PANELIZED DEEP RETROFITS OF MUNICIPAL BUILDINGS

Harrietsfield Williamswood Community Centre

Case Study Report

Issue Date: September 30, 2023

HALIFAX Natural Resources Canada Ressources naturelles Canada ReCover

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Acknowledgements

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This research project was led by The ReCover Initiative, a Nova Scotia based non-profit organization working to accelerate deep retrofits in Canada.

PANELIZED DEEP RETROFITS OF MUNICIPAL BUILDINGS

Harrietsfield Williamswood Community Centre

Executive Summary

Who is ReCover

ReCover is a Nova Scotia-based non-profit focused on revolutionizing Canada's buildings to combat climate change. Through innovative research, technology, and partnerships, they lead in scalable deep retrofit solutions. Their efforts in Canada lower energy costs and enhance well-being by collaborating with communities, building owners, and financial institutions.

What is the Project

This project examines six cases of municipally owned buildings, inspired by the successful Energiesprong approach from the Netherlands, which streamlines retrofits. Despite challenges adapting to Canada's diverse buildings and climates, some projects have successfully implemented some Energiesprong-inspired retrofits. The ReCover Initiative found cost-effective benefits in panelized retrofits for multi-unit dwellings, aiming for Net Zero Energy. The study seeks to apply effective residential retrofit strategies to support municipal decarbonization.

Project Objectives

The project objectives are to make deep retrofits in Canada more feasible, showcase a panelized retrofit approach, and enhance confidence in retrofits. It aims for a 50% reduction in EUI, a NZER scenario with potential for NZE through solar PV, minimal disruption to occupants, low embodied carbon solutions, cost-effectiveness, and a payback period of 20 years or less.

Methods Used

The project progressed through several phases : building selection based on criteria and evaluation, data collection including utility info and drawings, baseline energy modeling, designing retrofit scenarios with energy conservation measures, and cost analysis involving Class D cost estimation and TCBO modeling.

Building Performance Improvements

EUI

100% improvement

Existing : 146 kWh/m^2

Recommend : 0 kWh/m^2

GHG

100% improvement

Existing : 30,901 kg/yr

Recommend : 0 kg/yr

ROI

39 Years

When whole building cost of doing nothing exceeds whole building cost of retrofit.

Lifetime Savings

$1.8 Million

Existing : $4.9 M

Recommend : $3.1M

Retrofit Measures

2x4 ReCover wall panels
Attic insulation
High performance windows and doors
New ventilation system
69 kW Solar PV system

Acronyms and Definitions

ACH	**A**ir **C**hanges per **H**our, measured with a blower door test
CO_2e	**C**arbon di**O**xide **E**quivalent
Deep Retrofit	A project involving multiple energy efficiency and/or renewable energy measures in an existing building, designed to achieve major reductions in energy use. A deep retrofit usually includes reducing energy demand and switching from fossil fuels to electricity for space and water heating – to achieve 70% energy savings and 80% to 100% GHG emissions reductions.
Energiesprong	A retrofit methodology developed in the Netherlands to implement Net-Zero retrofits using prefabricated envelope panels and compact exterior mechanical pods. Energiesprong retrofits are financed by the cost savings from future energy consumption and required maintenance. Translation: Energy Leap.
EUI	**E**nergy **U**se **I**ntensity
FCA	**F**acility **C**ondition **A**ssessment: a comprehensive evaluation of a building's physical condition.
GHG	**G**reen**H**ouse **G**as
GWP	**G**lobal **W**arming **P**otential: a measure of how much energy the emissions of 1 ton of gas will absorb over a given time, relative to the emissions of 1 ton of carbon dioxide.
NZE	**N**et-**Z**ero **E**nergy building: a building in which on-site renewable energy generated equals the annual energy consumption of the building
NZER	**N**et-**Z**ero **E**nergy **R**eady building: a building whose annual energy consumption is low enough that it could be Net-Zero Energy with the addition of a source of renewable energy
PV	Solar **P**hoto**V**oltaic array
TCBO	**T**otal **C**ost of **B**uilding **O**wnership: building life cycle cost analysis that includes all major operating costs over the useful life of the building.
WRB	**W**ater-**R**esistive **B**arrier: a synthetic membrane installed outside of the building's sheathing to protect it from the impacts of bulk water.
ZCB	**Z**ero **C**arbon **B**uilding:

Introduction

Over one-third of Canada's planned greenhouse gas (GHG) emissions reductions will come from energy efficiency measures.[1] Increasing the pace and scale of deep retrofits is imperative to achieving net-zero emissions, as most buildings standing today will still exist in 2050.

Municipalities across Canada are working to implement climate action plans to reduce their GHGs and to protect people and infrastructure from the impacts of climate change. Deep retrofits support both efforts.

The Panelized Deep Retrofits of Municipal Buildings project includes six deep retrofit case studies of municipally owned buildings in Canada. The buildings studied are representative of buildings in municipalities throughout the country. Their uses include community centres, administration, transit, and maintenance facilities in three Canadian climate zones.

Conventional retrofit practices are not scalable. They require large budgets, custom design, and invasive construction. The only retrofit initiative to be successfully scaled to date is the Dutch approach, Energiesprong, which involves prefabricated panelized envelope over-cladding and systematic mechanical upgrades. This approach reduces time on site and project complexity compared with common retrofit practices and permits buildings to continue to be used during the work.

Energiesprong has succeeded in part because of the Netherlands' homogenous building stock. The diversity of buildings and range of climate conditions in Canada pose challenges in adapting the approach to this country, yet several Energiesprong-inspired projects have been completed or are under way. These include Ottawa Community Housing's four-unit townhouse retrofit completed in 2021, Sundance Housing Cooperative in Edmonton, which is mid-way through retrofits on their 59 townhouses, and three single family homes in Alberta.

Measures that focus on simple payback and short-term return on investment can be counterproductive with assets as long lasting as buildings. Economic evaluation through Total Cost of Building Ownership (TCBO) analysis is more appropriate for complex retrofit projects that make changes to multiple interrelated building systems.

The ReCover Initiative has studied the potential for prefabricated panelized deep retrofits in lo-rise multi-unit dwellings in two previous case studies[2]. These studies found the lowest TCBO over the anticipated life of the building was achieved through Net Zero Energy retrofits where the targets were met with an Energy Use Intensity (EUI) reduction of at least 75% before adding solar PV.

This study of Panelized Deep Retrofits of Municipal Buildings was undertaken to develop deep retrofit strategies to support municipal decarbonization efforts.

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[1] IEA (2022), *Canada 2022*, IEA, Paris https://www.iea.org/reports/canada-2022 , License: CC BY 4.0

[2] ReCover Initiative (2020) *ReCover Phase One Case Study Report* and ReCover Initiative (2022) *Scarlettwood Court Deep Retrofit Case Study Report*, https://www.recoverinitiative.ca/about-us/our-results/report-request

Project Objectives

The objectives of this study were to de-risk investment in deep retrofits in Canada, to provide evidence on the effectiveness and scalability of a panelized deep retrofit approach and to build confidence and experience in deep retrofits among Canadian municipalities and industry stakeholders.

The goals for the Deep Retrofits explored included:

1. Develop a scenario that achieves an Energy Use Intensity (EUI) reduction of 50%.
2. Develop a Net Zero Energy Ready (NZER) scenario that can achieve Net Zero Energy (NZE) with the addition of solar PV.
3. All solutions minimize occupant disruption during construction.
4. All solutions target minimal embodied carbon.
5. Identify the retrofit pathway to the lowest Total Cost of Building Ownership.
6. Demonstrate a calculated payback of 20 years or better.

Methodology

The project was completed in the following phases:

1) Building selection.
    a) Definition of selection criteria.
    b) Building evaluation and selection.
2) Data and document collection, including:
    a) Utility data
    b) Building drawings
    c) Facility Condition Assessment, ideally no more than five years old
    d) Field Review
3) Baseline energy modeling (hourly analysis).
    a) Determination of model inputs
    b) Energy Model Calibration
    c) Baseline energy model results

4) Design Energy Conservation Measures (ECMs) for retrofit scenarios, including:
    a) u-values, window, and door performance specifications
    b) mechanical and electrical systems upgrades
    c) panel design, including:
        i) structural design and fastening details.
        ii) panel dimensions and layouts.
        iii) hygrothermal modeling with WUFI Pro to assess moisture risk.
        iv) embodied carbon accounting.
        v) aesthetic upgrades.
5) Cost Analysis.
    a) Class D cost estimate.
    b) TCBO modeling.

Building Selection

A short-list of community recreational facilities was proposed for study by HRM. Retrofits to recreation facilities was strategic because safe, comfortable shelters will be needed in Halifax's communities in future extreme weather events and recreation facilities are well suited to adaptation for this use.

Criteria for consideration included the following:

- high EUI
- potential to eliminate fossil fuel-based building systems.
- high maintenance deficit
- simple form
- ample space to stage a panelized construction project.
- solar potential

The Harrietsfield Williamswood Community Centre was selected by the ReCover team and HRM based on these criteria.

Data and Document Collection

HRM provided the following data and supporting documents pertaining to the Harrietsfield Williamswood Community Centre:

- Floor plans (Appendix A)
- Capital Plan, Building Condition and Energy Assessments, 2013 (Appendix B)
- Fuel oil consumption records January 2018 - December 2021 (Appendix F)
- Electrical consumption records April 2017 - October 2021 (Appendix F)

Typically, a minimum of two years of consumption records for all utilities serving a building is required. As the time frame for this project included reduced building occupancy during the pandemic, at least one year preceding the beginning of the pandemic was included in analysis.

Comprehensive building drawings were no available. Smarter Spaces was engaged to complete **LiDAR** (Light Detection and Ranging) imaging to capture the external building geometry. The 3D point cloud generated from the scan was interpreted to produce CAD and BIM drawing files for use by the design team (Appendix A).

A site visit was conducted by design team members to verify structural, mechanical, and electrical details from the resources provided and to understand building conditions. The team also engaged with HRM staff to understand building usage patterns, baseline operational settings for mechanical systems and for information on occupant comfort and building deficiencies.

A new **Facility Condition Assessment** (FCA) was obtained from Capital Management Engineering Limited (Appendix B) as the existing Building Condition Assessment was nearly 10 years old and did not fully reflect the existing conditions.

Building Description

The Harrietsfield Williamswood Community Centre is a two-storey building with a gross floor area of 581m^2 (6,256sq. ft)[3].

Figure 1 Harrietsfield Williamswood Community Centre

The upper level of the building contains a day care centre which operates an after-school program and full day programs during summer and March Break. The facility includes a multipurpose room which is used for community recreation services including fitness classes, meetings, art classes and workshops and for private event rentals. Daily hours of operation are 10am – 9pm during the school year and 7:30am – 6:00pm in summer. The typical occupancy of the daycare is 50 people and occupancy of the multipurpose room varies, with an average of 150 people for events.

The building was originally a fire station estimated to have been constructed in 1970. It was converted to its current use in a major renovation in 1994. HRM has implemented several efficiency measures to the building including adding heat pumps (2015), LED lighting upgrades (since 2013) and a wall mounted solar air heater (2011).

The facility has been operated in partnership with the Harrietsfield Williamswood Community Centre Association (HWCCA) since 2010. Capital work on the building, including major repairs and maintenance of mechanical and electrical systems are the responsibility of HRM while utility costs are paid by the HWCCA.

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[3] Energy modeling is based on the internal area of 541m^2 (5833 sq. ft.).

Context

The Harrietsfield Williamswood Community Centre is located at 1138 Old Sambro Road, Halifax, Nova Scotia. Old Sambro Road is a busy street that connects rural and suburban parts of HRM and the Halifax Peninsula. The building is adjacent to an elementary school and backs onto a wooded area and a small lake. The surrounding area is primarily rural and residential.

Figure 2 Site Plan: Harrietsfield Williamswood Community Centre

Halifax is in Canadian building code climate zone 6. It has a temperate maritime climate, with short, warm summers and cold winters. The weather is humid and changeable in all seasons, with year-round potential for significant precipitation. Average temperatures in Nova Scotia are increasing and are predicted to continue to rise, with the incidence and severity of storms also accelerating.[4] High winds and driving rain are key building science concerns in Halifax.

Halifax was the second city in Canada to declare a climate emergency, shortly after Vancouver did so in January of 2019. In 2020, Halifax adopted one of Canada's most ambitious climate action plans, **HalifACT: Acting on Climate Together**. Decarbonizing buildings is the single most impactful GHG reduction strategy in the plan. In HRM, buildings are responsible for approximately 70% of energy use and 77% of GHG emissions (HalifACT: Acting on Climate Together, 2020, p.28). All existing buildings in the municipality to undergo deep energy and climate resilience retrofits by 2040 (HalifACT: Acting on Climate Together, 2020, p.36).

[4] Nova Scotia Department of Environment and Climate Change (2022) *Weathering What's Ahead: Climate Change Risk and Nova Scotia's Well-being*, https://climatechange.novascotia.ca/sites/default/files/uploads/climate-change-risk-report.pdf

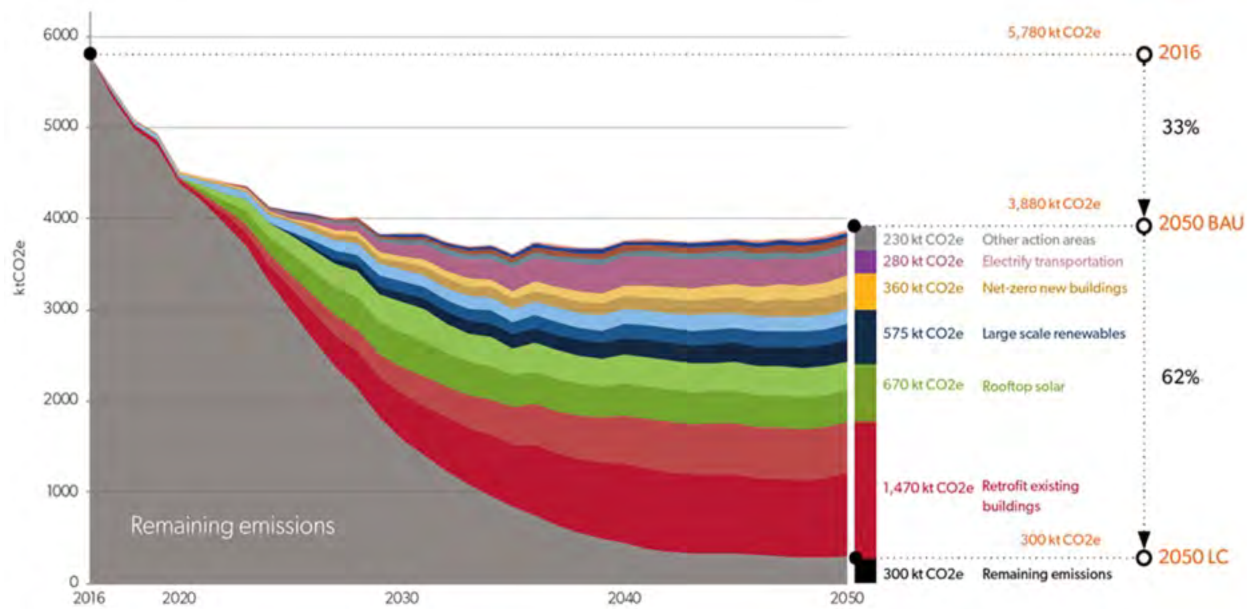

Figure 3 Pathway to reduce GHG emissions aligned with 1.5°
(HalifACT: Acting on Climate Together, 2020, p. 26-27.)

Building Code Considerations

A preliminary National Building Code of Canada (NBCC) review was completed to determine building code implications of a panelized retrofit to the Harrietsfield Williamswood Community Centre (Appendix L). The primary focus of the review was to determine if panels made with combustible materials can be installed on the existing structure.

As the building's primary use is a daycare and community centre, the structure is categorized as a **High Importance Building** as per Sentence 4.1.2.1.(3) in the 2015 edition of the National Building Code of Canada (NBCC). High Importance structures are subject to higher environmental loading, including snow, wind, and seismic loads, than a normal importance building.

The construction type, cladding and fire rating requirements for each exterior wall of a building are based on the area of the wall, its proximity to the property boundaries, and the building's occupancy classification. Based on the building's use as a community centre and childcare facility, it is classified as **NBCC Group A2 - Assembly Occupancy**.

The site is an irregular shape. The closest part of the building to the property line is on the north side, with the north line 6.5m from the building and roughly parallel to the north wall. Based on the setback distances, the structure and the cladding are permitted to be of either combustible or noncombustible construction. Therefore, combustible panels are permitted to be installed on the building.

Cellulose insulation has a Class 1 fire rating, which is the best fire rating for materials with the lowest level of risk. It is treated with borate which acts as both a fire retardant and pest repellant.

Building Enclosures

The main walls of the building are concrete block with interior 2x6 stud cavity walls offset from the concrete 100mm (4") and insulated with fiberglass batt. The lower level bump out walls are 2x6 framing with fiberglass batt. Openings from three former overhead doors on the west wall have been infilled with wood framing and fiberglass batt. The building is clad with fiber cement siding, with a small area of brick framing the former door openings. The windows are double glazed with vinyl frames.

The roof is framed with wood trusses and insulated with approximately 200mm (8") of loose cellulose at the ceiling plane. There appears to be a polyethylene vapour barrier installed in the walls and roof. Given the building's age, this is unlikely to be continuous.

The concrete slab-on-grade floors are believed to be uninsulated.

Table 1 Existing Thermal Enclosure Performance

	Effective USI W/m^2·K (Btu/h·ft^2·°F)	Effective RSI m^2·K/W (ft^2·°F·h/BTU)
weighted average walls	USI-0.47 (U-0.08)	RSI-2.11 (R-12)
weighted average roofs	USI-0.24 (U-0.04)	RSI-4.23 (R-24)
weighted average slab	USI-4.1 (U-0.7)	RSI-0.24 (R-1.36)
windows	USI-2.27 (U-0.4)	RSI-0.44 (R-2.5)

Existing Structure

The **foundation** consists of concrete foundation walls and strip footings. No structural deficiencies are apparent in the visible portions of the foundation and there is no evidence to suggest deficiencies in the buried portions.

The **above-grade walls** are 150mm (6") concrete masonry unit (CMU) block. These are the main load-bearing elements and the primary lateral load resisting system. The team was unable to confirm the presence of grout or steel reinforcing in the CMU voids. There is no evidence to suggest structural deficiencies in the wall system.

The **roof structure** is pre-engineered timber trusses with tongue and groove plank decking. The connection detail between the trusses and walls could not be verified during the site visit. It is assumed that the trusses bear on either a double top plate or a nailer supported on the CMU block walls.

The roof trusses are leaning, with the truss ridge approximately 25mm (1") east relative to the bottom chord of the truss. This issue wasn't identified in the 2013 Building Condition Assessment (Appendix B). A roof leak was also identified, by an employee of the daycare. This has anecdotally been present since Hurricane Dorian in September 2019.

The existing roof structure was determined to be inadequate to support the existing roof loads. Alterations or additions to the structure must be independent of the existing roof trusses.

Details of the existing structure and Structural Outline Specifications are provided in Appendix C.

Figure 4 Roof structure

Existing Mechanical Systems

Space heating is provided by a non-condensing oil-fired boiler with hydronic baseboard heaters. In 2011 a solar air heater was installed to provide supplemental heat. This is not believed to be contributing a significant amount of heating and was not included in energy modeling.

The building does not have a central **cooling** system. Two 2-ton heat pumps were installed to provide cooling in the multipurpose room and day care area in 2015 following occupant complaints during the summer. The heat pumps also provide supplemental space heating.

Building staff have reported that summertime comfort has improved since installing the heat pumps, but thermal comfort continues to be an ongoing issue in both summer and winter. It is believed that heating and cooling may be operating simultaneously at times with the existing systems.

The building **ventilation** does not meet code. There is no mechanical ventilation system and fresh air is supplied through natural infiltration, via operable windows and two louvers located in the multipurpose room which building staff have indicated are usually closed.

Rooftop exhaust fans are installed in the building's four washrooms and the kitchen includes a range hood exhaust. All exhaust fans are controlled with wall mounted switches.

Hot water is supplied by five 40-gallon electric water heaters, located near the points of use.

Controls for the baseboard radiators are standalone wall mounted thermostats and heat pumps are controlled manually. Baseboard heaters operate in the winter and shoulder seasons. The heat pumps are operated year-round on an inconsistent schedule. Only baseboard heaters were used during unoccupied periods during the pandemic.

Appendix D provides details of the existing mechanical system and Mechanical Outline Specification.

Existing Electrical Systems

It is important to consider electrical **site services** in the context of a panelized retrofit as wall and roof mounted elements and overhead wires add complexity in installing panels. The building has two existing service entrances which share a set of overhead secondary wires. There are two separate meters, one for each service entrance, on the exterior of the building.

The **interior lighting** throughout the building is fluorescent fixtures that have been retrofitted with LED lamps and ballasts. Emergency lighting, exit signage and the building fire alarm panel are battery operated.

The building lacks an automatic **lighting control system** and relies on manual control. The staff are diligent in lighting only occupied spaces, but this could lead to energy waste if lights are left on in unoccupied areas of the building for extended periods of time.

Appendix E provides details of the existing electrical system and Electrical Outline Specification.

Energy Consumption

Energy analysis was based on electrical records spanning April 2017 to October 2021 and fuel oil records from January 2018 to December 2021 (Appendix F). During the documented time span the building used an average of 4,810 L of fuel oil (51,722 ekWh) and 26,282 kWh of electricity annually. From March of 2020 and throughout 2021, energy use decreased due to reduced operations during the COVID-19 pandemic.

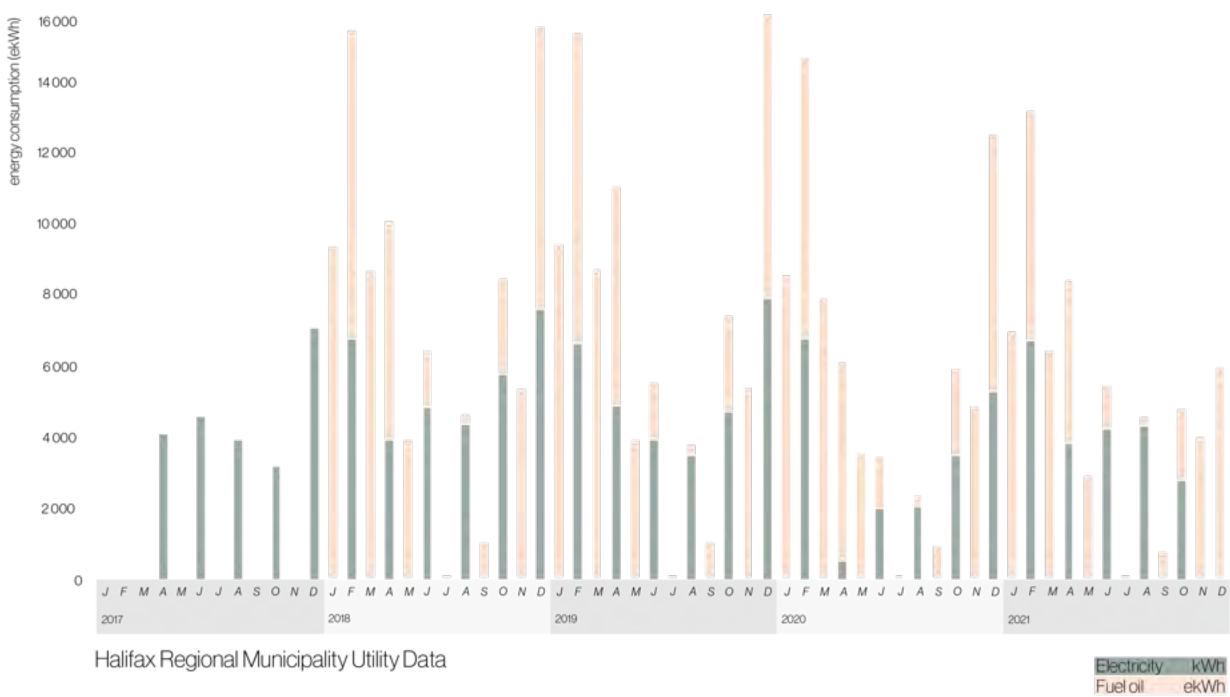

Figure 5 Historic Energy Use

Baseline Energy Model and Calibration

Whole building energy modeling was conducted with eQUEST to understand existing performance and to inform the development of retrofit scenarios. Energy model inputs (Appendix G) were based on data and documentation described earlier in this report and in consultation with HRM staff on occupancy patterns and operational set points of the mechanical and electrical equipment.

The heating system is complex with three heat sources operating on different schedules. The boiler is the primary heat source and is set to 15°C year-round. This is occasionally adjusted to 18-20°C in extremely cold weather. The two heat pumps operate at 20-21°C in the heating season and 18-19°C in summer. These are in use only when the building is occupied. The solar air heater is operational; however, its contribution is not believed to be significant, and it was excluded from the energy model.

The energy model was calibrated with historical utility data to closely reflect the current building performance. The modeled electrical consumption deviates from the existing usage by 3.4% and modeled fuel oil deviates by 0.8%.

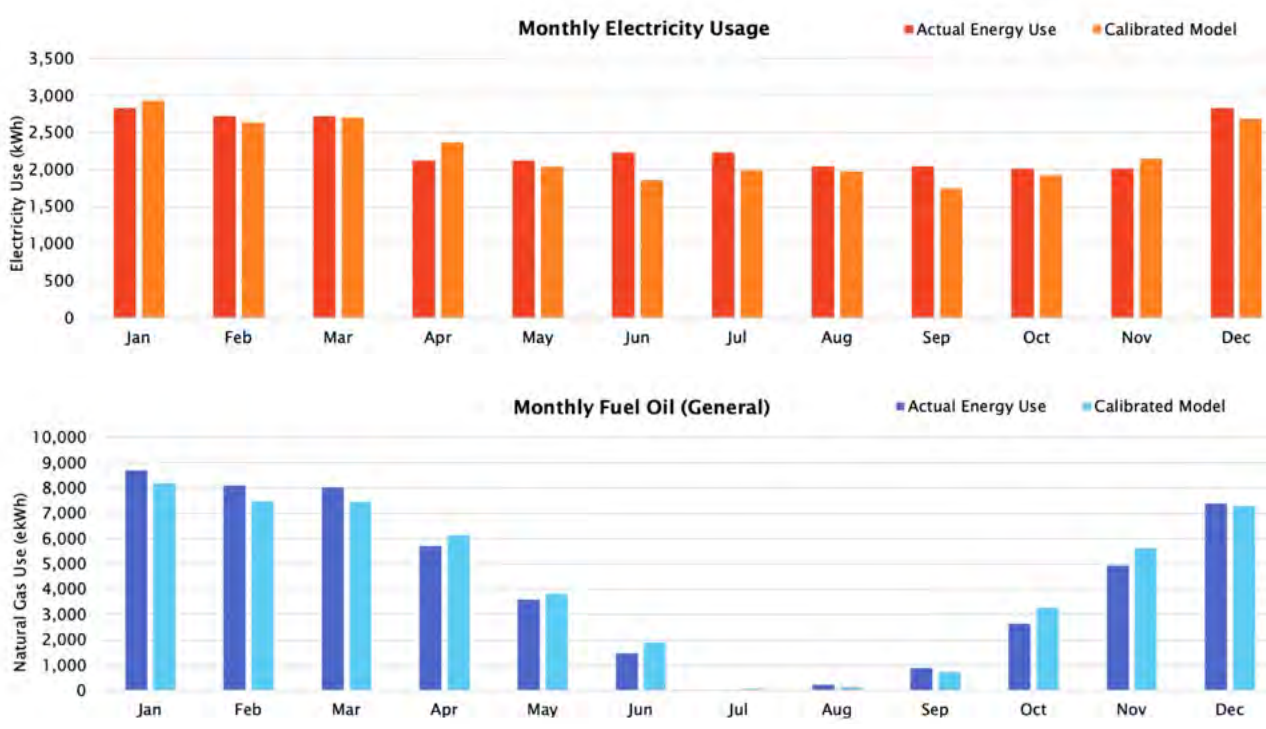

Figure 6 Calibrated Energy Use

The average Canadian daycare has an EUI of 230 kWh/m^2 and the average Canadian recreation facility has an EUI of 308 kWh/m^2 (this excludes high EUI occupancies such as ice rinks, swimming pools etc.).[5] Harrietsfield Williamswood Community Centre has an EUI of 145.9 ekWh/m^2/yr. It is 35% more efficient than the average daycare and 50% more efficient than the average rec centre.

This below average EUI can be partly attributed to the impact of the heat pumps and LED lighting in the building, but it is also due to the lack of ventilation. The Thermal Energy Intensity Demand (TEDI) gives a breakdown of heat losses by building component in the existing building. Ventilation heat losses account for only 2% of overall heat loss (Figure 7).

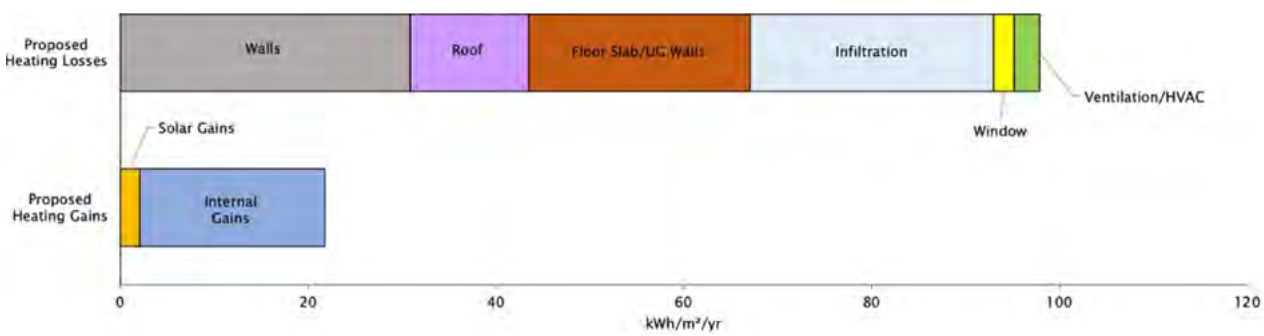

Figure 7 Thermal Energy Demand Intensity (TEDI) kWh/m^2/yr

[5] Energy Star (2021) Technical Reference. Canadian Energy Use Intensity by Property Type, https://portfoliomanager.energystar.gov/pdf/reference/Canadian%20National%20Median%20Table.pdf

Results

The design team worked collaboratively to develop retrofit scenarios targeting the project objectives. The analysis assumes a 'like for like' retrofit where space usage, occupancy schedules, internal geometry, volume of conditioned space, and window and door dimensions and locations are consistent with existing conditions.

The strategy for building enclosure upgrades is to retrofit the walls with prefabricated ReCover panels and to increase the depth of cellulose insulation in the roof. The existing roof can hold a few more inches of cellulose insulation, however for net-zero performance a new roof with a raised heel truss is necessary since a panelized approach is not possible.

Energy Conservation Measures

Energy conservation measures (ECMs) for the following four scenarios were developed:

1. **Minimum Upgrade** Scenario targeting a 50% reduction in TEUI from the baseline.
2. **NZER – ASHP** targeting a 75% reduction in TEUI from the baseline.
3. **NZER - GSHP** targeting a 75% reduction in TEUI from the baseline.
4. Net Zero Energy (**NZE**).

Building enclosure upgrades were developed for each scenario with post-retrofit airtightness targeting 0.5 L/s·m^2, a 75-80% reduction from the existing air infiltration. All scenarios propose upgrading to high performance windows.

Mechanical and electrical retrofits were developed based on ease of integration with existing systems and installation cost. All scenarios involve the full electrification of the building's mechanicals. As the building has a high occupant density, the heating and cooling systems were designed around the cooling loads. Each scenario includes the addition of high-performance ventilation.

For the NZER scenarios, both air source heat pumps (ASHP) and ground source heat pumps (GSHP) were considered in the design analysis. A GSHP is more energy efficient than an ASHP, however the capital costs of installing a GSHP system are typically much higher. Depending on the specific building details it is not immediately apparent which option is the better investment. The Net Zero Energy scenario is based on the GSHP option which resulted in the lowest TCBO.

Details of the retrofit scenarios are summarized in Table 2.

Table 2 Retrofit Scenarios Summary

	Existing Building	Minimum Upgrade	NZE – ASHP[1]	NZE – GSHP[1]
Effective Wall R-value	RSI-2.11 (R-12)	2x4 ReCover panel. RSI-4.23 (R-24)	2x10 ReCover panel. RSI-7.04 (R-40)	2x10 ReCover panel. RSI-7.04 (R-40)
Effective Roof R-value	RSI-4.23 (R-24)	Top up existing insulation with loose cellulose, RSI-6.16 (R-35)	New truss roof, increase loose cellulose to RSI-10.5 (R-60)	New truss roof, increase loose cellulose to RSI -10.5 (R-60)
windows	Vinyl, double glazed RSI-0.44 (R-2.5)	triple pane RSI-1.02 (R-5.56)	triple pane RSI-1.02 (R-5.56)	triple pane RSI-1.02 (R-5.56)
Air Tightness (L/s·m^2 at 75Pa)	2.3 L/s·m2	0.5 L/s·m2	0.5 L/s·m2	0.5 L/s·m2
Central Heating Equipment	Oil-fired boiler with single stage burner	Electric boiler (primary heat source)	Electric boiler	Ground source VRF (primary heat source), electric boiler
Heating System	Hydronic baseboards, 2 mini split units, and solar wall air heater	Hydronic baseboards[2] Existing + 2 new mini split units	Hydronic baseboards[2] Existing + 2 new mini split units (primary heat source)[3]	Hydronic baseboards[2], VRF indoor units
Air Conditioning	2 mini split units	existing + 2 new mini split units	existing + 2 new mini split units	VRF indoor units
DHW Equipment	Winter: tankless coil in boiler Summer: Electric water heater	Existing Electric Water Heater	Heat pump Water Heater	Heat pump Water Heater
Ventilation Equipment	none	90% SRE ERVs [4]	90% SRE ERVs [4]	90% SRE ERVs [4]
Electrical Service		Combine services in a new 400A main panel	Combine services in a new 400A main panel	Combine services in a new 400A main panel
Solar PV	none	none	51kW (DC)	51kW (DC)

[1] Net Zero Energy Ready systems are identical with exclusion of renewables.
[2] Includes extending the hydronic baseboard heaters into the daycare office.
[3] sized for 60% of the heating load.
[4] SRE ERV: Sensible heat-recovery efficiency energy/enthalpy recovery ventilator (Tempeff Dualcore or similar).

Table 3 Retrofit Scenarios EUI Reductions			
	Target TEUI	TEUI kWh/m^2	TEUI reduction
Existing	-	145.9	-
Minimum Upgrade	50% savings	80.9	45%
NZER – ASHP	75% savings	59.8	60%
NZER – GSHP	75% savings	59.7	60%
NZE	100% savings	0	100%

The modeled performance of the Minimum Upgrade and NZER scenarios does not meet the EUI reduction targets. This is primarily due to the impact of adding code compliant mechanical ventilation in the retrofits, which offsets some of the savings from the energy conservation measures. Figure 8 shows the TEUI comparison between the scenarios. Scenario 1 is the minimum upgrade and scenario 1b is the minimum upgrade with ventilation excluded. Without ventilation the minimum upgrade TEUI is 59.6 kWh/m^2, a 60% reduction over the existing.

The decision was made to proceed with the proposed ECMs despite falling short of the targets as net-zero performance was achievable with only 60% EUI savings and further upgrades would not be cost-effective.

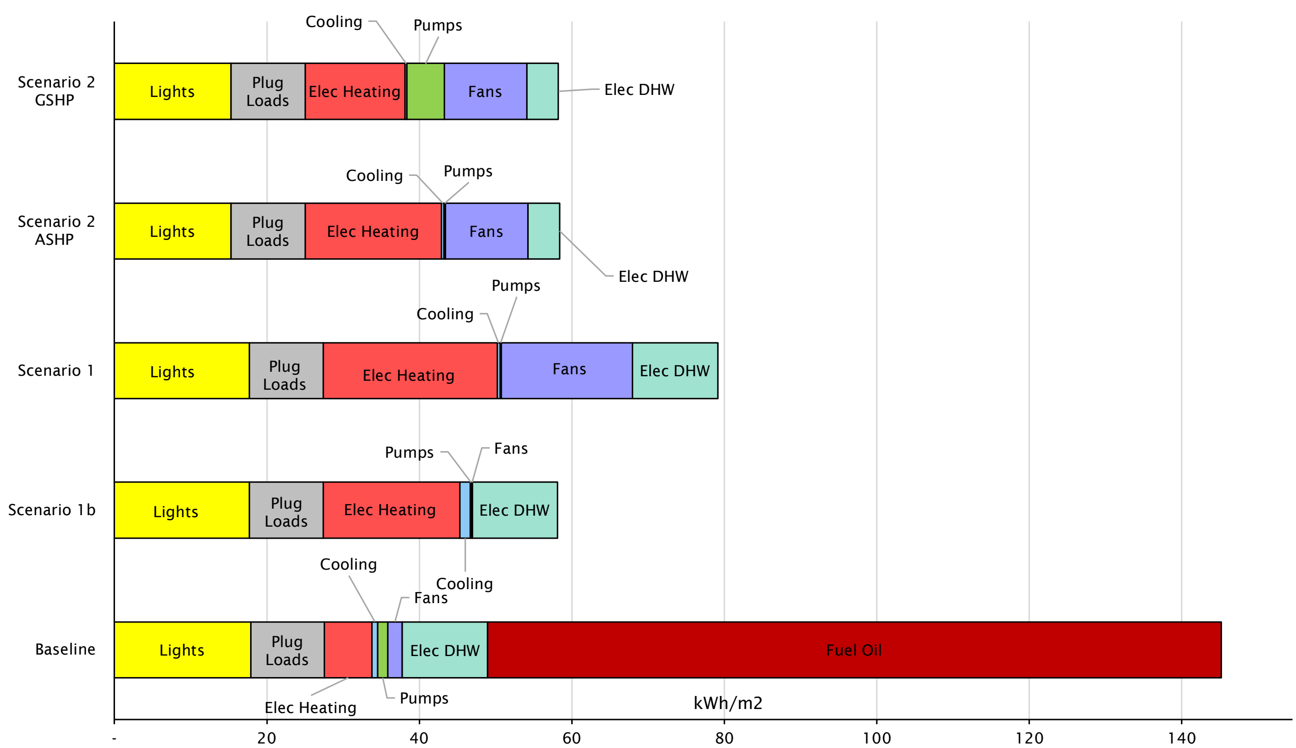

Figure 8 ECM Scenarios TEUI comparison

Design

Figure 9 Design South View

Aesthetic alterations may benefit the energy performance of the Harrietsfield Williamswood Community Centre. As noted earlier in this report, the building has a low window to wall ratio and its windows are obscured with security grilles. While glazing is thermally inferior to insulated walls, natural light and passive ventilation could meaningfully reduce energy use as lighting loads make up 25% of total energy used in the NZER scenarios.

To accurately evaluate the design options, the pre- and post-retrofit scenarios were modeled in a "like for like" manner. For this reason, increasing the glazing ratio was not explored in the study, however it is recommended that future design phases study the benefits of increasing window area on occupant comfort and lighting loads.

Replacing metal window grilles with alternative security measures such as improved exterior lighting and cameras would reduce obstruction to light and air flow through the windows. These measures may further reduce the EUI and provide less quantifiable benefits in increased comfort and enjoyment of the building by the users.

Currently the street elevation of the building is opaque and unfriendly. The concept design adds windows in the original overhead door openings and a timber shading device to filter light. This will screen sightlines of the daycare space from the street and mitigate overheating from late day sun. The doors at the public entrances are glazed to welcome in community members and daycare clientele.

The retrofitted walls and roof are clad with corrugated metal with wood accents at the entrances for a sense of warmth. Metal siding is an economical and environmentally responsible cladding option. It is highly durable and long-lasting, with a low lifetime maintenance burden, and at its end of life, it can be recycled or repurposed.

The new roof pitch is increased to 8:12 and the roofline simplified, eliminating several junctions that are present in the current roof. This provides more area for solar panels and reduces the potential for air and water leaks.

HRM has reported that vandalism has been experienced at the site. Attractive buildings can foster positive interactions between community members, and a heightened sense of community can positively influence issues such as littering, vandalism and crime.[6]

Architectural Elevation drawings are provided in Appendix L.

Figure 10 Concept Design Partial West Elevation-Section

Panelized Wall Details

The prototype ReCover panel is a wood framed box which holds carbon storing cellulose insulation. The depth of the frame is flexible depending on the needed performance.

The panel components were specified to minimize moisture risks by shedding precipitation on the outside and by promoting drying activity to the exterior through the panel assembly. This is important as the existing assemblies include vapour retarding materials, including polyethylene vapour barrier and rigid foam insulation, which will inhibit drying to the interior of the building. These materials will also inhibit outward vapour drive, from the interior into the panels, however given the age and condition of the building it is highly unlikely that these materials comprise a continuous vapour barrier. The panels are be designed to promote any moisture movement that occurs from the interior to dry to the exterior.

[6] Ramey, D., & Shrider, E. (2014). New Parochialism, Sources of Community Investment, and the Control of Street Crime. *Criminology and public policy*, 13, 193-216. https://doi.org/10.1111/1745-9133.12074.

Strapping on the interior side of the panel permits fitting adjustments against the existing walls and provides an internal air cavity that serves as a moisture buffer space for vapour diffusion from the inside to pass out through the panels. The frame backing layer is a “smart” vapour control membrane which varies in permeability depending on the relative humidity of its environment. If moisture is present between the panel and the existing walls the membrane fibers open to let moisture escape. Wood panel framing, plywood sheathing and cellulose insulation are all hygroscopic materials, meaning their fibers transport moisture from areas of higher humidity to those of lower humidity. A vapour-open water-resistive barrier (WRB) protects the outer plywood sheathing and provides a drainage plane behind the rainscreen cavity and metal siding.

Proposed NZER Scenario Panel RSI-4.8 (R-27)

1. metal cladding [7]
2. 19mm strapping/rainscreen cavity.
3. WRB membrane
4. plywood sheathing
5. dense-pack cellulose
6. framing: 2x10 frame with staggered studs[8]
7. variable permeability vapour control membrane
8. interior strapping

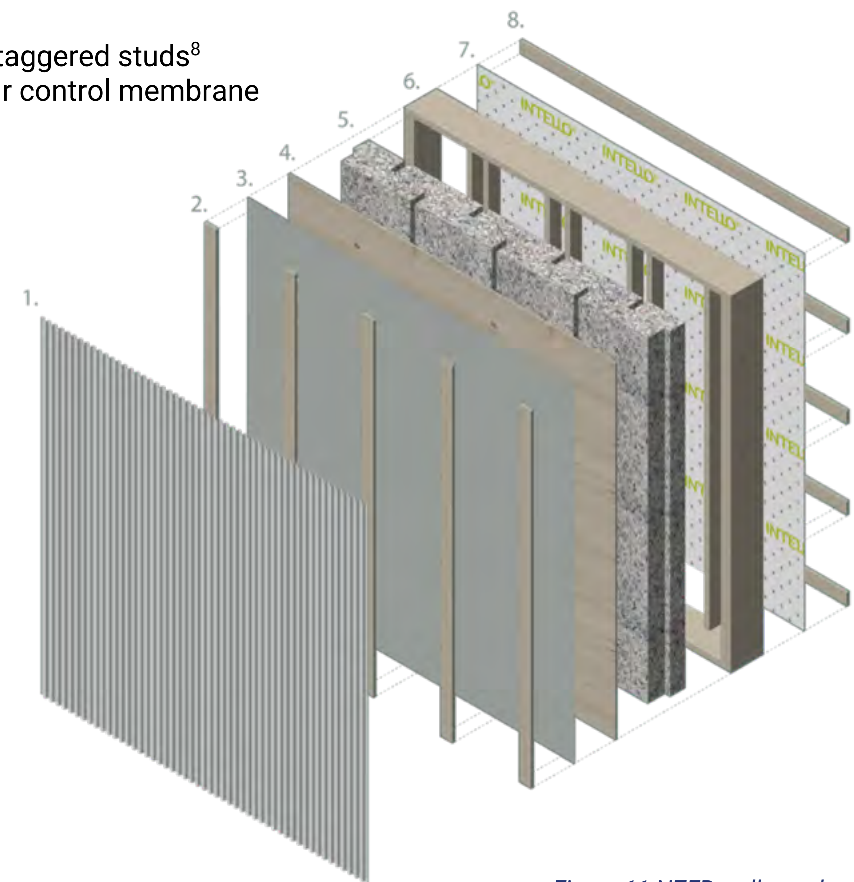

Figure 11 NZER wall panel

Panel schematics and connection details for each scenario are in Appendix H.

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[7] Panels will be assembled remotely; however, the cladding will be installed on site.
[8] Minimum Upgrade scenario panel is RSI-1.94 (R-11) with 2x4 stud framing at 24” o.c.

Structural Design

- Panels are fastened at the top and bottom only, with no mid-span connections.
- Panel heights in the proposed layout vary, and where panels exceed 3658mm (12') tall, must be framed with 2x6s. The proposed panel layout is provided in Appendix I.
- Panels are supported at the base by a steel bent plate lintel fastened to the concrete foundation wall and secured to the top of the CMU with Simpson Strong-Tie tie plates (Figure 12).
- New roof trusses bear on a new knee wall and continuous double top plate which runs between the existing trusses (Figure 12).

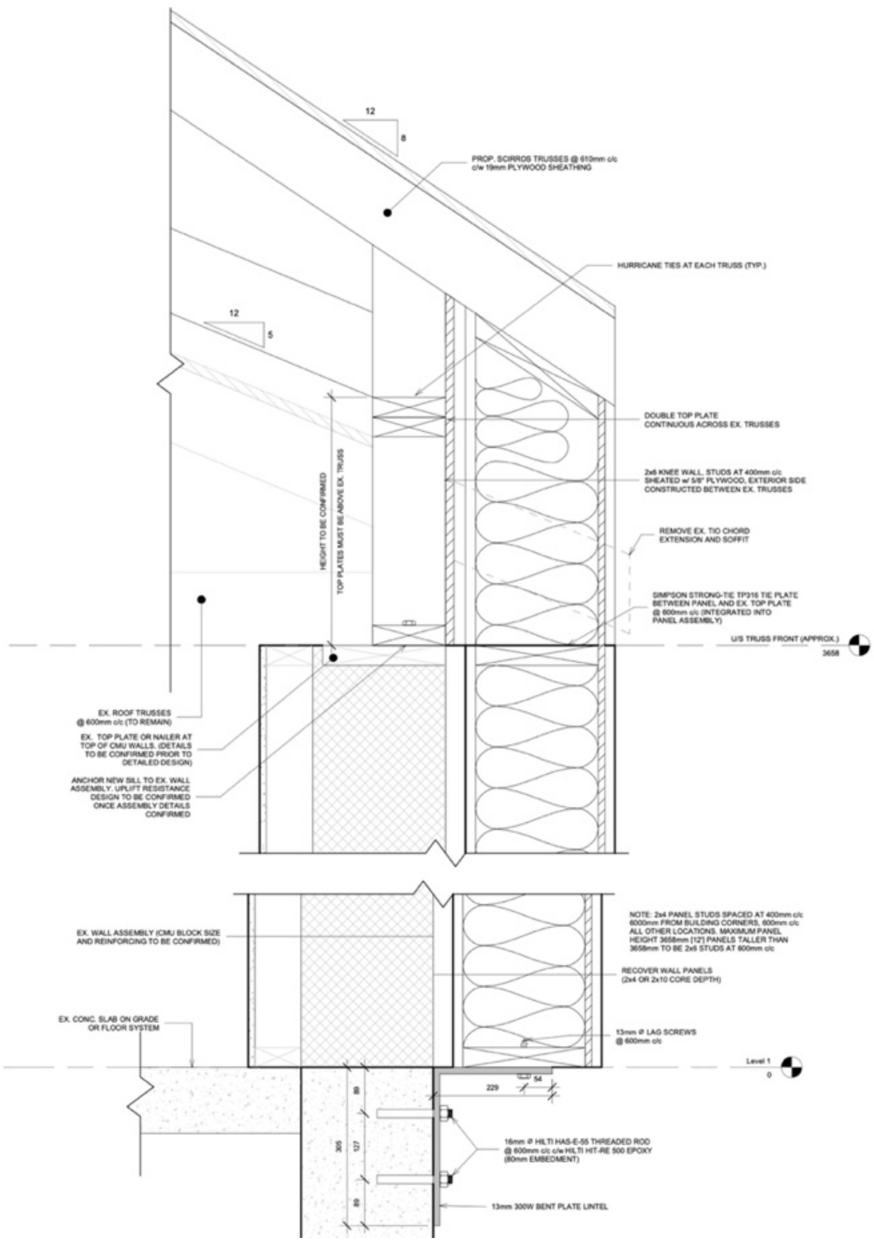


Figure 12 Panel connections at foundation and roof.

The panel widths vary based on optimized spacing around the building with a standard width of 2.4m (8') with modifications to suit the building geometry and window and door positions. The design includes prefabricated corner panels, to simplify installation in the field. These are 0.6m (2') wide in each direction.

The proposed panel layout is provided in Appendix I.

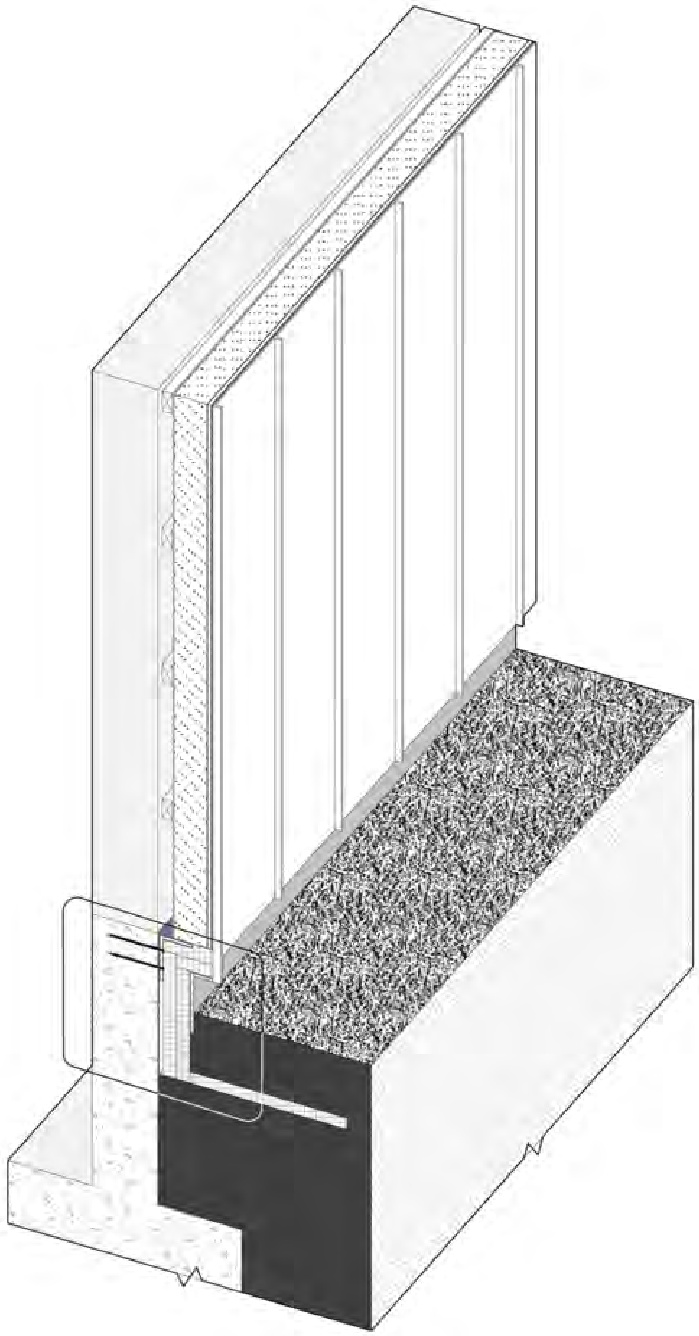


Figure 13 panel axonometric drawing

Foundation Insulation

The angled steel panel support at the foundation is a linear thermal bridge and should be fully covered by 100mm (4") of expanded polystyrene or mineral wool insulation to reduce heat losses and prevent localized condensation on the steel.

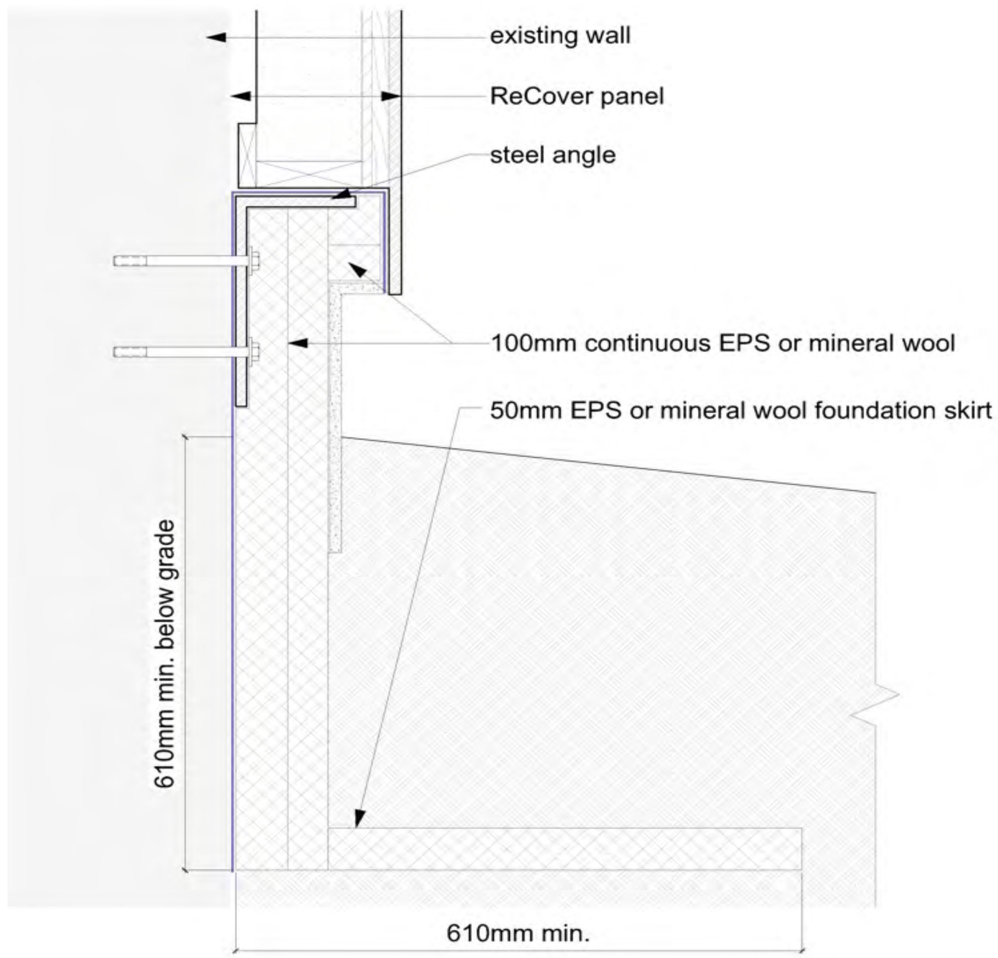


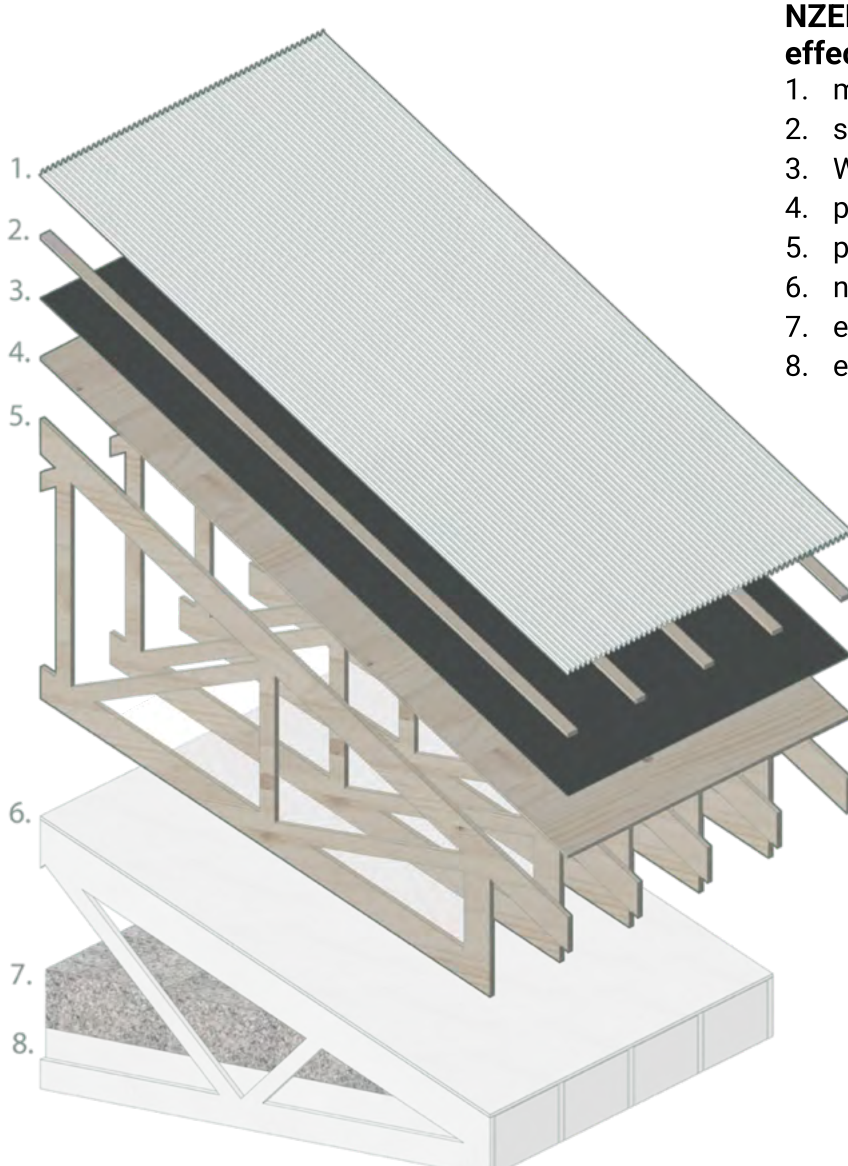
Figure 14 foundation insulation

Roof Details

A panelized roof retrofit is not a viable solution for the Harrietsfield Williamswood Community Centre as the existing roof cannot support added loading.

In the Minimum Upgrade scenario, the existing roof structure will remain, and the depth of the loose cellulose insulation will increase to bring thermal performance from RSI-4.23 to RSI-6.16.

In the NZER scenarios, pre-engineered scissor trusses will be installed above the existing roof, with loose cellulose insulation added to the existing cellulose to bring performance from RSI-4.23 to RSI-10.5. Generous openings will be made in the existing roof sheathing to provide a highly ventilated attic volume.



NZER Scenario Roof effective RSI-10.6 (R-60)

1. metal roofing
2. strapping
3. WRB membrane
4. plywood sheathing
5. pre-engineered roof trusses
6. new cellulose insulation
7. existing cellulose insulation
8. existing roof trusses

Figure 15 NZER Roof

Hygrothermal Modeling

The analysis of moisture and temperature over time is called hygrothermal analysis. Adding new materials to the exterior of a building can slow or block moisture from passing through, and prolonged exposure to moisture in the building assemblies can lead to durability issues including mold growth and decay.

Hygrothermal simulations were conducted on the Harrietsfield Williamswood Community Centre NZER wall and roof assemblies using WUFI® Pro (Appendix J). The analysis focused on the plywood sheathing and cellulose insulation in the assemblies, as biogenic materials are most susceptible to moisture damage. When moisture content of wood exceeds 20% for prolonged periods it can decay.

Hygrothermal performance is dependent on the material characteristics of each component of a building assembly. Assumptions were made regarding the materials in the existing walls and roof. Confirmation of the assumptions is required prior to finalizing the retrofit designs.

Simulations were run for each orientation of each assembly for a 10-year period post-retrofit. All assemblies displayed cyclical seasonal moisture fluctuations consistent with expectations for buildings in the Nova Scotia climate. Specifically, moisture content peaks in winter, with the greatest peak occurring in the first year post-retrofit, and spikes decrease in subsequent years. A moisture spike that exceeds 20% in one winter does not typically damage the building if drying occurs in the summer. Spikes above 20% that persist for several years indicate a potential for mould and eventual decay.

Most of the materials analyzed demonstrate a pattern like the one shown in Figure 16.

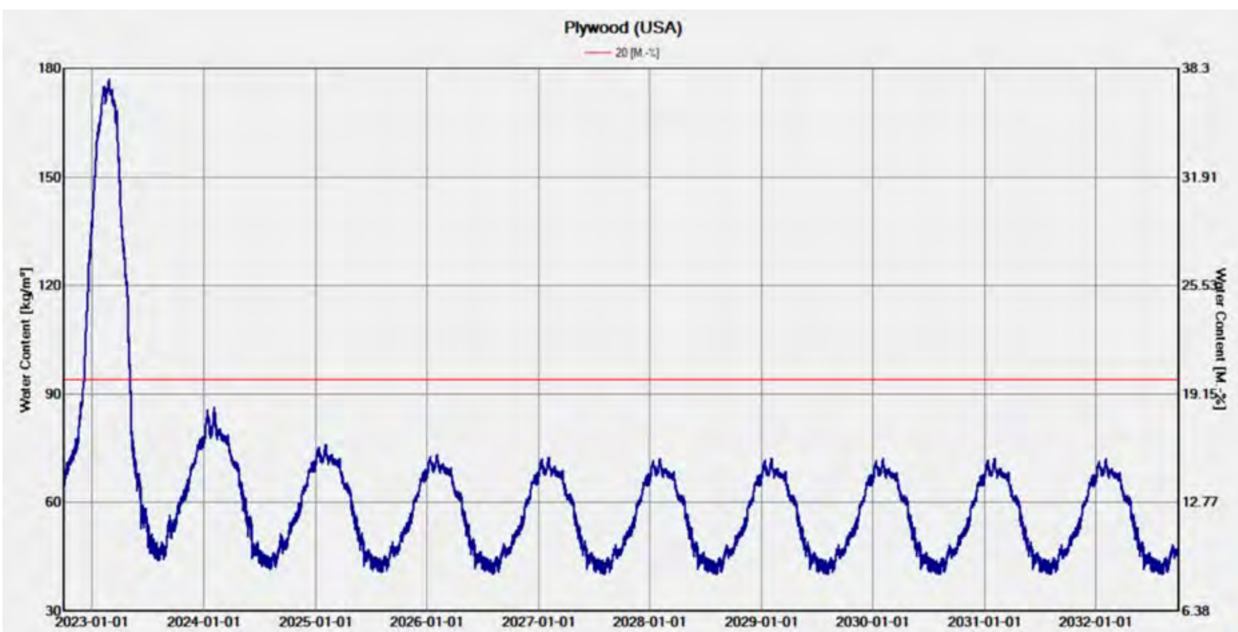


Figure 16 WUFI Pro output - north-west bump-out wall panel (inner plywood layer)

The east walls show annual spikes exceeding 20% moisture content in the outer layer of plywood in all 10 years of the analysis. This is indicative of risk but requires additional modeling after determining the actual materials in the existing assemblies. An alternate sheathing, such as gypsum based sheathing board, can be used for these walls if future modeling has the same results. Installing hygrothermal monitoring sensors in some assemblies may be valuable during the retrofit to compare modeled results with real data to inform future retrofits.

The post-retrofit building will have two attic spaces, a sealed inner attic and a ventilated outer one. Analysis of the roof assembly indicates that it should be designed with careful attention to venting. The attics will perform best with attic air exchange between 5-10 air changes per hour (ACH) however the best design from an airtightness perspective is for the existing attic to be airtight. Investigation of the existing roof to confirm the presence of a vapour barrier and other material specifications is necessary to make a definitive determination on roof venting.

The analysis identified the potential for mold growth in the fiberglass batt insulation in the existing main wall assemblies. Masonry can absorb and release a high volume of water. The current moisture load likely dries to the exterior, but adding layers to the wall may inhibit drying. Additionally, this wall is believed to have a polyethylene vapour barrier, which would block moisture from drying to the interior.

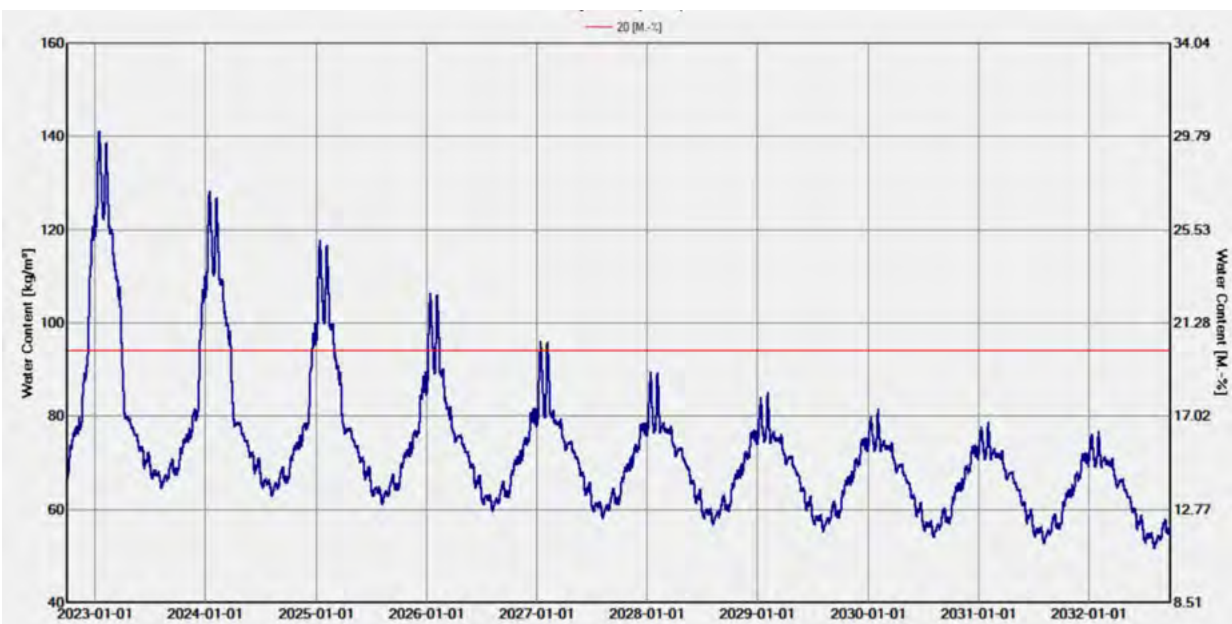


Figure 17 WUFI output - north-east roof assembly (inner plywood layer)

If the retrofit proceeds, is recommended that hygrothermal monitoring be implemented on selected assemblies to verify actual performance against modeling.

Embodied Carbon

With the short time remaining to limit the impacts of climate change, it is not responsible to complete retrofits that reduce long-term operational emissions while emitting high up-front embodied carbon. Materials used in retrofits must emit the lowest possible carbon or the construction emissions may offset the intended GHGs saved through the retrofit.

Carbon accounting is complex and imperfect. This is frequently used as justification for not factoring embodied carbon into decision making. The objective of including it in this study is not to deliver a definitive value for embodied carbon in the building, rather it is to contribute to the necessary discourse in the building industry, so that the impacts of embodied carbon on GHG emissions are more widely understood.

Embodied Carbon was modeled for this project in One Click LCA (Appendix K). Materials modeled were based on the most representative materials available to the Canadian market with Environmental Product Declarations (EPDs) available in the One Click LCA database. The analysis was limited to embodied carbon of assembly materials being added to the existing building including panel additions to above-grade walls, roofs, below-grade components, and windows and doors. HVAC and electrical components were excluded from the analysis.

The results include a whole life cycle assessment of the building in six impact categories: Global Warming, Ozone Depletion, Acidification, Eutrophication, Formation of tropospheric ozone, Depletion of nonrenewable energy, and Biogenic carbon storage.

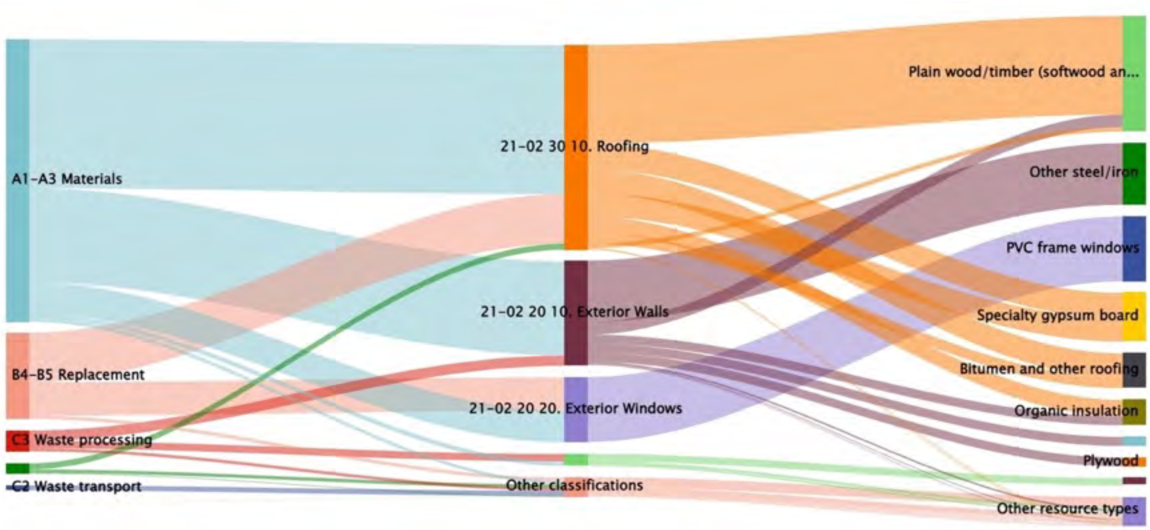


Figure 18 Life Cycle Impacts by Stage (%)

The major contributors to the GWP in this design are the wood trusses and steel cladding. The A1-A3 Materials stage contributed 70% of the total carbon emissions associated with this building as illustrated in Figure 18 & 19.

Table 4 Total Global Warming Potential			
gross floor area m^2	A1-A3 KgCO2e/m^2	A1-C4 KgCO2e/m2	Biogenic carbon KgCO2e/m2
456	**60.56**	**86.86**	**151.1**

The biogenic carbon storage surpasses that of the A1-C4 emissions by 43%, making a surplus in carbon storage capacity (Table 4). This storage is attributed to the wood products (87%) and cellulose insulation (13%) used in the assemblies (Figure 20).

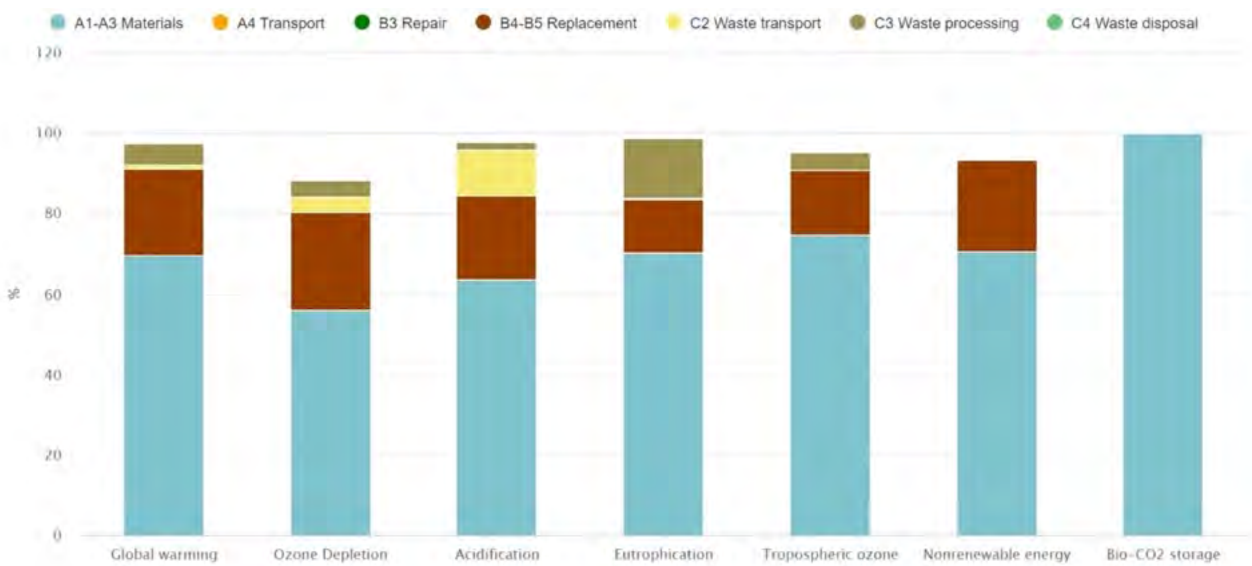


Figure 19 Global Warming by Stage and Material

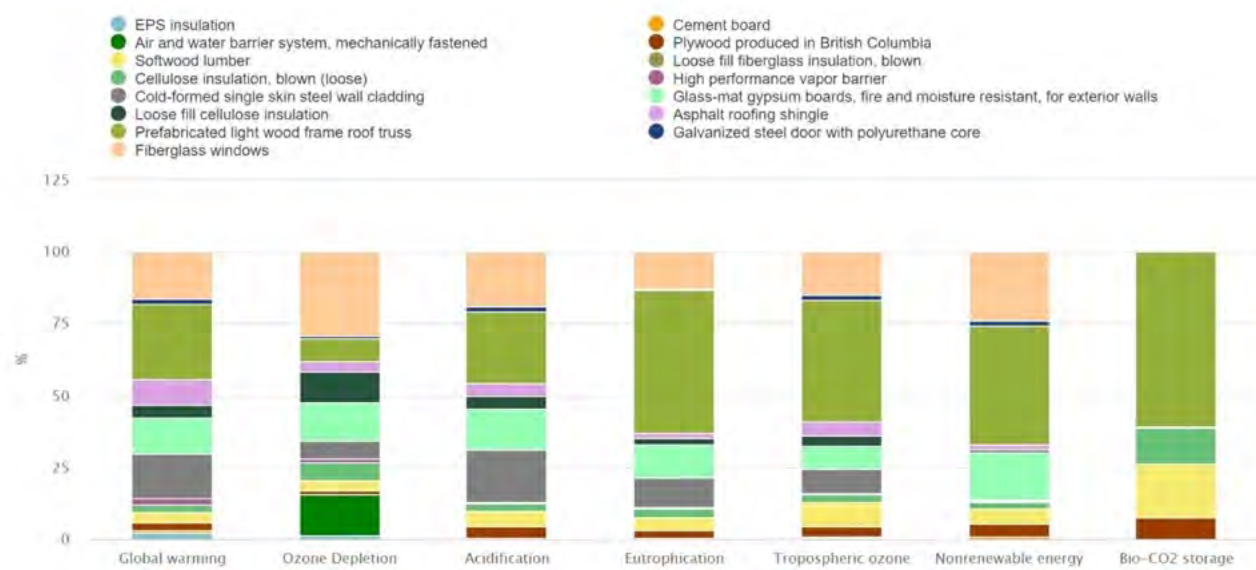


Figure 20 Life Cycle Impacts by Material (%)

Proposed Mechanical Systems

All scenarios:

- All scenarios are fully electrified.
- Plumbing vents that penetrate the roof are to be insulated from ceiling to floor with 3" pipe insulation to prevent thermal bridging.
- Hydronic baseboard heaters will be extended into the daycare office area.
- Existing building controls will remain with the addition of time clocks to ERVs.
- An auxiliary heat relay system will control both the mini split units and hydronic baseboards to ensure simultaneous heating and cooling does not occur.
- Two energy recovery ventilators (ERVs) will be added in the daycare and multipurpose areas. They will be dual core type with approximately 90% heat recovery efficiency.

1. Minimum Upgrade Scenario:

- Heating will continue to be provided by a combination of existing mini split units and hydronic baseboard heaters which will be served by a new 25 kW electric boiler.
- Cooling will be provided by a combination of new and existing mini split units. A 0.5-ton and a 1-ton unit will be installed for a total of 4 units in the building.
- Domestic hot water will be supplied by the existing electric water heater.
- Two energy recovery ventilators (ERVs) will be added in the daycare and multipurpose areas. They will be dual core type with approximately 90% heat recovery efficiency.

2. NZER – ASHP:

- Heating and cooling will be served by a combination of existing mini split units and two new single zone mini split units (0.5-ton and 0.75-ton) with indoor units in the daycare and multipurpose rooms. Heat pumps are sized to meet 60% of the peak heating load.
- 10 kW electric boiler sized for the remaining 40% of the load. Heating from the boiler will be distributed through the existing hydronic baseboards.
- Domestic water provided by a new 50-gallon heat pump water heater (HPWH).
- As ventilation loads are occupant dependent, the ERVs will have variable speed fans and be controlled by CO_2 sensors—one in the multipurpose room and one in the daycare.

3. NZER – GSHP:

- Heating and cooling will be provided by a 5-ton VRF ground source heat pump with ductless indoor units. It will be sized for 100% cooling capacity. Proposed borehole locations are shown in Figure 23.
- 5 kW electric boiler will serve as supplemental heat.
- The GSPH will use the existing hydronic baseboards, served from the new boiler.
- Domestic water provided by a new 50-gallon heat pump water heater (HPWH).
- As ventilation loads are occupant dependent, the ERVs will have variable speed fans and be controlled based on CO_2 sensors—one in the multipurpose room and one in the daycare.
- The GSHP and boiler plant will have direct digital control systems to operate equipment.

Proposed Electrical Systems

All Scenarios:

- Service upgrade to combine the two existing services into one single 400A service.
- Upgrade 2 light fixtures to LED (these were missed in earlier lighting upgrades).

1. Minimum Upgrade Scenario:
    - Existing lighting controls will remain.

2. NZER Scenarios
    - The lighting control system will be updated to include automatic lighting control throughout the building.

3. Net Zero Energy
    - 51kW (DC) solar pv array

Nova Scotia Power Net Metering Program

The current NS Power net metering agreement has expired. An update to the program is under review by the Nova Scotia Utility Review Board and Nova Scotia Power. Under the new net metering agreement, it is proposed to allow up to 1MW of solar to be installed on any building that incurs a demand charge. There will be two new classifications of net metered systems in the new program, a class 1 system which is under 100kW and a class 2 system which is under 1MW.

In the net metering program, 100% of the excess energy generated from the solar array goes back onto the NSPI grid, and the customer is credited for the energy generated. Under the new proposal, the credit will be a percentage of the customers electricity rate for class 2 systems and will be equal to the customers electricity rate for class 1 systems. The credits automatically come off the power bill, further reducing the cost, the more solar that is installed. Being involved in a net-metering program is an essential part of achieving net-zero as it allows any excess energy generated to flow back onto the grid. This building would be considered a class 1 building due to the size of the proposed PV array.

It is possible to install photovoltaics and not enroll in the net metering program. In this scenario, the building would draw power from the solar array as it is needed (up to the arrays maximum capacity). Any excess energy that is generated by the array is clipped (wasted) and no credit is given by the utility for that power. This scenario is only feasible if the customer routinely uses the approximate amount of power the array would generate. To optimize this, a short load study would be performed on the building to determine approximately how much energy is used at any given time of the day/ year, and an array of the average size could be constructed to offset that consumption. This scenario isn’t truly considered net-zero since to use 100% of the energy generated, the solar array must overproduce.

The net-metered option is recommended to ensure that a net-zero system can be achieved. As the conditions for the net-metering program are changing day to day, further consultation with Nova Scotia Power will be needed to ensure all requirements are met prior to construction.

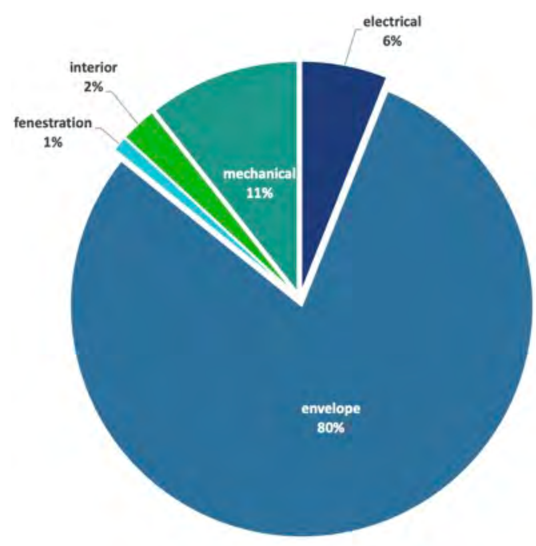
Construction Costs

Class D – Feasibility Cost Estimates (Appendix M) were obtained for the Minimum Upgrade, the two Net Zero Energy Ready scenarios and Net Zero Energy retrofit scenarios. The costs include all materials, labour, equipment, overheads, general conditions, plus markups and contractor's profit for the retrofit options. Pricing reflects competitive bids for every element of the work for a project of this type procured under an open market stipulated lump sum bid contract in Debert, Nova Scotia.

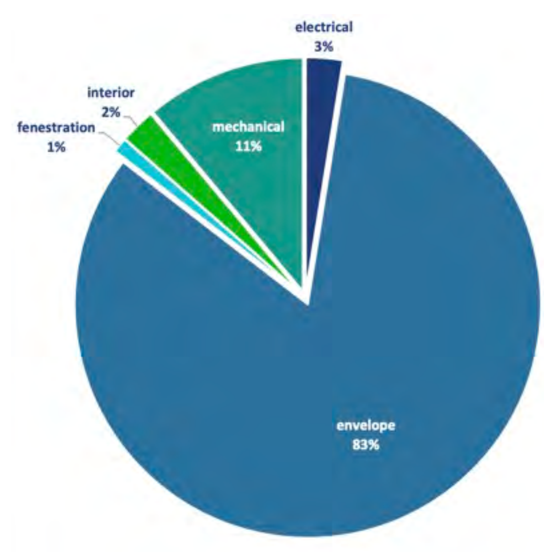
A Class D estimate is an indicative estimate of the final project costs and is expected to be within ±25% of actual costs.

A cost estimate for a fifth scenario, the Minimum Upgrade + Solar PV was extrapolated from data in the Class D estimates.

