Civic Centre

Service Delivery - Energy Audit – Final Report
Project Location: Township of Chapleau
Wood Project Number: BE20102014

Prepared for:

Township of Chapleau
20 Pine Street W. P.O. Box 129

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Prepared by:

Wood Environment & Infrastructure Solutions, a Division
900 Maple Grove Rd, Unit 10, Cambridge ON, N3H 4R7

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Executive Summary

Civic Centre Energy Audit

Wood PLC (Wood) was retained by the Township of Chapleau to conduct an energy audit on the Civic Centre located at 20 Pine St, Chapleau Ontario. An energy assesment consistent with ASHRAE Leve 2 guidelines was conducted for the Faciity. The site visit associated with this project was conducted on July 28th, 2020 by Nathan Sokolowski.

The aim of this study was to analyze the current energy performance of the Facility, conduct an onsite energy assessment, and produce a list of Energy Conservation Measures (ECMs) complete with relevant Opinion of Probable Costs.

The summary table below presents a list of opportunities identified during the energy assessment of the site Facility along with estimated costs, savings and simple payback.

Table E-1 Summary of ECMs

ECM	Measure	Opinion of Probable Cost	Estimated Savings				Estimated Total Savings	Simple Payback
			Propane	Electricity	Demand	Maintenance		
		($)	(L)	(kWh)	(kW)	($)	($)	(Years)
ECM-1	Reduce Infiltration	24,000	-	24,161 9.0%	10 6.0%	-	4,375	5.5
ECM-2	Window Film	29,000	-	45,607 16.9%	21 12.7%	-	8,259	3.5
ECM-3	Window Upgrades	103,000	-	94,057 34.9%	45 27.4%	-	17,032	6.0
ECM-4	Temperature Set Points	1,200	-	6,311 2.3%	5 3.2%	-	1,143	1.1
ECM-5	Propane Source MUA	62,000	(12,122)	206,680 76.7%	146 89.4%	-	30,209	2.1
ECM-6	Interior Lighting Retrofit & Control	23,000	-	6,892 2.6%	11 6.8%	470	1,718	13.4
ECM-7	Exterior Lighting Retrofit	600	-	3,768 1.4%	1 0.5%	30	712	0.8
Scenario 1		139,000	(10,631)	226,746 84.1%	151 92.9%	470	35,200	3.9
Scenario 2		134,000	-	127,847 47.4%	59 36.3%	30	23,181	5.8

Notes:

(1) It should be noted that the estimated savings associated with each scenario may not match the aggregated sum of the included measures evaluated separately. This is due to interactive effects between measures.

Wood has presented two (2) strategic implementation scenarios for the measures recommended in this assessment report. Scenario 1 is estimated to reduce site electricity by 84% which is widely due to swapping the electric perimeter heat in favour of a propane base make up air unit, capable of bringing in outdoor air and tempering it to programmed temperature control set points defined for each major zone in the facility. The overall annual cost savings for scenario 1 relative to the baseline year is $35,200. Scenario 2 is estimated to reduce site electricity by 47.4% which is widely due to upgrades to the building envelope and reducing the amount of infiltration and heat gain which is currently occurring. The overall annual cost savings for scenario 2 relative to the baseline year is $23,181.

Wood recommends that the Township proceeds with the suggested ECMs stated in implementation scenario 2. Upgrades to the building envelope to improve insulation and air tightness should be addressed before installing new HVAC equipment to ensure the right size of equipment is installed for the building heating load. This scenario includes the following ECMs:

Scenario 2, which contains:

- ECM-1: Infiltration Reduction;
- ECM-3: Window Replacement;
- ECM-4: Temperature Setbacks; and
- ECM-7: Exterior LED Retrofit.

By implementing the recommended measures listed above, the Facility has a potential savings of 127,847 kWh, equivalent to 47.4% reduction that may be anticipated relative to the simulated baseline year.

Wood recommends that the Township proceeds with the following building management and behavioral opportunities:

- Re-commissioning;
- Staff Training and Occupant Awareness; and
- Procurement Policy.

Wood recommends that the Township investigate further possibility of implementing the following opportunity/opportunities:

- Solar Photovoltaic Panels.

Further analysis is required to determine the potential savings and costs of these measures more accurately. It is recommended that the Township move forward to review the potential to incorporate these measures into the existing site energy and environmental management strategy.

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Acronyms and Abbreviations

ACH	Air changes per hour
BTU	British Thermal Unit
C	Celsius
ccASHP	Cold Climate Air Source Heat Pump
CDD	Cooling Degree Day
CFL	Compact Fluorescent
CO_2e	Carbon Dioxide Equivalent
ECM	Energy Conservation Measure
EUI	Energy Utilization Index
ft	Feet
ft^2	Square feet
g	Gram
GSHP	Geothermal Source Heat Pump
GJ	Gigajoule
HDD	Heating Degree Day
HP	Horse Power
HPS	High Pressure Sodium
HST	Harmonized sales tax
IRR	Internal Rate of Return
kW	Kilowatt
kWh	Kilowatt hour
L	Litre
LED	Light emitting diode
m	Meter
m^2	Square meter
m^3	Cubic meter
NPV	Net Present Value
UH	Unit Heater
W	Watt
Wood	Wood Environment & Infrastructure Solutions, Inc
U-Value	Thermal transmittance measured in BTU/(hr·ft^2·°F)

1.0 Introduction

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood) was retained by the Township of Chapleau (client) to conduct energy audits for six (6) township buildings. This report is specific for the Civic Centre located at 20 Pine St, Chapleau Ontario.

The assessment involved a review of approximately 1,450 m^2 (15,600 ft^2) of municipal offices, a library, a firehall, and a court/council chamber. This revealed the potential for the implementation of energy management measures which may improve the overall efficiency of the facility.

Our assessment methodology can be found in **Appendix A**.

1.1 PURPOSE

The Purpose of this project is to conduct an energy assessment on the Town's owned facilities to assess and determine energy usage for equipment/facility consumption and operational performance. The goal of the energy assessment is to provide recommendations based on behavioral, operational, facility, equipment performance and how the facilities can be improved to reduce energy consumption and overall operating costs. The assessment will identify both operating and capital improvements and provide a detailed analysis on simple payback and energy consumption reductions.

1.2 SCOPE OF ASSESSMENT

The detailed energy assessment consists of an on-site facility assessment, a utility analysis, and a detailed review and analysis of Energy Conservation Measures (ECMs). The energy assessment report is organized as follows:

- Facility description;
- Utility analysis and benchmarking;
- ECMs; and
- Conclusions and recommendations.

The Township of Chapleau provided the following documents to Wood for review:

- Utility records; and
- Facility drawings (floor plans).

The following appendices referenced below provide further background that form part of this report:

- Appendix A – Assessment Methodology;
- Appendix B – Assest Details;
- Appendix C – Lighting Inventory;
- Appendix D – Modeling methodology; and
- Appendix E – Utility data summary.

1.3 BACKGROUND

1.3.1 Client Information

The following table summarizes key client information related to this assignment.

Table 1-1 Key Client Information Summary

Customer Name	**Township of Chapleau**
Site Address	20 Pine St, Chapleau Ontario
Contact Person	Ms. Charley Goheen
Contact information	cgoheen@chapleau.ca
Utility Provider	Chapleau Hydro
Account Number	055159000

1.3.2 Acknowledgements

Wood would like to acknowledge the contribution of the Township of Chapleau and Facility staff whose help was invaluable in completing this assignment.

2.0 FACILITY DESCRIPTION AND CONDITION

The following sections summarize the observations made during the site investigation.

2.1 OVERVIEW

The Civic Centre was constructed in 1978. It has two (2) stories with the main floor accessible from Pine street and the lower floor accessible from the parking lot in the rear. The lower floor is constructed in a manner that the south exterior walls are below grade. The main floor contains a library and general office area. The lower floor contains a lawyer's office, court/council chamber, storage areas and a mechanical room. The firehall is situated on the west end of the building and cannot be accessed from the Civic Centre portion.

The municipal offices operate Monday-Friday during the week and is occupied by approximately 10 staff members from 8:30 AM to 4:30 PM. The public library is open 3 to 4 days a week, 12pm to 7pm, Monday to Thursday with 2 staff and varying levels of public visitors. The firehall is volunteer based and operates as required. There is typically one (1) firefighter who comes in once per week for upkeep and maintenance. Table 2-1 summarizes an overview of the building information

Table 2-1 General Building Information

Building Type	**Municipal offices, library, firehall**
General Occupants	10-15
Gross Floor Area	1,450 m2 (15,600 ft2)
Floors	2
Year Built	1978
Occupancy schedule	Office: Monday to Friday, 8:30 am to 4:30 pm Library: Monday to Thursday, 12:00pm to 7:00pm Court/Council Chamber: 2 Mondays per month, 6:30 pm till 9:00pm

2.2 UPGRADES/CHANGES

The roof insulation was re-worked in the late 90s due to water leaks that were occurring and the facility went through an interior renovation in 2019 which included modernization of the gallery, the inclusion of a barrier free accessible washroom as well as a washroom and canteen for the general office space.

