Waste Water Treatment Lagoon

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 of Wood Canada Limited
900 Maple Grove Rd, Unit 10, Cambridge ON, N3H 4R7

7 October 2020

Executive Summary

Waste Water Treatment Lagoon Energy Audit

Wood PLC (Wood) was retained by the Township of Chapleau to conduct an energy audit on the Waste Water Treatment Lagoon Civic Centre located at 300 Strathcona Rd, 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 29th, 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
			Electricity	Demand	Maintenance		
		($)	(kWh)	(kW)	($)	($)	(Years)
ECM-1	Infiltration Reduction	300	1,089 0.7%	- 1.3%	-	148	2.0
ECM-2	Blower Room Roof Insulation	1,800	- -	- 0.0%	300	300	6.0
ECM-3	Blower VFD	19,000	26,454 17.9%	3 9.8%	-	3,606	5.3
ECM-4	Temperature Control Setpoints	2,600	3,449 2.3%	2 7.0%	-	470	5.5
ECM-5	HRV	2,600	3,354 2.3%	- -	-	457	5.7
ECM-6	Interior Lighting Retrofit & Control	1,700	405 0.3%	1 4.1%	40	95	17.9
ECM-7	Exterior Lighting Retrofit	500	1,888 1.3%	- -	5	262	1.9
Scenario 1		23,000	32,217 21.8%	- -	40	4,431	5.2

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 recommends that the Township proceeds with the implementation scenario.

This scenario consists of the following conservation measures:

Implementation Scenario 1, which contains:

- ECM-1: Reduce Infiltration;
- ECM-3: Blower Variable Frequency Drive
- ECM-4: Temperature Set Points; and
- ECM-7: Exterior LED Retrofit..

By implementing the recommended measures listed above, the Facility has a potential savings of 32,217 kWh, equivalent to a 21.8% 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;
- Unit heater maintenance;
- Staff Training and Occupant Awareness; and
- Procurement Policy.

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
CDD	Cooling Degree Day
CO_2e	Carbon Dioxide Equivalent
ECM	Energy Conservation Measure
EUI	Energy Utilization Index
ft	Feet
ft^2	Square feet
g	Gram
GJ	Gigajoule
HDD	Heating Degree Day
HID	High Intensity Discharge
HP	Horse Power
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
V	Voltage
W	Watt
Wood	Wood Environment & Infrastructure Solutions, Inc
WWTL	Wastewater Treatment Lagoon
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 Waste Water Treatment Lagoon (WWTL) located at 300 Strathcona Rd, Chapleau, Ontario.

The assessment involved a review of approximately 92 m^2 (992 ft^2) of floor area comprised of laboratoy space, chemical storage and a blower room. This revealed the potential for the implementation of energy management measures which may improve the overall efficiency of the facility.

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.

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

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;
- 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	300 Strathcona Rd, Chapleau, Ontario
Contact Person	Ms. Charley Goheen
Contact information	cgoheen@chapleau.ca
Utility Provider	Chapleau Hydro
Account Number	055059011

1.3.2 Acknowledgements

Wood would like to acknowledge the contribution of the Township of Chapleau and Facility staff who 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

Sewage and wastewater from over 13 km of sewer mains and manholes is routed to the WWTL consisting of a grit removal chamber and two lagoons receiving fine bubble aeration where it is treated before being discharged into the Nebskwashi River. Currently, sewage effluent is disinfected with chlorine on a seasonal basis between May 1st and October 31st. The blowers, treatment chemicals, and equipment are housed next to the lagoon in concrete cinder block structure which is occupied by one (1) staff member for one (1) hour each day of the week or more if needed.

Table 2-1 summarizes an overview of the building information.