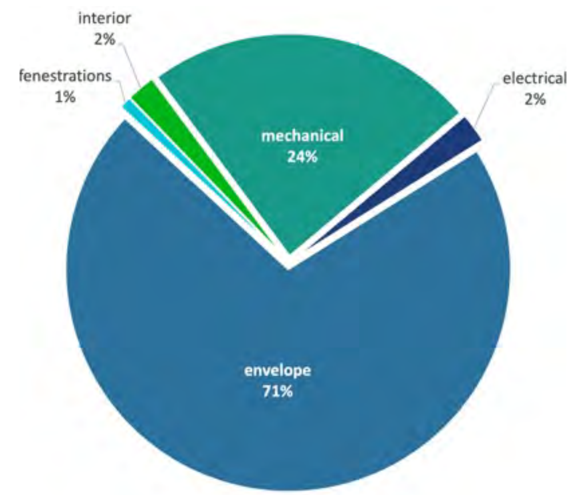
Minimum Upgrade	
Envelope	$921,031
Fenestration	$12,286
Interiors	$29,369
Mechanical	$122,524
Electrical	$69,790
total	**$1,155,000**



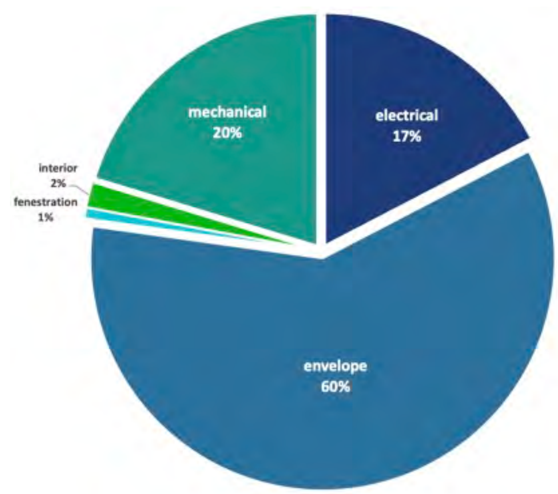
NZER ASHP	
Envelope	$994,999
Fenestration	$12,283
Interiors	$29,363
Mechanical	$133,216
Electrical	$30,624
total	**$1,200,486**



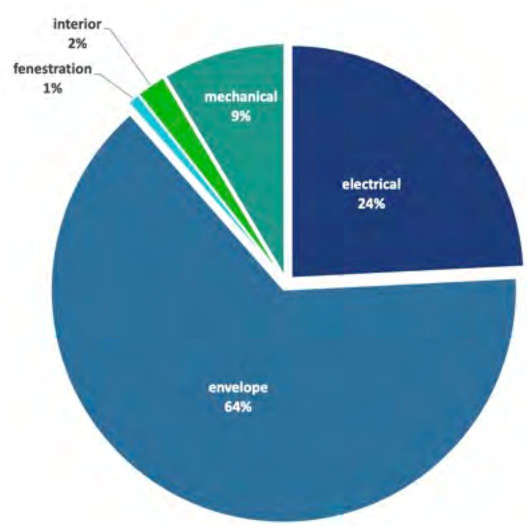
NZER GSHP	
Envelope	$994,717
Fenestration	$12,280
Interiors	$29,354
Mechanical	$337,538
Electrical	$29,3544
total	**$1,404,505**



NZER GSHP + PV	
Envelope	$994,717
Fenestration	$12,280
Interiors	$29,354
Mechanical	$337,538
Electrical	$288,958
total	**$1,662,998**



Minimum Upgrade + PV	
Envelope	$921,031
Fenestration	$12,286
Interiors	$29,369
Mechanical	$122,524
Electrical	$346,582
total	**$1,431,792**



Total Cost of Building Ownership

Total Cost of Building Ownership (TCBO) analysis was conducted using the SEEFAR-Valuation© program. Calculations include costs for utilities, carbon tax, maintenance, maintenance capital (replacing major components as they age out), interest, and escalation of these costs over time. TCBO analysis typically includes property tax and insurance, however the building is not subject to property tax and insurance costs were not quantifiable as the building is covered through a blanket policy where costs for one specific building can't be isolated. The input parameters for the SEEFAR-Valuation© are given in Appendix N.

The following tables present a comparative analysis of the existing **base case** TCBO and each of the retrofit scenarios explored by the design team. A base case TCBO was evaluated based on the current condition of the building and the maintenance and renewal that would be required for the next 60 years for all components of the building, including interior elements. The TCBO for each retrofit scenario was modeled based on the design details, modeled energy performance and construction cost estimates for the retrofit scenarios outlined in this report.

A sixth scenario was modeled as part of the TCBO that was not considered in the other five buildings in this study, the Minimum Upgrade scenario plus solar. This scenario is possible because the building is fully electrified in the Minimum Upgrade scenario. This scenario resulted in the best TCBO for the building.

Table 5 TCBO Summary

	Base Case	Min. Upgrade	NZER - ASHP	NZER - GSHP	NZE	Min + Solar
GHG emissions (kg) (60 Years)	1,854,060	1,762,328	1,302,802	1,298,862	0	0
EUI (kWh/m2/year)	146.0	80.9	59.8	59.6	0.0	0.0
TCBO at 60 years	**$4,917,000**	**$5,140,000**	**$4,517,000**	**$4,839,000**	**$3,442,000**	**$3,102,000**
TCBO Savings at 60 years	$0	-$223,000	$400,000	$78,000	$1,475,000	$1,815,000
% diff. from Base Case	-	-5%	8%	2%	30%	37%

Key TCBO Results:

- The base case TCBO is $4.9M, about three times the estimated Cost Replacement Value (CRV) of $1.75M.
- The minimum upgrade scenario uses 45% less energy than the base case but costs 5% more in lifetime operating costs.
- The Net Zero Energy Ready options use 60% less energy but offer less than 10% savings in lifetime operating costs.
- The Net Zero Energy retrofit provides 100% energy savings, and a $1.47M reduction in lifetime operating costs over a Net Zero Energy Ready retrofit.
- The lowest TCBO is the Minimum Upgrade plus which delivers a 37% reduction in lifetime operating costs, for a savings of $1.8M.

Table 6 Operating Cost Summary	Base Case	Min. Upgrade	NZER - ASHP	NZER - GSHP	NZE	Min + Solar
Utilities (including carbon tax)						
Cost	$ 2,972,000	$ 2,585,000	$ 1,922,000	$ 1,916,000	$ 42,000	$ 42,000
Diff. from Base Case	$ -	$ (387,000)	$ (1,050,000)	$ (1,056,000)	$ (2,930,000)	$ (2,930,000)
% diff from Base Case	0%	-13%	-35%	-36%	-99%	-99%
Energy Cost ($/ft2)	$ 509.51	$ 443.17	$ 329.50	$ 328.48	$ 7.20	$ 7.20
Maintenance						
Cost	$ 849,000	$ 186,000	$ 140,000	$ 140,000	$ 308,000	$ 414,000
Diff. from Base Case	$ -	$ (663,000)	$ (709,000)	$ (709,000)	$ (541,000)	$ (435,000)
% diff from Base Case	0%	-78%	-84%	-84%	-64%	-51%
Cost ($/ft2)	$ 145.55	$ 31.89	$ 24.00	$ 24.00	$ 52.80	$ 70.98
First Year Annual Maintenance						
Cost	$ 4,800	$ 1,600	$ 1,300	$ 1,200	$ 2,644	$ 3,559
Diff. from Base Case	$ -	$ (3,200)	$ (3,500)	$ (3,600)	$ (2,156)	$ (1,241)
% diff from Base Case	0%	-67%	-73%	-75%	-45%	-26%
Cost ($/ft2)	$ 0.82	$ 0.27	$ 0.22	$ 0.21	$ 0.45	$ 0.61

- The 60-year utility costs for the Base Case are 1.5 times the CRV of the building.
- The NZER options reduce the 60-year utility costs by 35%.
- A NZE retrofit reduces the energy cost by 99% to $42,000, which is the meter charge or minimum charge for the electrical service.
- In all retrofit scenarios maintenance costs are significantly reduced with maintenance for a NZE retrofit costing 51% less than the existing building.
- Insurance and property taxes would typically be in the TCBO but are not included here.

Parameters:

- The analysis start year is 2024. Utility, construction, and maintenance costs have been escalated to 2024. Construction costs have been escalated by 20% for 2022-23, and by 10% from 2023-24, or 32% over the two years.
- NS Power rates will increase by 7.1% in 2023 and 7.0% in 2024.
- Carbon tax for fuel oil came into effect in NS in 2023, it is calculated separately in the SEEFAR model and is not included in the fuel oil price.
- Carbon tax has been applied to electricity as it is expected to be passed on to the customer by NS Power.
- Solar panel maintenance is based on $28/kWdc/year.

Table 7 Capital Cost Summary

	Base Case	Min. Upgrade	NZER - ASHP	NZER - GSHP	NZE	Min + Solar
Initial Retrofit / HPB CostYear 1						
Initial Cost	$ 13,000	$ 1,369,000	$ 1,491,000	$ 1,708,000	$ 2,018,000	$ 1,646,000
Diff. from Base Case	$ -	$ 1,356,000	$ 1,478,000	$ 1,695,000	$ 2,005,000	$ 1,633,000
% diff from Base Case	0%	10431%	11369%	13038%	15423%	12562%
Cost ($/ft2)	$ 2	$ 235	$ 256	$ 293	$ 346	$ 282
Maintenance Capital Costs 60 Years						
Cost	$ 1,083,000	$ 1,001,000	$ 965,000	$ 1,075,000	$ 1,075,000	$ 1,001,000
Diff. from Base Case	$ -	$ (82,000)	$ (118,000)	$ (8,000)	$ (8,000)	$ (82,000)
% diff from Base Case	0%	-8%	-11%	-1%	-1%	-8%
Cost ($/ft2)	$ 186	$ 172	$ 165	$ 184	$ 184	$ 172
Retrofit / HPB + Maintenance Capital Costs 60 Years						
Total Costs	$ (1,096,000)	$ (2,370,000)	$ (2,456,000)	$ (2,783,000)	$ (3,093,000)	$ (2,647,000)
Diff. from Base Case	$ -	$ (1,274,000.00)	$ (1,360,000.00)	$ (1,687,000.00)	$ (1,997,000.00)	$ (1,551,000.00)
% diff from Base Case	0%	-116%	-124%	-154%	-182%	-142%

The Capital Cost Summary compares the first-year capital investment in maintaining the existing building with the construction costs for the retrofit scenarios. The capital costs for the retrofits have been escalated to 2024 values from the construction cost estimate. The retrofit costs are high because of the extensive work on the building enclosure and new mechanical systems and solar panels. The capital cost of the NZE scenario is more than the CRV of the building.

Maintenance capital is the cost of replacing major building components as they wear or age out. For example, the boiler needs to be replaced every 25 years. The costs to maintain the building in all scenarios is similar, at around $1M.

This analysis assumes that solar panels will not be replaced in the 60-year time frame of the analysis, but that they will undergo regular renewal through annual maintenance.

	Units	Base Case	Min. Upgrade	NZER - ASHP	NZER - GSHP	NZE	Min + Solar
Water	m3	-	-	-	-	-	-
Sewer Discharge	m3	-	-	-	-	-	-
Electric	kWh	26,995.00	43,839.00	32,408.00	32,310.00	32,310.00	43,839.00
Gas	m3	-	-	-	-	-	-
Heating Oil	Litres	4,812.00	-	-	-	-	-
GHG emissions	kg CO2 eq	30,901.01	29,372.13	21,713.36	21,647.70	-	-
Solar PV generated	kWh	-	-	-	-	32,310.00	43,839.00
Total	ekWh	79,125.00	43,839.00	32,408.00	32,310.00	-	-
Total	GJ	284.85	157.82	116.67	116.32	-	-
EUI	kWh/m2/yr	**145.96**	**80.87**	**59.78**	**59.60**	-	-

Table 8 Annual Energy Consumption

Key Results:

- Electricity consumption increases all retrofit scenarios due to electrification of the building's mechanical systems. Total annual energy consumption decreases all of the retrofit scenarios, and the NZE scenarios have zero consumption.
- GHG emissions and EUI are reduced across all retrofit scenarios.
- The minimum upgrade reduces GHGs and EUI by 45%.
- The NZER options reduce GHGs and EUI by 60% and the Net Zero Energy retrofits reduce GHGs by 100%.
- A new NS Power net metering policy is proposed to be adopted later in 2023. The building could be net-positive if policy permits.

Notes:

- Water consumption and sewer discharge were not measured. The cost of annual septic tank pumping is $4900/year, but as the system is shared with the elementary school on the adjacent site and as the cost is consistent in all scenarios, it was excluded from the analysis. There may be an opportunity for savings by replacing plumbing fixtures, but that was not undertaken in this study.
- The electrical rate for the Base Case is the domestic rate for two meters.
- The electrical rate in the retrofit scenarios assumes conversion to commercial billing.
- The minimum upgrade has a slightly higher electric rate because the anticipated demand for the electric boiler will be higher.
- The Net Zero options have a slightly lower demand charge and, thus, a lower average electricity rate.

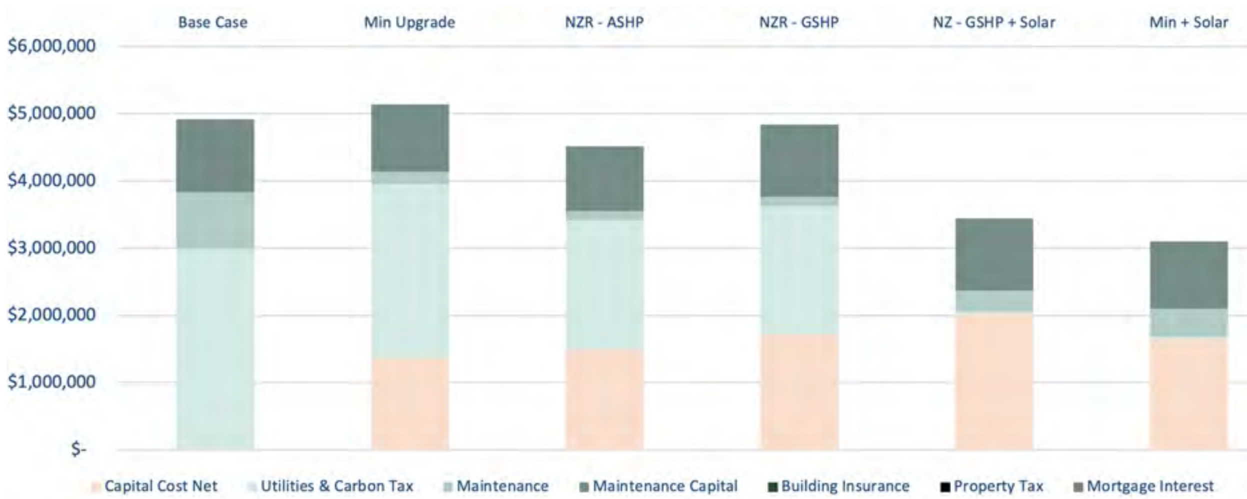


Figure 21 TCBO Comparison

Cumulative TCBO

The existing building has the lowest TCBO for the first 39 years, but the Minimum Upgrade + Solar scenario has lower costs for the remaining life of the building.

The Minimum Upgrade retrofit scenario with the addition of Solar PV is the best investment for this building, resulting in 100% GHG reductions and 37% operational savings compared with the base case.

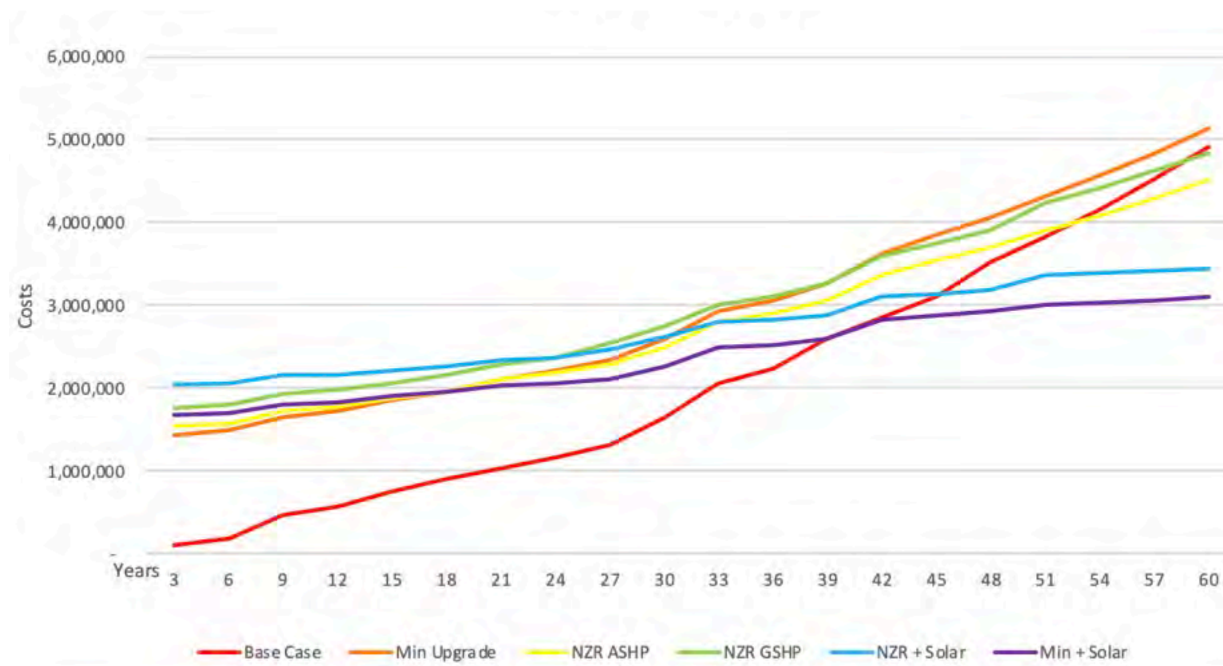


Figure 22 Cumulative TCBO

Discussion

The Harrietsfield Williamswood Community Centre is one of over fifty community recreation facilities owned by the city of Halifax. Many of these are in similar condition to Harrietsfield Williamswood, with inefficient energy use patterns and maintenance backlogs. All of these buildings require a deep retrofit to meet HRM's climate targets.

We can't underestimate the need for focus on resilience. In the past 12 months Nova Scotia has experienced unprecedented damage to property, infrastructure, and the natural world from the impacts of climate change including hurricanes, wildfire and severe flooding. Every building we touch from this point forward needs to be not only energy efficient but also robust enough to withstand the increased intensity of a more volatile climate, to protect its occupants and to protect the investment.

The cost of the recommended retrofit is higher than anticipated, but at $\$280/ft^2$ it is more economical to retrofit the building than to rebuilt it. The embodied carbon emissions from the retrofit are 86.86 $kgCO_2e$. Embodied carbon data is not readily available for community centres; however, this building is small enough that it can be evaluated at the scale of a large house. If the Harrietsfield Williamswood Community Centre were to be replaced by a new build with moderate carbon materials, its embodied carbon would be 68,400 $kgCO_2e$ based on a value of 150 $kgCO_2e$ per m^2. [9] This number doesn't include the embodied carbon content of the existing structure which would be sent to landfill, which contains significant amounts of carbon intensive concrete. If our goal is to stop emissions today, evaluating every retrofit through the lens of embodied carbon is valuable.

Economic modeling shows that it will be nearly 40 years before the cost of the retrofit catches up with the business-as-usual scenario. This is longer than the desired 20-year simple pay-back, however it is a building that needs a retrofit, among countless buildings that also need retrofits. The resulting building will be all electric, energy efficient and secure. While it will take a long time for the cash flow benefit to be seen, it is worth doing.

The learnings from retrofitting the Harrietsfield Williamswood Community Centre can be applied to Halifax's other small recreation facilities to generate momentum towards Halifax's retrofit goals.

[9] Passive Buildings Canada and Builders for Climate Action (2022) Emissions of Materials Benchmark Assessment for Residential Construction Report. https://www.buildersforclimateaction.org/report---embarc-report.html

Conclusions

This study of Panelized Deep Retrofits of Municipal Buildings was undertaken to develop deep retrofit strategies to support municipal decarbonization efforts by adapting the Energiesprong approach to the Canadian context.

The project goals were to develop deep retrofit scenarios that achieve 50% or more EUI savings and a scenario that can achieve Net Zero Energy (NZE) with the addition of solar PV. The solutions needed to minimize occupant disruption and embodied carbon. The recommended retrofit pathway would be the option with the lowest Total Cost of Building Ownership. Finally, the recommended solution should demonstrate a calculated payback of 20 years or better.

The ReCover team has studied the potential for prefabricated panelized deep retrofits in low-rise multi-unit dwellings in two previous case studies[10]. These studies found the lowest TCBO over the anticipated life of the building was achieved a Net Zero Energy retrofit with an approximate 75% reduction in EUI plus solar PV. The hypothesis of this project was that similar results would be found for municipal buildings. The results did not support the hypothesis.

While the results of this project were not expected, they do serve the objectives to de-risk investment in deep retrofits in Canada, to provide evidence on the effectiveness and scalability of a panelized deep retrofit approach and to build confidence and experience in deep retrofits among Canadian municipalities and industry stakeholders.

This study shows that the technical challenges are secondary to the overwhelming barrier of cost. It also showed that if investment in deep retrofits doesn't happen, municipalities will pay exponentially more down the road.

The work demonstrated that there is a myriad of technical options for most buildings, but the challenge is in developing solutions that are cost effective. Deep retrofits can save money, but it takes a very long time before the savings show up on a balance sheet.

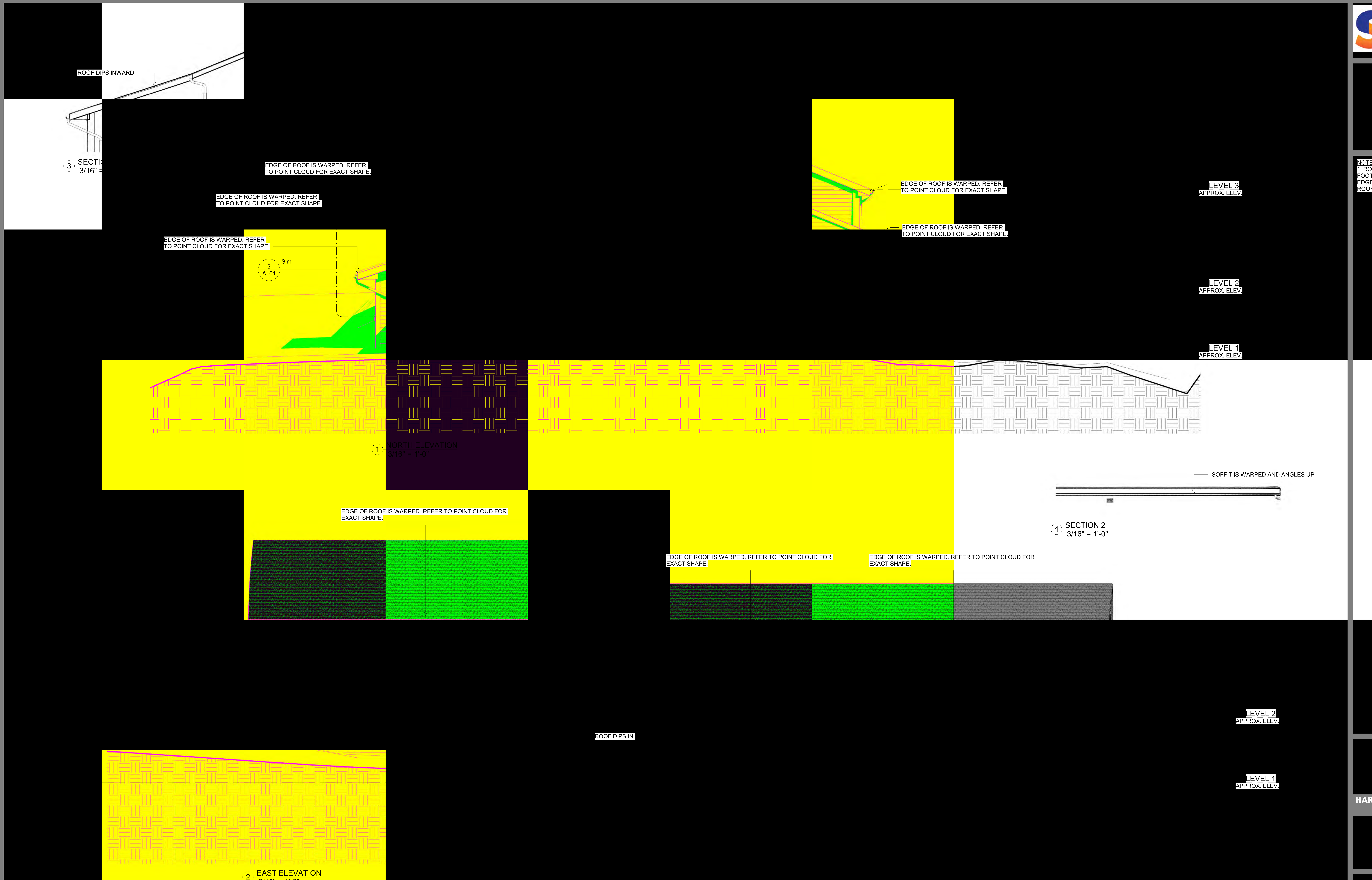
Deep GHG reductions are very achievable in municipal buildings. Retrofitting the Harrietsfield Williamswood Community Centre will prevent over 30,000 kgCO_2e annually and save 37% in lifetime operating costs over next 60 years.

[10] ReCover Initiative (2020) *ReCover Phase One Case Study Report* and ReCover Initiative (2022) *Scarlettwood Court Deep Retrofit Case Study Report*, https://www.recoverinitiative.ca/about-us/our-results/report-request

Appendix A

Pre-retrofit Drawings

- **Existing Drawings**
- **LiDAR Drawings**



SMARTER SPACES

NOTES
1. ROOF DOES NOT FOLLOW EXACT FOOTPRINT.
EDGES OF SLOPPED SIDES ARE WARPED.
ROOF WAS MADE BASED ON THE AVERAGE.

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HARRIETSFIELD/WILLIAMSWOOD COMMUNITY CENTRE

A101

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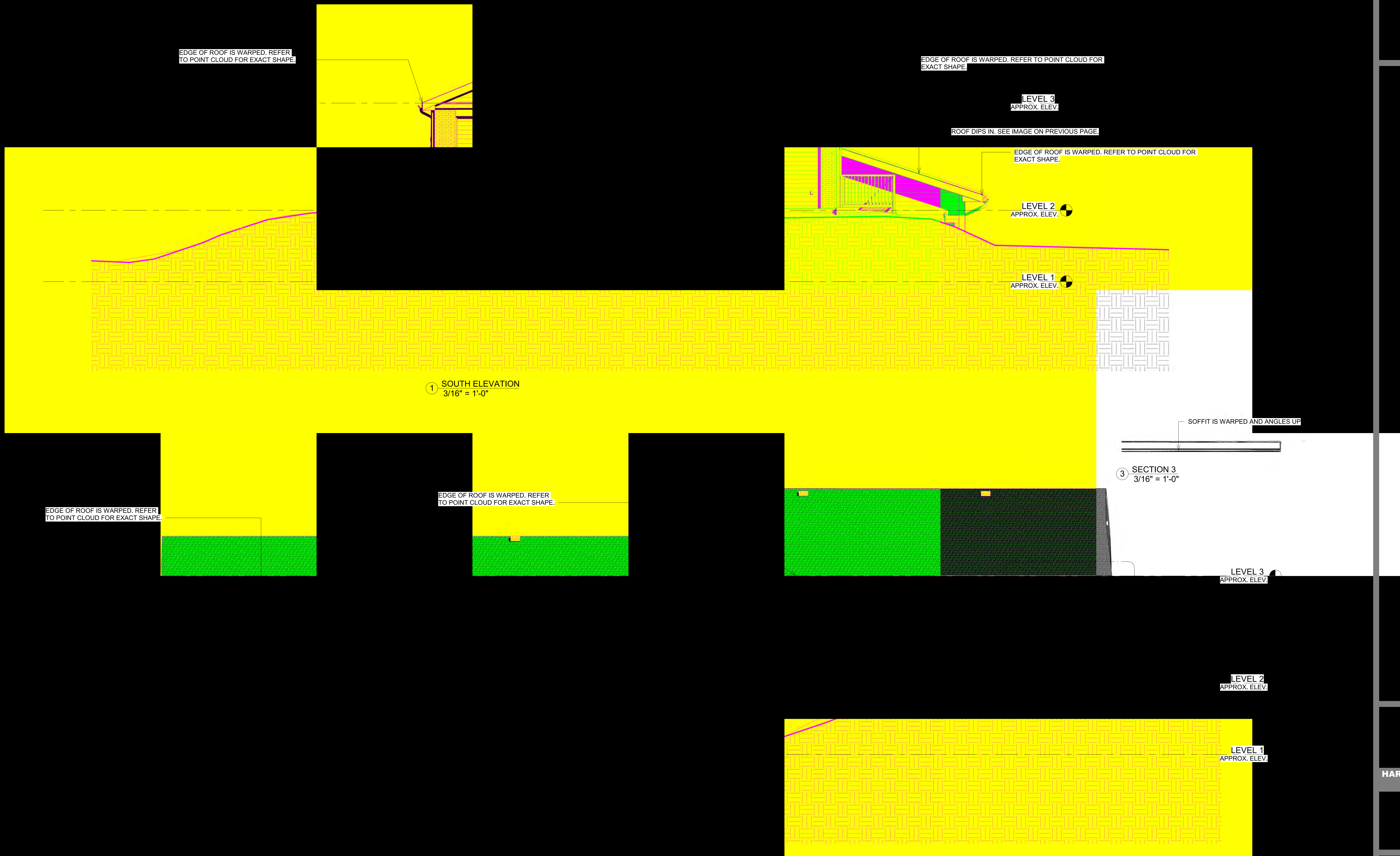

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HARRIETSFIELD/WILLIAMSWOOD COMMUNITY CENTRE

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Appendix B

Facility Condition Assessment

Capital Management Engineering Limited

EMPOWERING OUR CLIENTS WITH KNOWLEDGE

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HALIFAX REGIONAL MUNICIPALITY

Final Report

Capital Plan
Building Condition and Energy Assessments
Harrietsfield-Williamswood Community Centre
1138 Old Sambro Road
Halifax, Nova Scotia

March, 2013
Project Number 1201058 4 081

Prepared for: Mr. Greg MacKay, MBA P. Eng.
Infrastructure & Asset Management
Facility Development - Buildings
Halifax Regional Municipality
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Prepared by: Capital Management Engineering Limited
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Table of Contents

1 Introduction

Capital Management Engineering Limited (CMEL) was retained by the Buildings, Planning and Infrastructure Department of Halifax Regional Municipality (HRM), to complete a building condition assessment, twenty-five year capital plan and an energy assessment for the property know as Harrietsfield-Williamswood Community Centre located at 1138 Old Sambro Road, Halifax, Nova Scotia.

2 Purpose

Halifax Regional Municipality owns, operates and maintains Harrietsfield-Williamswood Community Centre. HRM has initiated a comprehensive review of the condition and utilization of Harrietsfield-Williamswood Community Centre in support of the Municipality`s long term asset management plan. The condition assessment, long range capital plan and energy assessment are intended to provide support to the long term asset management of the property known as Harrietsfield-Williamswood Community Centre.

3 Methodology

3.1 Project Approach

The project was broken down into the following phases:

➢ ***Phase I – Data Collection & Site Assessment***

To start the assessments, background information was collected on the facility. The information included, when available, floor plan drawings, up to three years of past energy consumption records, list of recent capital expenditures, and current facility design requirements.

Following the collection of background data, a site assessment was scheduled and completed. The site assessment was carried out to determine the makeup of the building(s), including type of construction, identification of major systems including:

- architectural and structural,
- roof construction and covering,
- interior finishes,
- mechanical and electrical and,
- specialty systems.

The systems and their respective components were visually assessed with respect to their rate of wear and observed condition to support the determination of their remaining useful life. During the site assessment, additional information was gathered from the site contact and site personnel, where possible, to further support the determination of the system and component conditions.

➢ ***Phase II - Capital Plan Calculations***

Following site visit the building was modelled using industry data to provide an anticipated replacement schedule for the constituent major components over the next twenty-five years with the objective of maintaining the current level of operations over the evaluation period. The remaining useful life of the major components was calculated by determining the year of installation, the expected useful life and providing adjustments where necessary based on the site observations.

In conjunction with the determination of the expected date for renewal of the major components, a corresponding cost estimate was developed. Estimates were based on the client's historical records, preferred client rates, local contractor pricing, and/or industry pricing guides such as RSMeans estimating guides.

- ***Phase III - Energy Assessment & Modelling***

  CMEL was provided with historical energy consumption data to support the energy assessment and modelling. A computer model of the building was developed using the information gathered from the site assessment. The modelling was completed using RETScreen (an industry accepted energy modelling tool developed by Natural Resources Canada). The baseline model was compared to the historical data to provide a level of confidence in the model. Upon successful completion of the baseline model, various energy efficiency measures were developed by substituting and/or adding various systems/components or implementing operational parameters that impact the energy usage while maintaining the current functionality of the building.

- ***Reporting and the EECP-T***

  The last phase of the project consisted of developing recommendations from the various calculations and modelling. In addition to the report, the findings were populated into the Energy Efficient Capital Planning Tool (EECP-T) which provides an effective means of managing the basic capital planning data and incorporates the analysis of energy efficiency projects into the overall capital and budgeting plan. The EECP-T also provides HRM with a tool to capture the recapitalization information on a going forward basis to support future capital investment and asset management strategies for the facility.

3.2 Expected Outcomes

The objective of the capital planning component of the Project was to produce a capital plan that identified the current building condition and anticipated capital investment requirement to sustain the facility over the next twenty-five years. The capital plan is based on using "*as like as kind"* component replacement. As a result, the capital plan for the facility will continue to be a respective baseline for comparative analysis of potential component refurbishments or substitutions.

The objective of the energy assessment component of the project was to identify specific alterations to the facility that would result in energy savings. The alterations are typically the result of component substitution, adding alternate technologies or changing building operations procedures while maintaining the same overall building use and objective. In some cases, where alternate technologies may produce a significant operational savings but not necessarily an energy reduction, the alternate technologies were identified but not labelled as energy saving measures.

3.3 General Methodology

The analysis for the building(s) consisted of the following:

- Interviews with the Coordinator-Buildings, as well as with the on-site building managers and maintenance staff as made available;
- Review of available building drawings and equipment specifications;
- On-site assessments that each included a building walk-through, data collection, collection of operating schedules and observation of building, equipment and component conditions;
- Review of energy consumption and billing data;
- Identification of building component and equipment replacement requirements, estimated costs and schedule;
- Identification of potential operational procedure changes and feasible capital reinvestment initiatives to improve energy efficiency;
- Population of the EECP-T with building condition and energy efficiency measures data to produce a 25 year Capital Plan; and,
- Responses to a review of a draft report by HRM.

3.4 Building Condition Assessment (BCA)

The BCA carried out by Capital Management Engineering Limited on the property is based on the ASTM Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process (ASTM E 2018-08) and consisted of the following:

- Interviews with building managers and maintenance staff and review of existing documentation including drawings, specifications and previous reports when available;
- A site visit to visually review the types and conditions of the building systems and elements;

- The identification of actions, with costs in present value dollars, to remediate health and safety issues, to mitigate code violations[1] and to repair major defects in materials or systems that may significantly affect the value of the building or continued operation of the site during the evaluation period;

- Recommendations, with cost estimates, for further investigations if required and an Opinion of Probable Costs for work that may be required as a result of these investigations; and,

- The preparation of a report, presented herein.

ASTM E 2018-08 defines a 'Physical Deficiency' as a conspicuous defect or significant deferred maintenance of a Site's material systems, components or equipment as observed during the site assessor's walk-through site visit. Included within this definition are material systems, components or equipment that are approaching, have reached, or have exceeded their typical Expected Useful Life (EUL) or whose Remaining Useful Life (RUL) should not be relied upon in view of actual or effective age, abuse, excessive wear and tear, exposure to the elements, lack of proper or routine maintenance, etc.. This definition specifically excludes deficiencies that may be remedied with routine maintenance, miscellaneous minor repairs, normal operating maintenance, etc., and excludes *de minimis* conditions that generally do not constitute a material physical deficiency of the Site.[2]

The assessment of the Site was based on a visual assessment of the visible and accessible components of the property, buildings and related structures. The site components, building exterior, roof membrane(s) and interior finishes of the on-site buildings and related structures were visually reviewed to check their condition and to identify if any obvious physical deficiencies were present. The review did not include an intrusive investigation of wall assemblies, ceiling cavities or any other enclosed spaces.

No physical tests were conducted and no samples of building materials were collected to confirm or support the findings presented unless otherwise noted in this report. Recommendations and estimates for additional testing or investigations may be presented as part of the report when, in the assessor's opinion, a condition may exist that would substantially alter the findings and cannot be adequately assessed by non-intrusive visual means.

The review of the mechanical and electrical systems at the property included discussions with the site contact(s). A visual review of the mechanical and electrical systems was conducted to determine the type of systems present, age and aesthetic condition. No physical tests were conducted on the mechanical and electrical operating systems.

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[1] A code compliance review is beyond the scope of this project; however specific codes may be referenced during the discussion as a reference standard.
[2] ASTM E 2018 Section 2.3.22

A detailed evaluation of the property development's compliance with national and provincial building codes and/or fire codes is not part of the scope of this assessment. However, applicable codes may be used as a reference in determining appropriate recommendations. It is assumed that the existing building was reviewed and approved by local authorities at the time of construction.

The estimated costs outlined in this report are based on the conditions observed during the site assessment and the documents provided. Estimated costs are based on a combination of past experience, known contractor pricing and estimating guides such as RSMeans. The opinions of cost are intended for global budgeting purposes only. Actual costs for work recommended can only be determined after preparation of tender documents and/or soliciting quotations from qualified contractors. Costs associated with site and scheduling restrictions, and impacts to ongoing operations have not been taken into account in determining probable costs. The replacement, repair or maintenance recommendations in this report should be confirmed with a more detailed site investigation and project evaluation prior to implementation.

For the purpose of this report the following temporal units have been applied:

- Immediate - year zero to one;
- Short term - years one to five;
- Long term - years six to ten; and
- Extended term - years eleven to twenty-five.

3.5 Energy Assessment

The energy assessment commenced with an analysis of at least one full year of past energy usage data for the station. All energy sources were taken into account including, but not limited to, electricity, fuel oil, propane, natural gas, and solar, where applicable. An energy usage profile was developed to determine the usage by season and compared to benchmark data.

The initial analysis was followed by a site assessment to catalogue the energy consuming items associated with the facility and its operation. During the site assessment, interviews with the site contact were conducted to establish the general operating conditions to support an accurate modelling of the facility over a twelve month period.

A baseline computer model was developed to create an energy profile and total energy consumption data which were compared to the known historical data. The model was refined until the variance was within acceptable limits. Typically a variance of 15% or less is sufficient to have confidence in the model.

Once the model was deemed acceptable, various energy efficiency measures (EEM) were modelled to determine the impact on the energy usage and evaluate the potential operational savings that would result. The cost to implement each of the EEM was estimated, using the same methodology as utilized in developing the capital plan costing. The simple pay back was calculated and an opinion offered with respect to the recommended EEM for the facility. The data was entered into the EECP-T to establish the relationship between the potential EEM and the current recapitalization schedule, thus providing additional value by allowing HRM to concurrently incorporate EEM with a scheduled replacement event.

3.6 Supporting Documents

HRM has supplied an estimated replacement value for the building (Report Name: *Halifax Regional Municipality Property Book Values, Working Copy October 1, 2012*). In the case of this building the replacement value appeared to be significantly below (or above) industry values for a similar building. For the purposes of this report CMEL has used a replacement cost based on industry standard estimates to support the calculation and subsequent comparison of Facility Condition index (FCI) values.

HRM has supplied the following documents to support the assessments. A copy of the floor plans, when available, has been appended to the report.

Supporting Document	Type	Date Issued	Issuing Party
Aerial Photo	Picture	4/1/2006	HRM
Background Floor plans	Picture	Unknown	HRM
Building Plans	Picture	12/14/1994	HRM
Historical Electrical Consumption	Energy Data	11/30/2012	HRM
Historical Oil Consumption	Energy Data	11/30/2012	HRM
Re-Roofing Construction Cost	Report	11/8/2011	HRM

4 Building Condition Assessment & Capital Plan

4.1 Salient Property Information

Property Name	Harrietsfield-Williamswood Community Centre
Street Address	1138 Old Sambro Road
City, Province	Halifax, Nova Scotia
Primary Use	Recreation Centre
Number of Buildings on Site	One + Storage Shed
Foundation	Standard concrete strip footings and foundation walls
Superstructure	Wood
Cladding	Vinyl Siding
Roof Membrane	Asphalt Shingles
Reported Year Built	1970 Estimated, Major Renovation 1994
Building Area	5770 ft^2
Evaluation Period	25 Years
Site Assessment Conducted By	George Polimac, Matt Bordian and Rob Naugler on February 25, 2013

Harrietsfield-Williamswood Community Centre is located at 1138 Old Sambro Road in Halifax, Nova Scotia. The property is bordered by Old Sambro Road to the west, forested lands to the north, a school to the south and a lake to the east. The building is estimated to have been built in the early 1970s and has had one addition since. A major renovation was completed in 1994. The building appears to have standard concrete footings and foundation walls supporting a wood structure. The building is one storey with two levels. The roof over the upper level is asphalt shingles and the roof over the lower level is modified bitumen applied over asphalt shingles. Both roofs are supported by wood roof trusses and wood deck. The building is clad with cement board horizontal siding.

Access to the property is from Old Sambro Road and forms part of the asphalt paved parking area to the west of the building. An asphalt paved driveway south of the building leads to additional asphalt paved parking at the east side of the building. It was reported that the building was purpose built as a fire station and later converted to a recreation centre. There is a small storage shed located to the east of the building.

Mr. George Polimac, Mr. Matt Bordian and Mr. Rob Naugler of CMEL conducted the site visit on February 25, 2013. CMEL was not accompanied by HRM personal during the site visit. All areas of the building were accessible during the site visit.

Selected photographs of the site are appended to the report.

4.2 Site Work (Category 1)

Description

Access to the property is by an asphalt paved driveway from Old Sambro Road. The driveway leads to an asphalt paved parking lot to the west of the building. An asphalt paved driveway along the south elevation leads to additional parking at the east end of the building. Concrete flatwork is limited to a pad at the main entrance doors and a concrete pad at the rear doors. There is a galvanized hand rail and a small wood platform providing wheel chair access applied over the concrete pad at the upper level. Landscaping is limited to graded areas and some grass and trees to the north and east of the building. Site lighting is limited to six building mounted metal halide fixtures. There is a small storage shed to the east of the building.

Observations/Comments

The asphalt paved parking and roadways appeared to be in fair to good condition with some cracking observed. It is estimated that the asphalt paving is approximately five years in age. The expected useful life of asphalt paving is approximately fifteen years. It is anticipated that the asphalt will require replacement within the extended term of the evaluation with repairs being required at approximately ten years of service. Costs for repairs and replacement have been included in the probable cost table.

The concrete pads appeared to be in good condition and are approximately twenty years in age. The expected useful life of concrete flatwork is in excess of fifty years. It is not anticipated that the flatwork will require replacement within the term of the evaluation. No costs have been included in the probable cost tables.

The wood deck is in fair condition and is approximately ten years of age with an expected useful life of twenty years. Due to the size, replacement of the deck is considered part of maintenance activities; no costs have been included in the probable cost tables.

The galvanized hand rail appeared to be relatively new and has an expected useful life in excess of thirty years. It is not anticipated that a replacement will be required during the term of the evaluation. No costs have been included in the probable cost tables.

The landscaped areas around the building appeared to be maintained and are in good condition. The expected useful life of landscaping is typically indefinite with regular maintenance. Based on observed condition, a significant replacement is not anticipated during the evaluation period. No costs have been included in the probable cost table.

The site lighting is limited to six building mounted metal halide wall packs. These fixtures have an expected useful life of approximately twenty years and appear to be in fair condition and approximately fifteen to twenty years in age. It is anticipated that they will require replacement in the short term of the evaluation. Costs have been included in the probable cost tables.

The storage shed appears to be in good condition and is clad with cement siding and has asphalt shingled roof and one metal service door. While the siding, roof and doors will require replacement in the extended term of the evaluation period, the quantities and costs are considered to relatively small. It is assumed that replacements will be handled under maintenance activities. No costs have been included in the probable cost tables.

Probable Cost Estimate

Item	Action	Year of Install	Expected Useful Life	Anticipated Year of First Expenditure	Quantity	Unit Cost	Cost per Occurrence
Asphalt Paving	Repair asphalt at ten years of service	2010	10	**2020**	2,185	$4.50	**$9,833**
Asphalt Paving	Replace asphalt paving	2010	15	**2025**	10,910	$4.50	**$49,095**
Site Lighting	Replace at end of useful life	1994	20	**2014**	6	$870.00	**$5,220**

4.3 Architecture, Exterior (Category 2)

Description

The building is clad with cement composite siding and a small amount of brick masonry. The building has very few windows. The windows appear to be vinyl framed horizontal slider type units. The doors are metal service type set in wood frames.

Observations/Comments

The cement siding was observed to be in good condition with only a couple of observed areas of minor damage. The manufacturer's warranty for this type of siding can be in excess of forty years depending on geographic location and installation. It is recommended that the manufacturer and warranty be confirmed. Pending confirmation and for the purposes of the capital plan a reduced expected useful life of twenty to thirty years has been used as many of the cement siding products have not performed as expected in the Nova Scotia climate. As a result it is anticipated that the siding will require replacement within the extended term of the evaluation. Costs have been included in the probable cost tables. Minor repairs can be completed under maintenance budgets. No costs have been included in the probable cost table.

The brick masonry appeared to be in fair to good condition with some minor damage. The mortar joints appeared to be in good condition. The expected useful life of brick masonry is sixty years. It is not anticipated that the masonry will require replacement during the term of the evaluation but minor repairs may be required. Minor repairs are considered maintenance activities. No costs have been included in the probable cost tables.

The vinyl framed windows appear to be in fair condition with no failed seals or damage; however, the vinyl is becoming discolored. The windows appear to be more than fifteen years in age and have an expected useful life of thirty to thirty-five years. It is anticipated that these windows will require replacement in the extended term of the evaluation. Costs have been included in the probable cost tables.

There are six metal doors that appeared to be in fair to good condition with some corrosion at the base of the doors and frames. Metal doors have an expected useful life of approximately twenty years. From the observed condition these doors appeared to be approximately ten years in age and are anticipated to require replacement in the long term of the evaluation. Costs have been included in the probable cost tables.

Probable Cost Estimate

Item	Action	Year of Install	Expected Useful Life	Anticipated Year of First Expenditure	Quantity	Unit Cost	Cost per Occurrence
Windows	Replace at end of useful life	1994	30	**2030**	1	$5,000	**$5,000**
Service Doors	Replace at end of useful life	2000	20	**2020**	6	$1,450	**$8,700**
Cement Siding	Replace at end of useful life	1994	30	**2024**	3,735	$12.00	**$44,820**

4.4 Roofing (Category 3)

Description

The roof over the upper level is an asphalt shingle system and the roof over the lower level is modified bitumen applied over asphalt shingles; both are reportedly supported by wood deck and wood roof trusses. Rain water is drained from the roof by eavestroughs and downspouts to the ground below.

Observations/Comments

The roof covering over the upper level appeared and was reported to be in poor to fair condition. There are no reported areas of active or recent water ingress. The roof membrane appeared to be and was reported to be approximately twenty years in age. The roof over the lower level was reported to have been installed in 2012 and appeared to be in good condition. The expected useful life of both types of roof system is approximately twenty years. It is anticipated that the upper roof and drainage system will require replacement during the short term of the evaluation and the lower roof in the extended term of the evaluation. The estimated costs and timing of the replacement have been included in the probable cost table.

Probable Cost Estimate

Item	Action	Year of Install	Expected Useful Life	Anticipated Year of First Expenditure	Quantity	Unit Cost	Cost per Occurrence
Asphalt Shingle	Replace at end of useful life	1994	20	**2014**	4,170	$4.23	**$17,639**
Modified Bitumen	Replace at end of useful life	2012	20	**2032**	2,250	$12.00	**$27,000**

4.5 Structure (Category 4)

Description

The building was reported to be founded on standard concrete strip footings and concrete foundation walls. The lower level appears to have one course of block masonry on top of the concrete foundation wall. The floors are poured in place slab on grade. The superstructure was reported to be wood supporting wood roof trusses and wood roof deck.

Observations/Comments

No major cracks were observed in the exposed foundation walls of the building that would suggest structural failure of the foundation. It is not anticipated that significant capital expenditure will be required during the term of the evaluation. No costs have been included in the probable cost tables.

Probable Cost Estimate

Item	Action	Year of Install	Expected Useful Life	Anticipated Year of First Expenditure	Quantity	Unit Cost	Cost per Occurrence
Building Structure	No significant capital expenditure is anticipated	1970	75	**2045**	1	-	**-**

4.6 Architecture, Interior (Category 5)

The building can be divided into three main areas;

1 A community hall;
2 The lower floor kitchen, washrooms, and offices; and
3 The upper floor daycare.

4.6.1 The Community Hall

Description

The community hall has vinyl tile floors painted drywall walls and a painted drywall ceiling. There are no doors other than exterior doors associated with this area.

Observations/Comments

Painted finishes have an expected useful life of approximately seven to ten years. The majority of the painted walls were in good condition with no observed areas of damage. It is anticipated that the painted finishes will require cyclical recoating throughout the term of the evaluation. Painting is considered a function of maintenance activities. No costs have been included in the probable cost tables.

The vinyl tile floors in the gymnasium appeared to be in fair to good condition with some minor scuffs and normal wear and tear. It was reported that the floors are approximately ten years of age. The expected useful life of vinyl tile floors is approximately twenty years. It is anticipated that the floors will require replacement within the long term of the evaluation. Costs have been included in the probable cost tables.

4.6.2 Lower Level – Kitchen and Washrooms and Offices

Description

The lower level kitchen and washroom area includes the main entrance vestibule and a small corridor. The kitchen has vinyl tile flooring and painted drywall walls and ceilings. The kitchen contains upper and lower cabinets, a bar, residential style stove, three refrigerators, a freezer and a residential style dishwasher. The vestibule and corridor have vinyl tile floors and painted drywall walls and ceilings. The washrooms have hard tile floors, painted drywall walls and painted drywall ceilings. There are washroom vanities and toilet partitions. The doors are wood set in wood frames. The offices have vinyl tile flooring, painted drywall walls and painted drywall ceilings.

Observations/Comments

Painted finishes have an expected useful life of approximately seven to ten years. The majority of the painted walls are in good condition with no observed areas of damage. It is anticipated that the painted finishes will require cyclical recoating throughout the term of the evaluation. Painting is considered a function of maintenance activities. No costs have been included in the probable cost tables.

The vinyl tile floors appear to be in fair condition with some areas showing normal wear and tear and one area where the tile has cracked. It appears that the floors are approximately five to ten years in age. The expected useful life of vinyl flooring is approximately twenty years. It is anticipated that these floors will require replacement within the extended term of the evaluation. Costs have been included in the probable cost tables. Minor repairs, if required, can be completed as maintenance activities. No costs have been included in the probable cost table.

The kitchen and bar millwork is in fair condition with poorly fitting hardware and faded finishes and was reported to be approximately twenty years in age. The expected useful life of millwork is approximately twenty years. It is anticipated that the millwork will require replacement within the short term. Costs have been included in the probable cost tables.

The kitchen appliances have an expected useful life of twenty years. It was reported that these appliances are less than twenty years in age and are in fair condition. It is anticipated that the appliances will require replacement in the short term of the evaluation. Costs have been included in the probable cost tables.

The hard floor and wall tile in the washrooms and vestibule were reported to have been replaced within the past five years and have an expected useful life of forty years. It is not anticipated that these floors will require replacement within the term of the evaluation. No costs have been included in the probable cost tables.

The washroom millwork is in fair condition with faded finishes and was reported to be approximately twenty years in age. The expected useful life of millwork is approximately twenty years. It is anticipated that the millwork will require replacement within the short term of this evaluation. Costs have been included in the probable cost tables.

The washroom partitions appeared to be in fair to good condition with properly functioning doors and hardware. They appear to be approximately ten to fifteen years in age with an expected useful life of twenty years. It is anticipated that they will meet their useful life and will require replacement in the long term of the evaluation. Costs have been included in the probable cost tables.

The wood doors in this area appeared to be in good condition with no observed damage and with properly functioning hardware. The expected useful life of wood interior doors is approximately forty to sixty years. These doors appeared to be less than ten years old. It is not anticipated that the doors will require replacement during the term of the evaluation. No costs have been included in the probable cost tables.

4.6.3 The Upper Level – Daycare

Description

The upper level contains an open program room and one washroom and is currently being used a daycare facility. The floors are vinyl tile, the walls are painted drywall and the ceilings are suspended tile in the main room and painted drywall in the washroom. The doors are wood set in wood frames.

Observations/Comments

The vinyl tile floors appear to be in fair to good condition with some areas showing normal wear and tear. It appears that the floors are approximately five years in age. The expected useful life of vinyl tile flooring is approximately twenty years. It is anticipated that these floors will require replacement within the extended term of the evaluation. Costs have been included in the probable cost tables.

The hard tile floors in the washroom appeared to be in good condition and are approximately five years in age. The expected useful life of hard tile floors is approximately forty years. It is not anticipated that the hard tile will require replacement during the term of the evaluation. No costs have been included in the probable cost tables.

The suspended tile ceilings appeared to be in good condition and are approximately five years in age. With an expected useful life of twenty years, it is anticipated that they will require replacement within the extended term of the evaluation. Costs have been included in the probable cost tables.

Painted finishes have an expected useful life of approximately seven to ten years. The majority of the painted walls are in good condition with no observed areas of damage. It is anticipated that the painted finishes will require cyclical recoating throughout the term of the evaluation. Painting is considered a function of maintenance activities. No costs have been included in the probable cost tables.

The wood doors in this area appeared to be in good condition with no observed damage and with properly functioning hardware. The expected useful life of wood interior doors is approximately forty to sixty years. These doors appeared to be less than five years in age. It is not anticipated that the doors will require replacement during the term of the evaluation. No costs have been included in the probable cost tables.

Probable Cost Estimate

Item	Action	Year of Install	Expected Useful Life	Anticipated Year of First Expenditure	Quantity	Unit Cost	Cost per Occurrence
Community Hall Floor	Replace Vinyl Tile floor	2003	20	2023	2,700	$8.11	$21,897
Lower Level Kitchen Millwork	Replace at end of useful life	1994	20	2016	1	$24,750	$24,750
Kitchen Appliances	Replace at end of useful life	1994	20	2016	1	$6,000	$6,000
Lower Level Vinyl Tile	Replace at end of useful life	2005	20	2025	770	$8.11	$6,245
Lower Level Washroom Millwork	Replace at end of useful life	1994	20	2016	1	$7,000	$7,000
Lower Level Washroom Partitions	Replace at end of useful life	2002	20	2022	1	$3,750	$3,750
Upper Level Vinyl Tile	Replace at end of useful life	2008	20	2028	2,000	$8.11	$16,220
Upper Level Suspended Ceiling	Replace at end of useful life	2008	20	2028	2,000	$5.15	$10,300

4.7 Mechanical Systems (Category 6)

4.7.1 Plumbing

Domestic water and sanitary services are by well and septic system. Domestic water enters the building in the main mechanical room where a water softener and filter system were observed. Within the building a combination of PEX and copper domestic water lines feed the washrooms and kitchen. Wastewater piping is assumed to be plastic and drains to a septic tank and septic field. The domestic hot water is produced by a Rheem electric hot water tank with a capacity of approximately 68 litres.

Observations/Comments

It was reported that the well was installed approximately twenty years ago. Typically the expected useful life of a well system is forty-five to fifty years with a pump and pressure tank replacement after twenty to twenty-five years. It was reported that the well has sufficient capacity for the needs of the facility. It is not anticipated that the well will require replacement within the term of the evaluation. No costs have been included in the probable cost tables.

The treatment equipment, pump and pressure tank was reported to be in good condition and had been replaced within the past ten years. The expected useful life for this equipment is typically fifteen to twenty years. Based on the reported condition and estimated remaining useful life, it is expected that a replacement will be required in the long term of the evaluation period. The estimated cost and timing of replacement have been included in the probable cost table.

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The septic tank and field were reported to have been upgraded within the past five years. The age of the tank is unknown but it is assumed to be original to the building. The expected useful life of this septic system is sixty years with regular pumping every three to five years depending on the use of the building. Based on the reported condition and remaining useful life, replacement of the tank is not anticipated during the evaluation period. No cost has been included in the probable cost table. Pumping is anticipated in the short, long and extended term of the evaluation period. Typically this is completed as part of regular maintenance activities and has not been included in the probable cost table.

The domestic water and sanitary piping were reported to be in good overall condition with no reported problems. It is assumed that the plumbing was upgraded with the kitchen in 1994. Typically, domestic and sanitary piping will have an expected useful life in excess of forty years with periodic repairs through its life cycle. Based on the observed, reported condition, and estimated remaining useful life of the components, a replacement is not anticipated during the evaluation period. No cost has been included in the probable cost table. Minor repairs can be completed as part of the maintenance budget and have not been included in the probable cost table.

There are twelve plumbing fixtures in the facility which include toilets, sinks and urinals. The fixtures appeared to be in fair to good condition. It is assumed that these fixtures were installed during the renovation in 1994. The expected useful life of the sinks, urinals and toilets is typically thirty to thirty-five years with faucets and shower heads having an expected useful life of twenty years. Based on the observed condition of the sinks, toilets and urinals, a replacement is anticipated in the extended term of the evaluation period. Costs have been included in the probable cost table. Replacement of the faucets and shower heads are anticipated in the extended term. Typically, faucets and shower heads are replaced as part of regular maintenance and have not been included in the probable cost table.

The domestic water heater appeared to be in fair to good condition with no reported problems of meeting demand; however, it is estimated that the heater is more than fifteen years old. The expected useful life of a hot water heater is fifteen years. Based on the observed and reported condition and estimated remaining useful life, a replacement is anticipated in the short term of the evaluation period. The estimated cost and timing of replacement have been included in the probable cost table.

4.7.2 Heating, Ventilation and Air Conditioning

Description

Heat for the building is provided by a Kerr Comet, oil fired boiler rated at 264,000 BTU/Hr maximum output. The boiler is located in a mechanical room located beside the kitchen. There are two 900 litre oil tanks mounted on a concrete pad exterior and adjacent to the building. There did not appear to be any spill containment, but concrete barriers provide impact protection. The boiler provides hot water to baseboard radiators and is controlled by wall mounted thermostats. Ventilation for the washrooms and kitchen is by ceiling mounted bathroom and kitchen exhaust fans.

Observations/Comments

It was reported that the boiler is over ten years in age. The boiler appeared to be and was reported to be operating correctly with an expected useful life in excess of twenty or more years. It is anticipated that it will require replacement within the long term of the evaluation. Costs have been included in the probable cost table for the retrofits.

The oil tanks were reported to have been installed in 2008 and appeared to be in good condition. Oil tanks have an expected useful life of fifteen years but may be replaced earlier due to insurance requirements. It is anticipated that the tanks will require replacement in the long term of the evaluation. An allowance for the replacement of the tanks has been included in the probable cost tables.

It was reported that the baseboard heaters have been upgraded since the construction of the building and have an expected useful life of forty years. It was further reported that they are working correctly. It is anticipated that they will require localized repairs and replacements over the term of the evaluation. Typically localized repairs are completed as maintenance activities. No costs have been included in the probable cost tables.

Small washroom and kitchen exhaust fans have an expected useful life of fifteen to twenty years. It was reported that the men's washroom fan is not functioning. While a replacement is anticipated in the short term of the evaluation the cost is considered minimal and can be attributed to maintenance activities. No costs have been included in the probable cost tables.

4.7.3 Vertical Conveyance

Description

There is no vertical conveyance at the facility.

Observations/Comments

No observations or comments

Probable Cost Estimate

Item	Action	Year of Install	Expected Useful Life	Anticipated Year of First Expenditure	Quantity	Unit Cost	Cost per Occurrence
Hot Water Heater	Replace at end of useful life	1994	15	**2015**	1	$1,000	**$1,000**
Water Softener, Pump and Pressure Tank	Replace at end of useful life	2002	20	**2022**	1	$6,000	**$6,000**
Plumbing Fixtures	Replace at end of useful life	1994	35	**2029**	1	$11,250	**$11,250**
Boiler	Replace at end of useful life	2000	20	**2022**	1	$9,000	**$9,000**
Oil Tanks	Replace at end of useful life	2000	20	**2020**	2	$1,500	**$3,000**

4.8 Electrical System (Category 7)

Description

The site is supplied with power from the local power utility. The building is equipped with two meters and two main breaker panels. One panel is a Square D main disconnect panel rated at 200A, 120/208V the other is a Siemens panel rate at 100A 120/208V. Power is distributed to lights and receptacles throughout the building.

The buildings lighting is mainly T8 fluorescent with some compact fluorescent task lighting.

The building is equipped with a small supplemental heat solar panel equipped with a solar powered fan.

Observations/Comments

The expected useful life of main breaker panels is forty years. The Square D panel appeared to be approximately twenty years old while the Siemens panel appeared to be about five to ten years old. It is anticipated that the Square D panel will require replacement during the extended term of the evaluation. Costs have been included in the probable cost table.

The expected useful life of light fixtures is typically twenty years, with lamps replaced as they fail. The majority of the interior lighting was observed to be T8 fluorescent suggesting that they had been replaced within the past ten years. Based on the observed condition and estimated remaining useful life it is anticipated that a replacement will be required during the long term of the evaluation period. The cost for replacement has been included in the probable cost table.

Distribution wiring has an expected useful life of approximately forty years; it is assumed that the distribution wiring will be replaced with the lighting where and if required. It is anticipated that the wiring will require localized replacement within the long term of the evaluation. Costs have been included in the probable cost table.

Probable Cost Estimate

Item	Action	Year of Install	Expected Useful Life	Anticipated Year of First Expenditure	Quantity	Unit Cost	Cost per Occurrence
Main Breaker Panel	Replace at end of useful life	1994	40	**2034**	1	$7,500	**$7,500**
Lighting	Replace at end of useful life	2000	20	**2020**	5,770	$2.50	**$14,425**
Distribution Wiring	Replace at end of useful life	1970	40	**2020**	5,770	$1.50	**$8,655**

4.9 Life Safety (Category 8)

Description

The building is monitored by a Mircom FA 300 series fire alarm panel located in the main entrance vestibule. The fire alarm panel is connected to fire alarm bells, smoke and heat detectors located throughout the building.

Emergency lighting is provided by battery back-up wall mounted lighting and illuminated LED exit signage strategically placed throughout the building.

There are a number of fire extinguishers mounted throughout the main building.

Observations/Comments

The fire alarm appeared to be in good condition and has had no reported problems. Fire alarm panels have an expected useful life of approximately twenty years. It is anticipated that the fire alarm panel will require replacement during the long term of the evaluation. Costs have been included in the probable cost table.

It was reported that the smoke detectors, heat detectors and exit lighting has been upgraded over time. It was further reported that the system is tested annually and fixtures replaced when required. The expected useful life of this equipment is typically twenty years. Based on the observed condition and estimated remaining useful life it is anticipated that a replacement will be required in the long term of the evaluation period. The cost for replacement has been included in the probable cost table.

The fire extinguishers were observed to have been recently inspected by Don Brenton's in May, 2012. Other than yearly inspections and occasional replacements no significant capital renewal costs are expected to be required. No costs have been included in the probable cost table.

Probable Cost Estimate

Item	Action	Year of Install	Expected Useful Life	**Anticipated Year of First Expenditure**	Quantity	Unit Cost	**Cost per Occurrence**
Fire Alarm Panel	Replace at end of useful life	2000	20	**2020**	1	$5,000	**$5,000**
Fire Detection and Emergency Lighting Devices and Wiring	Replace at end of useful life	2000	20	**2020**	5,770	$1.02	**$5,885**

4.10 Specialty Systems (Category 9)

Description

No Specialty Equipment Observed

Observations/Comments

Not Applicable

4.11 Opinion of Probable Costs

Priority Repair Recommendations

Priority repair costs are for deficiencies observed during the property condition assessment and energy review that require immediate action to prevent further deterioration to the element or to prevent possible injury due to unsafe conditions and/or code violations. No priority repair costs were identified

Major Component Repair and Replacement Project Costs

Probable costs for the major component replacements identified during the site assessment and energy audit were estimated. Major component replacements can be defined as components:

- That are the responsibility of the Property Owner;
- For which major repair or replacement costs are anticipated to be incurred during its useful life; and
- For which costs of repair or replacement will not be covered as part of the annual maintenance budgets.

Major component replacements and energy efficiency projects, and information for developing their estimated costs, are based on observations made during the site assessment on February 25, 2013. Quantities and areas are based on field observations, site interviews and/or client supplied drawings and equipment specifications. More precise quantity surveying or site measurements were beyond the scope of this assessment. Replacement and repair costs, and implementation of energy efficiency measures, are approximate and based on industry standards or CMEL experience. It is recommended that quotations from qualified contractors be obtained by HRM before any specific project is undertaken. HRM may also wish to seek advice on potential incentive programs that might assist in such replacements, particularly as they relate to energy efficiency upgrades.

Similarly, some of the identified projects may be undertaken without specific building or other permits. However, investigation of such needs, including detailed studies and engineering, was beyond the scope of this project and remains the responsibility of HRM.

Our opinion on the probable costs to remedy observed physical deficiencies, replace items that will exceed their expected useful life over the immediate term (0-1 years), short term (1-5 years), long term (6-10 years) and extended term (11-25 years) are summarized in the Cash Flow Report in ***Appendix A***.

5 Accessibility and Design Considerations

5.1 Accessibility and Code Compliance

Description

It was observed that the building is not equipped with barrier free entrances. Barrier free washrooms have been installed with accessible sink vanities. There is barrier free access to the upper level.

5.2 Code Compliance

Enquiries were made with HRM and the site contact to determine if there were any outstanding code compliance related issues or concerns associated with the building. HRM and the site contact reported that they were not aware of any outstanding code compliance violations at the time of the site visit.

6 Energy Assessment

An energy assessment was completed for the Halifax Williamswood Community Centre. Spreadsheets developed by CMEL were used to analyze historic electricity consumption. *RETScreen 4*, a widely accepted building energy model, also developed by NRCan, was used to analyze the building envelope, the heating and ventilation systems, the lighting and equipment. Climatological data from the Shearwater Airport was used.

6.1 Historical Energy Consumption and Demand

The facility relies on electricity and oil to meet its energy needs. Historical electricity and oil consumption data were provided by the Halifax Regional Municipality. Electrical data was provided from December, 2010 to October, 2012. With only one full year of consumption data a minimal analysis was completed. Electrical consumption appears to be consistent over the supplied period with a small decrease in consumption in 2012.

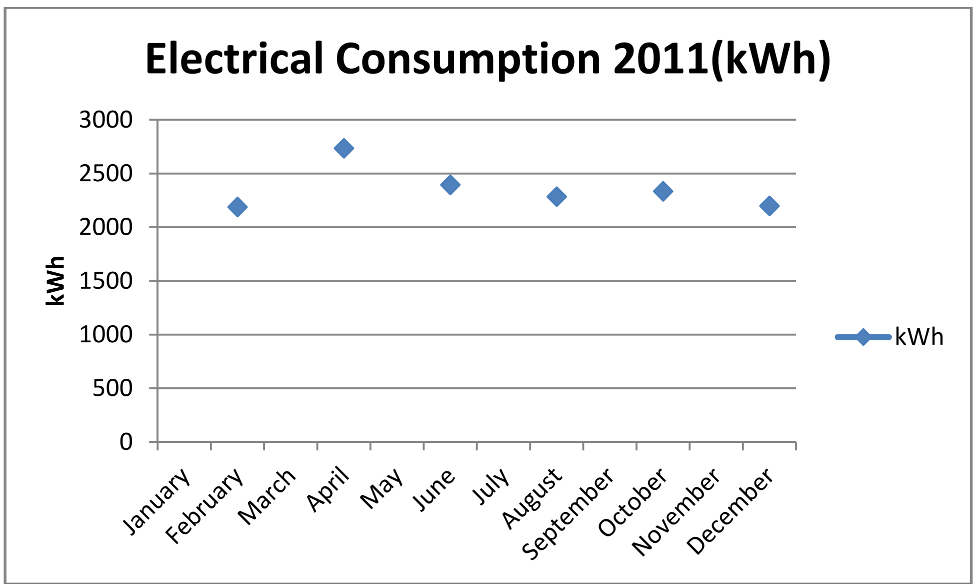
Oil data was provided from January, 2010 to May, 2012. The consumption patterns for oil were analyzed from 2010 to 2011. Oil consumption appears to be inconsistent over the supplied period. The 2010 oil consumption is significantly higher than 2011 consumption and also much higher over the same period of 2012 data.

A review of the past three years of energy data, broken down by type of energy (i.e. electricity and oil) showed that 2011 electricity and oil were the most suitable years to model.

Electricity is supplied by Nova Scotia Power and is charged at the General Tariff Rate Code 4. Electricity charged under rate code 4 is charged a base monthly fee and a usage fee. The facility is provided with oil purchased from Wilson Fuel. As with most commodities, fuel prices vary from month to month and year to year. For the purposes of the analysis an average price per liter was used. For the baseline analysis, energy costs were averaged over the twelve month period between January 1st, 2011 and December 31st, 2011. The following is a breakdown of the past energy consumption by energy source.

The electricity service for the facility which is subject to General Tariff Rate Code 4 is summarized below:

Electrical Consumption				
Year	2009	2010	2011	2012
Month	Electricity kWh	Electricity kWh	Electricity kWh	Electricity kWh
January				
February			2189	2116
March				
April			2735	1695
May				
June			2395	1803
July				
August			2285	1750
September				
October			2335	1658
November				
December		2651	2199	
Total	**0**	**2651**	**14138**	**9022**



From the data provided this facility consumed 14,138 kWh (50.90 GJ) of electricity in 2011. Electricity costs were $1,896.50 inclusive of taxes and miscellaneous service charges or an average of $0.1341 per kilowatt hour.

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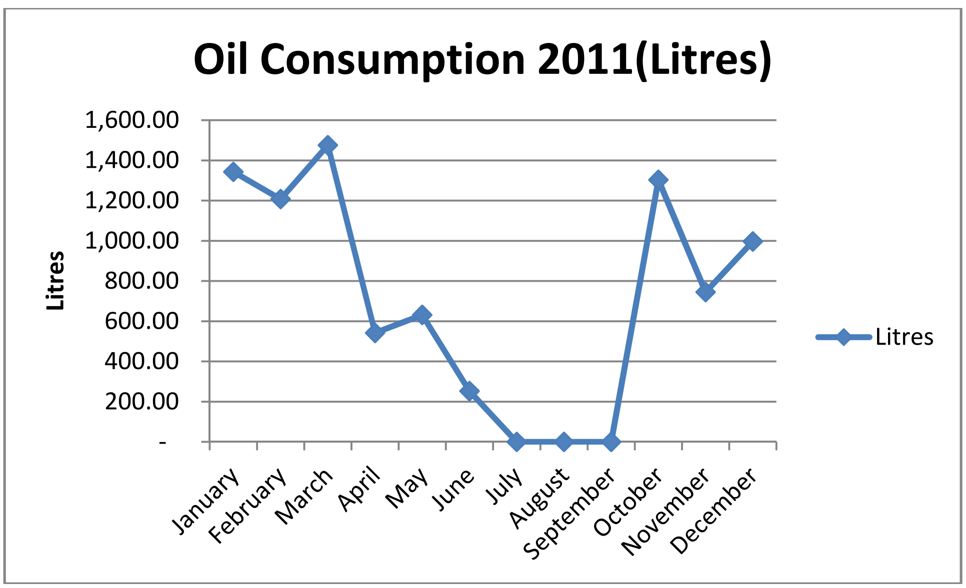
The electricity consumed by the facility under rate code 4 was purchased from Nova Scotia Power. The cost of energy and electricity demand is as follows:

- Service charge/month $10.83
- Energy Charge $0.12683/Kwh
- Demand Charge not applicable under Rate code 4

Oil consumption is summarized as follows:

Fuel Oil Consumption				
Year	2009	2010	2011	2012
Month	Oil Litres	Oil Litres	Oil Litres	Oil Litres
January		2,732.90	1,343.00	1,177.00
February		2,438.30	1,207.70	971.10
March		1,153.70	1,475.50	814.20
April		1,024.40	541.90	700.90
May		490.00	631.60	521.30
June		-	252.60	
July		-	-	
August		200.70	-	
September		91.00	-	
October		-	1,303.50	
November		2,336.50	745.10	
December		1,637.40	996.80	
Total	**-**	**12,104.90**	**8,497.70**	**4,184.50**



The facility consumed 8,497.7L (329.71 GJ) of oil in 2011. Fuel oil costs were $6,934.52 inclusive of taxes and delivery fees or an average of $0.8160/liter.

6.2 Historic Water Consumption

Water is supplied by a drilled well and not metered therefore consumption data was not available.

6.3 Baseline Assumptions

The day care operated Monday to Friday from 1:30pm to 6pm. The Community Centre operates in the evenings and on weekends as needed for bookings. Heating is controlled by wall mounted controls. Lights are controlled by wall mounted switches.

The building is heated by hot water baseboards. Hot water for the baseboards is supplied by a Kerr Comet boiler. Hot water is supplied by an indirect fired water heater supplied from the boiler. There is a solar air heater providing preheated warm air to the daycare.

There is no cooling supplied to the facility.

It was observed and reported that the majority of the lighting is T8 fluorescent fixtures with electronic ballasts. Exterior lighting appears to be metal halide. Exit signs were observed to be LED.

A baseline energy model was developed using the foregoing information, observations during the site visit, and additional information supplied by the occupants of the building. In addition to the above the following assumption(s) were made to complete the baseline model, the assumptions included:

- In our model we have assumed that the buildings envelope is of medium tightness which indicates the occasional window or door being left open and/or some air infiltration around windows and doors and through the building envelope

- It was further assumed that the roofs are insulated to an R value of 40 and that the walls are insulated to an R value of 20. R values were taken from provided renovation drawings.

The baseline model was compared to the known historical data. A variance of less than 6% was achieved which was within the industry standard of 15 % modelling variance typically accepted for this level of energy assessments. Once this balance was achieved, the recent building modifications were implemented and now the model was considered suitable as a comparative baseline for quantifying various energy efficiency measures (EEM). EEM were identified by modelling component or system changes and or incorporation of alternate technologies that would result in a change in energy consumption for the facility. Changes in operational procedures were also reviewed taking into account that the current facility operational parameters had to be maintained.

6.4 Energy and Demand Saving Measures

The buildings heating and cooling system is controlled by wall mounted controls. Temperatures were generally set at 20°C throughout the building during the site visit.

After using *RETScreen 4* to model a number of options, the following potential energy efficiency measures (EEM) were further considered and modelled for potential energy related cost savings;

1. Decommission unused fridges;
2. Install new boiler;
3. Demand water heater; and
4. Programmable thermostats.

The results of the analyses of these measures are discussed further as follows, first addressing those initiatives that are viable EEM and followed by a number of other observations with respect to other initiatives that may be considered but would have longer payback periods.

6.4.1 Unused Equipment- Fridges

While on site it was noted that the Community Centre currently has five fridges plugged in with minimal food and beverages inside. It was noted that they are taking the initiative to unplug and decommission two of the current five fridges. Unplugging the fridges was modelled for an energy savings of 3GJ and a cost savings of $210 for an immediate payback.

Savings Summary-Fridges

Description	Estimated Energy Savings (GJ)	Energy Type	Estimated Cost	Estimated Annual Savings	Simple Payback (yrs)
Fridges	3	Electricity	$0	$210	0

6.4.2 Heating System

The facility is currently heating the building with a boiler that is assumed to be operating at 75% efficiency. Installing a new boiler at an efficiency of up to 85% is recommended. Installing a new boiler was modelled at a cost of $8,000 for an energy cost savings of $1,012 and a simple payback of 8.7 years. Although there is no reduction in the net energy required to heat the building, there is a significant improvement in the conversion of the fuel to usable building energy, i.e. conversion efficiency.

Savings Summary-Heating System

Description	Estimated Energy Savings (GJ)	Energy Type	Estimated Cost	Estimated Annual Savings	Simple Payback (yrs)
Boiler	40	Oil	$9,000	$1,030	8.7

6.4.3 On Demand Hot Water Heater

While on site it was noted that the facility is currently heating hot water with an indirect tank connected to the boiler. The boiler has to be on during the summer to provide hot water even though there is no heating demand from the building. An “on demand” hot water heater which will only consume energy when there is a need for the hot water can be installed. This would be advantageous for the facility as there is a relatively low use for hot water. Installing an electric on demand hot water heater at a cost of $1,500 was considered and modelled for an energy cost savings of $406 and a simple payback of 3.7 years.

Savings Summary- Water Heater

Description	Estimated Energy Savings (GJ)	Energy Type	Estimated Cost	Estimated Annual Savings	Simple Payback (yrs)
Hot Water Heater	16	Oil	$1,500	$406	3.7

6.4.4 Programmable Thermostats

It was noted during the site assessment that the building is fitted with manually controlled thermostats which can be adjusted by any occupant of the building. Building temperature was reported to be left at 20^{o}C even while unoccupied. Programmable thermostats would allow the facility to decrease the temperature of the community hall and day care when it is not in use. Installing programmable thermostats in the community hall and day care with a 3 degree setback at a cost of $2,000 was considered and modelled for an energy cost savings of over $1,715 and a simple payback of 2.0 years.

Savings Summary-Thermostat

Description	Estimated Energy Savings (GJ)	Energy Type	Estimated Cost	Estimated Annual Savings	Simple Payback (yrs)
Programmable Thermostat	66	Oil	$2,000	$1,715	2.0

6.5 Energy Efficiency Project Costs, Savings and Payback

The following table summarizes the individual energy saving projects recommended for the Facility.

EEM Summary

Description	Estimated Energy Savings (GJ)	Energy Type	Estimated Cost	Estimated Annual Savings	Simple Payback (yrs)
Fridges	3	Electricity	$0	$210	0
Boiler	40	Oil	$9,000	$1,030	8.7
Hot Water Heater	16	Oil	$1,500	$406	3.7
Programmable Thermostat	66	Oil	$2,000	$1,715	2.0

The implementation of all of the above energy efficiency initiatives will cost HRM approximately $12,500 and produce a combined estimated annual energy savings of 114GJ and $3,140 at 2012 energy prices, producing a simple payback of 4.0 years. These cost estimates are budget level costs only and assume that HRM would be hiring contractors to carry out the work.

It should be noted that the simple sum of the energy savings isn't always equal to the total savings when all the EEM are added together. Due to the interaction of systems on each other, energy savings results of combined EEM are often less than the simple sum of the individual EEM.

6.5.1 Discussion of Finding

The facility currently has an energy utilization index (EUI) 0.71 of GJ/m^2 (equivalent gigajoules of annual energy consumption per square meter of conditioned space). This is slightly above average for comparable community centers. Implementation of the recommended EEM has the potential to reduce building energy consumption by as much as 114 gigajoules for a EUI of 0.49 GJ/m^2, well below the 0.69 GJ/m^2 average.[3].

These analyses are carried out assuming that the building's utilization will continue at the current level. Savings are based on the 2012 NS Power electricity rates, and the 2012 average annual fuel oil cost per liter. Additional savings and reduced paybacks will be realized as and when energy prices increase, and/or as building utilization increases, and/or as some of the following miscellaneous potential initiatives are undertaken.

Savings greater than 30% are uncommon. However in this case the current building has high energy intensity most likely as a result of obvious building deficiencies. The obvious deficiencies were identified and incorporated into the model which resulted in the conclusion that savings beyond the norm are achievable. The modelling of the building relies on general assumptions regarding air infiltration and other factors which can have

[3] Information provided by Energy Smart Data for New Brunswick Buildings Energy Utilization Index

a significant impact on the resultant energy savings. Actual energy savings from the implementation of the EEM may differ significantly from the theoretical model.

6.6 Other Observations

The energy assessment process identified a number of more minor energy conservation items that can be addressed through normal maintenance activities. These include a regular check and repair of the weather stripping and caulking around all doors and windows, ensuring that all water pipes (hot and cold) are insulated, and ensuring that all plugs and light switches on exterior walls are fitted with insulated gaskets. These, as well as better management of water consumption and plug loads discussed below, had too long a simple payback and are not considered feasible.

6.6.1 Equipment Management

Staff should be engaged to identify potential savings through scheduling of equipment use, retirement of redundant equipment, and replacement of inefficient models. Over time, equipment should be replaced with Energy Star® rated units, and it should also be sized to closely meet the precise needs of the users.

It is recommended that the inventory of energy consuming equipment be reviewed with a view to removing unused equipment from the building, replacing little used equipment (copiers, for example) with fewer and more energy efficient models to reduce standby power consumption, and replacing older, inefficient equipment with more efficient models as and when replacement is required.

It is noted that all of this equipment has an effect on the heating of the building. Energy savings from reducing equipment energy consumption (as with the lighting) usually produces less net energy saving than might often be anticipated.

7 Opinion of Probable Costs and FCI

7.1 Capital Plan

Probable costs are for the major component replacement identified in the Capital Plan and Probable Cost Estimate and can be defined as:

- Components that are the responsibility of the Property Owner,
- For which major repair or replacement costs are anticipated to be incurred during the evaluation period, and
- For which costs of repair or replacement will not be covered as part of the annual maintenance budgets.

The estimated costs are based on observations made during the day of the site assessment on February 25, 2013. Quantities and areas are based on field observations and or site interviews. Quantity surveying or site measurements were beyond the scope of this assessment. Replacement and repair costs are approximate and based on industry standards. It is recommended that quotations from qualified contractors be obtained before any specific item identified for replacement is repaired or replaced.

The probable costs have been entered into the EECP-T which provides a list of major components by system. The EECP-T also provides a probable cost table identifying the anticipated cost by year and calculates the corresponding Facility Condition index, (FCI).

The EECP-T takes into consideration the hard costs as well as incorporates soft costs on an annual basis. The EECP-T also incorporates the energy assessment findings and incorporates those EEM which are recommended and compares the traditional *"as like as kind"* component replacement building condition with the incorporation of EEM over the evaluation term.

The basic EECP-T input and output sheets are presented in **Appendix A.**

The populated version of this base Capital Plan has been provided, along with additional instruction and advice, to HRM separately. It forms the main product of this project and is supported by this document which discusses the facilities' condition at a specific time.

7.2 Capital Plan Recommendations

The assessment of Harrietsfield-Williamswood Community Centre property and building were completed on February 25, 2013. At the time of the assessment the site appeared to be in fair overall condition and the buildings appeared to be maintained in operable condition. It is recommended that asphalt pavement, Interior finishes, mechanical equipment, lighting, life safety components and specialty equipment be closely monitored and replaced as indicated in the probable cost tables.

7.3 Energy Audit Recommendations (EEM)

The following table summarizes the individual energy saving projects recommended for the Facility.

EEM Summary

Description	Estimated Energy Savings (GJ)	Energy Type	Estimated Cost	Estimated Annual Savings	Simple Payback (yrs)
Fridges	3	Electricity	$0	$210	0
Boiler	40	Oil	$9,000	$1,030	8.7
Hot Water Heater	16	Oil	$1,500	$406	3.7
Programmable Thermostat	66	Oil	$2,000	$1,715	2.0

The implementation of all of the above energy efficiency initiatives will cost HRM approximately $12,500 and produce a combined estimated annual energy savings of 114GJ and $3,140 at 2012 energy prices, producing a simple payback of 4.0 years. These cost estimates are budget level costs only and assume that HRM would be hiring contractors to carry out the work.