The suspended fluorescent lights and incandescent pot lights in the general office area were also retrofitted to LED lamps.

2.3 BUILDING ENVELOPE

The lower floor of the Civic Centre and Firehall is a slab on grade with the walls constructed of concrete block, expanded foam insulation and exterior brick. There are some portions of the lawyers office and court/council chamber having drywall. The ceiling is acoustic tile with a built-up metal deck. The upper floor interior is a combination of concrete block with insulated brick walls, wood frame infill walls with fiberglass insulation, and drywall with rigid insulation foam. The exterior is mostly brick with weathered cedar siding finishes in areas.

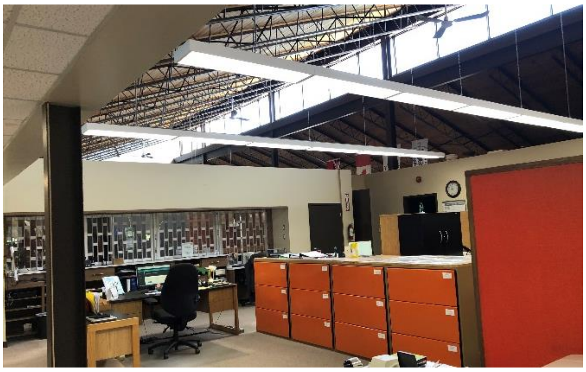
The roof assembly consists of web steel joints, structural wood decking, 2 ½" fiberglass insulation and metal roof panels. The windows are original to construction with the most common style being aluminum frame 'fixed over slider' types with insulated windows. The seals have deteriorated over time and leak significant amounts of air. There are transom style windows in the firehall, lawyers office and storage area of the lower floor and there are clerestory windows on the upper floor to provide natural light to the library and office spaces. The upper floor and lower floor entrances have vestibule style double doors equipped with handicap operators. The weather stripping at the entrances have evidence of wear and tear becoming bent or cracked in spots with areas where light is visible between the gaps. There are balconies off the library north wall accessible via sliding glass doors that were observed open during the site visit to allow ventilation and fresh air to the upper floor. The remaining exterior doors are insulated aluminum with weather stripping in fair condition. Select photos representative of the general building envelope construction and interior are presented below and captured under **Figure 2-1** in the table of contents.

Figure 2-1 Civic Centre Site Photos

Civic Centre entrance – South façade

Firehall – South façade


Civic Center - North West façade


Upper floor general office area


Upper floor library


Lower floor court/council chamber


Lower floor lawyer's offices

2.4 MECHANICAL SYSTEMS

The following mechanical systems and components were identified during the site visit.

2.4.1 Heating, Ventilation and Air Conditioning

The building is heated by perimeter electrical baseboard and cabinet heaters. During the site assessment, it was confirmed that no ventilation supply is provided within the building. Furthermore, no exhaust fans aside from the Firehall, canteen, and washrooms. The south facing offices are equipped with KoolKing 1 ton capacity window mounted air conditioner units. There are 4 in total for the facility and they are manually operated by staff to provide cooling on hot summer days

2.4.2 Building Controls

The perimeter electric heat is controlled with a Honeywell Excel 5000 open Building Automation System (BAS). Seven (7) thermostats placed throughout the facility provide temperature control and pre-set time restrictions for the heaters for the general zones listed below. The temperature setpoint in occupied and unoccupied modes are 22°C and 17°C respectively except for the Firehall which is always in unoccupied mode with a 10°C setpoint. Certain zones are equipped with manual overrides to force the system from unoccupied mode when needed.

Table 2-2 Building Occupancy Schedule

Zone	Schedule	Manual Override
Basement lobby	Occupied: Monday to Friday 7:00 AM to 5:00 PM Unoccupied: Weekends	N/A
Council Chambers/Court Room		3 hour
General Office/main foyer		1 hour
Board Room	Occupied: Monday to Friday 7:00 AM to 9:00 PM Unoccupied: Weekends	N/A
Library (South & North Thermostat)	Occupied: Tues, Wed, Thurs 12:00 PM to 7:00 PM Unoccupied: Friday & Weekends	1 hour for north thermostat
Firehall	Unoccupied: 24/7	1 hour

2.5 ELECTRICAL SYSTEMS

The following electrical systems were identified during the site visit.

2.5.1 Domestic Hot Water

Domestic Hot Water (DHW) is provided to the facility by a GSW 4.5 kW electric hot water heater with a storage capacity of 284 L. The unit is equipped with a Grundfos circulation pump to provide on-demand hot water to the faucets throughout the Facility.

2.5.2 Lighting Systems

The interior lighting systems in most spaces are fluorescent tube (T-12) 4ft liner lamps or U-tube lamps controlled with manual on/off switches. There are halogen incandescent fixtures on dimmer switches in the court/council chamber and incandescent lights in the side rooms of the firehall. The general office area was upgraded to LED fixtures during the 2019 renovation. Exterior lighting consists of a combination of LED lamps, halogen lamps and high pressure sodium (HPS) lamps on integrated photocell control. The exit signs throughout the building are from the original construction and contain incandescent bulbs.

Lighting Inventory can be found in **Appendix C.**

2.5.3 Plug Loads

Plug loads are typical items essential to facility operation. These include desktops, laptops, printers, projectors and common office equipment. It also includes extra, and redundant equipment not needed in daily operation including personal plug load items found in staff offices such as electric space heaters, coffee makers and radios.

3.0 UTILITY ANALYSIS AND BENCHMARKING

The following sections detail the energy analysis that was performed for the Facility, and includes a utility analysis, a comparison to a benchmark, and a breakdown of energy consumed by fuel type and major end-use.

3.1 ELECTRICITY

There is one (1) electricity meter on site which measures the purchased energy for the building. Collected utility data can be found in **Appendix E.**

Utility data was provided for a period of two (2) years from January 2018 to December 2019. A review of electricity costs from 2019 Chapleau Hydro invoices yielded a blended rate of $0.18/kWh which accounts for transmission, use, regulatory fees, global adjustment and HST. Table 3-1 summarizes the electricity consumption data for the years provided.

Table 3-1 Summary of Utility Data

Year	Electricity	
	Consumption (kWh)	Cost ($)
Jan-2018 to Dec-2018	276,480	50,066
Jan-2019 to Dec-2019	285,360	51,674

The figure below illustrates the electrical consumption for the facility.

Figure 3-1 Monthly Electricity Consumption

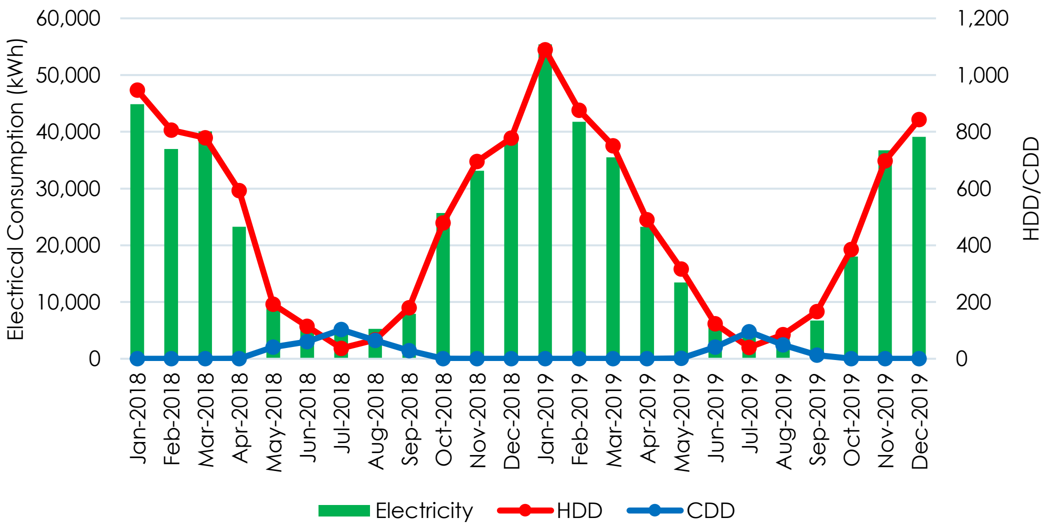


Figure 3-1 shows that electricity consumption peaks in the winter months; this is to be expected for a building in a heating dominated climate with electricity being the only energy source present. There is a small baseload during the summer periods consisting of DHW heating, lighting, plug loads, air conditioning and exhaust fans.