Table 2-1 General Building Information

Building Type	**Testing laboratory, chemical/equipment storage**
General Occupants	1
Gross Floor Area	92 m^2
Floors	1
Year Built	1985
Occupancy schedule	Shift work, typically 1 hour per day

2.2 BUILDING ENVELOPE

The building construction is a concrete cinder block structure on a concrete slab with exterior brick façade containing three (3) rooms; One designated as a laboratory, one for chemical storage and one for the blower equipment and backup generator. The lab and chemical storage have 9 feet plaster ceilings with attic space above. The blower room is lined with wood wool insulation panels and does not have an attic space. The roof is pitched with asphalt shingles. There are no windows.

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 Waste Water Treatment Lagoon Site Photos

Facility – North-West Façade

Aeration Lagoon

Blower Room

Chlorine Room

2.3 MECHANICAL SYSTEMS

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

2.3.1 Process Equipment

Sewage and wastewater in the lagoons receive fine bubble aeration provided by two (2) 20 HP tri-lobe positive displacement blowers manufactured by Blower Engineering Incorporated. The blowers are constant speed and operate one at a time, typically for 6 months continuous before switching over. Other process equipment includes a 10 HP recirculation pump, a 5 HP effluent wash pump, a ½ HP chlorine feed pump, and two (2) ¼ HP alum pumps.

2.3.2 Heating, Ventilation and Air Conditioning

The building is 100% electric heat in the form of wall mounted unit heaters (UHs) and cabinet heaters. Each unit is controlled with dedicated thermostats that are manually set. Typical setpoints are 18°C.

The blower room contains a ½ HP ventilation fan which runs constantly from October to April to exhaust heat generated from the blowers. A ¼ HP ventilation fan in the chlorine room operates to exhaust fumes as necessary. The office contains a 1/6 HP exhaust fan that runs when infrequently to provide ventilation to the space. Each exhaust fan is interlocked with motorized dampers and controlled with on/off wall switches.

2.3.3 Domestic Hot Water

There is no domestic hot water at the facility.

2.4 ELECTRICAL SYSTEMS

The following electrical system and components were identified during the site visit.

2.4.1 Lighting Systems

The lab is equipped with high output T5 fixtures and the remaining interior lighting systems are T8 fluorescent fixtures. These lights are controlled with on/off wall switches Exterior lighting consists of high intensity (HID) wall packs on integrated photocell control. No adequate road lighting is present. The facility used to have mercury vapor lamps for roadway lighting, but they have been damaged and do not operate.

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

2.4.2 Plug Loads

Plug loads are common items essential to facility operation. These include desktops, printers and common office equipment. It also includes equipment for water testing such as refrigerators, scales and dosing equipment.

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.

The utility electricity consumption data is summarized for the years 2018 to 2019 in Table 3-1 below.

Table 3-1 Summary of Utility Data for January 2018 to December 2019

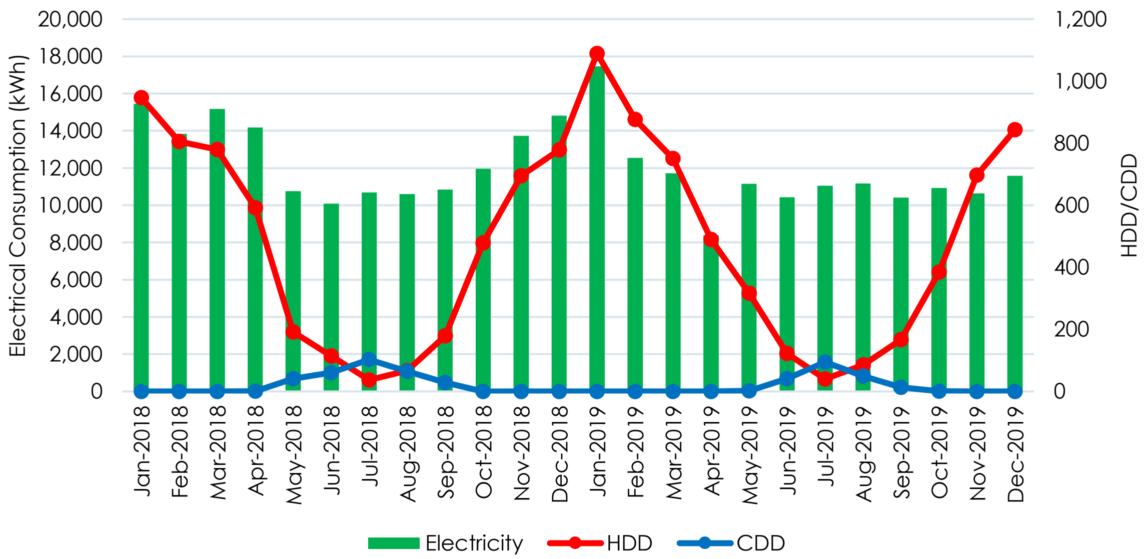
Year	Electricity	
	Consumption (kWh)	Cost ($)
Jan-2018 to Dec-2018	152,145	20,738
Jan-2019 to Dec-2019	137,492	18,741

