ASHRAE LEVEL II ENERGY AUDIT

THE TOWNSHIP OF NORTH DUMFRIES

NORTH DUMFRIES PUBLIC WORKS DEPOT
1168 Greenfield Rd, Cambridge, ON

Project No.: 2018-0527-11

May 28, 2019

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Project No.: 2018-0527-11

May 28, 2019

Shelley Stedall
The Township of North Dumfries
2958 Greenfield Road
Ayr, ON N0B 1E0

Dear Shelley Stedall,

RE: North Dumfries Energy Audits

WalterFedy is pleased to submit the attached ASHRAE Level II Energy Audit to The Township of North Dumfries. This report encompasses the originally agreed to scope, and has identified the potential for energy consumption and cost saving measures at North Dumfries Public Works Depot located at 1168 Greenfield Rd in Cambridge, ON.

Based on the information provided by the The Township of North Dumfries, the report was completed with the data supplied and collected, as well as engineering judgement and various analysis tools to arrive at the final recommendations.

All of which is respectfully submitted,

WALTERFEDY

Josh Gibbins, P.Eng.
Senior Energy Engineer
Energy Management Solutions

jgibbins@walterfedy.com
519.576.2150 x480

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EXECUTIVE SUMMARY

This report presents the results of a ASHRAE Level II Energy Audit completed by WalterFedy for The Township of North Dumfries at North Dumfries Public Works Depot located at 1168 Greenfield Rd in Cambridge, ON.

The purpose of this ASHRAE Level II Energy Audit is to review how energy is currently being consumed within the facility, gain an understanding of how the facility is being operated, and provide recommendations for how energy can be saved through energy conservation measures (ECMs).

This ASHRAE Level II Energy Audit was prepared in conjunction with a Building Condition Assessment (BCA) of North Dumfries Public Works Depot. ECMs are based on replacement recommendations with energy savings potential in the BCA report as well as emerging and renewable energy technologies when applicable.

North Dumfries Public Works Depot facility consists of three 1 storey buildings built in various years.

Table 1 summarizes the annual electricity and fuel oil consumption for North Dumfries Public Works Depot during the baseline year of 2017. The facility's energy use intensity was benchmarked against other similar /buildingtype facilities.

Table 1: Facility annual utility summary

Annual Electricity Consumption	[kWh]	39,676
Annual Electricity Cost	[$]	4,446
Facility Electricity EUI	[kWh/ft^2]	2.3
Median Electricity EUI	[kWh/ft^2]	2.9

*Utility costs calculated using utility rates described in Table 6.

Table 2 summarizes the annual utility savings and simple paybacks for the recommended conservation measures evaluated in this report. Conservation measures were evaluated independently and do not reflect interactive effects.

Table 2: Recommended ECM summary table

ECM	**Electricity Savings** [kWh]	**Demand Savings** [kW]	**Fuel Oil Savings** [L]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Radiant tube heaters	0	0.0	11,845	4,786	10,200	0	2.1
Drive Thru Air Curtain	-1,488	0.0	6,778	7,899	45,000	0	5.7
Electric baseboard programmable thermostat	648	0.0	0	73	500	0	6.9

Note: Cost savings calculated using utility rates from Table 6.

Table 3 summarizes the recommended ECMs which were analyzed qualitatively.

Table 3: Recommended ECM summary table

ECM	**Estimated Cost**	**Estimated Annual Savings**	**Priority**
Behavioral change for drive-through doors	None	High	High

1 INTRODUCTION

1.1 Objectives

WalterFedy was hired by The Township of North Dumfries to complete an ASHRAE Level II Energy Audit at their North Dumfries Public Works Depot facility at 1168 Greenfield Rd in Cambridge, ON. The purpose of this ASHRAE Level II Energy Audit is to review how energy and water is currently being consumed within the facility, gain an understanding of how the facility is being operated, and provide recommendations for how energy can be saved through conservation measures.

This report identifies and explains potential energy conservation measures and provides economic analyses in order to estimate utility savings, budget implementation costs, and simple payback periods. Energy savings are within an accuracy of +/-30% while implementation costs are within an accuracy of +/-50%.

The goal is to recognize ECMs with high savings and reasonable payback periods. An analysis of historical energy use provides insight into the consumption patterns of the facilities. The data and information pertaining to the property reflects conditions and operations at the time of the site survey on November 22, 2018.

1.2 Scope of work

The scope of work is as follows:

- Review and analyze the historical energy consumption of each building.
- Conduct an on-site survey of each building's energy consuming equipment and system areas.
- Review operating logs and interview site building operations personnel to obtain insight into operating issues and practices.
- Perform an opportunity assessment including but not limited to:
  - The estimated energy unit and cost savings identified for each Energy Conservation Measures (ECM);
  - The energy saving recommendations from current state for each new ECM identified, documenting proposed equipment or operational changes from current equipment;
  - An explanation of the methodology and calculations utilized to obtain the energy and cost saving estimates;
- and document such assessment.
- Determine the cost to implement the recommended measures, including equipment installation and significant changes to maintenance costs, and determine the simple payback period for each ECM using the estimated savings.
- Provide a ranking of ECM opportunities in order of payback period category (1 to 3 years, 3 to 5 years, and 6 to 10 years)
- Identify and include in the final Report all available grants or incentives per identified ECM available through the Independent Electricity System Operator (IESO), Local Utility or other Government programs and include identified grant.

1.3 Contact information

The contact information of the the Owner and Consultant (WalterFedy) can be found in Table 4.

Table 4: Contact Information

Client:	**Consultant:**
Shelley Stedall Treasurer, Director of Corporate Services 519.632.8800 x123 sstedall@northdumfries.ca	Josh Gibbins, P.Eng. Senior Energy Engineer 519.576.2150 x480 jgibbins@walterfedy.com
The Township of North Dumfries 2958 Greenfield Road Ayr, ON N0B 1E0	WalterFedy 675 Queen Street South, Suite 111 Kitchener, ON N2M 1A1

2 HISTORICAL ENERGY USE ANALYSIS

2.1 General information

Electricity suppliers for North Dumfries Public Works Depot are summarized in Table 5.