To establish a baseline year, a linear regression analysis (R-squared analysis) was completed on the electricity data The R-square (R2) value is a measure of the degree of correlated agreement between the electricity consumed and the dependent variable chosen, in this case CDD and HDD. An R2 value of 1 represents a perfect correlation, while a lower value indicates a lesser degree of influence between the variables. In general, an R2 value indicates a strong correlation between 0.8 and 1; a moderate correlation between 0.7 and 0.8; and a weak correlation below 0.7. By using an R2 analysis to correlate energy usage to outdoor temperature, it may be possible to normalize data to a typical year, thereby removing the effects of temporary peaks or lulls due to varying weather patterns and determine how closely energy consumption is related to the weather.

The calculated R2 of **0.98** for HDD and **0.54** for CDD shows the facilities electricity consumption is heavily influenced by a dropping outdoor air temperature. The correlation between CDD is weak as the air conditioning throughout the building is limited to perimeter offices and staff will only operate such equipment on very hot days.

3.2 SIMULATED BASELINE YEAR

Using a combination of Carrier's Hourly Analysis Program (HAP 5.11) software and Microsoft Excel based calculations, a baseline energy simulation was created and calibrated against the modeled energy consumption described previously to within the target of 20% of the annual consumption value. The accuracy of the calibration changes between utility record datasets due to the variability of weather; the modeled consumption has been normalized against weather, removing peaks and lulls due to varying weather patterns and allowing for a more accurate calibration. This model has been used as the basis for the end-use breakdowns in the subsequent sections. The modeling methodology can be found in **Appendix D**. Table 3-2 summarizes the simulated baseline year for the facility.

Table 3-2 Summary of Simulated Baseline Year Energy Consumption

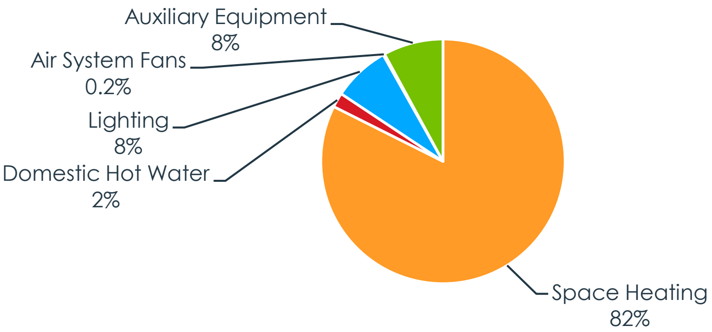
Year	Electricity		Total			
	Consumption (kWh)	Cost ($)	EUI (GJ/m²)	EUI (ekWh/ft²)	Cost Index ($/m²)	Cost Index ($/ft²)
Baseline	269,474	48,797	0.67	17.28	33.68	3.13

3.3 ANNUAL ENERGY CONSUMPTION BREAKDOWN BY MAJOR END-USE

The total annual energy consumption of the Facility was analyzed and broken down into major end-use categories. These categories included in this analysis consist of:

- **Space Heating** – This includes all space heating provided by perimeter electric heat to maintain the space temperature;
- **Domestic Hot Water** – All domestic hot water used in building;
- **Air System Fans** – All exhaust fans serving the facility;
- **Auxiliary Equipment** – This includes all energy consumed by all plugged in equipment such as computers and telephones as well as any miscellaneous process equipment that may be installed, such as snack bar appliances and the kitchen equipment.
- **Lighting** – All interior and exterior lighting.

Figure 3-2 Annual Energy Consumption Breakdown by Major End-Use



From the figure above, space heating is the end use that consumes the most energy at the facility with 82%. This is to be expected since Canada is a heating dominated climate. The facility does not contain air systems other than simple low horsepower exhaust fans which provide little air movement placing all the heating load on perimeter base boards and unit heaters. Lighting (8%) and auxiliary equipment (8%) are the next large users followed by DHW (2%) which together make up the baseload for the facility, which makes sense due to the nature of the activity at the facility

3.4 BUILDING ENERGY PERFORMANCE BENCHMARKING

The facility Energy Utilization Index (EUI) was calculated by dividing the total annual energy used by the gross floor area. The table below compares the EUI at the Facility to the Office of Energy Efficiency (OEE) benchmarks for the **Information and Cultural Industries sector** and the **Office sector** to assess the Facility's energy performance against similar buildings. Comparisons were drawn from OEE tables specific to space conditioning as this is the primary end use for the Facility relative to auxiliary loads.

Table 3-3 EUI Benchmarking

Calculated in Utility Analysis		OEE Benchmark[(1)]		Sector
GJ/m²	ekWh/ft²	GJ/m²	ekWh/ft²	
0.71	18.35	0.80	20.56	Information & Culture
		0.73	18.89	Offices

Based on the analysis, the EUI for the estimated baseline year for the Facility is approximately 11% lower than the OEE benchmark when referring to the Information and Cultural Industries and 3% lower than the OEE benchmark for Offices.

4.0 ASSESSMENT FINDINGS

This section provides an overview of the ECMs analyzed in this report. For each measure, estimates of the annual savings in each of the following were determined:

- Electricity demand and consumption;
- Fuel switch consumption;
- Total energy cost;
- Maintenance cost; and,
- GHG emissions.

The first three (3) items were determined using the simulated baseline model wherever possible. For some measures, hand calculations were used when the model was not able to simulate the measure. The maintenance cost premiums were estimated using commercial cost estimating software or based on Wood's experience with similar projects.

GHG emission reductions were calculated based on the results from the detailed analysis. The following table lists the GHG emission factors used.

Table 4-1 Energy Source Emission Factors

Energy Source	Emission Factor
Electricity	0.0000393 tonnes/kWh
Propane	1.55 tonnes/m^3

The following ECMs were reviewed:

- ECM-1: Infiltration Reduction;
- ECM-2: Window Films;
- ECM-3: Window Replacement;
- ECM-4: Temperature Setbacks;
- ECM-5.1: Heating System Upgrade Option 1 – Heat Pumps;
- ECM-5.2: Heating System Upgrade Option 2 – Ground Water Source Heat Pumps;
- ECM-5.3: Heating System Upgrade Option 3 – Propane RTUs;
- ECM-6: Interior LED Retrofit & Controls; and
- ECM-7: Exterior LED Retrofit.

4.1 BUILDING ENVELOPE

4.1.1 ECM-1: INFILTRATION REDUCTION

Existing Condition

All structural components within the building envelope are bound to experience varying levels of air or heat exchange at transection. Infiltration into the building can also create a significant heating load source in the buildings. Due to the age, construction and usage, the Facility may experience large heating loads due to air leakage and excessive infiltration through door openings, window openings, cracks, and exhaust/plumbing penetrations which can increase heating energy. Infiltration will occur during all hours of the day due to the absence of a ventilation system to provide positive pressurization to the building. Staff members mention windows in the office area are covered with plastic film during the winter to reduce cold air drafts.

Because of the constant variation in wind speed and pressure, along with actual air infiltration greatly varying throughout the year, the average infiltration rate for the Facility was assumed to be constant with ACH rate of 0.5 based on the definition of average infiltration through exterior walls, windows and doors provided by ASHRAE fundamentals 2009.

Proposed Condition

The installation or replacement of worn or broken weather stripping, window caulking, and foam sealants can contribute towards reducing air infiltration around doors, windows, piping, cracks, and exhaust/plumbing penetrations.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The infiltration ACH for spaces with doors, walls and windows were reduced on average by 30% because of weather-stripping and caulking.

A detailed building envelope or thermography testing could be conducted to identify anomalies related to thermal bridges, air infiltration/exfiltration, and heat transfer due to design or construction of the building.

The following assumptions were made during the analysis of this measure:

- For calculation purposes, weather-stripping and caulking of walls, windows and doors can reduce infiltration by a minimum of 30%;
- Replacing worn and/or broken weather-stripping and caulking would not require additional modifications to the buildings structure.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-2 ECM-1: Infiltration Reduction Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
24,161	9.0	9.8	6.0	-	4,375	2.4

The following table summarizes the financial analysis associated with this measure.

Table 4-3 ECM-1: Infiltration Reduction Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
24,000	4,375	5.5	4,359	4.4	5.9

The measure offers a payback 5.5 years and provides a positive NPV and IRR.

The following table summarizes the costs associated with this measure.