It should be noted that the simple sum of the energy savings isn't always equal to the total savings when all the EEM are added together. Due to the interaction of systems on each other, energy savings results of combined EEM are often less than the simple sum of the individual EEM.

7.4 Facility Condition Index (FCI) Definition

The Facility Condition Index (FCI) is a metric often used for benchmarking in the real estate industry. It is used to assess the current and projected condition of a building asset. By definition, the FCI is defined as the ratio of the Accumulated Deferred Maintenance (ADM) costs to the Current Building Replacement Value (CRV). The FCI can be defined in terms of the following equation:

$$\text{Facility Condition Index (FCI)} = \frac{\text{Accumulated Deferred Maintenance (ADM)}}{\text{Current Building Replacement Value (CRV)}}$$

Building condition is often defined in terms of the FCI. Generally accepted industry standards for FCI's are as follows:

FCI	Remark
0-5%	excellent to good condition
5-10%	good to fair condition
>10%	fair to poor condition

Overall the lower the FCI the better the condition of the building and the lower the risk that an unexpected recapitalization issue will arise which could result in a specific building shutdown or restricted operation. As an FCI increases, the building is in increasingly poor condition as the backlog of poorly operating or inoperable components in need of replacement rises. An increasing FCI, or backlog of deferred maintenance, impacts not only the capital requirement but leads to increased operation costs especially through emergency maintenance costs.

7.5 Anticipated FCI graph

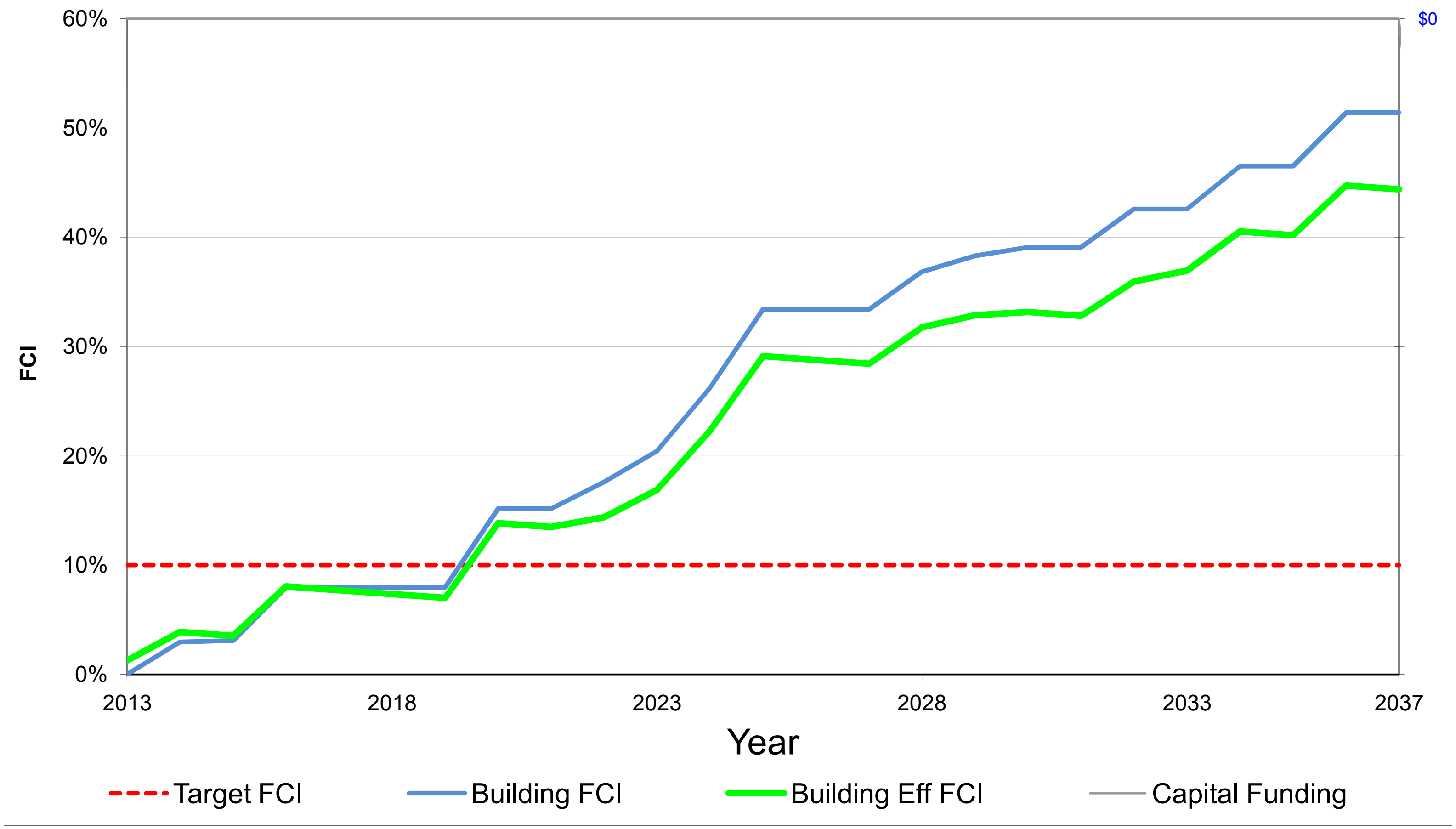
The EECP-T has the ability to project an FCI for a given building taking into account the anticipated probable costs by year over the evaluation period and offsetting the requirement by a proposed funding allowance. Multiple funding streams can be modelled. Typically a target FCI would be determined and the funding requirement calculated to meet the preferred FCI value.

The EECP-T also graphs the outcomes of incorporating energy efficiency projects and overlays the finding on the FCI graph to allow for easy comparison of the two recapitalization strategies. Incorporating energy efficiencies allows HRM to potentially reinvest the operation savings gained from energy efficiency measures back into capital projects to better the building's condition without increasing the overall cost of ownership.

In the event that more than one energy efficiency project is recommended, each individual project has been entered into the EECP-T. The individual savings for each EEM has been identified however the percentage to apply to future capital projects has been discounted to avoid overstating the net effect of combined savings. The discount percentage is based on the net combined savings in comparison to the sum total savings.

Projected Facility Condition Index of Harrietsfield-Williamswood Community Centre

March-27-13



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8 Limitations

This report may not be relied upon by any other person or entity without the expressed written consent of Capital Management Engineering Limited and Halifax Regional Municipality. Any other parties that rely or make decisions based on this report do so solely at their own risk.

Capital Management Engineering makes no warranties, whether written or oral, statutory, expressed or implied, in connection with the services provided, including, without limitation, any warranty of fitness for any particular purpose or use with respect to the property or building components and systems.

Capital Management Engineering's cumulative liability for all claims relating to this report or the services provided shall not exceed the total amount of all fees actually paid for this report.

The opinions of cost are intended for global budgeting purposes only. Actual costs for recommended work can only be determined after preparation of tender documents, detailing the site restrictions, effects and or restrictions on ongoing operations of the building and requirements associated with the construction schedule.

The recommendations made in this report are based on the visual observations made by the assessor during the site assessment and are limited to the areas of the site and building that were observed and accessible during the assessment. Concealed, inaccessible and un-observed areas may be in a different condition than what is reported herein. During the site assessment the assessor will attempt to verify any additional information provided by the site contact. However, in many cases the information will be relied upon and presented without field verification.

9 Closure

Capital Management Engineering Limited is pleased to present this report and the accompanying electronic version of the base capital plan to HRM. The findings presented suggest a strategic long term view to managing municipal assets and will provide HRM with the tools to support the development and definition of a strategy for the constituents of HRM and Harrietsfield-Williamswood Community Centre.

Harrietsfield-Williamson CC FINAL

Appendix A - Capital Plan

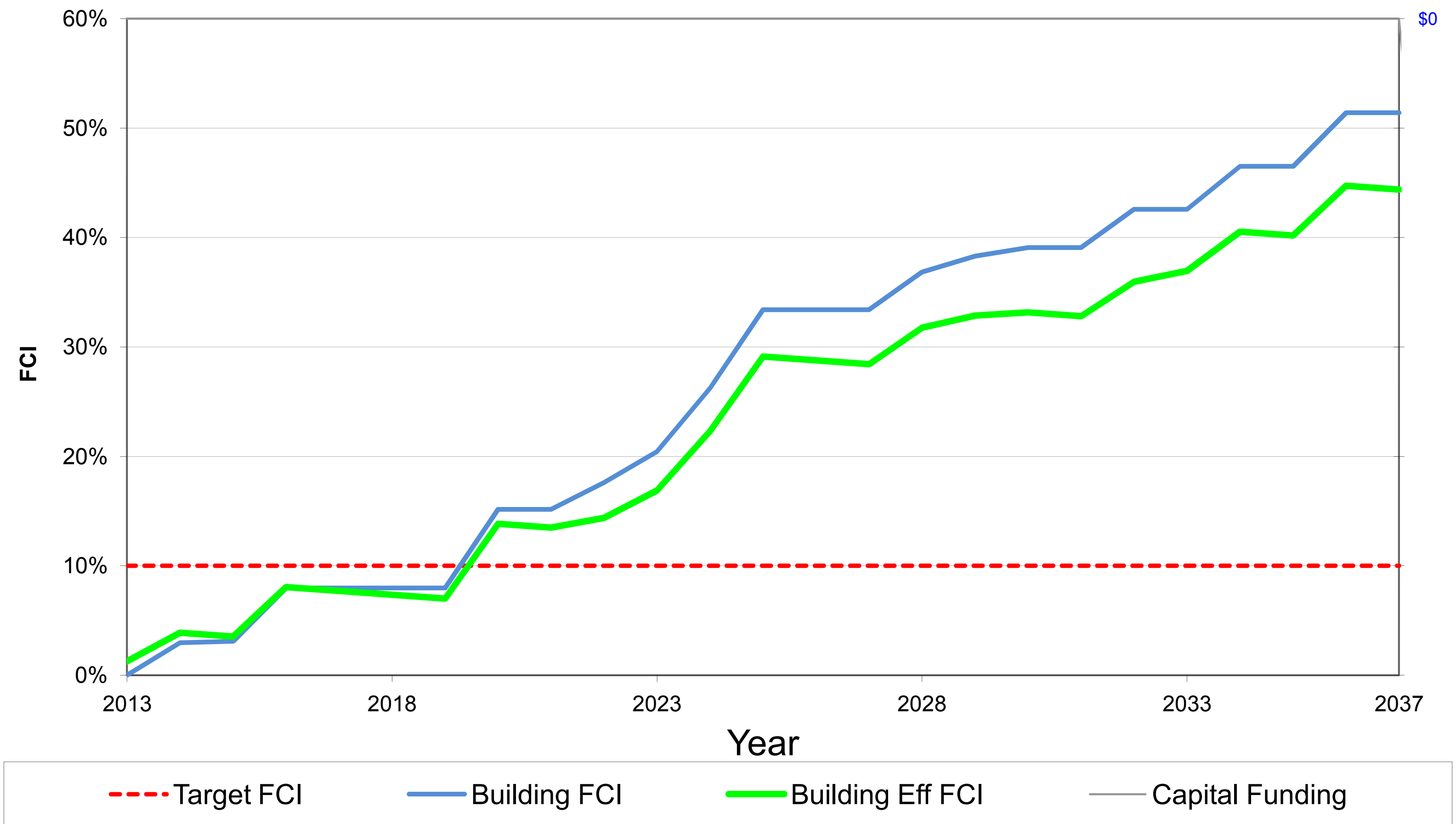
General Building Information Worksheet

Building Name		Harrietsfield-Williamswood Community Centre
Civic Address		1138 Old Sambro Road
Municipality, City		Halifax
Primary Use / Building Type		Recreation
Primary Units		Square Foot
Building Area Square Foot		5,770
Replacement Cost per Square Foot	$	154
Building Replacement Cost	$	887,714
Year of Construction or Major Renovation		1970
Start Year		2013
Current Year		2013
Target FCI		10%
Soft Costs (%)		15%
Interest Rate		3.50%
Inflation Rate		2.50%

Asset Definition Columns

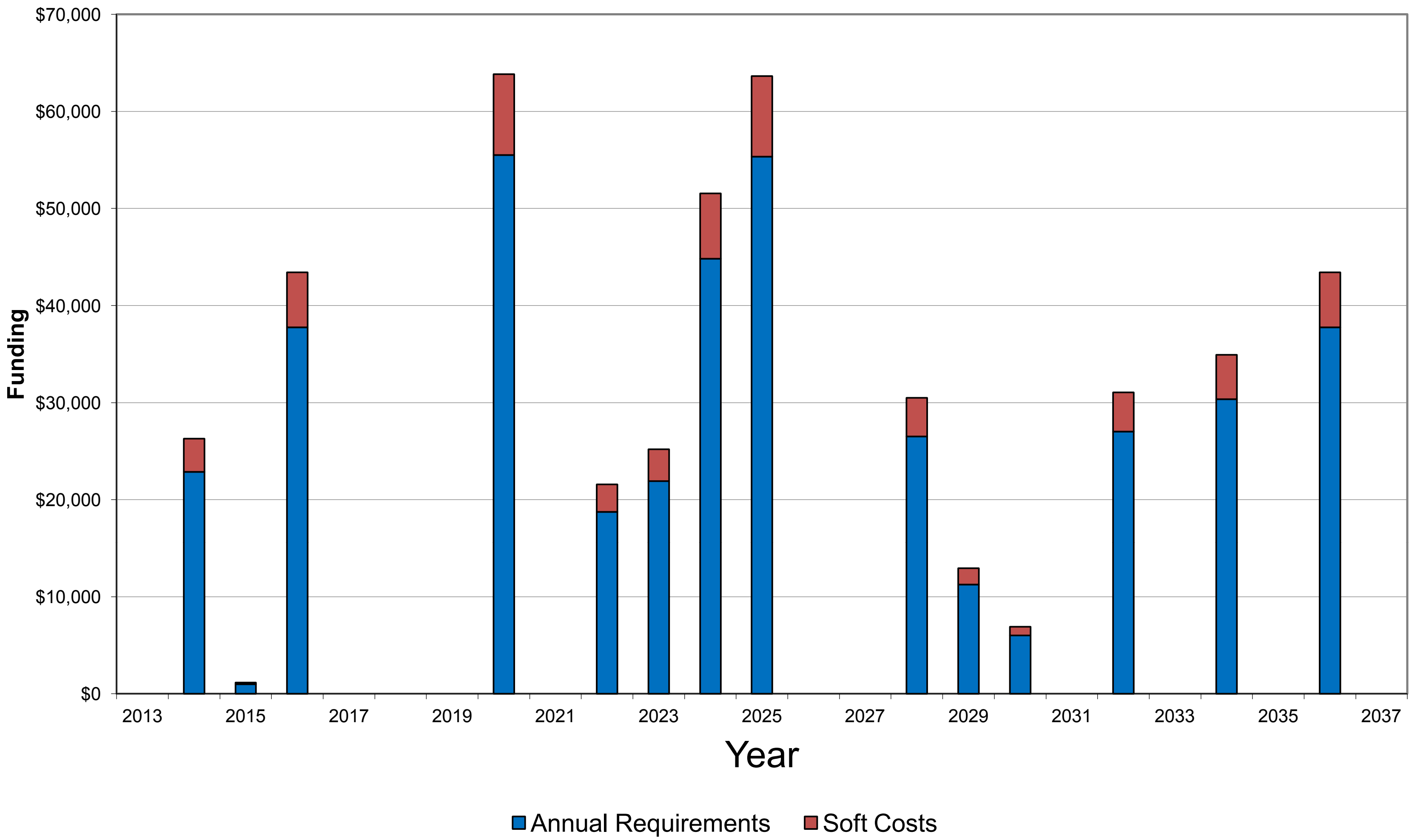
1	Site Work (Category 1)
2	Architecture, Exterior (Category 2)
3	Roof (Category 3)
4	Structure (Category 4)
5	Architecture, Interior (Category 5)
6	Mechanical (Category 6)
7	Electrical (Category 7)
8	Life Safety / Fire Suppression (Category 8)
9	Specialty Systems (Category 9)

Projected Facility Condition Index of Harrietsfield-Williamswood Community Centre March-27-13



Recapitalization Costs by Year for Harrietsfield-Williamswood Community Centre

March-27-13



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Harrietsfield-Williamswood Community Centre
Energy Audit Worksheet

Project	Year to Complete Energy Project	Expected Useful Life (EUL)	Capital Plan Item	Cost of Project	Payback Years	Savings Realized Per Year Based on Project Completion	% to Apply to Capital Projects Going forward	Total $ Available Per Year	Year Funding from Savings Becomes Available
Fridges	2013	40		$ -	0.0	$ 210	93%	$ 210	2014
Boiler	2013	20	Boiler	$ 9,000	8.9	$ 1,030	93%	$ 958	2014
Demand Water Heater	2013	20	Hot Water Heater	$ 1,500	3.7	$ 406	93%	$ 378	2014
Programmable Thermostats	2013	15		$ 2,000	1.2	$ 1,715	93%	$ 1,595	2014

Harrietsfield-Williamswood Community Centre
Project Output Sheet for Period from 2013 to 2018

Component	Recapitalization Detail	Year of Replacement	Expected Useful Life (EUL)	Current Age	Decision Parameters: Life Safety	O&M Impact	Impact to Business	Utility	Vision	Total	Total Cost
Fridges	as per recommendations from Energy Audit	2013	40	NA	No	Yes	NA	High	NA	2	$ -
Demand Water Heater	as per recommendations from Energy Audit	2013	20	NA	No	Yes	NA	High	NA	2	$ 1,500
Programmable Thermostats	as per recommendations from Energy Audit	2013	15	NA	No	Yes	NA	High	NA	2	$ 2,000
Site Lighting	Replace at end of useful life	2014	20	19	No	Yes	No	Normal	No	1	$ 5,220
Asphalt Shingle	Replace at end of useful life	2014	20	19	No	No	Yes	Normal	No	1	$ 17,639
Lower Level Kitchen Millwork	Replace at end of useful life	2016	20	19	No	No	Yes	Normal	No	1	$ 24,750
Kitchen Appliances	Replace at end of useful life	2016	20	19	No	No	Yes	Normal	No	1	$ 6,000
Lower Level Washroom Millwork	Replace at end of useful life	2016	20	19	No	No	Yes	Normal	No	1	$ 7,000

Building Component Summary Worksheet

Harrietsfield-Williamswood Community Centre

								Decision Parameters										
Component	Recapitalization Detail	Year of Installation or Repair	Expected Useful Life (EUL)	Current Age	Theoretical Remaining Useful Life (RUL)	Useful Life Corrected For Observations	Year of Replacement	Life Safety	O&M Impact	Impact to Business	Utility	Vision	Total	Type of event (Cyclic/Single)	Unit	Quantity	Unit Cost	Total Cost
Site Work (Category 1)																		
Asphalt Paving	Repair asphalt at ten years of service	2010	10	3	7	7	2020	No	No	No	Normal	No	0	Single	ft²	2,185	$ 4.50	$ 9,833
Asphalt Paving	Replace asphalt paving	2010	15	3	12	12	2025	No	No	No	Normal	No	0	Cyclical	ft²	10,910	$ 4.50	$ 49,095
Site Lighting	Replace at end of useful life	1994	20	19	1	1	2014	No	Yes	No	Normal	No	1	Cyclical	EA	6	$ 870.00	$ 5,220
Architecture, Exterior (Category 2)																		
Windows	Replace at end of useful life	1994	30	19	11	17	2030	No	Yes	No	Normal	No	1	Cyclical	LS	1	$ 5,000.00	$ 5,000
Service Doors	Replace at end of useful life	2000	20	13	7	7	2020	No	Yes	No	Normal	No	1	Cyclical	Ea	6	$ 1,450.00	$ 8,700
Cement Siding	Replace at end of useful life	1994	30	19	11	11	2024	No	No	No	Normal	No	0	Cyclical	ft²	3,735	$ 12.00	$ 44,820
Roof (Category 3)																		
Asphalt Shingle	Replace at end of useful life	1994	20	19	1	1	2014	No	No	Yes	Normal	No	1	Cyclical	ft²	4,170	$ 4.23	$ 17,639
Modified Bitumen	Replace at end of useful life	2012	20	1	19	19	2032	No	No	Yes	Normal	No	1	Cyclical	ft²	2,250	$ 12.00	$ 27,000
Structure (Category 4)																		
Building Structure	No significant capital expenditure is anticipated	1970	75	43	32	32	2045	No	No	Yes	Normal	No	1	Single	ft²	1	$ -	$ -
Architecture, Interior (Category 5)																		
Community Hall (Gymnasium) Floor	Replace Vinyl Tile floor	2003	20	10	10	10	2023	No	No	Yes	Normal	No	1	Cyclical	ft²	2,700	$ 8.11	$ 21,897
Lower Level Kitchen Millwork	Replace at end of useful life	1994	20	19	1	3	2016	No	No	Yes	Normal	No	1	Cyclical	LS	1	$ 24,750.00	$ 24,750
Kitchen Appliances	Replace at end of useful life	1994	20	19	1	3	2016	No	No	Yes	Normal	No	1	Cyclical	LS	1	$ 6,000.00	$ 6,000
Lower Level Vinyl Tile	Replace at end of useful life	2005	20	8	12	12	2025	No	No	No	Normal	No	0	Cyclical	ft²	770	$ 8.11	$ 6,245
Lower Level Washroom Millwork	Replace at end of useful life	1994	20	19	1	3	2016	No	No	Yes	Normal	No	1	Cyclical	LS	1	$ 7,000.00	$ 7,000
Lower Level Washroom Partitions	Replace at end of useful life	2002	20	11	9	9	2022	No	No	Yes	Normal	No	1	Cyclical	LS	1	$ 3,750	$ 3,750
Upper Level Vinyl Tile	Replace at end of useful life	2008	20	5	15	15	2028	No	No	Yes	Normal	No	1	Cyclical	ft²	2,000	$ 8	$ 16,220
Upper Level Suspended Ceiling	Replace at end of useful life	2008	20	5	15	15	2028	No	No	Yes	Normal	No	1	Cyclical	ft³	2,000	$ 5.15	$ 10,300

Capital Management Engineering Limited

Building Component Summary Worksheet

Harrietsfield-Williamswood Community Centre

								Decision Parameters										
Component	Recapitalization Detail	Year of Installation or Repair	Expected Useful Life (EUL)	Current Age	Theoretical Remaining Useful Life (RUL)	Useful Life Corrected For Observations	Year of Replacement	Life Safety	O&M Impact	Impact to Business	Utility	Vision	Total	Type of event (Cyclic/Single)	Unit	Quantity	Unit Cost	Total Cost
Mechanical (Category 6)																		
Hot Water Heater	**Replace at end of useful life**	**1994**	**15**	**19**	**-4**	**2**	**2015**	**No**	**No**	**Yes**	**Normal**	**No**	**1**	**Cyclical**	**Ea**	**1**	**$ 1,000**	**$ 1,000**
Water Softener, Pump and Pressure Tank	Replace at end of useful life	2002	20	11	9	9	2022	No	No	Yes	Normal	No	1	Cyclical	LS	1	$ 6,000	$ 6,000
Plumbing Fixtures	Replace at end of useful life	1994	35	19	16	16	2029	No	No	Yes	Normal	No	1	Cyclical	LS	1	$ 11,250	$ 11,250
Boiler	**Replace at end of useful life**	**2000**	**20**	**13**	**7**	**9**	**2022**	**No**	**Yes**	**Yes**	**Normal**	**No**	**2**	**Cyclical**	**Ea**	**1**	**$ 9,000**	**$ 9,000**
Oil Tanks	Replace at end of useful life	2000	20	13	7	7	2020	No	No	Yes	Normal	No	1	Cyclical	Ea	2	$ 1,500	$ 3,000
Electrical (Category 7)																		
Main Breaker Panel, Square D	Replace at end of useful life	1994	40	19	21	21	2034	No	Yes	Yes	Normal	No	2	Cyclical	LS	1	$ 7,500	$ 7,500
Lighting	Replace at end of useful life	2000	20	13	7	7	2020	No	Yes	Yes	Normal	No	2	Cyclical	ft²	5,770	$ 2.50	$ 14,425
Distribution Wiring	Replace at end of useful life	1970	40	43	-3	7	2020	No	Yes	Yes	Normal	No	2	Cyclical	ft²	5,770	$ 1.50	$ 8,655
Life Safety / Fire Suppression (Category 8)																		
Fire Alarm Panel	Replace at end of useful life	2000	20	13	7	7	2020	Yes	No	Yes	High	No	3	Cyclical	LS	1	$ 5,000	$ 5,000
Fire Detection and Emergency Lighting Devices and Wiring	Replace at end of useful life	2000	20	13	7	7	2020	Yes	No	Yes	High	No	3	Cyclical	ft²	5,770	$ 1.02	$ 5,885
Specialty Systems (Category 9)																		
Energy Capital Replacements																		
Fridges	as per recommendations from Energy Audit	NA	40	NA	NA	NA	2013	No	Yes	NA	High	NA	2	Cyclical	LS	1	$ -	$ -
Boiler	as per recommendations from Energy Audit	NA	20	NA	NA	NA	2013	No	Yes	NA	High	NA	2	Cyclical	LS	1	$ 9,000.00	$ 9,000
Demand Water Heater	as per recommendations from Energy Audit	NA	20	NA	NA	NA	2013	No	Yes	NA	High	NA	2	Cyclical	LS	1	$ 1,500.00	$ 1,500
Programmable Thermostats	as per recommendations from Energy Audit	NA	15	NA	NA	NA	2013	No	Yes	NA	High	NA	2	Cyclical	LS	1	$ 2,000.00	$ 2,000

Harrietsfield-Williamswood Community Centre
Cash Flow Analysis Output Sheet

Component	Recapitalization Detail	Type of event (cyclic/single)	Year of Installation or Repair	Expected Useful Life (EUL)	Useful Life Corrected For Observations	Year of Replacement	Unit Cost	Total Cost	Year 1 2013	Year 2 2014	Year 3 2015	Year 4 2016	Year 5 2017	Year 6 2018	Year 7 2019	Year 8 2020	Year 9 2021	Year 10 2022
Site Work (Category 1)																		
Asphalt Paving	Repair asphalt at ten years of service	Single	2010	10	7	2020	$ 5	$ 9,833	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9,833	$ -	$ -
Asphalt Paving	Replace asphalt paving	Cyclical	2010	15	12	2025	$ 5	$ 49,095	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Site Lighting	Replace at end of useful life	Cyclical	1994	20	1	2014	$ 870	$ 5,220	$ -	$ 5,220	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Site Work (Category 1) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ 5,220	$ -	$ -	$ -	$ -	$ -	$ 9,833	$ -	$ -
Site Work (Category 1) Summary									$ -	$ 5,220	$ -	$ -	$ -	$ -	$ -	$ 9,833	$ -	$ -
Architecture, Exterior (Category 2)																		
Windows	Replace at end of useful life	Cyclical	1994	30	17	2030	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Service Doors	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 1,450	$ 8,700	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,700	$ -	$ -
Cement Siding	Replace at end of useful life	Cyclical	1994	30	11	2024	$ 12	$ 44,820	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Architecture, Exterior (Category 2) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,700	$ -	$ -
Architecture, Exterior (Category 2) Summary									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,700	$ -	$ -
Roof (Category 3)																		
Asphalt Shingle	Replace at end of useful life	Cyclical	1994	20	1	2014	$ 4	$ 17,639	$ -	$ 17,639	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Modified Bitumen	Replace at end of useful life	Cyclical	2012	20	19	2032	$ 12	$ 27,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Roof (Category 3) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ 17,639	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Roof (Category 3) Summary									$ -	$ 17,639	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Structure (Category 4)																		
Building Structure	No significant capital expenditure is anticipated	Single	1970	75	32	2045	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Structure (Category 4) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Structure (Category 4) Summary									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Architecture, Interior (Category 5)																		
Community Hall (Gymnasium) Floor	Replace Vinyl Tile floor	Cyclical	2003	20	10	2023	$ 8	$ 21,897	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Lower Level Kitchen Millwork	Replace at end of useful life	Cyclical	1994	20	3	2016	$ 24,750	$ 24,750	$ -	$ -	$ -	$ 24,750	$ -	$ -	$ -	$ -	$ -	$ -
Kitchen Appliances	Replace at end of useful life	Cyclical	1994	20	3	2016	$ 6,000	$ 6,000	$ -	$ -	$ -	$ 6,000	$ -	$ -	$ -	$ -	$ -	$ -
Lower Level Vinyl Tile	Replace at end of useful life	Cyclical	2005	20	12	2025	$ 8	$ 6,245	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Lower Level Washroom Millwork	Replace at end of useful life	Cyclical	1994	20	3	2016	$ 7,000	$ 7,000	$ -	$ -	$ -	$ 7,000	$ -	$ -	$ -	$ -	$ -	$ -
Lower Level Washroom Partitions	Replace at end of useful life	Cyclical	2002	20	9	2022	$ 3,750	$ 3,750	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,750
Upper Level Vinyl Tile	Replace at end of useful life	Cyclical	2008	20	15	2028	$ 8	$ 16,220	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Upper Level Suspended Ceiling	Replace at end of useful life	Cyclical	2008	20	15	2028	$ 5	$ 10,300	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Architecture, Interior (Category 5) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ 37,750	$ -	$ -	$ -	$ -	$ -	$ 3,750
Architecture, Interior (Category 5) Summary									$ -	$ -	$ -	$ 37,750	$ -	$ -	$ -	$ -	$ -	$ 3,750

Harrietsfield-Williamswood Community Centre
Cash Flow Analysis Output Sheet

Component	Recapitalization Detail	Type of event (cyclic/single)	Year of Installation or Repair	Expected Useful Life (EUL)	Useful Life Corrected For Observations	Year of Replacement	Unit Cost	Total Cost	Year 11 2023	Year 12 2024	Year 13 2025	Year 14 2026	Year 15 2027	Year 16 2028	Year 17 2029	Year 18 2030	Year 19 2031	Year 20 2032
Site Work (Category 1)																		
Asphalt Paving	Repair asphalt at ten years of service	Single	2010	10	7	2020	$ 5	$ 9,833	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Asphalt Paving	Replace asphalt paving	Cyclical	2010	15	12	2025	$ 5	$ 49,095	$ -	$ -	$ 49,095	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Site Lighting	Replace at end of useful life	Cyclical	1994	20	1	2014	$ 870	$ 5,220	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Site Work (Category 1) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ 49,095	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Site Work (Category 1) Summary									$ -	$ -	$ 49,095	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Architecture, Exterior (Category 2)																		
Windows	Replace at end of useful life	Cyclical	1994	30	17	2030	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000	$ -	$ -
Service Doors	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 1,450	$ 8,700	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cement Siding	Replace at end of useful life	Cyclical	1994	30	11	2024	$ 12	$ 44,820	$ -	$ 44,820	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Architecture, Exterior (Category 2) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ 44,820	$ -	$ -	$ -	$ -	$ -	$ 5,000	$ -	$ -
Architecture, Exterior (Category 2) Summary									$ -	$ 44,820	$ -	$ -	$ -	$ -	$ -	$ 5,000	$ -	$ -
Roof (Category 3)																		
Asphalt Shingle	Replace at end of useful life	Cyclical	1994	20	1	2014	$ 4	$ 17,639	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Modified Bitumen	Replace at end of useful life	Cyclical	2012	20	19	2032	$ 12	$ 27,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 27,000
Roof (Category 3) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 27,000
Roof (Category 3) Summary									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 27,000
Structure (Category 4)																		
Building Structure	No significant capital expenditure is anticipated	Single	1970	75	32	2045	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Structure (Category 4) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Structure (Category 4) Summary									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Architecture, Interior (Category 5)																		
Community Hall (Gymnasium) Floor	Replace Vinyl Tile floor	Cyclical	2003	20	10	2023	$ 8	$ 21,897	$ 21,897	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Lower Level Kitchen Millwork	Replace at end of useful life	Cyclical	1994	20	3	2016	$ 24,750	$ 24,750	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Kitchen Appliances	Replace at end of useful life	Cyclical	1994	20	3	2016	$ 6,000	$ 6,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Lower Level Vinyl Tile	Replace at end of useful life	Cyclical	2005	20	12	2025	$ 8	$ 6,245	$ -	$ -	$ 6,245	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Lower Level Washroom Millwork	Replace at end of useful life	Cyclical	1994	20	3	2016	$ 7,000	$ 7,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Lower Level Washroom Partitions	Replace at end of useful life	Cyclical	2002	20	9	2022	$ 3,750	$ 3,750	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Upper Level Vinyl Tile	Replace at end of useful life	Cyclical	2008	20	15	2028	$ 8	$ 16,220	$ -	$ -	$ -	$ -	$ -	$ 16,220	$ -	$ -	$ -	$ -
Upper Level Suspended Ceiling	Replace at end of useful life	Cyclical	2008	20	15	2028	$ 5	$ 10,300	$ -	$ -	$ -	$ -	$ -	$ 10,300	$ -	$ -	$ -	$ -
Architecture, Interior (Category 5) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ 21,897	$ -	$ 6,245	$ -	$ -	$ 26,520	$ -	$ -	$ -	$ -
Architecture, Interior (Category 5) Summary									$ 21,897	$ -	$ 6,245	$ -	$ -	$ 26,520	$ -	$ -	$ -	$ -

Harrietsfield-Williamswood Community Centre
Cash Flow Analysis Output Sheet

Component	Recapitalization Detail	Type of event (cyclic/single)	Year of Installation or Repair	Expected Useful Life (EUL)	Useful Life Corrected For Observations	Year of Replacement	Unit Cost	Total Cost	Year 21 2033	Year 22 2034	Year 23 2035	Year 24 2036	Year 25 2037
Site Work (Category 1)													
Asphalt Paving	Repair asphalt at ten years of service	Single	2010	10	7	2020	$ 5	$ 9,833	$ -	$ -	$ -	$ -	$ -
Asphalt Paving	Replace asphalt paving	Cyclical	2010	15	12	2025	$ 5	$ 49,095	$ -	$ -	$ -	$ -	$ -
Site Lighting	Replace at end of useful life	Cyclical	1994	20	1	2014	$ 870	$ 5,220	$ -	$ 5,220	$ -	$ -	$ -
Site Work (Category 1) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ 5,220	$ -	$ -	$ -
Site Work (Category 1) Summary									$ -	$ 5,220	$ -	$ -	$ -
Architecture, Exterior (Category 2)													
Windows	Replace at end of useful life	Cyclical	1994	30	17	2030	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -	$ -
Service Doors	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 1,450	$ 8,700	$ -	$ -	$ -	$ -	$ -
Cement Siding	Replace at end of useful life	Cyclical	1994	30	11	2024	$ 12	$ 44,820	$ -	$ -	$ -	$ -	$ -
Architecture, Exterior (Category 2) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -
Architecture, Exterior (Category 2) Summary									$ -	$ -	$ -	$ -	$ -
Roof (Category 3)													
Asphalt Shingle	Replace at end of useful life	Cyclical	1994	20	1	2014	$ 4	$ 17,639	$ -	$ 17,639	$ -	$ -	$ -
Modified Bitumen	Replace at end of useful life	Cyclical	2012	20	19	2032	$ 12	$ 27,000	$ -	$ -	$ -	$ -	$ -
Roof (Category 3) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ 17,639	$ -	$ -	$ -
Roof (Category 3) Summary									$ -	$ 17,639	$ -	$ -	$ -
Structure (Category 4)													
Building Structure	No significant capital expenditure is anticipated	Single	1970	75	32	2045	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Structure (Category 4) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -
Structure (Category 4) Summary									$ -	$ -	$ -	$ -	$ -
Architecture, Interior (Category 5)													
Community Hall (Gymnasium) Floor	Replace Vinyl Tile floor	Cyclical	2003	20	10	2023	$ 8	$ 21,897	$ -	$ -	$ -	$ -	$ -
Lower Level Kitchen Millwork	Replace at end of useful life	Cyclical	1994	20	3	2016	$ 24,750	$ 24,750	$ -	$ -	$ -	$ 24,750	$ -
Kitchen Appliances	Replace at end of useful life	Cyclical	1994	20	3	2016	$ 6,000	$ 6,000	$ -	$ -	$ -	$ 6,000	$ -
Lower Level Vinyl Tile	Replace at end of useful life	Cyclical	2005	20	12	2025	$ 8	$ 6,245	$ -	$ -	$ -	$ -	$ -
Lower Level Washroom Millwork	Replace at end of useful life	Cyclical	1994	20	3	2016	$ 7,000	$ 7,000	$ -	$ -	$ -	$ 7,000	$ -
Lower Level Washroom Partitions	Replace at end of useful life	Cyclical	2002	20	9	2022	$ 3,750	$ 3,750	$ -	$ -	$ -	$ -	$ -
Upper Level Vinyl Tile	Replace at end of useful life	Cyclical	2008	20	15	2028	$ 8	$ 16,220	$ -	$ -	$ -	$ -	$ -
Upper Level Suspended Ceiling	Replace at end of useful life	Cyclical	2008	20	15	2028	$ 5	$ 10,300	$ -	$ -	$ -	$ -	$ -
Architecture, Interior (Category 5) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ 37,750	$ -
Architecture, Interior (Category 5) Summary									$ -	$ -	$ -	$ 37,750	$ -

Harrietsfield-Williamswood Community Centre
Cash Flow Analysis Output Sheet

Component	Recapitalization Detail	Type of event (cyclic/single)	Year of Installation or Repair	Expected Useful Life (EUL)	Useful Life Corrected For Observations	Year of Replacement	Unit Cost	Total Cost	Year 1 2013	Year 2 2014	Year 3 2015	Year 4 2016	Year 5 2017	Year 6 2018	Year 7 2019	Year 8 2020	Year 9 2021	Year 10 2022
Mechanical (Category 6)																		
<<Hot Water Heater>>	Replace at end of useful life	Cyclical	1994	15	2	2015	$ 1,000	$ 1,000	$ -	$ -	$ 1,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Water Softener, Pump and Pressure Tank	Replace at end of useful life	Cyclical	2002	20	9	2022	$ 6,000	$ 6,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,000
Plumbing Fixtures	Replace at end of useful life	Cyclical	1994	35	16	2029	$ 11,250	$ 11,250	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
<<Boiler>>	Replace at end of useful life	Cyclical	2000	20	9	2022	$ 9,000	$ 9,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9,000
Oil Tanks	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 1,500	$ 3,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,000	$ -	$ -
Mechanical (Category 6) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,000	$ -	$ 6,000
Mechanical (Category 6) Summary									$ -	$ -	$ 1,000	$ -	$ -	$ -	$ -	$ 3,000	$ -	$ 15,000
Electrical (Category 7)																		
Main Breaker Panel, Square D	Replace at end of useful life	Cyclical	1994	40	21	2034	$ 7,500	$ 7,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Lighting	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 3	$ 14,425	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 14,425	$ -	$ -
Distribution Wiring	Replace at end of useful life	Cyclical	1970	40	7	2020	$ 2	$ 8,655	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,655	$ -	$ -
Electrical (Category 7) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 23,080	$ -	$ -
Electrical (Category 7) Summary									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 23,080	$ -	$ -
Life Safety / Fire Suppression (Category 8)																		
Fire Alarm Panel	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000	$ -	$ -
Fire Detection and Emergency Lighting Devices and Wiring	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 1	$ 5,885	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,885	$ -	$ -
Life Safety / Fire Suppression (Category 8) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,885	$ -	$ -
Life Safety / Fire Suppression (Category 8) Summary									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,885	$ -	$ -
Energy Capital Replacements																		
<<Fridges>>	as per recommendations from Energy Audit	Cyclical	NA	40	NA	2013	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
<<Boiler>>	as per recommendations from Energy Audit	Cyclical	NA	20	NA	2013	$ 9,000	$ 9,000	$ 9,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
<<Demand Water Heater>>	as per recommendations from Energy Audit	Cyclical	NA	20	NA	2013	$ 1,500	$ 1,500	$ 1,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
<<Programmable Thermostats>>	as per recommendations from Energy Audit	Cyclical	NA	15	NA	2013	$ 2,000	$ 2,000	$ 2,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Capital Replacements Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Capital Replacements Summary									$ 12,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Harrietsfield-Williamswood Community Centre
Cash Flow Analysis Output Sheet

Component	Recapitalization Detail	Type of event (cyclic/single)	Year of Installation or Repair	Expected Useful Life (EUL)	Useful Life Corrected For Observations	Year of Replacement	Unit Cost	Total Cost	Year 11 2023	Year 12 2024	Year 13 2025	Year 14 2026	Year 15 2027	Year 16 2028	Year 17 2029	Year 18 2030	Year 19 2031	Year 20 2032
Mechanical (Category 6)																		
<<Hot Water Heater>>	Replace at end of useful life	Cyclical	1994	15	2	2015	$ 1,000	$ 1,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,000	$ -	$ -
Water Softener, Pump and Pressure Tank	Replace at end of useful life	Cyclical	2002	20	9	2022	$ 6,000	$ 6,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Plumbing Fixtures	Replace at end of useful life	Cyclical	1994	35	16	2029	$ 11,250	$ 11,250	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,250	$ -	$ -	$ -
<<Boiler>>	Replace at end of useful life	Cyclical	2000	20	9	2022	$ 9,000	$ 9,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Oil Tanks	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 1,500	$ 3,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Mechanical (Category 6) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ 11,250	$ -	$ -	$ -
Mechanical (Category 6) Summary									$ -	$ -	$ -	$ -	$ -	$ -	$ 11,250	$ 1,000	$ -	$ -
Electrical (Category 7)																		
Main Breaker Panel, Square D	Replace at end of useful life	Cyclical	1994	40	21	2034	$ 7,500	$ 7,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Lighting	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 3	$ 14,425	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Distribution Wiring	Replace at end of useful life	Cyclical	1970	40	7	2020	$ 2	$ 8,655	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Electrical (Category 7) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Electrical (Category 7) Summary									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Life Safety / Fire Suppression (Category 8)																		
Fire Alarm Panel	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Fire Detection and Emergency Lighting Devices and Wiring	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 1	$ 5,885	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Life Safety / Fire Suppression (Category 8) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Life Safety / Fire Suppression (Category 8) Summary									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Capital Replacements																		
<<Fridges>>	as per recommendations from Energy Audit	Cyclical	NA	40	NA	2013	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
<<Boiler>>	as per recommendations from Energy Audit	Cyclical	NA	20	NA	2013	$ 9,000	$ 9,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
<<Demand Water Heater>>	as per recommendations from Energy Audit	Cyclical	NA	20	NA	2013	$ 1,500	$ 1,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
<<Programmable Thermostats>>	as per recommendations from Energy Audit	Cyclical	NA	15	NA	2013	$ 2,000	$ 2,000	$ -	$ -	$ -	$ -	$ -	$ 2,000	$ -	$ -	$ -	$ -
Energy Capital Replacements Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Capital Replacements Summary									$ -	$ -	$ -	$ -	$ -	$ 2,000	$ -	$ -	$ -	$ -

Harrietsfield-Williamswood Community Centre
Cash Flow Analysis Output Sheet

Component	Recapitalization Detail	Type of event (cyclic/single)	Year of Installation or Repair	Expected Useful Life (EUL)	Useful Life Corrected For Observations	Year of Replacement	Unit Cost	Total Cost	Year 21 2033	Year 22 2034	Year 23 2035	Year 24 2036	Year 25 2037
Mechanical (Category 6)													
<<Hot Water Heater>>	Replace at end of useful life	Cyclical	1994	15	2	2015	$ 1,000	$ 1,000	$ -	$ -	$ -	$ -	$ -
Water Softener, Pump and Pressure Tank	Replace at end of useful life	Cyclical	2002	20	9	2022	$ 6,000	$ 6,000	$ -	$ -	$ -	$ -	$ -
Plumbing Fixtures	Replace at end of useful life	Cyclical	1994	35	16	2029	$ 11,250	$ 11,250	$ -	$ -	$ -	$ -	$ -
<<Boiler>>	Replace at end of useful life	Cyclical	2000	20	9	2022	$ 9,000	$ 9,000	$ -	$ -	$ -	$ -	$ -
Oil Tanks	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 1,500	$ 3,000	$ -	$ -	$ -	$ -	$ -
Mechanical (Category 6) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -
Mechanical (Category 6) Summary									$ -	$ -	$ -	$ -	$ -
Electrical (Category 7)													
Main Breaker Panel, Square D	Replace at end of useful life	Cyclical	1994	40	21	2034	$ 7,500	$ 7,500	$ -	$ 7,500	$ -	$ -	$ -
Lighting	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 3	$ 14,425	$ -	$ -	$ -	$ -	$ -
Distribution Wiring	Replace at end of useful life	Cyclical	1970	40	7	2020	$ 2	$ 8,655	$ -	$ -	$ -	$ -	$ -
Electrical (Category 7) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ 7,500	$ -	$ -	$ -
Electrical (Category 7) Summary									$ -	$ 7,500	$ -	$ -	$ -
Life Safety / Fire Suppression (Category 8)													
Fire Alarm Panel	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -	$ -
Fire Detection and Emergency Lighting Devices and Wiring	Replace at end of useful life	Cyclical	2000	20	7	2020	$ 1	$ 5,885	$ -	$ -	$ -	$ -	$ -
Life Safety / Fire Suppression (Category 8) Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -
Life Safety / Fire Suppression (Category 8) Summary									$ -	$ -	$ -	$ -	$ -
Energy Capital Replacements													
<<Fridges>>	as per recommendations from Energy Audit	Cyclical	NA	40	NA	2013	$ -	$ -	$ -	$ -	$ -	$ -	$ -
<<Boiler>>	as per recommendations from Energy Audit	Cyclical	NA	20	NA	2013	$ 9,000	$ 9,000	$ 9,000	$ -	$ -	$ -	$ -
<<Demand Water Heater>>	as per recommendations from Energy Audit	Cyclical	NA	20	NA	2013	$ 1,500	$ 1,500	$ 1,500	$ -	$ -	$ -	$ -
<<Programmable Thermostats>>	as per recommendations from Energy Audit	Cyclical	NA	15	NA	2013	$ 2,000	$ 2,000	$ -	$ -	$ -	$ -	$ -
Energy Capital Replacements Summary Excluding Projects Replaced by Energy Efficiency Improvements									$ -	$ -	$ -	$ -	$ -
Energy Capital Replacements Summary									$ 10,500	$ -	$ -	$ -	$ -

Harrietsfield-Williamswood Community Centre
Cash Flow Summary Output Sheet

Harrietsfield-Williamswood Community Centre	Year 1 2013	Year 2 2014	Year 3 2015	Year 4 2016	Year 5 2017	Year 6 2018	Year 7 2019	Year 8 2020	Year 9 2021	Year 10 2022
Site Work (Category 1)	$ -	$ 5,220	$ -	$ -	$ -	$ -	$ -	$ 9,833	$ -	$ -
Architecture, Exterior (Category 2)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,700	$ -	$ -
Roof (Category 3)	$ -	$ 17,639	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Structure (Category 4)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Architecture, Interior (Category 5)	$ -	$ -	$ -	$ 37,750	$ -	$ -	$ -	$ -	$ -	$ 3,750
Mechanical (Category 6)	$ -	$ -	$ 1,000	$ -	$ -	$ -	$ -	$ 3,000	$ -	$ 15,000
Electrical (Category 7)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 23,080	$ -	$ -
Life Safety / Fire Suppression (Category 8)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,885	$ -	$ -
Specialty Systems (Category 9)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL for Harrietsfield-Williamswood Community Centre	$ -	$ 22,859	$ 1,000	$ 37,750	$ -	$ -	$ -	$ 55,498	$ -	$ 18,750

Facility Condition Calculation Output Sheet

Harrietsfield-Williamswood Community Centre	Year 1 2013	Year 2 2014	Year 3 2015	Year 4 2016	Year 5 2017	Year 6 2018	Year 7 2019	Year 8 2020	Year 9 2021	Year 10 2022
Balance Carried from Previous Year	$ -	$ -	$ 26,288	$ 27,438	$ 70,850	$ 70,850	$ 70,850	$ 70,850	$ 134,673	$ 134,673
Anticipated Annual Recap Requirement	$ -	$ 22,859	$ 1,000	$ 37,750	$ -	$ -	$ -	$ 55,498	$ -	$ 18,750
Soft Costs	$ -	$ 3,429	$ 150	$ 5,663	$ -	$ -	$ -	$ 8,325	$ -	$ 2,813
Total Anticipated Requirements	$ -	$ 26,288	$ 27,438	$ 70,850	$ 70,850	$ 70,850	$ 70,850	$ 134,673	$ 134,673	$ 156,236
Capital Funding	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Operational Costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Maintenance Costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Loan Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building Replacement Value	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714
Amount of Deferred Maintenance	$ -	$ 26,288	$ 27,438	$ 70,850	$ 70,850	$ 70,850	$ 70,850	$ 134,673	$ 134,673	$ 156,236
Annual Cost of Ownership	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
FCI	0.00%	2.96%	3.09%	7.98%	7.98%	7.98%	7.98%	15.17%	15.17%	17.60%

Harrietsfield-Williamswood Community Centre
Cash Flow Summary Output Sheet

Harrietsfield-Williamswood Community Centre	Year 11 2023	Year 12 2024	Year 13 2025	Year 14 2026	Year 15 2027	Year 16 2028	Year 17 2029	Year 18 2030	Year 19 2031	Year 20 2032	Year 21 2033	Year 22 2034	Year 23 2035	Year 24 2036	Year 25 2037
Site Work (Category 1)	$ -	$ -	$ 49,095	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,220	$ -	$ -	$ -
Architecture, Exterior (Category 2)	$ -	$ 44,820	$ -	$ -	$ -	$ -	$ -	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Roof (Category 3)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 27,000	$ -	$ 17,639	$ -	$ -	$ -
Structure (Category 4)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Architecture, Interior (Category 5)	$ 21,897	$ -	$ 6,245	$ -	$ -	$ 26,520	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 37,750	$ -
Mechanical (Category 6)	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,250	$ 1,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Electrical (Category 7)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,500	$ -	$ -	$ -
Life Safety / Fire Suppression (Category 8)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Specialty Systems (Category 9)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL for Harrietsfield-Williamswood Community Centre	$ 21,897	$ 44,820	$ 55,340	$ -	$ -	$ 26,520	$ 11,250	$ 6,000	$ -	$ 27,000	$ -	$ 30,359	$ -	$ 37,750	$ -

Facility Condition Calculation Output Sheet

Harrietsfield-Williamswood Community Centre	Year 11 2023	Year 12 2024	Year 13 2025	Year 14 2026	Year 15 2027	Year 16 2028	Year 17 2029	Year 18 2030	Year 19 2031	Year 20 2032	Year 21 2033	Year 22 2034	Year 23 2035	Year 24 2036	Year 25 2037
Balance Carried from Previous Year	$ 156,236	$ 181,417	$ 232,960	$ 296,601	$ 296,601	$ 296,601	$ 327,099	$ 340,036	$ 346,936	$ 346,936	$ 377,986	$ 377,986	$ 412,899	$ 412,899	$ 456,312
Anticipated Annual Recap Requirement	$ 21,897	$ 44,820	$ 55,340	$ -	$ -	$ 26,520	$ 11,250	$ 6,000	$ -	$ 27,000	$ -	$ 30,359	$ -	$ 37,750	$ -
Soft Costs	$ 3,285	$ 6,723	$ 8,301	$ -	$ -	$ 3,978	$ 1,688	$ 900	$ -	$ 4,050	$ -	$ 4,554	$ -	$ 5,663	$ -
Total Anticipated Requirements	$ 181,417	$ 232,960	$ 296,601	$ 296,601	$ 296,601	$ 327,099	$ 340,036	$ 346,936	$ 346,936	$ 377,986	$ 377,986	$ 412,899	$ 412,899	$ 456,312	$ 456,312
Capital Funding	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Operational Costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Maintenance Costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Loan Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building Replacement Value	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714
Amount of Deferred Maintenance	$ 181,417	$ 232,960	$ 296,601	$ 296,601	$ 296,601	$ 327,099	$ 340,036	$ 346,936	$ 346,936	$ 377,986	$ 377,986	$ 412,899	$ 412,899	$ 456,312	$ 456,312
Annual Cost of Ownership	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
FCI	20.44%	26.24%	33.41%	33.41%	33.41%	36.85%	38.30%	39.08%	39.08%	42.58%	42.58%	46.51%	46.51%	51.40%	51.40%

Harrietsfield-Williamswood Community Centre
Cash Flow Summary Output Sheet - Including Efficiency Projects

Harrietsfield-Williamswood Community Centre	Year 1 2013	Year 2 2014	Year 3 2015	Year 4 2016	Year 5 2017	Year 6 2018	Year 7 2019	Year 8 2020	Year 9 2021	Year 10 2022
Site Work (Category 1)	$ -	$ 5,220	$ -	$ -	$ -	$ -	$ -	$ 9,833	$ -	$ -
Architecture, Exterior (Category 2)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,700	$ -	$ -
Roof (Category 3)	$ -	$ 17,639	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Structure (Category 4)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Architecture, Interior (Category 5)	$ -	$ -	$ -	$ 37,750	$ -	$ -	$ -	$ -	$ -	$ 3,750
Mechanical (Category 6)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,000	$ -	$ 6,000
Electrical (Category 7)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 23,080	$ -	$ -
Life Safety / Fire Suppression (Category 8)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,885	$ -	$ -
Specialty Systems (Category 9)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Capital Replacements	$ 12,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL for Harrietsfield-Williamswood Community Centre	$ 12,500	$ 22,859	$ -	$ 37,750	$ -	$ -	$ -	$ 55,498	$ -	$ 9,750

Facility Condition Calculation Output Sheet - Including Efficiency Projects

Harrietsfield-Williamswood Community Centre	Year 1 2013	Year 2 2014	Year 3 2015	Year 4 2016	Year 5 2017	Year 6 2018	Year 7 2019	Year 8 2020	Year 9 2021	Year 10 2022
Balance Carried from Previous Year	$ -	$ 11,235	$ 34,382	$ 31,242	$ 71,514	$ 68,373	$ 65,233	$ 62,092	$ 122,775	$ 119,634
Anticipated Annual Recap Requirement	$ 12,500	$ 22,859	$ -	$ 37,750	$ -	$ -	$ -	$ 55,498	$ -	$ 9,750
Soft Costs	$ 1,875	$ 3,429	$ -	$ 5,663	$ -	$ -	$ -	$ 8,325	$ -	$ 1,463
Total Anticipated Requirements	$ 14,375	$ 37,523	$ 34,382	$ 74,654	$ 71,514	$ 68,373	$ 65,233	$ 125,915	$ 122,775	$ 130,847
Capital Funding	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Operations Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Maintenance Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Operational Savings	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140
Loan Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building Replacement Value	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714
Amount of Deferred Maintenance	$ 11,235	$ 34,382	$ 31,242	$ 71,514	$ 68,373	$ 65,233	$ 62,092	$ 122,775	$ 119,634	$ 127,706
Annual Cost of Ownership	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)
FCI	1.27%	3.87%	3.52%	8.06%	7.70%	7.35%	6.99%	13.83%	13.48%	14.39%

Harrietsfield-Williamswood Community Centre
Cash Flow Summary Output Sheet - Including Efficiency Projects

Harrietsfield-Williamswood Community Centre	Year 11 2023	Year 12 2024	Year 13 2025	Year 14 2026	Year 15 2027	Year 16 2028	Year 17 2029	Year 18 2030	Year 19 2031	Year 20 2032	Year 21 2033	Year 22 2034	Year 23 2035	Year 24 2036	Year 25 2037
Site Work (Category 1)	$ -	$ -	$ 49,095	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,220	$ -	$ -	$ -
Architecture, Exterior (Category 2)	$ -	$ 44,820	$ -	$ -	$ -	$ -	$ -	$ 5,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Roof (Category 3)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 27,000	$ -	$ 17,639	$ -	$ -	$ -
Structure (Category 4)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Architecture, Interior (Category 5)	$ 21,897	$ -	$ 6,245	$ -	$ -	$ 26,520	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 37,750	$ -
Mechanical (Category 6)	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,250	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Electrical (Category 7)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,500	$ -	$ -	$ -
Life Safety / Fire Suppression (Category 8)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Specialty Systems (Category 9)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Capital Replacements	$ -	$ -	$ -	$ -	$ -	$ 2,000	$ -	$ -	$ -	$ -	$ 10,500	$ -	$ -	$ -	$ -
TOTAL for Harrietsfield-Williamswood Community Centre	$ 21,897	$ 44,820	$ 55,340	$ -	$ -	$ 28,520	$ 11,250	$ 5,000	$ -	$ 27,000	$ 10,500	$ 30,359	$ -	$ 37,750	$ -

FacFacility Condition Calculation Output Sheet - Including Efficiency Projects

Harrietsfield-Williamswood Community Centre	Year 11 2023	Year 12 2024	Year 13 2025	Year 14 2026	Year 15 2027	Year 16 2028	Year 17 2029	Year 18 2030	Year 19 2031	Year 20 2032	Year 21 2033	Year 22 2034	Year 23 2035	Year 24 2036	Year 25 2037
Balance Carried from Previous Year	$ 127,706	$ 149,747	$ 198,150	$ 258,650	$ 255,510	$ 252,369	$ 282,027	$ 291,824	$ 294,434	$ 291,293	$ 319,203	$ 328,137	$ 359,910	$ 356,769	$ 397,041
Anticipated Annual Recap Requirement	$ 21,897	$ 44,820	$ 55,340	$ -	$ -	$ 28,520	$ 11,250	$ 5,000	$ -	$ 27,000	$ 10,500	$ 30,359	$ -	$ 37,750	$ -
Soft Costs	$ 3,285	$ 6,723	$ 8,301	$ -	$ -	$ 4,278	$ 1,688	$ 750	$ -	$ 4,050	$ 1,575	$ 4,554	$ -	$ 5,663	$ -
Total Anticipated Requirements	$ 152,888	$ 201,290	$ 261,791	$ 258,650	$ 255,510	$ 285,167	$ 294,964	$ 297,574	$ 294,434	$ 322,343	$ 331,278	$ 363,050	$ 359,910	$ 400,182	$ 397,041
Capital Funding	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Operations Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Maintenance Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Operational Savings	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140	$ 3,140
Loan Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Building Replacement Value	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714	$ 887,714
Amount of Deferred Maintenance	$ 149,747	$ 198,150	$ 258,650	$ 255,510	$ 252,369	$ 282,027	$ 291,824	$ 294,434	$ 291,293	$ 319,203	$ 328,137	$ 359,910	$ 356,769	$ 397,041	$ 393,901
Annual Cost of Ownership	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)	$ (3,140)
FCI	16.87%	22.32%	29.14%	28.78%	28.43%	31.77%	32.87%	33.17%	32.81%	35.96%	36.96%	40.54%	40.19%	44.73%	44.37%

Appendix C – HRM Building Forms

BUILDING - SITE CONDITION ASSESSMENT (PAGE 1)

HRM Building ID: 297

Building of Interest:

Building Name: Harrietsfield - Williamswood Community Centre

Also Known As:

PID: 00388363

Civic #: 1138

Street: Old Sambro Road

Community: Halifax

Postal Code:

Urban ☐ Suburban ☐ Rural ☒

Trees:

Hardwood: 20+ — Good ☒ Okay ☐ Poor ☐

Softwood: 20+ — Good ☒ Okay ☐ Poor ☐

Shrubs/Bushes: — Good ☐ Okay ☐ Poor ☐

Flowers & Plantings:

Approximate SqFt: — Condition: Good ☐ Okay ☐ Poor ☐

Landscaping:

Description: Asphalt Paving; Grass; Scrub Grass; Gravel Road; Trees — Condition: Good ☐ Okay ☐ Poor ☐

Parking Lot / Driveway:

Section	Location	Area (SqFt)	# Catch Basins	Curb Material	Deficiency	Priority	Notes
1	Northwest Parking	2750	1	None			Access and Parking at Front of Building
2	Southwest Driveway	5250	0	None			Access to Rear of Building
3	Southeast Driveway and Par	2910	0	None			Includes Apron / Play Area at Rear Door
4							
5							
6							

Deficiencies: 1. Heavily Patched 2. Aligatoring 3. Fissures 4. Bumps & Pot Holes 5. Broken / Missing Curbs

Parking Spots: 10+/- — Condition of Pavement Markings: Good ☐ Okay ☐ Poor ☐

Sidewalks:

Section	Location	Area (SqFt)	Material	Deficiency	Priority	Notes
1						
2						
3						

BUILDING - SITE CONDITION ASSESSMENT (PAGE 2)

HRM Building ID: 297

Lighting: # Poles: 1 | # Lights: 8 | Notes: 1 Street Light on Pole and 7 Building Mounted Lights

Fencing:

Section	Length	Type			Notes
1		Wood ☐	Chain Link ☐	Other	
2		Wood ☐	Chain Link ☐	Other	
3		Wood ☐	Chain Link ☐	Other	

Sheds:

Shed	Size	Material	Notes
1	10x14	Cement Fibre Siding	Approx Size. Southeast of Main Building
2			
3			

Other Features:
(Check Applicable)

Skate Park ☐ Basketball ☐ Playground ☐

Playground Equipment: Play Structure ☐ Basic Equipment ☐ Estimated Value:

Sports Field ☐ Bleachers ☐ Dugouts ☐

Pond ☐ River/Lake ☐ Swimming Pool ☐

Other: Other: Other:

Site Exposures:
(Provide photos for each)

Side	Exposure	Distance Away
North Side	Old Sambro Road (Northwest)	45'
South Side	Henry Lake (Southeast)	485'
East Side	Forest (Northeast)	10'
West Side	Neighbouring Property (Southwest)	35'

Notes & Observations:

Site is Sloped Higher to Lower From Front to Rear With Grade Entry Each Storey

Assessed By: CMEL

Date: 27 February 2013

BUILDING - GENERAL ASSESSMENT (PAGE 1)

HRM Building ID: 297

Building of Interest:

Building Name: Harrietsfield - Williamswood Community Centre
Also Known As:
PID: 00388363
Civic #: 1138
Street: Old Sambro Road
Community: Halifax
Postal Code:

Replacement Cost:

Building Cost: $ 887,714
Additional Fixed Improvement Cost: $
Total Replacement Cost: $ 887,714

Basic Characteristics:

Year of Construction:
(or) Estimated Age:
Floors Above Ground: 1
Floors Below Ground: 1
Total # Floors: 2

Floor	SqFt	Notes
5+		
4		
3		
2		
1 (Ground Level)	2000	Daycare Main Room; Storage; Washroom / Laundry
B1	3770	Meeting Room; Washrooms; Kitchen; Canteen; Offices
B2+		

Total SqFt:

Elevators:
Are Certificates Up To Date? Yes ☐ No ☐
Notes:

Heritage Property? Yes ☐ No ■
Heritage #:

Construction:

Roof: *(see Roofing Assessment Form)*

						Other	Notes
Foundation:	Slab ■	Pile ☐	Crawl Space ☐	T-Shaped ■			Assumed
Material:	Wood ☐	Concrete ■	Cement Block ☐	Stone ☐			
Interior Walls:	Wood ■	Metal ☐	Concrete ☐	Stone ☐			Assumed
Insulation:	Fibreglass ☐	Plastic (polystyrene) ☐	Unknown ■				
Exterior Walls:	Wood ■	Metal ☐	Concrete ☐	Stone ☐			Assumed
Insulation:	Fibreglass ☐	Plastic (polystyrene) ☐	Unknown ■				
Floors:	Wood ☐	Metal ☐	Concrete ■	Stone ☐			Assumed
Windows:	Single Glazed ☐	Double Glazed ■					Vinyl Construction

BUILDING - GENERAL ASSESSMENT (PAGE 2)

HRM Building ID: 297

Building Additions:

Addition	Location	Area (SqFt)	Date of Addition	Description of Space
1				
2				
3				
4				

Estimated Value of Additions:

Occupancy:

Ownership / Usage: HRM Owned/HRM Occupied [ ] HRM Owned/Rented or Leased [ ] Rented or Leased [ ]

	%		%		%
[ ] Correctional		[ ] Museum		[ ] Residential	
[ ] Fire Station		[ ] Art Gallery		[ ] Retail	
[ ] Police Station		[ ] Bus Terminal		[ ] Offices	
[ ] Library		[ ] Ferry Terminal		[ ] Manufacturing	
[ ] School		[ ] Maintenance Depot		[ ] Salt Dome	
[x] Community Centre	100	[ ] Recycling Facility		[ ] Storage	
[ ] Event Centre		[ ] Composting Facility		[ ] Parking Structure	
[ ] Recreation Facility		[ ] Waste Facility		[ ] Vacant	
[ ]		[ ]		[ ]	

Are there flammable liquids used on site? Yes [x] No [ ] Notes: #2 Fuel Oil

Is smoking permitted inside the building? Yes [ ] No [x]

Are there any sleeping quarters? Yes [ ] No [x] Are they used? Yes [ ] No [ ] By whom?

Does the building include: Daycare [x] Eldercare [ ] Before/After School Program [ ]

Bar - Full Time [ ] Bar - Occasional [ ] Arena [ ]

Protection:

Water Supply: Well [x] City [ ] Cistern (non P) [ ]

Are Automatic Sprinklers Present? Yes [ ] No [x] Percentage of Building: %

Are Heat/Smoke Detectors Present? Yes [ ] No [ ] Wired [ ] Battery [ ] Percentage of Building: %

Are the Sprinkler/Heat/Smoke Alarms Monitored? Yes [ ] No [ ] By Whom?

Distance to Nearest Fire Station/Hall: 0.2 Miles Is it a Volunteer Dept? Yes [x] No [x]

Is there a Fire Hydrant(s) Within 250 feet of Building? Yes [ ] No [x]

Are Fire Extinguishers Present Throughout? Yes [x] No [ ] How Many? Certificates Up To Date? Yes [ ] No [ ]

Is there a Burglary Alarm? Yes [x] No [ ] Monitored? Yes [ ] No [ ] By Whom?

Burglary Alarm Is: Wired [ ] Battery [ ]

Is there a Generator? Yes [ ] No [x] Is the Generator: Wired [ ] On Site [ ]

Are there Security Cameras? Yes [ ] No [ ] Monitored? Yes [ ] No [ ] By Whom?

Is there a Watchman Service? Yes [ ] No [ ] Monitored? Yes [ ] No [ ] By Whom?

BUILDING - GENERAL ASSESSMENT (PAGE 3)

HRM Building ID: 297

Septic/Sewer: Underground Septic Storage ☐ Septic Field/Bed ☒ Municipal Service ☐ Notes: Southeast of Building

UST Info:

Does the Property Operate Underground Storage Tanks (USTs)? Yes ☐ No ☒

Has the Property Operated USTs in the Past? Yes ☐ No ☐

Tank	Size	Is the Tank:	Contents	Age	Material
1		Active ☐ Inactive ☐			
2		Active ☐ Inactive ☐			
3		Active ☐ Inactive ☐			

Are UST Inventory Records Maintained? Yes ☐ No ☐ Where are they Stored?

Is Tank Upgrade/Testing Info Available? Yes ☐ No ☐ Where is it Stored?

Do Tank Removal Reports Exist? Yes ☐ No ☐ Where are they Stored?

Was Remediation ever Required at these Tanks? Yes ☐ No ☐

Have there been any Reports of Leaks or Spills? Yes ☐ No ☐

Any Leaks or Spills When the Tank was Removed? Yes ☐ No ☐

AST Info:

Does the Property Operate Above Ground Storage Tanks (ASTs) Yes ☒ No ☐

Has the Property Operated ASTs in the Past? Yes ☒ No ☐

Is the AST Located Inside or Outside the Building? Inside ☐ Outside ☒

Tank	Size	Is the Tank:	Contents	Age	Material
1	909L	Active ☒ Inactive ☐	#2 Fuel Oil	2008	Metal
2	909L	Active ☒ Inactive ☐	#2 Fuel Oil	2008	Metal
3		Active ☐ Inactive ☐			

Are AST Inventory Records Maintained? Yes ☐ No ☐ Where are they Stored?

Is Tank Upgrade/Testing Info Available? Yes ☐ No ☐ Where is it Stored?

Are there any Reported or Documented Records of Release, Spills or Remedial History Yes ☒ No ☐

Are there any Signs of Spillage Related to the AST? Yes ☐ No ☐

Are ASTs Protected from Vehicular Impact? Yes ☑ No ☐

Notes & Observations:

Building is Split Level Entire Storey Front to Rear with Approx 500 sq ft of Overlap and Walkout Lower Level

Assessed By: CMEL

Date: 27 February 2013

BUILDING - MECHANICAL EQUIPMENT ASSESSMENT (PAGE 1)

HRM Building ID: 297

Building of Interest:

Building Name: Harrietsfield - Williamswood Community Centre
Also Known As:
PID: 00388363
Civic #: 1138
Street: Old Sambro Road
Community: Halifax
Postal Code:

Energy Source:

Furnace Oil ☑ Heavy Oil ☐ Propane ☐ Electric ☐ Natural Gas ☐ Geothermal ☐

Other: Solar Panels
Notes: Solar Provides Supplemental Building Heat

Heating Units:

Unit	HP	Fuel	Manufacturer	Age	Notes
1		Solar Panels			Building Mounted on South Facing Wall
2		#2 Fuel Oil	Kerr		Comet 270 Oil Fired Hot Water Boiler
3					
4					

% Building Served By:

HW Radiators	%	Steam Radiators	%	Electric	%
HW Baseboard Radiators	100 %	In-Floor Heat	%	Hot Air	%
Geothermal	%		%		%

Cooling Units:

Unit	Tons	Manufacturer	VFD	Model	Year	DX	CW	Tower
1			☐			☐	☐	☐
2			☐			☐	☐	☐
3			☐			☐	☐	☐
4			☐			☐	☐	☐

Window Units #:

Ventilation - Central, Exhaust, Kitchen Units:

AHU#	Manufacturer	VFD	Cooling?	Heating?	Model	Year	Cfm @ Pressure	Heat Recovery	Humidity
1		☐	☐	☐					☐
2		☐	☐	☐					☐
3		☐	☐	☐					☐
4		☐	☐	☐					☐
5		☐	☐	☐					☐
6		☐	☐	☐					☐

BUILDING - MECHANICAL EQUIPMENT ASSESSMENT (PAGE 2)

HRM Building ID: 297

Exterior Grills/Louvers:

#	Condition
1	
2	
3	
4	

Water:

Domestic HW Tank 1: Age: 15 +/- Size: 68 Litres
Source of Heat: Electric

Domestic HW Tank 2: Age: Size:
Source of Heat:

Domestic HW Tank 3: Age: Size:
Source of Heat:

Domestic HW Tank 4: Age: Size:
Source of Heat:

Number of Heat Pumps: Notes

Number of Washrooms: Male Female Unisex
Toilets Urinals Waterless WC Showers Sinks

Kitchen:

Are there Kitchen Facilities? Yes ☒ No ☐

Does it Contain a Fryer? Yes ☐ No ☑ Stove? Yes ☑ No ☐

Major Equipment:

#	Equipment	Fuel Source	#	Equipment	Fuel Source
1	Range Stove	Electric	11		
2	Fridge	Electric	12		
3	Fridge	Electric	13		
4	Fridge	Electric	14		
5	Fridge	Electric	15		
6			16		
7			17		
8			18		
9			19		
10			20		

BUILDING - MECHANICAL EQUIPMENT ASSESSMENT (PAGE 3)

HRM Building ID: 297

Air Compressors:

#	Manufacturer	Notes
1		
2		
3		
4		

Sprinkler Pumps: Number: HP:

Sprinkler: Wet ☐ Dry ☐ Stand Pipes:

Specialized Equipment (Fire Dept, Rink, Pool, Etc):

Notes & Observations:

Assessed By: CMEL

Date: 27 February 2013

BUILDING - ROOFING ASSESSMENT (PAGE 1)

HRM Building ID: 297

Building of Interest:

Building Name: Harrietsfield - Williamswood Community Centre

Also Known As:

PID: 00388363

Civic #: 1138

Street: Old Sambro Road

Community: Halifax

Postal Code:

Access:

Roof Access: Ladder ☐ Stairs ☐ Others: No On Site Means of Access

Roof Sections:

Section	Slope	SqFt	Age	Type	Condition (Good/Okay/Poor)	Repairs (None/Some/Many)	Parapet Height	Parapet Condition (Good/Okay/Poor)
1	4:12	2191			G ☐ O ☐ P ☐			G ☐ O ☐ P ☐
2	4:12	2882		Rolled Bitumen	G ☐ O ☐ P ☐			G ☐ O ☐ P ☐
3	4:12	522		Rolled Bitumen	G ☐ O ☐ P ☐			G ☐ O ☐ P ☐
4					G ☐ O ☐ P ☐			G ☐ O ☐ P ☐
5					G ☐ O ☐ P ☐			G ☐ O ☐ P ☐
6					G ☐ O ☐ P ☐			G ☐ O ☐ P ☐
7					G ☐ O ☐ P ☐			G ☐ O ☐ P ☐
8					G ☐ O ☐ P ☐			G ☐ O ☐ P ☐
9					G ☐ O ☐ P ☐			G ☐ O ☐ P ☐
10					G ☐ O ☐ P ☐			G ☐ O ☐ P ☐

Penetrations & Accessories:

Section	Plumbing Vent Stacks	HVAC	Drains	Curbs	Electrical	Scuppers	Ladders	Other
1		1						
2								
3								
4								
5								
6								
7								
8								
9								
10								

Notes: No Visual Access to Approx Half of Roof

BUILDING - ROOFING ASSESSMENT (PAGE 2)

HRM Building ID: 297

Deficiencies:

Section	SqFt	Deficiencies					Notes
1		Shingles Missing ☐	Cracks ☐	Bad Flashing ☐	Bubbles/Blisters ☐	Delamination ☐	
2		Shingles Missing ☐	Cracks ☐	Bad Flashing ☐	Bubbles/Blisters ☐	Delamination ☐	
3		Shingles Missing ☐	Cracks ☐	Bad Flashing ☐	Bubbles/Blisters ☐	Delamination ☐	
4		Shingles Missing ☐	Cracks ☐	Bad Flashing ☐	Bubbles/Blisters ☐	Delamination ☐	
5		Shingles Missing ☐	Cracks ☐	Bad Flashing ☐	Bubbles/Blisters ☐	Delamination ☐	
6		Shingles Missing ☐	Cracks ☐	Bad Flashing ☐	Bubbles/Blisters ☐	Delamination ☐	
7		Shingles Missing ☐	Cracks ☐	Bad Flashing ☐	Bubbles/Blisters ☐	Delamination ☐	
8		Shingles Missing ☐	Cracks ☐	Bad Flashing ☐	Bubbles/Blisters ☐	Delamination ☐	
9		Shingles Missing ☐	Cracks ☐	Bad Flashing ☐	Bubbles/Blisters ☐	Delamination ☐	
10		Shingles Missing ☐	Cracks ☐	Bad Flashing ☐	Bubbles/Blisters ☐	Delamination ☐	

Skylights:

Roof Section	Size	Notes	Roof Section	Size	Notes

Gutters:

Notes: Building has Gutters and Downspouts

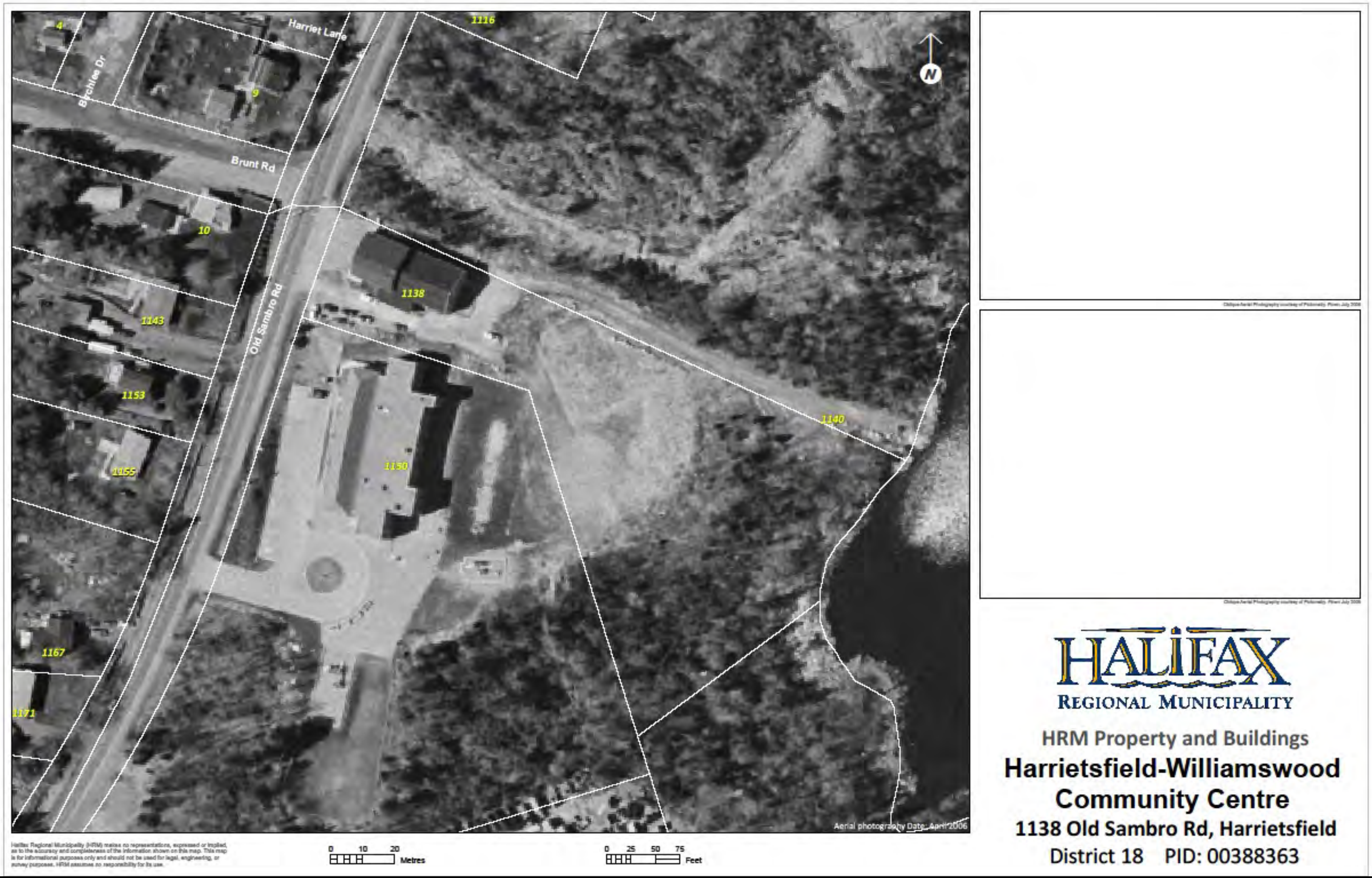
Notes & Observations:

No Visual Access to Approx Half of Roof

Assessed By: CMEL

Date: 27 February 2013

Appendix D – Aerial & Elevation Photos



Aerial Photo. Provided by HRM	Date: Nov. 2013

West Elevation	Date: Nov. 2013

South Elevation	Date: Nov. 2013

East Elevation

Date: Nov. 2013

North Elevation	Date: Nov. 2013

Appendix C
Structural Outline Specification

HARRIETSFIELD-WILLIAMSWOOD COMMUNITY CENTRE

Building Use and Occupancy

The Harrietsfield-Williamswood Community Centre is a small, two-level community centre building located at 1138 Old Sambro Road in Harrietsfield, Nova Scotia. The structure is owned and operated by Halifax Regional Municipality and currently used primarily as a daycare and community hall. A photo of the building is shown in Figure 1.

Figure 1: Harrietsfield-Williamswood Community Centre

As the building’s primary use is a daycare and community centre, the structure is categorized as a High Importance building as per Sentence 4.1.2.1.(3) in the 2015 edition of the National Building Code of Canada (NBCC). A High Importance building is defined as:

> “Buildings that are likely to be used as post-disaster shelters, including buildings whose primary use is:
> - As an elementary, middle, or secondary school
> - As a community centre
>
> Manufacturing and storage facilities containing toxic, explosive, or other hazardous substances in sufficient quantities to be dangerous to the public if released.”

High Importance structures are subject to higher environmental loading, including snow, wind, and seismic loads, than a normal importance building.

Structural Analysis

Foundation System

It is understood that the foundation consists of concrete foundation walls with concrete strip footings. No major cracks were observed in visible portions of the foundation wall along the exterior perimeter of the building. Although the condition of the buried foundation walls are unknown, there was no evidence identified to suggest structural deficiencies in the foundation.

Above-Grade Walls

It is understood that the single-storey above grade walls consist of 6” concrete masonry unit (CMU) block walls which act as the main load-bearing elements as well as the primary lateral load resisting system (LLRS). The walls were not visible at the time of the inspection. Accordingly, we were unable to confirm the presence of grout or steel reinforcing bars within the CMU voids. Similar to the foundation, there was no evidence to suggest structural deficiencies in the wall system.

Roof Structure

The roof structure above the East and West sections of the building consists of pre-engineered timber trusses with 3/4" tongue and groove plank decking. The trusses have an overall span of approximately 45’, with a roof pitch of approximately 5/12. Notably, the spacing of the varies slightly, and was measured to be between 27”-29” during the structural measure-up of the roof structure.

The trusses consist of 2x8 top chords, 2x6 bottom chords, and 2x4 web members. Although lumber grade stamps were not identified during the inspection, the timber members have been assumed to be No. 2 Spruce-Pine-Fir (SPF) lumber based on conservative visual grading. Truss members are connected via galvanized steel truss plates, which did not contain a manufacturer’s identification stamp. A photo of the typical roof structure is shown in Figure 2.

Figure 2: Typical roof truss.

Based on DesignPoint's measurements and structural model, the existing roof structure is not adequate to support the existing loads, including the existing dead and live loads and high-importance environmental loading based on NBCC 2015 requirements for Halifax, Nova Scotia. The structural utilization ratio of each of the truss member types is summarized in Table 1. A utilization ratio of 1.00 indicates a member that is at 100% capacity; values above 1.00 are considered to be overloaded and structurally deficient under code-prescribed loading.

Table 1: Harrietsfield-Williamswood Community Centre Truss Member Summary

Member	Section	Utilization Ratio
Top Chord	2x8	1.28
Bottom Chord	2x6	1.38
Web Tension Members	2x4	0.47
Web Compression Members	2x4	2.00

Additionally, the trusses were found to be leaning slightly, with the top chord at the ridge leaning East relative to the bottom chord of the truss. This offset was in the order 50mm measured between the bottom chord and the ridge of the truss. This could be a result of improper bracing during construction causing the trusses to not be placed plumb, or it may be evidence of a lateral shift due to wind parallel to the ridge of the building. This supports the findings of the 3D scan, which show the ridge of both the upper and lower roof structures protruding towards the east (rear) of the property. Of note, this was not identified in the Building Condition Assessment completed in March 2013. An employee of the daycare identified a leak in the roof, which has anecdotally been present since Hurricane Dorian in September 2019.