Table 5: Facility utility information.

Facility Name:	North Dumfries Public Works Depot
Location:	1168 Greenfield Rd, Cambridge, ON
Electrical LDC*:	Energy+
LDC Account No.:	00015330-00

*Electrical Local Distribution Company

2.2 Utility rates

The utility rates shown in Table 6 are used throughout this report to evaluate the energy conservation measures identified in this ASHRAE Level II Energy Audit.

The electricity rate is an average determined using the winter, summer and shoulder (spring) months of utility bills. The fuel oil rates are an average determined from 12 months of utility bills. The propane rates are estimated rates from Union Gas.

Table 6: Facility utility rates

Electricity Consumption	[$/kWh]	0.11
Fuel Oil	[$/L]	1.19
Propane	[$/L]	0.77

2.3 Incentive summary

Electricity incentives

Electricity savings incentives have been calculated based on the IESO saveONenergy Retrofit Program as summarized in Table 7.

Table 7: Electricity savings incentives

Project Type	Demand Incentive	Consumption Incentive
Lighting	$400 / kW	$0.05 / kWh
Non-lighting	$800 / kW	$0.10 / kWh

1. The greater of the kW or kWh incentive will apply
2. Incentive capped at 50% of project cost

2.4 Data sources

The following data sources were used in this historical energy use analysis:

- 24 months of Energy+ monthly electricity bills.
- 24 months of monthly fuel oil bills.
- Daily weather data for Kitchener/Waterloo.

2.5 Facility utility use

Due to different billing periods among the utilities, monthly consumption was determined by calculating an average daily consumption over a billing period and summing the average daily consumption for each month of the year.

Electricity consumption

Table 8 summarizes the annual electricity consumption of North Dumfries Public Works Depot for the baseline year of 2017.

Table 8: Facility annual electricity consumption

Annual Electricity Consumption	[kWh]	39,676
Annual Electricity Consumption Costs	[$]	4,446

As seen in Figure 1, electricity consumption varies with time of year.

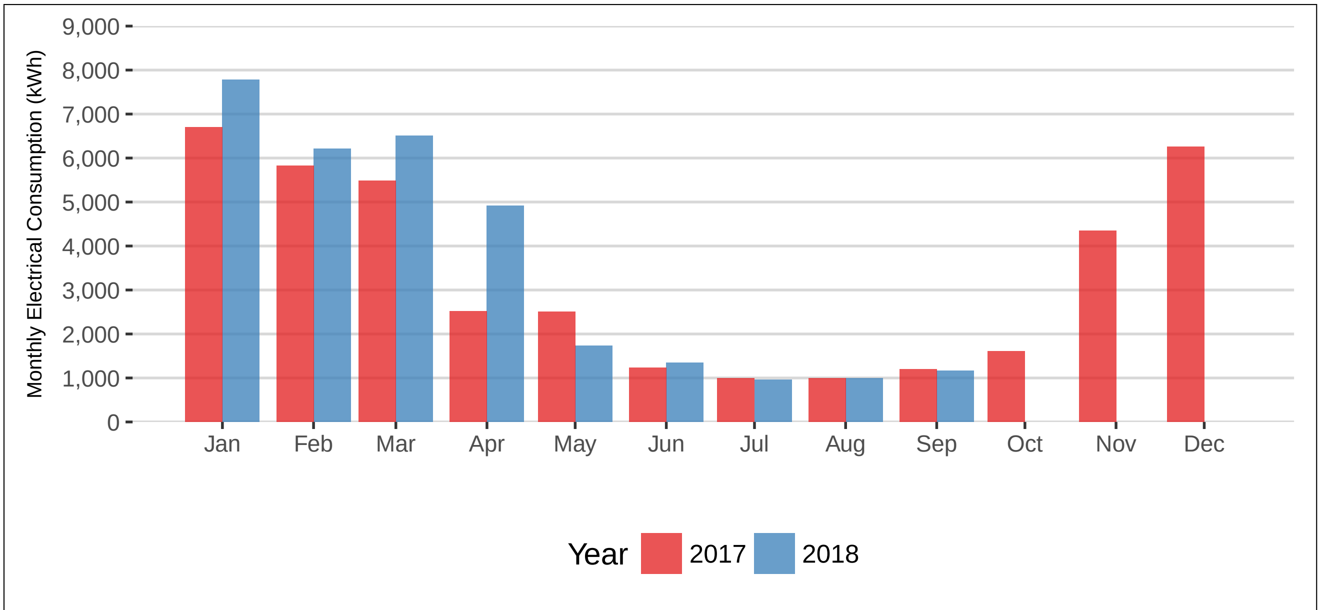

Figure 1: Monthly electricity consumption for the baseline period

Fuel oil consumption

Table 9 summarizes the annual fuel oil consumption of North Dumfries Public Works Depot for the baseline year of 2017.

Table 9: Facility annual fuel oil consumption

Annual Fuel Oil Consumption	[L]	17,767
Annual Fuel Oil Consumption Costs	[$]	21,143

Fuel oil is used for space heating during the winter season. As seen in Figure 2, there is no fuel oil consumption in the summer as it is only used for space heating. Fuel oil consumption increases as outdoor temperature decreases.

Fuel oil regression analysis

As fuel oil is used to heat outdoor ventilation air during the heating season, a linear regression analysis was completed comparing monthly fuel oil consumption to heating degree days as seen in Figure 3.