Table 4-4 ECM-1 Infiltration Reduction Opinion of Probable Cost Breakdown

Item	Cost ($)
Door Seal (x12)	685
Loading Dock (x2)	3,270
Window Caulking	7,920
Installation	5,000
Engineering (11%)	1,580
Commissioning and Training (7%)	1,000
Contingency (10%)	2,200
TOTAL (to nearest hundredth)	**24,000**

4.2 WINDOWS

4.2.1 ECM-2: Window Films

Existing Condition

The existing windows on throughout the Facility are clear and allow for heat gain and heat loss to the spaces they serve throughout the year.

Proposed Condition 1 – Window Films

When it comes to thermal resistance, windows are by far the weakest thermal point in a wall. Energy efficiency for windows is measured in U-value. U-value measures the rate of heat transfer. This is different from R-value, which measures the thermal resistance. Window insulation film can decrease a window's U-value, due to the air trapped between the room and the window.

Static cling window insulation film reduces the amount of heat and UV rays that enter through your window. Some films reduce heat transfer of the window by up to 50% and block up to 70% of solar heat gain. This could significantly reduce the Facility heating and cooling costs. Silver tinted films work better than clear or lightly tinted films but also reduce the visibility through your window.

In terms of implementation the window film is applied directly onto the existing windows and there are no additional space requirements.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The overall window U-value of existing windows was assumed to be 0.9 with venetian blinds and 1.2 without. The U-value with films applied was reduced to 0.57 and 0.7 for windows with and without shading respectively.

The following assumption were made during the analysis of this measure:

- Fixed over slider windows in the general office area and library utilize venetian blinds;
- Transom and clerestory windows do not have any forms of shading;
- Films can be applied to windows throughout the Facility with minimum effort required except clerestory windows which require additional effort due to height above floor level.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-5 ECM-2: Window Film Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
45,607	16.9	20.7	12.7	-	8,259	4.6

The following table summarizes the financial analysis associated with this measure.

Table 4-6 ECM-2: Window Film Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
29,000	8,259	3.5	45,336	23.1	3.7

The measure has a simple payback of 3.5 years and will result in reduced run times of the perimeter heating equipment. This measure will also reject the suns heat and harmful UV rays during the summer improving comfort and reducing warm spots.

The following table summarizes the costs associated with this measure.

Table 4-7 ECM-2: Window Film Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	21,400
Installation	2,200
Engineering (11%)	2,300
Contingency (10%)	2,600
TOTAL (to nearest thousand)	**29,000**

4.2.2 ECM-3: Window Replacement

Existing Condition

The windows are original to construction with the most common style being aluminum frame 'fixed over slider' types. Other types include transom and clerestory windows. The windows lack any sort of window film glazing and represent a weak link in the building envelope allowing substantial heat gain and heat loss in the summer and winter respectively.

Proposed Condition 2 – Window Replacement

The existing facility windows could be replaced with high performance Energy Star certified windows allowing to create a more air tight and insulated building envelope.

In terms of implementation, the replacement should occur during the weekends when the Facility is generally unoccupied. The process can be completed in phases with the upper floor, lower floor, and firehall each being completed at separate times.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The overall window U-value of existing windows was assumed to be 0.9 with venetian blinds and 1.2 without. The new windows were modelled to have a U-value of 0.18 as listed in the minimum requirements of efficient windows by Natural Resources Canada.

The following assumption were made during the analysis of this measure:

- Any existing issues and damages to window fenestration will be repaired during the retrofit process; and
- Existing windows can be easily removed and the retrofit to framing will not cause any structure implications.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-8 ECM-3: Window Replacement Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
94,057	34.9	44.6	27.4	-	17,032	9.4

The following table summarizes the financial analysis associated with this measure.

Table 4-9 ECM-3: Window Replacement Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
103,000	17,032	6.0	280,523	14.1	6.5

This measure offers savings with a moderate payback of 6.5 years. A positive NPV and IRR suggest that the township can further look at investigating the opportunity to upgrade the buildings envelope in the near future.

The following table summarizes the costs associated with this measure.

Table 4-10 ECM-3: Window Replacement Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	67,700
Installation	18,400
Engineering (11%)	7,400
Contingency (10%)	9,400
TOTAL (to nearest thousand)	**103,000**

4.3 HVAC

4.3.1 ECM-4: TEMPERATURE CONTROL SET POINTS RETROFIT

Existing Condition

The existing perimeter heat which serves the Civic Centre is programmed to operate based on the space temperature and set point of the spaces. The Civic Centre spaces are scheduled to heat to 22°C during occupied mode and 17°C during unoccupied mode.

Proposed Condition

The existing BAS setpoints and schedule can be further optimized to allow adjusting of temperature that best suit the space and its scheduling needs.

In terms of implementation a third-party contractor can recommission the system. A staff member can be trained to use the existing controller or an alternative more user-friendly controller be acquired.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The heating occupied, and unoccupied set points were reduced from an average of 19.5 °C (67 °F) to an average of 18.5 °C (65 °F) for all Civic Centre spaces to show how a small adjustment on the electric heating system can have a large on effect on energy savings.

The following assumptions were made during the analysis of this measure:

- The thermostats' set points are maintained at the suggested temperatures throughout the year with no variance.
- An HVAC technician at $85/hr could review the system in detail and train a staff member how to implement scheduling and setbacks.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-11 ECM-4: Temperature Control Set Point Retrofit Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
6,311	2.3	5.2	3.2	-	1,143	0.6

The following table summarizes the financial analysis associated with this measure.

Table 4-12 ECM-4: Temperature Control Set Point Retrofit Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
1,200	1,143	1.1	9,087	91.4	1.1

This measure is low cost and can be implemented with little difficulty if a staff member is trained to utilize the existing BAS.

The following table summarizes the costs associated with this measure.

Table 4-13 ECM-4: Temperature Control Set Point Retrofit Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	950
Engineering (11%)	100
Commissioning and Training (7%)	65
Contingency (10%)	100
TOTAL (to nearest hundredth)	**1,200**

4.3.2 ECM-5: HEATING SYSTEM UPGRADE

Exiting Condition

The existing Facility is currently served by electric resistance heating in the form of perimeter baseboard and unitary heat.

Option 1: Air to Air Source Heat Pumps

Multizone cold climate air to air source heat pumps (ccASHP) can be used to provide heating. One outdoor unit can be combined with upwards of 8 indoor fan coils to provide zoned climate control with individual thermostats. The electric heat may be retained in case there is a need for backup heat source and can be used if supplemental heating is required on very cold days.

In terms of implementation, heat pumps should always be installed by licensed, trained professionals. Upgrades to the building envelope to improve insulation and air tightness should be addressed before installing new equipment to ensure the right size of equipment is installed for the building heating load. Outdoor units can be ground mounted or roof mounted and in either scenario there is adequate space at the facility to do so. A small space needs to be allocated to the indoor coil, but it is versatile as it can be mounted either on the floor, wall or ceiling. The sensors would be tied into programmable thermostats to control each zone individually. Consideration will need to be given to the details of wiring the sensor to the controller. Several vendors carry ccASHP in their product line and they require periodic maintenance to maintain proper operation such as keeping the outdoor unit free from snow, ice and debris. As the system will be largely automated little training will be required.

Analysis

This heating system option was analyzed using the end-use model generated from Carrier's HAP software as a basis. The electric perimeter heat throughout the Facility was replaced with split DX fan coils that have an average coefficient of performance (COP) rating of 3.2 and a backup electric auxiliary heating that initiates at 4.4°C (40°F). A rate of $0.5954/L is used for propane including purchase cost and GHG carbon tax.

Option 2: Geothermal Heat Pump

Geothermal heat pumps operate on the same principals of an ASHP with the benefit of higher COP especially during extreme cold weather. The Kebsquasheshing River adjacent to the building can be used as a renewable energy source and supply heat to the Facility. A heat pump can concentrate heat by compressing refrigerant and then transferring this heat into spaces via indoor coils or heat exchangers. The refrigerant gas becomes cold when the pressure is release and this coldness can be exchanged with warmer water from the river. The river has a more consistent temperature profile throughout the year than the outdoor air meaning the need for an auxiliary heating source (in the case of ASHP) is eliminated.

In terms of implementation, these types of systems typically use a series of pumps and closed loops of piping that are submerged and anchored so they float a couple feet above the bottom of river bed. An experience geo-exchange designer along with environmental permits and legal approvals are challenges to implementation.

Analysis

This heating system option was analyzed using the end-use model generated from Carrier's HAP software as a basis. The electric perimeter throughout the Facility was replaced with a ground water source heat pump that uses surface water instead of a cooling tower and has an average COP rating of 3.6.

