednesday – 6 hrs each - 5 people
- **Fall and winter**: **FOOD SCIENCE:** 1 lab a week – 3 hrs each lab - 20 students

Number of students using the lab in winter

50 students in each lab x 7 number of lab sessions each week x 12 number of weeks = 4200

6 students in lab x 3 lab session each week x 8 no of weeks = 144

18 students x 3 labs a week x 4 weeks = 216

25 students x 2 labs x 4 weeks = 200

Food science: 20 students x 1 lab a week x 12 weeks = 240

Total students in winter = 4200 + 144 + 216 + 200 + 240 = 5000

Number of students using the lab in summer

5 staff x 2 days a week x 9 weeks = 90

Total students in summer = 90

Number of students using the lab in fall

30 students x 4 labs per week x 12 weeks = 1440

Food science: 20 students x 1 lab a week x 12 weeks = 240

Total students in fall = 1680

Thus, the total number of students using the lab in one year = 6770

Winter:

4 hrs x 7 labs x 12 weeks = 336

4 hrs x 3 labs x 8 weeks = 96

4 hrs x 3 labs x 4 weeks = 48

4 hrs x 2 labs x 4 weeks = 32

3 hrs x 1 lab x 12 weeks = 36

Total hours in winter = 548

Summer:

6 hrs x 2 labs x 9 weeks = 108

Total hours in summer = 108

Fall:

4 hrs x 4 labs x 12 weeks = 192

3 hrs x 1 lab x 12 weeks = 36

Total hours in fall = 228

Total hours of operation in a year = 884

2. **Equipment and its usage**

- **Industrial Dishwasher**

Total number of hours lab used x

Time dishwasher used is: one third of total time lab in use

Pre rinsing: half of this one third time

Pre-rinse : 7L/min

Number of racks/hr: 50

- **Household dishwasher**

Number of machine: 1

Times used per week: 1

Number of weeks used: 24

Water consumption: 15L per cycle (www.energystar.gov) Average consumption

- **Laundry machines**

Number of machines: 2

Times used per week: 20

Weeks used in a year: 34

Water used per cycle: 40 L

The machines are front loading. Details from specification sheet reveal that it uses 40L of water per washing cycle.

- **Combi oven**

Number of ovens: 2

Times used: once a month

Number of months: 12

Water consumption: 59L

Water is basically used to wash the oven. It has an automated washing system. This has to be done once a month.

Rational (The company) provided me with information about water used in each washing cycle. The setting used by Lab in charge Judy Campbell is strong setting. It takes two hours to wash the oven. The email from rational is saved.

This oven also uses steam while cooking. It depends on what you are cooking and what setting you are cooking on. Because there is so much variation in what is being cooked and what setting is being used, it is difficult to determine.

- **Steam Jacket Kettle**

There are 2-3 kettles but only one is used.

Quantity: 1

No of days used: 3

No of weeks used: 24

Water consumption: ? insufficient information

- **Wash stations and sinks**

Number of work station sinks: 8

Number of times work station sink used: 8 during each lab by each student

Number of hand wash sinks: 6

Number of times hand wash sink used: 4 times by each student in each lab

Horticulture center:

1. Green House Water Consumption

- Days of operation- 1st April to 1st July (12 weeks)
- Use – Irrigation
- Number of Green House – 2. But the details provided about water use include both the greenhouses, thus no need to multiply the consumption by 2.
- Usage - The plants in the green house are watered using a standard garden hose. This is used at full pressure.
- April 1st to May 1st and June 1st to July 1st – 30 minutes everyday
- May 1st to June 1st – 1 hour every day.
- Flow rate - 43L per min

2. Fields

- Days of operation – 1st June to 1st September
- Use – Irrigation
- The method of irrigation used is drip irrigation. The drip lines are spaced 2.5 meters apart.
- The fields are irrigated twice a week for 3 hours each time when it is used.
- Flow rate- The flow rate was calculated in a previous study by a graduate student of the Dean and was found to be 0.34 Gallons/ min/ 100 feet = 0.042L/min/m

Irrigated Area –

- Block 4: 50m x 45m
- Block 8: 120m x 40m
- Block 10A: 70m x 60m
- Block 10B: 60m x 50m
- Range 1,2,3 and 4: 20m x 100m each range

3. Orchid spraying

- Tank capacity – 1000L
- Frequency of spraying – 10 times a year

4. Rain water harvesting

- The rain water harvesting system was installed as a part of student project that was funded by SPF.
- This project installed 3 tanks of 2500 Gallons each
- This is mainly used to water the green house from May 1 to July 1.
- This water is occasionally used to wash machines.