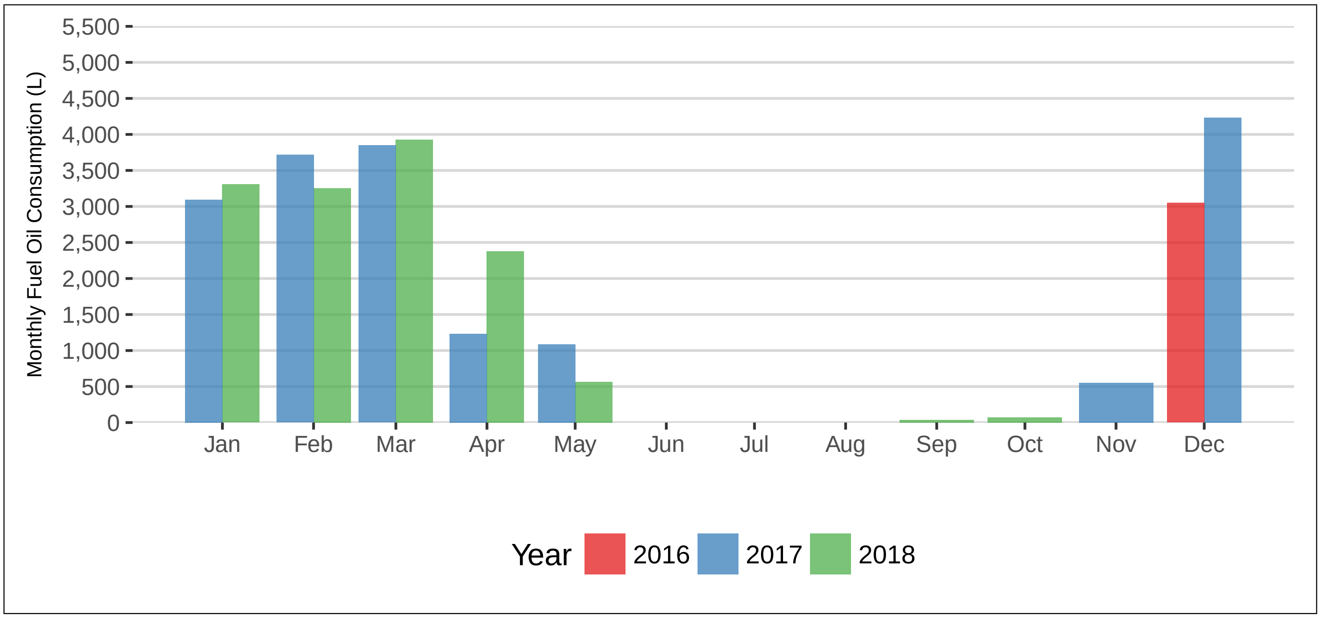

Figure 2: Monthly fuel oil consumption for the baseline period

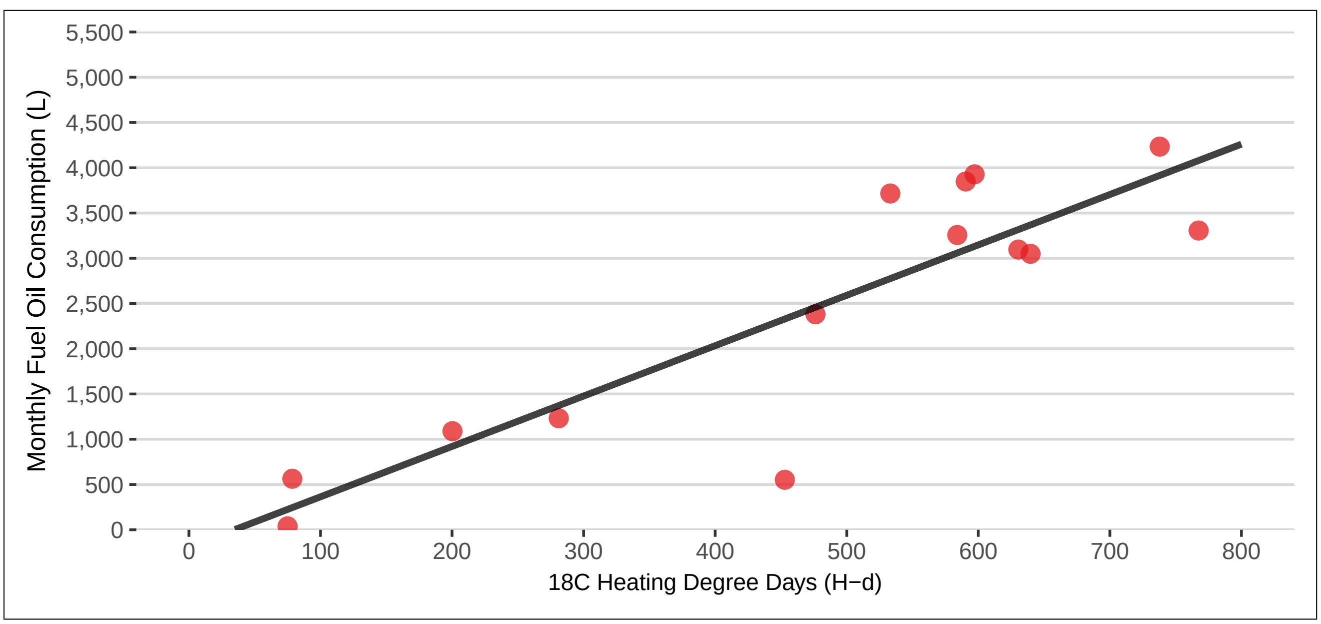

Figure 3: Linear regression of fuel oil consumption vs. heating degree days

Linear regression resulted in the following model for fuel oil consumption based on heating degree days (HDD):

$$\text{Fuel oil consumption [m}^3\text{]} = -193 + 5.6 \times 15°\text{C HDD } (r^2 = 0.77)$$

The r^2 value, also called the coefficient of determination, is a measure of how well the model predicts the actual consumption data. An r^2 value of 1 indicates that the linear regression model correctly predicts every data point. In this case, 77% of the variability in the fuel oil consumption data can be explained by correlating consumption to heating degree days.

Fuel oil and propane comparison

It is understood that the facility will be converting from fuel oil to propane in the near future. As such, it is important to understand the differences between the two fuel sources. Table 10 summarizes the cost difference per unit of energy for fuel oil and propane.