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 \$0.136/kWh which accounts for transmission, use, regulatory fees, global adjustment and HST. The figure below illustrates the electrical consumption for the facility.

Figure 3-1 Monthly Electricity Consumption



The figure shows electricity peaks in the winter months which is indicative of the electric heat utilized by the building. Note the consumption in October 2019 through December 2019 appears to remain flat and it is suspected that the electric heat was not being utilized at this time. From the figure, it appears there is a monthly baseload of 10,000 kWh which is comprised mostly of the blower system. Lighting and plug load account for little energy use since this building is rarely occupied.

To establish a baseline year, a linear regression analysis (R-squared analysis) was completed on the electricity data The R-square 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 R-squared value of 1 represents a perfect correlation, while a lower value indicates a lesser degree of influence between the variables. In general, an R-squared 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.

The calculated R-squared value of **0.54** for HDD and **0.18** for CDD shows the facilities electricity consumption is process driven and not influenced by outdoor air temperature.

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 utility data was averaged for each month that was provided and was used to compared against the simulated baseline year. 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

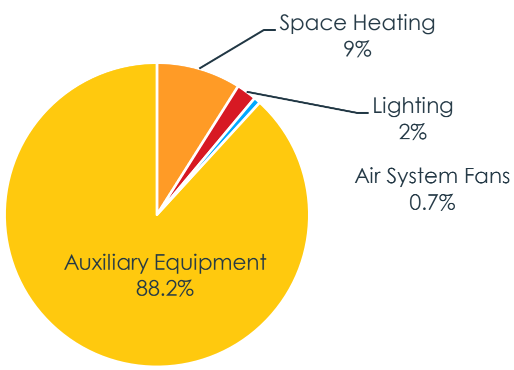
Year	Electricity	
	Consumption (kWh)	Cost ($)
Baseline	147,738	20,137

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 wall mounted and cabinet UHs;
- **Lighting** – All interior and exterior lighting.
- **Air System Fans** – All exhaust fans serving the facility;
- **Auxiliary Equipment** – This includes energy consumed by process equipment, mainly blower motors and small plug loads.

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



3.4 BUILDING ENERGY UTILIZATION INDEX

The facility Energy Utilization Index (EUI) was calculated by dividing the total annual energy used by the average daily amount of treated water discharged[1]. The table below compares the EUI at the Facility to the Energy Star Portfolio Manager benchmarks for **Wastewater Treatment Plant** to assess the Facility's energy performance against similar buildings.

Table 3-3 EUI Benchmarking

Calculated in Utility Analysis	Energy Star Portfolio Manager Benchmark
$GJ/m^3/day$	$GJ/m^3/day$
0.19	1.51

Based on the analysis, the EUI for the estimated baseline year for the facility is approximately 87% less than the Energy Star Benchmark. It should be noted that the OEE benchmark is created from all Wastewater Treatment Plant buildings regardless of size, location, operational schedule, HVAC system, and building envelope design; as a result, it should be viewed as a *guide* instead of a direct comparison with identical buildings within the same geographic area.