Recommendations

Overall, the main structural system of the Harrietsfield-Williamswood Community Centre appears to be performing at a satisfactory level with no signs of structural failure or fatigue. However, there is some concern that the roof structure has shifted laterally due to wind load, which may further reduce the capacity of the structure.

Commentary L of the National Building Code of Canada provides guidance for the assessment of existing structures to analyze current performance and to support modifications to the existing structural system. It is possible to appeal to satisfactory past performance when assessing existing structures, as modern codes generally consist of stricter loading provisions than previous codes or best practices of construction.

However, these provisions are not directly applicable where the structural system of the building is being modified to a point where the loading on existing members is modified. Changes in loading may be due to:

- A change in occupancy of the building.
- Additions causing snow drifting.
- Addition of dead load to the building assemblies.
- A modification of the primary load path.

In the context of the ReCover Project, adding panels to the envelope of a structure will increase the dead load of the primary structure and, depending on connection details, may modify the load path in such a way that the loading on main structural members is changed. Accordingly, it is our opinion that the existing structure, particularly the roof structure, should be assessed as per current codes and standards, despite evidence of satisfactory past performance. Accordingly, it is recommended that roof panels be designed to be independent of the existing roof trusses. We have proposed a system of roof panels, consisting of new pre-engineered trusses, to span the existing roof and bear on the existing exterior walls. The existing connection detail between the trusses and walls was not able to be verified during the site visit. It has been assumed that existing trusses bear on either a double top plate or a nailer on top of CMU block walls. In order to fasten the new trusses, we propose a small knee wall is constructed between existing trusses to allow for a continuous double top plate above the existing trusses. This wall shall be sheathed and anchored to the existing wall to transfer lateral loads from the new roof into the existing walls. A schematic of the proposed roof connection detail is shown in Figure 3.

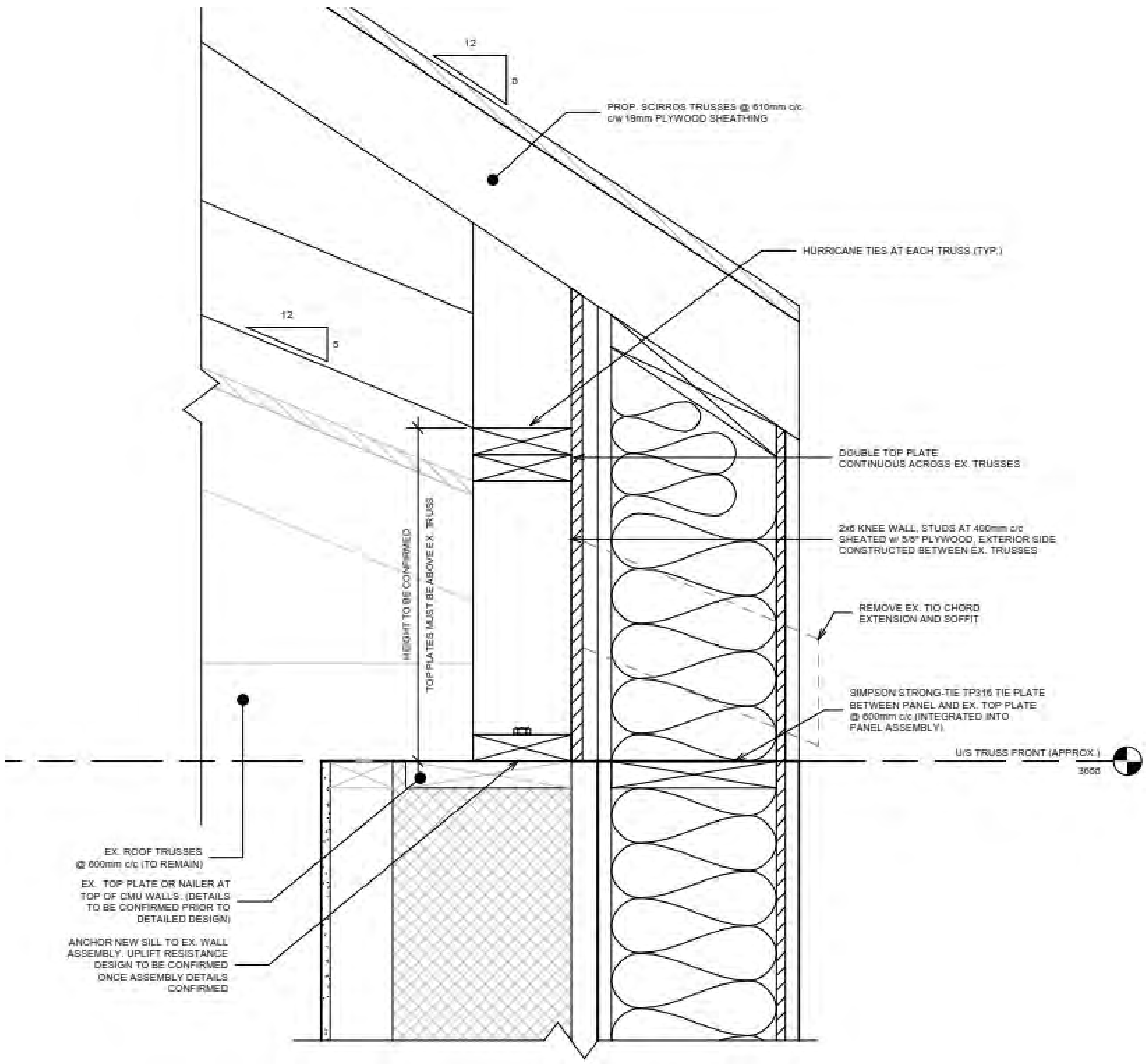


Figure 3: Proposed panel connection detail at roof.

Based on preliminary panel design provided by ReCover, it is understood the primary framing of the panels will consist of 2x4 studs at 610mm on centre. Based on wind loading calculations for Halifax, Nova Scotia, it is recommended that the maximum panel height with 2x4 framing is 3658mm [12’] based on flexural resistance to wind load on the structure. Additionally, with increased wind loading at the corners of the building, it is recommended that stud spacing is decreased to 400mm on centre within 6m of the building corners. It should be noted that wall panels are designed to be fastened to the building at the foundation and at floor/roof diaphragms only. Mid-height connections to the existing stud and masonry walls are not permitted as they will alter the existing lateral load distribution of the structure. If taller panels are required, 2x6 framing is required in the ReCover wall panels.

To support the base of the panels, we have proposed a steel bent plate lintel fastened to the existing concrete foundation wall to support the proposed wall panels. A preliminary detail for the support of the wall panels is shown in Figure 4.

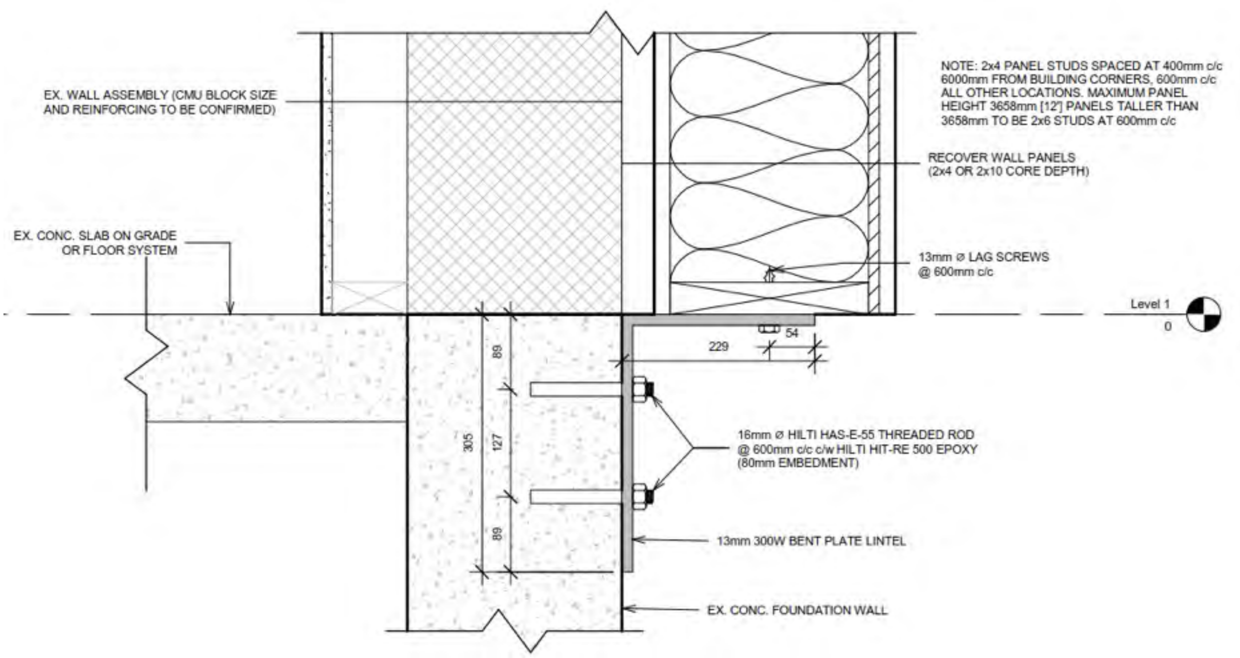


Figure 4: Proposed panel support at foundation.

Full preliminary structural details are available in Appendix A. It must be noted that these details are preliminary for the purposes of feasibility only. Existing connection details and geometry must be confirmed prior to finalizing panel connection design.

Appendix D
Mechanical Outline Specification

PURPOSE

The purpose of this Design Summary is to document the mechanical systems for the energy retrofit of the Harrietsfield – Williamswood Community Centre. The building is located at 1138 Old Sambro Rd in Halifax, Nova Scotia. The intent is to summarize the existing features for the electrical power and lighting disciplines.

The original building is estimated to have been constructed in 1970 with a major renovation occurring in 1994. The building's main floor includes a multipurpose room which is primarily used for recreation services such as meetings, art classes, and workshops. The second floor operates as a day care.

EXISTING SYSTEMS

Site Services

The building currently has two existing service entrances, one for the upper level and one for the lower level. Both service entrances share the same set of overhead secondary wires which run back to a nearby poletop transformer. There are two separate meters, one for each service entrance located on the exterior of the building. The size of the overhead shared secondary conductors is unknown due to the lack of a single line diagram. The upper-level service is sized at 100A and terminates onto a panel c/w a built in 100A, 80% rated main breaker. The lower-level service is sized at 200A and terminates onto a panel c/w a built in 200A, 80% rated main breaker.

Figure 1: Service Entrances

Figure 2: Upper Level Meter

Figure 3: Lower Level Meter

Electrical Power Distribution Services

Existing Branch Circuit Panelboards

There are only two panelboards within the building which are the two service entrance rated boards for the upper and lower levels. The upper level has a 1P, 240V, 100A panelboard with an 80% rated 100A main breaker. The upper-level panelboard appears to be in okay condition, no formal panel schedule is available however each circuit on the panelboard itself is labeled with tape and marker. All existing wire from this panel appears to be BX cabling.

The lower level has a 1P, 240V, 200A panelboard with an 80% rated 200A main breaker. The lower-level panelboard appears to be in good condition. No formal panel schedule is available, however similar to the upper-level panelboard, each circuit on the panel itself is labeled with tape and marker. Most existing wiring is NMD90 with a few runs of BX cable.

The majority of the breakers in both panelboards are 15A, with a few 20A breakers throughout. There is also a 2P, 40A breaker in the upper-level panelboard for the range in the kitchen. There are a few spare breaker spaces in the lower level 200A panelboard.

Figure 4: Lower Level Panelboard

Figure 5: Upper Level Panelboard

Referencing table A-8.4.3.2.2, Division B of the 2017 National Energy Code the basic plug load for each section of the building is as follows.

Occupancy Type	Demand Load	Area
Multipurpose Room	2.5 W/m^2	2000 m^2
Office	7.5 W/m^2	240 m^2
Daycare	1.5 W/m^2	1735 m^2
Kitchen	10 W/m^2	340 m^2
Storage	0.5 W/m^2	917 m^2
Washrooms	1 W/m^2	250 m^2

Emergency Power Distribution
No emergency power distribution was present on site. Emergency lighting, exit signage and the building fire alarm panel are battery operated.

Lighting and Lighting Control System

Interior Lighting
The upstairs daycare in the building appears to have had an LED retrofit done a few years back. The existing lighting throughout the upper level is primarily 2'x4' retrofitted fluorescent fixtures with LED lamps and ballasts. The fixtures appear to be in good condition and no replacement or modification is needed. The LPD for the building is estimated to be 7W/m^2.

Figure 6: Daycare Lighting

Figure 7: Toy Storage Lighting

The downstairs multipurpose are of the building has also been retrofit to LED recently. The existing lighting throughout is primarily surface mounted 2 lamp linear retrofitted fluorescent fixtures with new LED lamps and ballasts. These fixtures are in good condition and no replacement or modification is needed.

Figure 7: Multipurpose Room Lighting

Figure 8: Downstairs Kitchen Lighting

Lighting Control System

Currently, the building lacks an automatic lighting control system relying entirely on manual control. This could lead to energy waste if lights are left on in unoccupied areas of the building for extended periods of time (overnight). Addition of an automatic lighting control system is recommended.

PROPOSED SYSTEMS

Systems have been proposed as per the minimum acceptable, net zero ready and net zero scenarios. The details of each system are provided below. For the purpose of this study, it has been assumed that the occupancy schedules and space usage are consistent with existing conditions.

In all scenarios, the existing building electrical service will need to be upgraded to allow for the electrification of heating and cooling equipment.

1. Minimum Acceptable Scenario

Lighting

For the minimum acceptable scenario, all existing fixtures that were missed by the LED retrofit should be converted to LED. Since the majority of the building has already been retrofit to LED, no further action is needed for compliance with the minimum acceptable scenario. There are approximately 2 fixtures that need to be upgraded to LED using LED retrofit bulbs.

Lighting Control

The minimum acceptable scenario does not change any of the existing lighting controls. Controls will remain manual on/off with no automatic control.

Power Distribution

The minimum acceptable scenario should combine the two existing electrical services to the upper and lower level into one service. Currently, the building is set up to pay two separate residential power bills. Combining these into one commercial power bill may help reduce the power rate for the building and will also help set the building up for further electrification of equipment in the future. Currently, because the building is set up for residential billing, there is no information on demand load of either panel. This means there is no information on how much additional electrical load the panels can handle without being overloaded. Even considering the minimum acceptable added load, it is extremely likely a service upgrade will be required. Based on the proposed loads, a single 400A electrical service is recommended. This would also involve upgrading the shared secondary conductors back to the pole top transformers. The existing 100A panel upstairs would be re-fed from the new 400A panel. The service would remain as single-phase.

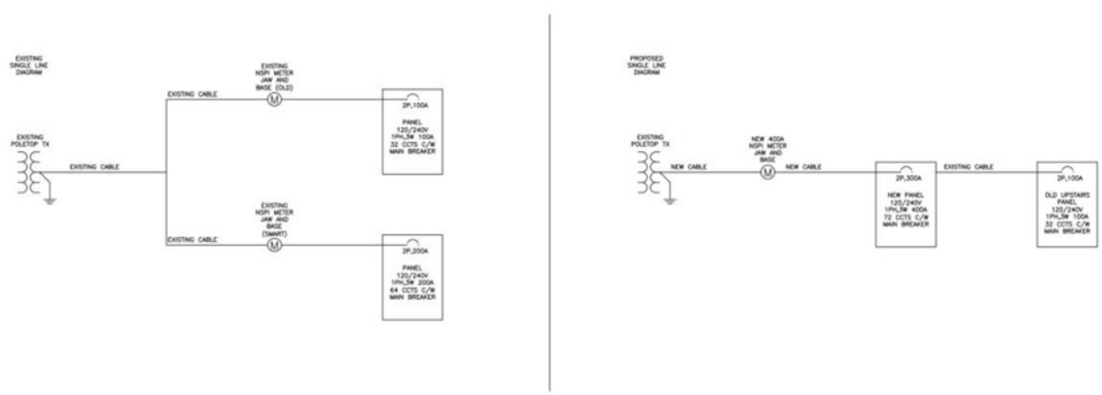


Figure 9: Proposed SLD

No photovoltaics will be added as part of the minimum acceptable scenario.

Minimum Acceptance Scenario Electrical Loads	Qty	kW	Total Load
90 L/s ERV with ECM motors and polypropylene cores	1	2	2
250 L/s ERV with ECM motors and polypropylene cores	1	2	2
0.5 ton mini split heat pumps	1	4	4
1 ton mini split heat pumps	1	5	5
25kW Electric Boiler	1	25	25
Total Added Load			38

2. Net Zero Ready Scenario

The net zero scenario systems include full electrification of the HVAC and DHW systems. Two options have been proposed: air source heat pumps and ground source heat pumps.

Lighting

Similar to the minimum acceptance scenario, all existing fixtures that were missed by the LED retrofit should be converted to LED. Since the majority of the building has already been retrofit to LED, no further action is needed for compliance with the net-zero ready scenario. Where the existing fixtures are in good condition, replacement is not necessary at this time.

Lighting Control System

The lighting control system will be updated throughout the building to include automatic lighting control. This upgrade will help reduce unnecessary energy waste by automatically controlling the lighting to only be used while spaces are occupied. Automatic control will be provided in accordance with the national energy code. The two main zones used will be daycare and multipurpose space. Daylight sensors will be provided in all areas with natural light and vacancy sensors will be provided in all areas as required by the National energy Code. All new lighting control will be low voltage 0-10V or wireless.

Electrical Power Distribution System

In the net zero ready scenario, a significant amount of mechanical equipment will be electrified, greatly increasing the load on the distribution system. Similar to the minimum acceptance scenario, a service upgrade will be required to combine the two separate services and ensure there is enough room to support the electrification of equipment. It has been calculated from the energy model that the building has a maximum solar potential of 51kW (DC), which will need to be fully utilized to achieve a net-zero building. Based on existing information available, the estimated building demand load would be estimated to be around 24kW (100A). With this estimate in mind, the proposed 400A service protected by a 300A main breaker should be sufficient to supply both the proposed mechanical changes, and up 43kW (AC) of solar potential. All new mechanical and solar equipment will be supplied off the new proposed 400A main panel.

Air Source Heat Pump (ASHP) Option

Net-Zero Ready (ASHP)	Qty	kW	Total Load (kw)
540 L/s ERV with ECM motors and polypropylene cores	1	2	2
420 L/s ERV with ECM motors and polypropylene cores	1	2	2
0.5 ton mini split heat pumps	1	4	4
0.75 ton mini split heat pumps	1	5	5
190 Gallon packaged heat pump water heats	1	5	5
10kW Electric Boiler	1	10	10
Electric boiler Pump	1	0.153	0.153
Total Added Load			28

Ground Source Heat Pump (GSHP) Option

Net-Zero Ready (ASHP)	Qty	kW	Total Load (kw)
Nominal 5 ton ground source heat Pump	1	6.24	6.24
0.5 ton mini split heat pumps	1	5	5
0.75 ton mini split heat pumps	1	8	8
5kW Electric Boiler	1	5	5
Ground Loop Circ Pumps	3	2.2	6.6
Electric boiler Pump	1	0.153	0.153
540 L/s ERV with ECM motors and polypropylene cores	1	2	2
420 L/s ERV with ECM motors and polypropylene cores	1	2	2
190 Gallon packaged heat pump water heats	1	5	5
Total Added Load			40

The main breaker will be installed at 300A rather than 400A, to increase the amount of solar potential available to install on the system. Reducing the interrupting capacity of the main breaker to 300A reduces the risk of overloading the main bus inside the 400A panelboard which allows more solar to be installed compared to a 400A main breaker. This change allows for up to 43kW (AC) of solar to be installed compared to only 19kW of solar if a 400A main breaker was used. To achieve a net-zero building, the energy model predicts 50kW (DC) of solar to be installed. Using a DC:AC ratio of 1.7, this means the nameplate of the array would need to be 30kW (AC).

A letter would be sent to the utility (Nova Scotia Power) to inform them of added load onto the buildings existing electrical service. A new poletop transformer may be provided by the utility if they feel it is necessary to account for the added load. The letter would include an updated load calculation showing what the existing load is on the building (obtained from the year-old demand load study) and what the new load will be. The cost of replacement of the existing pad mount transformer is covered by the utility if it is required.

3. Net Zero Scenario

The net zero scenario is identical to the net zero ready scenario with the addition of a PV system. Since the PV system already accounts for in the net-zero ready scenario, there is no changes needed to the electrical distribution system.

The current Nova Scotia Power net metering agreement has expired. An update to the program is currently being reviewed by the Nova Scotia Utility Review Board and Nova Scotia Power. Under the old agreement only 100kW of solar could be installed on any building. Under the new net metering agreement, it is proposed to allow up to 1MW of solar to be installed on any building that incurs a demand charge. There will be two new classifications of net metered systems in the new program, a class 1 system which is under 100kW and a class 2 system which is under 1MW. In the net metering program, 100% of the excess energy generated from the solar array goes back onto the NSPI grid, and the customer gets a credit for the energy generated. Under the new proposal, the credit will be a percentage of the customers electricity rate for class 2 systems and will be equal to the customers electricity rate for class 1 systems. The credits automatically come off the power bill, further reducing the cost, the more solar that is installed. Being involved in a net-metering program is an essential part of achieving net-zero as it allows any excess energy generated to flow back onto the grid. This building would be considered a class 1 building due to the size of the PV array being proposed.

It is possible to install photovoltaics and not enroll in the net metering program. In this scenario, the building would draw power from the solar array as it is needed (up to the arrays maximum capacity). Any excess energy that is generated by the array is clipped (wasted) and no credit is given by the utility for that power. This scenario is only feasible if the customer routinely uses the approximate amount of power the array would generate. To optimize this, a short load study would be performed on the building to determine approximately how much energy is used at any given time of the day/ year, and an array of the average size could be constructed to offset that consumption. This scenario isn't truly considered net-zero since in order to use 100% of the energy generated, the solar array must overproduce.

Air Source Heat Pump (ASHP) Option

Maximum Allowable PV Array Size (AC)	PV Array Size (DC) DC:AC Ratio of 1.7:1	Introduced Demand Load (Mechanical)	Total New Demand Load	Main Panelboard Size	Main Breaker Size	Net Metering Eligible
30kW	51kW	28kW (117A)	52kW (217A)	400A	300A (80% rated)	Yes (with new agreement)

Ground Source Heat Pump (GSHP) Option

Maximum Allowable PV Array Size (AC)	PV Array Size (DC) DC:AC Ratio of 1.7:1	Introduced Demand Load (Mechanical)	Total New Demand Load	New Panelboard Size	New Main Breaker Size	Net Metering Eligible
30kW	51kW	40kW (167A)	64kW (267A)	400A	300A (100% rated)	Yes (with new agreement)

Note a DC:AC ratio of 1.7:1 is used as recommended ratio of array size to inverter size. Final Ratio to be confirmed by system designer. Replacement of the main switchgear is recommended in all scenarios.

Out of the two different methods of metering, the net-metered option is recommended to ensure that a net-zero system can be achieved. As the current conditions for the net-metering program are changing day to day, further consultation with Nova Scotia Power will be needed to ensure all requirements are met prior to construction.

Appendix E
Electrical Outline Specification

PURPOSE

The purpose of this Design Summary is to document the mechanical systems for the energy retrofit of the Harrietsfield – Williamswood Community Centre. The building is located at 1138 Old Sambro Rd in Halifax, Nova Scotia. The intent is to summarize the existing features for the electrical power and lighting disciplines.

The original building is estimated to have been constructed in 1970 with a major renovation occurring in 1994. The building's main floor includes a multipurpose room which is primarily used for recreation services such as meetings, art classes, and workshops. The second floor operates as a day care.

EXISTING SYSTEMS

Site Services

The building currently has two existing service entrances, one for the upper level and one for the lower level. Both service entrances share the same set of overhead secondary wires which run back to a nearby poletop transformer. There are two separate meters, one for each service entrance located on the exterior of the building. The size of the overhead shared secondary conductors is unknown due to the lack of a single line diagram. The upper-level service is sized at 100A and terminates onto a panel c/w a built in 100A, 80% rated main breaker. The lower-level service is sized at 200A and terminates onto a panel c/w a built in 200A, 80% rated main breaker.

Figure 1: Service Entrances

Figure 2: Upper Level Meter

Figure 3: Lower Level Meter

Electrical Power Distribution Services

Existing Branch Circuit Panelboards

There are only two panelboards within the building which are the two service entrance rated boards for the upper and lower levels. The upper level has a 1P, 240V, 100A panelboard with an 80% rated 100A main breaker. The upper-level panelboard appears to be in okay condition, no formal panel schedule is available however each circuit on the panelboard itself is labeled with tape and marker. All existing wire from this panel appears to be BX cabling.

The lower level has a 1P, 240V, 200A panelboard with an 80% rated 200A main breaker. The lower-level panelboard appears to be in good condition. No formal panel schedule is available, however similar to the upper-level panelboard, each circuit on the panel itself is labeled with tape and marker. Most existing wiring is NMD90 with a few runs of BX cable.

The majority of the breakers in both panelboards are 15A, with a few 20A breakers throughout. There is also a 2P, 40A breaker in the upper-level panelboard for the range in the kitchen. There are a few spare breaker spaces in the lower level 200A panelboard.

Figure 4: Lower Level Panelboard

Figure 5: Upper Level Panelboard

Referencing table A-8.4.3.2.2, Division B of the 2017 National Energy Code the basic plug load for each section of the building is as follows.

Occupancy Type	Demand Load	Area
Multipurpose Room	2.5 W/m^2	2000 m^2
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Storage	0.5 W/m^2	917 m^2
Washrooms	1 W/m^2	250 m^2

Emergency Power Distribution
No emergency power distribution was present on site. Emergency lighting, exit signage and the building fire alarm panel are battery operated.

Lighting and Lighting Control System

Interior Lighting
The upstairs daycare in the building appears to have had an LED retrofit done a few years back. The existing lighting throughout the upper level is primarily 2’x4’ retrofitted fluorescent fixtures with LED lamps and ballasts. The fixtures appear to be in good condition and no replacement or modification is needed. The LPD for the building is estimated to be 7W/m^2.

Figure 6: Daycare Lighting

Figure 7: Toy Storage Lighting

The downstairs multipurpose are of the building has also been retrofit to LED recently. The existing lighting throughout is primarily surface mounted 2 lamp linear retrofitted fluorescent fixtures with new LED lamps and ballasts. These fixtures are in good condition and no replacement or modification is needed.

Figure 7: Multipurpose Room Lighting

Figure 8: Downstairs Kitchen Lighting

Lighting Control System

Currently, the building lacks an automatic lighting control system relying entirely on manual control. This could lead to energy waste if lights are left on in unoccupied areas of the building for extended periods of time (overnight). Addition of an automatic lighting control system is recommended.

PROPOSED SYSTEMS

Systems have been proposed as per the minimum acceptable, net zero ready and net zero scenarios. The details of each system are provided below. For the purpose of this study, it has been assumed that the occupancy schedules and space usage are consistent with existing conditions.

In all scenarios, the existing building electrical service will need to be upgraded to allow for the electrification of heating and cooling equipment.

1. Minimum Acceptable Scenario

Lighting

For the minimum acceptable scenario, all existing fixtures that were missed by the LED retrofit should be converted to LED. Since the majority of the building has already been retrofit to LED, no further action is needed for compliance with the minimum acceptable scenario. There are approximately 2 fixtures that need to be upgraded to LED using LED retrofit bulbs.

Lighting Control

The minimum acceptable scenario does not change any of the existing lighting controls. Controls will remain manual on/off with no automatic control.

Power Distribution

The minimum acceptable scenario should combine the two existing electrical services to the upper and lower level into one service. Currently, the building is set up to pay two separate residential power bills. Combining these into one commercial power bill may help reduce the power rate for the building and will also help set the building up for further electrification of equipment in the future. Currently, because the building is set up for residential billing, there is no information on demand load of either panel. This means there is no information on how much additional electrical load the panels can handle without being overloaded. Even considering the minimum acceptable added load, it is extremely likely a service upgrade will be required. Based on the proposed loads, a single 400A electrical service is recommended. This would also involve upgrading the shared secondary conductors back to the pole top transformers. The existing 100A panel upstairs would be re-fed from the new 400A panel. The service would remain as single-phase.

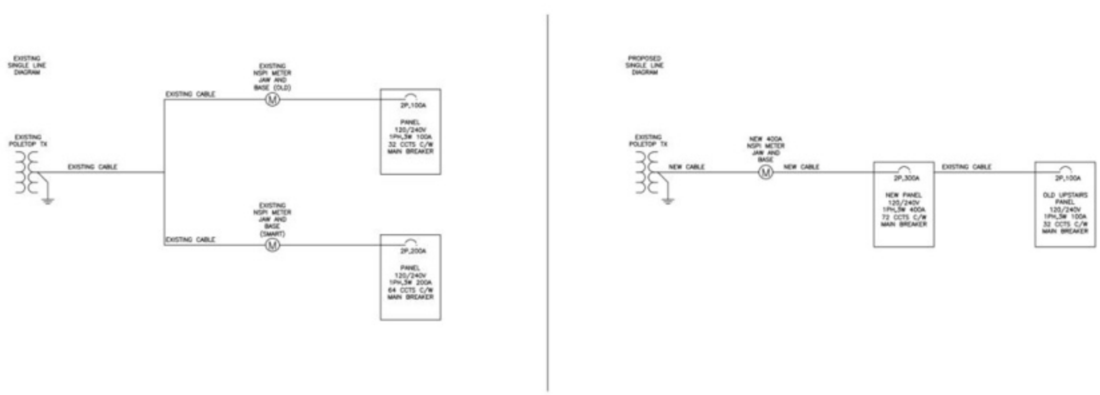


Figure 9: Proposed SLD

No photovoltaics will be added as part of the minimum acceptable scenario.

Minimum Acceptance Scenario Electrical Loads	Qty	kW	Total Load
90 L/s ERV with ECM motors and polypropylene cores	1	2	2
250 L/s ERV with ECM motors and polypropylene cores	1	2	2
0.5 ton mini split heat pumps	1	4	4
1 ton mini split heat pumps	1	5	5
25kW Electric Boiler	1	25	25
Total Added Load			38

2. Net Zero Ready Scenario

The net zero scenario systems include full electrification of the HVAC and DHW systems. Two options have been proposed: air source heat pumps and ground source heat pumps.

Lighting

Similar to the minimum acceptance scenario, all existing fixtures that were missed by the LED retrofit should be converted to LED. Since the majority of the building has already been retrofit to LED, no further action is needed for compliance with the net-zero ready scenario. Where the existing fixtures are in good condition, replacement is not necessary at this time.

Lighting Control System

The lighting control system will be updated throughout the building to include automatic lighting control. This upgrade will help reduce unnecessary energy waste by automatically controlling the lighting to only be used while spaces are occupied. Automatic control will be provided in accordance with the national energy code. The two main zones used will be daycare and multipurpose space. Daylight sensors will be provided in all areas with natural light and vacancy sensors will be provided in all areas as required by the National energy Code. All new lighting control will be low voltage 0-10V or wireless.

Electrical Power Distribution System

In the net zero ready scenario, a significant amount of mechanical equipment will be electrified, greatly increasing the load on the distribution system. Similar to the minimum acceptance scenario, a service upgrade will be required to combine the two separate services and ensure there is enough room to support the electrification of equipment. It has been calculated from the energy model that the building has a maximum solar potential of 51kW (DC), which will need to be fully utilized to achieve a net-zero building. Based on existing information available, the estimated building demand load would be estimated to be around 24kW (100A). With this estimate in mind, the proposed 400A service protected by a 300A main breaker should be sufficient to supply both the proposed mechanical changes, and up 43kW (AC) of solar potential. All new mechanical and solar equipment will be supplied off the new proposed 400A main panel.

Air Source Heat Pump (ASHP) Option

Net-Zero Ready (ASHP)	Qty	kW	Total Load (kw)
540 L/s ERV with ECM motors and polypropylene cores	1	2	2
420 L/s ERV with ECM motors and polypropylene cores	1	2	2
0.5 ton mini split heat pumps	1	4	4
0.75 ton mini split heat pumps	1	5	5
190 Gallon packaged heat pump water heats	1	5	5
10kW Electric Boiler	1	10	10
Electric boiler Pump	1	0.153	0.153
Total Added Load			28

Ground Source Heat Pump (GSHP) Option

Net-Zero Ready (ASHP)	Qty	kW	Total Load (kw)
Nominal 5 ton ground source heat Pump	1	6.24	6.24
0.5 ton mini split heat pumps	1	5	5
0.75 ton mini split heat pumps	1	8	8
5kW Electric Boiler	1	5	5
Ground Loop Circ Pumps	3	2.2	6.6
Electric boiler Pump	1	0.153	0.153
540 L/s ERV with ECM motors and polypropylene cores	1	2	2
420 L/s ERV with ECM motors and polypropylene cores	1	2	2
190 Gallon packaged heat pump water heats	1	5	5
Total Added Load			40

The main breaker will be installed at 300A rather than 400A, to increase the amount of solar potential available to install on the system. Reducing the interrupting capacity of the main breaker to 300A reduces the risk of overloading the main bus inside the 400A panelboard which allows more solar to be installed compared to a 400A main breaker. This change allows for up to 43kW (AC) of solar to be installed compared to only 19kW of solar if a 400A main breaker was used. To achieve a net-zero building, the energy model predicts 50kW (DC) of solar to be installed. Using a DC:AC ratio of 1.7, this means the nameplate of the array would need to be 30kW (AC).

A letter would be sent to the utility (Nova Scotia Power) to inform them of added load onto the buildings existing electrical service. A new poletop transformer may be provided by the utility if they feel it is necessary to account for the added load. The letter would include an updated load calculation showing what the existing load is on the building (obtained from the year-old demand load study) and what the new load will be. The cost of replacement of the existing pad mount transformer is covered by the utility if it is required.

3. Net Zero Scenario

The net zero scenario is identical to the net zero ready scenario with the addition of a PV system. Since the PV system already accounts for in the net-zero ready scenario, there is no changes needed to the electrical distribution system.

The current Nova Scotia Power net metering agreement has expired. An update to the program is currently being reviewed by the Nova Scotia Utility Review Board and Nova Scotia Power. Under the old agreement only 100kW of solar could be installed on any building. Under the new net metering agreement, it is proposed to allow up to 1MW of solar to be installed on any building that incurs a demand charge. There will be two new classifications of net metered systems in the new program, a class 1 system which is under 100kW and a class 2 system which is under 1MW. In the net metering program, 100% of the excess energy generated from the solar array goes back onto the NSPI grid, and the customer gets a credit for the energy generated. Under the new proposal, the credit will be a percentage of the customers electricity rate for class 2 systems and will be equal to the customers electricity rate for class 1 systems. The credits automatically come off the power bill, further reducing the cost, the more solar that is installed. Being involved in a net-metering program is an essential part of achieving net-zero as it allows any excess energy generated to flow back onto the grid. This building would be considered a class 1 building due to the size of the PV array being proposed.

It is possible to install photovoltaics and not enroll in the net metering program. In this scenario, the building would draw power from the solar array as it is needed (up to the arrays maximum capacity). Any excess energy that is generated by the array is clipped (wasted) and no credit is given by the utility for that power. This scenario is only feasible if the customer routinely uses the approximate amount of power the array would generate. To optimize this, a short load study would be performed on the building to determine approximately how much energy is used at any given time of the day/ year, and an array of the average size could be constructed to offset that consumption. This scenario isn't truly considered net-zero since in order to use 100% of the energy generated, the solar array must overproduce.

Air Source Heat Pump (ASHP) Option

Maximum Allowable PV Array Size (AC)	PV Array Size (DC) DC:AC Ratio of 1.7:1	Introduced Demand Load (Mechanical)	Total New Demand Load	Main Panelboard Size	Main Breaker Size	Net Metering Eligible
30kW	51kW	28kW (117A)	52kW (217A)	400A	300A (80% rated)	Yes (with new agreement)

Ground Source Heat Pump (GSHP) Option

Maximum Allowable PV Array Size (AC)	PV Array Size (DC) DC:AC Ratio of 1.7:1	Introduced Demand Load (Mechanical)	Total New Demand Load	New Panelboard Size	New Main Breaker Size	Net Metering Eligible
30kW	51kW	40kW (167A)	64kW (267A)	400A	300A (100% rated)	Yes (with new agreement)

Note a DC:AC ratio of 1.7:1 is used as recommended ratio of array size to inverter size. Final Ratio to be confirmed by system designer. Replacement of the main switchgear is recommended in all scenarios.

Out of the two different methods of metering, the net-metered option is recommended to ensure that a net-zero system can be achieved. As the current conditions for the net-metering program are changing day to day, further consultation with Nova Scotia Power will be needed to ensure all requirements are met prior to construction.

Appendix F

Pre-retrofit Utility Records

Halifax
Energy Use As Reported by Client

Summarized by Monthly Consumption

As calculated by RDH

Electrical Consumption (kWh)

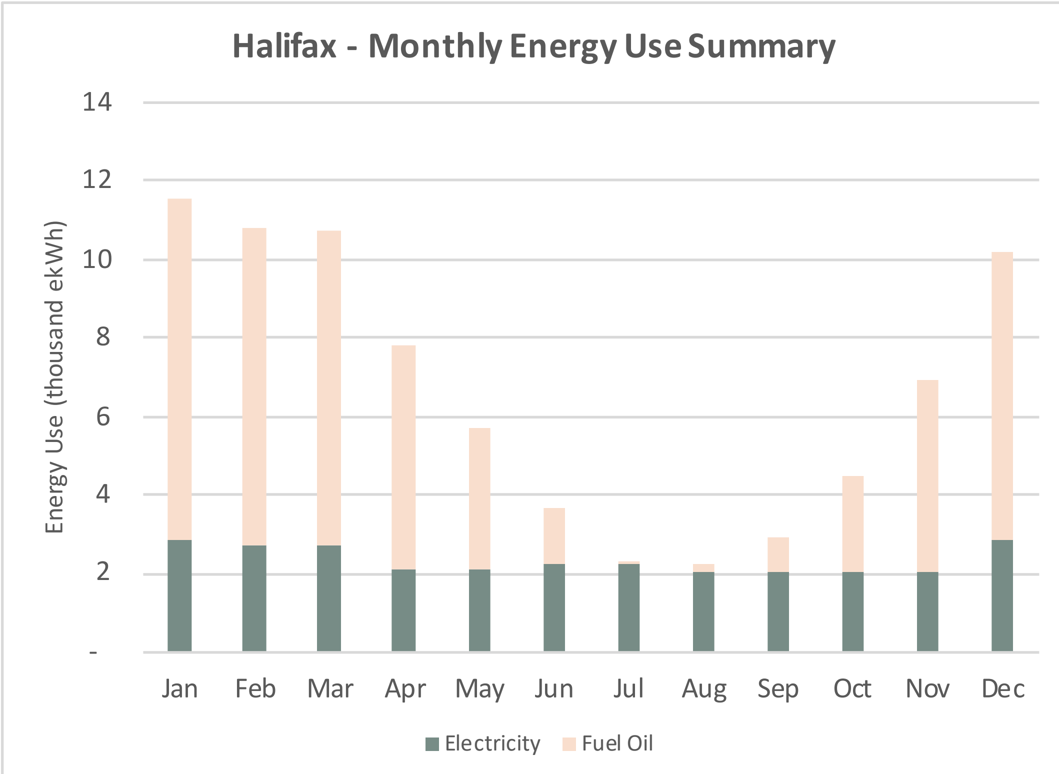
	2017	2018	2019	2020	2021	Average	
Jan						2,830	Jan
Feb	-	6,852	6,719	6,869	6,816	2,726	Feb
Mar	-	-	-	-	-	2,726	Mar
Apr	4,144	3,968	4,956	492	3,901	2,121	Apr
May	-	-	-	-	-	2,121	May
Jun	4,645	4,914	3,978	2,000	4,302	2,230	Jun
Jul	-	-	-	-	-	2,230	Jul
Aug	3,970	4,424	3,544	2,065	4,393	2,041	Aug
Sep	-	-	-	-	-	2,041	Sep
Oct	3,208	5,859	4,772	3,509	2,812	2,016	Oct
Nov	-	-	-	-	-	2,016	Nov
Dec	7,196	7,704	8,025	5,375	-	2,830	Dec

*electrical billing is bimonthly, monthly use was extrapolated

Fuel Oil (L)

	2019	2020	2021	2022	Avg. (M^3)	ekWh	
Jan	886	889	804	657	809	8,696	Jan
Feb	825	828	749	612	754	8,103	Feb
Mar	819	821	743	607	747	8,037	Mar
Apr	581	583	527	431	531	5,707	Apr
May	366	367	332	271	334	3,589	May
Jun	149	149	135	110	136	1,462	Jun
Jul	1	1	1	1	1	15	Jul
Aug	24	24	21	17	21	231	Aug
Sep	90	90	82	67	82	884	Sep
Oct	253	254	230	188	231	2,485	Oct
Nov	503	505	457	373	459	4,940	Nov
Dec	754	756	684	559	688	7,399	Dec

ekWh converstion factor used	10.75


Halifax - Monthly Energy Use Summary
Energy Use (thousand ekWh)
14
12
10
8
6
4
2
-
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity
Fuel Oil

Appendix G

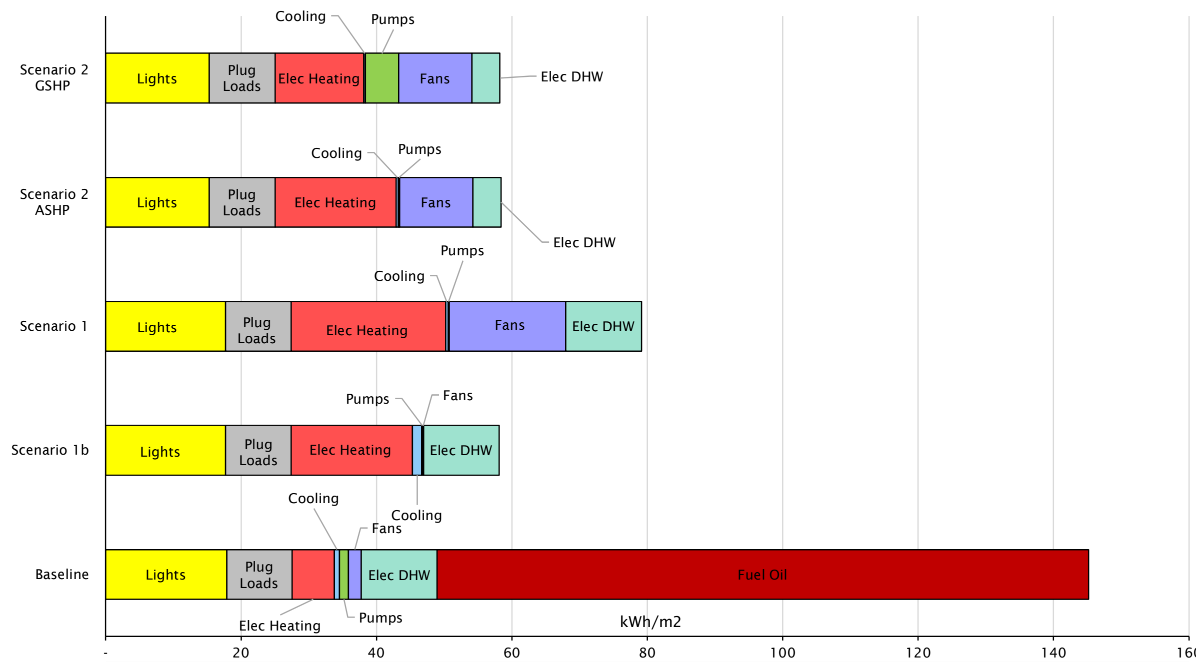
Energy Model Reports

RDH BUILDING SCIENCE

Halifax

These values are based on a model with no unmet heating hours and only represent the relative fraction of enlosure losses.

Total Energy Use Intensity TEUI (kWh/m²/yr):

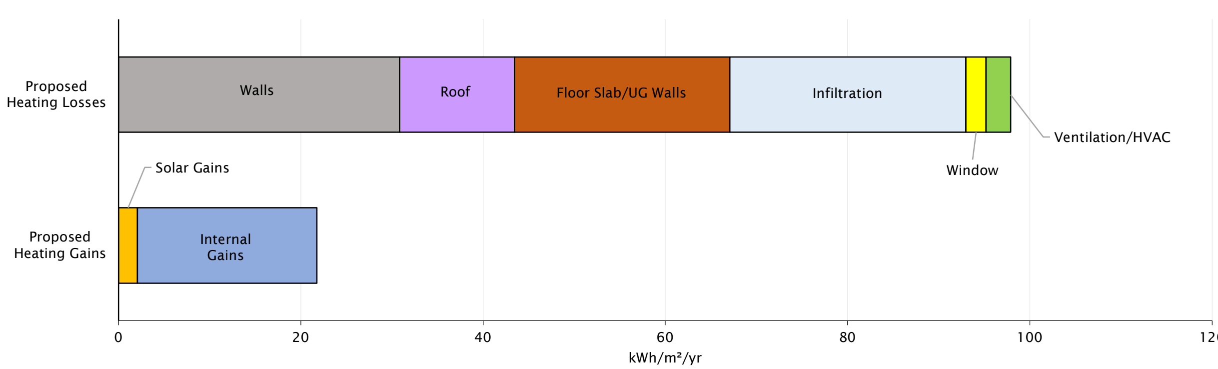


	Baseline	Scenario 1b	Scenario 1	Scenario 2 ASHP	Scenario 2 GSHP
Lights	17.88	17.70	17.70	15.33	15.33
Plug Loads	9.68	9.68	9.68	9.68	9.68
Elec Heating	6.20	17.96	22.82	17.89	13.11
Cooling	0.80	1.34	0.38	0.36	0.26
Pumps	1.27	0.18	0.18	0.18	4.91
Fans	1.93	0.10	17.21	10.82	10.83
Elec DHW	11.18	11.15	11.17	4.13	4.13
Fuel Oil	96.23	-	-	-	-

Note: The values presented above represent the relative proportion of each component of total energy use.

	TEUI		Total kWh	
Baseline	145.9	kWh/m²/yr	79080	kWh/yr
Scenario 1b (No Ventilation)	59.6	kWh/m²/yr	32293	kWh/yr
Scenario 1	80.9	kWh/m²/yr	43839	kWh/yr
Scenario 2 ASHP	59.8	kWh/m²/yr	32408	kWh/yr
Scenario 2 GSHP	59.6	kWh/m²/yr	32310	kWh/yr

Thermal Energy Demand Intensity TEDI (kWh/m²/yr) of the Baseline Model



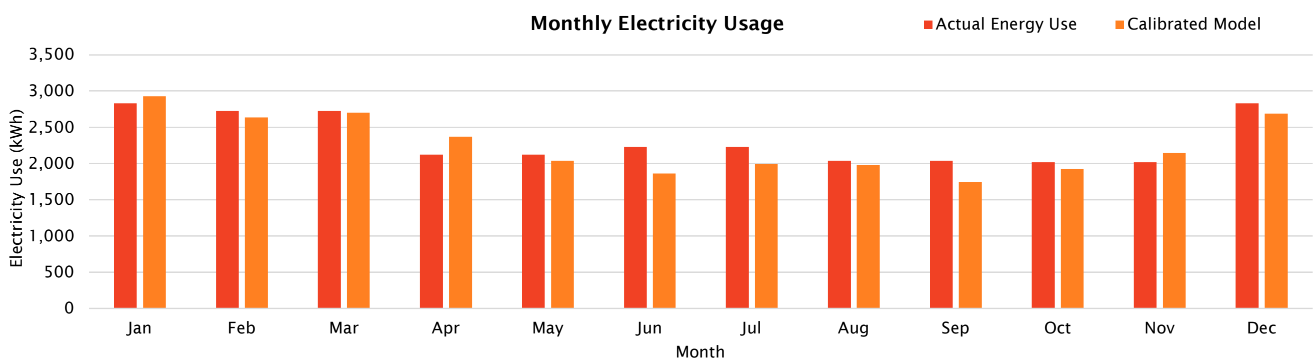
Note: The values presented above, represent the relative proportion of each component of the thermal energy demand intensity. These values include adjustments that account for internal gains from lights/plug loads/solar

Halifax

Project #, Building Name: Calibrated Model Filename: Weather File		26522, Halifax Community Centre 2022-11-16 Halifax CC Model.inp CAN_NS_HALIFAX-INTL-A_8202251_CWEC.BIN
Total Energy, kWh	7.97E+04	**List of Model Calibrations:** -Change in utility consumption April/May 2020. Calibrated against 2018/2019/2021 data for these months only.
Meter EUI, kWh/m2	147	-Building baseboard set point is 15C and 20C for heat pumps. Baseboard capacities have been greatly reduced to model lower set point. Current **average** temperature in February during occupied hours is 64 F and 62 F after hours
Model EUI, kWh/m2	146	-Reduced DHW by 50% of original NECB flow rate to match reduced hours in lower floor

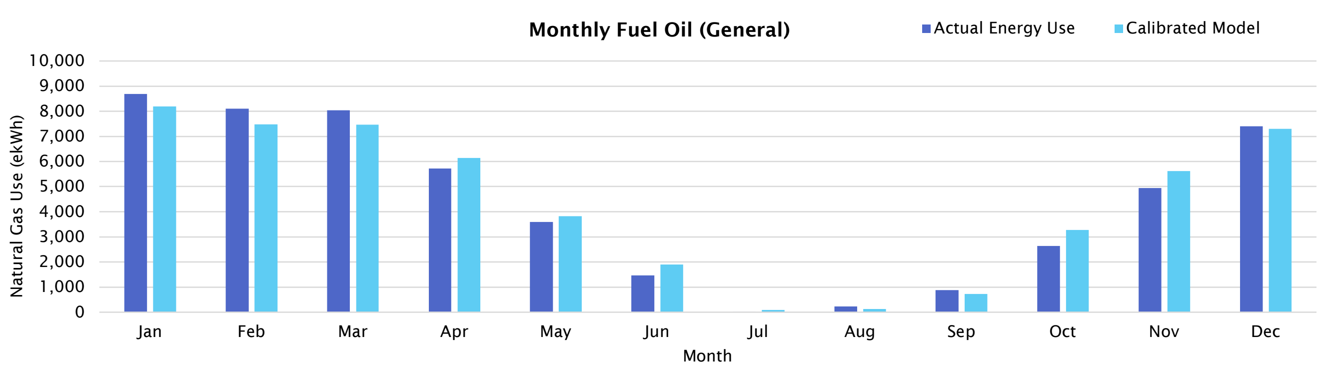
Monthly Electricity Usage (kWh)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Actual Energy Use	2,830	2,726	2,726	2,121	2,121	2,230	2,230	2,041	2,041	2,016	2,016	2,830	27,928
Calibrated Model	2,928	2,633	2,704	2,369	2,036	1,859	1,990	1,975	1,742	1,921	2,145	2,688	26,991
Difference	98	-92	-21	248	-85	-371	-240	-67	-300	-95	129	-142	-937
% Difference	3.5%	-3.4%	-0.8%	11.7%	-4.0%	-16.6%	-10.8%	-3.3%	-14.7%	-4.7%	6.4%	-5.0%	-3.4%



Monthly Fuel Oil Usage (ekWh)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Actual Energy Use	8,696	8,103	8,037	5,719	3,596	1,462	15	231	884	2,641	4,940	7,399	51,722
Calibrated Model	8,199	7,477	7,466	6,142	3,824	1,898	81	125	727	3,268	5,621	7,298	52,125
Difference	-497	-626	-570	423	228	435	66	-106	-157	626	681	-102	402
% Difference	-5.7%	-7.7%	-7.1%	7.4%	6.3%	29.8%	449.1%	-45.7%	-17.8%	23.7%	13.8%	-1.4%	0.8%



RDH

Halifax Harrietsfield-Williamswood Community Centre

Energy Model Input Summary

METHODOLOGY	
The following summary outlines the Proposed Design as presented in the drawings and narratives provided to RDH. Where these documents are not fully developed, assumptions were made based on previous experience. This information will be used to assess the energy savings of the current design to confirm the design is on track to achieve the targeted performance.	
Documents Referenced	Harrietsfield-Williamson CC Final.pdf HARRIETSFIELD CC EX COND 20220714 - Smarter Spaces Dwgs IPECC dwgs dated 11-Dec-2013 Site Photos Halifax Existing Mechanical.pdf

ARCHITECTURAL

Spaces	Model Area				Units	
Total	**5,833**				ft^2	
Multipurpose room	2,279				ft^2	
Kitchen	145				ft^2	
Office	285				ft^2	
Daycare	2,349				ft^2	
Washroom/mech	505				ft^2	
Storage	270				ft^2	

Building Enclosure	Halifax Community Center	Scenario 1: Minimum Acceptable (50%) Reduction	Scenario 2: Net Zero Ready ASHP	Scenario 2: Net Zero Ready GSHP	Units	Notes
Above Grade CMU Walls W1	R-15.24 (R-12 reduced)	Panelized wall to meet R-24 overall effective	Panelized wall to meet R-40 overall effective	Panelized wall to meet R-40 overall effective	IP	Assume all walls are 2x6 framing with batt insulation. From the Assembly Details.pdf it appears that some assemblies include block wall and interior batt. Framing is not specified in these assemblies but assumed. RSI - wall and roof assemblies from Arch Reduced by 20% to account for linear and point thermal bridging
Roof R1	R-30 (R-24 reduced)	Panelized roof to meet R-35 overall effective	Panelized roof to meet R-60 overall effective	Panelized roof to meet R-60 overall effective	IP	Asphalt shingles with 3/4" wood deck, vented attic and 8" loose cellulose fill in trusses per Assembly Details.pdf RSI - wall and roof assemblies from Arch Reduced by 20% to account for linear and point thermal bridging
Glazing	U-0.4 SHGC-0.37 VT-0.43	U-0.18 SHGC-0.32 VT-0.43	U-0.18 SHGC-0.32 VT-0.43	U-0.18 SHGC-0.32 VT-0.43	IP	Vinyl windows with insulated glazing per Harrietsfield-Williamson CC Final.pdf. Arch confirmed
Doors	U-0.2	U-0.2	U-0.2	U-0.2	IP	Arch confirmed

Fenestration	Halifax Community Center	Scenario 1: Minimum Acceptable (50%) Reduction	Scenario 2: Net Zero Ready ASHP	Scenario 2: Net Zero Ready GSHP	Elevation	
Window to Wall Ratio					North	per Arch
					South	per Arch
					East	per Arch
					West	per Arch
					Overall	Building Elevations
Infiltration Rate	2.3 L/s/m² exterior vertical enclosure and roof area @ 75Pa (Modelled as 0.42 L/s/m² @ 5Pa, assumed operating pressure)	Reduce to 0.5 L/s/m² @ 75Pa	Reduce to 0.5 L/s/m² @ 75Pa	Reduce to 0.5 L/s/m² @ 75Pa		Reduced to midway between ASHRAE Fundamentals, Leaky Building (2009) and ASHRAE Fundamentals, Average Building (2009); Infiltration rate per m^2 of exterior envelope.

MECHANICAL- Waterside

Plant	Halifax Community Center	Scenario 1: Minimum Acceptable (50%) Reduction	Scenario 2: Net Zero Ready ASHP	Scenario 2: Net Zero Ready GSHP	Units	
Heating Plant	Kerr Comet Central Oil Fired Boiler	Electric boiler serving baseboards + Mini-split heat pumps to meet 60% of design heating load	Electric boiler serving baseboards + Mini-split heat pumps to meet 60% of design heating load	Electric boiler serving baseboards + VRF Ground Source Heat Pump to meet 60% of design heating load		Harrietsfield-Williamson CC Final.pdf
Heat Output	264,000	85,375	Boiler = 34,150 Heat Pumps see below	Boiler = 17,000 GSHP = 61,000	BTUh	Harrietsfield-Williamson CC Final.pdf
Heating Efficiency	85%	Boiler = 100% Heat Pumps see below	Boiler = 100% Heat Pumps see below	Boiler = 100% GSHP COP = 5.4	%	Halifax Existing Mechanical.pdf
Hot Water Pumps	Autosize	8 gpm electric boiler pump	8 gpm electric boiler pump	Boiler = 5gpm Ground loop = 15 gpm with VFD Ground loop pump = 3*2.2kW		
Design HW temp	180	180	180	180	F	Assumed Mech to confirm
Loop Design DT	40	40	40	40	F (delta)	Assumed Mech to confirm
Cooling Plant	Provided by Mini-splits (see description below under the Air-side section)	Provided by Mini-splits (see description below under the Air-side section)	Provided by Mini-splits (see description below under the Air-side section)	VRF GSHP Capacity = 54,500 Btu/hr EER = 14.7		
Cooling Pumps	N/A	N/A	N/A	N/A		
Cooling Efficiency	N/A	N/A	N/A	N/A		

MECHANICAL- Airside						
Solar Air Heater serving Daycare	**Halifax Community Center**	**Scenario 1: Minimum Acceptable (50%) Reduction**	**Scenario 2: Net Zero Ready ASHP**	**Scenario 2: Net Zero Ready GSHP**	**Units**	**Halifax Existing Mechanical.pdf**
Heating Capacity	400	400	400	400	BTU/h	Peak Collection 9,900 BTU/day - equates to ~ 400 BTU/h at peak sunny day. Not modelled as this is not a significant load
Fan Power	14.5	14.5	14.5	14.5	W	
Minisplit serving Daycare	**Halifax Community Center**	**Scenario 1: Minimum Acceptable (50%) Reduction**	**Scenario 2: Net Zero Ready ASHP**	**Scenario 2: Net Zero Ready GSHP**	**Units**	**Halifax Existing Mechanical.pdf**
Air Flow	715 (MAX, 5 speed)	715 (MAX, 5 speed) + 340	715 (MAX, 5 speed) + 340	555+364 (MAX, 3 speed) Fan power = 2x27W	CFM	Halifax Existing Mechanical.pdf
Cooling Capacity	24,000	24000+9000 (new)	24000+9000 (new)	12,000+18,000	BTU/h	Per site photos
Cooling Efficiency	10	Existing = 10 New = 16.3	Existing = 10 New = 16.3	see plant above	EER	Halifax Existing Mechanical.pdf
Heating Capacity	28,800	28,800+11000 (new)	28,800+11000 (new)	13,500+20,000	BTU/h	Per site photos
Heating Efficiency	10	Existing = 10 New = 13.8	Existing = 10 New = 13.8	see plant above	HSPF	Halifax Existing Mechanical.pdf
Schedule	Runs based on occupant use	Runs based on occupant use	Runs based on occupant use	Runs based on occupant use		Halifax Existing Mechanical.pdf
Minisplit serving Multipurpose Room	**Halifax Community Center**	**Scenario 1: Minimum Acceptable (50%) Reduction**	**Scenario 2: Net Zero Ready ASHP**	**Scenario 2: Net Zero Ready GSHP**	**Units**	**Halifax Existing Mechanical.pdf**
Air Flow	715 (MAX, 5 speed)	715 (MAX, 5 speed) + 400	715 (MAX, 5 speed)+340	555+364 (MAX, 3 speed) Fan power = 2x27W	CFM	Halifax Existing Mechanical.pdf
Cooling Capacity	24,000	24000+12000 (new)	24000+9000 (new)	12,000+18,000	BTU/h	Per site photos
Cooling Efficiency	10	Existing = 10 New = 13.2	Existing = 10 New = 16.3	see plant above	EER	Halifax Existing Mechanical.pdf
Heating Capacity	28,800	28,800+13600 (new)	28,800+11000 (new)	13,500+20,000	BTU/h	Per site photos
Heating Efficiency	10	Existing = 10 New = 13	Existing = 10 New = 13.8	see plant above	HSPF	Halifax Existing Mechanical.pdf
Schedule	Runs based on occupant use	Runs based on occupant use	Runs based on occupant use	Runs based on occupant use		Halifax Existing Mechanical.pdf
Zone Heating	**Halifax Community Center**	**Scenario 1: Minimum Acceptable (50%) Reduction**	**Scenario 2: Net Zero Ready ASHP**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
Description	Hydronic Baseboards	Hydronic Baseboards Baseboards added to daycare office	Hydronic Baseboards Baseboards added to daycare office	Hydronic Baseboards Baseboards added to daycare office		Harrietsfield-Williamson CC Final.pdf
Supplemental Heat	Supplemental heating solar panel and solar powered fan	Supplemental heating solar panel and solar powered fan	Supplemental heating solar panel and solar powered fan	Supplemental heating solar panel and solar powered fan		Harrietsfield-Williamson CC Final.pdf
Ventilation Systems	**Halifax Community Center**	**Scenario 1: Minimum Acceptable (50%) Reduction**	**Scenario 2: Net Zero Ready ASHP**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
Washrooms Exhaust Fans (4 total)	200 CFM with 0.3 W/cfm fan power	Ducted to ERV (see below)	Ducted to ERV (see below)	Ducted to ERV (see below)		Harrietsfield-Williamson CC Final.pdf per M&R Assumed 2 hrs runtime per day.
Kitchen Exhaust Fan	200 CFM 0.3W/CFM	200 CFM 0.3W/CFM	200 CFM 0.3W/CFM	200 CFM 0.3W/CFM		Harrietsfield-Williamson CC Final.pdf per M&R 1 hr runtime per day.
Outdoor air	Natural ventilation via above exhaust fans	Provided by ERVs. Runs during building occupied hours. Daycare = 890 cfm Multipurpose = 1144 cfm	Provided by ERVs. Runs on CO2 sensors Daycare = 890 (400 min) cfm Multipurpose = 1144 (180 min) cfm	Provided by ERVs. Runs on CO2 sensors Daycare = 890 (400 min) cfm Multipurpose = 1144 (180 min) cfm		
Energy Recovery	n/a	Dual Core 90% Sensible 70% latent	Dual Core 90% Sensible 70% latent	Dual Core 90% Sensible 70% latent		
ERV Fan Power (supply+exhaust)		1.2	1.2	1.2	W/cfm	

Space types	**MNECB Schedule**	**MNECB Schedule**	**MNECB Schedule**	**MNECB Schedule**	**Total Occupancy**	
Multipurpose Room	10am-9pm (10am-6pm summer) - Calibrated to majority evenings only	10am-9pm (10am-6pm summer) - Calibrated to majority evenings only	10am-9pm (10am-6pm summer) - Calibrated to majority evenings only	10am-9pm (10am-6pm summer) - Calibrated to majority evenings only	77.51 Occupants	NECB RFI 18 Occupancy patterns
Kitchen						
Offices	10am-9pm (10am-6pm summer)	10am-9pm (10am-6pm summer)	10am-9pm (10am-6pm summer)	10am-9pm (10am-6pm summer)		
Daycare	2pm - 9pm	2pm - 9pm	2pm - 9pm	2pm - 9pm		
Space type	**Heating Setpoint/ Setback**	**Heating Setpoint/ Setback**	**Heating Setpoint/ Setback**	**Heating Setpoint/ Setback**	**Cooling Setpoint/**	
Mini Splits	68 - 70 F	68 - 70 F	68 - 70 F	68 - 70 F	65-68 F	RFI 25
Baseboards	59 F	59 F	59 F	59 F	N/A	RFI 25. Modeled as reduced capacity of baseboards with building set point at 68 F
DHW	**Halifax Community Center**	**Scenario 1: Minimum Acceptable (50%) Reduction**	**Scenario 2: Net Zero Ready ASHP**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
Heating Source	Electric	Electric	Packaged HP Water Heater (ASHP) Seasonal COP = 2.0	Packaged HP Water Heater (ASHP) Seasonal COP = 2.0		Harrietsfield-Williamson CC FINAL.pdf
DHW Tank Setpoint	140	140	140	140	F	per M&R
DHW Delivery Setpoint	120	120	120	120	F	per M&R
Load	0.185	0.185	0.185	0.185	gpm peak	DHW load will be based on occupancy. Using the NECB W/person based on space type. Reduced by 50% for calibration as space is mostly evenings only per RFI 18
ELECTRICAL						
Lighting	**Halifax Community Center**	**Scenario 1: Minimum Acceptable (50%) Reduction**	**Scenario 2: Net Zero Ready ASHP**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
General	0.65	0.65	0.65	0.65	W/ft2	Per M&R email (2022-11-10)
Occupancy Sensor Controls	None	None	Automatic lighting control	Automatic lighting control		
Daylight Sensor Controls	None	None	Daylight controls in daycare and multipurpose space	Daylight controls in daycare and multipurpose space		
Process Loads						
Washrooms	0.09	0.09	0.09	0.09	W/ft2	Assumed per NECB
Kitchen	0.93	0.93	0.93	0.93	W/ft2	Assumed per NECB
Storage	0.09	0.09	0.09	0.09	W/ft2	Assumed per NECB
Office	0.7	0.7	0.7	0.7	W/ft2	Assumed per NECB
Mulitpurpose Room	0.09	0.09	0.09	0.09	W/ft2	Assumed per NECB
Daycare	0.46	0.46	0.46	0.46	W/ft2	Assumed per NECB

Appendix H

Panel Schematics

- **Panel Schematics**
- **Panel Connection Details**

Wall Panel Schematics

Cellulose - R11 - 2x4 - 1/2” Plywood

ReCover Initiative

ReCover

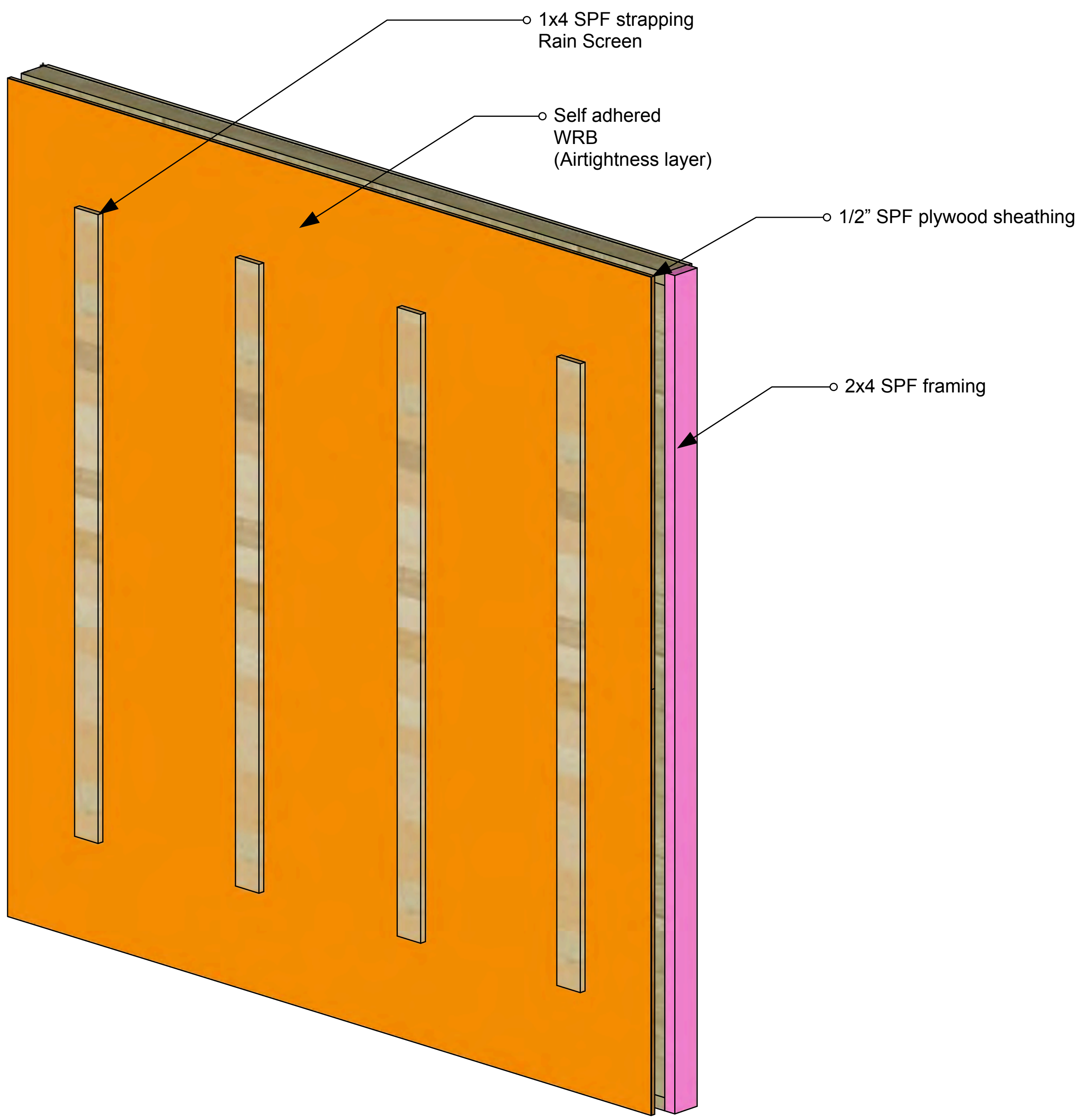
Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

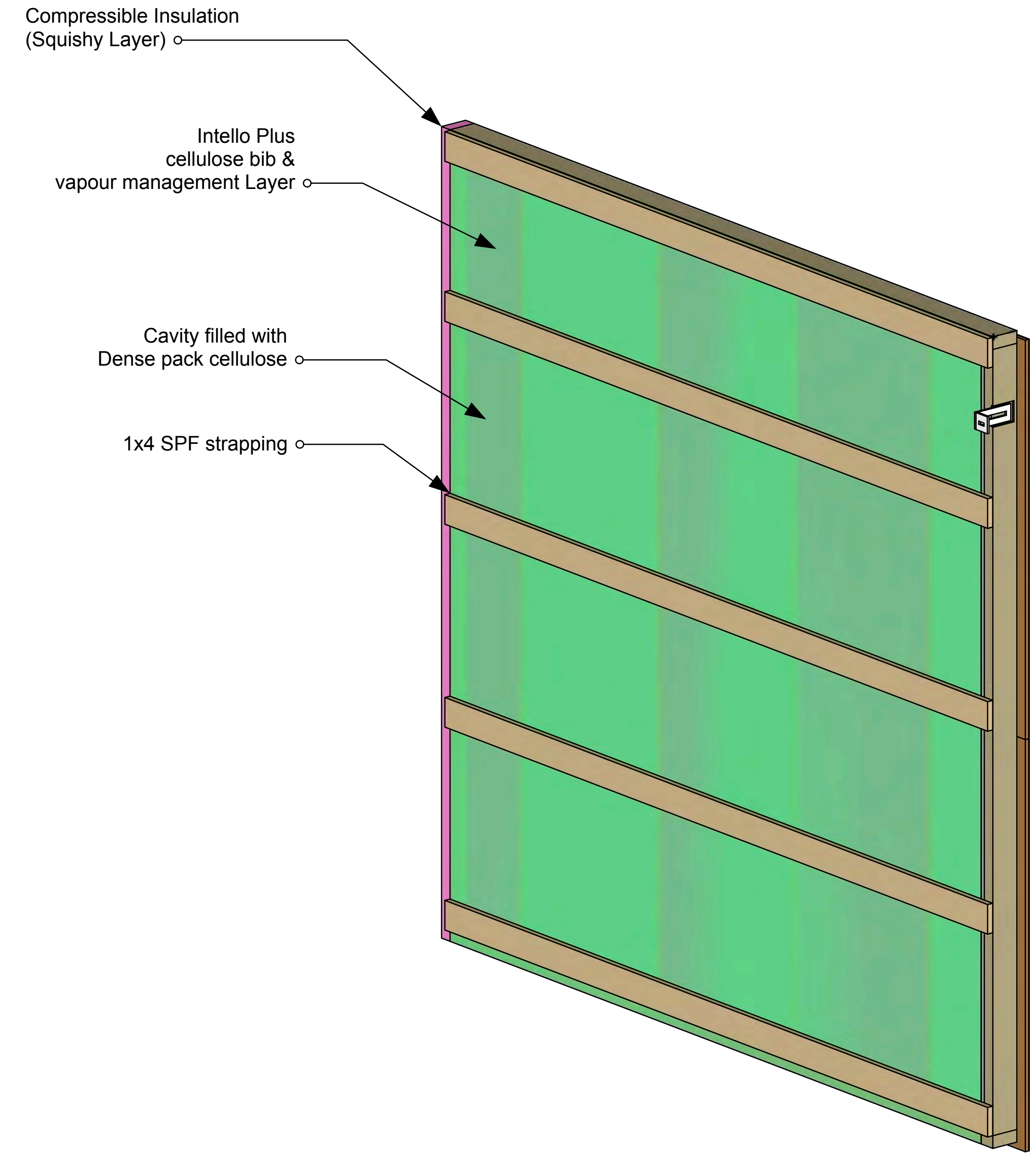
DRAWN BY
Nick Rudnicki

Panel - Overview

Panel schematic with all membranes in place



EXTERIOR VIEW



INTERIOR VIEW

ReCover

Version Date
February 27, 2023

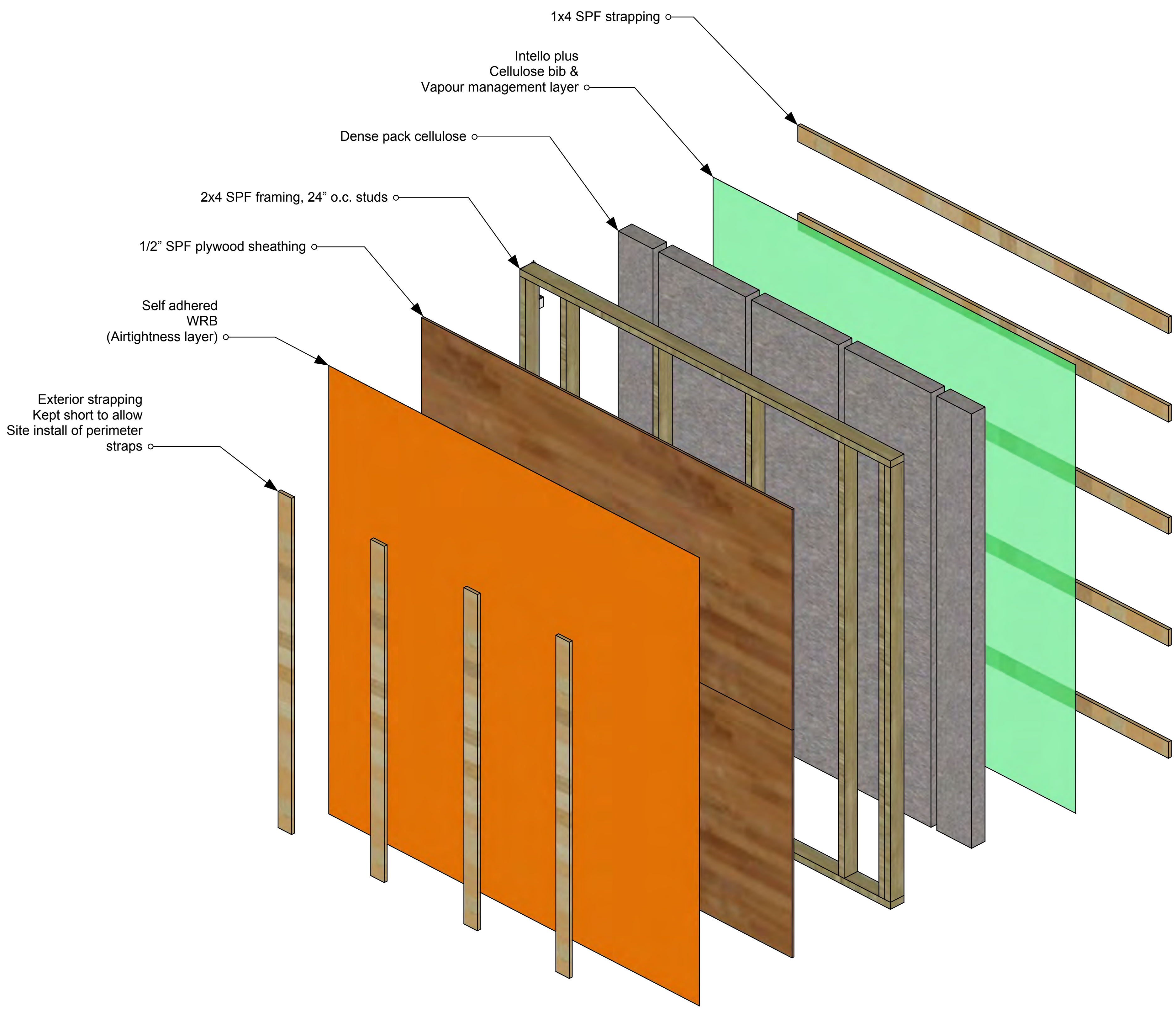
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

02

Panel - Exploded View

Panel schematic with all membranes in place



ReCover

Version Date
February 27, 2023

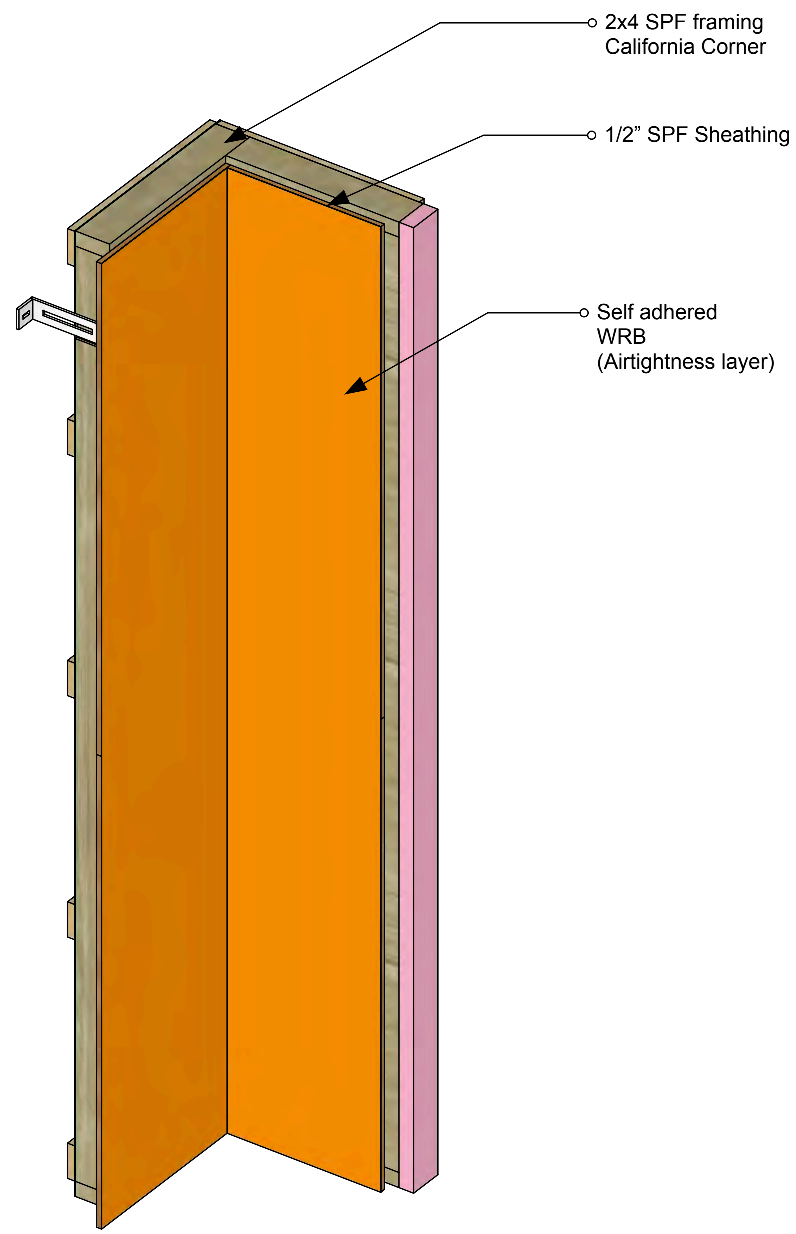
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