Proposed Option 3: Propane MUA unit

A make up air unit, capable of brining in outdoor air, could provide tempered air into the zones of the Facility using propane as the fuel source. This would require the installation of a 1,500 L fuel storage tank outside the facility, connection gas piping and some duct work as propane is currently not available on site

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The electric fan coils and unit heaters throughout the Facility were replaced with a constant air volume make up air unit to provide 15°C (60°F) tempered air to the zones throughout the Facility. The unit was sized based on the ASHRAE 90.1 2013 energy standard using an average efficiency of 80%.

The following table summarizes the estimated energy savings associated with each option suggested in this measure.

Table 4-14 ECM-5: Heating System Upgrade Annual Energy Savings

Option	Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
	(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
1	-	-	65,011	24.1	49.4	30.3	(250)	11,772	6.5
2	-	-	117,117	43.5	86.9	53.3	(1,000)	21,208	11.7
3	-12,122	-	206,680	76.7	146	89.4	-	30,209	1.9

The following table summarizes the financial analysis associated with this measure.

Table 4-15 ECM-5: Heating System Upgrade Financial Savings

Option	Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
	($)	($)	(years)	($)	(%)	(years)
1	119,000	11,522	10.3	29,489	3.1	11.7
2	201,000	20,208	9.9	130,681	5.8	11.2
3	62,000	30,209	2.1	327,301	45.7	2.1

Option 1 and 2 do not justify implementation on energy savings alone as these options generally require additional study to refine the project merit. These options are presented as an HVAC technology benchmark showing the energy savings potential based on an increase in the COP of an electricity based heating system. This provides the township of Chapleau with a comparison if the Civic Centre were to continue using electric sourced heating when the existing equipment reaches its end of life. Option 3 offers attractive financials and provides a simple payback of 2.1 years.

The following table summarizes the costs associated with the three (3) options. Due to the long paybacks for options 1 & 2 they are excluded from ECM summary tables in the conclusion and executive summary.

Table 4-16 ECM-5: Heating System Upgrade Opinion of Probable Cost Breakdown

Item	Option 1 Cost ($)	Option 2 Cost ($)	Option 3 Cost ($)
Project Cost	92,000	154,700	48,000
Engineering (11%)	10,100	17,000	5,300
Commissioning and Training (7%)	6,400	10,800	3,400
Contingency (10%)	10,800	18,300	5,700
TOTAL (to the nearest thousand)	**119,000**	**201,000**	**62,000**

4.4 LIGHTING

4.4.1 ECM-6: INTERIOR LED RETROFIT & CONTROLS

Existing Condition

The current lighting system is manually operated with the majority of the spaces throughout the Facility currently using T12 fixtures with lamps rated at 34 W each and U-Tube fixtures with lamps rated at 40 W each. There are also halogen and incandescent fixtures in the court/council chamber and firehall with lamps rated at 100 W each.

Proposed Condition

The T12 lamps could be replaced with 16 W LED lamps and halogen incandescent with 16 W LED lamps. The U-Tube fixtures could be replaced with 32 W LED Fixtures. Note that since LED lamps have a longer service life than fluorescent lamps, maintenance savings will be achieved through fewer lamp replacements.

There are no additional space requirements for the new lamps, as they should be able to directly replace the existing lamps in the same space as the current fixtures. Depending on the style of the fixture, the entire fixture may need to be replaced rather than the lamp only; it is also possible that Town staff may wish to replace the fixture for cosmetic reasons. A mock up of lighting fixtures is recommended prior to implementation to ensure aesthetics.

LED lamps and fixtures are widely available from several vendors. Energy Star or Design Lighting Consortium (DLC) lamps and fixtures should be selected to ensure compliance with incentive programs. As there is little difference in the operation and maintenance of the new LED lamps no training will be required.

Many spaces within the Facility experience varying, and occasionally little to no occupancy. Occupancy sensors with override capability could be tied into the lighting system to enable lighting setbacks in these areas when they are not being used, or when Facility personnel inadvertently keeps the lights on. This configuration would reduce energy consumption by only having the lights on when the space is occupied.

However, it is important that manual switches be readily accessible in case of emergency situations to control the lighting in the space or due to failure of the occupancy sensors.

The following list of spaces could be equipped with occupancy sensors:

- Perimeter offices;
- North library;
- Court/council chamber;
- Lawyer offices; and
- Firehall storage and mechanical rooms.

In terms of implementation, a relatively small space needs to be allocated to the occupancy sensor, as it needs to be mounted either on the wall or ceiling. The sensors would be tied into the controller to control each zone individually. Consideration will need to be given to the details of wiring the sensor to the controller. Several vendors carry occupancy sensors in their product line and they require little maintenance to maintain proper operation. As the system will be largely automated little training will be required.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The lighting wattages of the affected areas were reduced to simulate the effect of the lower wattage LED lamps. The lighting schedule occupied hours were reduced for the spaces listed to simulate the effect of utilizing occupancy sensors to turn off lighting in these areas when unoccupied.

The following assumptions were made during the analysis of this measure:

- Existing lamp lifetime is 5 years and are replaced at the rate of 20% per year;
- Proposed LED lamp lifetime is 10 years;
- Proposed LED lamps replacing T12 lamps will utilize 16 W LED lamps;
- Proposed LED fixtures replaces U-Tube fixtures will utilize 32 Watts;
- Minimum effort required to upgrade fixture with low ceiling heights.
- Occupancy sensors will reduce the lighting operating hours by approximately 10%; and,
- 20 sensors would be required for proper coverage within the spaces listed.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-17 ECM-6: Interior Lighting & Control Retrofit Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
6,892	2.6	11.0	6.8	470	1,248	0.7

The following table summarizes the financial analysis associated with this measure.

Table 4-18 ECM-6: Interior Lighting & Control Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
23,000	1,718	13.4	(7,536)	-6.8	N/A

The financials for this measure are poor due to the building model accounting for increased usage from the perimeter heating system to offset the sensible heat loss from the lighting retrofit. Therefore, this measure to be implemented on a lamp per lamp basis when existing lamps fail.

The following table summarizes the costs associated with this measure.

Table 4-19 ECM-6: Interior Lighting Retrofit & Controls Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	17,400
Engineering (11%)	1,900
Commissioning and Training (7%)	1,200
Contingency (10%)	2,100
TOTAL (to nearest hundredth)	**23,000**

4.4.2 ECM-7: EXTERIOR LED RETROFIT

Existing Condition

Some exterior lamps at the Facility currently use HPS fixtures with lamps rated at 70 W and 75 W each.

Proposed Condition

The HPS fixtures could be retrofitted with 22 W LED fixtures.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The lighting wattages of the exterior building were reduced to simulate the effect of the lower wattage LED lamps.

The following assumptions were made during the analysis of this measure:

- Existing lamp lifetime is 5 years and are replaced at the rate of 20% per year;
- Proposed LED lamp lifetime is 10 years;
- Proposed LED lamps replacing HID lamps will utilize 22 W LED lamps; and
- Minimum effort required to upgrade fixtures around building exterior.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-20 ECM-7: Exterior LED Retrofit Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
3,768	1.4	0.8	0.5	30	682	0.4

The following table summarizes the financial analysis associated with this measure.

Table 4-21 ECM-7: Exterior LED Retrofit Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
600	712	0.8	5,812	114.5	0.9

This measure offers attractive financials and a payback under 1 year due to the efficiency gain using LED technology over conventional light sources.

The following table summarizes the costs associated with this measure.

Table 4-22 ECM-7: Exterior LED Retrofit Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	460
Engineering (11%)	50
Commissioning and Training (7%)	40
Contingency (10%)	50
TOTAL	**600**

5.0 IMPLEMENTATION GUIDELINES

It is recommended that the measures that are the simplest and have the least interruption to the occupants be implemented first. It is important to consider phasing as a means of implementation in order avoid occupant disruption, levels of expenditure, and time to implement. Table 5-1 summarizes the implementation guidelines for each measure, which are high level timeline estimates and can vary considerably.