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;
- Total energy cost;
- Maintenance cost; and,
- GHG emissions.

The first two (2) 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 Electricity Emission Factors

Energy Source	CO2e Emission Factor
Electricity	0.0000393 tonnes/kWh

[1] Data from the 2019 Annual Performance Report for the Chapleau Sewage Treatment Plant

The following ECMs were reviewed:

- ECM-1: Reduce Infiltration;
- ECM-2: Blower Room Roof Insulation;
- ECM-3: Temperature Set Points;
- ECM-4: Heat Recovery Ventilation;
- ECM-5: Blower Variable Frequency Drive;
- 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 additional heating loads due to air leakage and excessive infiltration through door openings, cracks, and exhaust/plumbing penetrations which can increase heating energy. The average infiltration rate for the Facility was assumed to be 0.5 ACH.

Proposed Condition

The installation or replacement of worn or broken weather stripping and foam sealants can contribute towards reducing air infiltration around doors, 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%; and
- 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)
1,089	0.7	0.4	1.3	0	148	0.1

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)
300	148	2.0	662	43.2	2.1

This measure offers attractive financials and provides a simple payback of two (2) years.

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 (x3)	170
Installation	40
Engineering (11%)	30
Commissioning and Training (7%)	20
Contingency (10%)	40
TOTAL	**300**

4.1.2 ECM-2: BLOWER ROOM ROOF (R-30) RETROFIT

Existing Condition

During the winter period, heat loss through the ceiling of the blower room causes snow on the roof to melt. This creates snowmelt which leads to ice forming on the entrance walkway and stairs. This becomes a safety hazard which must be addressed by staff before they can enter the building, may delay work.

Proposed Condition

Insulate the blower room roof to R-30 using spray foam.

Analysis

This measure is a simple hand calculation. The following assumption were made during the analysis of this measure:

- Staff spend 10 hours per year removing ice build-up at this facility; and
- The typical hourly wage is $30/hr.

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

Table 4-5 ECM-2: Roof R-30 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)
-	-	-	-	300	-	-

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

Table 4-6 ECM-2: Roof R-30 Retrofit Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
1,800	300	6.0	900	8.4	6.4

This measure provides maintenance savings and can eliminate a safety hazard for staff.

The following table summarizes the costs associated with this measure.

Table 4-7 ECM-2: Roof Insulation (R-30) Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	900
Installation (70%)	600
Engineering (11%)	100
Contingency (10%)	200
TOTAL (to nearest hundredth)	**1,800**

4.2 HVAC

4.2.1 ECM-3: TEMPERATURE CONTROL SET POINTS

Existing Condition

The existing wall mounted and cabinet UHs which serve the lab and chemical rooms are programmed to operate based on the space temperature and set point of the spaces are controlled by local thermostats. These spaces are typically occupied less than 5% of the time and are not visited frequently. This can contribute towards wasting energy by conditioning to higher heating set points during unrequired times. It should be noted that the thermostats are not locked-out and anyone can adjust the temperature set point to whatever they see fit and inadvertently forget to return the temperature back to its proper setpoint.

Proposed Condition

The existing manual thermostats can be upgraded to programmable thermostats to allow adjusting of temperature that best suit the space and its scheduling needs, as well as maintain a constant temperature in the given space. These thermostats provide the opportunity to lower the space setpoint during unoccupied hours and can have override features with timers programmed so staff can call for additional if they will be working in the space.

In terms of implementation, there are no additional space requirements for the programmable thermostats, as they should be able to directly replace the existing manual thermostats in the same space. The programmable thermostats are typically reliable with proper maintenance, and there are several vendors that carry them as part of their product line.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The heating set points were reduced from an average of 18°C (64.4 °F) to an average of 15 °C (59 °F).