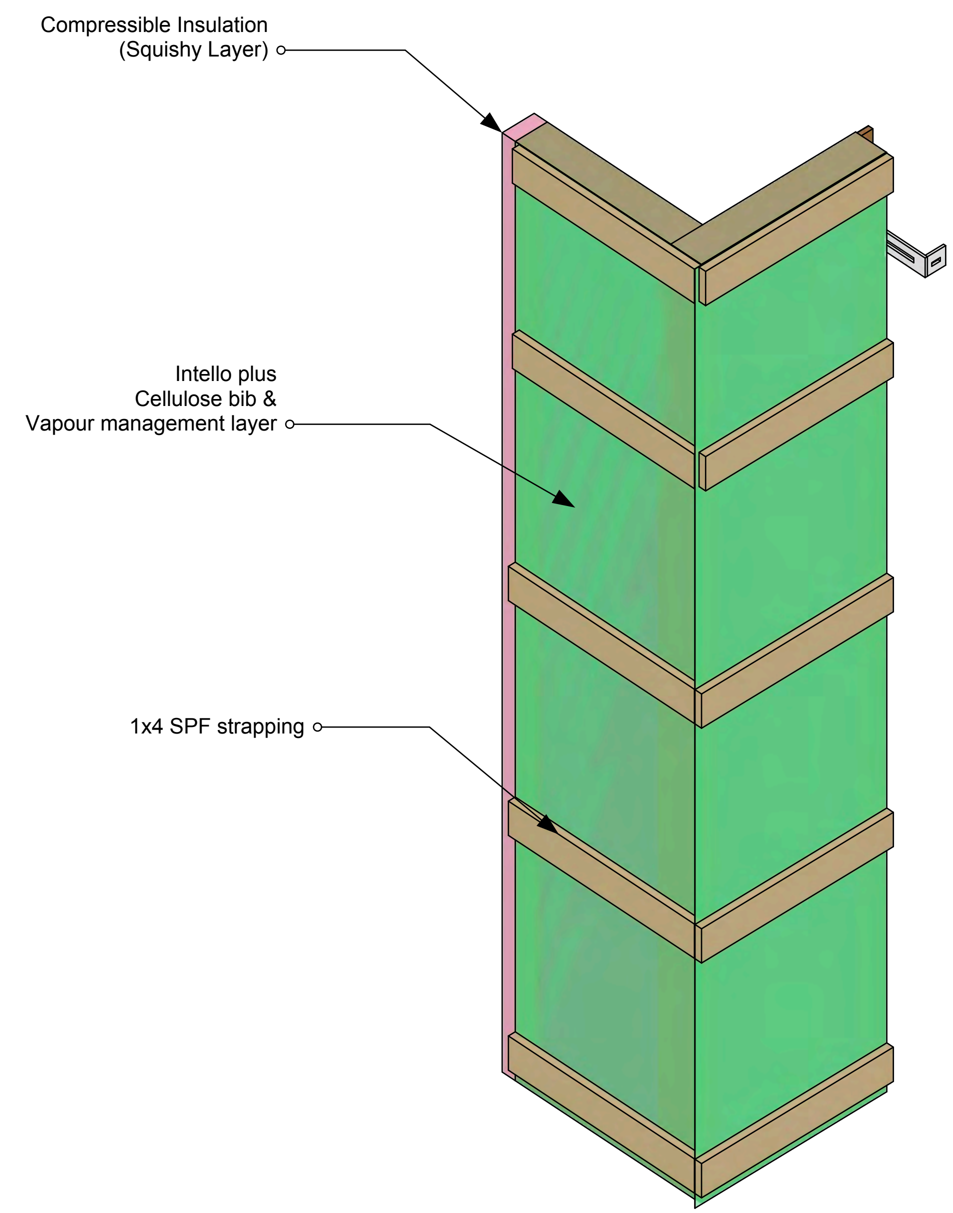
03

Panel - Inside Corner

Panel schematic with all membranes in place



EXTERIOR VIEW



INTERIOR VIEW

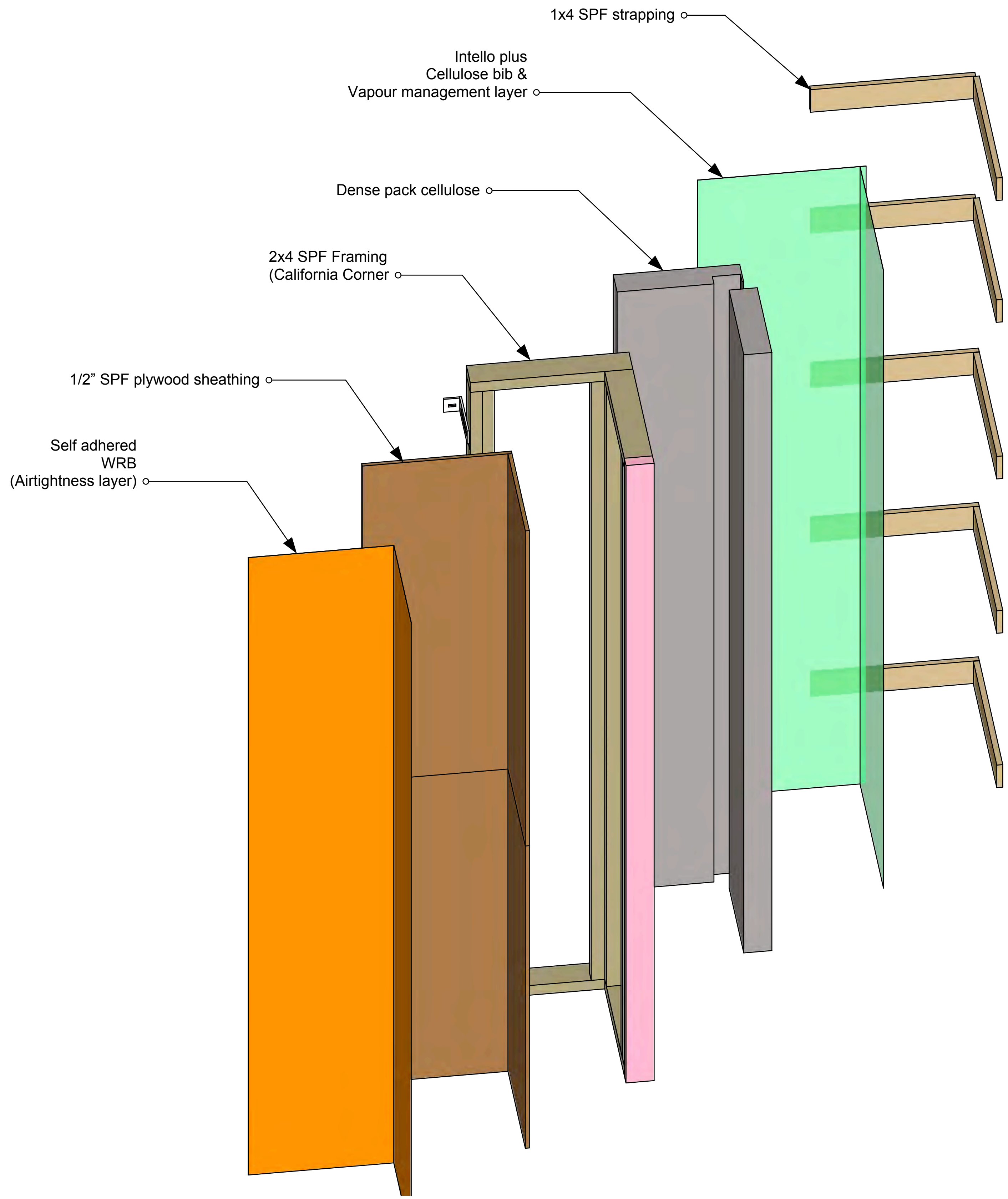
Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

Panel - Inside Corner - Exploded

Panel schematic with all membranes in place



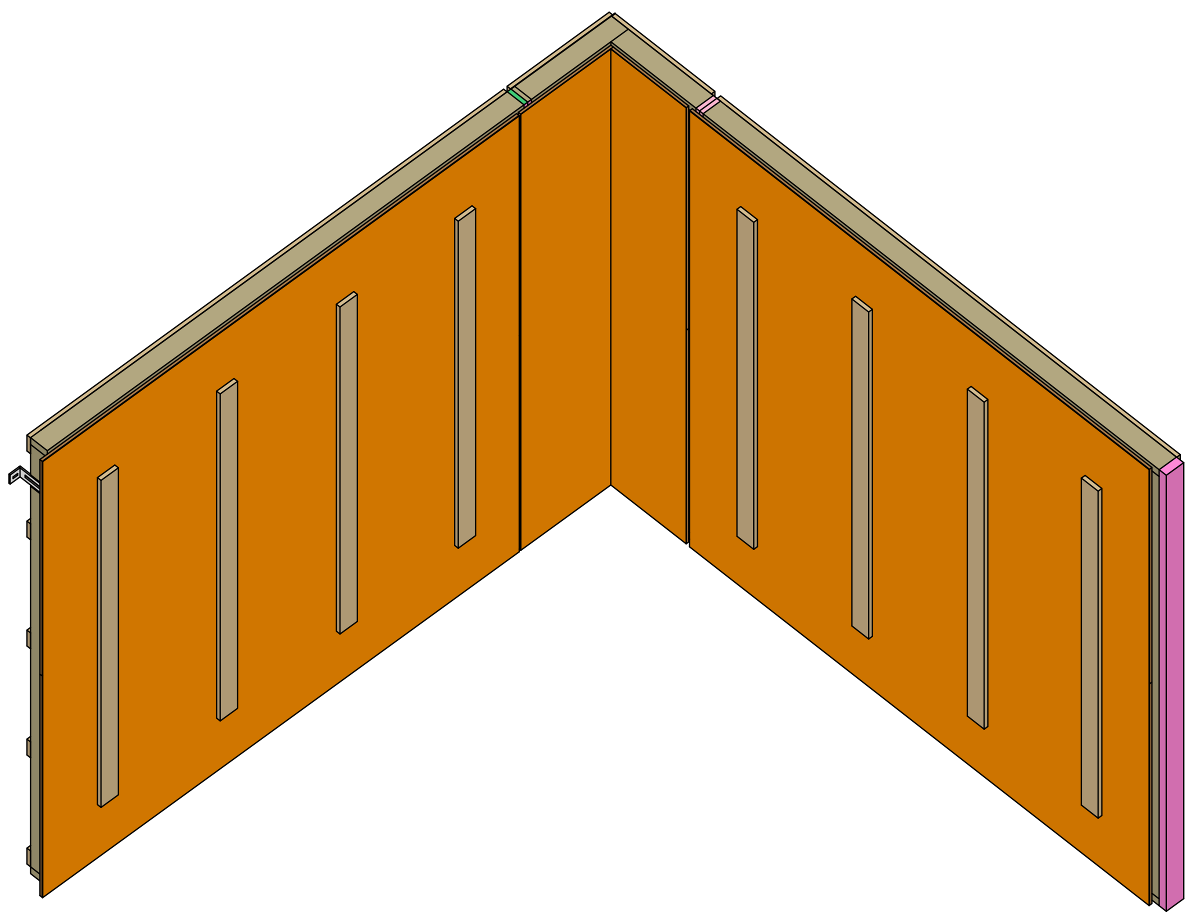
ReCover

Version Date
February 27, 2023

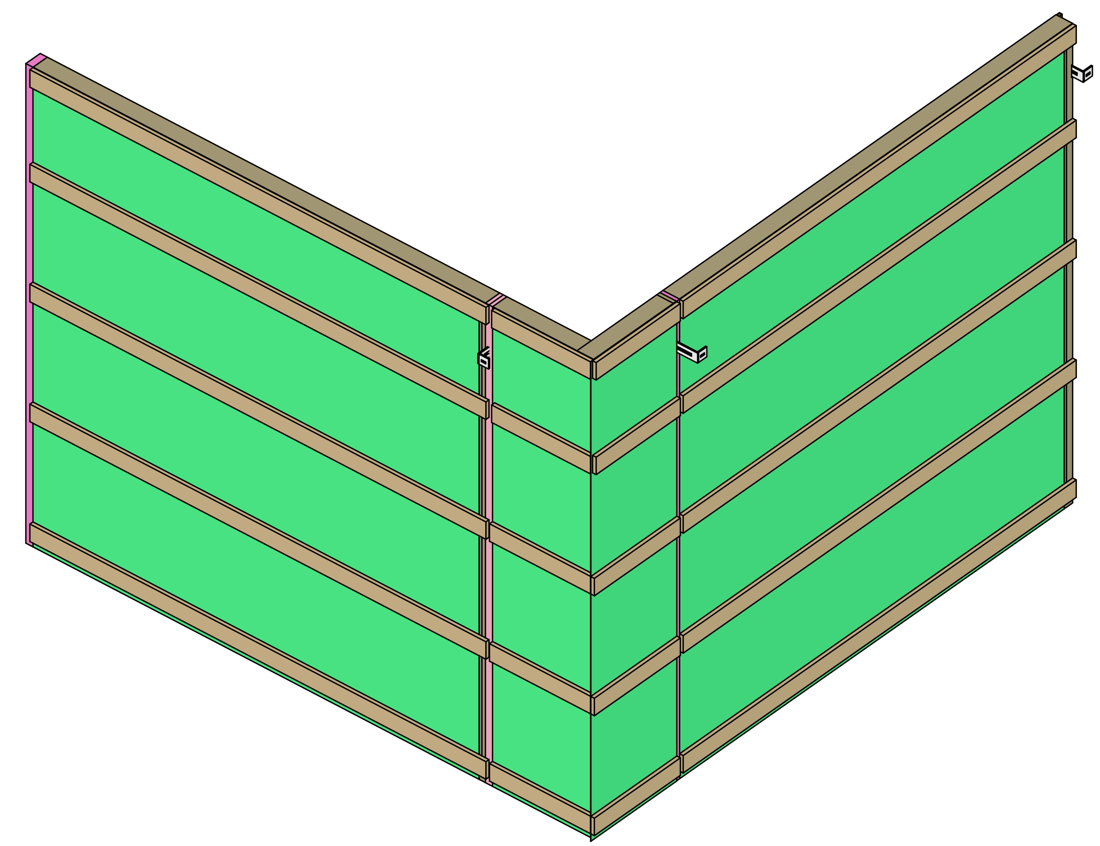
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

Inside Corner Installed



EXTERIOR VIEW



INTERIOR VIEW

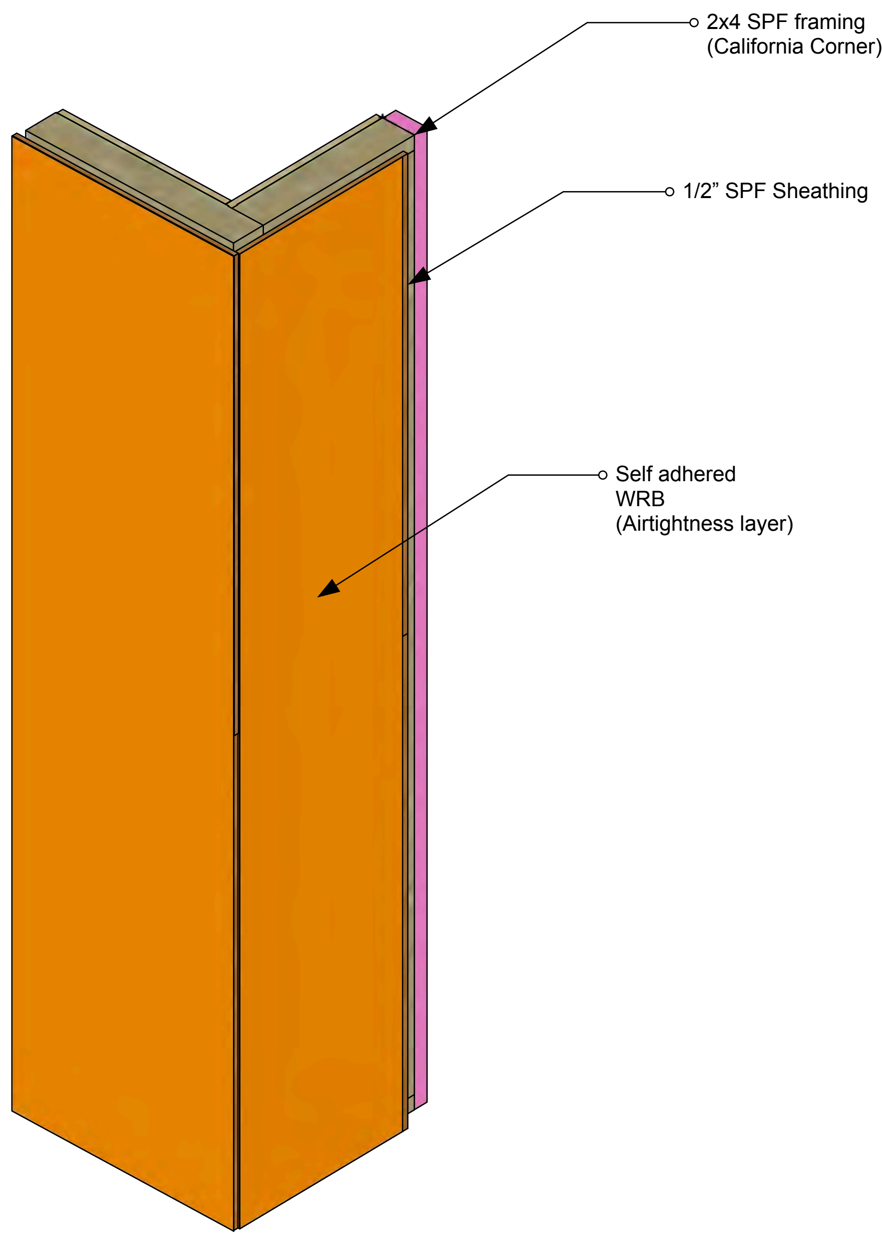
Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

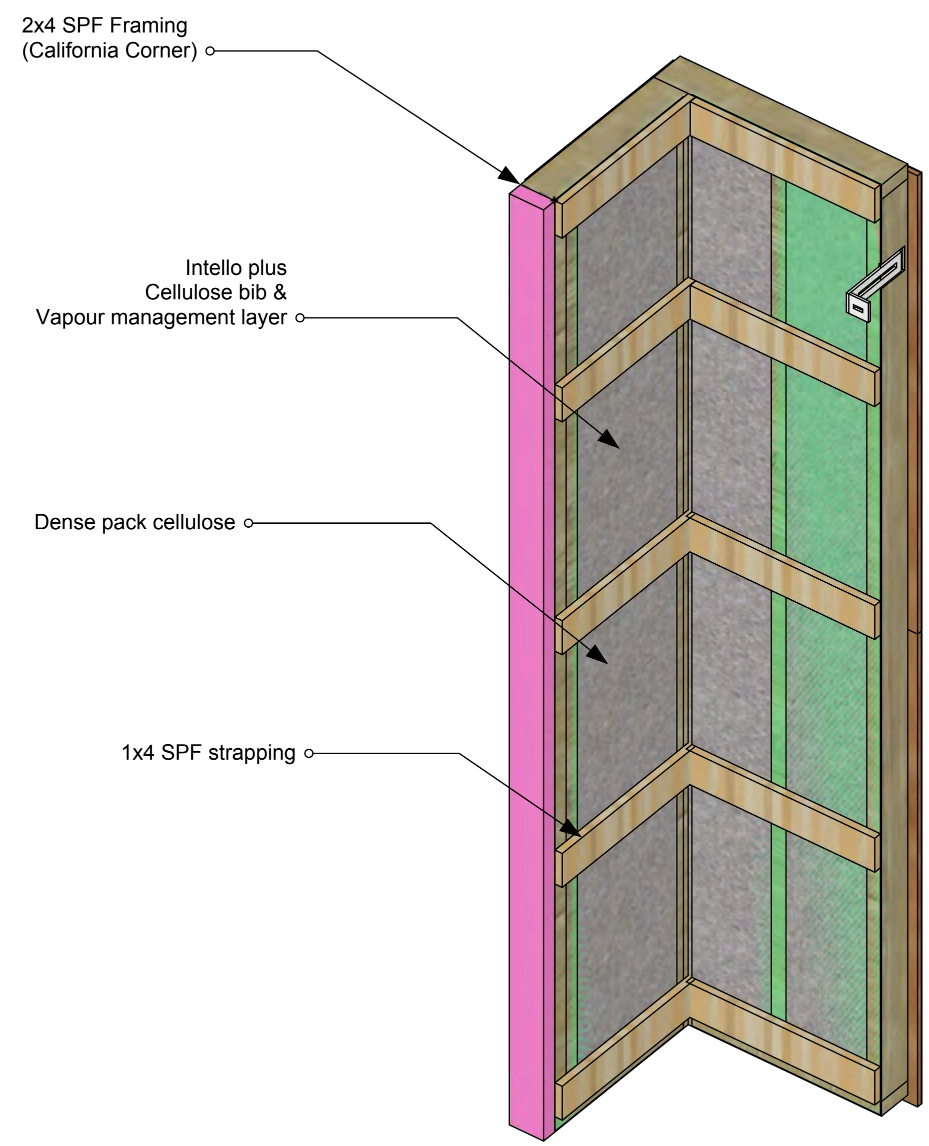
DRAWN BY
Nick Rudnicki

Panel - Outside Corner

Panel schematic with all membranes in place



EXTERIOR VIEW



INTERIOR VIEW

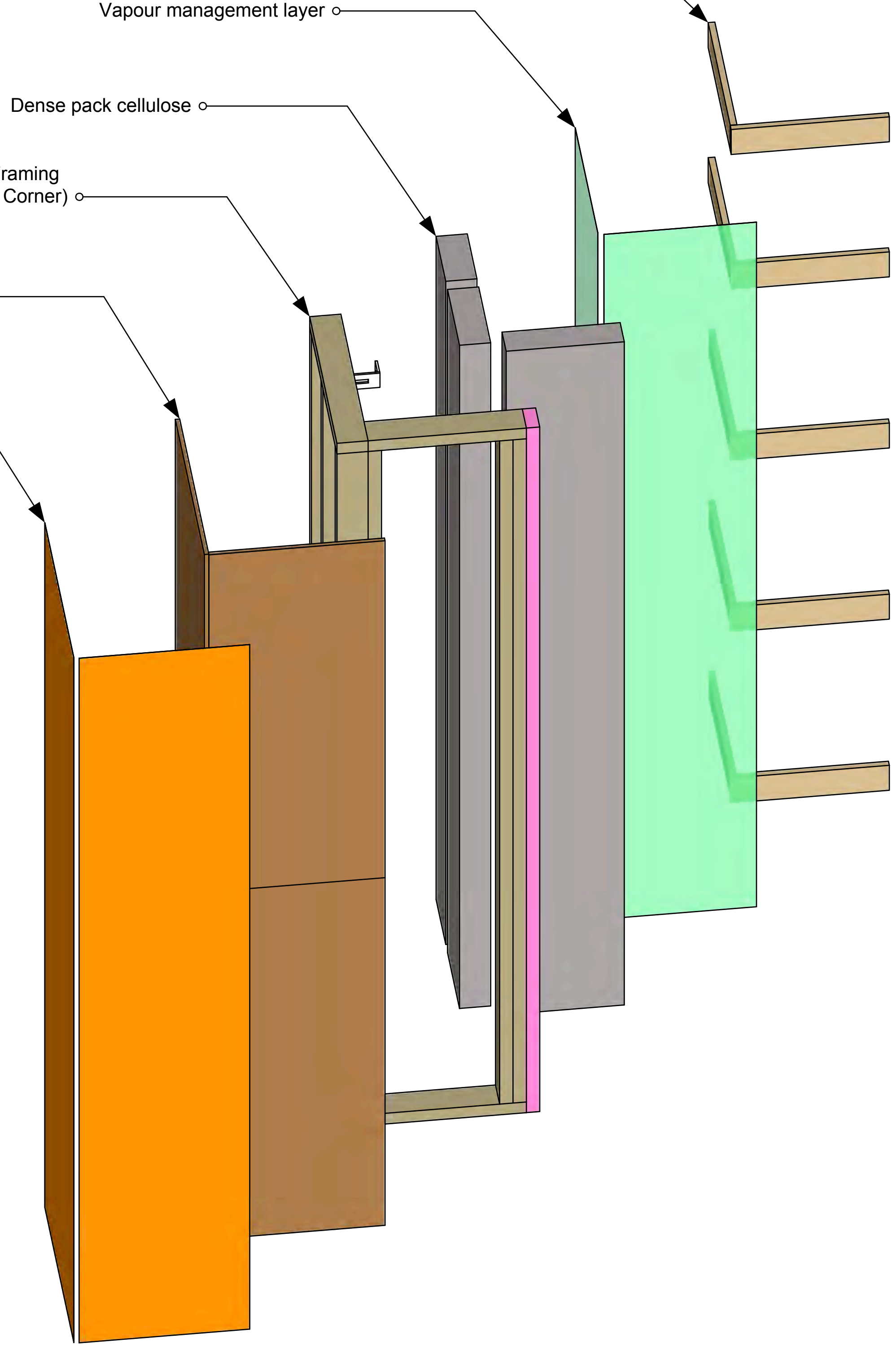
Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

Panel - Outside Corner - Exploded

Panel schematic with all membranes in place



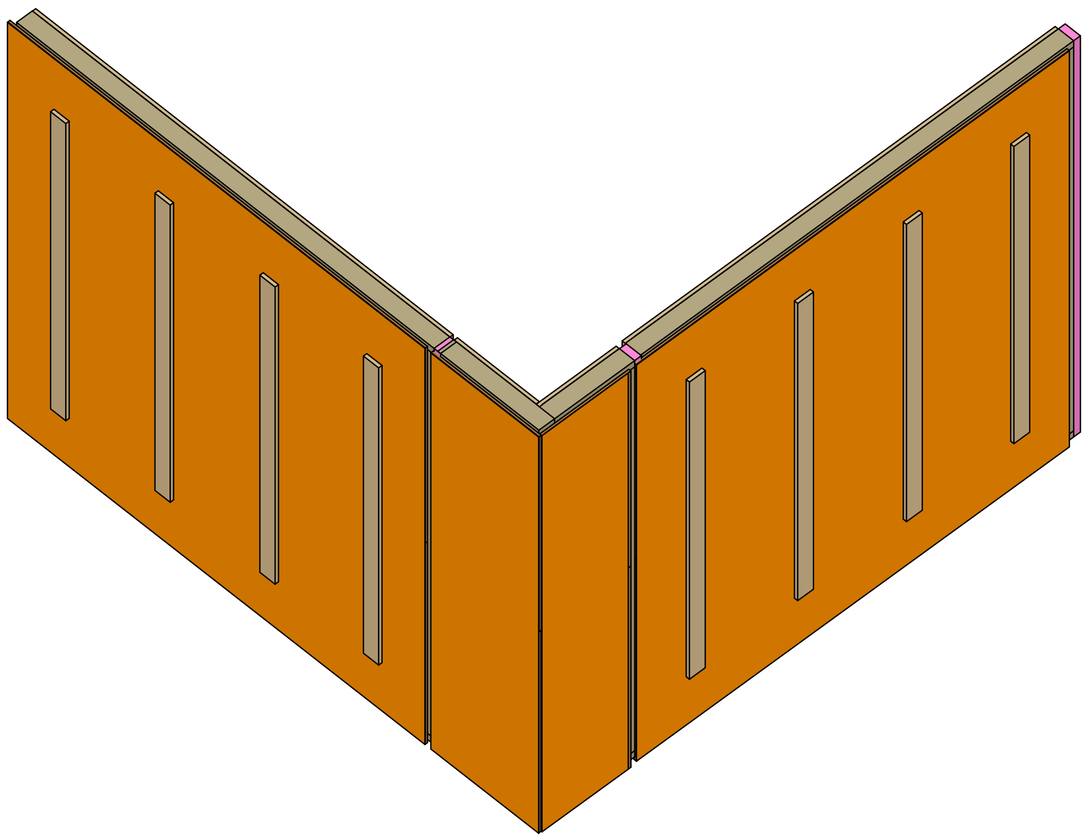
ReCover

Version Date
February 27, 2023

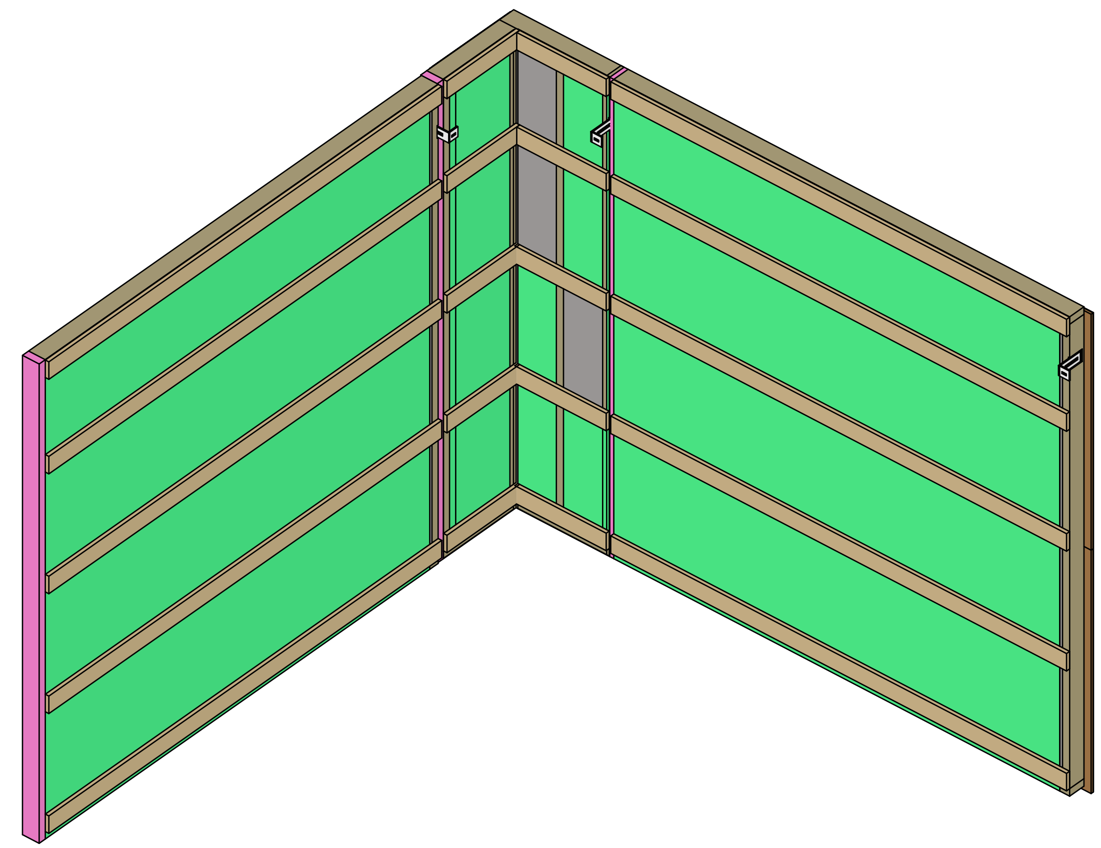
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

Outside Corner Installed



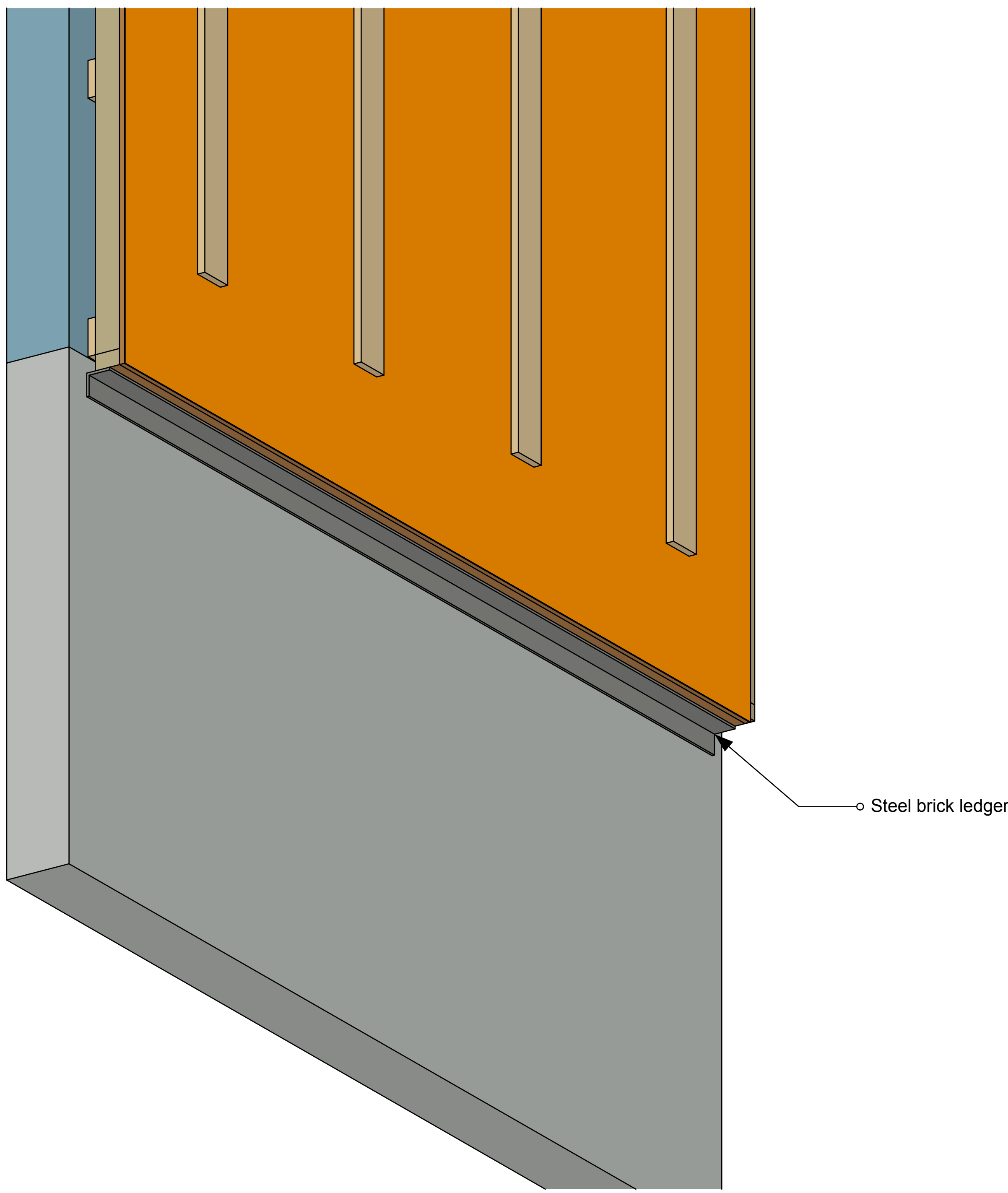
EXTERIOR VIEW



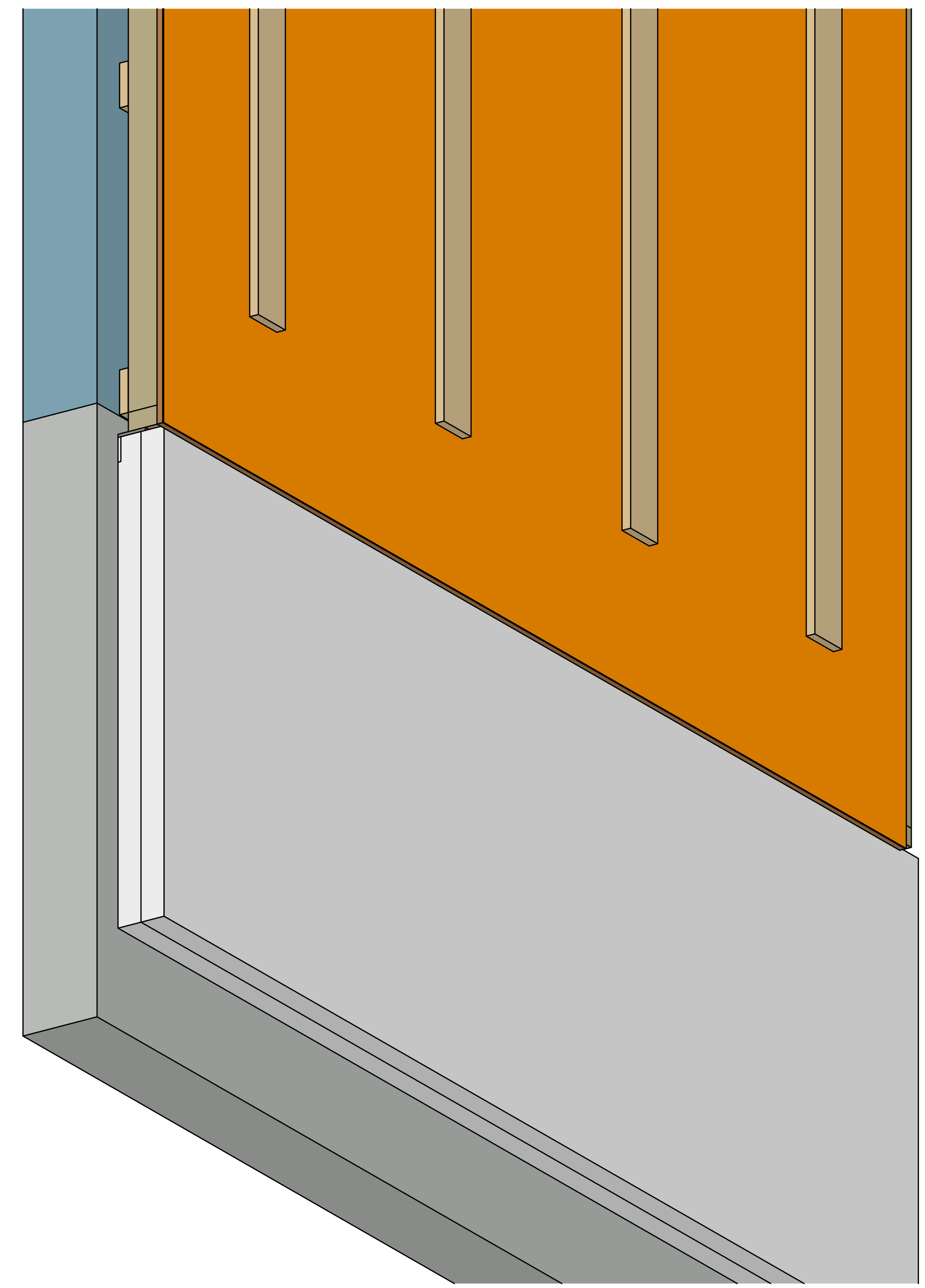
INTERIOR VIEW

Foundation Attachment - Ledger

“Brick Ledger” style continuous ledger for panel support



BEFORE SITE INSULATION



AFTER SITE INSULATION

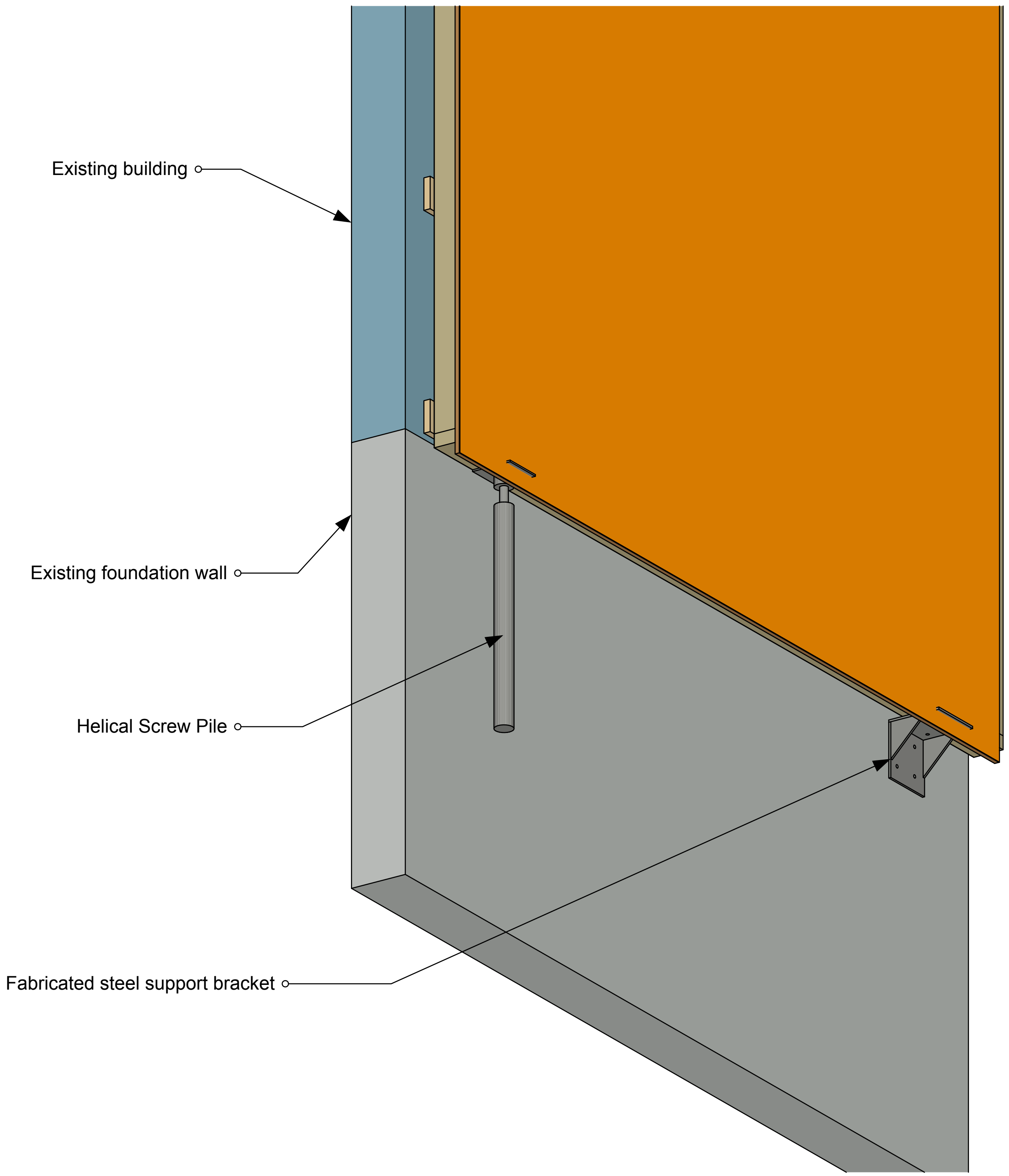
Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

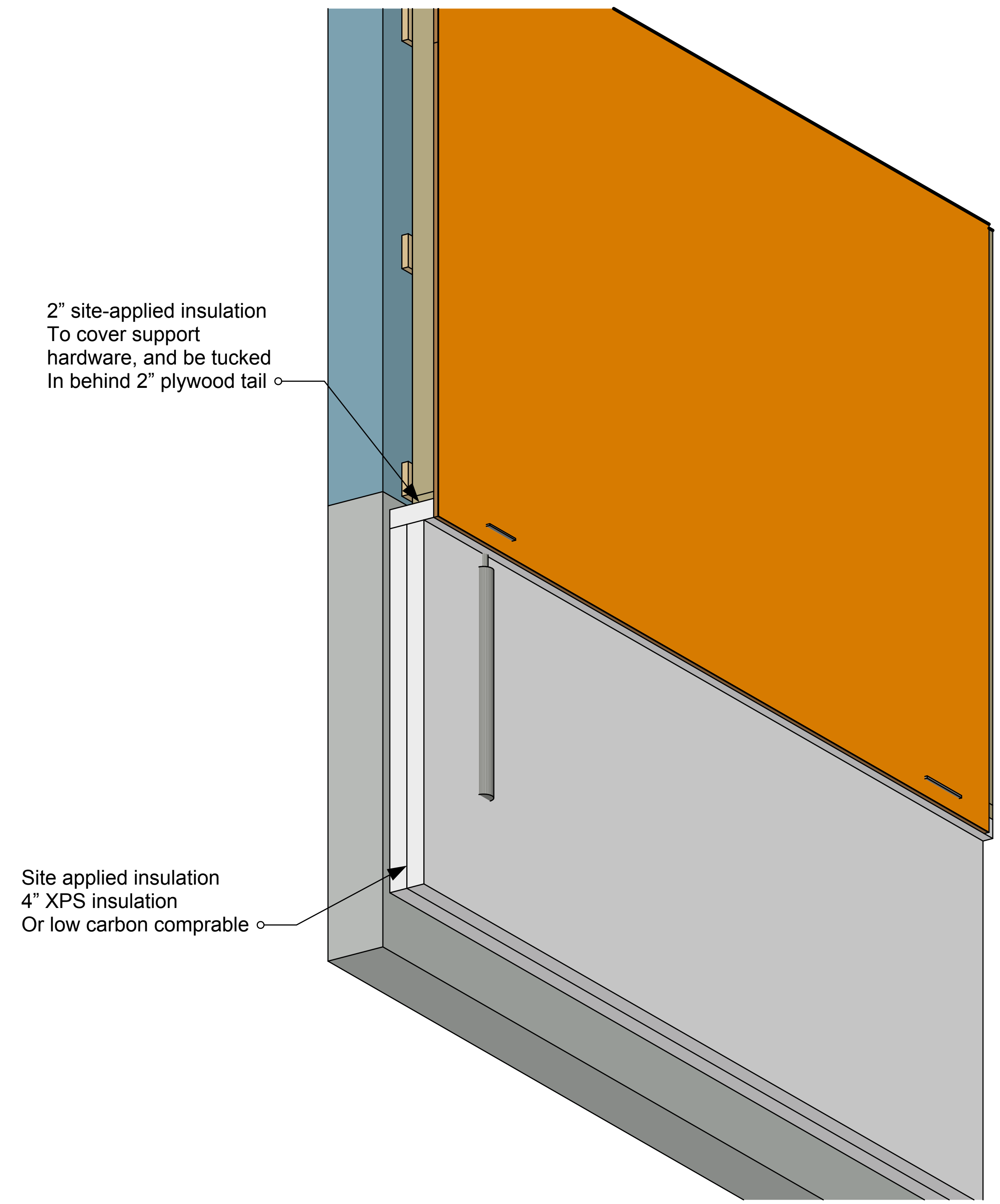
DRAWN BY
Nick Rudnicki

Foundation Attachment - Pile or Bracket

First options for attaching the panels to the foundation



BEFORE SITE INSULATION



AFTER SITE INSULATION

ReCover

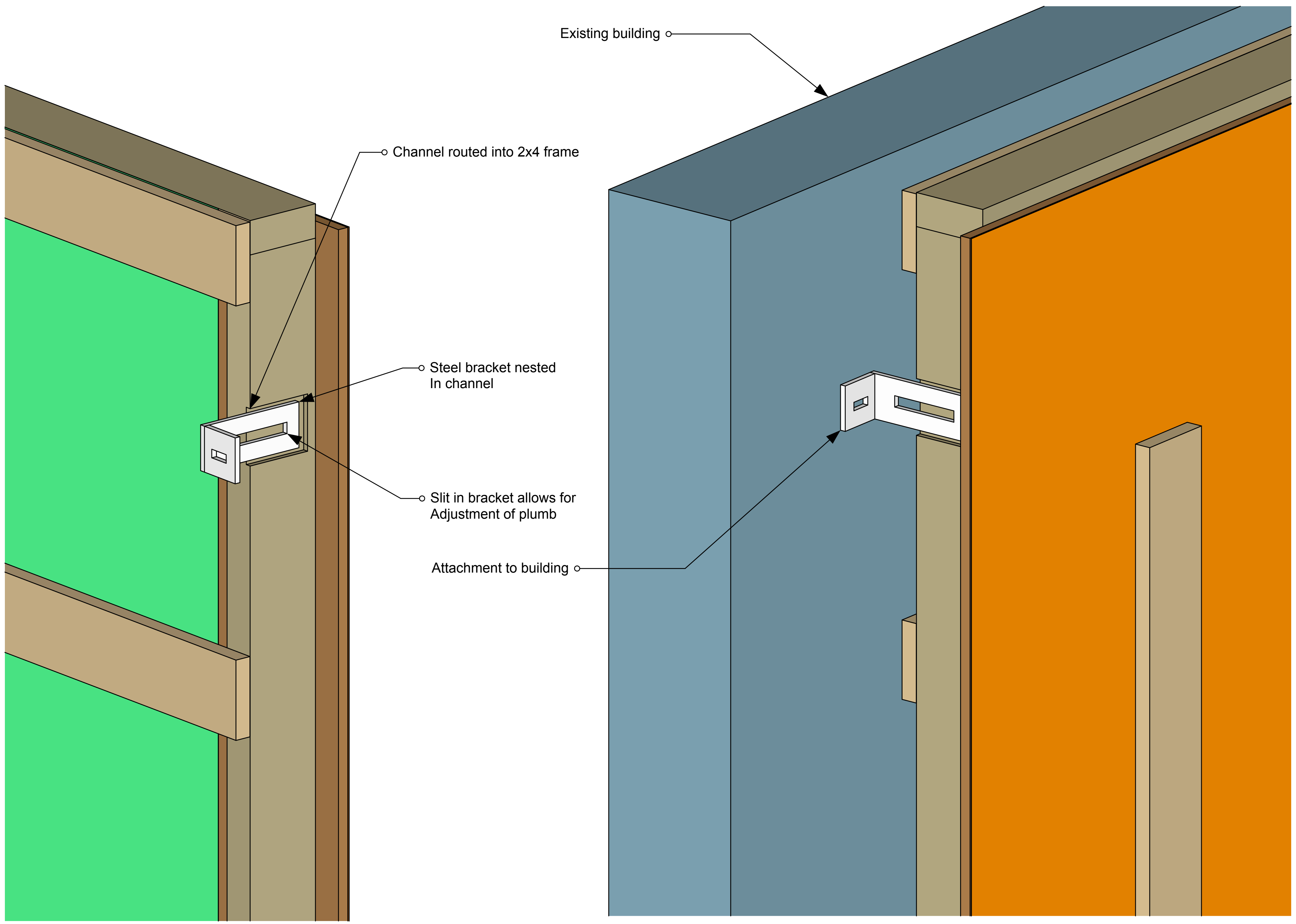
Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

Attach to Existing

Bracket to attach individual panels to existing



INTERIOR VIEW **EXTERIOR VIEW**

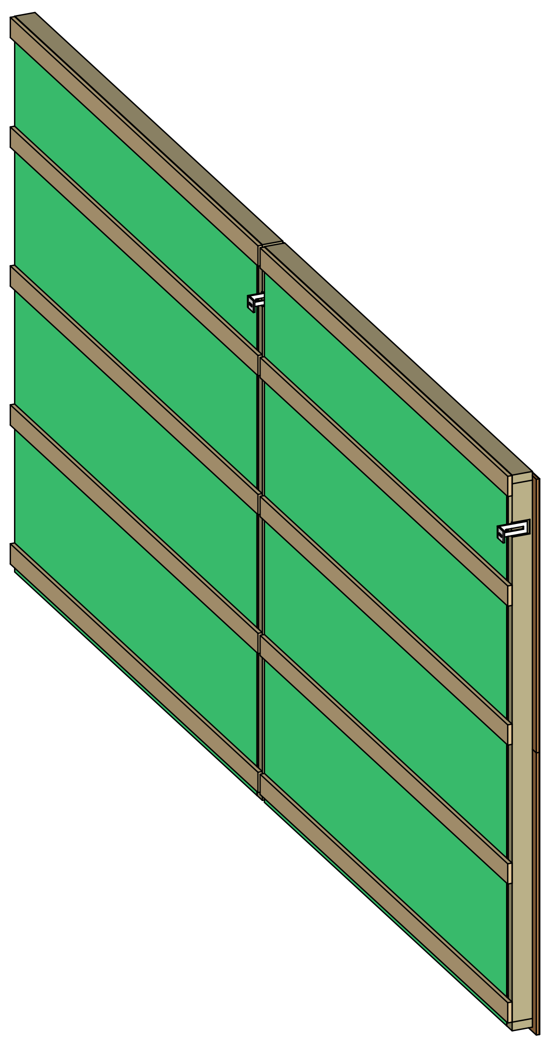
ReCover

Version Date
February 27, 2023

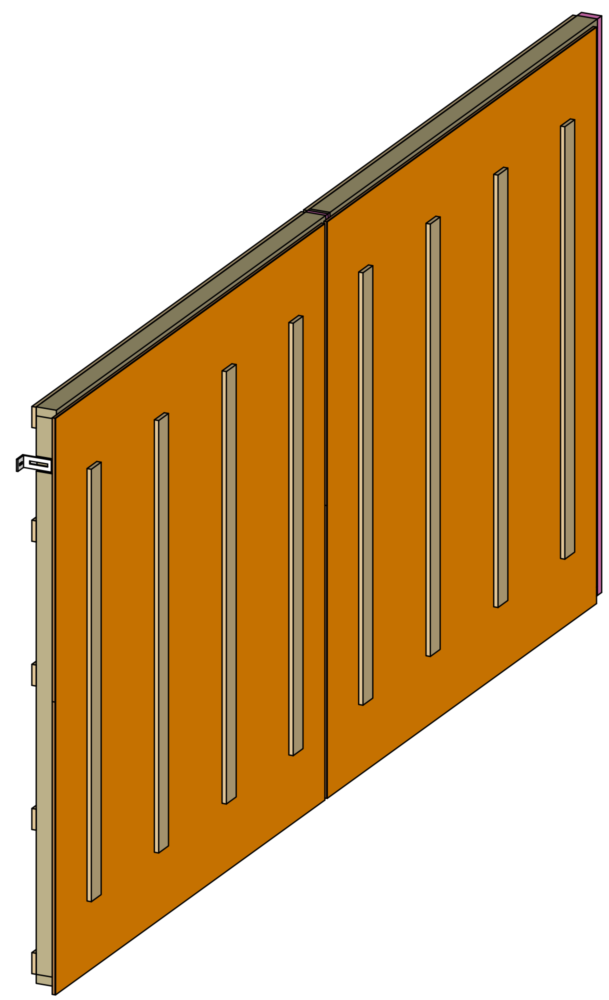
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

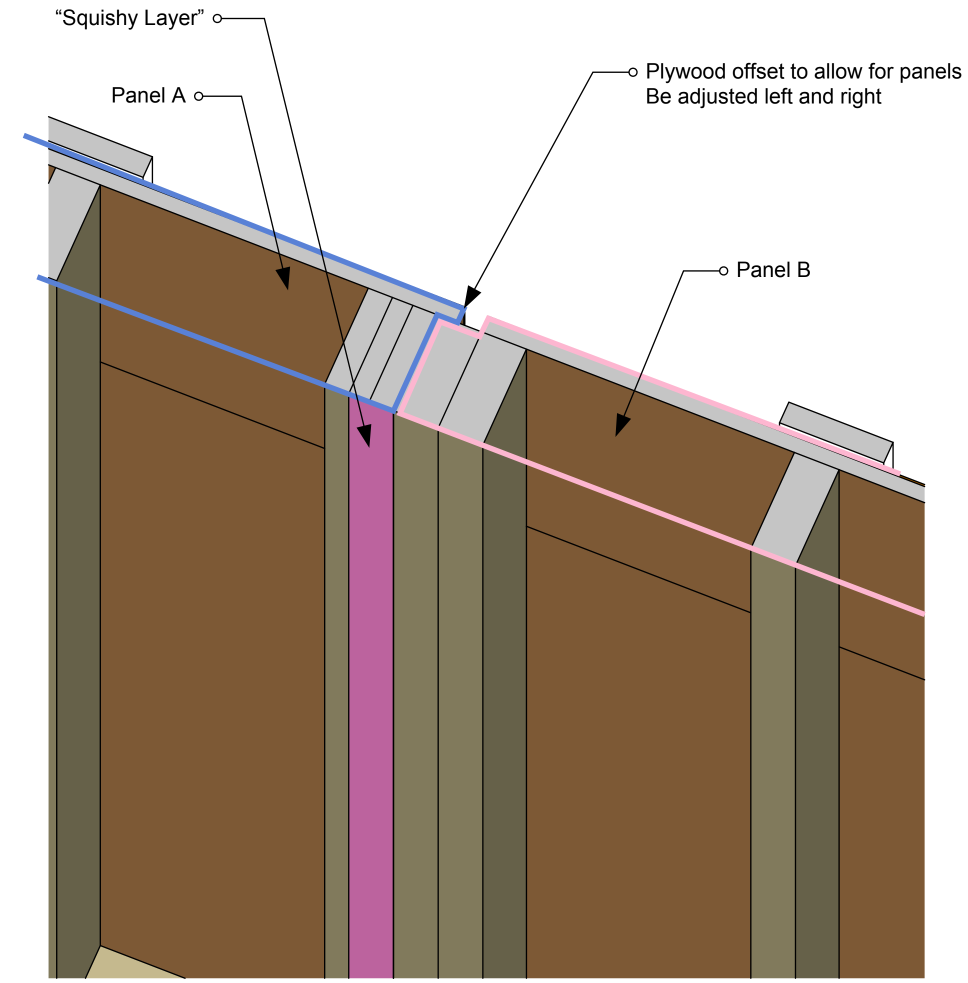
Vertical Wall Joins



INTERIOR VIEW



EXTERIOR VIEW



SECTION VIEW

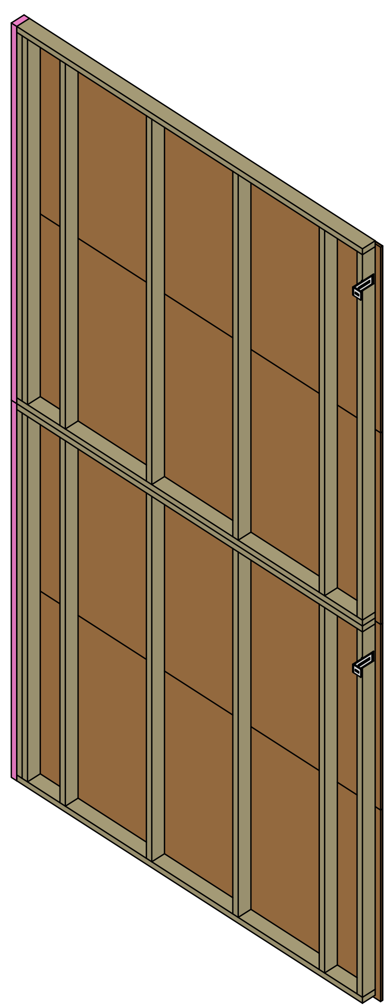
ReCover

Version Date
February 27, 2023

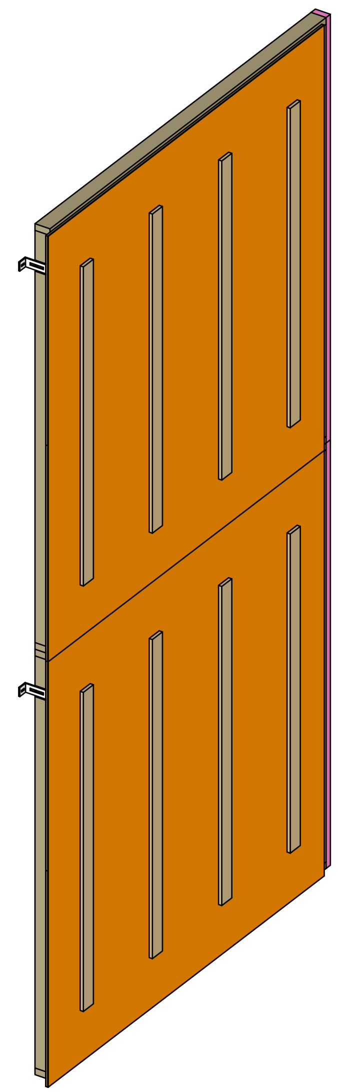
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

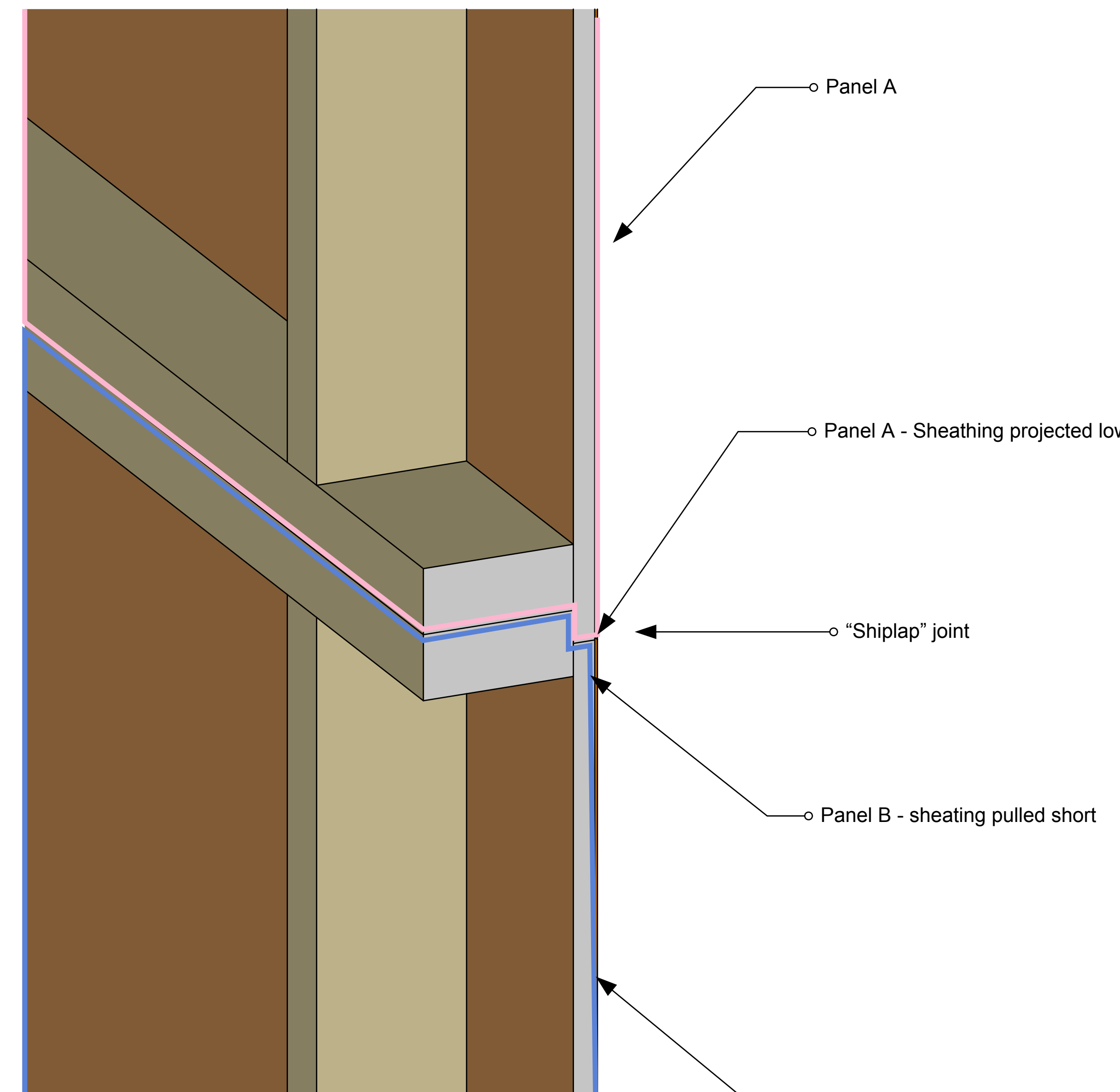
Horizontal Wall Joins



INTERIOR VIEW



EXTERIOR VIEW



SECTION VIEW

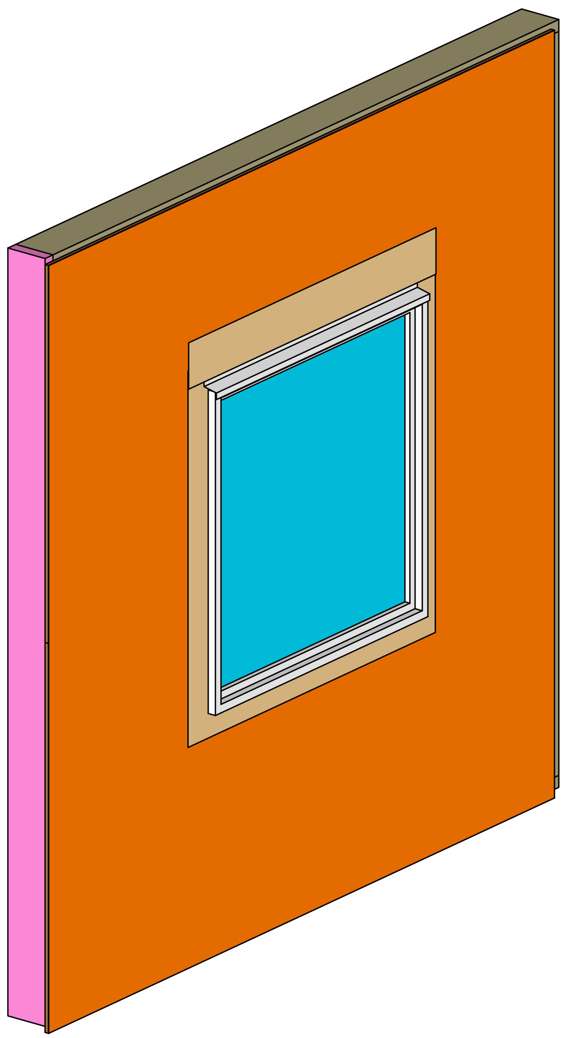
ReCover

Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

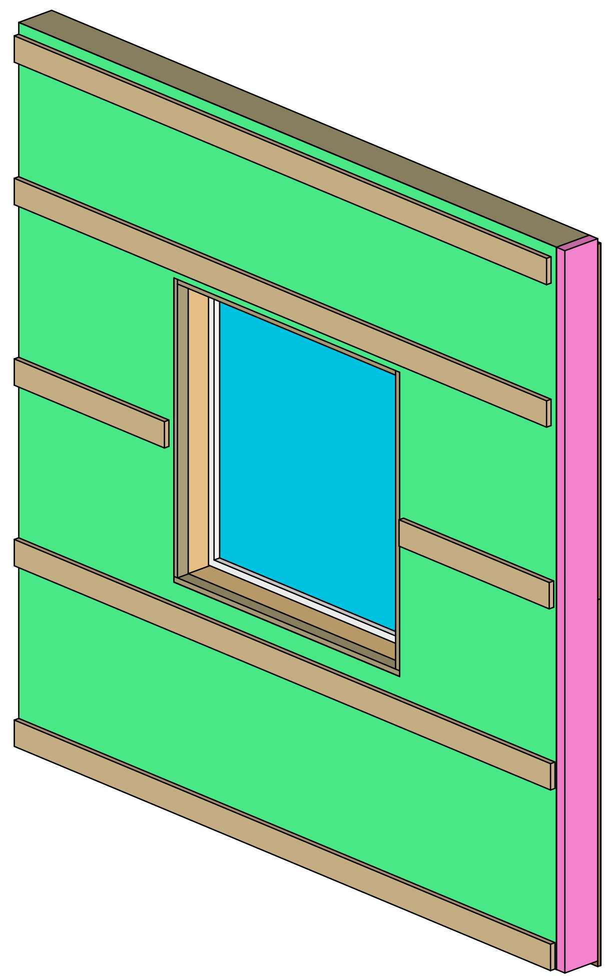
DRAWN BY
Nick Rudnicki

Window Panel

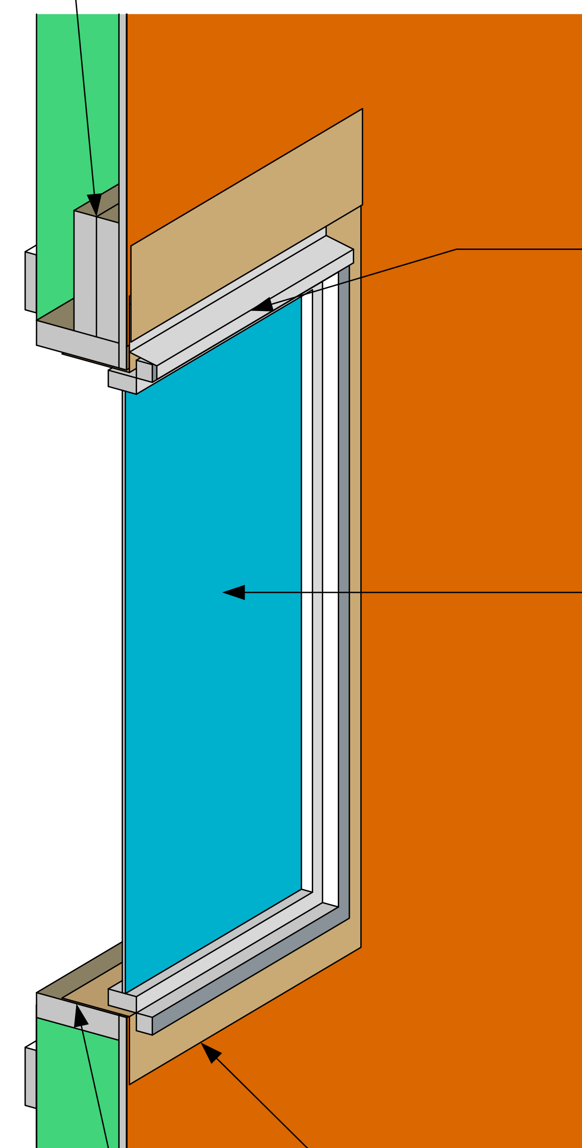


PANEL
EXTERIOR VIEW

Window installed in factory
Window installed as an "outie" to minimize how much window sill there is exposed to the rain



PANEL
EXTERIOR VIEW



ReCover

Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

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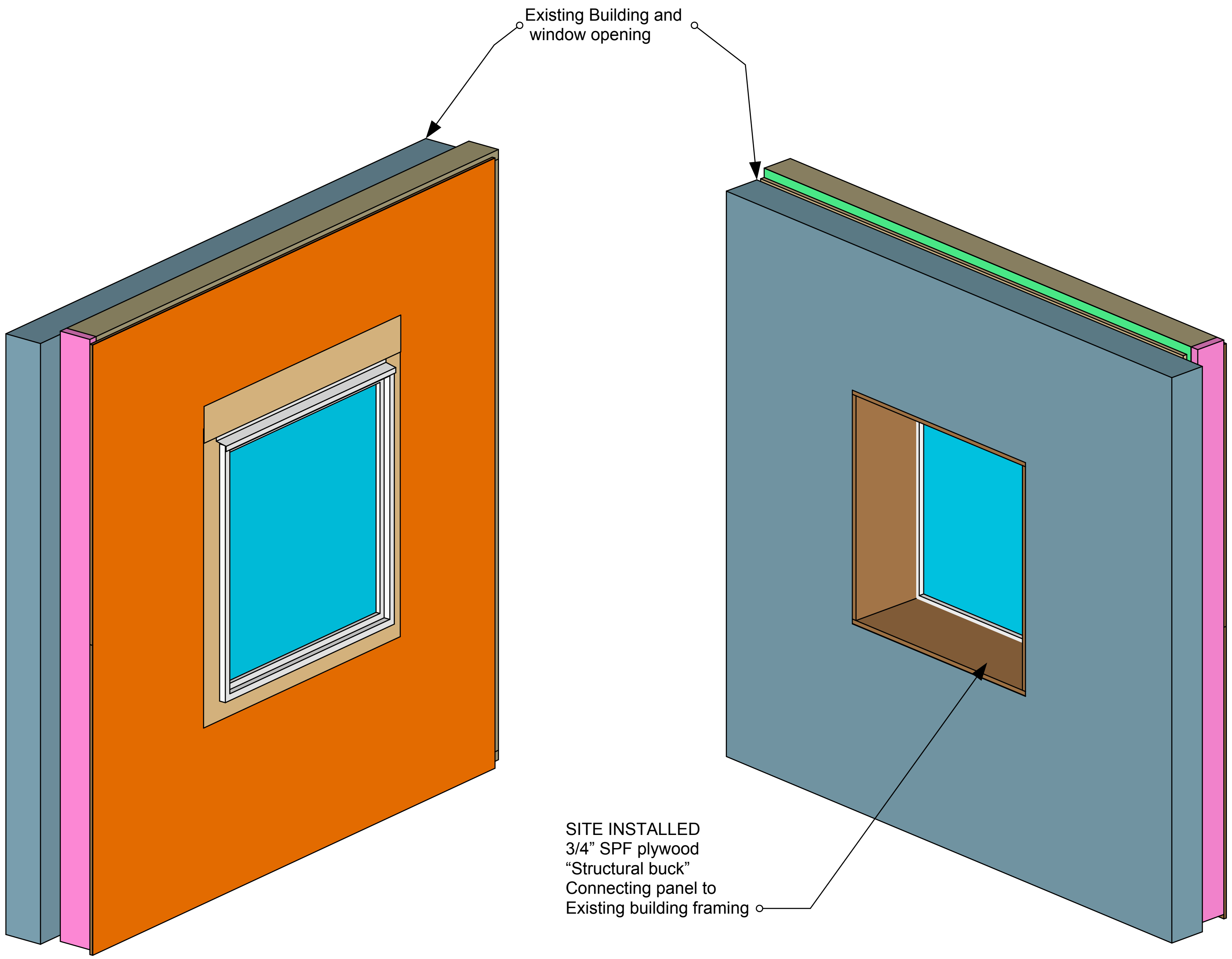
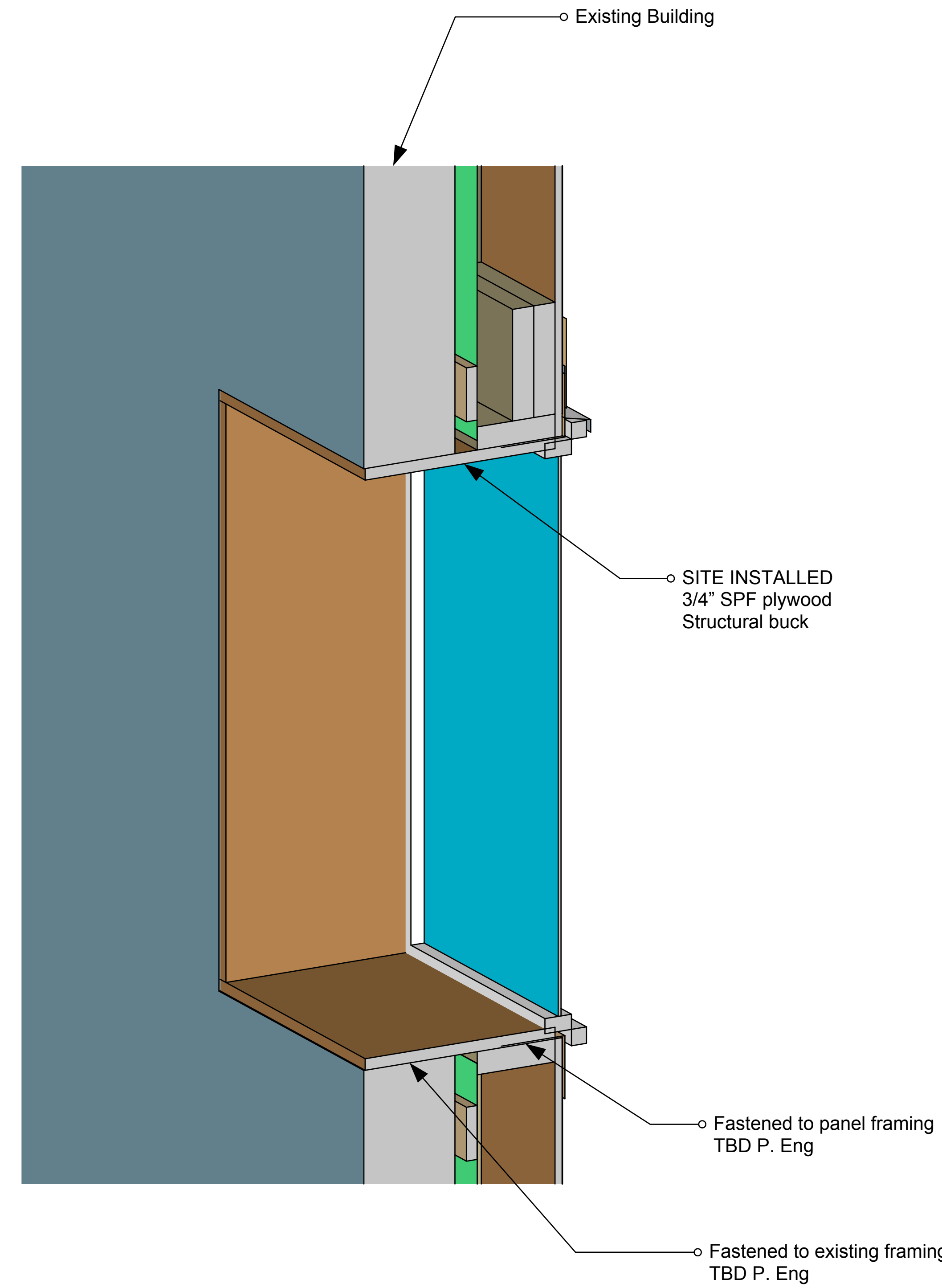
Window Penetration



EXTERIOR VIEW **INTERIOR VIEW**



SECTION VIEW

ReCover

Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

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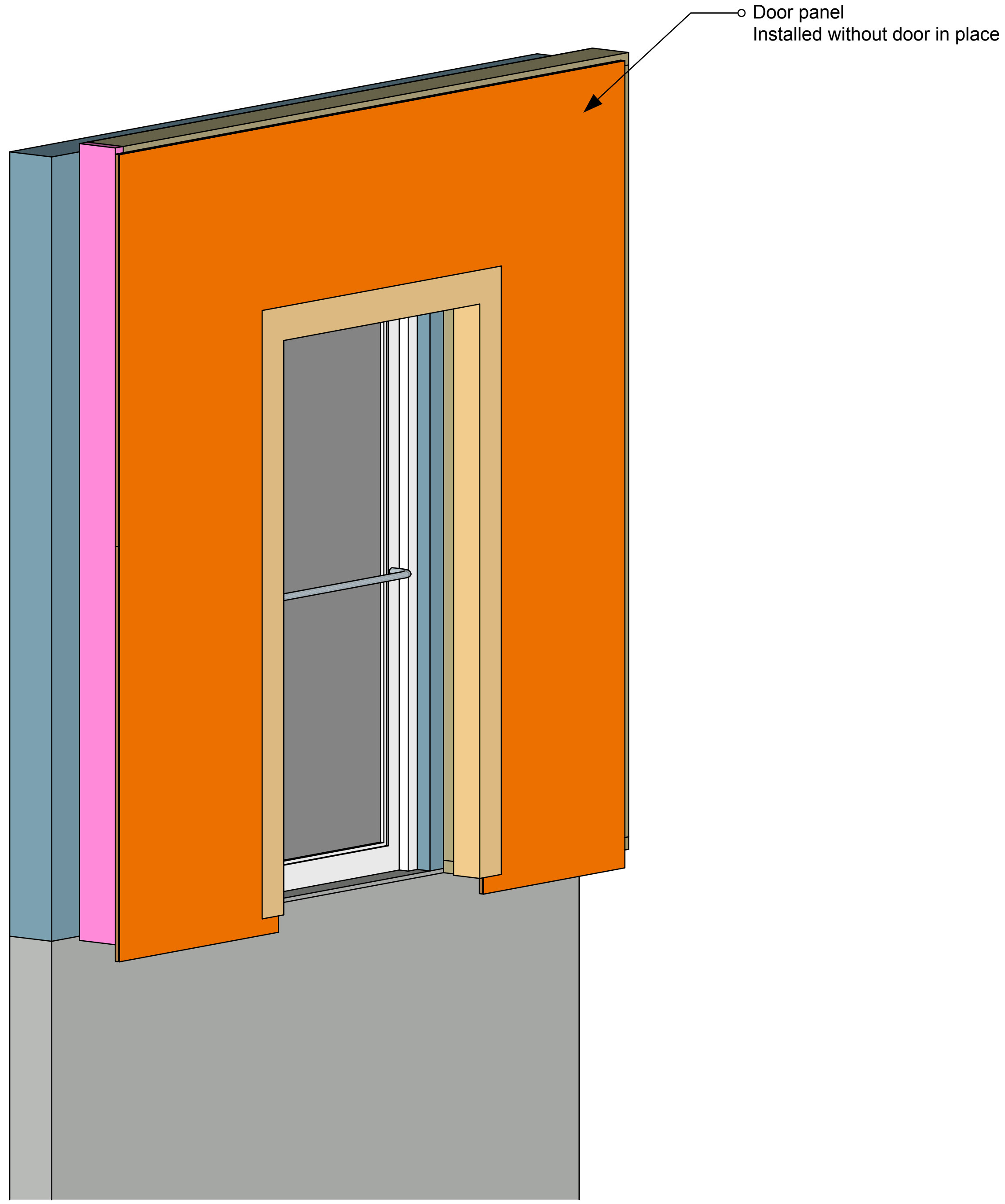
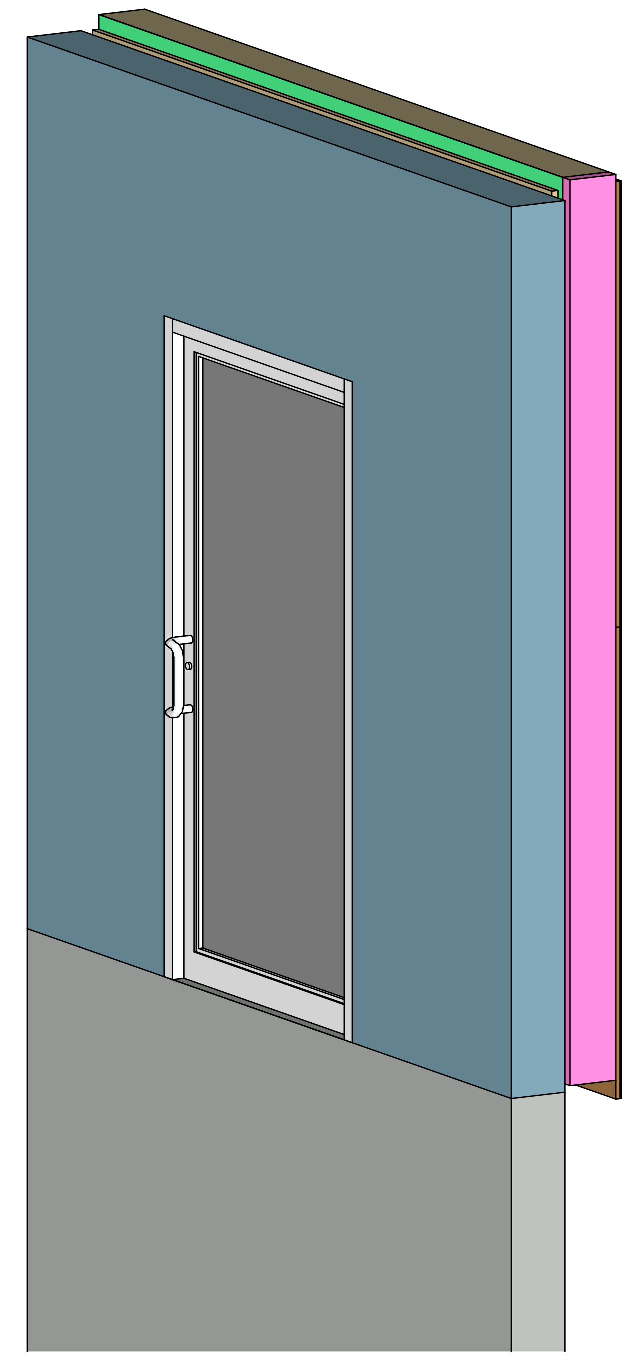
Door Penetration Panel