Table 10: Fuel cost comparison

Fuel Oil	[$/MMBtu]	32.79
Propane	[$/MMBtu]	31.84

However, it is also important to consider factors other than cost when evaluating the two fuels. Fuel oil burner systems have a lower peak effiency than propane systems (e.g. 85% vs 94%). Additionally, propane is a cleaner burning fuel meaning that there could be less maintenance required on the equipment.

2.6 Energy end uses

Table 11 summarizes the energy end uses for North Dumfries Public Works Depot.

Table 11: Annual energy end uses

End Use	Fuel Oil Consumption [L]	Electricity Consumption [kWh]	Total Energy Consumption [ekWh]	Total Energy Percentage [%]	Energy Costs [$]
Space Heating	17,767	2,160	191,156	84.1	21,143
HVAC	-	22,040	22,040	9.7	2,470
Water Heating	-	5,654	5,654	2.5	634
Lighting	-	9,443	9,443	4.2	1,058
Appliances/Plug loads	-	379	379	0.17	42
Totals	17,767	39,676	227,240	100	25,347

1. Refer to Table 6 for the utility rates used.
2. Fuel oil converted to ekWh using factor of 11 ekWh/L.
3. HVAC includes equipment such as ventilation fans and motors.
4. Total end use energy consumption matches the total baseline year energy consumption.

Calculations

- Fuel oil consumption is used only for space heating.
- Electricity consumption was divided into space heating, domestic hot water heating, lighting, appliances/plug loads, and HVAC.
- Space heating electricity consumption estimated based on 10 Wh/ft^2 operating continuously during the year for areas with electric heating.
- Domestic hot water heating electricity consumption estimated based on typical domestic hot water usage throughout the year.

- Interior lighting electricity consumption estimated based on typical operating hours throughout the year.
- Exterior lighting electricity consumption estimated based on 12 hour/day operation throughout the year.
- Appliances and plug loads estimated based on Canada ACP - NECB 2011 guidelines.
- HVAC loads (fans, pumps, etc.) estimated as the remainder of the total annual electricity consumption.

2.7 Energy use intensity (EUI)

The intent of this section is to compare annual energy consumption of the facility under investigation to a database of similar Public Works Depot facilities. Data was obtained from the Ontario government which collects energy consumption and other building data from Broader Public Sector (BPS) organizations such as municipalities, school boards, universities, and hospitals. Annual consumption was normalized against the building's floor area to determine each facility's EUI.

As seen in Table 12, North Dumfries Public Works Depot is 22% below the median electricity EUI for similar Public Works Depot facilities. The red bars in Figure 4 show the electricity and fuel oil EUI of North Dumfries Public Works Depot in comparison to similar Public Works Depot facilities in the database.

Table 12: Facility Electricity EUI comparison

Facility Electricity EUI	[kWh/ft^2]	2.3
Median Electricity EUI	[kWh/ft^2]	2.9

Figure 5 compares the total annual electricity consumption of all North Dumfries facilities.