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;
- The existing UHs can support programmable thermostats and will operate accordingly; and
- 3 sensors would be required for proper coverage within the spaces listed.

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

Table 4-8 ECM-3: Temperature Control Set Points Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
3,449	2.3	2.2	7.0	-	470	0.3

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

Table 4-9 ECM-3: Temperature Control Set Points Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
2,600	470	5.5	1,631	10.4	5.9

This measure has a moderate payback of 5.5 years and will result in reduced run times of the wall mounted and cabinet UHs. The following table summarizes the costs associated with this measure.

Table 4-10 ECM-3: Temperature Control Set Points Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	2,000
Engineering (11%)	230
Commissioning and Training (7%)	140
Contingency (10%)	230
TOTAL (to nearest hundredth)	**2,600**

4.2.2 ECM-4: HEAT RECOVERY VENTILATOR

Existing Condition

The blower room contains a ½ HP ventilation fan which runs constantly from October to April to exhaust heat generated from the blowers.

Proposed Condition

A heat recovery ventilator (HRV) can extract heat from the blower room exhaust stream and use it to warm air from the lab and chlorine room. This will reduce the need for electric heat in the lab and chlorine room.

Analysis

This measure was calculated using a custom spreadsheet. The following assumption were made during the analysis of this measure:

- Air from the lab and/or chlorine room can be vented through a HRV and dumped back into the same space(s).

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

Table 4-11 ECM-4: Heat Recovery Ventilator Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
3,354	2.3	-	-	-	457	0.3

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

Table 4-12 ECM-4: Heat Recovery Ventilator Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
2,600	457	5.7	3,292	13.4	6.1

The measure offers savings with a moderate payback of 5.7 years. A positive NPV and IRR suggest that the township can further look at investigating the opportunity of a HRV to reduce the load on the existing electric heating system.

The following table summarizes the costs associated with this measure.

Table 4-13 ECM-4: Spectator Heating Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	2,000
Engineering (11%)	220
Commissioning and Training (7%)	140
Contingency (10%)	240
TOTAL (to the nearest hundred)	**2,600**

4.3 PROCESS EQUIPMENT UPGRADES

4.3.1 ECM-5: BLOWER VARIABLE FREQUENCY DRIVE

Existing Condition

The two blower motors are constant speed and operate on a duty standby cycle with one unit running for 6 months then rotated off while the other comes on.

Proposed Condition

Routine testing occurs at the facility to comply with the Ontario Clean Water Agency (OCWA) compliance regulations including the monitoring of the 5 day Biological Oxygen Demand (BOD_5) for influent and effluent streams on a weekly and monthly basis. In 2019 the average BOD_5 of 14.8 mg/L was well below the effluent limit of 30 mg/L suggesting the amount of aeration could be reduced.

The blower motors can be equipped with VFD to ramp down rate of aeration during periods of high dissolved oxygen concentrations in the lagoon or periods of low BOD_5 in the influent stream.

Analysis

This measure was calculated using an online VFD calculator. The following assumption were made during the analysis of this measure:

- The existing blower motors are capable of VFD
- Blowers operation could be reduced from 100% year round to the following,

% Speed	% Hours
100	30
75	40
60	20
50	10

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

Table 4-14 ECM-5: Blower VFD Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
26,454	17.9	3.1	9.8	-	3,606	2.6

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

Table 4-15 ECM-5: Blower VFD Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
19,000	3,606	5.3	62,193	16.6	5.6

The measure offers savings with a moderate payback of 5.3 years. A positive NPV and IRR suggest that the township can further look at investigating in the opportunity to provide additional process flow flexibility.

The following table summarizes the costs associated with this measure.

Table 4-16 ECM-5: Blower VFD Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	14,900
Engineering (11%)	1,600
Commissioning and Training (7%)	1,000
Contingency (10%)	1,700
TOTAL (to the nearest hundred)	**19,000**

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 T8 fixtures with lamps rated at 32 W each and T5 fixtures with lamps rated at 54 W each.