EXTERIOR VIEW



INTERIOR VIEW

ReCover

Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

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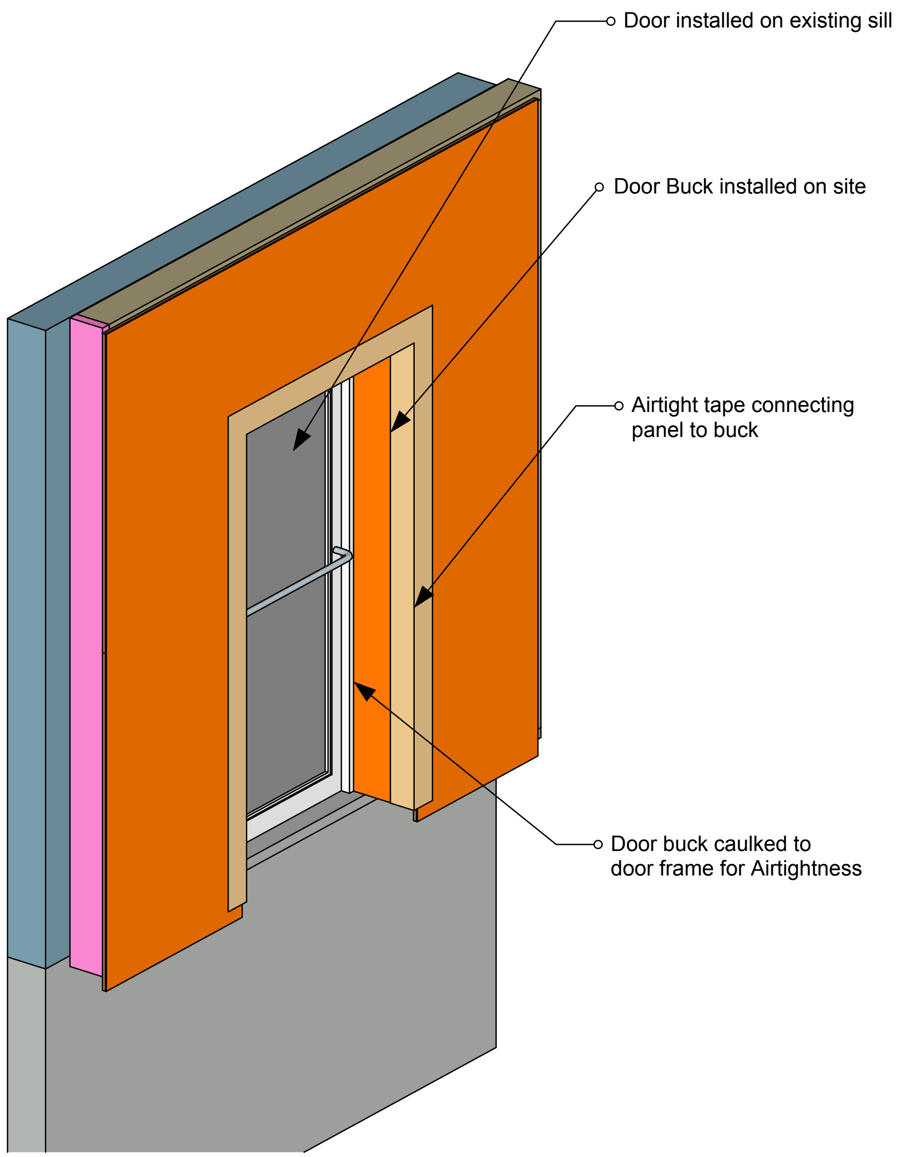
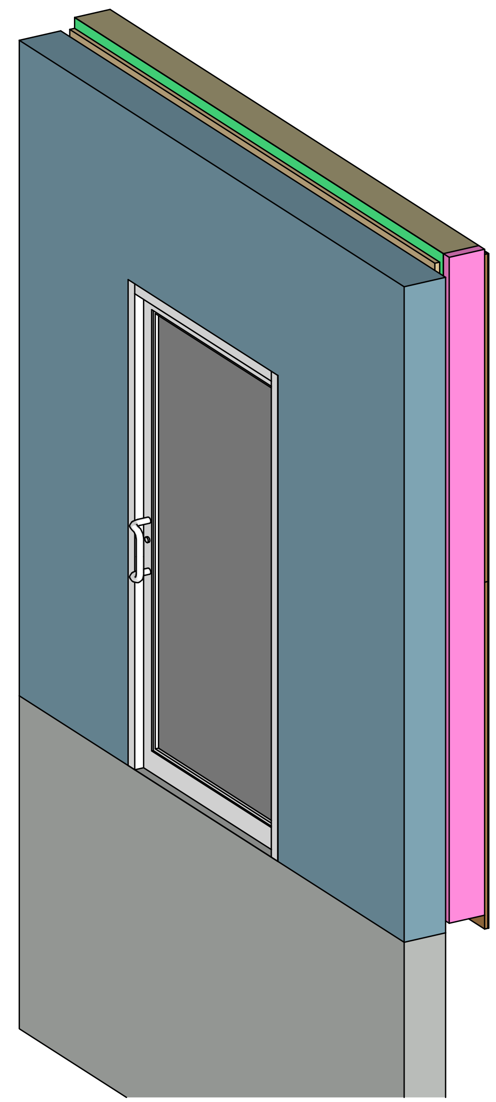
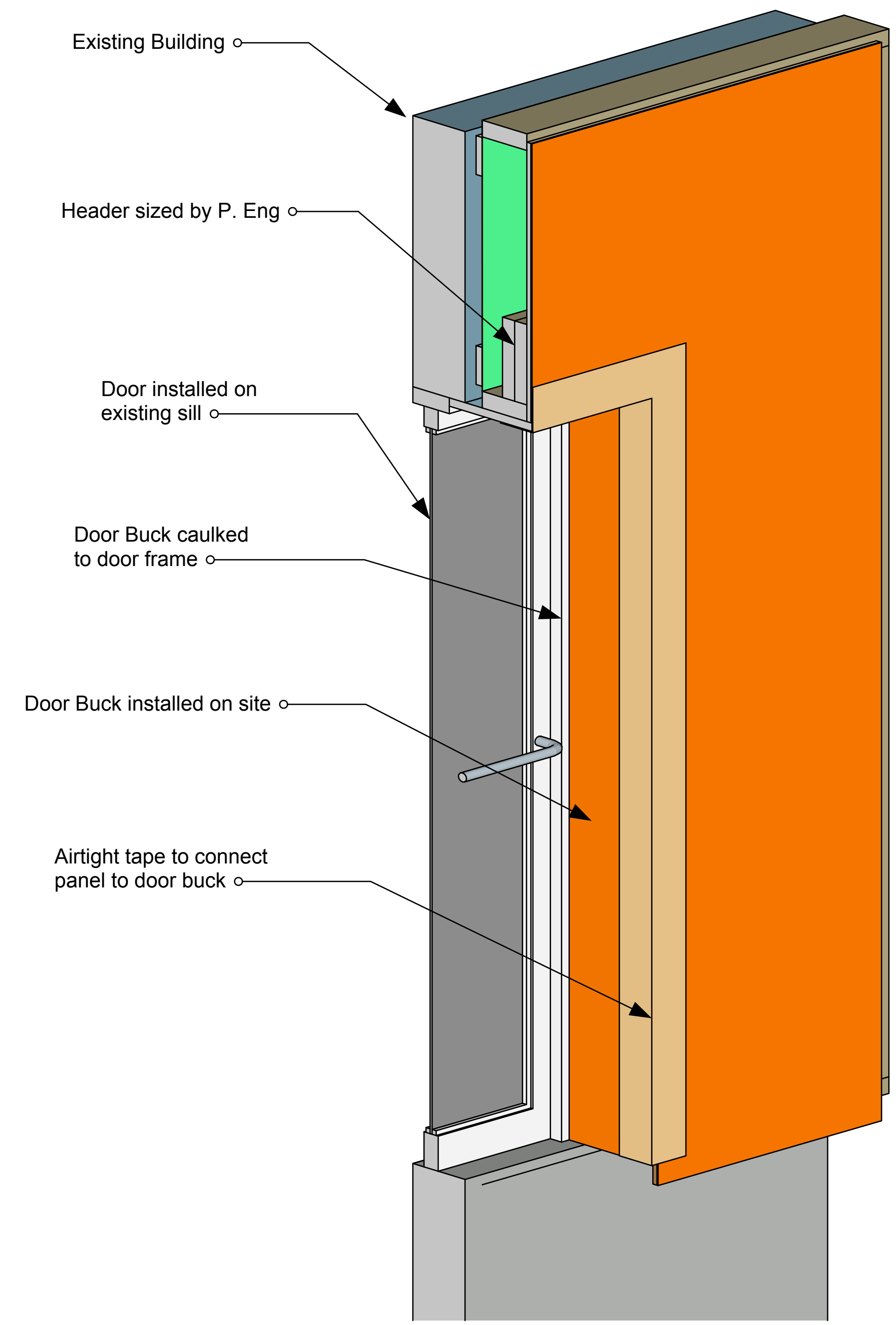
Door Penetration Panel Installed



EXTERIOR VIEW



INTERIOR VIEW



SECTION VIEW

Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

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Nick Rudnicki

Wall Panel Schematics

Cellulose - R28 - 2x10 - 1/2" Plywood

ReCover Initiative

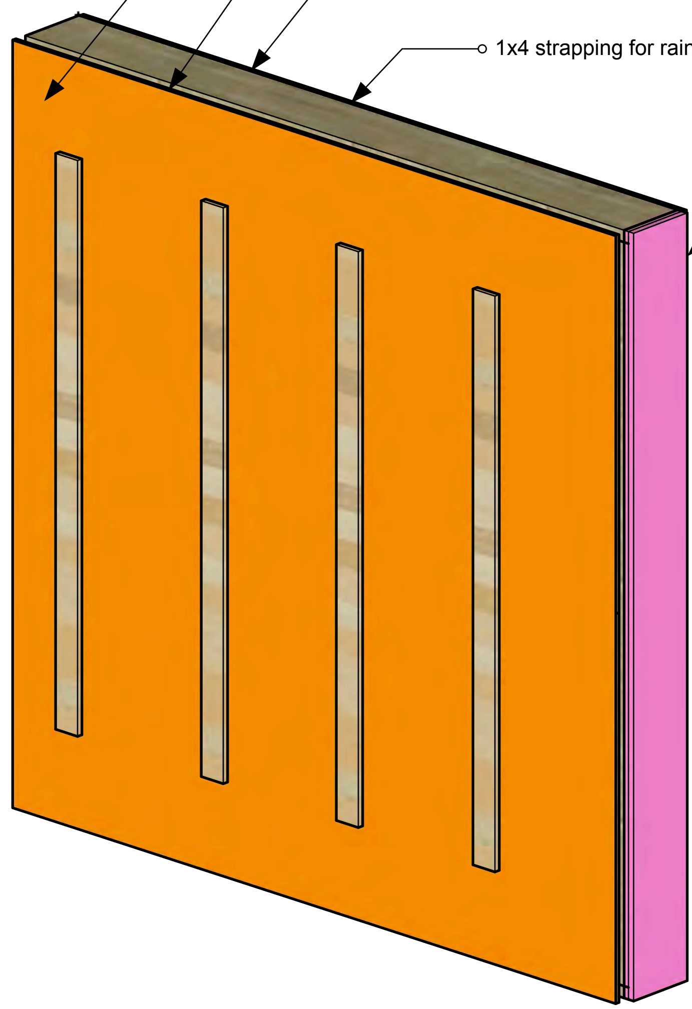
ReCover

Version Date
February 27, 2023

PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

Basic Panel - Overview



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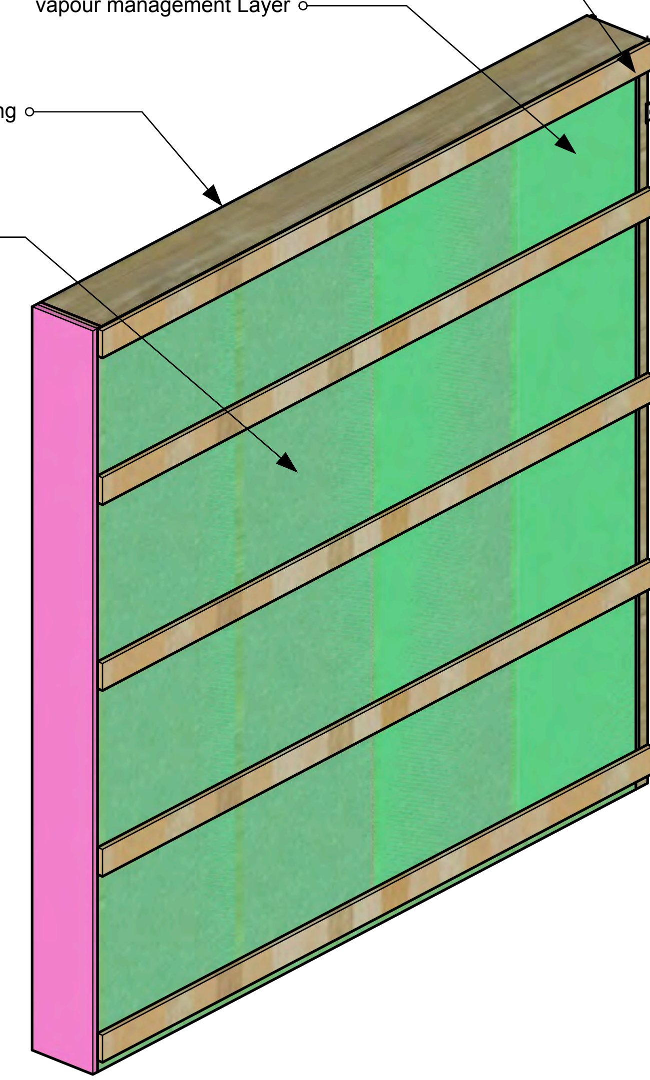


INTERIOR VIEW

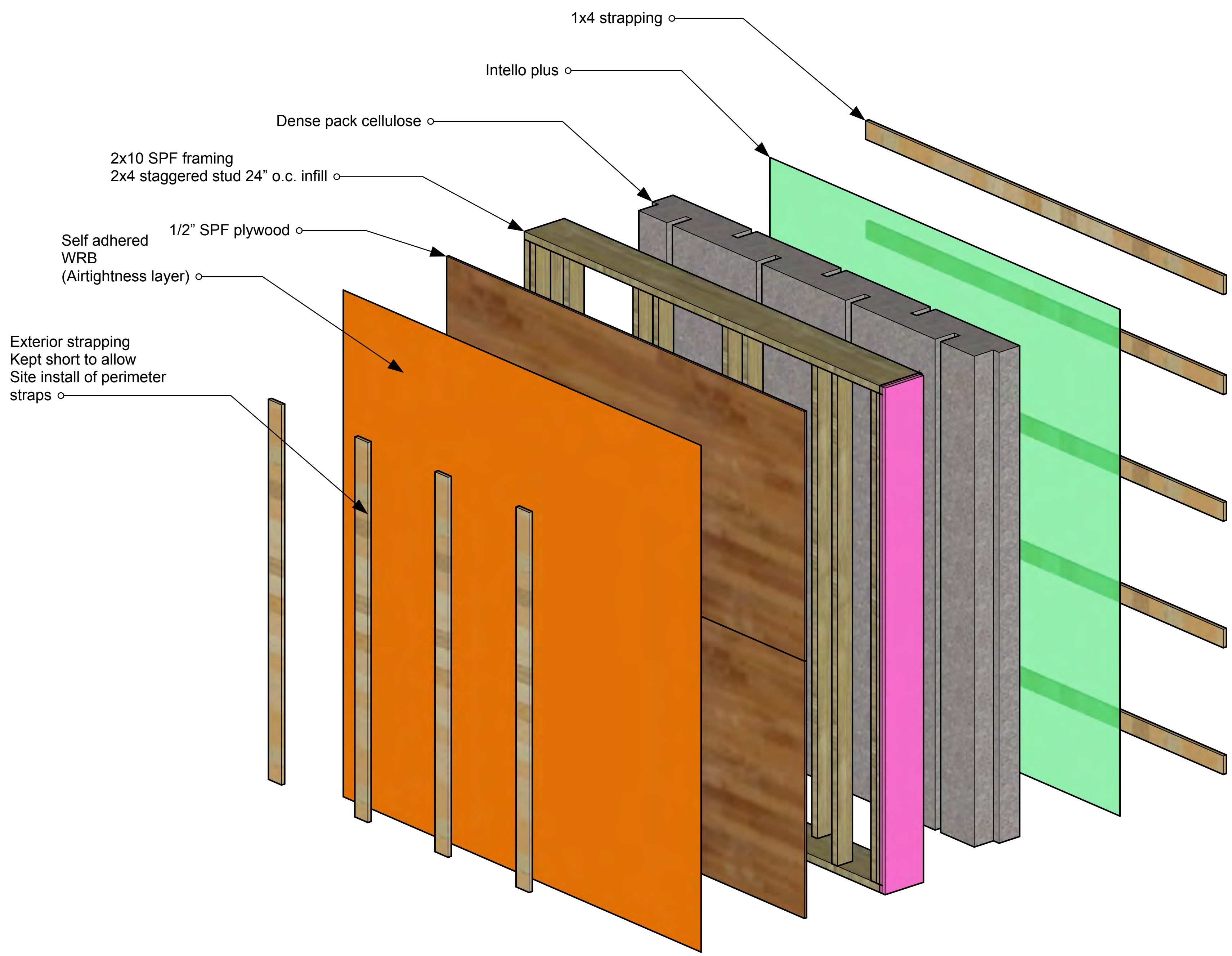
ReCover

Version Date
February 27, 2023

PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

Basic Panel - Exploded View



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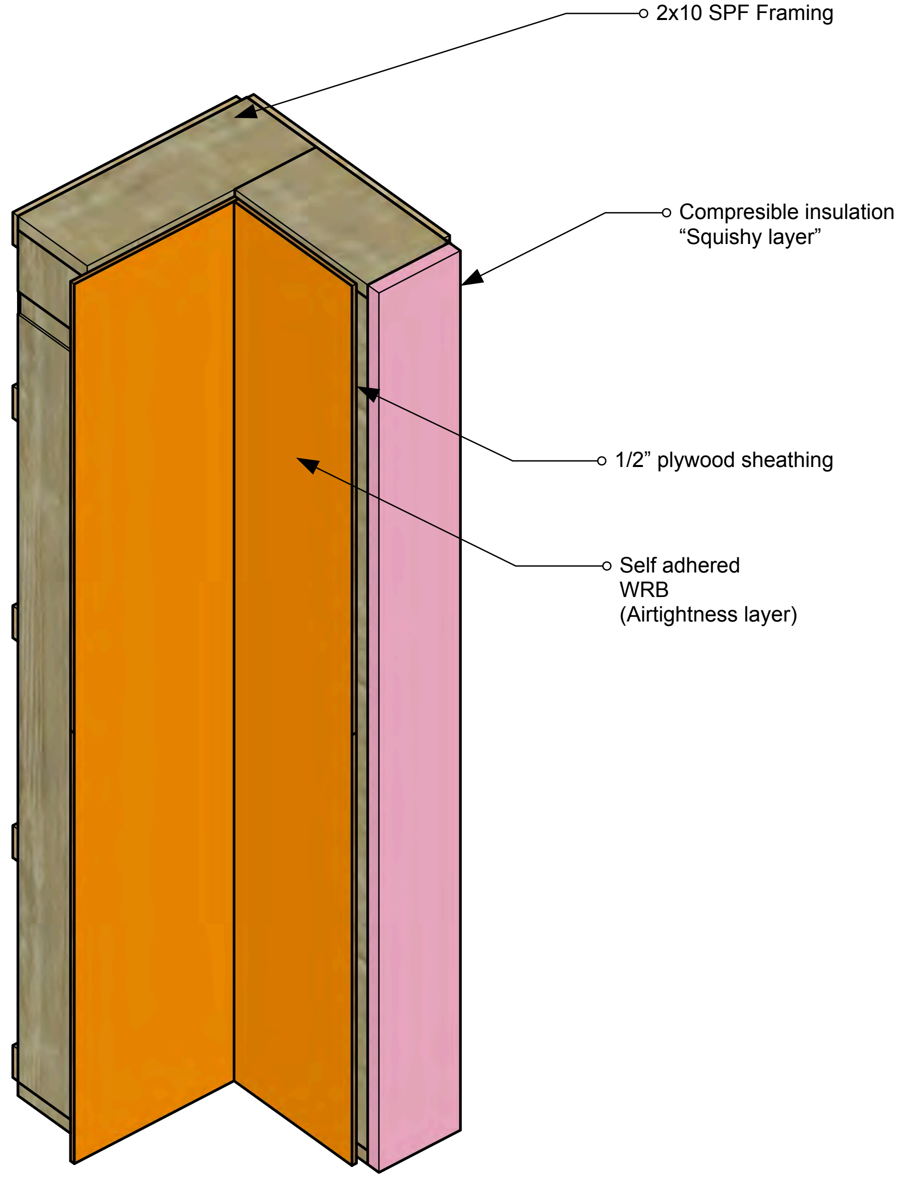
Version Date
February 27, 2023

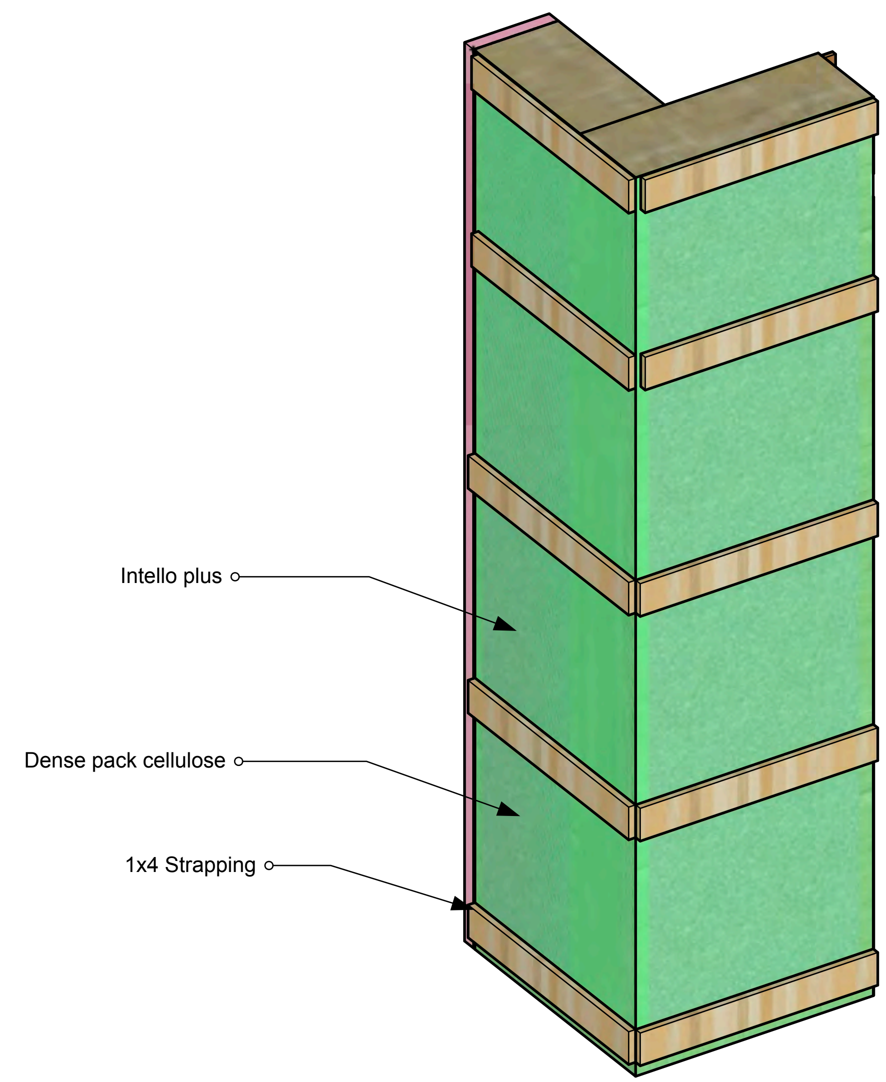
PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

Inside Corner Panel - Overview



EXTERIOR VIEW



INTERIOR VIEW

ReCover

Version Date
February 27, 2023

PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
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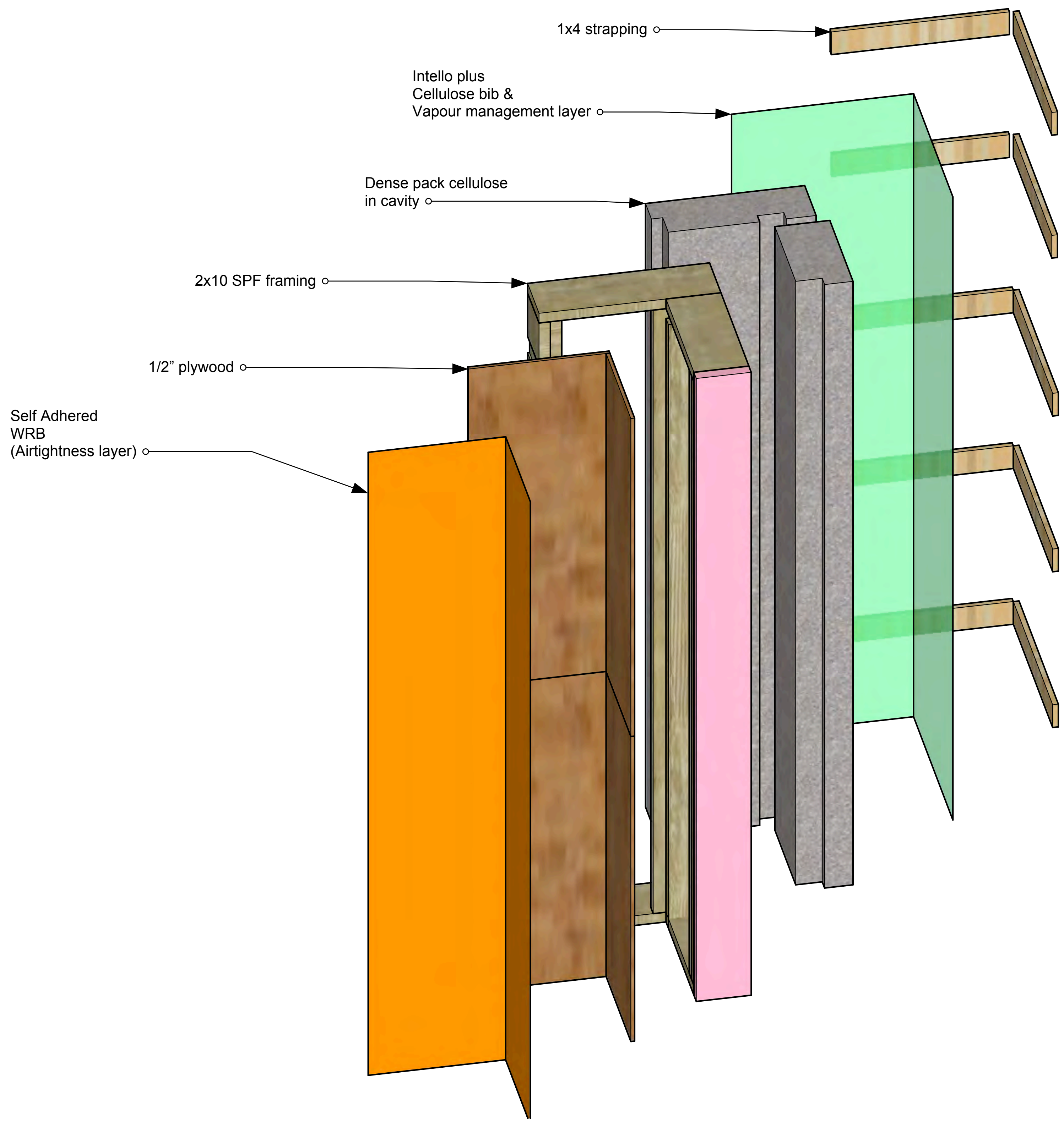
Inside Corner Panel - Exploded View



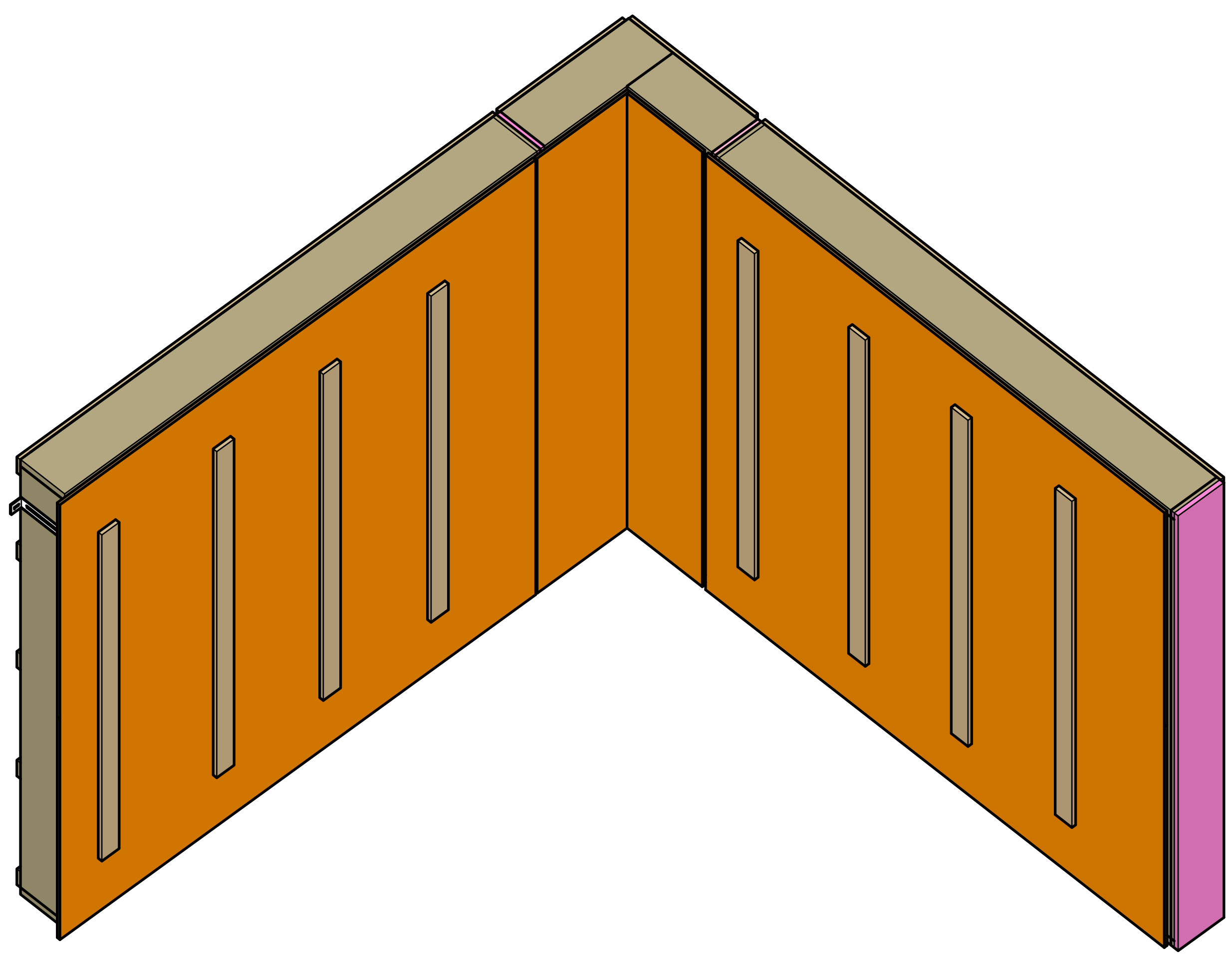
ReCover

Version Date
February 27, 2023

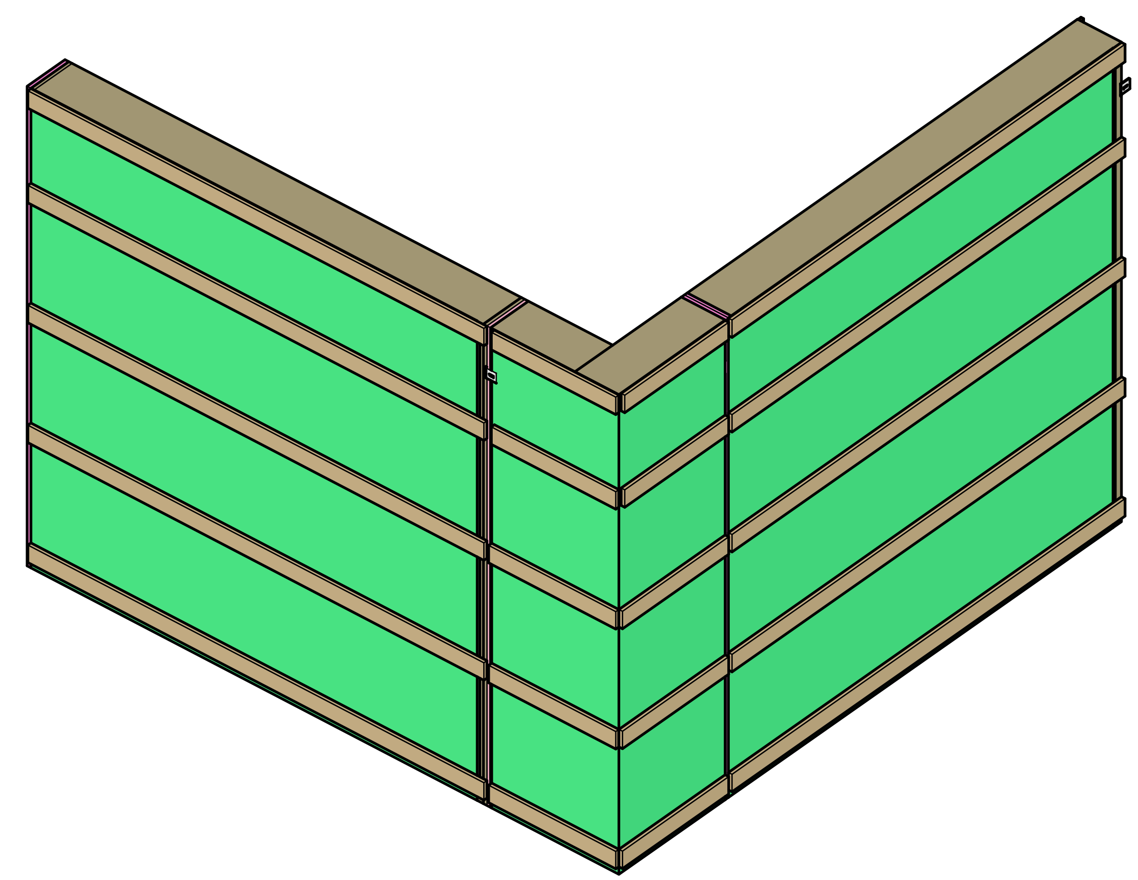
PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

Inside Corner Installed



EXTERIOR VIEW



INTERIOR VIEW

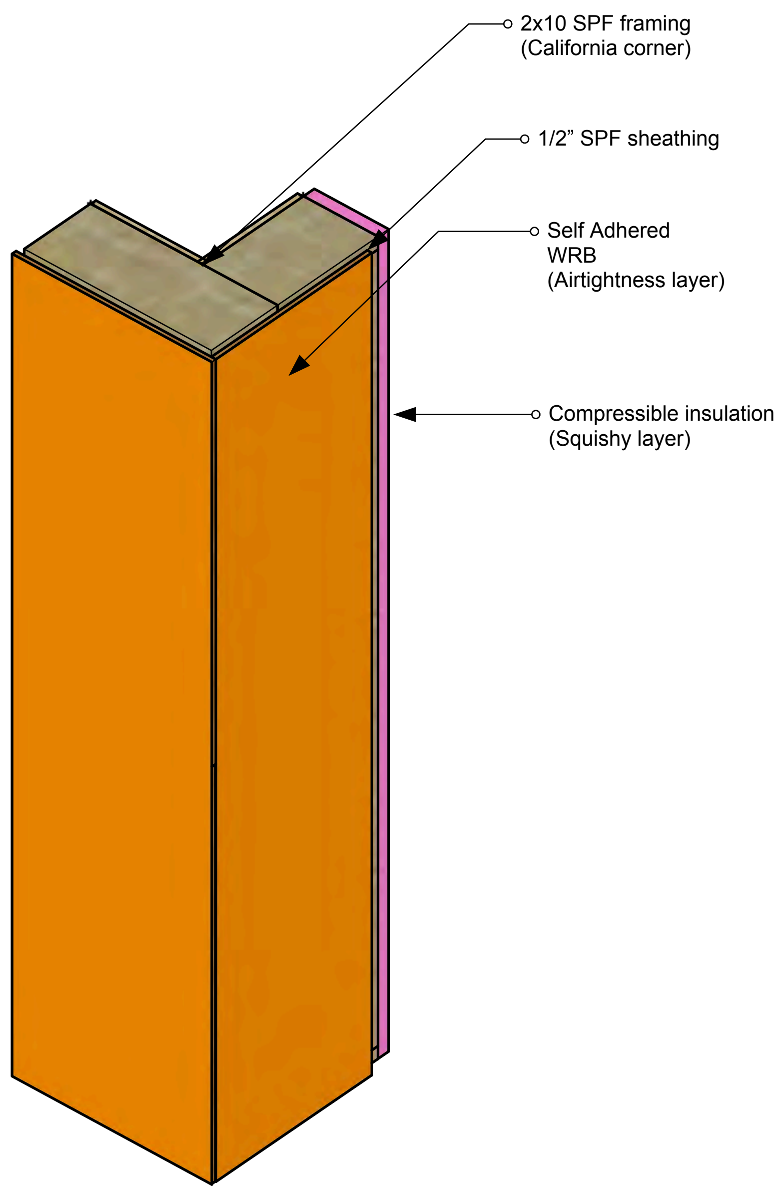
ReCover

Version Date
February 27, 2023

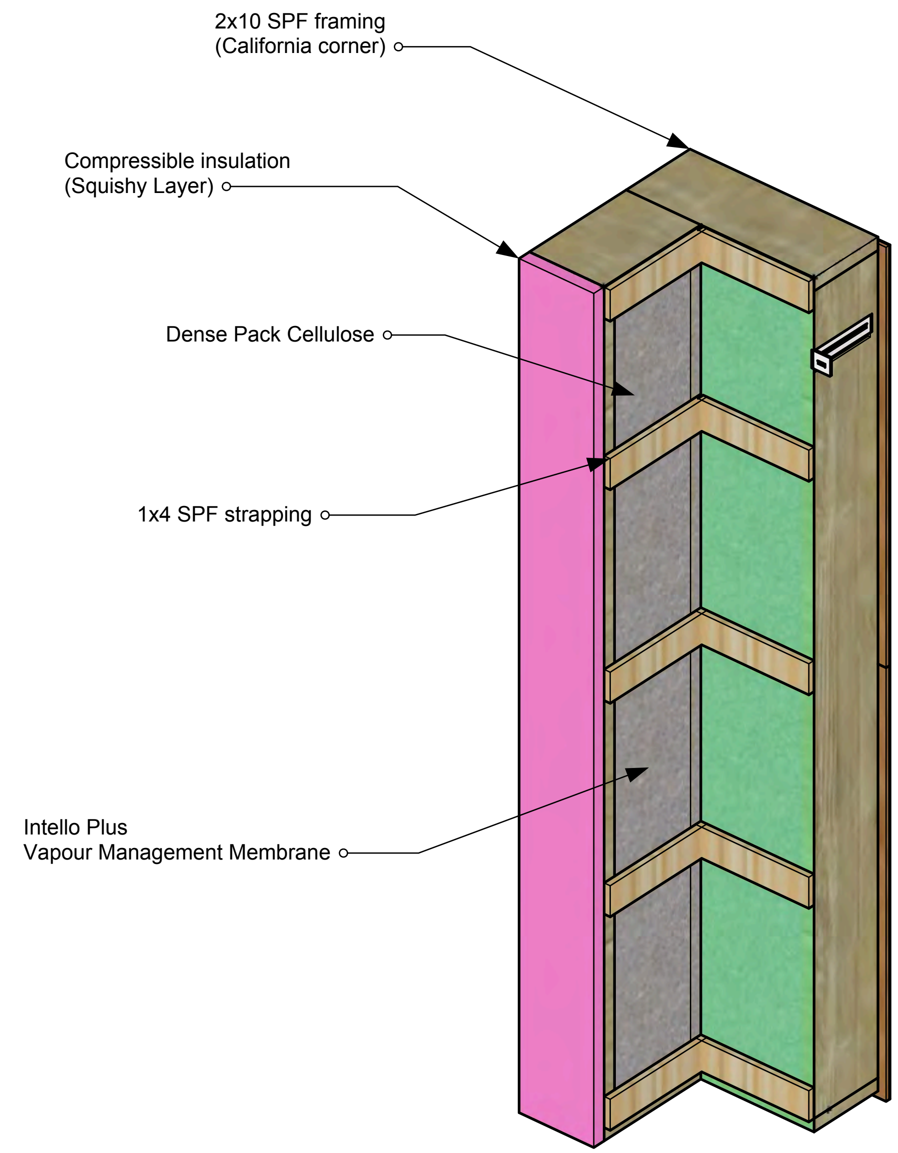
PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

Outside Corner Panel - Overview



EXTERIOR VIEW



INTERIOR VIEW

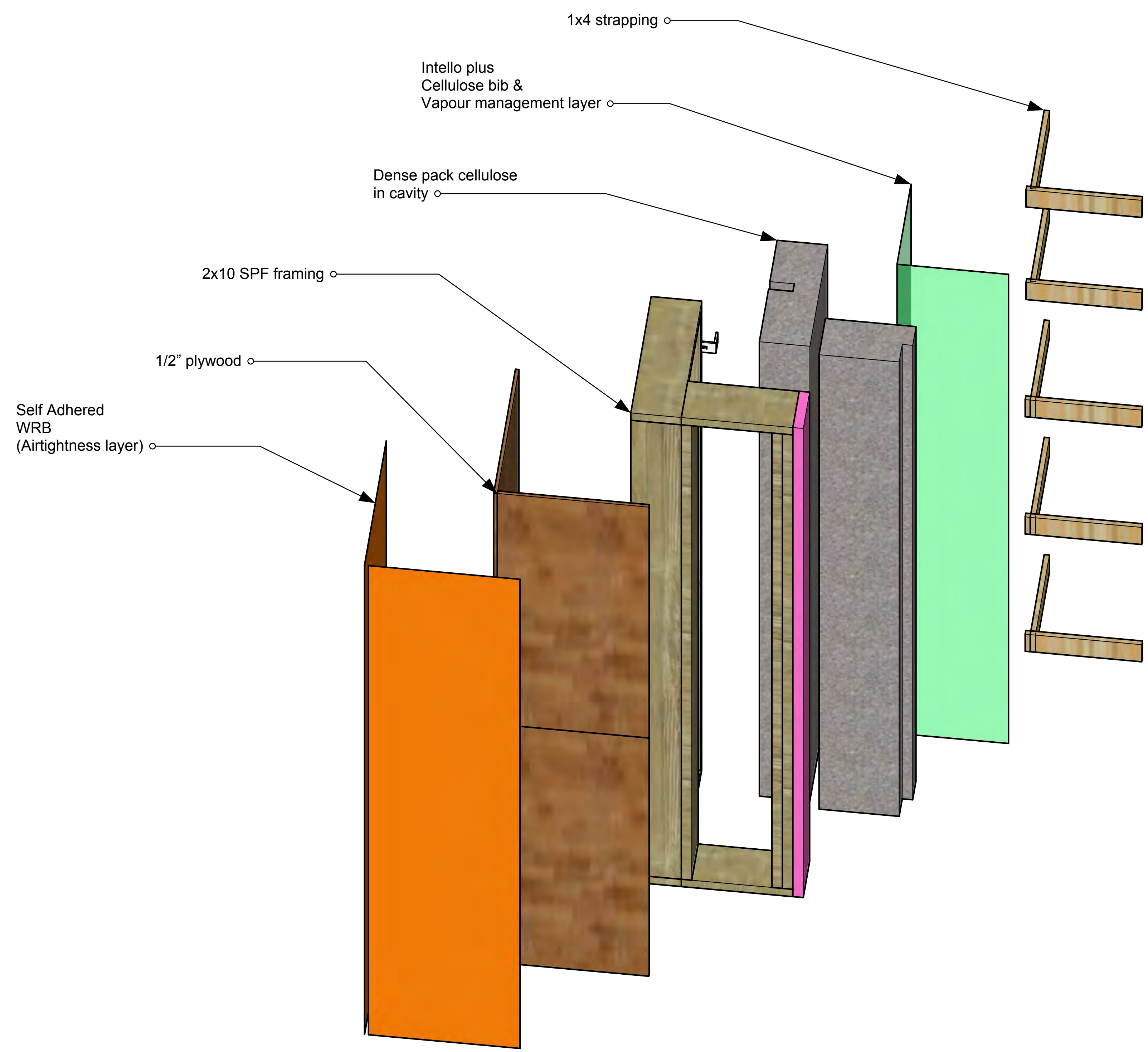
ReCover

Version Date
February 27, 2023

PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

Outside Corner Panel - Exploded View



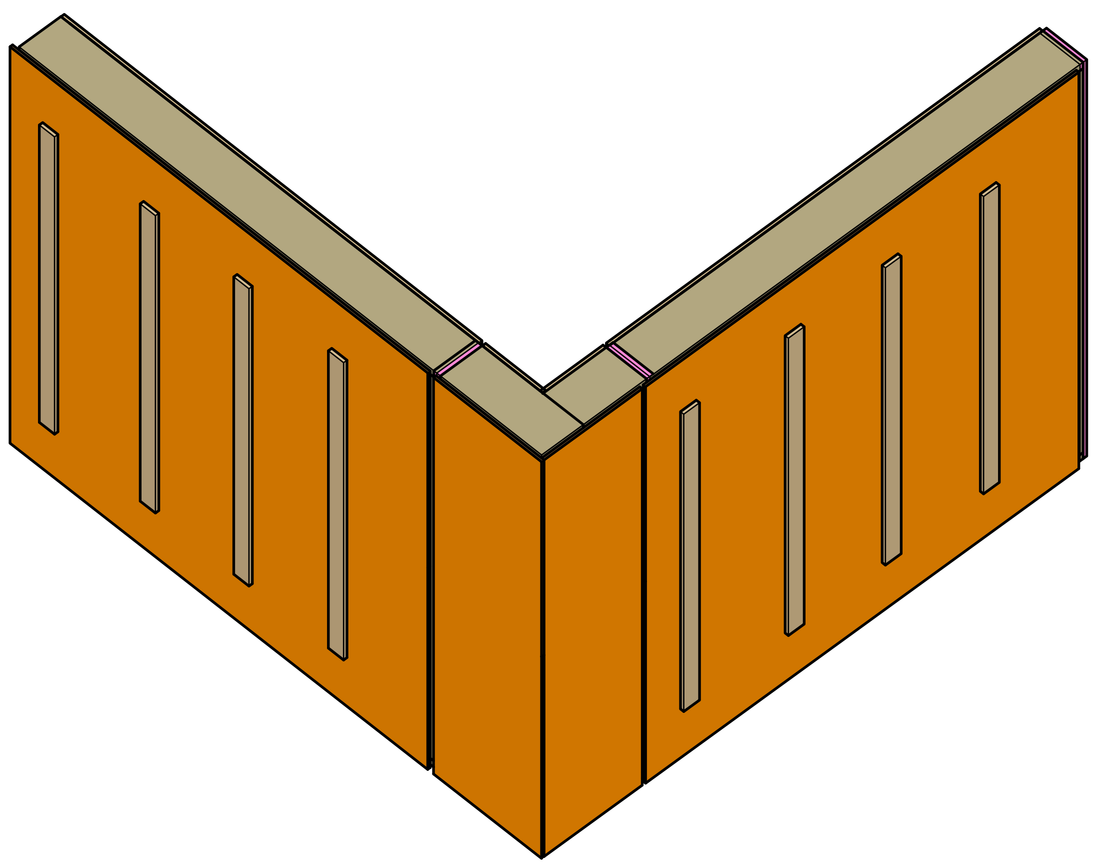
ReCover

Version Date
February 27, 2023

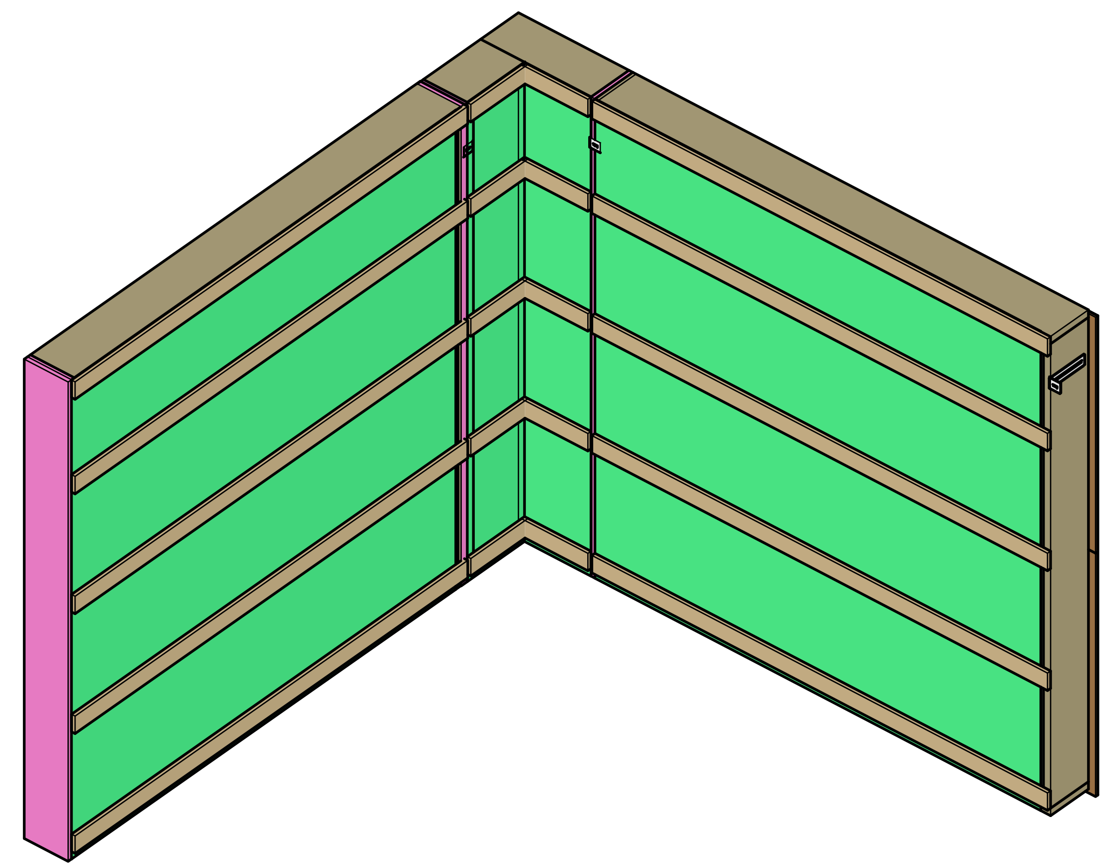
PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

Outside Corner Installed



EXTERIOR VIEW

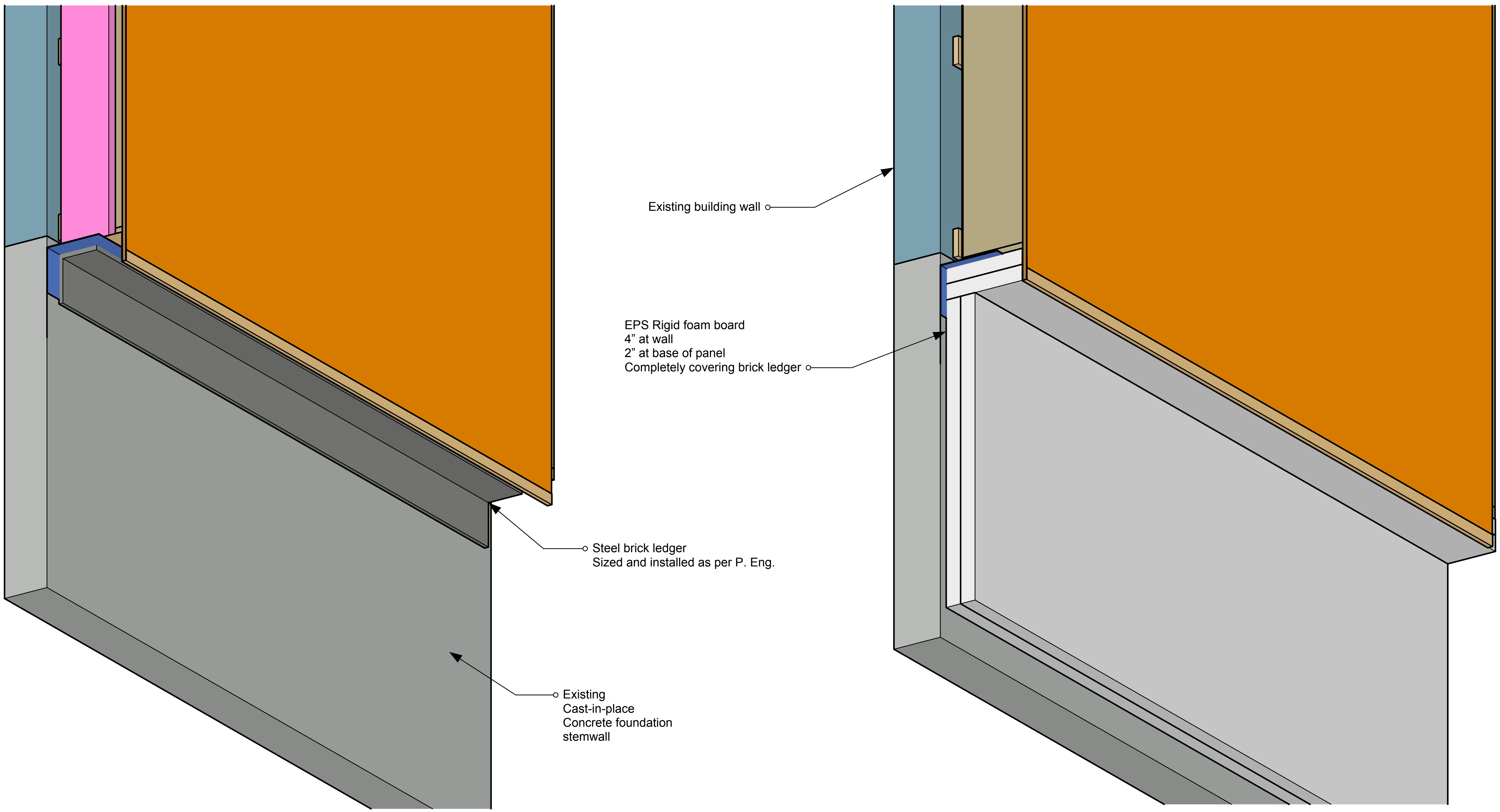


INTERIOR VIEW

ReCover
Version Date
February 27, 2023
PROJECT
2x10 R28 Cellulose
Panel Schematics
Drawn By
Nick Rudnicki

Foundation Attachment - Brick Ledger

"Brick Ledger" style continuous ledger for panel support



BEFORE SITE INSULATION

AFTER SITE INSULATION

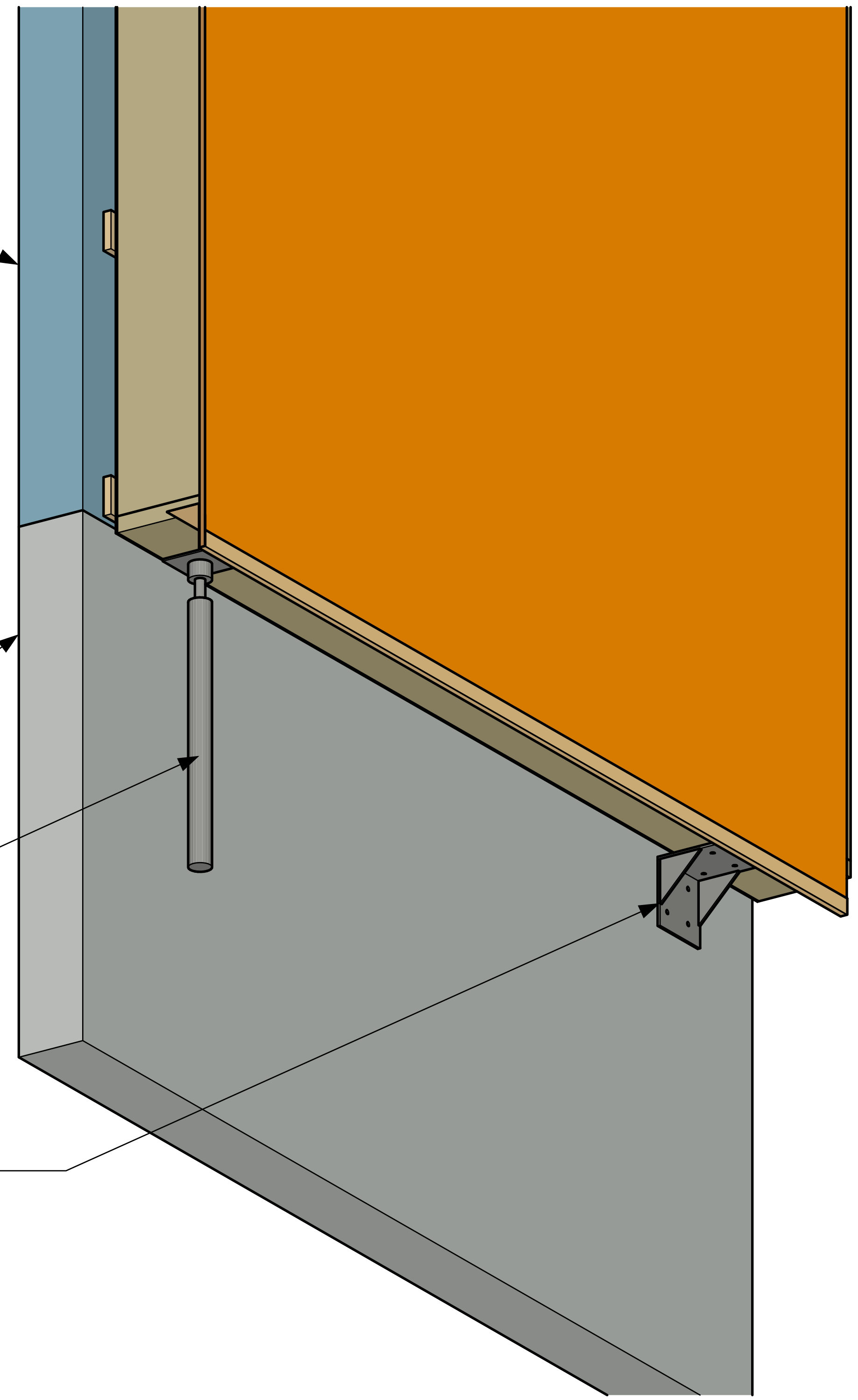
ReCover

Version Date
February 27, 2023

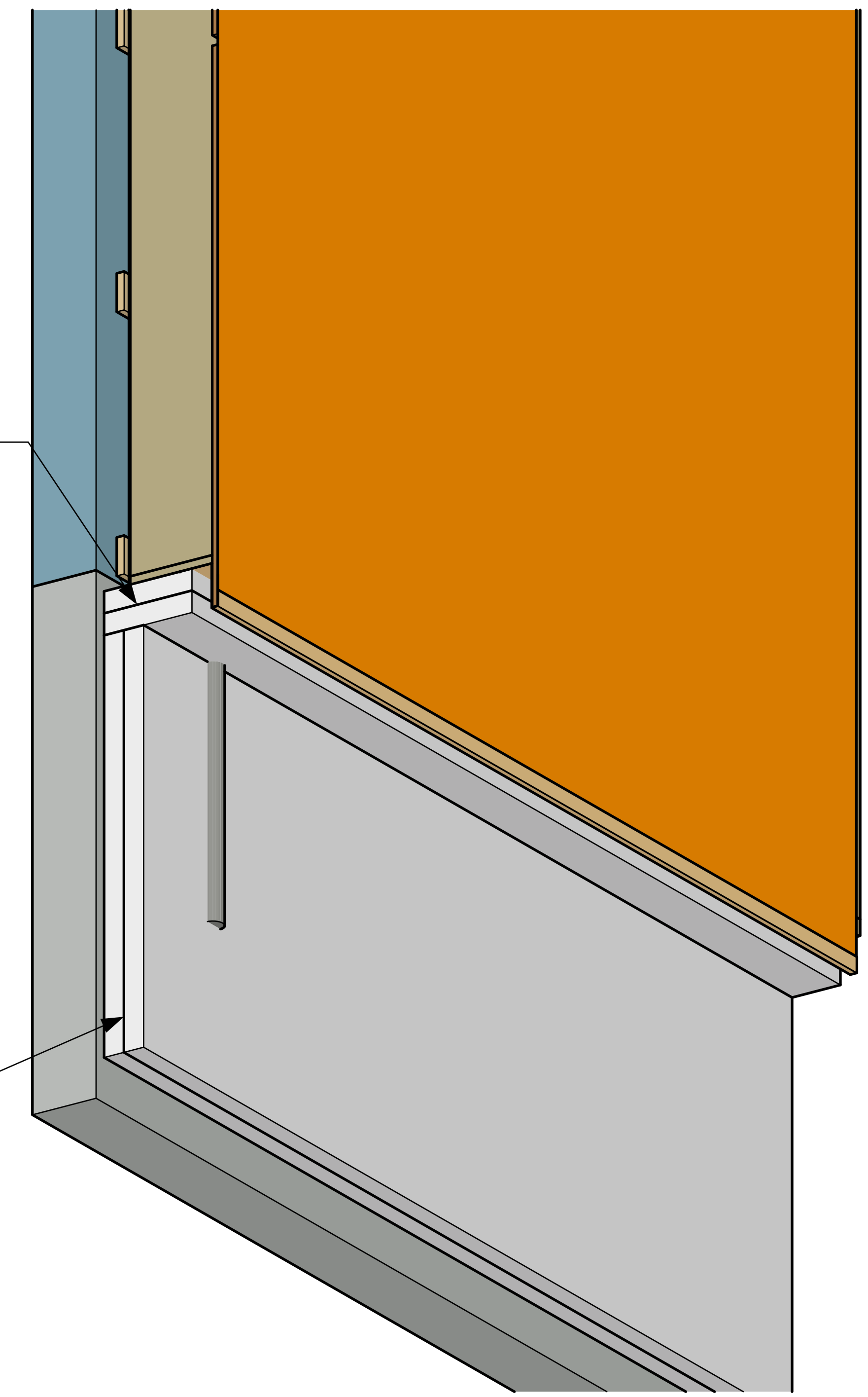
PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

Alternate Foundation Attachment - Pile or Bracket



BEFORE SITE INSULATION



AFTER SITE INSULATION

ReCover

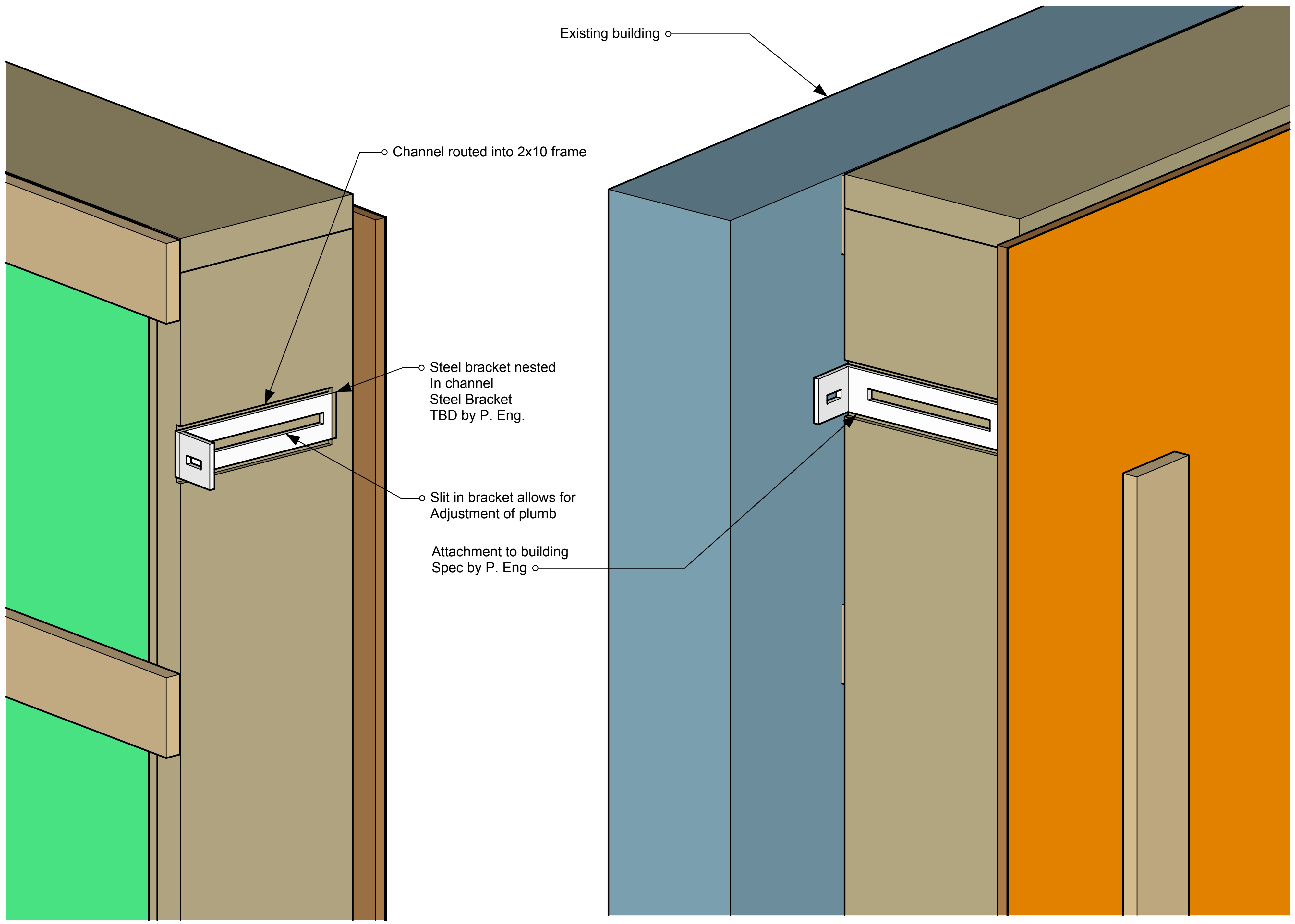
Version Date
February 27, 2023

PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

Attach to Existing Building

Bracket to attach individual panels to existing



INTERIOR VIEW **EXTERIOR VIEW**

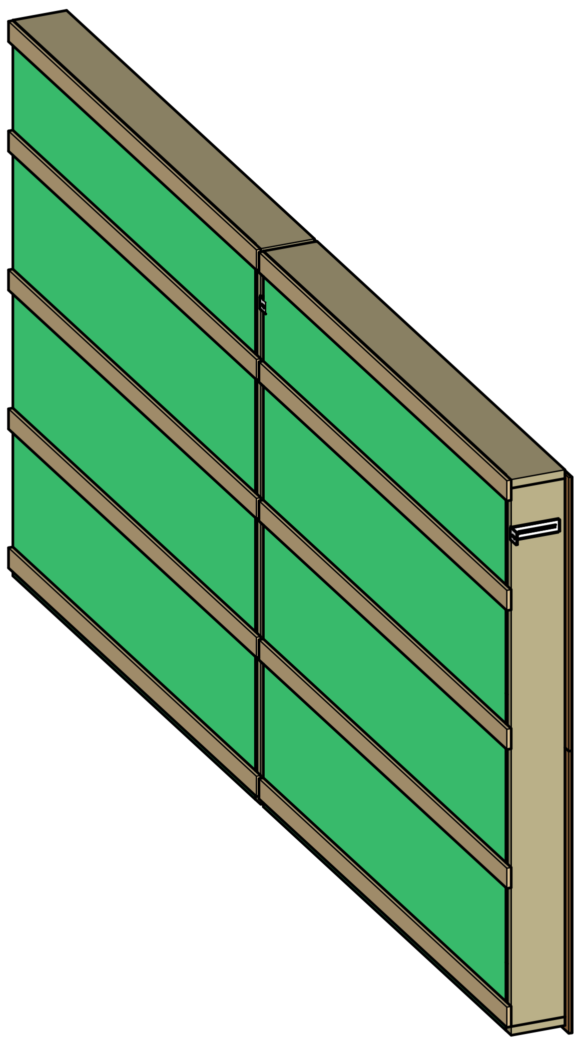
ReCover

Version Date
February 27, 2023

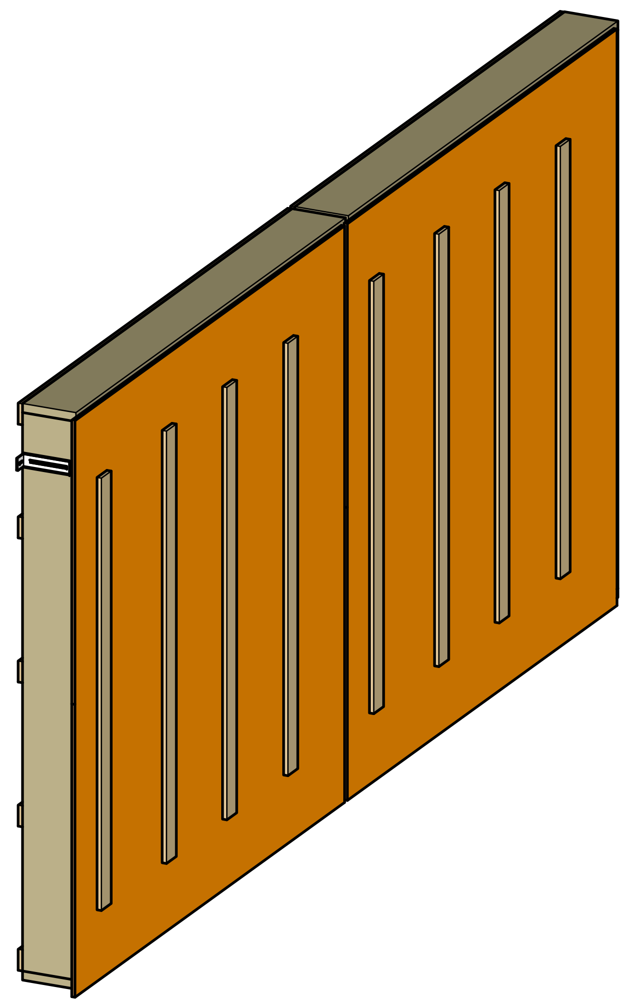
PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

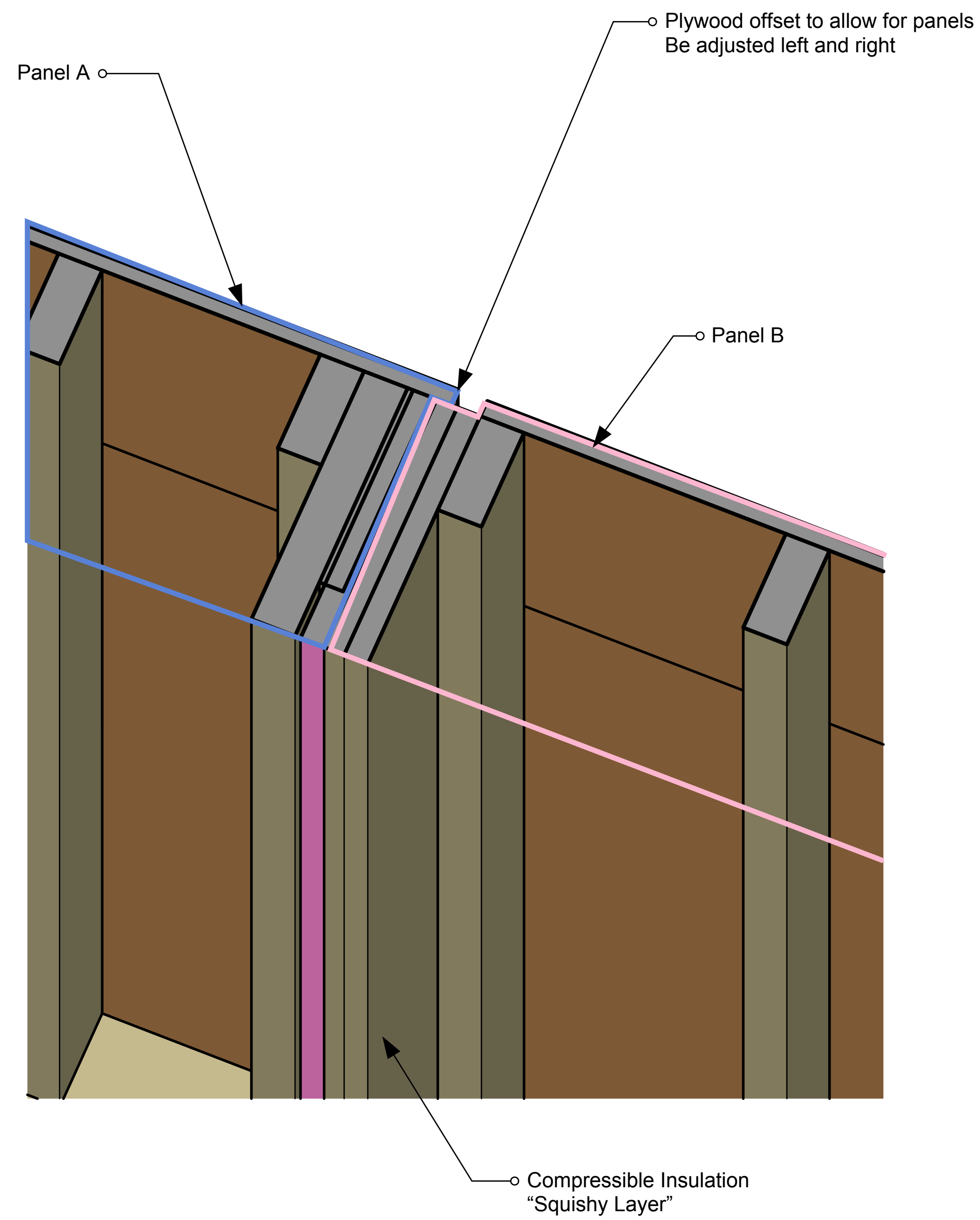
Vertical Wall Joints



INTERIOR VIEW



EXTERIOR VIEW



SECTION VIEW

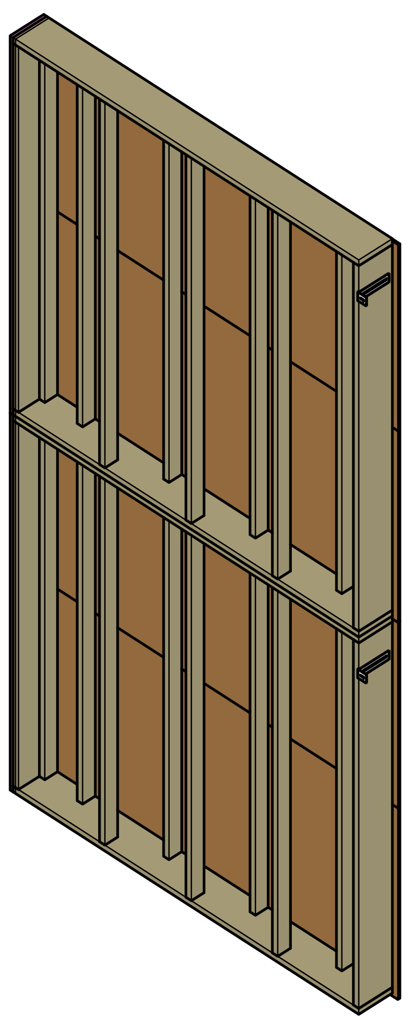
ReCover

Version Date
February 27, 2023

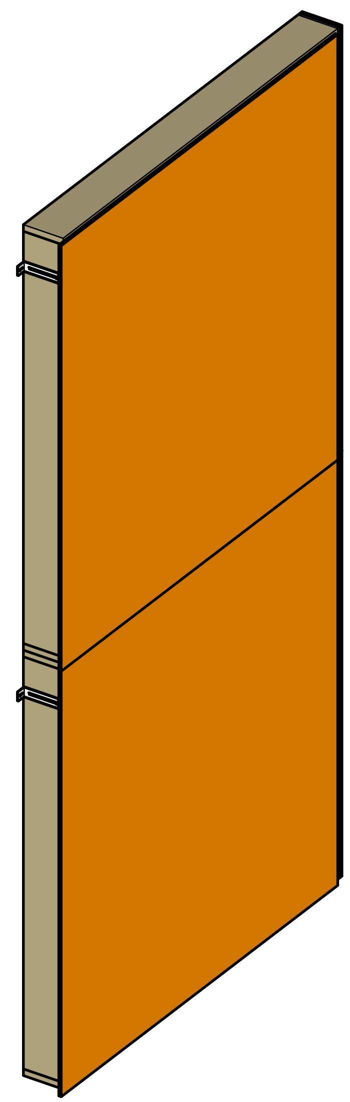
PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

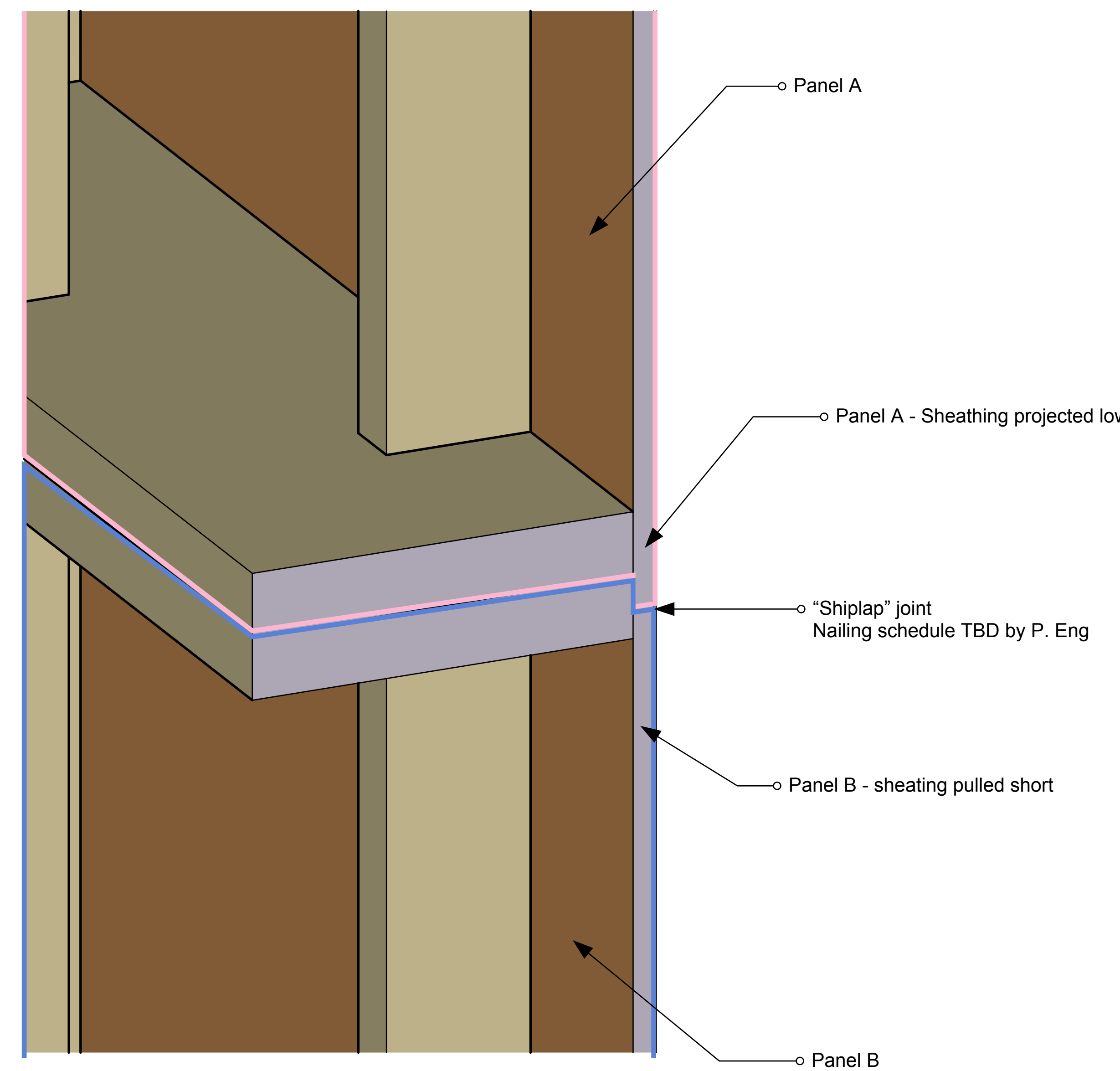
Horizontal Wall Joins



INTERIOR VIEW



EXTERIOR VIEW



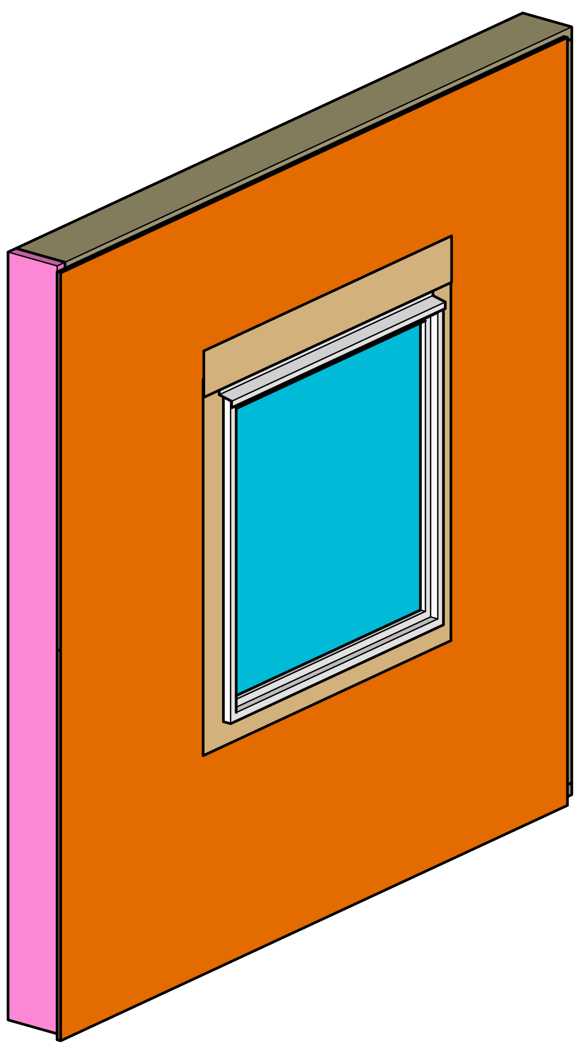
SECTION VIEW

Version Date
February 27, 2023

PROJECT
2x10 R28 Cellulose
Panel Schematics

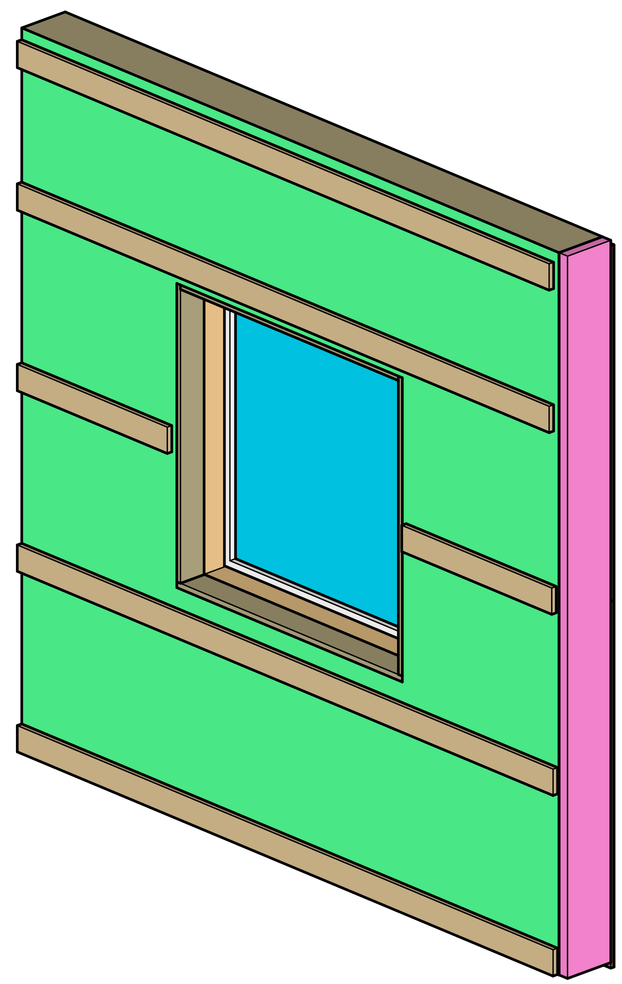
Drawn By
Nick Rudnicki

Window Panel

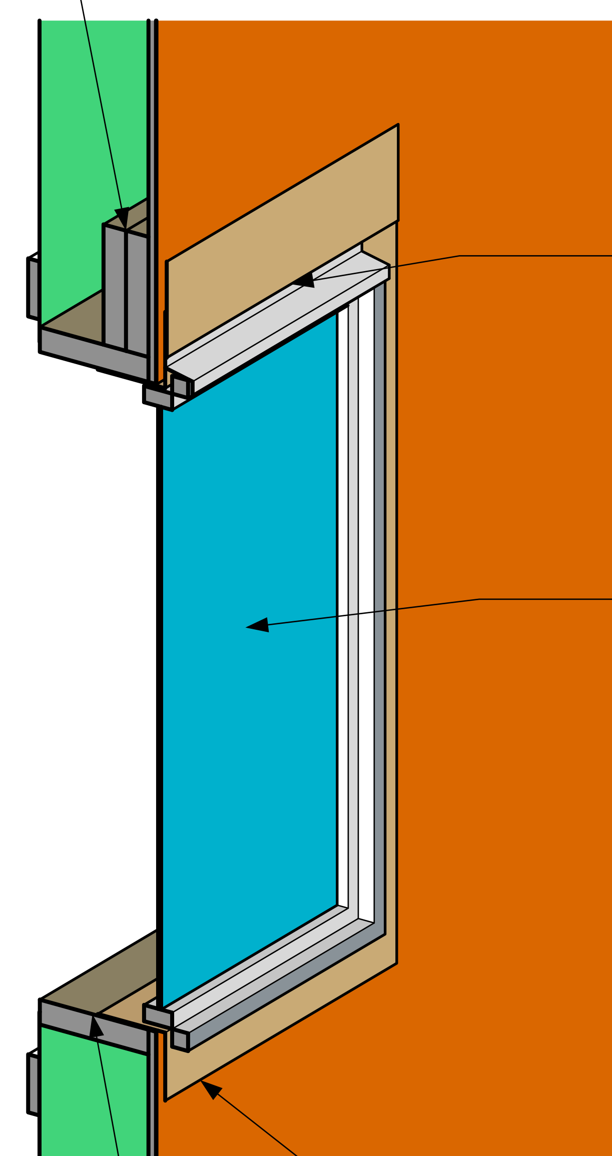


PANEL
EXTERIOR VIEW

Window installed in factory
Window installed as an "outie" to minimize how much window sill there is exposed to the rain