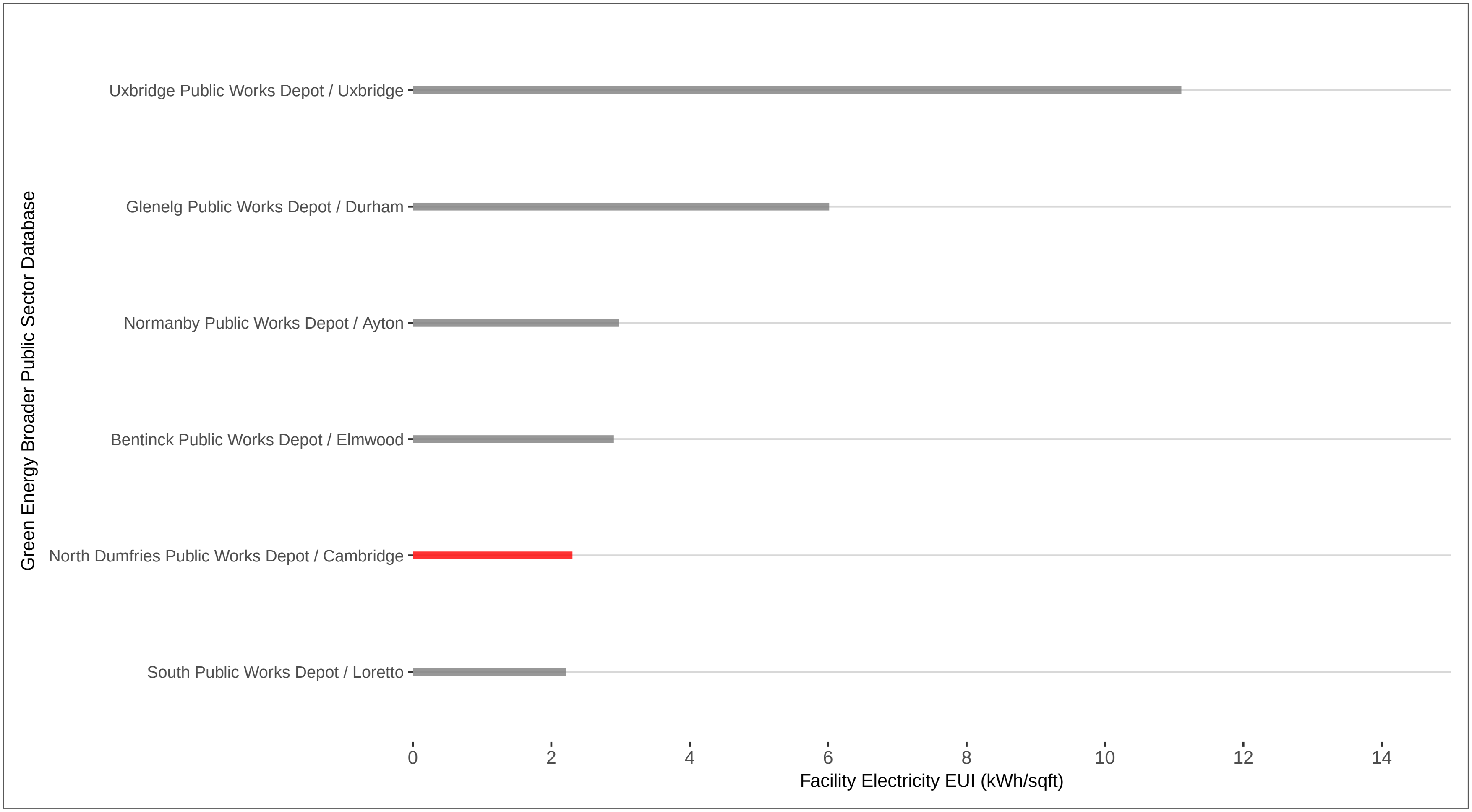

Figure 4: Annual electricity energy use intensity by building

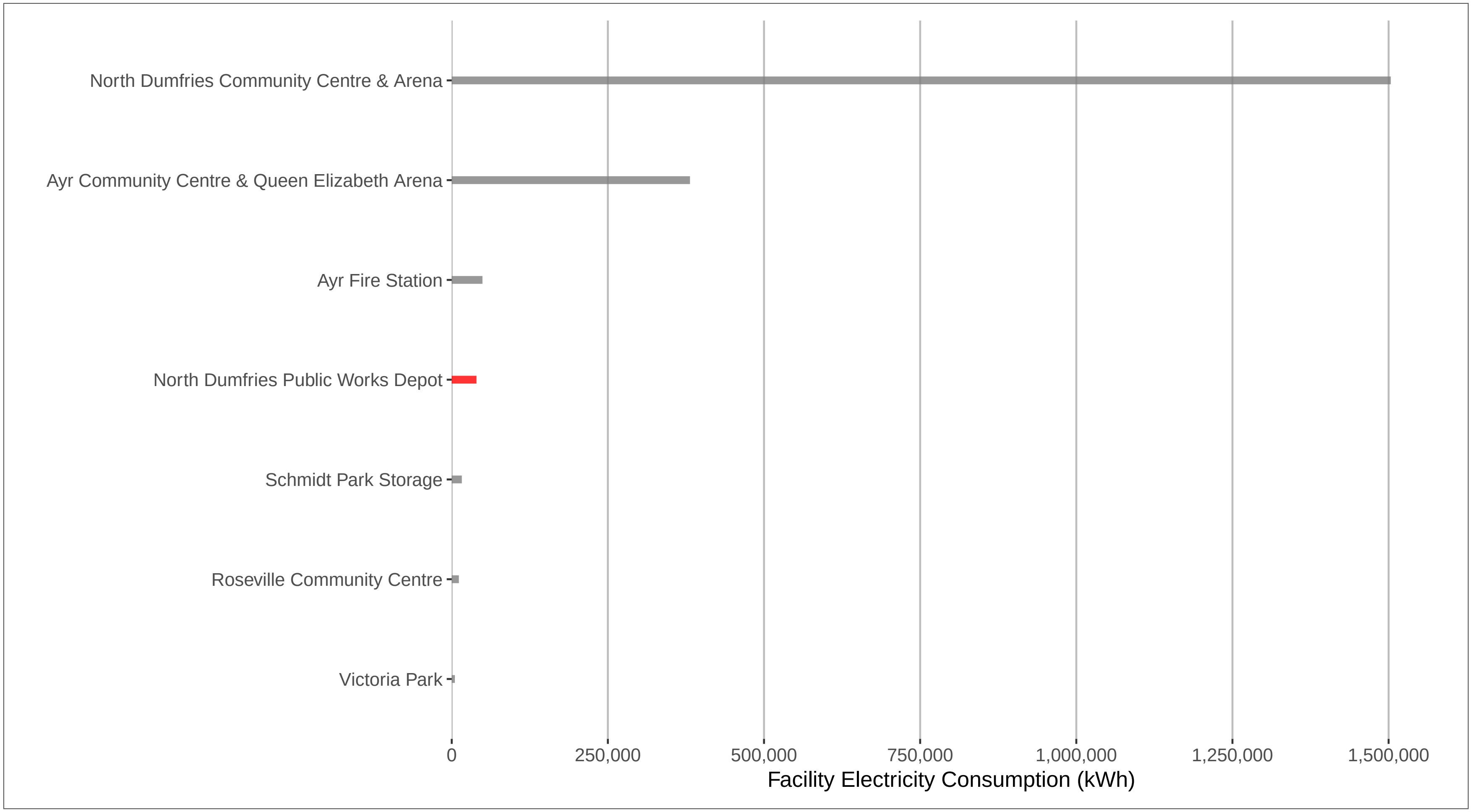

Figure 5: Annual electricity energy use by building

3 EXISTING CONDITIONS

3.1 General facility information

North Dumfries Public Works Depot is a 1-storey Public Works Depot facility consisting of three buildings (main building, quonset hut, and storage building) built in various years as well as a sand storage building. It consists mainly of storage and garage areas. Table 13 summarizes the general facility information for North Dumfries Public Works Depot.

Table 13: Facility background information

Facility name:	North Dumfries Public Works Depot
Location:	1168 Greenfield Rd, Cambridge, ON
Number of floors:	1
Facility floor area:	17,212 ft^2
Year of construction:	various
Building type:	Public Works Depot

3.2 Facility occupancy schedule

The facility operates throughout the year. Table 14 shows the typical weekly occupied hours for the facility.