Table 5-1 ECM Implementation Plan Outline by Measure

ECM/Scenario	Design Period	Construction Period	Seasonal Requirements	Occupant Disruption
Infiltration Reduction	1-2 Weeks	1-2 Weeks	None	None
Window Films	2-3 Weeks	1-2 Months	None	Low
Window Replacement	1-2 Months	2-3 Months	None	Moderate
Temperature Control Set Points	1-2 Weeks	1-2 Weeks	None	None
Heating System Upgrade	3-4 Months	4-6 Months	Ideally Summer	High
Interior LED Retrofit	4-8 weeks	1-2 Months	None	Moderate
Exterior LED Retrofit	1-2 Weeks	1-2 Weeks	None	Low
Scenario 1	4-5 Months	6-8 Months	Ideally Summer	High
Scenario 2	2-3 Months	3-4 Months	None	Moderate

6.0 BUILDING MANAGEMENT AND BEHAVIOURAL OPPORTUNITIES

Perimeter Baseboard Heater Maintenance

Baseboard heaters should be cleaned once a year to keep them working safely and efficiently. Debris such as dirt, dust, garbage and hair can accumulate on the fins. The heater cover should be removed and any visible debris inside the unit should be cleaned using a vacuum, soft brush or even a steam pressure cleaner. If any of the fins are bent or damaged they should be straighten using a pair of needle-nose pliers, metal scrapper or putty knife. Occupants should also ensure units remain free from obstructions such as window treatments, carpet, and other items.

Staff Training and Occupant Awareness

Equipment operation practices and policies can also have a significant impact upon energy consumption. There is generally ample opportunity for energy savings from general equipment left on when not in use. An energy efficiency awareness program should be put in place to encourage staff to frequently check temperature set points if heating is not required, similarly if lights are manually left on when not in use at the end of the day, and for the weekends.

Procurement Policy

Purchasing efficient products reduces energy costs without compromising quality. It is strongly recommended that a procurement policy be implemented as a key element for the overall energy management strategy at the Township. An effective policy would direct procurement decisions to select EnergyStar® qualified equipment in contracts or purchase orders. For products not covered under EnergyStar®, the EnerGuide labeling should be reviewed to select products with upper level performance in their category. Improved energy performance will involve the investment in energy efficient equipment coupled with a user education and awareness program.

7.0 OTHER OPPORTUNITIES CONSIDERED

Ceiling Fan Replacement

Ceiling fans assist with air destratification by reducing the stack, or chimney effect of heat loss and also serve to distribute heated air more evenly throughout a space. Based on observations during the site visit and interviews with staff, the existing fans are noisy and are often not used. It is recommended the Township of Chapleau replace existing noisy ceiling fans with energy star models that have the ability to reverse fan direction; This will provide the additional benefit of a cooling effect during warm weather.

Roof Insulation Upgrade

It was assumed that the existing roof insulation at the Facility is under-insulated and uses an assumed rigid board insulation of approximately R-25. An interior retrofit was modelled that considered adding closed cell type spray foam to the interior roof structure improving the insulation to R-45. The result was a 3.5% reduction in heating costs which is not significant savings to justify the cost of implementation and change in aesthetics of the structural wood decking.

Solar Photovoltaic Panels

There exists strong potential to install solar photovoltaic (PV) panels on the available roof space. A high level study was conducted using the National Renewable Energy Laboratory's (NREL) PVWatts ® software tool to establish a preliminary estimate of the electricity production potential of a roof mounted solar PV system. The roof footprint was assessed, and a roof mount installation was proposed on the south facing pitched roof. The assumption was made that 75% of the proposed roof space could be utilized and was unobstructed (clear of vents and protrusions).

The following table summarizes the estimated energy savings associated with this measure.

Table 7-1 Estimated solar PV generation potential

System Type	Available Panel Space (m^2)	Estimated System Size (kW)	Array Azimuth (deg)	Array Tilt (deg)	Array Output (kWh/yr)
Roof mount	380	56	135	10	61,600

Based on results from the PVWatts simulations, it is estimated, based on PV system physical and design characteristics summarized above, that 71,500 kWh could potentially be generated at the WTP. This would offset 10.4% of the existing site wide electricity load. Hardware (solar panels, inverters, racking systems, balance of system) costs and soft costs (installation labour, deposit upgrade etc.) make up the installation cost of a PV system. To inform capital cost estimates and expected ongoing operation and maintenance costs, wood applied an installed cost per watt of $2.59/W, based on market guidance and past engineering experience, along with 11% engineering fee, 7% commissioning and training and 10% contingency.

The following table summarizes the financial analysis associated with this measure.

Table 7-2 Solar PV System Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
190,000	10,753	17.7	20,904	0.9	21.9

8.0 IMPLEMENTATION SCENARIO

Wood has identified strategic implementation scenarios for the measures recommended in this assessment report.

It should be noted that the estimated savings associated with the implementation scenarios may not match the aggregated sum of the included measures evaluated separately. This is due to interactive effects between measures.

Scenario-1

The following ECMs are included in this scenario:

- ECM-1: Infiltration Reduction;
- ECM-2: Window Films;
- ECM-5: Heating System Upgrade Option 3 – Propane RTUs; and
- ECM-6: Interior LED Retrofit & Controls.

The following table summarizes the estimated energy savings associated with this implementation scenario.

Table 8-1 ECM-Scenario 1: Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
-10,631	-	226,746	84.1	151	92.9	470	34,730	6.2

The following table summarizes the financial analysis associated with this implementation scenario.

Table 8-2 ECM-Scenario 1: Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
139,000	35,200	3.9	177,837	19.5	4.2

The scenario upgrades components and systems in major Facility end users including the building envelope, heating system and lighting system and offers a payback under four (4) years with a positive NPV and IRR. The following table summarizes the costs associated with this implementation scenario.

Table 8-3 ECM-Scenario 1: Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	101,200
Installation	7,100
Engineering (11%)	11,100
Commissioning and Training (7%)	7,100
Contingency (10%)	12,600
TOTAL (to nearest hundredth)	139,000

Scenario-2

The following ECMs are included in this scenario:

- ECM-1: Infiltration Reduction;
- ECM-3: Window Replacement;
- ECM-4: Temperature Setbacks; and
- ECM-7: Exterior LED Retrofit.

The following table summarizes the estimated energy savings associated with this implementation scenario.

Table 8-4 ECM-Scenario 2: Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
-	-	127,847	47.4	59.1	36.3	30	23,151	12.8

The following table summarizes the financial analysis associated with this implementation scenario.

Table 8-5 ECM-Scenario 2: Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
134,000	23,181	5.8	74,652	9.3	6.2

The scenario retains the existing perimeter heating system incorporating temperature set backs at night while providing upgrades to the building envelope and exterior lighting system. This scenario offers a simple payback of 5.8 years with a positive NPV and IRR.

The following table summarizes the costs associated with this implementation scenario.

Table 8-6 ECM-Scenario 2: Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	83,300
Installation	23,400
Engineering (11%)	9,200
Commissioning and Training (7%)	5,800
Contingency (10%)	12,200
TOTAL (to nearest hundredth)	134,000

9.0 CONCLUSIONS AND RECOMMENDATIONS

Several ECMs were identified during the detailed energy assessment. The following table summarizes all the ECMs that were reviewed along with estimated costs, savings, and simple payback.

Table E-1 Summary of ECMs

ECM	Measure	Opinion of Probable Cost	Estimated Savings				Estimated Total Savings	Simple Payback
			Propane	Electricity	Demand	Maintenance		
		($)	(L)	(kWh)	(kW)	($)	($)	(Years)
ECM-1	Reduce Infiltration	24,000	-	24,161 9.0%	10 6.0%	-	4,375	5.5
ECM-2	Window Film	29,000	-	45,607 16.9%	21 12.7%	-	8,259	3.5
ECM-3	Window Upgrades	103,000	-	94,057 34.9%	45 27.4%	-	17,032	6.0
ECM-4	Temperature Set Points	1,200	-	6,311 2.3%	5 3.2%	-	1,143	1.1
ECM-5	Propane Source MUA	62,000	(12,122)	206,680 76.7%	146 89.4%	-	30,209	2.1
ECM-6	Interior Lighting Retrofit & Control	23,000	-	6,892 2.6%	11 6.8%	470	1,718	13.4
ECM-7	Exterior Lighting Retrofit	600	-	3,768 1.4%	1 0.5%	30	712	0.8
Scenario 1		139,000	(10,631)	226,746 84.1%	151 92.9%	470	35,200	3.9
Scenario 2		134,000	-	127,847 47.4%	59 36.3%	30	23,181	5.8

Notes:
It should be noted that the estimated savings associated with each scenario may not match the aggregated sum of the included measures evaluated separately. This is due to interactive effects between measures

Wood recommends that the Township proceeds with the suggested ECMs stated in implementation scenario 2. Upgrades to the building envelope to improve insulation and air tightness should be addressed before installing new HVAC equipment to ensure the right size of equipment is installed for the building heating load. This scenario includes the following ECMs:

Scenario 2, which contains:

- ECM-1: Infiltration Reduction;
- ECM-3: Window Replacement;
- ECM-4: Temperature Setbacks; and
- ECM-7: Exterior LED Retrofit.

By implementing the recommended measures listed above, the Facility has a potential savings of 127,847 kWh, equivalent to a 47.4% reduction that may be anticipated relative to the simulated baseline year.