Proposed Condition

The T8 lamps could be replaced with 16 W LED lamps and T5 lamps could be replaced with 15 W LED lamps. 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.

The Facility can utilize occupancy sensors with override capability 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. Each room in the building should be equipped with an occupancy sensor.

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 each room 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 T8 and T5 lamps will utilize 16 W and 15 W LED lamps;
- Minimum effort required to upgrade fixture with low ceiling heights;
- Occupancy sensors will reduce the lighting operating hours by approximately 50%; and,
- 3 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 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)
405	0.3	1.3	4.1	40	55	-

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

Table 4-18 ECM-6: Interior LED Retrofit Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
1,700	95	17.9	(843)	<0	N/A

The measure offers savings with a poor payback. A negative NPV and IRR suggest the township can implement this measure 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 LED Retrofit & Controls Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	1,000
Engineering (11%)	280
Commissioning and Training (7%)	200
Contingency (10%)	250
TOTAL (to nearest hundredth)	**1,700**

4.4.2 ECM-7: EXTERIOR LED RETROFIT

Existing Condition

The exterior lamps at the Facility currently use HID fixtures with lamps rated at 70 W. Mercury Vapor fixtures with lamps rated at 175 W each used to operate until they were damage and yet to be replaced. For purpose of this measure the simulation will consider the mercury vapour lamps operate.

Proposed Condition

The HID lamps could be retrofitted with 22 W LED lamps and the mercury vapor lamps could be replaced with 50 W LED lamps.

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 and mercury vapour lamps will utilize 22 W and 50 W LED lamps; and
- Minimum effort required to upgrade fixtures around building exterior and along driveway entrance.

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

Table 4-20 ECM-7: Exterior Lighting 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)
1,888	1.3	-	-	<10	257	0.2

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

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

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
500	262	1.9	1,861	48.7	2.0

This measure offers attractive financials and a payback of two (2) years due to the efficiency gain using LED technology over conventional light sources such as HID or mercury vapour lamps.

The following table summarizes the costs associated with this measure.

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

Item	Cost ($)
Project Cost	370
Engineering (11%)	50
Commissioning and Training (7%)	35
Contingency (10%)	45
TOTAL (to nearest hundredth)	**500**

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. The following table 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
Roof Insulation (R-30) Retrofit	2-4 Weeks	1-2 Months	Ideally Summer	Moderate
Temperature Control Set Points	1-2 Weeks	None	None	None
Heat Recovery Ventilator	2-4 Weeks	3-4 Weeks	Ideally Summer	High
Blower VFD Retrofit	2-4 Weeks	3-4 Weeks	None	High
Interior LED Retrofit	4-8 weeks	1-2 Months	None	Moderate
Exterior LED Retrofit	1-2 Weeks	1-2 Weeks	None	Moderate
Scenario 1	1-2 Months	2-3 Months	None	High

6.0 BUILDING MANAGEMENT AND BEHAVIOURAL OPPORTUNITIES

Re-commissioning

Re-commissioning is the process of returning the building systems to their design specifications after the Facility has been in operation for a period of time, typically about five years, as well as updating operations to match the current needs of the Facility.

It is recommended the building undergo re-commissioning again in the near future.

Unit Heater Maintenance

Electric 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. The motor shaft should turn freely with bearing lubricated to ensure adequate operation and motors using belt drives should have the belt tension checked. Electrical connections should be tightened to ensure they are secure and have not vibrated loose from operation during the heating season.

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 IMPLEMENTATION SCENARIO

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

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

Scenario 1, which contains:

- ECM-1: Reduce Infiltration;
- ECM-3: Temperature Set Points;
- ECM-5: Blower Variable Frequency Drive; and
- ECM-7: Exterior LED Retrofit.