Table 14: Typical weekly hours

Monday - Friday	6:00 am - 3:00 pm
Saturday - Sunday	Closed

3.3 Building envelope

Table 15: Existing main building envelope details

Component	**Installed**	**Description**
Floor foundation	1975	4” poured reinforced concrete
Mezzanine floor	2000	Poured concrete
Pitched roofing structure	1975	steel post and beam structure
Exterior walls	1975	corrugated metal siding
Exterior windows	1975	steel framed, single glazed windows
Exterior windows	1975	aluminum framed, single glazed windows
Exterior doors	1975	hollow metal doors with metal frames
Overhead door	2000	insulated overhead doors
Pitched roof	1975	standing seam metal roofing

Table 16: Existing quonset hut building envelope details

Component	**Installed**	**Description**
Floor foundation	1970	4” poured reinforced concrete
Rounded roof structure	1970	wood framed roofing
Exterior walls	1970	corrugated metal siding at front and back of building
Exterior windows	1970	wooden framed, single glazed windows along perimeter
Exterior doors	1970	hollow metal doors in metal frames
Overhead door	1970	insulated overhead doors within building
Rounded roof structure	1970	corrugated metal roofing

Table 17: Existing storage building envelope details

Component	Installed	Description
Floor foundation	2009	4" poured reinforced concrete atop strip footings
Pitched roofing structure	2009	wooden framed roof
Exterior walls	2009	corrugated metal siding
Exterior walls	2009	translucent corrugated siding
Exterior doors	2009	hollow metal door in hollow metal frame
Overhead door	2009	insulated overhead door
Roof coverings	2009	corrugated metal siding

Exterior roof

Main building: The roofing system installed is a pitched roof with standing seam metal roofing.

Quonset hut: The roofing system installed is a rounded roof with corrugated metal roofing.

Storage building: The roofing system installed is a pitched roof with corrugated metal roofing.

Exterior walls

Main building: The exterior walls of consist of corrugated metal siding.

Quonset hut: The exterior walls of consist of corrugated metal siding at the front and back of the building.

Storage building: The exterior walls of the Storage Building is cladded with corrugated metal siding. The upper portion of the north and south walls are finished with a transluscent corrugated siding which allows for natural light to enter the storage building.

(a) Main building exterior wall (b) Quonset hut exterior wall (c) Storage building exterior wall

Figure 6: Building exterior walls

Exterior windows and doors

Main building: Three steel framed, single glazed windows are situated along the perimeter of the building. Two of the windows are original to construction and one in the lunch room was installed during the addition in 2000.

Quonset hut: Two hollow metal doors in hollow metal frames are positioned along the perimeter of the building. There is one insulated overhead door within the building.

Storage building: One hollow metal door in a hollow metal frame is used as the entrance into the storage building. There is one insulated overhead doors within the building.

(a) Exterior door (b) Exterior windows (c) Window details

Figure 7: Building exterior windows and doors

3.4 Mechanical systems

Table 18: Existing mechanical equipment

Description	Manufacturer	Model	Qty	Location	Installed	Size
DHW heater	John Wood	JW50SDE130	1	Main Shop washroom	2011	N/A
Furnace (oil)	N/A	N/A	2	Main Shop garage	1975	N/A
Air compressor	Devair	TASV-5052-03	1	Main Shop garage	2007	N/A
Exhaust fan	N/A	N/A	2	Main Shop rooftop	1975	N/A
Electric baseboard heaters	N/A	N/A	2	Main Shop lunchroom & offices	2000	N/A
Ceiling mounted industrial fans	N/A	N/A	2	Main Shop garage	2000	N/A
Emergency generator	Generac	G0070381	1	Main Shop site	N/A	N/A
Furnace oil storage tank	Clemmer	N/A	1	Main Shop site	1975	1360L
DHW heater	Rheem	N/A	1	Quonset Hut washroom	2000	N/A
Furnace (oil)	N/A	N/A	1	Quonset Hut garage	2000	N/A
Exhaust fan	N/A	N/A	1	Quonset Hut rooftop	2000	N/A
Ceiling mounted industrial fans	N/A	N/A	3	Quonset Hut garage	2000	N/A
Water storage tank	N/A	N/A	1	Storage Building exterior walls	2003	N/A

Space heating system

Space heating in areas such as washrooms, offices, and garages are provided by fuel oil furnaces. The break room in the main building has an electric baseboard heater. The furnaces and baseboard heater are controlled by digital thermostats.

(a) Furnace (b) Baseboard heater (c) Digital thermostat

Figure 8: Space heating systems

Domestic hot water system

Domestic hot water is provided through two electric domestic hot water boilers.

(a) DHW heater (b) DHW tank

Figure 9: Domestic hot water system

Ventilation system

The wash bays have outside air dampers controlled by CO sensors.

(a) Arena exhaust (b) Washroom exhaust

Figure 10: Ventilation system

3.5 Lighting

Table 19: Existing lighting fixtures

Location	Fixture Type	Wattage	Quantity	Installed
Exterior	Wallpack	50	4	1970
Garage	T8 Fluorescent	64	12	1970
Garage	T8 Fluorescent	64	10	1970
Garage	T8 Fluorescent	230	4	2009
Wash Bay	T8 Fluorescent	112	7	2000
Throughout	T8 Fluorescent	59	6	1970
Throughout	T5 Fluorescent	65	3	N/A

Exterior lighting

Exterior lighting consists mainly of wall pack units.

(a) Wallpack

Figure 11: Exterior lighting

Interior lighting

Interior spaces and garages have lighting provided mainly by fluorescent T8 fixtures.


(a) Garage fluorescent fixtures


(b) Garage fluorescent fixtures


(c) Office fluorescent fixtures

Figure 12: Interior lighting

3.6 Plumbing fixtures

The plumbing fixtures within the main building consist of one floor mounted toilet and and one wall mounted lavatory in the washroom, and one steel kitchen sink in the lunchroom.

The washroom in the quonset hut equipped with one floor mounted toilet and and one wall mounted lavatory.

Table 20: Existing plumbing fixtures

Description	Manufacturer	Qty	Location	Installed
Toilet	N/A	1	Main Shop washroom	2000
Toilet	N/A	1	Quonset Hut washroom	2000
Faucet	N/A	1	Main Shop washroom	2000
Facuet	N/A	1	Main Shop kitchen	2000
Faucet	N/A	1	Quonset Hut washroom	2000


(a) Washroom faucet


(b) Toilet

Figure 13: Typical plumbing fixtures

4 ENERGY CONSERVATION MEASURES

4.1 Building envelope upgrades

Building envelope upgrades typically include the following components:

- Roof: Increasing insulation to reduce heat losses through the roof.
- Exterior walls: Increase insulation to reduce heat losses through the exterior walls.
- Windows: Replacing old windows with new high efficiency windows to reduce heat losses through the windows.