PANEL
EXTERIOR VIEW



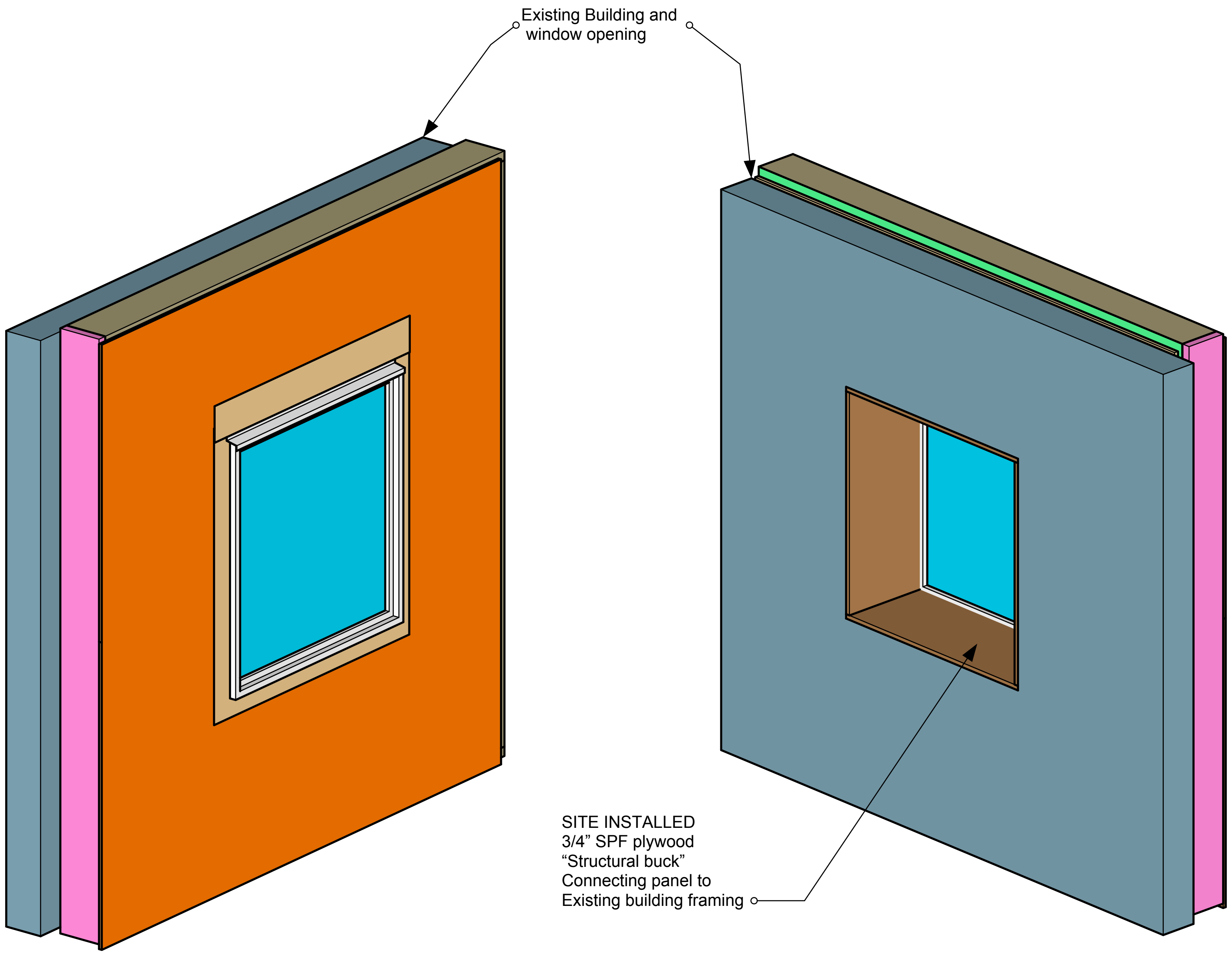
ReCover

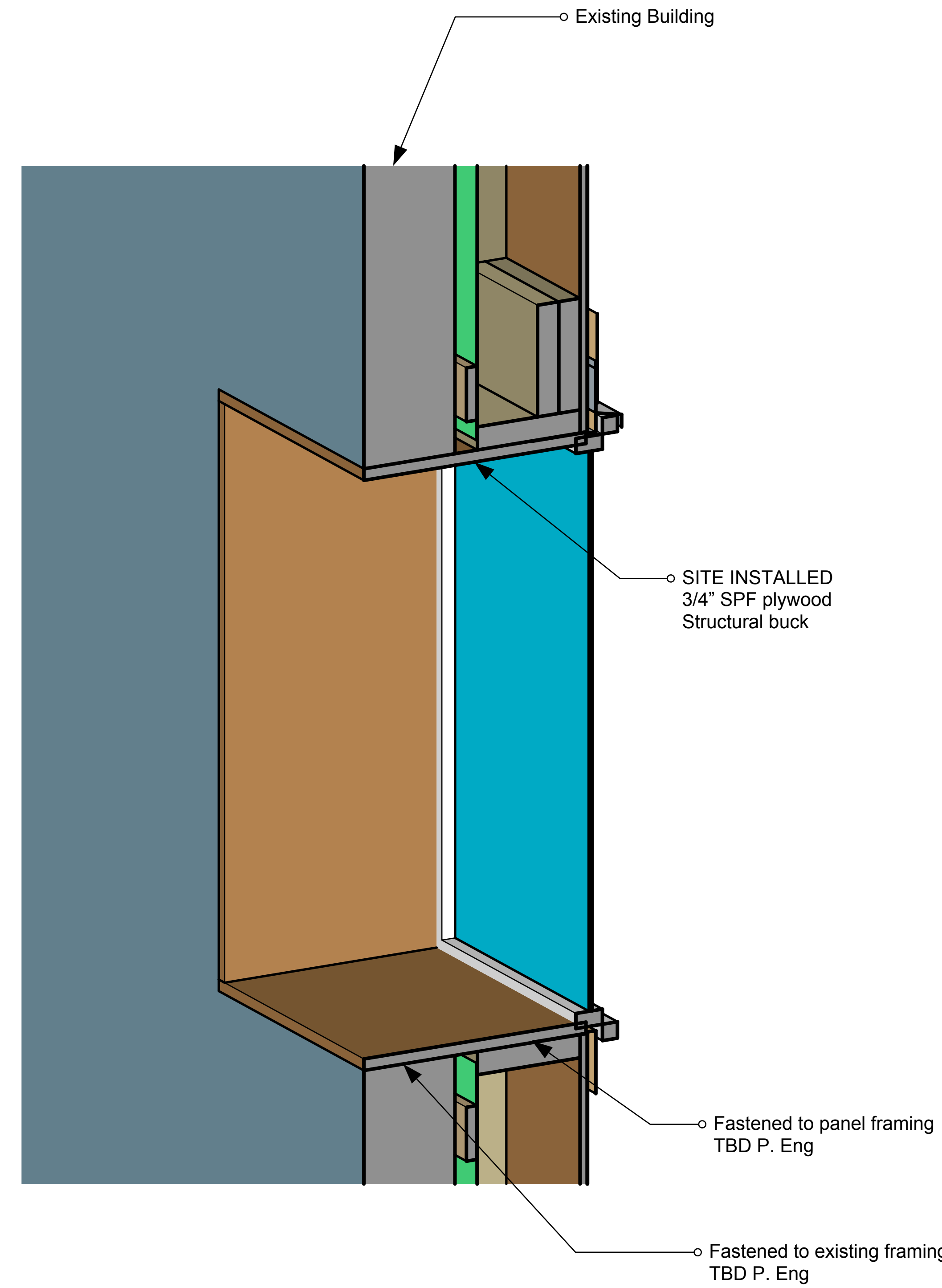
Version Date
February 27, 2023

PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

Window Panel Install



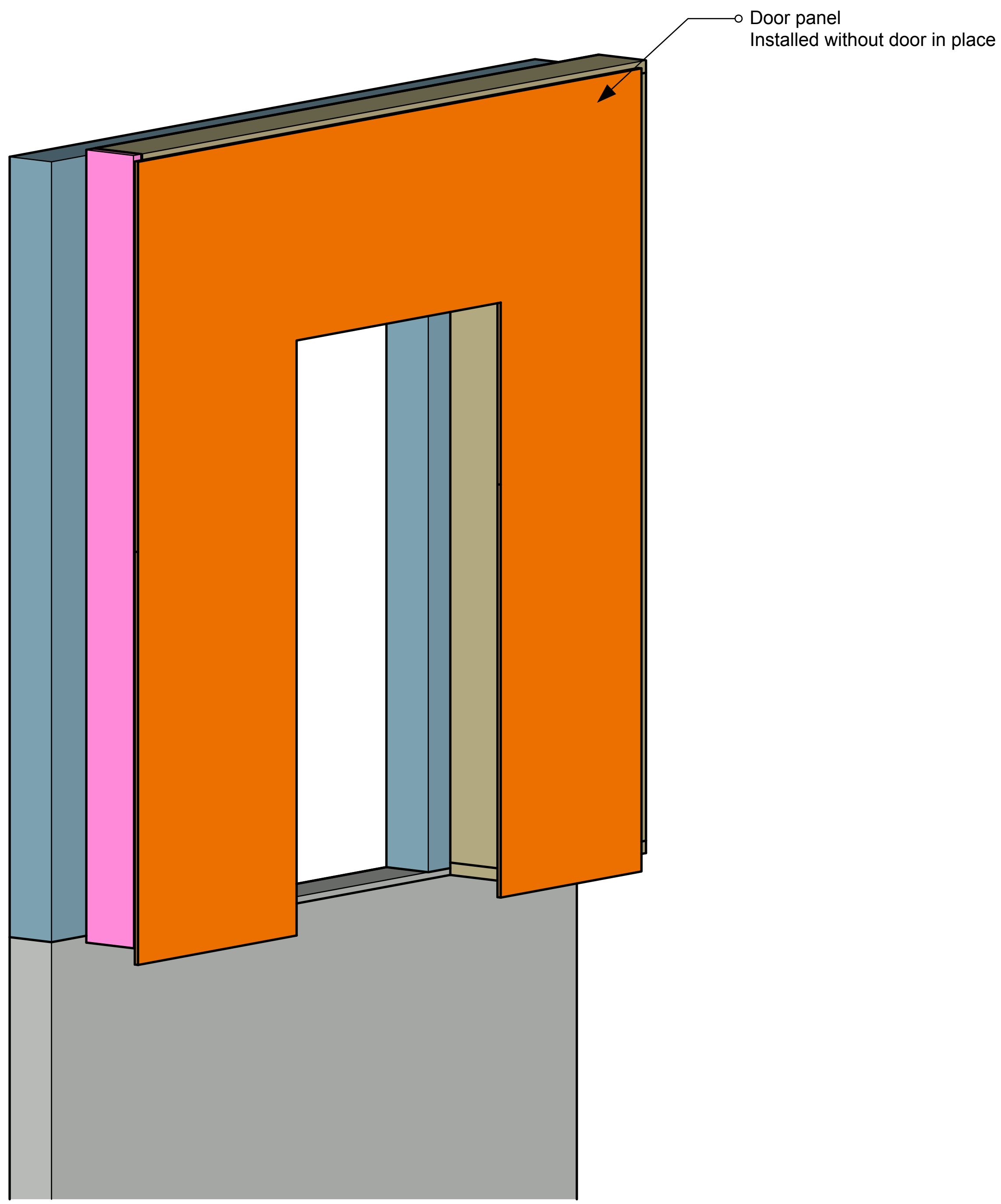


Version Date
February 27, 2023

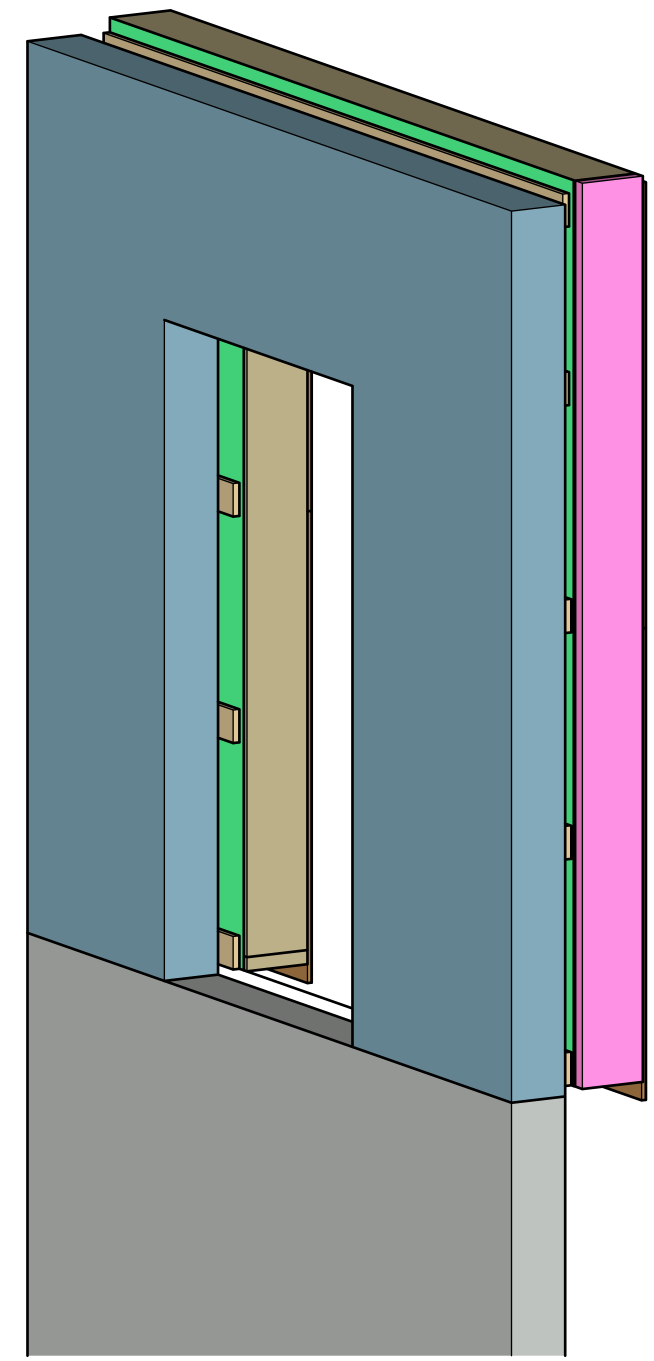
PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

Door Penetration Panel



EXTERIOR VIEW



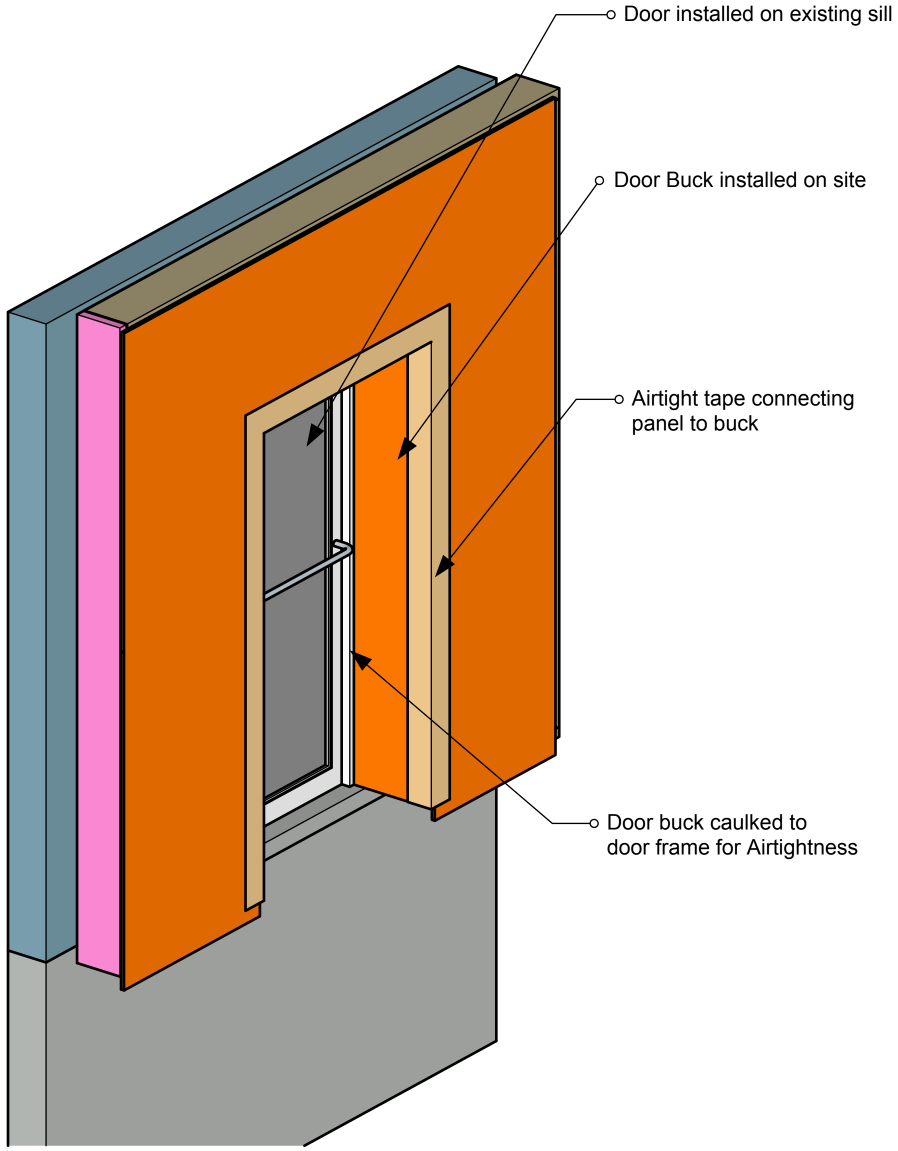
INTERIOR VIEW

Version Date
February 27, 2023

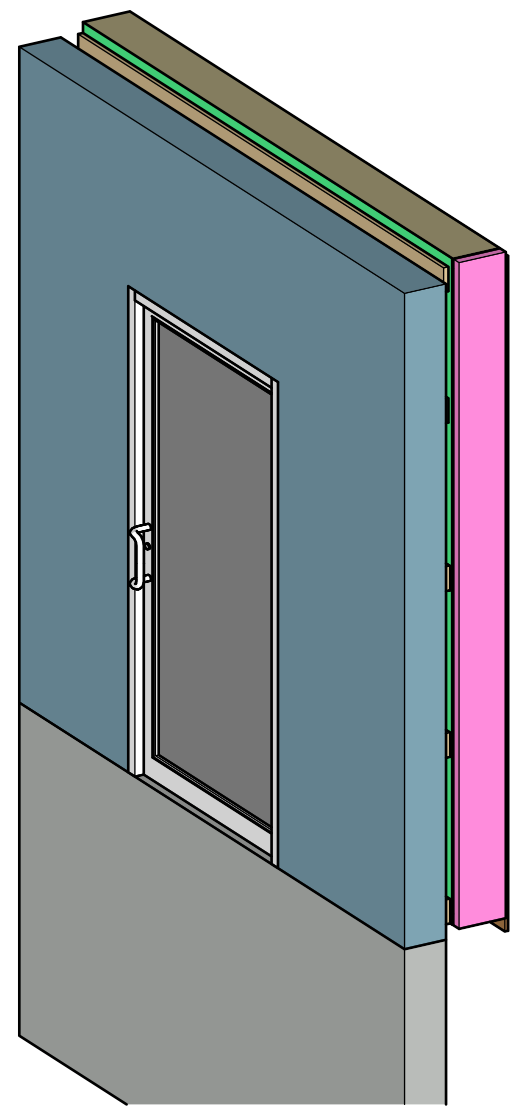
PROJECT
2x10 R28 Cellulose
Panel Schematics

Drawn By
Nick Rudnicki

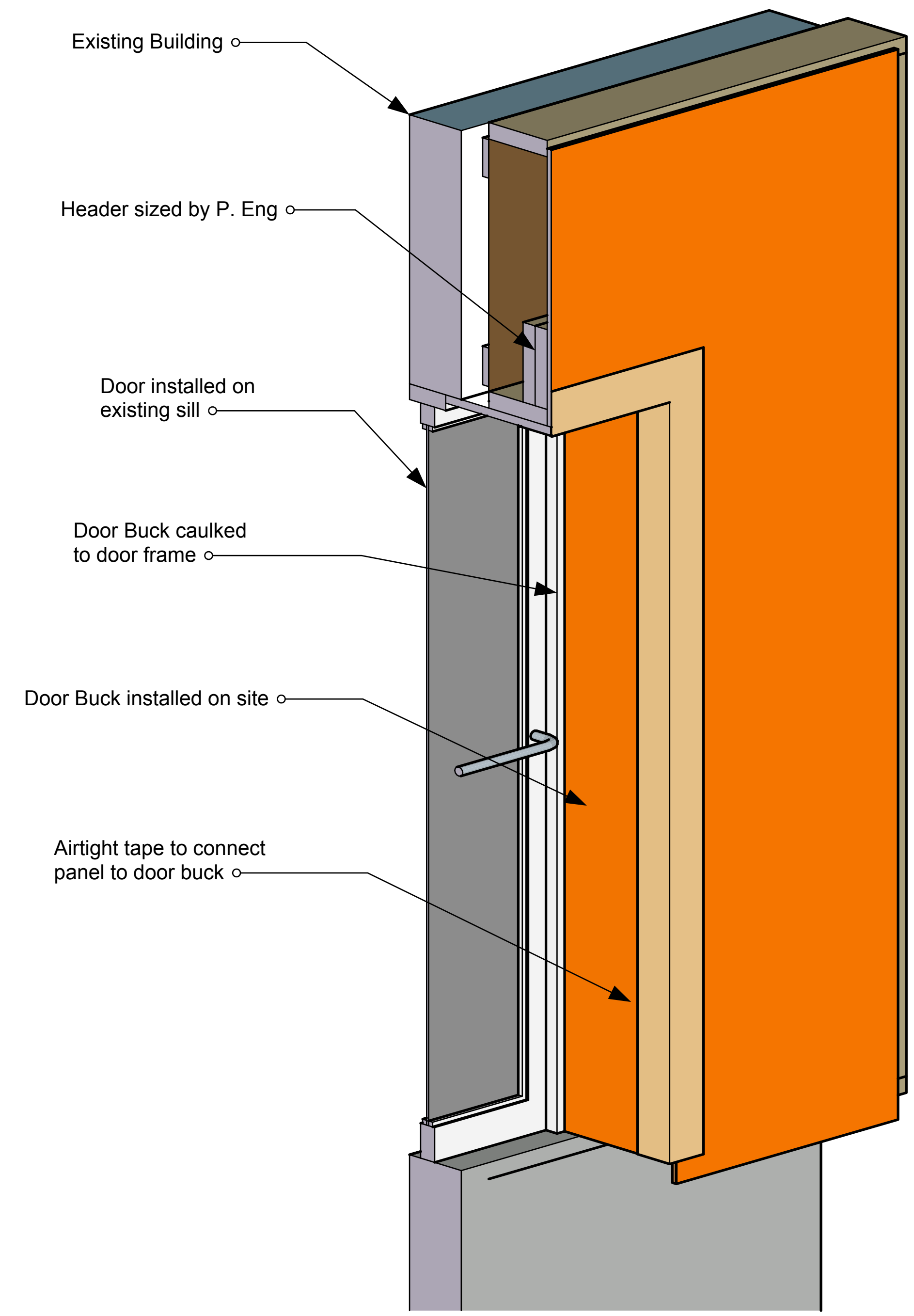
Door Penetration Panel Installed



EXTERIOR VIEW



INTERIOR VIEW



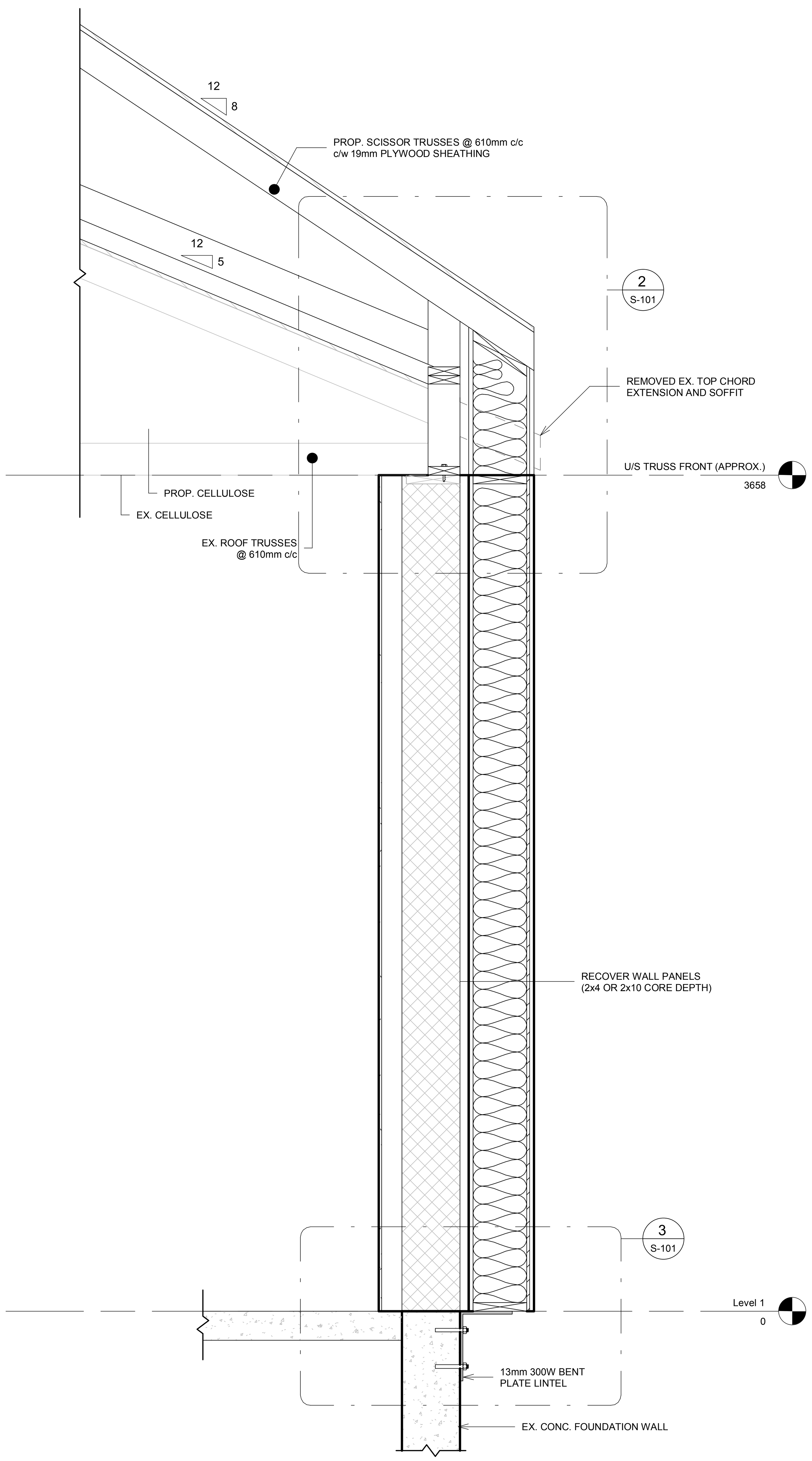
SECTION VIEW

ReCover

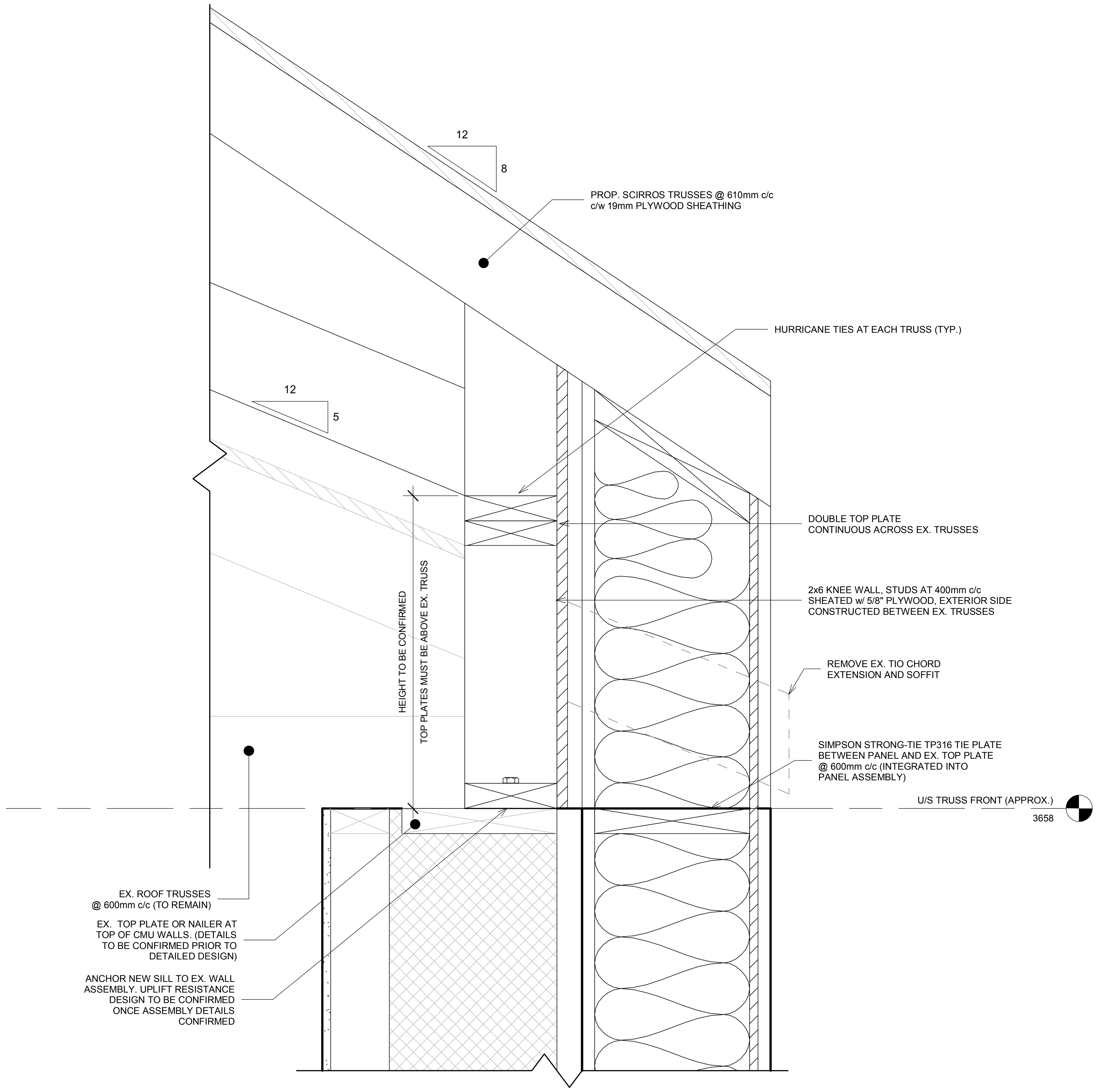
Version Date
February 27, 2023

PROJECT
2x10 R28 Cellulose Panel Schematics

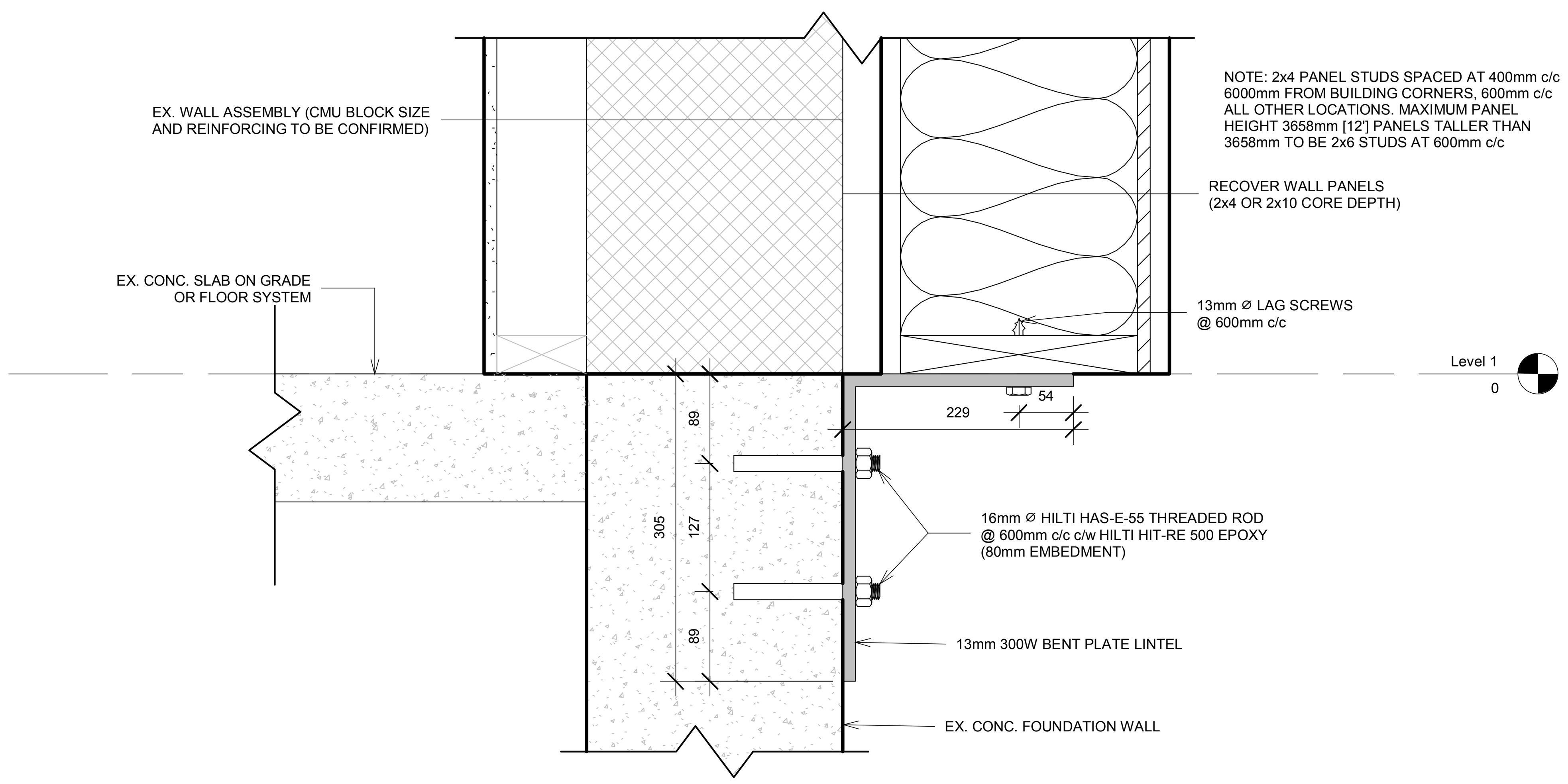
Drawn By
Nick Rudnicki



1
S-101
TYPICAL WALL SECTION
1 : 15



2
S-101
PANEL CONNECTION AT ROOF
1 : 5



3
S-101
FOUNDATION LINTEL
1 : 5

PRELIMINARY

ISSUE	DATE	DESCRIPTION
1	27-FEB-2023	ISSUED FOR REVIEW

CONSULTANT

DESIGNPOINT
engineering • surveying • solutions
902.832.5597
designpoint.ca

CLIENT

RECOVER INITIATIVE

PROJECT DESCRIPTION

HARRIETSFIELD WILLIAMSWOOD COMMUNITY CENTRE
HARRIETSFIELD, NOVA SCOTIA

SHEET DESCRIPTION

PANEL CONNECTION DETAILS

Drawn	Engineer	Project No.	Drawing No.
A. MCCRACKEN	E. TEASDALE	22-316	S-101
Scale	Filename		1 or 1
As indicated	22-316_Halifax.rvt		

Appendix I

Panel Layouts

Halifax Williamswood Community Centre Panelized Retrofit

Construction Plan

City of Halifax

ReCover

CLIENT
City of Halifax
111 Provost St
New Glasgow
NS, B2H 5E1

Version Date
February 26, 2023

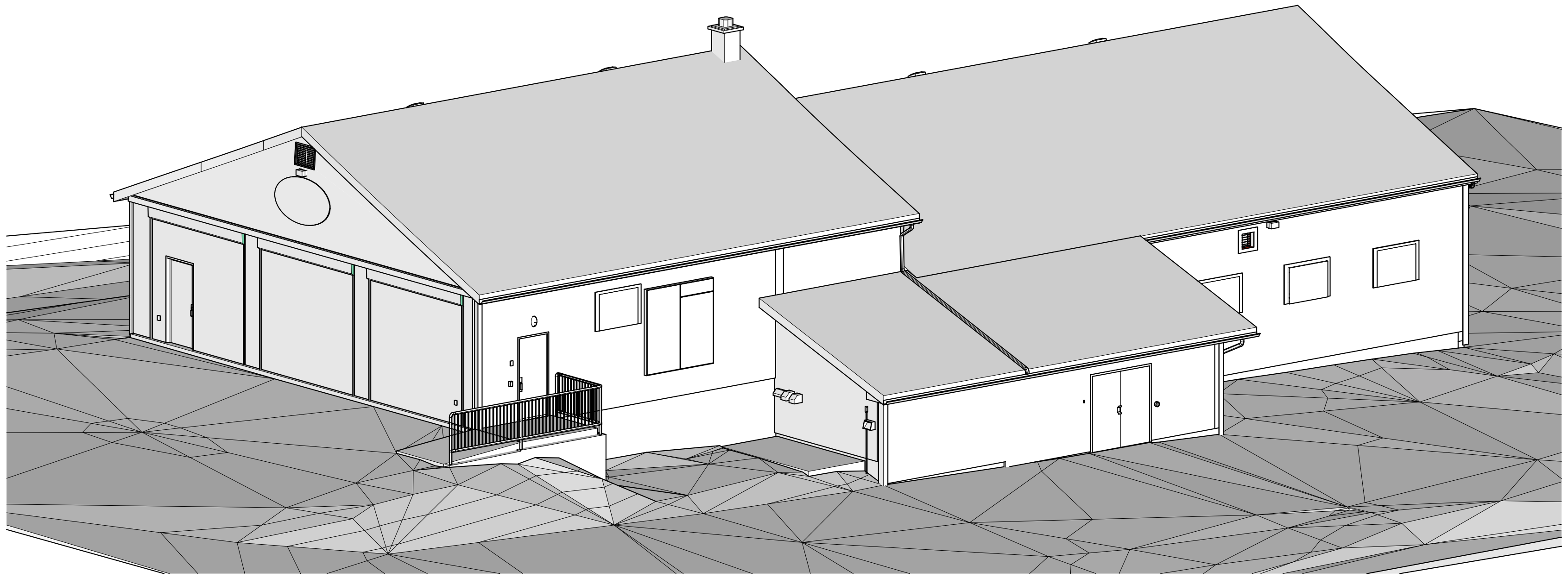
Project Address
1138 Old Sambro Road
Halifax
Nova Scotia

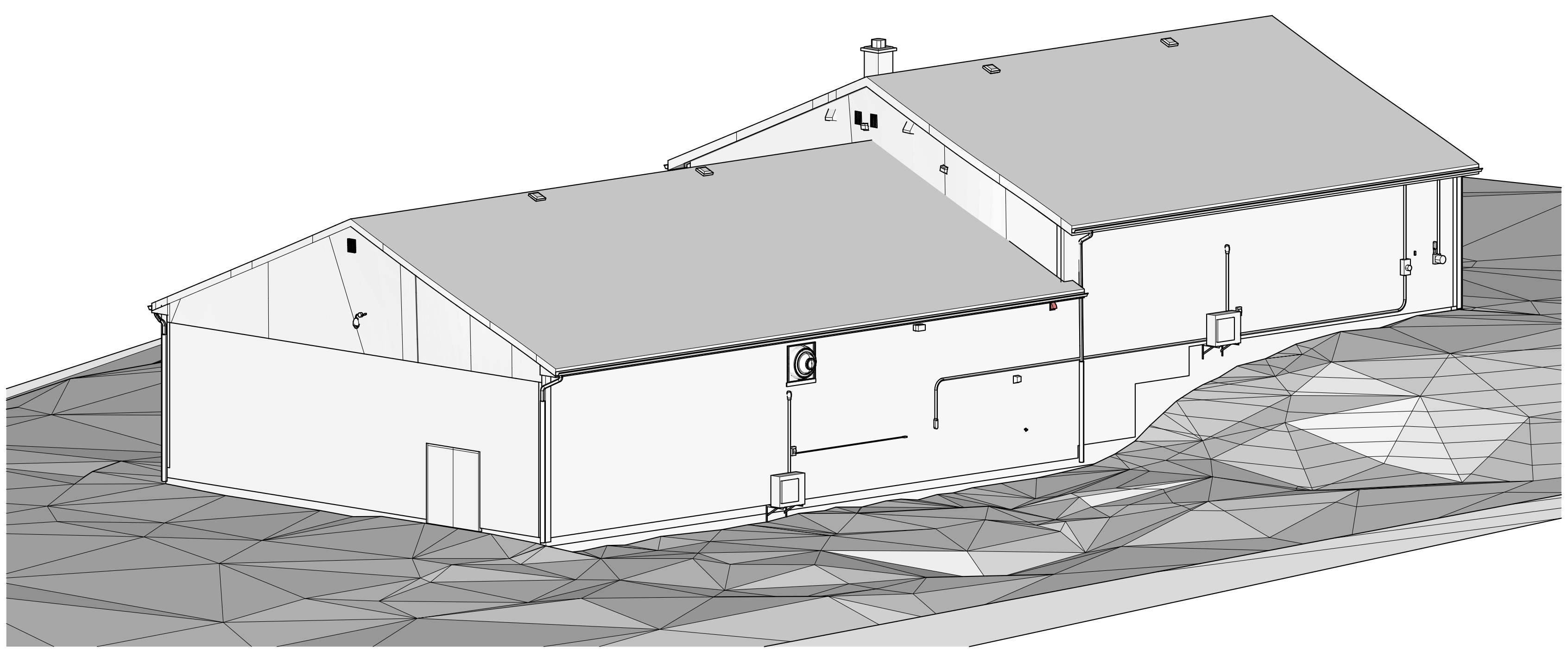
PROJECT
Panelized Retrofit

DRAWN BY
Nick Rudnicki

01

Existing Building





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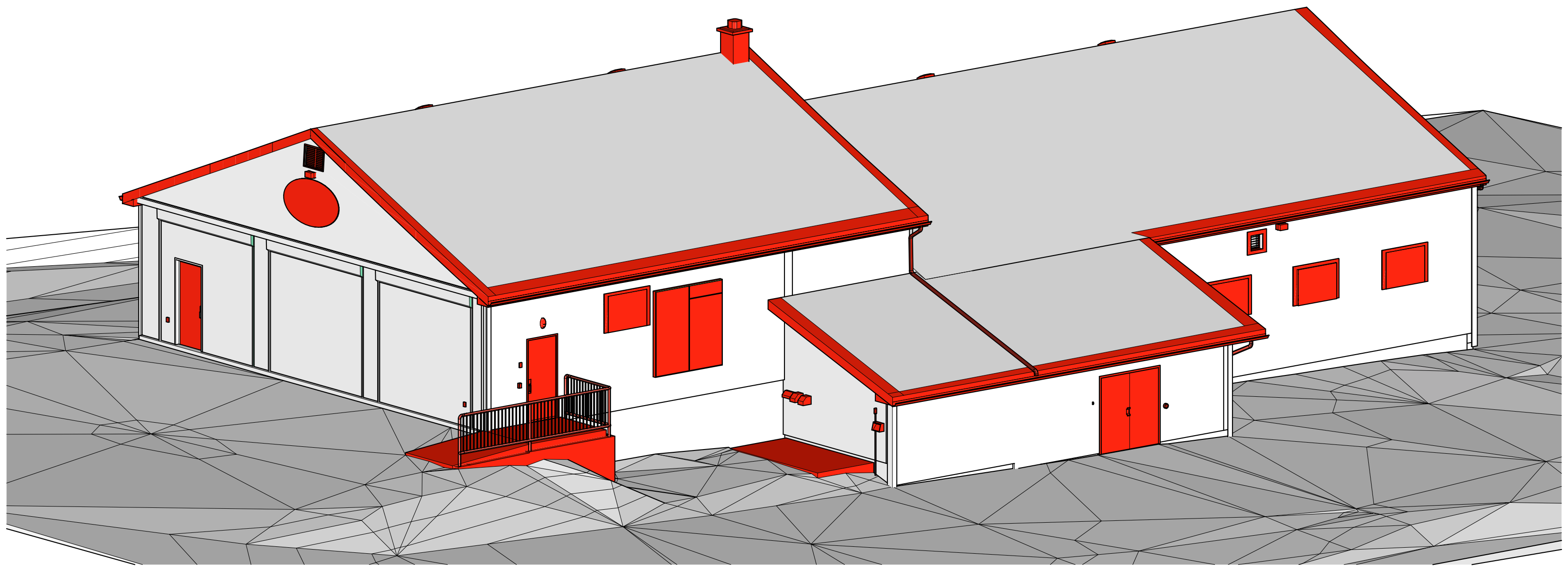
Halifax
Nova Scotia

PROJECT
Panelized Retrofit

DRAWN BY
Nick Rudnicki

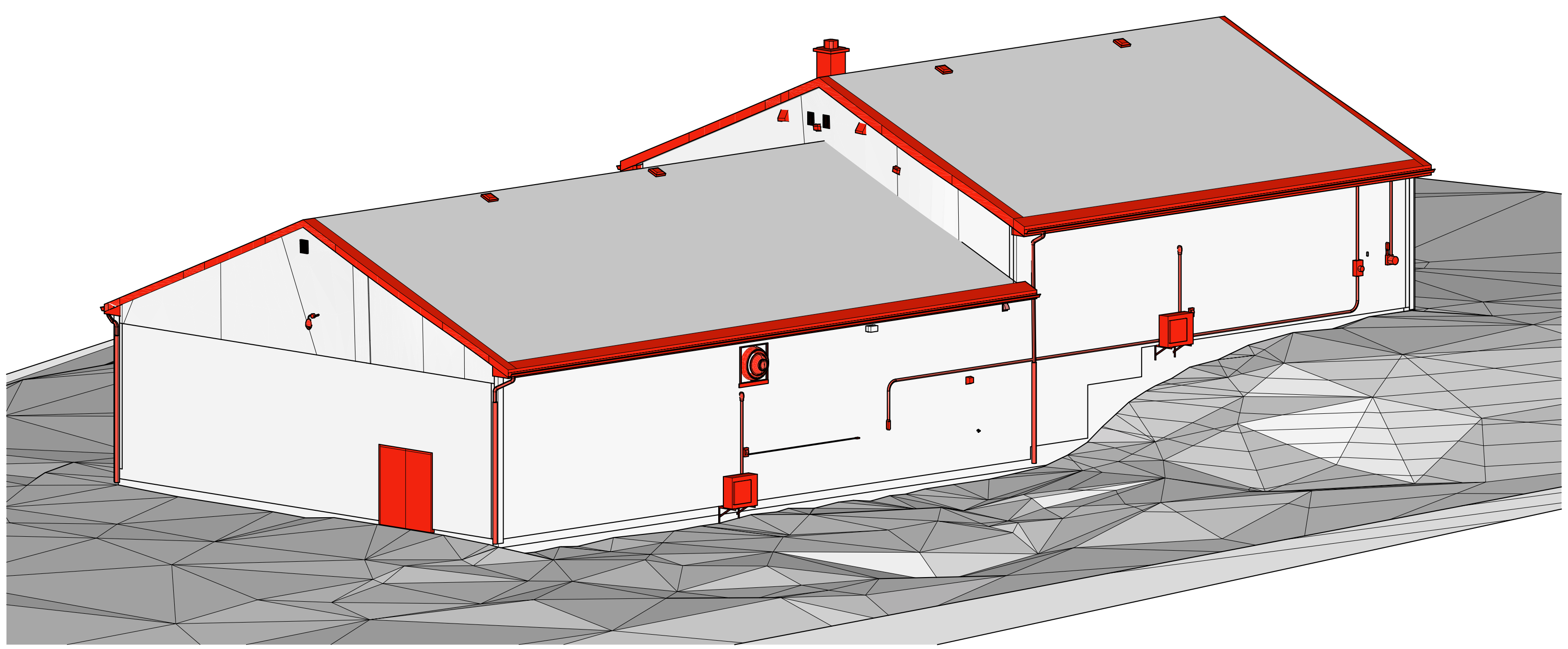
02

Demolition and Excavation



Scope of Demolition

- remove chimney and roof vents
- remove roof overhangs
- remove windows and doors
- remove entryway platform
- remove mechanicals attached to outside of building
- remove electrical and heat pump conduits



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February 26, 2023

Project Address
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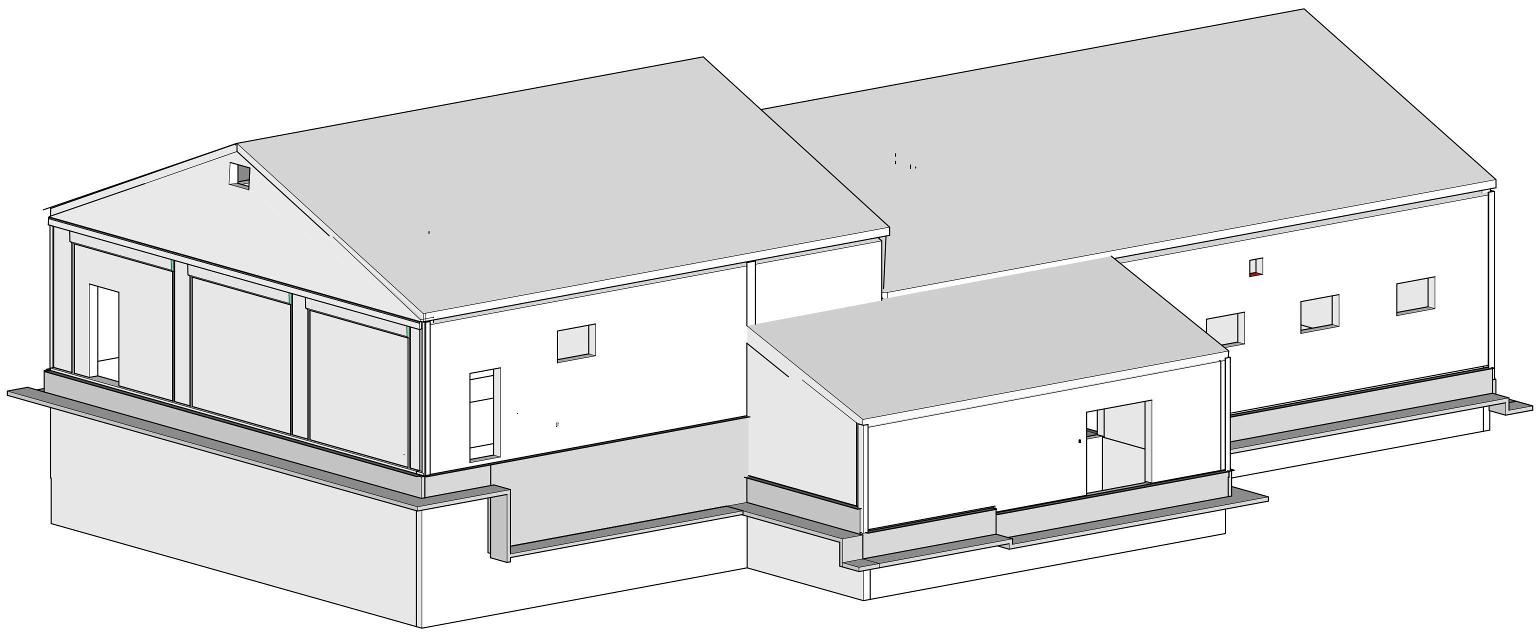
Halifax
Nova Scotia

PROJECT
Panelized Retrofit

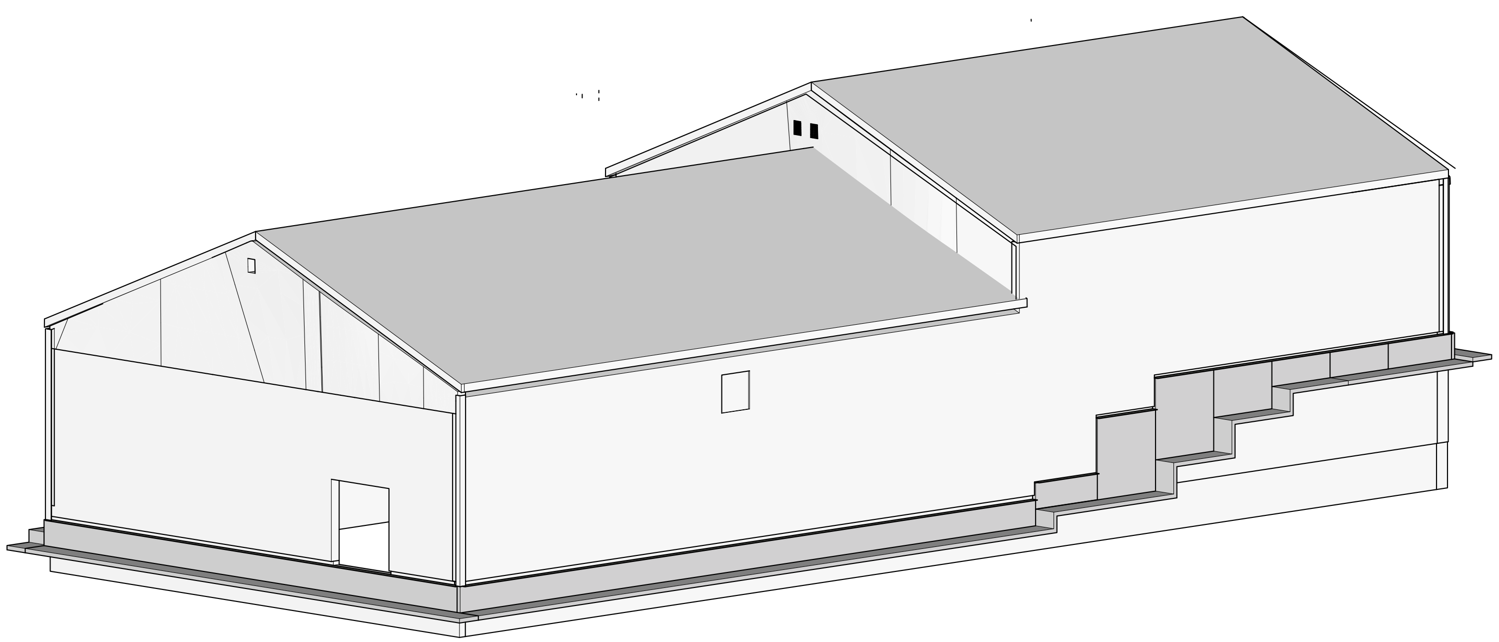
DRAWN BY
Nick Rudnicki

Wall Panel Support and Foundation Insulation



1. Install wall panel support bracket

2. Install foundation insulation
(See page 06 for details)



ReCover

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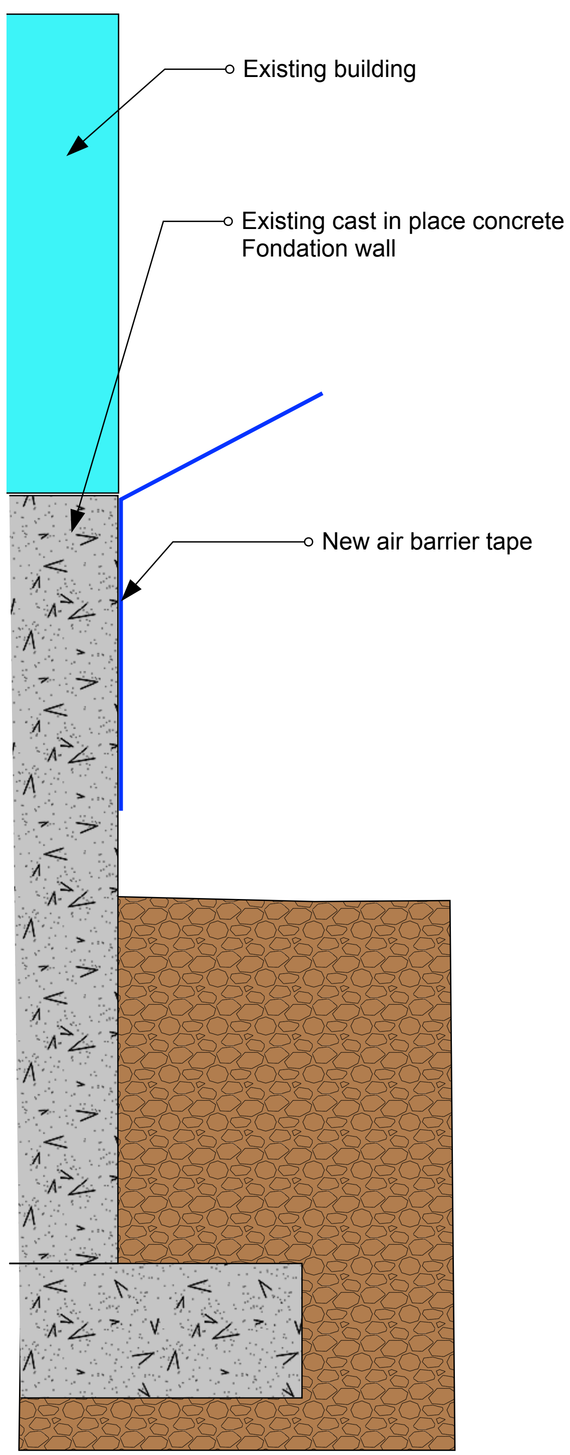
February 26, 2023

Project Address
1138 Old Sambro Road
Halifax
Nova Scotia

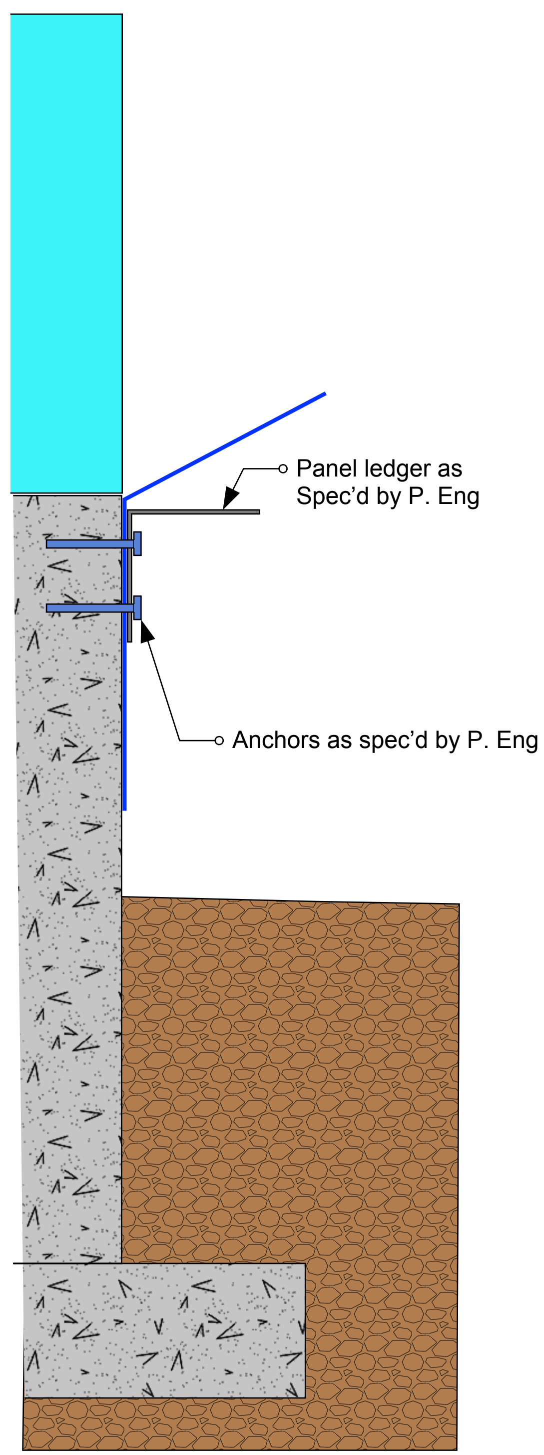
PROJECT
Panelized Retrofit

DRAWN BY
Nick Rudnicki

Foundation Insulation and Panel Base

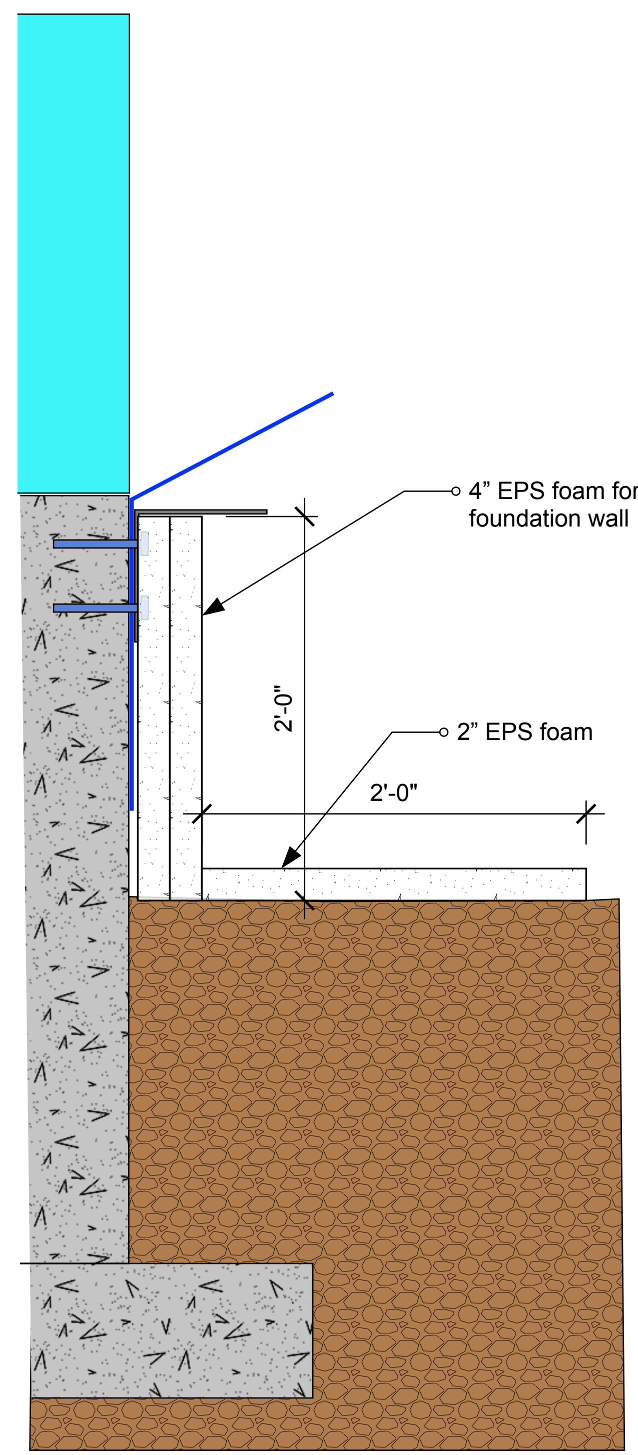


STEP 1
Install the Air barrier



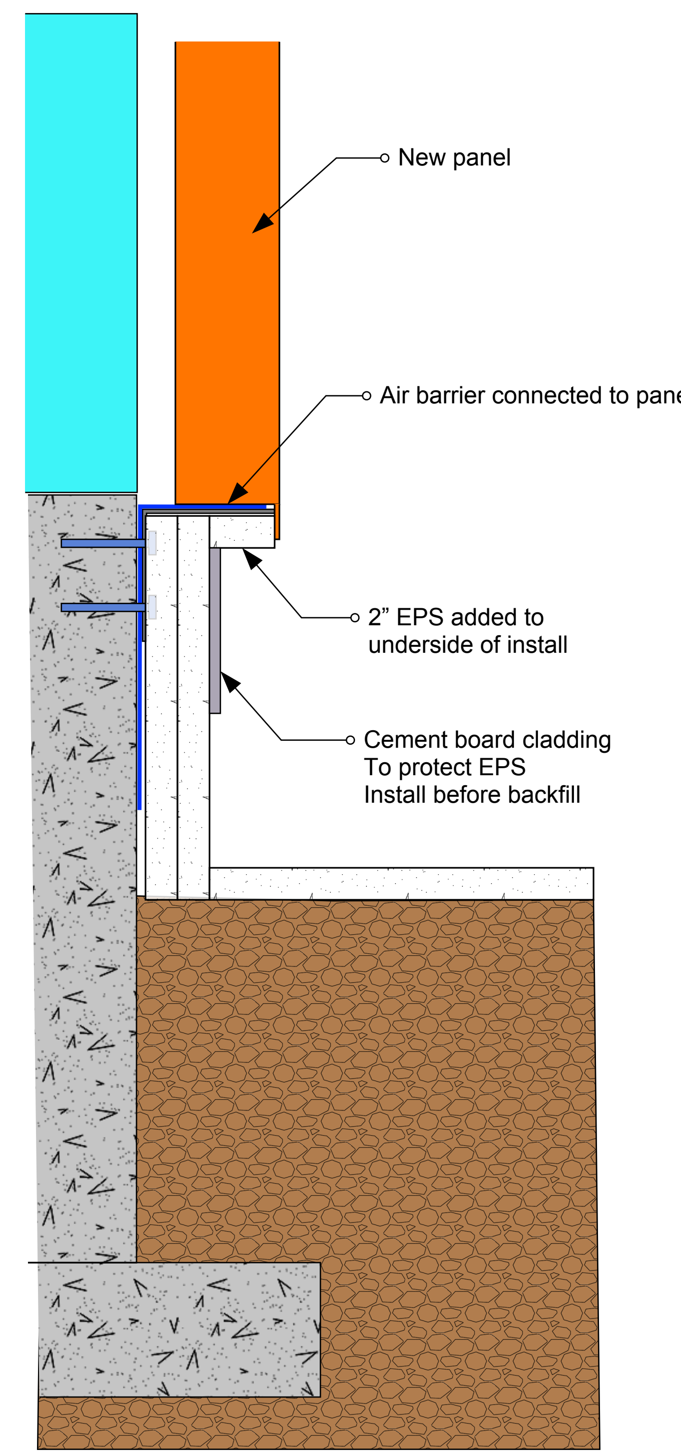
STEP 2
Install panel ledger overtop of air barrier.

Allow flap of air barrier to come out over the top of the ledger.



STEP 3
Install 4” of EPS to foundation wall to a depth of 24”

Install a 2” thick and 24” wide fin of EPS at a depth of 24” below grade



STEP 4
Install Panel on top of ledge

Tie air barrier to panel

Attach cement board to portion of foundation wall EPS that will be exposed after backfill

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New Glasgow
NS, B2H 5E1

Version Date
February 26, 2023

Project Address
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Halifax
Nova Scotia

PROJECT
Panelized Retrofit

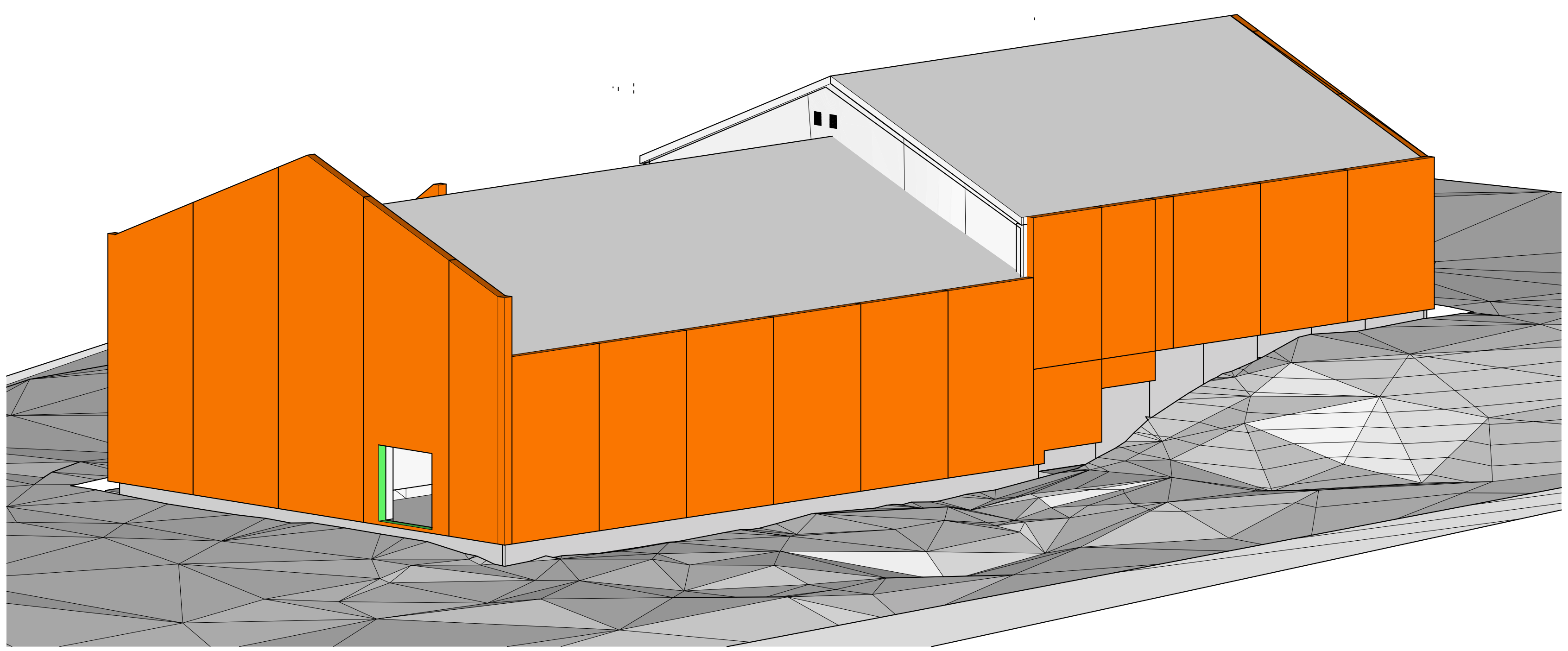
DRAWN BY
Nick Rudnicki

Panel Install

1. Install wall panels according to P. Eng specs (TBD)

2. Gable panels to have a sloped top to accommodate new roof pitch.

3. Panels to overshoot existing roofline to create a new uniform roof line.



ReCover

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Project Address
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Halifax
Nova Scotia

PROJECT
Panelized Retrofit

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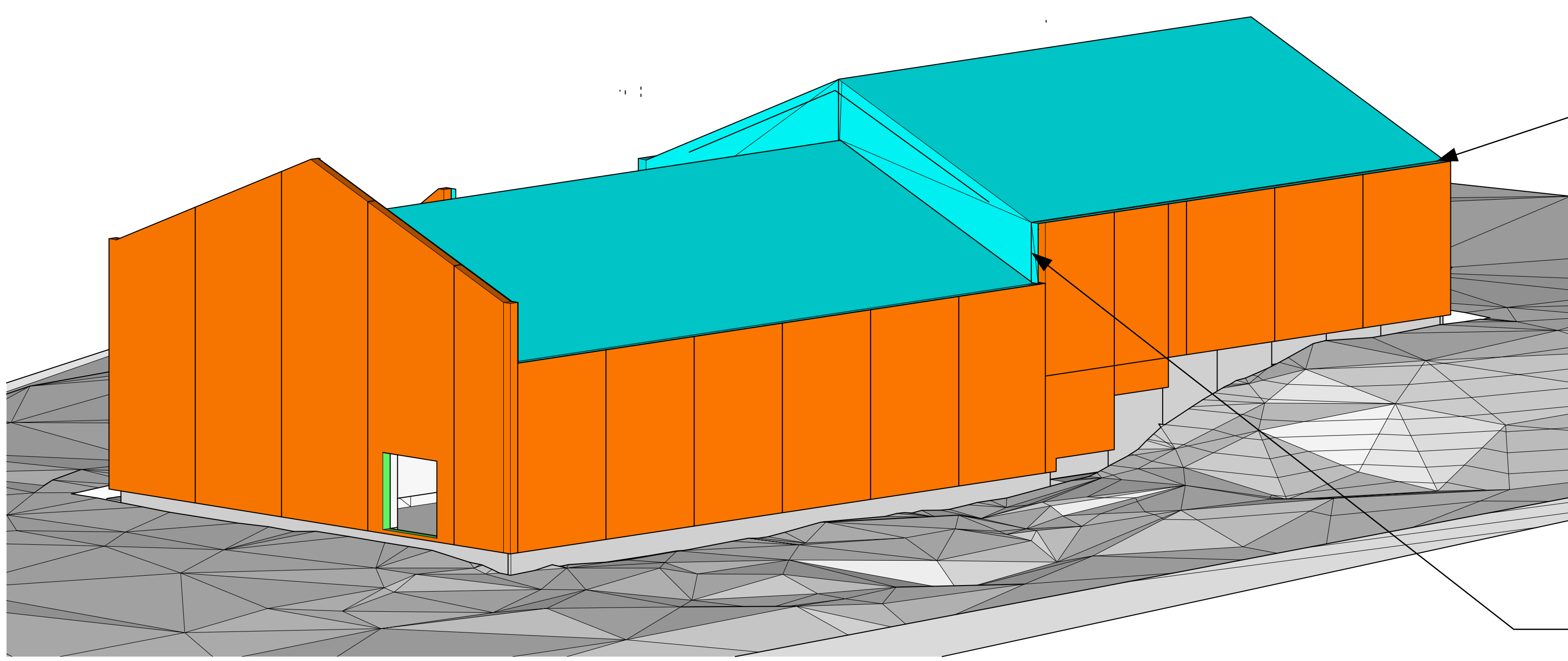
Nick Rudnicki

Air Barrier

1. Cover existing roof in air barrier membrane.

2. New roof membrane to be made tight to air barrier in wall panels with tape and sealant as needed.



ReCover

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City of Halifax
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NS, B2H 5E1

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Halifax
Nova Scotia

PROJECT
Panelized Retrofit

DRAWN BY
Nick Rudnicki

New Roof and Insulation

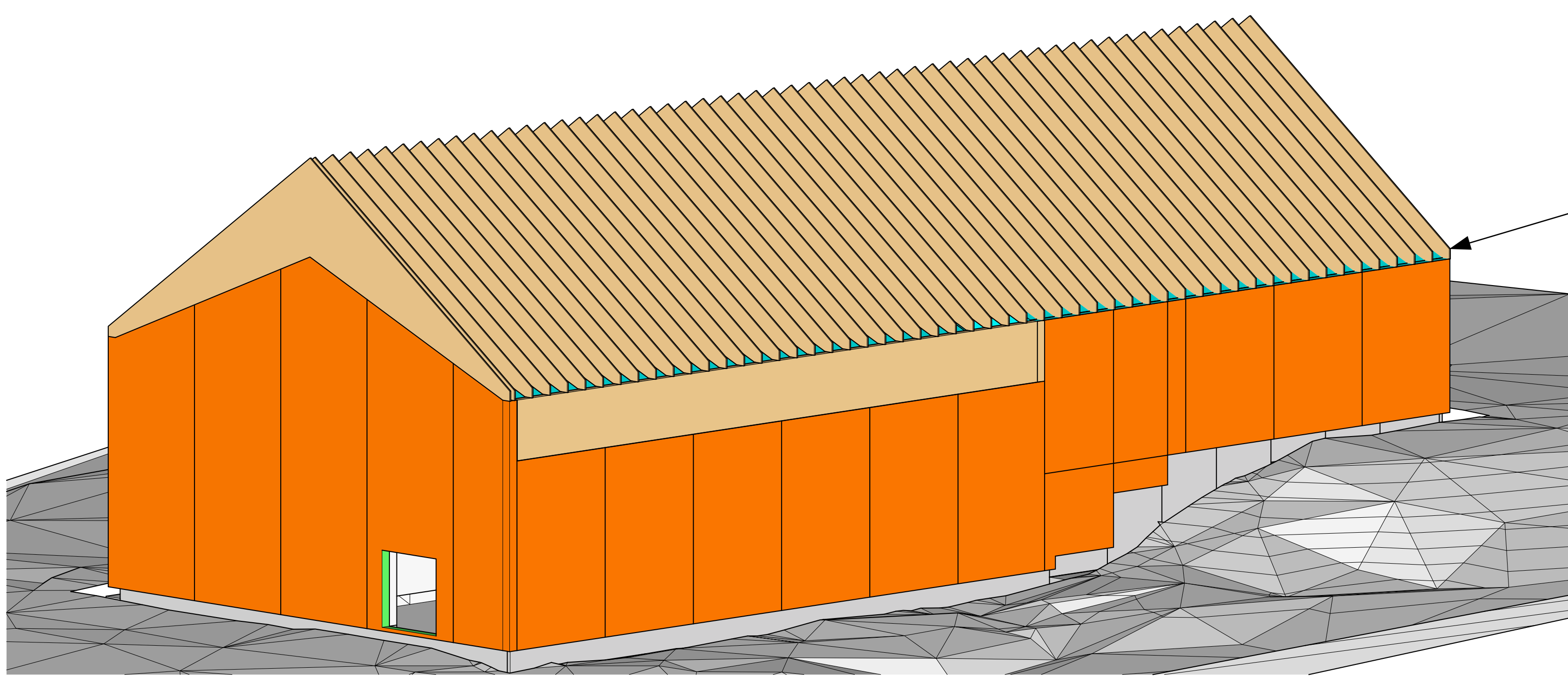
1. Install roof truss's to create new continuous roof.

2. Stick framed roof over bump out.

3. Install blown in cellulose in new attic space.

4. Install roof sheathing.

5. Install new roofing as per architect.



Raised heel truss's created needed depth to accommodate blown in cellulose

ReCover

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February 26, 2023

Project Address
1138 Old Sambro Road
Halifax
Nova Scotia

PROJECT
Panelized Retrofit

DRAWN BY
Nick Rudnicki

Appendix J

Hygrothermal Report

- **Report**

RE: Preliminary WUFI® Pro Results – PRELIMINARY DRAFT, FOR FINAL REVIEW

Location: 1138 Old Sambro Road, Halifax, Nova Scotia

Date: 2023-02-24

The services of Stanley Francispillai, P. Eng. (Quebec, Nova Scotia), were retained by Habit Studio Incorporated for the ReCover Initiative: Panelized Deep Energy Retrofits of Municipal Buildings project. These services were limited to the presentation of results for the hygrothermal modelling of the post-retrofit above-grade wall and roof assemblies of six municipal buildings using the ReCover Initiative team's panel design. The present report serves as a summary of the WUFI® Pro results obtained for the Williamswood/Harrietsfield Community Centre located at 1138 Old Sambro Road in Halifax, Nova Scotia.

INTRODUCTION

It is understood that the Williamswood/Harrietsfield Community Centre was approximately built in 1970. The building is located in a small clearing east of the intersection of Brunt Road and Old Sambro Road, north of Harrietsfield Elementary School, and approximately 154-m from Henry Lake, a small lake to the East. The building in question is oriented a few degrees east of due North. The building is partially sheltered from the treeline located to the North (**Figure 1**).

Figure 1 – Plan view location and orientation of the Williamswood/Harrietsfield Community Centre (shaded red), Halifax (Google, 2023)

SCOPE OF WORK

The scope of work for this project includes the presentation of results associated with the hygrothermal modelling of the post-retrofit exterior wall and roof assemblies of the Williamswood/Harrietsfield Community Centre over a 10-year period using the software WUFI® Pro. This includes both the "Main Building" as well as the "Bump-Out" located to the South (see **Figure 1**). The simulations use preliminary assumptions based on discussions made with the ReCover team, as well as the PHIUS+ protocol *Moisture Risk Analysis & Assessment using WUFI v1.1* (G. Wright, P. Ferreira, R. Richman, 2021).

The hygrothermal modelling includes all above-grade exterior walls and roof structures. The retrofit designs used in the hygrothermal models were provided by the ReCover team.

It is of note that no design was conducted by Stanley Francispillai, P. Eng. Existing assemblies were obtained from available documents, and retrofit assemblies were defined by the ReCover team for simulation through WUFI® Pro. This report consists of the output of these simulations.

INPUTS & ASSUMPTIONS

Prior to completing the preliminary simulations in WUFI®, the inputs and assumptions guiding the simulations were chosen with the ReCover team. No site-visit was conducted by the author of this report; thus, the inputs and assumptions of the hygrothermal simulations are based solely on the input from ReCover. Reference documents are included in **APPENDIX D**.

OUTDOOR CLIMATE: The outdoor climate was modelled using data available to the author of this report for Halifax, Nova Scotia (Halifax CWEC data, 1995 with monthly rain allocated on an hourly basis via Canadian Climate Normals). It is to be noted that this custom climate file is for typical weather patterns and does not consider extreme weather events. A pre-defined Halifax climate file was not available in the WUFI® database.