10.0 STUDY LIMITATIONS

It must be noted that an energy audits prime goal is to identify the energy savings opportunities that likely meet the Township of Chapleau's minimum payback criteria. Energy savings and installation costs are estimates only. Detailed designs are always recommended before proceeding, along with final complete payback analysis.

This report documents work that was performed using methods and procedures that are generally consistent with the ASHRAE level 2 guidelines, subject to the level of investigative effort outlined in this report and generally accepted and prevailing industry standards at the time and location in which the services were provided. No other representations, warranties, or guarantees are made, including no assurance that this work has uncovered all potential issues associated with the identified property that may impact energy consumption or implementation of proposed measures.

This report provides an evaluation of potential for energy conservation opportunities at the Civic Centre located at 20 Pine St in Chapleau Ontario, that was assessed at the time the work was conducted and is based on information obtained by and/or provided to Wood at that time. There are no assurances regarding the accuracy and completeness of this information. All information received from the client or third parties in the preparation of this report has been assumed by Wood to be correct. Wood assumes no responsibility for any deficiency or inaccuracy in information received from others.

Activities at the property or additional information subsequent to Wood's assessment may have significantly altered the potential and feasibility of the opportunities or conclusions identified within the report.

Conclusions made within this report consist of Wood's professional opinion as of the time of the writing of this report and are based solely on the scope of work described in the report, the limited data available, and the results of the work. The savings calculations are our estimate of saving potentials and are not a guarantee. The impact of building changes in space functionality, operations, usage, equipment retrofit, and weather need to be considered when evaluating the savings.

This report has been prepared for the exclusive use of the client identified herein and any use by any third party is prohibited. Wood assumes no responsibility for losses, damages, liabilities or claims, howsoever arising, from third party use of this report.

11.0 CLOSURE

Wood conducted an Energy Audit at the Civic Centre located at 20 Pine St in Chapleau Ontario. Electricity conservation and efficiency measures were investigated, provided, and assessed in terms of energy savings, fuel switch opportunities and utility cost savings along with capital project costs and financial analysis. Through our analysis we have identified seven (7) ECMS including one (1) fuel switch opportunity.

Wood has presented two (2) strategic implementation scenarios for the measures recommended in this assessment report. Scenario 1 is estimated to reduce site electricity by 84% which is widely due to swapping the electric perimeter heat in favour of a propane base make up air unit, capable of brining in outdoor air and tempering it to programmed temperature control set points defined for each major zone in the facility. The overall annual cost savings for scenario 1 relative to the baseline year is $35,200. Scenario 2 is estimated to reduce site electricity by 47.4% which is widely due to upgrades to the building envelope and reducing the amount of infiltration and heat gain which is currently occurring. The overall annual cost savings for scenario 2 relative to the baseline year is $23,181.

Wood recommends proceeding with scenario 2 and maintaining the existing perimeter heating system while it still has useful life. Additional recommendations include the following building management and behavioral opportunities:

- Perimeter Baseboard Heater Maintenance
- Staff Training and Occupant Awareness; and
- Procurement Policy.

Wood Environment & Infrastructure Solutions

a Division of Wood Canada Limited,

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Signature: Nathan Sokolowski	**Signature:** Ayman Nicola

Appendix A

Appendix A Assessment Methodology

Site Visits

The visit included a detailed interview with technical staff regarding the buildings' function as well as discussing any issues that were persistent and opportunities for operational optimization. A comprehensive tour of the site was also conducted to evaluate the HVAC, lighting, and controls systems.

Utility Analysis

An analysis of the Civic Centre's consumption provides a good starting point from which to:

- Identify potential energy conservation measures (ECMs); and,
- Develop a baseline against which ECM performance can be quantified.

The consumption (and demand) registered on historical data for the utility meter can also be examined to identify issues that are affecting the energy performance of the site.

Utility data for electricity was provided by the Township of Chapleau dating back to 2018 for the Chapleau Hydro utility meter.

Utility Rates

In terms of savings related to the identified measures, a blended rate is used which effectively assumes that reduction in consumption will only reduce the cost by the rate that applies to the last unit of energy used. The blended rates naturally include all fees, taxes, and bulk charges which may be included in each utility provider's billings. These rates are listed the table below.

Table A-1 Utility Rates (January 2019 – December 2019)

Item	Value	Units
Electricity Rate	0.18	$/kWh

Envelope System Assessment

The envelope and architectural assessment involves a non-intrusive visual inspection of the facility and a review of any available drawings to determine the condition and type of construction. Special attention will be paid to doors and windows during this review.

Mechanical System Assessment

The mechanical portion of the assessment involves taking a comprehensive inventory of mechanical components and an accurate appraisal of operational times and efficiencies for each mechanism. This is inclusive of all HVAC, Domestic Hot Water, and process related equipment. The Building Automation System (BAS) and/or manual equipment controls will be inventoried and assessed for integration. Sequence of operations will be examined for improvement opportunities.

Electrical System Assessment

A comprehensive assessment of the site's lighting includes a detailed review the existing fixtures and controls throughout the site. Consideration is also given to operational hours and the diligence of occupants at switching OFF manually operated lighting. A comprehensive assessment of the site's other electrical equipment including motors, transformers and process equipment.

Energy Conservation Measure Identification and Analysis

Each measure proposed for implementation on this project has been selected based on its viability, as measured against the following criteria:

- costs and savings within overall criteria for evaluation guidelines;
- appropriateness for tasks performed in the space;
- condition of existing systems;
- consistency of application (all areas of similar function are consistent);
- equipment approval by facilities personnel; and,
- impact on occupant behaviour and general acceptance of changes.

The energy savings calculations are based on a best estimate of the anticipated reductions taking into consideration direct savings from electrical consumption and electrical demand where appropriate. Savings associated with heating and cooling measures are calculated relating to heating and cooling degree-days for the site which are taken from the most appropriate local weather data source, which assumes an average balance point[1] temperature of 18°C (64.4 °F).

Costs associated with implementing the respective measures are estimated based on the approximate 'capital cost' for the materials and labor (including demolition and installation). Costs are determined from previous project experience and/or through published cost estimate data (RS Means…). All costs represent Wood's opinion on probable cost and are provided as approximate estimates to give economies of scale. Further investigation and detailed costing should be carried out prior to implementation.

For any systems or equipment that are on site and not functioning (not consuming energy) no energy conservation measures have been considered. The scope of this exercise is to find opportunities to reduce energy consumption and where there is no possibility to do so, no measures have been discussed in the report.

Recommendations

From the options considered, recommendations are put forward based on financial and practical feasibility using indicators such as simple payback, capital cost and net present value (NPV).

[1] The balance point temperature is the external temperature at which the building's heating equipment is initiated.

Appendix B

Appendix B Asset Details

This table below presents the equipment inventory for the facility at the time of the site visit.

Description	Floor	Location	Room	Manufacturer	Model	Quantity	Phase	Voltage	Amps	HP	Demand (kW)
Base Board Heater	Lower	Court	101	Chromalux	WCH-630T-12S	9	1	208			3
Cabinet Heater	Lower	Lobby	102	N/A	N/A	1	1	208			2.5
Base Board Heater	Lower	Lobby	102	Chromalux	WCH-630T-12S	3	1	208			3
Cabinet Heater	Lower	Vestibule	112	N/A	N/A	1	1	208			2.5
Base Board Heater	Lower	Lawyers	112/113	N/A	N/A	4	1	208			3
Cabinet Heater	Upper	Foyer Gallery	202	N/A	N/A	1	1	208			2.5
Cabinet Heater	Upper	Gallery	203	N/A	N/A	1	1	208			2.5
Base Board Heater	Upper	Meeting Room	204	Chromalux	WCH-630T-12S	2	1	208			3
Base Board Heater	Upper	Offices	206, 212, 213, 214	N/A	N/A	7	1	208			3
Cabinet Heater	Upper	Office	207	N/A	N/A	1	1	208			2.5
Cabinet Heater	Upper	General Office	211	N/A	N/A	6	1	208			2.5
Cabinet Heater	Upper	Library	215	N/A	N/A	5	1	208			2.5
Base Board Heater	Upper	Library	215	N/A	N/A	5	1	208			3
Base Board Heater	Upper	Work Room	216	N/A	N/A	2	1	208			3
Cabinet Heater	Lower	FH - Office	218	N/A	N/A	1	1	208			2.5
Base Board Heater	Lower	FH - Lockers	220	N/A	N/A	1	1	208			3
Base Board Heater	Lower	FH - Workshop	221	N/A	N/A	1	1	208			3
Unit Heater	Lower	FH	217	N/A	N/A	4	1	208			25
Ceiling Fans	Upper	General Office	211	Can Arm	N/A	3	1	120	0.6		0.072
Ceiling Fans	Upper	Library	215	Can Arm	N/A	3	1	120	0.6		0.072
Window A/C	Upper	Offices	206, 212, 213, 214	KoolKing	KWH101CEIA	4	1	115	8.03		0.92345