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

Table 7-1 ECM-Scenario 1: Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
32,217	21.8	.	0.0	40	4,391	3.2

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

Table 7-2 ECM-Scenario 1: Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
23,000	4,431	5.2	16,886	11.9	5.5

The scenario upgrades components and control systems in major Facility end users including the building envelope, heating system, process equipment and lighting system and offers a payback under 5.2 years with a positive NPV and IRR.

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

Table 7-3 ECM-Scenario 1: Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	17,700
Engineering (11%)	2,100
Commissioning and Training (7%)	1,200
Contingency (10%)	2,000
TOTAL (to nearest hundredth)	**23,000**

8.0 CONCLUSIONS AND RECOMMENDATIONS

Seven 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
			Electricity	Demand	Maintenance		
		($)	(kWh)	(kW)	($)	($)	(Years)
ECM-1	Infiltration Reduction	300	1,089 0.7%	- 1.3%	-	148	2.0
ECM-2	Blower Room Roof Insulation	1,800	- -	- 0.0%	300	300	6.0
ECM-3	Blower VFD	19,000	26,454 17.9%	3 9.8%	-	3,606	5.3
ECM-4	Temperature Control Setpoints	2,600	3,449 2.3%	2 7.0%	-	470	5.5
ECM-5	HRV	2,600	3,354 2.3%	- 0.0%	-	457	5.7
ECM-6	Interior Lighting Retrofit & Control	1,700	405 0.3%	1 4.1%	40	95	17.9
ECM-7	Exterior Lighting Retrofit	500	1,888 1.3%	- -	5	262	1.9
Scenario 1		23,000	32,217 21.8%	- -	40	4,431	5.2

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 1. This includes the following ECMs:

Scenario 1, which contains:

- ECM-1: Reduce Infiltration;
- ECM-3: Blower Variable Frequency Drive
- ECM-4: Temperature Set Points; and
- ECM-7: Exterior LED Retrofit.

By implementing the recommended measures listed above, the Facility has a potential savings of 32,217 kWh, equivalent to a 21.8% reduction that may be anticipated relative to the simulated baseline year.

9.0 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 WWTP located at 300 Strathcona Rd, 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.

This report is limited by the following:

- Our interpretation of the objective and scope of works during the study period;
- The information provided by the Municipality; and,
- Measures identified in this report are subject to the professional engineering design process before being implemented.

The recommendations and our opinion of probable costs associated with these recommendations, as presented in this report, are based on walk-through non-invasive observations of the parts of the building which were readily accessible during our visual review. Conditions may exist that are not as per the general condition of the system being observed and reported in this report. Opinions of probable costs presented in this report are also based on information received during interviews with operations and maintenance staff.

The opinions of probable costs are intended for global budgeting purposes only. The scope of work and the actual costs of the work recommended can only be determined after a detailed examination of the site element in question, understanding of the site restrictions, understanding of the effects on the ongoing operations of the site/building, definition of the construction schedule, and preparation of tender documents. We expressly waive any responsibilities for the effects of any action taken as a result of these endeavors unless we are specifically advised of prior to, and participate in the action, at which time, our responsibility will be negotiated.

10.0 CLOSURE

Wood conducted an Energy Audit at the Water Treatment Plant located at 300 Strathcona Rd in Chapleau Ontario. Electricity conservation and efficiency measures were investigated, provided, and assessed in terms of energy savings and utility cost savings along with capital project costs and financial analysis. Through our analysis we have identified seven (7) ECMs. Wood has presented a strategic implementation scenario for the measures recommended in this assessment report. The scenario is estimated to reduce site electricity use by 21.8% for an overall cost savings relative to the baseline year of $4,431.

Additional recommendations include the following building management and behavioral opportunities:

- Recommissioning;
- Unit heater maintenance;
- Staff Training and Occupant Awareness; and
- Procurement Policy.