Building envelope upgrades are not recommended to be considered until the envelope components are due for replacement due to the high cost of implementation, and low opportunity for utility savings. A qualitative analysis of the building envelope upgrades are presented in Table 21.

Table 21: Building envelope upgrades

Category	**Description**
Building component	Building envelope (roof, exterior walls, windows)
Recommended change	Increase insulation in roof and exterior walls, and replace windows
Impact on occupant comfort	Improved thermal comfort due to reduced heat loss, and increased air tightness
Estimated cost	High (> $100,000)
Estimated level of annual savings	Low (> 100 year payback)
Priority	Medium

4.2 Electric baseboard programmable thermostat

As stated previously, the break room in the main building has space heating provided by an electric baseboard which operates continuously to maintain the temperature of the space. Electricity consumption savings can be achieved by installing a programmable thermostat on the baseboard heater as setbacks can be implemented during unoccupied hours.

Assumptions

- Installing programmable thermostat will allow the operating hours of the electric baseboards to be reduced by 30%.

Calculations

- Electricity consumption savings calculated using the annual space heating electricity consumption and the assumed efficiency improvement from the programmable thermostat.

Table 22 provides a summary of the electric baseboard programmable thermostat analysis results.

Table 22: Electric baseboard programmable thermostat

ECM	**Electricity Savings** [kWh]	**Fuel Oil Savings** [L]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Electric baseboard programmable thermostat	648.0	0	73	500	0	6.9

Note: Cost savings calculated using utility rates from Table 6.

4.3 Radiant tube heaters

Space heating for North Dumfries Public Works Depot storage and garage area is provided by fuel oil furnaces. North Dumfries Public Works Depot plans to replace the existing fuel oil furnaces with newer propane furnaces for space heating.

Due to the nature of the spaces (large storage areas and garages), it would be more energy efficient to install propane radiant tube heaters. This is because they can heat personnel and objects directly rather than the large volumes of air that would be distributed to the space.

The radiant tube heaters can be equipped with advanced sensors which will result in increased cost savings. Advanced sensors can measure both ambient and radiant temperatures for more accurate temperature readings. They also sense when lights are turned off and automatically switch to unoccupied mode which has temperature setbacks. Installing these sensors can result in system efficiency improvements of up to 15%. A single sensor can be used to control a single radiant tube heater unit or multiple units in a single HVAC zone.

Assumptions

- Radiant heaters effectivley reduce the space heating requirement by 20%.
- Installing advanced temperature sensors will result in a further 15% system efficiency improvement.
- A total of two radiant tube heaters will be installed: one for the main building and one for the quonset hut.
- A total of two sensors will be installed: one sensor each for the two tube heaters.

Calculations

- Propane consumption is calculated as the reduced effective space heating requirement and efficiency improvements from advanced sensors.
- Cost savings include savings from switching to propane from fuel oil and effective reduction of space heating for radiant tube heaters.
- Capital costs estimated using quotes obtained from suppliers.

Table 23: Radiant tube heater upgrade

ECM	**Electricity Savings** [kWh]	**Fuel Oil Savings** [L]	**Propane Savings** [L]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Radiant tube heaters	0	11,844.9	-12,080	4,786	10,200	0	2.1

Note: Cost savings calculated using utility rates from Table 6.

4.4 Behavioral change for drive-through doors

Through conversations with site staff, it was understood that the overhead door in the quonset hut is left open throughout the year. This is true even in the heating season when the furnace in the building is running. Leaving the door open in this manner would mean that warm air from inside the building is being released to the outdoors and the furnaces would have to run constantly to maintain temperature in the interior space.

The doors should be closed whenever they are not in use. This is a no cost measure which would reduce the energy consumption of the furnaces significantly. A qualitative analysis of this behavioral change is presented in Table 24.

Table 24: Behavioral change for drive-through doors

Category	Description
Building component	Drive-through doors
Recommended change	Close doors whenever they are not in use
Impact on occupant comfort	Improved thermal comfort due to reduced heat loss
Estimated cost	None
Estimated level of annual savings	High (< 1 year payback)
Priority	High

4.5 Air curtains for drive-through doors

The drive-through area of the garage experiences heat loss during the heating season due to the constant opening and closing of the drive-through doors.

Air curtains force inside air at high velocity downwards over the door to act as a air barrier. The curtain minimizes air exchange between the inside hot air and the outside cold air, reducing the demand for space heating.

Assumptions

- A total of three air curtains will be installed for the garage area.
- The dimensions of each drive-through door are 15 ft. (Height) and 9 ft. (Width).
- The indoor temperature is kept at 68°F.
- The doors are open for total of 1 hour(s) each day during the weekdays.
- The electricity demand to operate a single air curtain is 4.6 kW.

Calculations

- Fuel oil cost savings calculated using heat loss equations found in ASHRAE Handbook 2001 Chapters 26 and 32, average daily outside air temperatures during the heating season, and the parameters described above.
- The electricity required to operate the air curtain is calculated by multiplying the demand by the daily operating hours and the number of days requiring space heating in the year.
- Cost savings is calculated by subtracting the cost of electricity required to operate the air curtain from fuel oil cost savings.
- Capital costs estimated using quotes obtained from suppliers.

Table 25 summarizes the energy savings for installing an air curtain on the drive through overhead door.

Table 25: Install solar PV system

ECM	Electricity Savings [kWh]	Fuel Oil Savings [L]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
Drive Thru Air Curtain	-1,488.4	6,778	7,899	45,000	0	5.7

Note: Cost savings calculated using utility rates from Table 6.