Description	Floor	Location	Room	Manufacturer	Model	Quantity	Phase	Voltage	Amps	HP	Demand (kW)
Exhaust	Lower	Storage	105	N/A	N/A	1	1	120		0.08	0.06
Exhaust	Lower	Lower Washrooms	107/108	N/A	N/A	1	1	120	0.2		0.024
Exhaust	Upper	Library Washroom	216	N/A	N/A	1	1	120	0.2		0.024
F-8 Exhaust	Upper	General Office Washroom	210	N/A	N/A	1	1	120	0.2		0.024
F-9 Exhaust	Upper	Canteen	208	N/A	N/A	1	1	120	0.3		0.036
F-10 Exhaust	Upper	Foyer Washroom	202	N/A	N/A	1	1	120	0.2		0.024
F-3 Exhaust	Lower	FH	217	Penn	N/A	1	1	120		0.17	0.12
F-4 Exhaust	Lower	FH	217	Penn	N/A	1	1	120		0.25	0.19
F-6 Exhaust	Lower	FH	217	Penn	N/A	1	1	120		0.33	0.25
F-7 Exhaust	Lower	FH - Tower	222	Trane	N/A	1	1	120		0.08	0.06
Hot Water Heater	Lower	Storage	105	GSW	6G80SDEB1	1	1	240			4.5
HW Circulation Pump	Lower	Storage	105	Grundfos	UPS26-99SFC	1	1	115			0.2
Washing Machine	Lower	FH	219	Ready Rack	GCWF1069GS1	1	1	120			
Air Compressor	Lower	FH	220	Ingersoll-Rand	T102C20P-3	1	1	120	15		1.8
Air Compressor	Lower	FH	220	Bauer	C-E3	1	1	120		5	3.73
Server	Lower	Storage	115	Lawyers Office	N/A	1					0.7
Server	Upper	Civic Centre Mech Rm	105	Civic Centre	N/A	1					0.7
Server	Lower	FH Mech Rm	226	Firehall	N/A	1					0.7

Appendix C

Chapleau

Appendix C Lighting Inventory

The table below presents the existing lighting at the facility at the time of the site visit.

Space	Fixture #	Fixture Housing	Fluorescent Lamp Type	Lamps	Lamp Length (ft)	Lamp Watts	Ballast	Fixture Watts	Total Watts
Lower Floor	25	Rec, 2x2 troffer	T12, Standard wattage	2	U	40	Mag-ES	85	2125
Lower Floor	7	Rec, 2x2 troffer	T12, Standard wattage	2	U	40	Mag-ES	85	595
Lower Floor	4	Rec, 2x4 trofer	T12, Energy efficient	2	4	34	Mag-ES	72	288
Lower Floor	6	Susp, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	432
Lower Floor	4	Surf, 1x4	T12, Energy efficient	1	4	34	Mag-ES	43	172
Lower Floor	1	Susp, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	72
General Office	24	Rec, 2x2 troffer	T12, Standard wattage	2	U	40	Mag-ES	85	2040
General Office	4	Susp, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	288
General Office	1	Surf, 1x4	T12, Energy efficient	1	4	34	Mag-ES	43	43
Library	4	Rec, 1x4 troffer	T12, Energy efficient	2	4	34	Mag-ES	72	288
Library	41	Susp, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	2952
Library	9	Rec, 2x2 troffer	T12, Standard wattage	2	U	40	Mag-ES	85	765
Library	1	Surf, 1x4	T12, Energy efficient	1	4	34	Mag-ES	43	43
Firehall	21	Susp, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	1512
Firehall	5	Surf, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	360
Firehall	2	Rec, 1x4 troffer	T12, Energy efficient	2	4	34	Mag-ES	72	144
Firehall	5	Surf, 1x4	T12, Energy efficient	1	4	34	Mag-ES	43	215
Firehall Tower	4	Surf, 1x4	T12, Energy efficient	1	4	34	Mag-ES	43	172

The table below presents the existing non-fluorescent lighting at the facility at the time of the site visit.

Space	Fixture #	Fixture Housing	Fixture Type	Lamps #	Lamp Watts	Fixture Watts	Total Watts
Lower Floor	16	Rec, down	LED	1	18.5	18.5	296
Lower Floor	8	Rec, track	Halogen Incandescent	1	100	100	800
Lower Floor	1	Surf, circular	Incandescent	1	100	100	100
General Office 1	5	Rec, down	LED	1	18.5	18.5	92.5
General Office 1	5	Rec, down	LED	1	18.5	18.5	92.5
General Office 2	18	Surf, 1x4	LED	2	24	48	864
General Office 2	3	Rec, 2x2 troffer	LED	2	18	36	108

Firehall 2	3	Surf, circular	Incandescent	1	100	100	300
Exterior	3	Surf, sconce	Halogen Incandescent	1	75	75	225
Exterior	2	Surf, sconce	High Pressure Sodium	1	70	95	190
Exterior	13	Rec, down	LED	1	18.5	18.5	240.5
Exterior	2	Surf, sconce	LED	1	18.5	18.5	37
Exterior	1	Surf, sconce	LED	1	18.5	30	30
Exterior	3	Grnd-Mnt, Pole	High Pressure Sodium	1	70	95	285

Appendix D

Appendix D Modelling Methodology

The building simulation program Carrier HAP version 5.11 was used to simulate how each recommendation would perform under the existing buildings characteristics. The program uses typical weather data along with input from the user of the building's HVAC equipment, building occupancy schedule, envelope materials, plug loads, and process loads to simulate design alternatives.

The Facility's internal gains were entered in the baseline model using occupancy counts and estimating electrical appliances such as computers, copiers, and printers amongst others; the ASHRAE Fundamentals 2013 Handbook was used as a guide for estimating the loads from this equipment.

To determine the Facility's lighting load consumption, lighting counts were taken on site and verified against the electrical reflected ceiling drawings, the lighting inventory was then used to determine the interior, exterior, and perimeter lighting loads. Where lighting information could not be obtained ASHRAE Fundamentals 2013 Handbook was used as a guide.

The Facility's HVAC components were generated in the model using a combination of manufacturer specifications, mechanical drawings, schedules, and equipment asset details for the HVAC systems. A combination of manufacturer specifications and nameplates were used for units within the Facility. In addition, the building operator's description of the Facility's HVAC sequences of operations and BAS information and setpoints were also accounted for in the model.

To ensure that the baseline model was operating similarly to the existing building, the Facility's baseline consumption based on the utility billing data was compared to the building simulation's energy consumption outputs. This comparison was done both analytically by comparison to total consumption and visually by comparing monthly trends to expected consumption.

Appendix E

Appendix E Utility Data Summary

The table below presents the collected utility data for the site.

Month-Year	Days in Billing Period	Electricity Consumption (kWh)	Electricity Cost ($)
Jan-2018	31	44,880	-
Feb-2018	28	36,960	-
Mar-2018	31	40,080	-
Apr-2018	30	23,280	-
May-2018	31	9,120	-
Jun-2018	30	5,520	-
Jul-2018	31	5,520	-
Aug-2018	31	5,280	-
Sep-2018	30	7,920	-
Oct-2018	31	25,680	-
Nov-2018	30	33,120	-
Dec-2018	31	39,120	-
Jan-2019	31	55,440	$7,359.59
Feb-2019	28	41,760	$5,861.10
Mar-2019	31	35,520	$4,582.08
Apr-2019	30	23,280	$3,138.30
May-2019	31	13,440	$2,913.57
Jun-2019	30	6,480	$2,289.67
Jul-2019	31	4,320	$1,244.80
Aug-2019	31	4,560	$2,997.92
Sep-2019	30	6,720	$1,693.15
Oct-2019	31	18,000	$4,331.01
Nov-2019	30	36,720	$7,651.96
Dec-2019	31	39,120	$7,610.60

Month-Year	Days in Billing Period	Electricity Demand (kW)
Jan-2019	31	220.8
Feb-2019	28	201.6
Mar-2019	31	201.6
Apr-2019	30	187.2
May-2019	31	158.4
Jun-2019	30	148.8
Jul-2019	31	43.2
Aug-2019	31	273.6
Sep-2019	30	67.2
Oct-2019	31	96
Nov-2019	30	172.8
Dec-2019	31	201.6