Plant Research Facility:

1. Large Growth Chambers

Watering the plant usage

Number of growth chambers: 3

Number of chambers operational at any given point: 1

Number of pots in each chamber: 80

Water used in each pot: 0.2L/pot/day

Water used in washing each pot: 5L/pot

Cooling the chamber usage

Number of growth chambers: 3

Number of chambers operational at any given point: 1

Operation time: 25% of 365 days

Usage: 38L/min

2. Small Growth Chambers:

Watering the plant usage

Number of growth chambers: 8

Number of chambers operational at any given point: 3

Number of pots in each chamber: 40

Water used in each pot: 0.2L/pot/day

Water used in washing each pot: 5L/pot

Cooling the chamber usage

Number of growth chambers: 8 but 2 are water cooled and 6 is air cooled

Number of chambers operational at any given point: 3, consider 1 is water cooled

Operation time: 25% of 365 days

Usage: 3.8L/min

<u>Growth chambers in Raymond Building:</u>

In my interview with Guy Rimmer (Plant Science Department technician), it was noted that there are three main zones where the growth chambers are located. These growth chambers are water cooled, but it exists in a closed loop system. Thus according to Guy the makeup used is negligible in theory unless there is any leakage. The main water consumption is watering the plant and washing the plant pots once the experiment is over.

ZONE 1

Number of growth chambers: 50

Number of chambers operational at any given point: 22

Number of pots in each chamber: 40

Water used in each pot: 0.2L/pot/day

Water used in washing each pot: 5L/pot

ZONE 2: BUFFER ZONE

Number of growth chambers: 21

Number of chambers operational at any given point: 6

Number of pots in each chamber: 40

Water used in each pot: 0.2L/pot/day

Water used in washing each pot: 5L/pot

ZONE 3: QUARANTINE ZONE

This area has not been used in over 2 years

Cattle complex:

1. Milk House

This is a room where the milk collection system and collection tank is located. In this room water is used for following processes

- Collection pipe washing system: This system consists of a tank which is used to wash the pipes. The tank is a cylinder that is 3ft in height and 2ft in diameter. 1 washing cycle consist of 4 phases, namely sanitize, rinse, hot wash and cold rinse. The tank fills up once during each phase. Thus in one cycle the tank is filled 4 times. In a day, milk is collected twice, thus there are two washing cycles in a day.
- Bulk tank washing system: This bulk tank is basically the tank where milk is stored. The tank is emptied every 2nd day. Each time the tank is emptied, it is washed. The amount of water used in one cycle was determined by technical details given in the product catalog. The cooler model used in the cattle complex is 6000 – 8000 and the minimum water requirement per cycle is 113.6 Liter. Other way of calculating the actual water consumption is having details about the run time and the pipe pressure. But neither of these details was available with the farm manager.
- Milk house floor washing: This is done twice a day. This is done using a standard hose (Flow rate of which is to be calculated). Farm manager Paul Meldrum said that this takes about 5-10 minutes but other employees said it takes about 20-25 minutes. (IDEA: Pressure washer).
- The Pipe washing system and the bulk tank washing system consist of plate cooler and a compressor both of which are water cooled. But water from plate cooler is collected and used as drinking water for cows. Water from the compressor is collected and used as hot water.
- Also, an important point to be noted is the water that is used to wash the floor in the milk house is then used for flushing the gutters in the cattle complex to collect cow dung and urine.

2. Feed for adult cows

- This feed is prepared once a day. However the amount of water in this feed varies every day. But after obtaining information from the technician, it was estimated that on an average 500kg of water is used daily to prepare this feed. Convert kg to liter? (At 4 degree Celsius 1kg = 1 liter)

3. Feed for heifers

- The feed is prepared 3 times in a day.
- 18 Liters of water is used each time to prepare the feed.
- 15 Liters of water is used to wash the trolley in which the feed is prepared. This is done each time before preparing the feed.
- A standard hose is used for washing the area after preparing the feed. The hose is used approximately for 2 minutes each time.

4. Pressure wash the complex

- This is done once every year.
- This is done by 3 workers using 3 pressure wash machines for the whole day.
- Calculation?

5. Washing the floor of the complex

- The floor is washed once every month using a standard garden hose.
- This takes approximately 1 hour.
- Flow rate to be calculated?

6. Washing Machine

- There are 2 washing machines at the complex but only 1 is used.
- This is used 3 times in a day.

7. Washing the Scrapper

- The scraper is washed using a standard garden hose.
- The hose is used twice a day.
- It is used for 10 minutes each time.

8. Number of cows

- Milking cows: 75
- Dry cows: 10
- Heifers (12 months old and older) : 35
- Heifers (12 months old and younger): 40

Questionnaire for custodial staff:

1. **Name**:

____

2. **Contact information**:

____

3. **Working Area** - This information includes all the area that is cleaned by you where water is used: Example – Laird 1st floor or Laird 2nd floor.

____

____

4. **Type of machine used for cleaning** – Small machine or big machine :

____

5. **Bucket used** – please mention if you know the capacity of the bucket:

____

6. **Frequency of use (Machine)** - How many times do you use the machine in your shift:

____

7. **Frequency of use (Bucket)** - How many times do you use the bucket in your shift:

____

8. **Use of hose to clean the mop** – Do you use the hose to clean the mop? If yes then approximately **how many times do you clean the mop** in your shift and for **how much time do you use the hose**?

____

9. **Any important information** that you like to give that would be helpful for this audit?