4.6 LED lighting retrofit

LED lighting technology continues to rapidly advance, resulting in increased energy efficiency, improved product reliability, increased selection, and reduced costs. Applications where lighting retrofits are typically the most feasible include facilities with dated light fixtures (prior to T8 fluorescent lamps), contain high light fixture densities (resulting in a high W/ft^2 ratio), and have extended daily use (24/7 operation). Replacing existing fixtures with LED fixtures can decrease overall lighting costs significantly, while providing improved lighting levels for occupants.

This report analyzes a LED fixture replacement with no fixture reduction. LED fixture replacement has the following benefits:

- Allows for the highest level of flexibility for enhanced lighting controls, whether it is tied to occupancy and daylight sensors, zonal controls, wireless, addressable sensors, or network solutions to be integrated on each luminaire.
- Maximized performance when the fixture body is designed with the proper heat dissipation for LED light sources.
- Optimized visual comfort with lenses designed to reduce LED glare and improve the light distribution.

Assumptions

- The existing light fixtures were retrofitted on a one-for-one basis.
- LED fixture replacement costs on a per fixture basis were held constant. No economies of scale were assumed.
- Costs include both fixture and installation costs.
- No maintenance cost savings were taken into account.
- Operating hours for the majority of fixtures are 2,340 hours per year.

Calculations

- The existing lighting electrical demand [kW] was determined by summing the electrical demand for all lights in the building.
- The existing lighting electrical demand [kW] was multiplied by the annual operating hours to determine the annual electricity consumption [kWh] for the existing lighting.
- A review of each existing light fixture type was completed to determine a suitable LED fixture replacement (per unit basis).
- An approximate cost and electrical power [W] for each LED fixture replacement was determined.
- The annual electricity consumption and monthly demand for the LED retrofit scenario was calculated and compared to the existing conditions.

Table 26 provides a summary of the LED lighting retrofit analysis results.

Table 26: LED lighting retrofit

ECM	**Electricity Savings** [kWh]	**Fuel Oil Savings** [m^3]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
LED lighting retrofit	4,490.5	0	503	6,900	768	12.2

Note: Cost savings calculated using utility rates from Table 6.

4.7 Install rooftop solar PV system

A solar PV analysis was conducted for North Dumfries Public Works Depot using the HelioScope online modeling tool. A detailed report of the analysis and results can be found in the Appendices. This section provides a summary of the report's analysis and recommendations.

Assumptions

- The roof can structurally support the solar panels.
- Solar panels were placed with setbacks from roof edge and accounting for existing rooftop structures and shading.
- Solar panels were arranged in a configuration to maximize power production.

Calculations

- 96 x 320 W panels for total system size of 31 kW.
- Demand savings estimated at 20% of total system size.
- Electricity will be credited under a net metering scenario at the utility price of $0.112/kWh.
- Total system installed cost estimated at $3.00/W.

Table 27 provides a summary of the solar PV analysis results.

Table 27: Install solar PV system

ECM	**Electricity Savings** [kWh]	**Fuel Oil Savings** [m^3]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Install solar PV system	33,909.0	0	3,800	92,200	0	24.3

Note: Cost savings calculated using utility rates from Table 6.

4.8 Replace plumbing fixtures

The existing plumbing fixtures are described in Section 3.6. Replacing the existing fixtures with new low flow fixtures presents an opportunity to reduce water consumption and electricity consumption through reduced domestic hot water consumption.

Table 28 compares existing fixtures to new low flow fixtures.

Table 28: Proposed plumbing fixtures

Fixture	**Duration** [min]	**Current Flow** [lpm]	**Current Use** [m^3]	**New Flow** [lpm]	**New Use** [m^3]	**Savings** [m^3]
Washroom faucet	0.25	6	3.5	4.5	2.6	0.88
Toilet	N/A	6	14	4.8	11	2.8

A qualitative analysis of the plumbing fixture replacements are presented in Table 29.

Table 29: Building envelope upgrades

Category	**Description**
Building component	Plumbing fixtures (faucets, toilets, etc.)
Recommended change	Replace existing fixtures with low flow fixtures
Impact on occupant comfort	N/A
Estimated cost	Medium (> $1,000)
Estimated level of annual savings	Low (> 100 year payback)
Priority	Low (low opportunity for cost savings due to low fixture usage)

5 RECOMMENDATIONS

Table 30 summarizes the annual energy savings and simple paybacks for the conservation measures evaluated in this report. Conservation have been sorted based on their payback period.

Table 30: Conservation measures summary table

ECM	**Electricity Savings** [kWh]	**Demand Savings** [kW]	**Nat. Gas Savings** [m^3]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Radiant tube heaters	0	0.0	11,845	4,786	10,200	0	2.1
Drive Thru Air Curtain	-1,488	0.0	6,778	7,899	45,000	0	5.7
Electric baseboard programmable thermostat	648	0.0	0	73	500	0	6.9
LED lighting retrofit	4,490	1.9	0	503	6,900	768	12.2
Install solar PV system	33,909	6.1	0	3,800	92,200	0	24.3

Note: Cost savings calculated using utility rates from Table 6.

Table 31 summarizes the conservation measures recommended for implementation or further investigation. These were selected as they had a payback period of less than 10 years.

Table 31: Recommended conservation measures summary table

ECM	**Electricity Savings** [kWh]	**Demand Savings** [kW]	**Nat. Gas Savings** [m^3]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Radiant tube heaters	0	0.0	11,845	4,786	10,200	0	2.1
Drive Thru Air Curtain	-1,488	0.0	6,778	7,899	45,000	0	5.7
Electric baseboard programmable thermostat	648	0.0	0	73	500	0	6.9

Note: Cost savings calculated using utility rates from Table 6.

Table 32 summarizes all ECMs which were analyzed qualitatively.

Table 32: Qualitative ECM summary table

ECM	Estimated Cost	Estimated Annual Savings	Priority
Behavioral change for drive-through doors	None	High	High
Replace plumbing fixtures	Medium	Low	Low
Building envelope upgrades	High	Low	Low

APPENDICES