Wood Environment & Infrastructure Solutions

a Division of Wood Canada Limited,

Prepared by:	Reviewed by:
Name: Nathan Sokolowski, CEM, P.Eng.	**Name: Ayman Nicola, M.Sc., C.E.T., P.Eng.**
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 Wastewater Treatment Lagoon'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	0.136	$/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[2] 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).

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

Appendix B

Appendix B **Asset Details**

The table below presents the equipment inventory for the Facility at the time of the site visit.

Description	Location	Manufacturer	Model	Qty	Phase	Voltage	Amps	HP	Demand (kW)
Unit Heater	Blower Rm	Ouellet	N/A	1	3	600	4.81	6.70	5.00
Wall Mount Heaters	Chlorine Rm	Chromalux	CEP-30 C	2	3	600	2.89	4.03	3.00
Unit Heater	Eyewash	Ouellet	N/A	1	3	600	4.81	6.70	5.00
Exhaust with interlocked damper	Blower Rm	-	N/A	1	1	120	8.6	0.5	0.37
Exhaust with interlocked damper	Chlorine Rm	-	N/A	1	1	120	4.3	0.25	0.19
Exhaust with interlocked damper	Office	-	N/A	1	1	120		0.167	0.12
Supply Fan	Eyewash	-	N/A	1	1	120			0.04
Blower Motor 1	Blower Rm	Toshiba	0204SDSC41A-P3	1	3	575	20	20	15.00
Blower Motor 2	Blower Rm	Tatung Super-Max	WHO204FFHT	1	3	575	19.6	20	14.91
Chlorine Feed Pump (Pit)	-	Home Plummer	S48E11B67	1	1	120	8.6	0.5	0.37
Effluent Wash Pump	-	-	-	1	1			5	3.73
Recirculation Pump	-	-	-	1	1			10	7.46
Alum Pump	-	-	-	2	1			0.25	0.19
Generator Block Heater	Blower Rm	Hotstart	TPS101GT8-000	1	1	120			1.00
Generator Battery Charger	Blower Rm	Vulcan	DS-12	1	1	120	2.3		0.28

Appendix C

Appendix C Lighting Inventory

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

Space	Qty	Fixture Housing	Fluorescent Lamp Type	Lamps	Lamp Length (ft)	Lamp Watts	Ballast	Fixture Watts	Total Watts
Office	5	Rec, 2x4 trofer	T8, Instant start	4	4	32	Electronic	112	560
Blower Room	10	Surf, 1x4	T8, Instant start	2	4	32	Electronic	65	650
Chlorine/ Eyewash	3	Surf, 1x4	T5, Standard, High output lamp	2	4	28	Electronic	63	189

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

Space	Qty	Fixture Housing	Lens Cover	Fixture Type	Lamps #	Lamp Watts	Fixture Watts	Total Watts
Exterior	4	Surf, sconce	Clear	High Pressure Sodium	1	70	95	280
Exterior	1	Grnd-Mnt, Pole	Clear	Mercury Vapor	1	175	205	175

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	15,457	-
Feb-2018	28	13,828	-
Mar-2018	31	15,177	-
Apr-2018	30	14,178	-
May-2018	31	10,760	-
Jun-2018	30	10,089	-
Jul-2018	31	10,689	-
Aug-2018	31	10,608	-
Sep-2018	30	10,837	-
Oct-2018	31	11,962	-
Nov-2018	30	13,736	-
Dec-2018	31	14,824	-
Jan-2019	31	17,472	$2,202.64
Feb-2019	28	12,554	$1,586.18
Mar-2019	31	11,720	$1,479.07
Apr-2019	30	8,378	$1,077.14
May-2019	31	11,152	$1,426.92
Jun-2019	30	10,433	$1,477.15
Jul-2019	31	11,048	$1,576.07
Aug-2019	31	11,176	$1,583.44
Sep-2019	30	10,416	$1,476.44
Oct-2019	31	10,924	$1,559.05
Nov-2019	30	10,641	$1,587.69
Dec-2019	31	11,578	$1,708.80