BUILDING RETROFIT TO ACHIEVE SUSTAINABILITY GOALS

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PROBLEM DEFINITION AND OBJECTIVES

Figure 1: Site location, North York region.

Objectives

- Reduce operational carbon emissions through deep energy retrofit.
- Electrify mechanical systems while maintaining winter maintenance functionality.
- Improve energy efficiency of building systems and controls.
- Integrate on-site renewable energy and future-ready infrastructure.

Reference: Google Earth. *3525 Baseline Rd, Sutton West, ON L0E 1R0.* Satellite imagery and site location data. Retrieved from https://earth.google.com/

The York Region North District Road Maintenance Facility is a high-energy, gas-heated municipal building with significant heat loss from large bay doors and aging mechanical systems. The facility must remain fully operational year-round while reducing energy use and carbon emissions to meet EnerPHit Net Zero Carbon targets.

BUILDING ENVELOPE

1. Insulated Metal Panels

- Kingspan prefabricated panels increase air tightness and lower the number of materials installed.
- R-values of up to 46 for roofing panels and up to 72 for wall panels, reducing energy consumption. Exceeds EnerPHit standard with air leakage rate of 0.8 ACH50

2. Overhead Rolling Steel Bay Door Systems

- Insulated slats provide thermal resistance, air leakage, and resist heat flow. Compliant with EnerPHit standards with secondary barrier.

MECHANICAL AND ELECTRICAL

1. Space Heating:

- Central hydronic heating system powered by cold-climate air-to-water heat pumps, with a high-efficiency condensing boiler for peak and backup heating. Existing bay infrared heaters are replaced with hydronic unit heaters.

2. Ventilation:

- Central heat recovery ventilation system provides tempered fresh air, while maintenance bay exhaust is controlled using CO/NOx sensors to reduce unnecessary energy use.

3. Electrical & Controls:

- Building systems are fully electrified and integrated through a centralized building automation system, including LED lighting with occupancy and daylight controls.

4. On-Site Energy:

- A rooftop solar PV system offsets electrical demand and charges a battery energy storage system to reduce peak loads and improve winter storm resilience.

RENEWABLE ENERGY

1. Solar PV System

- Rooftop solar PV array.
- Generates roughly 191,625 kWh annually.
- Will offset approximately 20-30% of the facility's total electrical consumption.

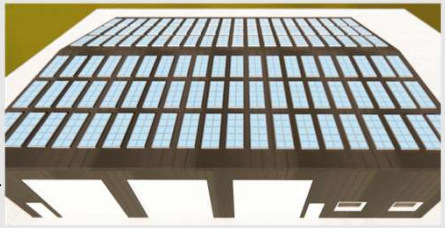

Figure 2: Facility solar panels on roof.

2. EV Charging Stations

- To support future fleet electrification, the retrofit supports five level 3 DC fast chargers.

WATER EFFICIENCY

1. Greywater Recycling

- Hydraloop Cascade greywater recycling system to treat water from showers and sinks for reuse in toilet flushing.
- Reduces potable water consumption with minimal disruption.

2. Rainwater Harvesting

- Rainwater is collected and routed to a below-grade 50,000 L concrete cistern.
- Annual rainfall volumes providing up to 400,000 L of recoverable water to support wash bay pre-rinsing, irrigation, and non-potable cleaning functions.

PRELIMINARY DESIGN

Table 1: Beam applied moment and moment resistance comparison.

Moment Type	Variable	Exterior W200x21	Interior W200x27	Second Floor W410x39	Units
Applied Factored	M_f	111	197	193	kNm
Resistance	M_r	64.6	83	217	kNm

Figure 3: Proposed retrofit envelope.

CARBON EMISSIONS

- Annual carbon emissions of the proposed retrofit design were estimated and compared to the baseline design without having implemented the proposed solutions.
- The building envelope upgrades are estimated to reduce carbon emissions by 28%.

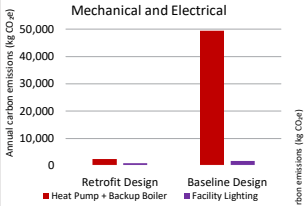

Figure 4: Mechanical and electrical carbon emissions.

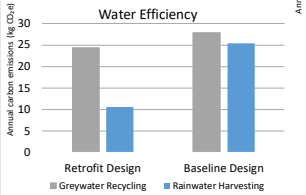

Figure 5: Water efficiency carbon emissions.

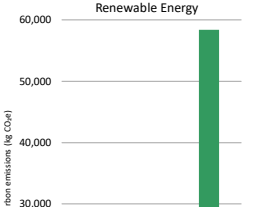

Figure 6: Renewable energy carbon emissions.

PROJECT BUDGET

Table 2: Total budget for retrofit design.

Project Totals	
Subtotal	$2,620,173
20% Contingency	$524,034.60
Total Cost	**$3,144,207.60**

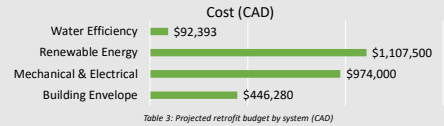

Table 3: Projected retrofit budget by system (CAD)

RISK ASSESSMENT

- Modifications will be made to the facility's exterior walls, roof assemblies, bay doors, energy sources, mechanical and electrical systems, and water efficiency.
- Notable risks relate to the constructability challenges during panel installation, airtightness performance of new rolling steel bay doors, roof capacity for the PV system, the increased demand associated with EV charging, heat pumps, and HRV systems.

Table 4: Preliminary risk assessment.

1 = Lower Risk 2 = Moderate Risk 3 = Higher Risk

Component	Probability of Underperformance	Impact on Facility Operations	Cost Sensitivity	Maintenance Demand	Installation Complexity
Exterior Walls & Roof	1	2	2	1	2
Bay Doors	2	2	2	2	2
Solar PV System	2	2	3	2	3
Power Charging Stations	2	3	2	2	2
Battery Energy Storage	1	2	3	1	2
Building & Truck Bay Heating	2	3	2	2	2
Office & Support Space Conditiong	1	2	2	1	2
Mechanical Ventilation	2	2	2	2	2
Domestic Hot Water System	1	2	2	1	2
Electrical Service Expansion	2	3	3	2	3
Lighting & Controls	1	2	2	1	1
Automation System	2	3	2	1	2
Greywater Recycling	2	2	2	2	2
Rainwater Harvesting	2	1	2	2	2
Fixture Upgrades	1	1	1	1	1