INDOOR CLIMATE: The non-residential indoor climate was modelled using sinusoidal functions. The average indoor temperature and relative humidity setpoints of 19.5°C and 50% were used in these simulations. The range of temperatures simulated were based on RDH Building Science's energy model inputs for the Halifax project (*2023 01 03 Halifax Energy Model Inputs.pdf*). The relative humidity setpoint of 50% was assumed for regular occupancy. As it is unclear as to what future tenancy patterns and moisture loads will be present, the following assumptions were made regarding the indoor climate:

Table 1 – Setpoints used in WUFI® for interior climate of building

Interior Setpoints	Average	Amplitude	Range	Date of Maximum Value
Temperature	19.5°C	1.5°C	18°C – 21°C	July 15th (assumed)
Relative Humidity	50%	10%	40% – 60%	July 15th (assumed)

Note: it is assumed that the temperature and relative humidity setpoints are applied to the entire buildings

ASSEMBLY MATERIALS: Based on the information obtained, the primary existing wall and roof assemblies shown in **Table 2** were modelled for the building (detailed material properties are included in **APPENDIX A** and **APPENDIX B**). The assemblies proposed for the existing building were originally sourced from the project document *22 09 16 - Willaimswood Assembly Details.pdf* by RSI Projects. Final retrofit designs and assemblies were conveyed by the ReCover team via emails (2022-12-12, Nick Rudnicki; 2023-02-15, Amanda McNeil; 2023-02-22, Lorrie Rand).

It should also be noted that assumptions were made regarding certain assemblies. For instance, the air spaces within the building's post-retrofit roof were simulated at an average thickness of 0.6-m (new and existing "attic" spaces). Other modelling assumptions are included in notes below the following table as well as in the Appendices. **Assembly material choices and assumptions should be reviewed for agreement with existing and proposed conditions.**

Table 2 – Halifax building assemblies and material components used in WUFI® simulations (see notes on following page)

Assembly	**Materials (Interior to Exterior)**	**Thickness, m (inch)**
Main Walls	Gypsum Board	0.016 (0.63)
	6mil Poly*	0.001 (0.04)
	Fiberglass Batt Insulation	0.152 (6.0)
	Void	0.1 (3.94)
	Block Wall	0.203 (8.0)
	Gap/Strapping (ReCover-assumed)	0.01 (0.39)
	Wood Fiber Siding**	0.011 (0.41)
	Air Space	0.02 (0.79)
	Cellulose Bib	0.001 (0.04)
	Dense-Pack Cellulose	0.235 (9.25)
	Plywood	0.013 (0.51)
	Weather Resistive Barrier (WRB)	0.001 (0.04)
	Air Space	0.01 (0.39)
	Metal Cladding* **	0.001 (0.04)
North-West Main & Bump-Out Walls	Gypsum Board	0.016 (0.63)
	6mil Poly*	0.001 (0.04)
	Fiberglass Batt Insulation	0.14 (5.5)
	Gap/Strapping (ReCover-assumed)	0.01 (0.39)
	Wood Fiber Siding**	0.011 (0.41)
	Air Space	0.02 (0.79)
	Cellulose Bib	0.001 (0.04)
	Dense-Pack Cellulose	0.235 (9.25)
	Plywood	0.013 (0.51)
	Weather Resistive Barrier (WRB)	0.001 (0.04)
	Air Space	0.01 (0.39)
	Metal Cladding* **	0.001 (0.04)
Roof (shaded-only)	Gypsum Board	0.016 (0.63)
	Polyethylene Membrane	0.001 (0.04)
	Low-Density Cellulose*****	0.203 (8.0)
	Air Space	0.600 (23.62)
	Plank Decking******	0.019 (0.75)
	Asphalt Shingle System	0.004 (0.16)
	Polyethylene Membrane	0.001 (0.04)
	Low-Density Cellulose*** **	0.305 (12.0)
	Air Space	0.600 (23.62)
	Plywood	0.016 (0.63)
	PVC Membrane	0.002 (0.06)
	Air Space	0.01 (0.39)
	Metal Cladding* **	0.001 (0.04)

*6mil Poly modelled using **PE-Membrane (Poly; 0.07 perm)** material from WUFI
Wood Fiber Siding modelled using **Composite Wood Siding material from WUFI, but with higher permeance
***Metal Cladding modelled using **Roof Membrane V13** from WUFI as per protocol
*****Low-Density Cellulose modelled using **Cellulose Fibre (heat cond.: 0,04 W/mK)** WUFI material, but with higher conductivity and lower density
******Plank Decking modelled using **Plywood (USA)** WUFI material

MOISTURE & AIR SOURCES: To determine how the retrofit walls perform under certain environmental stresses, a 1% driving rain moisture source was placed on the exterior face of the WRB in the form of a fictitious 1-mm layer of brick, as per the PHIUS+ protocol. Moreover, the vented cladding was given a default ventilation rate of 25 air changes per hour (ACH) and was placed within the 10-mm "*Air layer 10mm; metallic*" material which is pre-defined by WUFI® for use adjacent to metal surfaces.

For the roof assemblies, a **1-ACH rate was defined between the metal roof cladding and the outermost (new) roof membrane**. No information was provided concerning air exchange rates within the newly created attic spaces. Therefore, for the Williamswood/Harrietsfield Community Centre, several scenarios were simulated for the new attic given the double-attic post-retrofit system present (existing attic was assumed to experience 10-ACH) – these are presented in the **RESULTS** section of this report.

ORIENTATIONS: The two types of wall assemblies, both the Main Walls and the Bump-Out Walls, were simulated in WUFI® in their respective orientations as per the building's positioning: North-East, South-East, and South-West for the Main Walls, and North-West, South-East, and South-West for the Bump-Out Walls (it is worth noting that the North-West assembly for both the Main Wall and Bump-Out Wall is the same). These walls were all set to 90° inclinations from the horizontal. The new roof assembly is composed of two separate gable roof systems, both new and existing, and inclined towards the North-East and South-West. For this preliminary work, the 22.5° inclination of the existing roof was utilized for simulations. Although the new gable roof was designed to be inclined at 35°, **WUFI®'s output Balances were not close enough to indicate reliable results. For this reason, the 22.5° inclination of the existing roof, whose simulations' Balances were more similar, was used.**

RAIN LOAD: In terms of rain loading, the ASHRAE Standard 160 rain load calculation method was utilized. For the wall assemblies, the rain exposure factor was based on the building's height of less than 10-m, while the rain exposure category was assumed to be medium, as the building is located approximately 154-m from Henry Lake, a small body of water. The wall assemblies' rain deposition factor was automatically defined based on the steep-slope roof structures involved. These same assumptions were used for the roof assembly, with the only difference being the rain deposition factor requiring a higher value due to increased bulk water contact from rainwater runoff. Finally, the adhering fraction of rain for the roof was set to "no absorption" given the metal cladding involved.

BOUNDARY CONDITIONS: For the post-retrofit condition studied, it was assumed that the proposed exterior metal cladding would be painted, while the interior side of the various walls were also simulated with painted finishes based on site-visit photographs shared from the municipality. In the same manner, the roof's exterior metal finish was assumed to be painted, as was the gypsum interior finish. These paints would affect the surface transfer (sd) coefficients of the hygrothermal models – other sd-coefficients considered in the models are included in **APPENDIX B**.

INITIAL CONDITIONS: Finally, as per ASHRAE 160, initial material conditions were set to EMC80 (equilibrium moisture content at 80% relative humidity), while concrete-based materials were set to EMC90; for all materials, the starting temperature was set to 20°C. The simulations were defined to begin on October 1st, 2022, which is the default starting day for WUFI®, and continue for a period of 10-years.

Other inputs of the WUFI® simulations can be found in the software's auto-generated results report, included in **APPENDIX B**.

RESULTS

The PHIUS+ protocol's post-processing and evaluation procedure was sourced for describing the results of the post-retrofit hygrothermal simulations conducted.

POST-RETROFIT MAIN WALL ASSEMBLY

The post-retrofit North-East, South-East, and South-West Main Wall assemblies simulated did not demonstrate any numerical errors for all orientations and conditions tested – no convergence failures occurred, and the differences between balances of change in total water content and the sum of the moisture fluxes were very small. (**Note:** The North-West Main Wall assembly is identical to the North-West Bump-Out Wall assembly – the results of both are presented in the next section under a single simulation)

As recommended by the protocol, the plywood layers were subdivided into three adjacent layers for near-surface condition assessment, with the outermost and innermost layers being 1/8-inch thick. The plywood layers and other biogenic materials were focused upon for this feasibility report given their susceptibility to decay and mold. To estimate decay risk, the time periods during which the mass percentage of water content (MC) remains above 20% were studied.

In all orientations, there is at least one spike in mass percentage of water content (MC) above 20% between November 2022 and May 2023 in one of the new plywood layers. For instance, the innermost 1/8-inch layer of the new plywood of the North-East Main Wall assembly experiences a MC above 20% between approximately 2022/11/25 and 2023/05/08, 2023/12/21 and 2024/04/05, as well as 2025/01/11 and 2025/03/17, but then remains below 20% in subsequent years (**Figure 2**Figure 2). Moreover, in the South-East orientation, the outermost plywood layer demonstrates recurring spikes in MC above 20% – this begins in the first year of simulation, lasting from 2023/01/30 to 2023/03/08. This spike decreases in duration and maximum MC in each subsequent year, but the annual spike remains above 20% during the simulated 10-year period (**Figure 3**).

For mold-related durability, a VTT simulation was conducted using the WUFI® Pro plug-in which examines the mold growth index at the specified locations. The plywood layers and the outermost element of the cellulose layer were simulated using VTT. The plywood layers were defined with a sensitivity class of "Sensitive" (second-highest risk category) and a material class experiencing "Almost no decline". The cellulose and existing fiberglass batt layers were simulated in VTT as proxies for the structural wood members (not modelled) located within these cavities. Based on discussions with ReCover, it was assumed that the chemical properties of the cellulose insulation may impart greater mold resistance to the cavity wood members – for this reason, a sensitivity class of "Medium resistant" was used to simulate the wood members within the cellulose cavity. For the fiberglass batt layer, the "Sensitive" class was used.

The mold growth index ranges from 0 to 6 and is coupled with a traffic light scheme in the WUFI® plug-in, ranging from green (uncritical) to yellow to red (inacceptable) – within the yellow range, there is potential risk for mold growth, however more information would be required (such as the specific material used) to decide whether the risk is deemed acceptable or inacceptable.

In all orientations simulated for the Main Wall assembly, the elements chosen for VTT simulation within the plywood and cellulose layers demonstrated a green VTT traffic light, indicating low mold growth indices. **However, within the existing fiberglass batt layer, the outer element(s) chosen for VTT simulation indicated a yellow VTT traffic light (mold growth index <1.6) in all orientations. For instance, in the South-West orientation, the mold growth index in the elements studied increases during the first year of simulation, peaks at the end of 2023/beginning of 2024, and decreases in subsequent years (Figure 4).**

It should be noted that although a sheathing substitution (e.g., WUFI®'s pre-defined DensElement™ Barrier System) may eliminate certain durability issues related to the biogenic nature of plywood (simulated solely in the North-East orientation), **the mold growth index remains in the yellow VTT region within the fiberglass batt** (proxy for existing wood studs assumed to be part of the existing wall assembly). This may be explored further for alternative sheathing options in the various orientations of the Main Wall assembly.

For these reasons, and per the PHIUS+ protocol, it is understood that the proposed post-retrofit wall assembly may manage moisture adequately based on the information available and the assumptions presented in this report. However, this is dependent on whether the plywood can be subject to certain periods of high moisture content, as well as all wood layers' mold resistance properties. The existence of wood studs in the fiberglass batt layer may create mold issues and should be studied further.

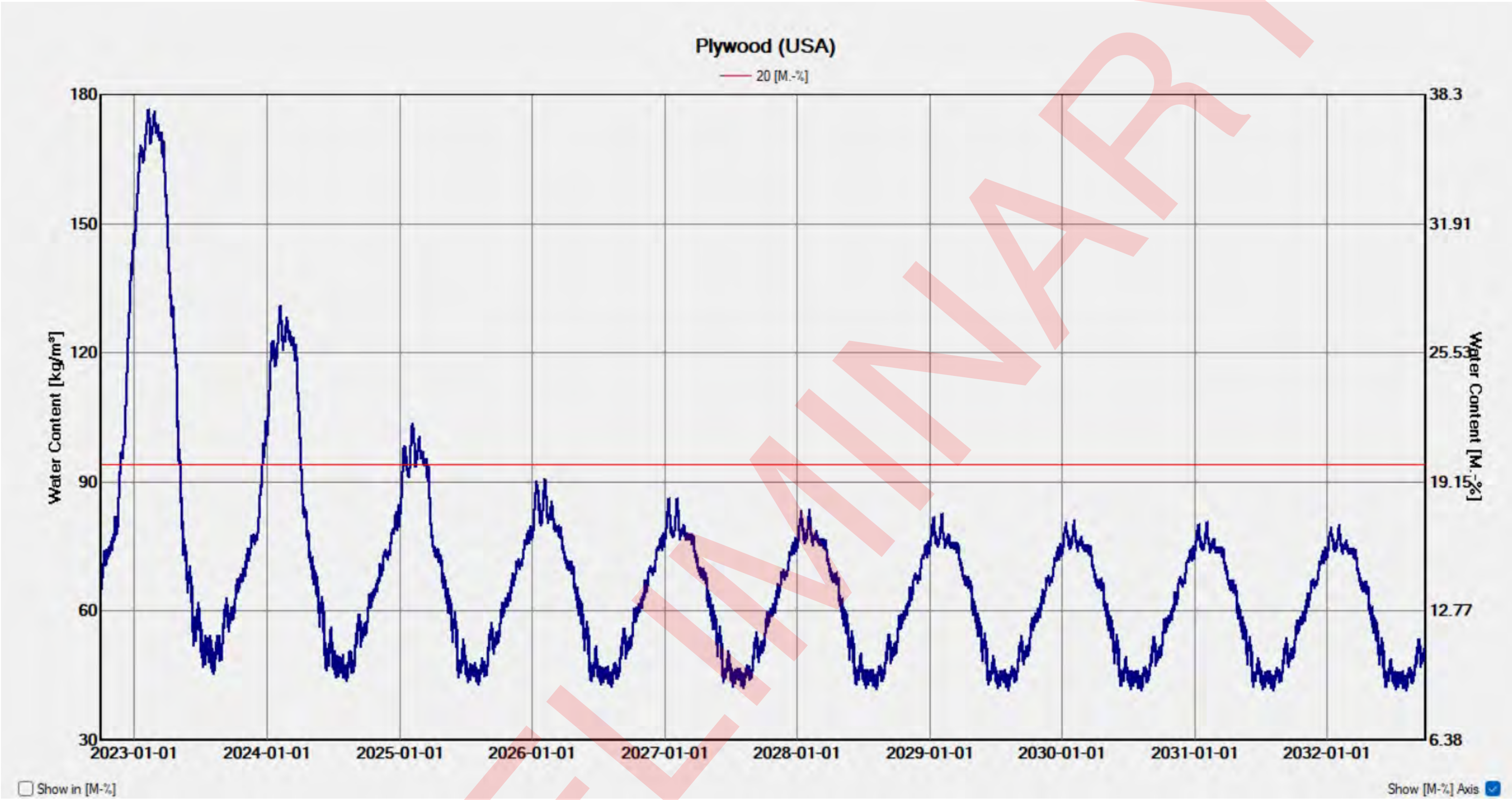


Figure 2 – WUFI® output for North-East Main Wall assembly: water content (kg/m³, %) over 10-year period studied for post-retrofit North-East Main Wall assembly's [new] inner 1/8-inch plywood layer

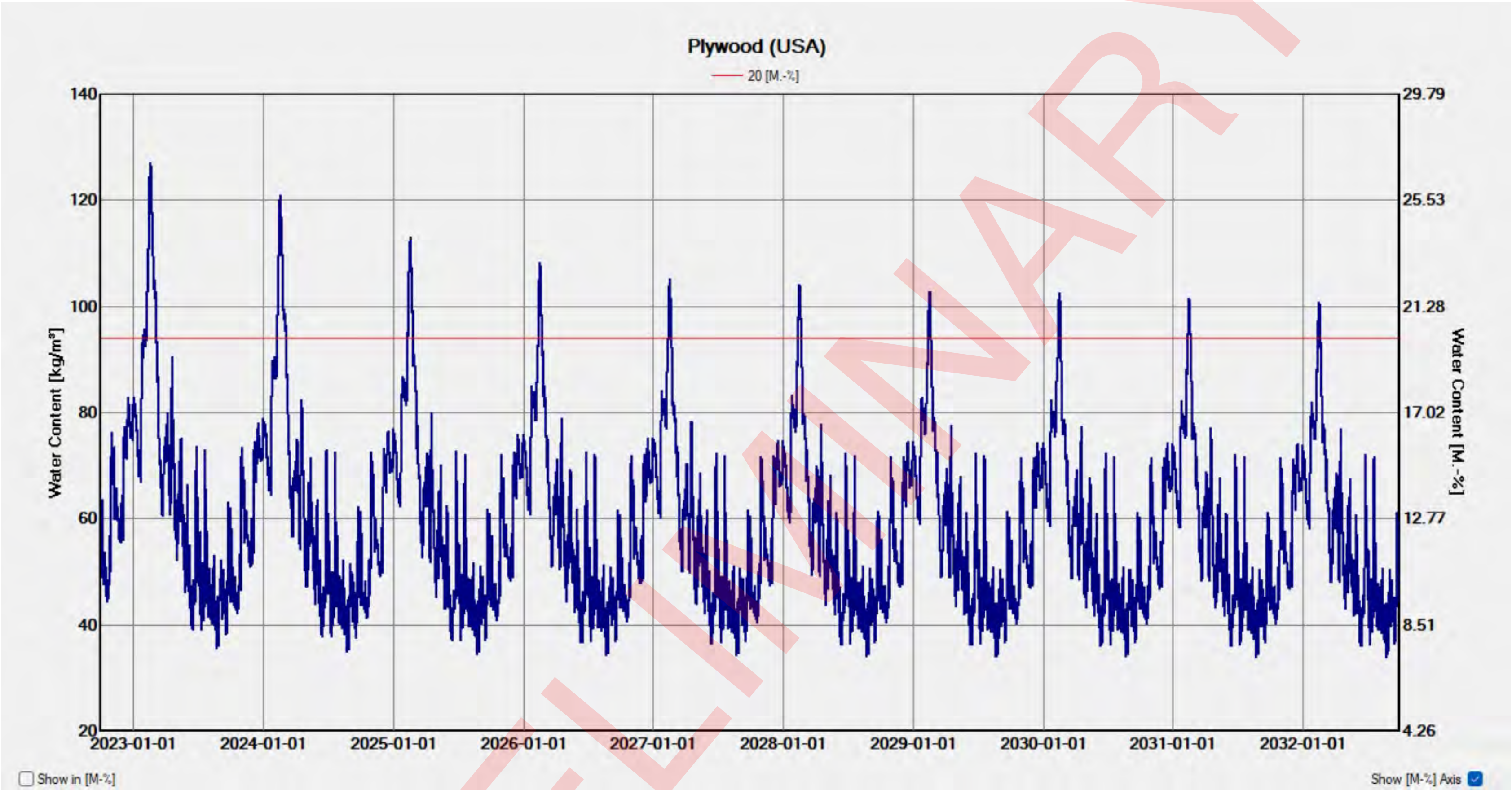


Figure 3 – WUFI® output for South-East Main Wall assembly: water content (kg/m³, %) over 10-year period studied for post-retrofit South-East Main Wall assembly's outer 1/8-inch plywood layer

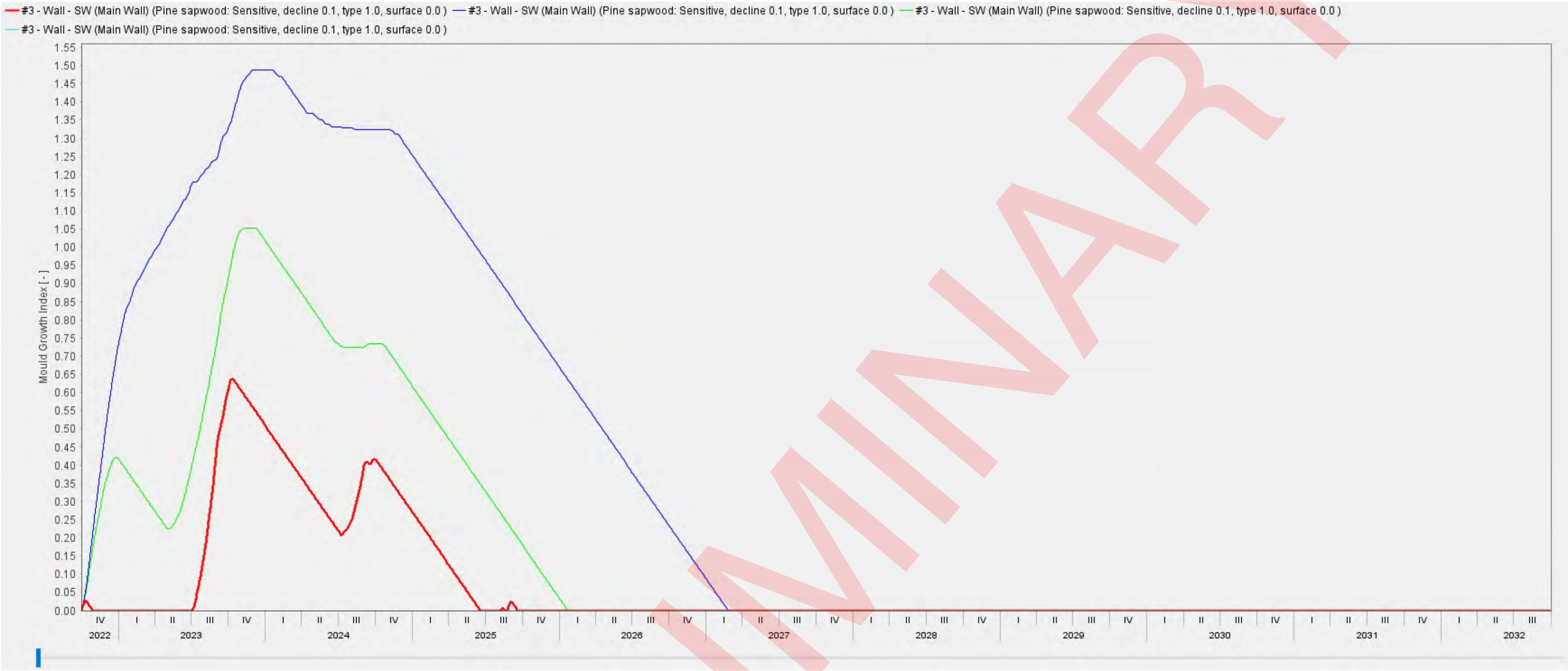


Figure 4 – WUFI® output for South-West Main Wall assembly: VTT mold growth index simulation over 10-year period studied for post-retrofit South-West Main Wall assembly's fiberglass batt layer (proxy for assumed existing wood studs) (blue: outermost fiberglass element [Yellow VTT]; green: second-outermost fiberglass element [Yellow VTT]; red: two innermost fiberglass elements [Green VTT])

POST-RETROFIT BUMP-OUT WALL ASSEMBLY

The post-retrofit North-West, South-East, and South-West Bump-Out Wall assemblies simulated did not demonstrate any numerical errors for all orientations and conditions tested – no convergence failures occurred, and the differences between balances of change in total water content and the sum of the moisture fluxes were very small. (**Note:** The North-West Main Wall assembly is identical to the North-West Bump-Out Wall assembly – the results of both are presented in this section under a single simulation)

Once again, the plywood layer was subdivided into three adjacent layers per the PHIUS+ protocol. As was the case in the Main Wall assembly simulations, certain plywood layers experience periods of MC above 20%. For instance, the innermost plywood 1/8-inch layer in the North-West orientation experiences a spike in MC above 20% between approximately 2022/12/07 and 2023/05/07, but then remains below 20% after this point (**Figure 5**). On the other hand, in the South-East orientation, the outermost plywood layer demonstrates recurring spikes in MC above 20% – this begins in the first year of simulation, lasting from 2023/01/30 to 2023/03/08. This spike decreases in duration and maximum MC in each subsequent year, but the annual spike remains above 20% during the simulated 10-year period (**Figure 6**).

Using the same assumptions previously stated for mold growth parameters in the Main Wall assemblies, another VTT simulation was conducted for the Bump-Out Wall assemblies. In all orientations simulated, the elements chosen for VTT simulation within the plywood, cellulose, and fiberglass batt layers demonstrated a green VTT traffic light, indicating low mold growth indices.

It should be noted that a sheathing substitution (e.g., WUFI®'s pre-defined DensElement™ Barrier System) may eliminate certain durability issues related to the biogenic nature of plywood – this wall assembly was also modelled per ReCover's request (North-West orientation simulated). Moreover, the mold growth index remains in the green VTT region within the cellulose and fiberglass batt (which serve as proxies for wood studs that are assumed to be part of the new and existing wall assemblies). Alternative sheathing options in the various orientations of the wall assemblies should be further explored.

For these reasons, and per the PHIUS+ protocol, it is understood that the proposed post-retrofit wall assembly may manage moisture adequately based on the information available and the assumptions presented in this report. However, this is dependent on whether the plywood can be subject to certain periods of high moisture content, as well as all wood layers' mold resistance properties.

Alternative sheathing options may allow for more suitable moisture management and should be explored further.

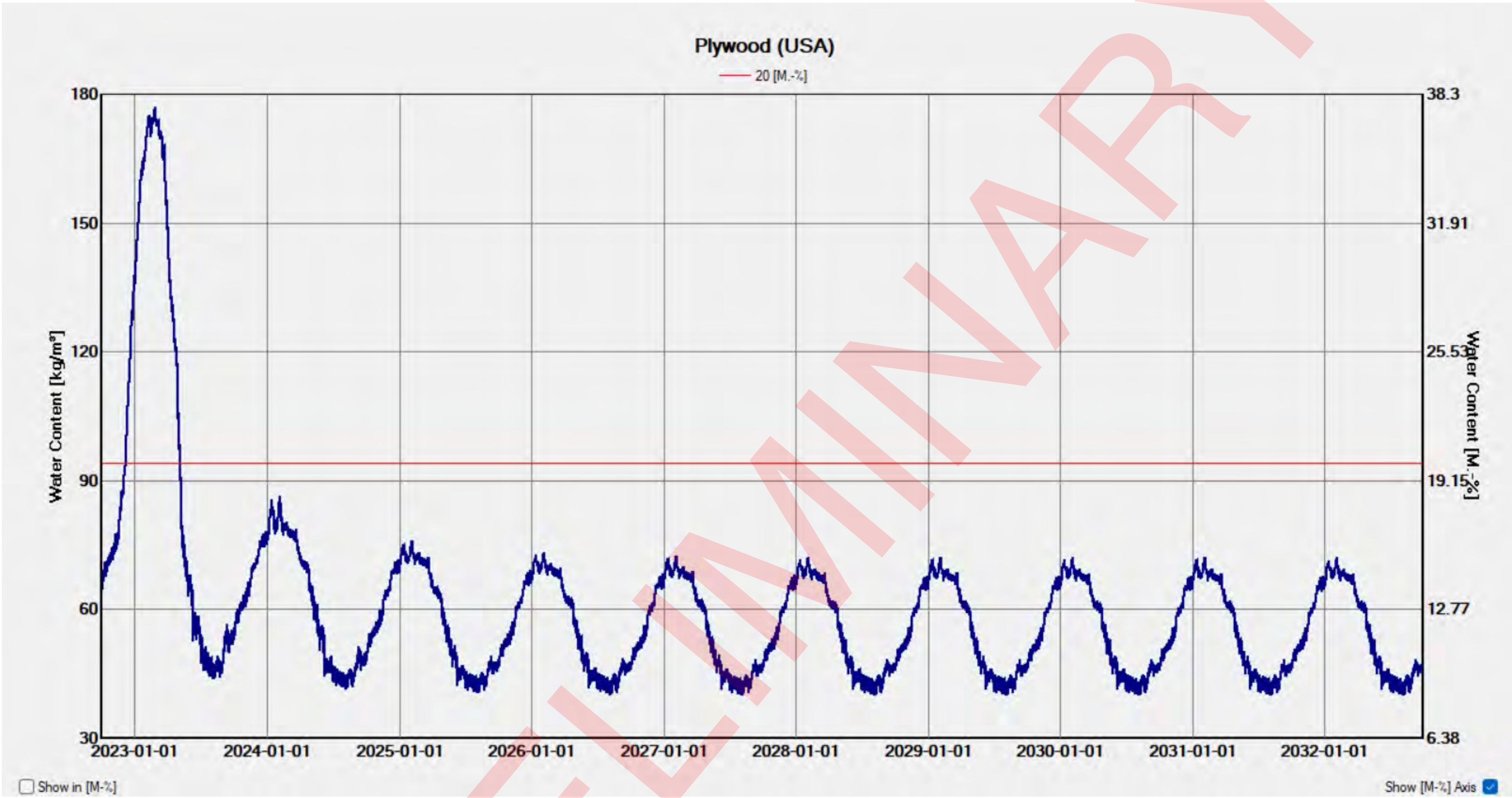


Figure 5 - North-West, innermost, bump-out

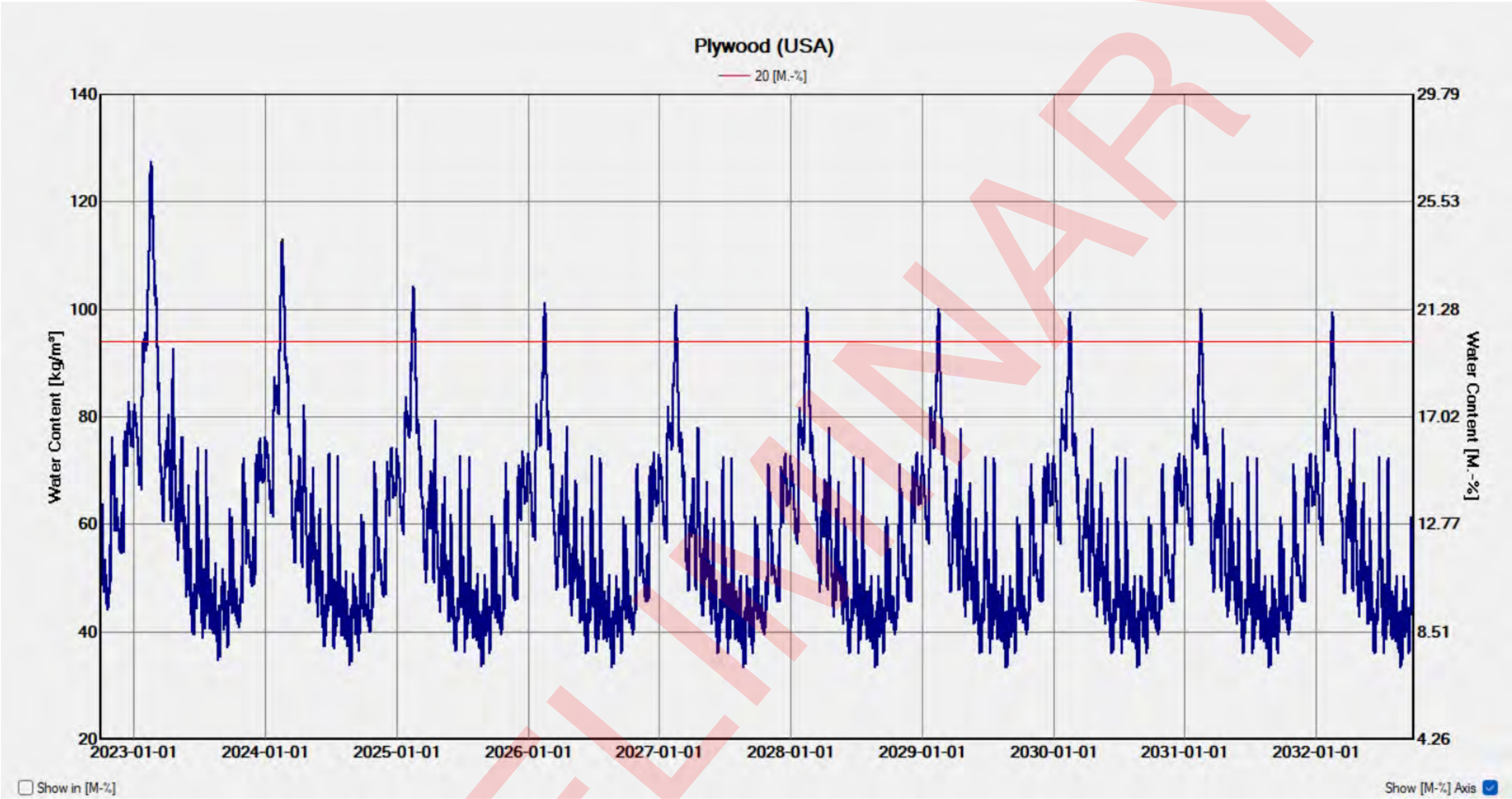


Figure 6 - South-East, outermost, bump-out

POST-RETROFIT ROOF ASSEMBLY

The post-retrofit double-attic assembly simulated did not demonstrate any numerical errors for all orientations and conditions tested – no convergence failures occurred, and the differences between balances of change in total water content and the sum of the moisture fluxes were very small. It is to be noted that the grid/mesh for these simulations was refined (500 versus typical 100) to attain these smaller Balance differences.

The new and existing plywood layers were subdivided, respectively, into three adjacent layers per the PHIUS+ protocol. The plywood layers were the author's focus for the assembly observations given their biogenic nature. Due to lack of information regarding venting, attic space/height, etc., several scenarios were studied for the Williamswood/Harrietsfield Community Centre post-retrofit double-attic roof. This included varying the air change rates in the two attic spaces in the following scenarios:

Table 3 – Scenarios simulated in WUFI® Pro for post-retrofit double-attic assembly

Roof Orientation	Existing Attic Air Exchange Rate	New Attic Air Exchange Rate
North-East (22.5° inclination, shaded)	0-ACH from interior	10-ACH from exterior
	10-ACH from interior	
	0.1-ACH from interior	
	0.01-ACH from interior	
	5-ACH from interior & exterior	
South-West (22.5° inclination, shaded)	0-ACH from interior	10-ACH from exterior
	10-ACH from interior	
	0.1-ACH from interior	
	0.01-ACH from interior	
	5-ACH from interior & exterior	

In the various roof assembly scenarios simulated, the MC generally spikes within the plywood layers if 0-ACH or 0.01-ACH are specified as the existing attic air exchange rate. For instance, in the North-East 0-ACH existing attic scenario, the existing plywood's outermost 1/8-inch layer experiences MC levels above 20% from approximately mid-April 2023 to mid-June 2023, as well as late-April 2024 to late-May 2025 (**Figure 7**). Furthermore, the existing plywood's innermost 1/8-inch layer (same scenario) experiences above 20% MC from early December 2022 to the end of March 2023. This spike is an annual occurrence, though the duration and maximum MC decrease with each year until 2028 – thereafter, the main spikes fall below the 20% threshold (**Figure 8**). Meanwhile, **the three scenarios with existing attic exchange rates greater than or equal to 0.1-ACH (0.1-ACH from interior, 10-ACH from interior, and 5-ACH from interior & exterior) do not experience significant spikes above 20% MC in their respective plywood layers** during the simulated 10-year period.

However, it should be noted that, per WUFI® film results, **the relative humidity (RH) in the new attic air space (behind the new plywood layer and above the new cellulose layer) reaches**

approximately 100% in all scenarios (**Figure 9**). Moreover, the scenarios with 0-ACH or 0.01-ACH existing attic exchange rates demonstrate elevated RH levels (approximately 90%) in the existing attic space (though the max RH seems to decrease annually), while the 0.1-ACH existing attic exchange rate scenario only seems to reach 90% RH in the existing attic in the first year of simulation.

A VTT simulation was also conducted using the WUFI® Pro plug-in. The new and existing plywood layers, as well as the outermost and innermost elements of the existing cellulose layer, were all simulated. The existing cellulose layer was simulated in VTT as a proxy for the structural wood members (not modelled) located within the existing cellulose layer. As per the wall simulations, the plywood layers were defined with a sensitivity class of "Sensitive" and a material class experiencing "Almost no decline". However, as it is unknown what condition and properties characterize the existing cellulose layer, or if its mold resistance would be imparted to the structural wood members within, the "Sensitive" class was used in this layer.

The scenarios with 0-ACH or 0.01-ACH existing attic exchange rates demonstrate higher mold growth indices versus the three other, higher existing exchange rate scenarios. For instance, the North-East 0-ACH existing attic scenario indicated the yellow VTT traffic light for the innermost 1/8-inch new plywood layer – the mold growth index increases more rapidly until 2028, after which the increase is steady but less pronounced. Meanwhile, the entire existing plywood layer indicated a yellow VTT traffic light, with the mold growth index approaching 3.0 and then decreasing gradually over time (**Figure 10**).

The scenario with 0.1-ACH existing attic scenario indicates a yellow VTT traffic light in the same layers as per the 0-ACH and 0.01-ACH scenarios, however the magnitudes of the mold growth indices are much lower (approximately 1.1 – 1.4).

The scenarios with 10-ACH and 5-ACH interior/exterior existing attic exchange rates seem to demonstrate the most favourable mold growth index results, as only the innermost 1/8-inch new plywood layer indicates a yellow VTT traffic light with a slight but steady increase over time. The magnitude of the mold growth index is approximately 1.2 – 1.4 (**Figure 11**).

For these reasons, and per the PHIUS+ protocol, it is understood that the proposed post-retrofit roof assembly with higher existing attic exchange rates may manage moisture adequately based on the information available and the assumptions presented in this report. The scenarios with 10-ACH and 5-ACH existing attic space rates demonstrate more favourable results in terms of both MC within the plywood layers as well as mold growth indices. However, all scenarios' performance is dependent on whether the plywood can be subject to certain periods of high moisture content, as well as all wood layers' mold resistance properties. Moreover, the high RH levels within the attic spaces must also be considered.

Further detail (proper double-attic system modelling, calculated exchange rates, attic heights, etc.) of the post-retrofit roof assembly is required and future simulations should be conducted if this project should proceed to construction.

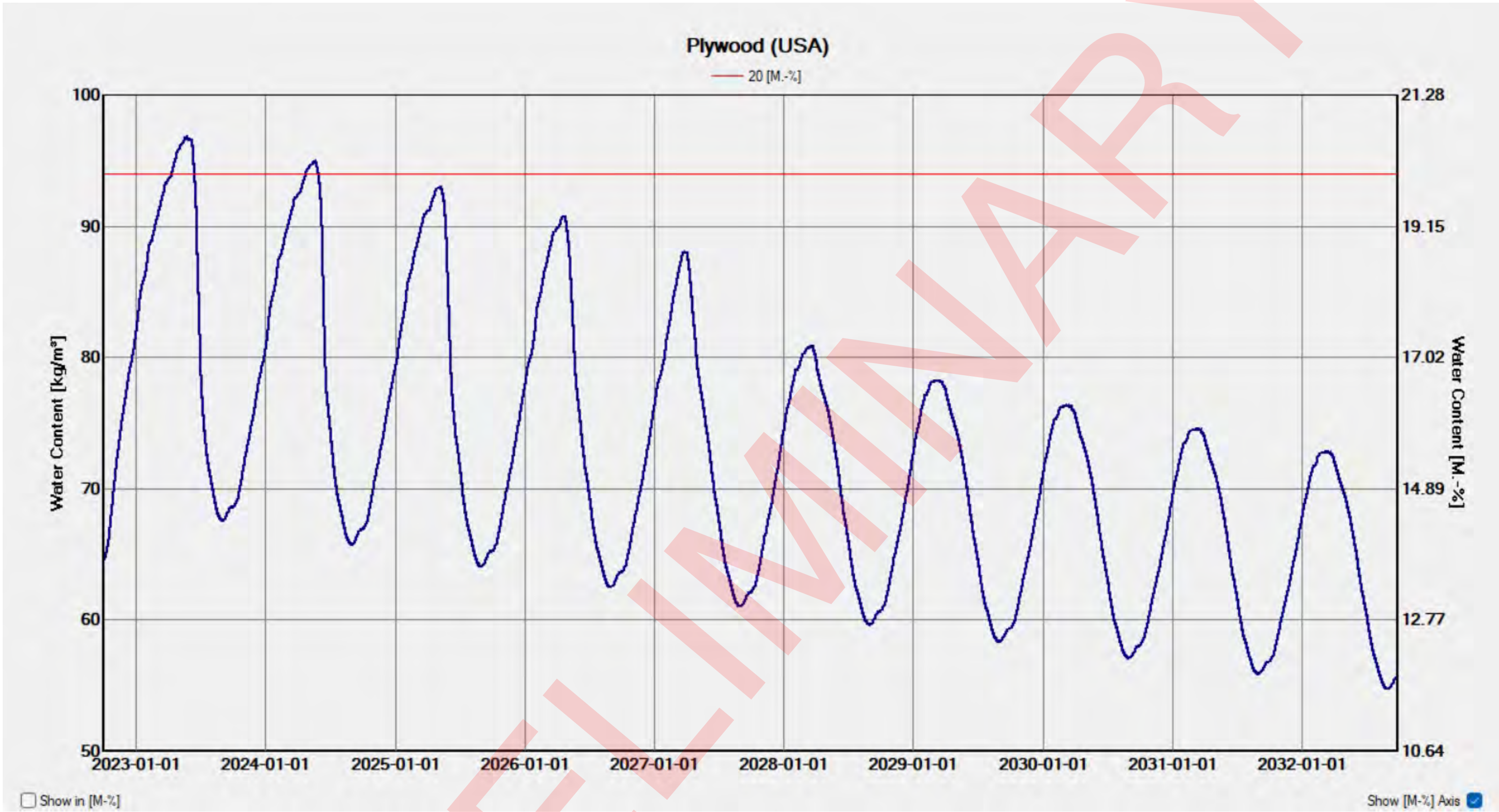


Figure 7 – WUFI® output for North-East Roof assembly: water content (kg/m³, %) over 10-year period studied for post-retrofit North-East Roof assembly's [existing] outer 1/8-inch plywood layer (scenario with 0-ACH existing attic, 10-ACH new attic space, shaded)

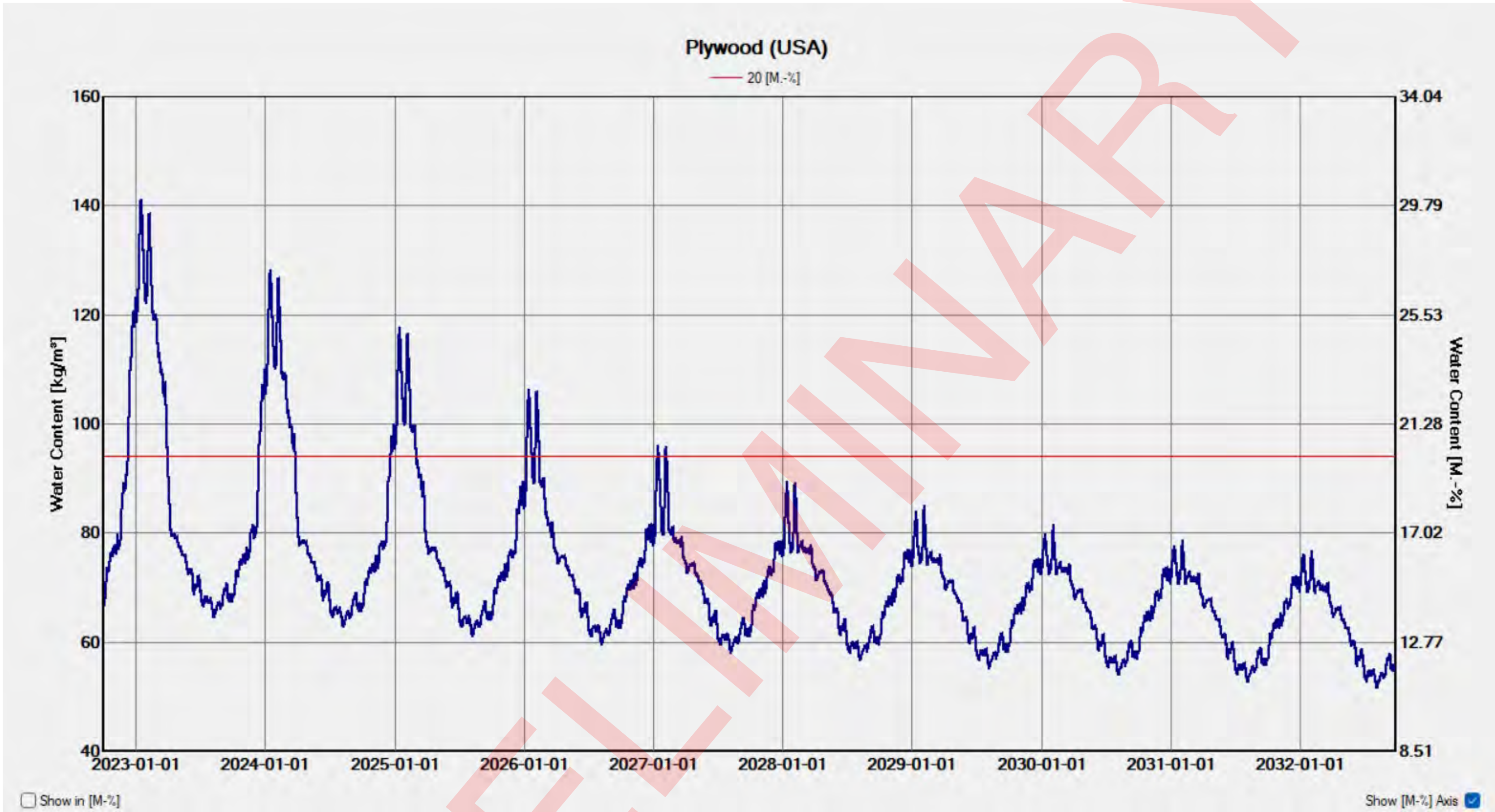


Figure 8 – WUFI® output for North-East Roof assembly: water content (kg/m³, %) over 10-year period studied for post-retrofit North-East Roof assembly's [existing] inner 1/8-inch plywood layer (scenario with 0-ACH existing attic, 10-ACH new attic space, shaded)

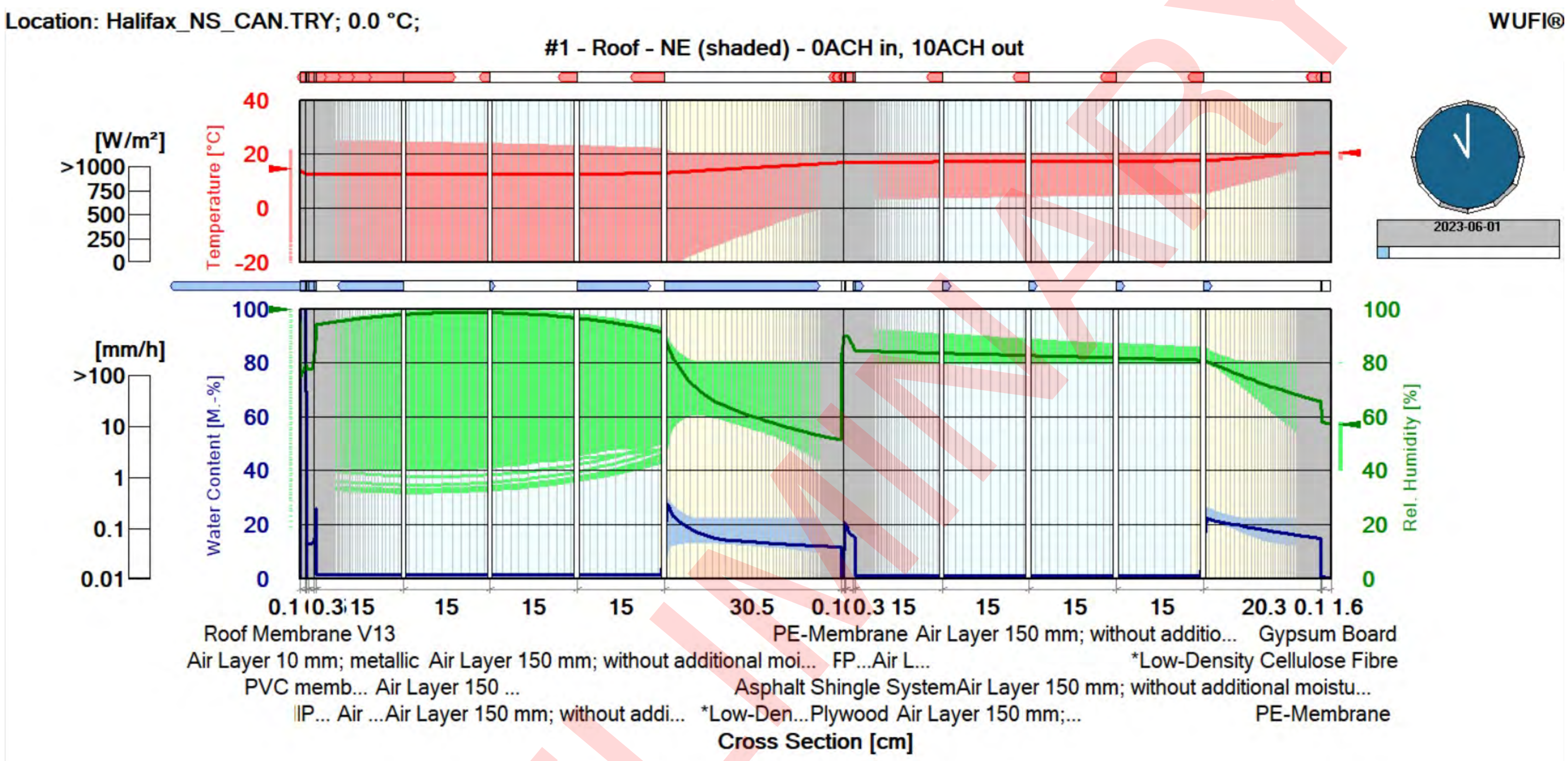


Figure 9 – WUFI® film output for North-East Roof assembly: temperature(°C) and water content (kg/m³, %) over 10-year period studied for post-retrofit North-East Roof assembly – high RH in new airspace/ attic space (scenario with 0-ACH existing attic, 10-ACH new attic space, shaded)

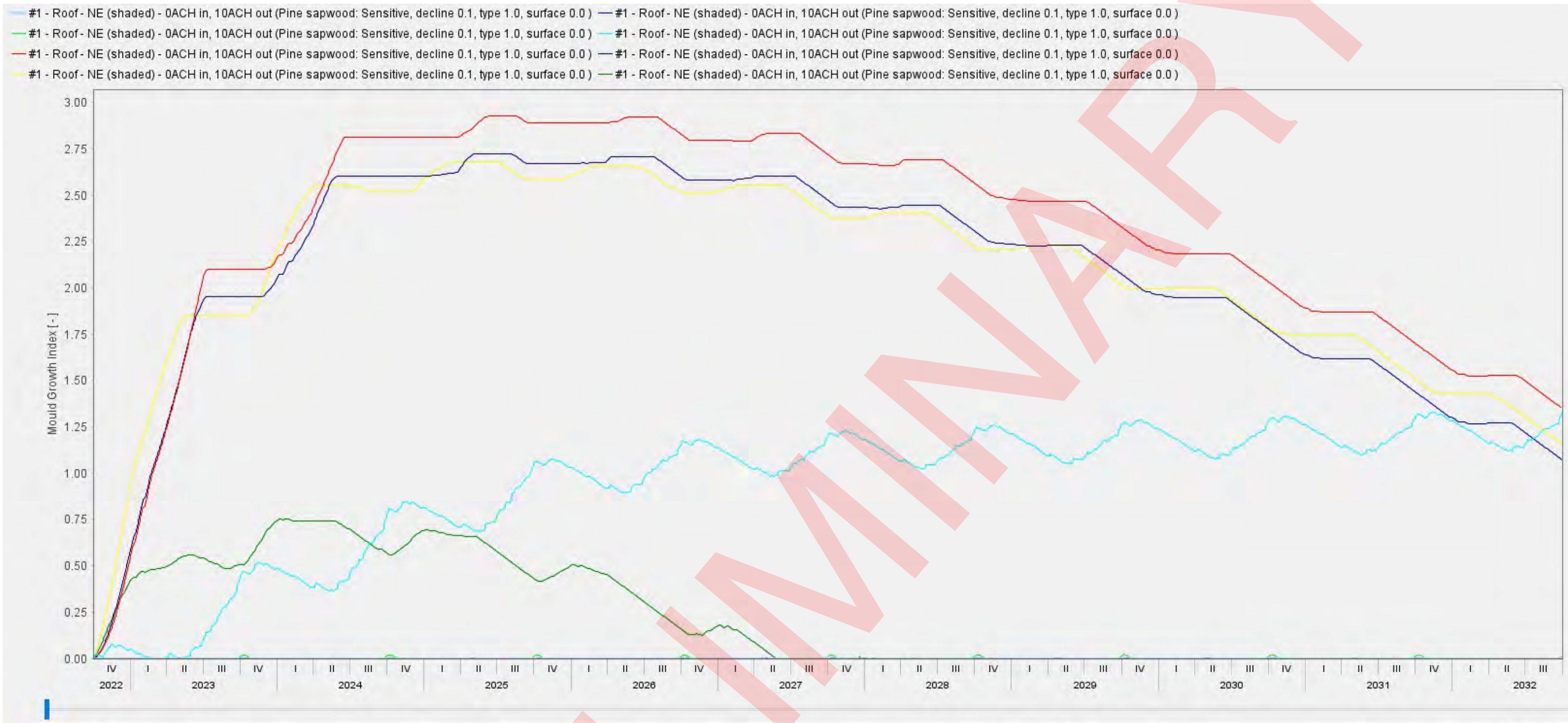


Figure 10 – WUFI® output for North-East Roof assembly: VTT mold growth index simulation over 10-year period studied for post-retrofit North-East Roof assembly (scenario with 0-ACH existing attic, 10-ACH new attic space, shaded)
(dark blue: new outer plywood, light green: new center plywood, light blue: new inner plywood,
red: existing outer plywood, black: existing center plywood, yellow: existing inner plywood,
dark green: existing outer cellulose element, grey: existing inner cellulose element)

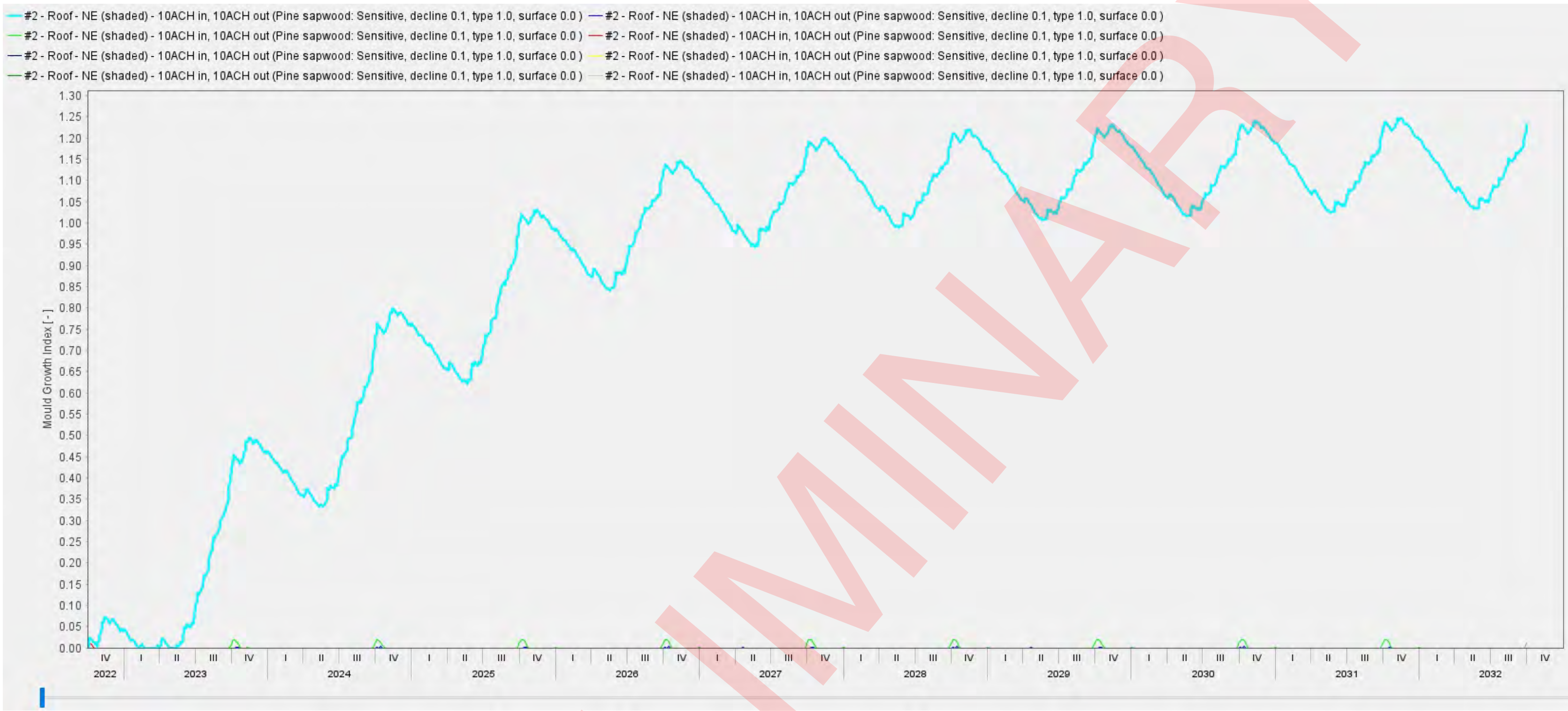


Figure 11 – WUFI® output for North-East Roof assembly: VTT mold growth index simulation over 10-year period studied for post-retrofit North-East Roof assembly (scenario with 10-ACH existing attic, 10-ACH new attic space, shaded)
(dark blue: new outer plywood, light green: new center plywood, light blue: new inner plywood,
red: existing outer plywood, black: existing center plywood, yellow: existing inner plywood,
dark green: existing outer cellulose element, grey: existing inner cellulose element)

LIMITATIONS OF STUDY

The results presented in this report are subject to certain limitations, including the following:

- Wall and roof assembly materials and thicknesses were assumed based on information obtained from the City of Halifax and the ReCover team, as well as available predefined WUFI® materials;
- The venting behind the wall (25-ACH) and roof (1-ACH) metal cladding systems were estimated for this preliminary draft report based on the PHIUS+ protocol and previous modelling projects;
- The attic spaces simulated were of average estimated height;
- The double-attic/roof system with varying inclinations cannot be specifically modelled in WUFI® Pro, as one inclination must be chosen for the entire assembly under simulation. To the knowledge of the author, modelling techniques for double-attic systems such as the present case are not well studied in literature and should be investigated further for the overall ReCover project;
- All material properties, including but not limited to thermal conductivity and permeability, were assumed based on WUFI® Pro default values as well as the ReCover team's approximations. The specific vulnerability of the existing and proposed materials to moisture and mold growth is approximated, and should be validated with specialists;
- Damage functions indicated in the report were the only ones studied – rot/decay of the wood elements (excluding sheathing), corrosion of any metal elements, bulk water leaks, and any other damage functions were not simulated due to limitations of the one-dimensional WUFI® Pro software, information available, and scope of work;
- Mold growth index simulation using VTT requires estimation of the properties of each material layer studied. The assumptions used in this feasibility study should be validated with specialists in this field. The mold growth risks involved could be higher if the materials specified for the project are more vulnerable to mold growth than the approximated materials modelled in WUFI®;
- VTT results can vary from one element to another within a given material layer – the results presented in this report are dependent on the elements chosen for simulation;
- The climate file used for the simulations approximates the typical weather experienced by the building under simulation (no extreme weather events), and also cannot adequately model the micro-climate experienced by the building in its specific location;
- All interfaces, connections, and details (e.g., interface between wall and roof assemblies) were not modelled in WUFI® Pro and should be validated by others;
- This report assumes that any issues with the existing envelope will be addressed prior to conducting the retrofit, including but not limited to cracking of the masonry, unsealed penetrations, etc.;
- WUFI® Pro is a one-dimensional software that cannot quantify all real-world hygrothermal phenomena. For instance, WUFI® 2-D could better approximate a complex

two-dimensional phenomenon that WUFI® Pro could not – certain software is therefore better served in certain situations;

- WUFI® Pro is a software and is limited by the quality of data inputted into each case studied – given the nature of the preliminary study in question, the information available for the assemblies' components, the unknown properties of each material, and the approximated indoor/outdoor conditions, great care must be taken when considering the WUFI® Pro results presented in this feasibility report.

If the ReCover team's retrofit design should move forward to construction, it is imperative that a more thorough investigation of the wall and roof assemblies in question be conducted so that more accurate predictions of the assemblies' hygrothermal performance can be made. Further information of the building is necessary, including but not limited to validation of the wall and roof assemblies, determination of material thicknesses and properties, etc. Therefore, the results of the WUFI® Pro models presented in this report can only be used as a first step towards understanding the post-retrofit hygrothermal performance of the wall and roof assemblies in question. **This preliminary feasibility report cannot be used for construction purposes.** Once further investigation of the actual conditions is completed (e.g., wall and roof openings) and the design of the panels are reviewed and approved by the appropriate parties, hygrothermal models will need to be simulated with the validated inputs, a specific location-based climate file, etc. This will create a more accurate WUFI® model of the building envelope in question and allow for a better understanding of the assemblies' hygrothermal performance post-retrofit.

It is hoped that this report is to your satisfaction. If you have any questions, please do not hesitate to contact Stanley Francispillai.

Stanley Francispillai, P. Eng. (QC, NS)
WUFI® Pro Software Modeller
(438) 872-5524

APPENDIX A

Assembly Notes

Assembly Notes

Project:	Halifax NRCan Pilot Project
Case:	North-East, South-East, South-West Main Wall
Reference Files:	*"22 09 16 - Willaimswood Assembly Details.pdf" - RSI Projects* *Email: 2022-12-12, Nick Rudnicki* *Email: 2023-02-15, Amanda McNeil* *Email: 2023-02-22, Lorrie Rand* *Phone & video calls with ReCover Team*

Assembly (Exterior to Interior)	**Modelled Material (WUFI)**	**Alterations (If Applicable)**	**Supporting Docs. (If Applicable)**
Metal cladding	Roof Membrane V13 (Generic Materials)	-	PHIUS+ protocol
3/4" vented air gap	Air Layer 10 mm; metallic (Generic Materials)	Specific air layer behind metallic surfaces	PHIUS+ protocol
High Perm WRB (Assume PERM 50, Tech specs available)	Spun Bonded Polyolefin Membrane (SBP) (North America Database)	-	Assumption
1/2" SPF Plywood	Plywood (USA) (N.A. Database)	Split into three layers, 1/8" inner and outer	PHIUS+ protocol
9.25" of dense pack cellulose	Cellulose Fibre (heat cond.: 0,04 W/mK) (Fraunhofer Database)	-	Past ReCover project assumption
Cellulose Bib Super high PERM	INTELLO PLUS (ETA) (N.A. Database)	-	ReCover Team
1/2" air gap (from 1x4 SPF strapping)	Air Layer 20 mm; without additional moisture capacity (Generic Materials)	-	For strapping + existing wall abnormalities
Wood fiber siding	Composite Wood Siding (N.A. Database)	Permeability at each RH level increased by 15% to achieve approximately 10 perms permeance under WET conditions as per Building Science Corp. Info-312	Assumption
Vent cavity/strapping (ReCover assumed)	Air Layer 10 mm; without additional moisture capacity (Generic Materials)	-	For strapping
Block wall	Concrete Brick (N.A. Database)	8" thickness, per standard concrete block width	Assumption
4" void	Air Layer 100 mm; without additional moisture capacity (Generic Materials)	-	-
6" fiberglass batt	Low Density Glass Fiber Batt Insulation (N.A. Database)	-	-

6mil poly	PE-Membrane (Poly; 0.07 perm) (Fraunhofer-IBP Database)	-	-
5/8" drywall	Gypsum Board (USA) (N.A. Database)	-	-

Assembly Notes

Project: Halifax NRCan Pilot Project

Case: North-West, South-West, South-East Bump-Out Wall (+ North-West Main Wall)

Reference File: *"22 09 16 - Willaimswood Assembly Details.pdf" - RSI Projects*
Email: 2022-12-12, Nick Rudnicki
Email: 2023-02-15, Amanda McNeil
Email: 2023-02-22, Lorrie Rand
Phone & video calls with ReCover Team

Assembly (Exterior to Interior)	**Modelled Material (WUFI)**	**Alterations (If Applicable)**	**Supporting Docs. (If Applicable)**
Metal cladding	Roof Membrane V13 (Generic Materials)	-	PHIUS+ protocol
3/4" vented air gap	Air Layer 10 mm; metallic (Generic Materials)	Specific air layer behind metallic surfaces	PHIUS+ protocol
High Perm WRB (Assume PERM 50, Tech specs available)	Spun Bonded Polyolefin Membrane (SBP) (North America Database)	-	Assumption
1/2" SPF Plywood	Plywood (USA) (N.A. Database)	Split into three layers, 1/8" inner and outer	PHIUS+ protocol
9.25" of dense pack cellulose	Cellulose Fibre (heat cond.: 0,04 W/mK) (Fraunhofer Database)	-	Past ReCover project assumption
Cellulose Bib Super high PERM	INTELLO PLUS (ETA) (N.A. Database)	-	ReCover Team
1/2" air gap (from 1x4 SPF strapping)	Air Layer 20 mm; without additional moisture capacity (Generic Materials)	-	For strapping + existing wall abnormalities
Wood fiber siding	Composite Wood Siding (N.A. Database)	Permeability at each RH level increased by 15% to achieve approximately 10 perms permeance under WET conditions as per Building Science Corp. Info-312	Assumption
Vent cavity/strapping (ReCover assumed)	Air Layer 10 mm; without additional moisture capacity (Generic Materials)	-	For strapping
5.5" fiberglass batt	Low Density Glass Fiber Batt Insulation (N.A. Database)	-	-
6mil poly	PE-Membrane (Poly; 0.07 perm) (Fraunhofer-IBP Database)	-	-
5/8" drywall	Gypsum Board (USA) (N.A. Database)	-	-

Assembly Notes			
Project:	Halifax NRCan Pilot Project		
Case:	North-East, South-West Roof		
Reference File:	*"22 09 16 - Willaimswood Assembly Details.pdf" - RSI Projects* *Email: 2022-12-12, Nick Rudnicki* *Email: 2023-02-15, Amanda McNeil* *Email: 2023-02-22, Lorrie Rand* *Phone & video calls with ReCover Team*		
Assembly (Exterior to Interior)	**Modelled Material (WUFI)**	**Alterations (If Applicable)**	**Supporting Docs. (If Applicable)**
Metal roofing	Roof Membrane V13 (Generic Materials)	-	PHIUS+ protocol
3/4" air gap	Air Layer 10 mm; metallic (Generic Materials)	Specific air layer behind metallic surfaces; Also assumed 1ACH venting with exterior	PHIUS+ protocol
Low perm roof membrane	PVC Membrane (N.A. Database)	-	Assumption
5/8" sheathing	Plywood (USA) (N.A. Database)	Split into three layers, 1/8" inner and outer	PHIUS+ protocol
Vented air space	Air Layer 150 mm; without additional moisture capacity (Generic Materials)	4 x material = 600 mm airspace Vented at 10ACH	Assumption
12" loose fill cellulose	Cellulose Fibre (heat cond.: 0,04 W/mK) (Fraunhofer-IBP)	Bulk density changed to 55 kg/m3; Thermal conductivity changed to 0,05 W/mK	Assumption; ReCover
6 mil vapour barrier taped for air tightness	PE-Membrane (Poly; 0.07 perm) (Fraunhofer-IBP)	-	Assumption
Asphalt Shingles	Asphalt Shingle System (N.A. Database)	-	Assumption
3/4" T+G Plank Decking	Plywood (USA) (N.A. Database)	0.019m thickness Split into three layers, 1/8" inner and outer	PHIUS+ protocol
Unvented air space	Air Layer 150 mm; without additional moisture capacity (Generic Materials)	4 x material = 600 mm airspace Vented at 0, 0.01, 0.1, and 10ACH with interior, or 5ACH mixed interior and exterior	Assumption

8" loose pack cellulose	Cellulose Fibre (heat cond.: 0,04 W/mK) (Fraunhofer-IBP)	Bulk density changed to 55 kg/m3; Thermal conductivity changed to 0,05 W/mK	Assumption; ReCover
6 mil vapour barrier	PE-Membrane (Poly; 0.07 perm) (Fraunhofer-IBP)	-	Assumption
5/8" drywall	Gypsum Board (USA) (N.A. Database)	-	-

Appendix K

Embodied Carbon

NRCan | Recover FEED Studies

Halifax Building Retrofit Embodied Carbon Assessment

Fatma Osman, BA, Toronto Metropolitan University

INTRODUCTION

This report presents an embodied carbon analysis of the Halifax retrofit project proposed by the Recover Initiative as part of the NRCan FEED studies. Understanding the embodied carbon in the construction industry can help reduce the overall carbon footprint of buildings, which is one of the main goals the Recover initiative works to achieve. This report emphasizes the importance of embodied carbon analysis and the environmental impacts attributed to material selection.

SCOPE OF WORK

The scope of work includes conducting an embodied carbon analysis of the retrofit project; all materials that are proposed to be added to the existing building. This analysis is limited to embodied carbon of assembly materials and does not include other systems, such as the HVAC systems. Specifically, the analysis looks at additions to above-grade walls, roofs, below-grade components, and windows and doors. The results include a whole life cycle assessment of the building in six impact categories: Global Warming, Ozone Depletion, Acidification, Eutrophication, Formation of tropospheric ozone, Depletion of nonrenewable energy, and Biogenic carbon storage.

INPUTS AND ASSUMPTIONS

- The materials used in the analysis were chosen based on the most representative materials available to the Canadian market that has Environmental Product Declarations (EPDs) available in the One Click LCA software database.
- Materials were chosen based on their environmental performance; averages were prioritized (unless low-carbon materials were specified by the Recover design team).
- The service life used in the analysis is 60 years as per LEED v4 minimum requirement for whole building LCAs.
- Materials within assembly panels were assumed to have a 60 years service life as the building; all other materials were left to default service lives as per the One Click software.

THIS REPORT CONTAINS

- Summary of Results.
- Summary of Global Warming Potential (GWP) per building floor area.
- Graphs that summarize the detailed tables.
- Detailed data on assembly materials and specific products used in the assessment (in Appendix).
- Detailed data on embodied carbon of the different life stages of the buildings in the form of tables (in Appendix).

Halifax Retrofit Project LCA results summary

Table 1: Total Global Warming Potential

Halifax building gross floor area m2	A1-A3 KgCO2e/m2	A1-C4 KgCO2e/m2	Biogenic carbon KgCO2e/m2
456	60.56	86.86	151.1

The major contributors to the GWP in this design are the wood used for building the truss, and the steel wall cladding. The A1-A3 Materials stage contributed 70% of the total carbon emissions associated with this building as illustrated in Figure 1 & 2. Table 1 above shows that the biogenic carbon storage of this building design surpasses that of the A1-C4 emissions by 43%, making the building have a surplus in carbon storage capacity. This storage is attributed to the wood products (87%) and cellulose insulation (13%) used in the assembly as shown in Figure 3. The results graphs below show the breakdowns of life cycle stages and impact categories associated with the materials.

Results Graphs

Halifax Retrofit Global Warming by Stage and Material

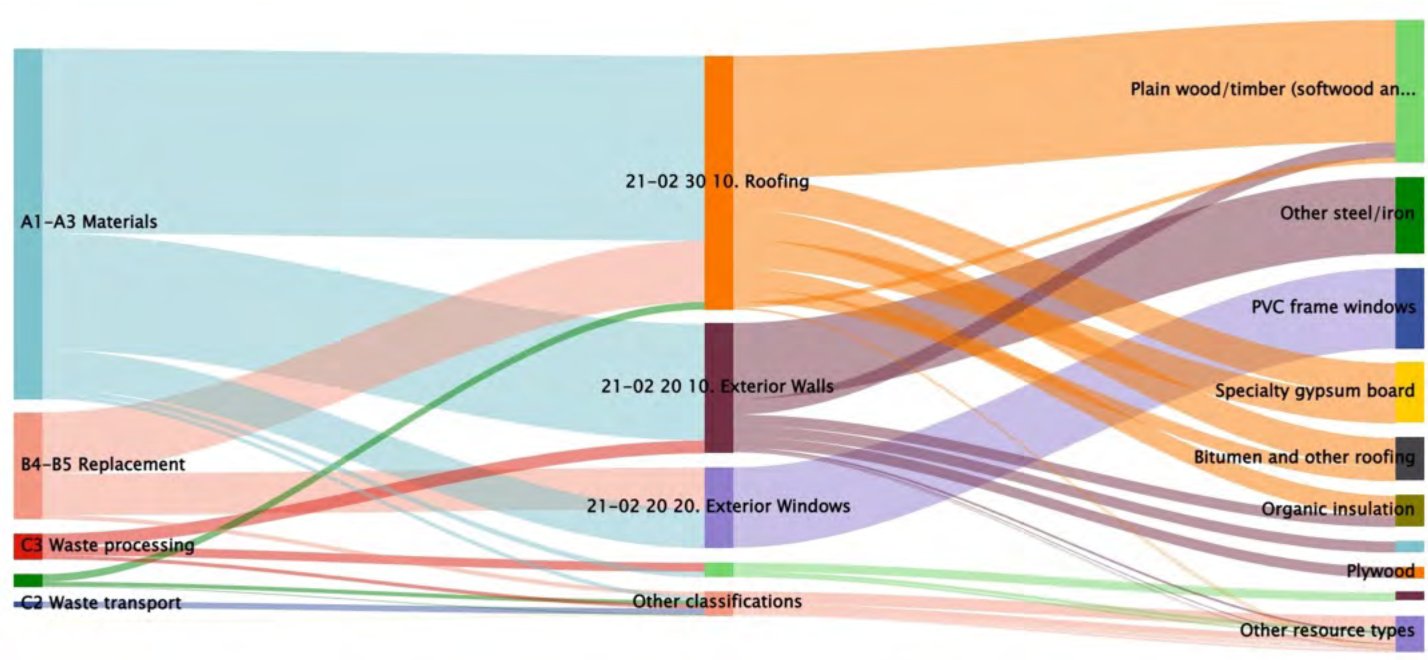


Figure 1: Halifax retrofit design breakdown of the life cycle stages and the associated materials

Halifax Retrofit Life-Cycle Impacts by Stage (%)

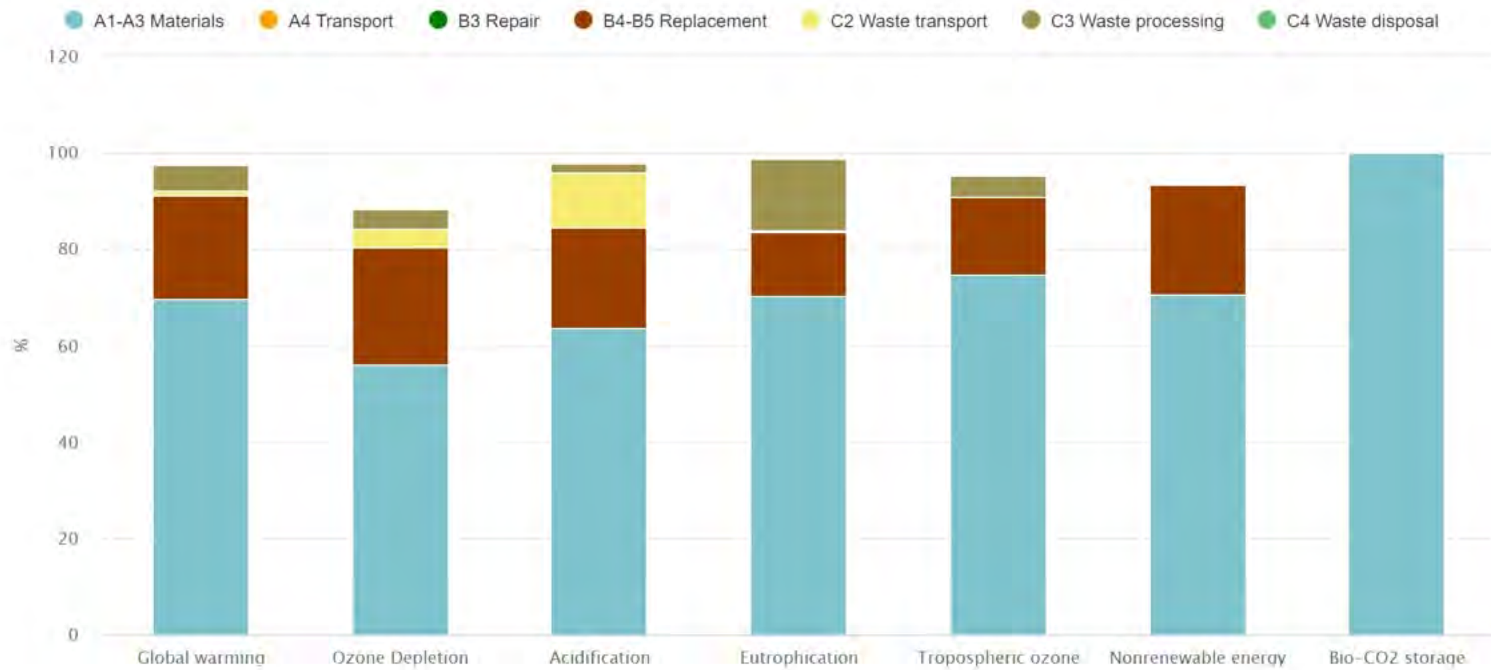


Figure 2: Halifax retrofit design breakdown of the life cycle impact categories and the associated life cycle stages

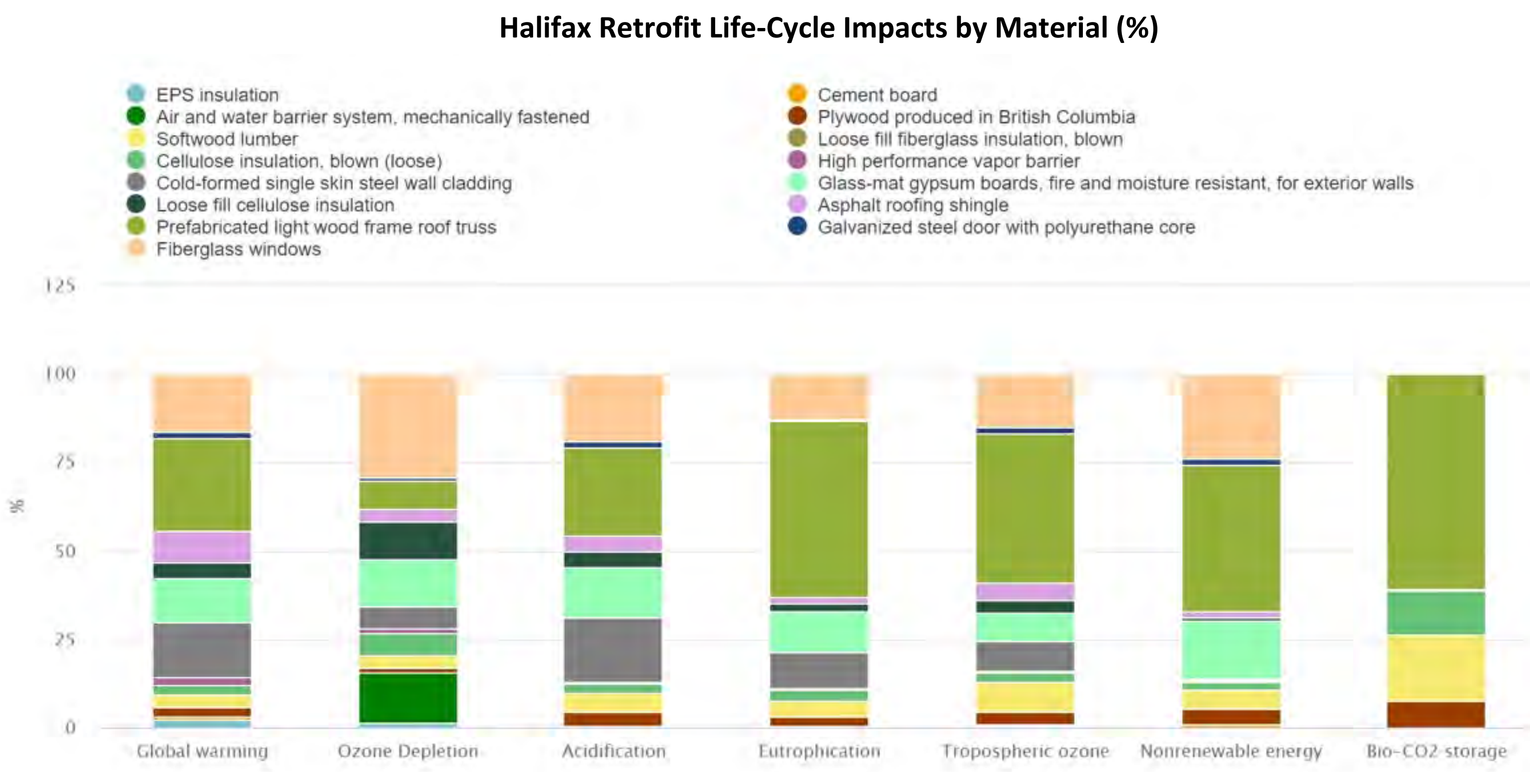


Figure 3: Halifax retrofit design breakdown of the life cycle impact categories and the associated materials

Appendix

Proposed Retrofit Assemblies and Environmental Impact calculations

Halifax

Wall Panel Assembly (R28)

Material (ReCover specification)	Description (from EPD)	Thickness (mm)	Volume of material (m3)	Carbon emissions (A1-A3) (KgCO2E)	% of total
Self Adhered WRB	Air and water barrier system, mechanically fastened, 0.0225 lbs/ft2, 0.11 kg/m2, Tyvek (DuPont)		*	42.7	0.4%
1/2" SPF plywood sheathing	Plywood produced in British Columbia, 477.33 kg/m3 (Forestry Innovation Investment)	13	6.604	869.6	9.0%
2x6 SPF framing	Softwood lumber, 405 kg/m3 (Canadian Wood Council)		14.464	1070.6	11.1%
Compressible insulation	Loose fill fiberglass insulation, blown, Rsi=1 m2K/W, 19.84 mm, 0.46 kg/m2, 23.2 kg/m3, (Johns Manville)	21	0.615	17.1	0.2%
Exterior strapping (#3)	Softwood lumber, 405 kg/m3 (Canadian Wood Council)		0.722	53.4	0.6%
Dense pack cellulose (9.5")	Cellulose insulation, blown (loose), L = 0.039 W/mK, R = 2.56 m2K/W (15 ft2°Fh/BTU), 50 kg/m3 (3.12lbs/ft3), (applicable for densities: 40-90 kg/m3 (2.5-5.62 lbs/ft3)),	234.95	100.191	879.8	9.1%
Intello plus	High performance vapor barrier, 0.021 in (0.5 mm), 0.76 kg/m2, Florprufe® 120 (GCP Applied Technologies)		*	149.4	1.6%
1x4 strapping	Softwood lumber, 405 kg/m3 (Canadian Wood Council)		1.204	89.1	0.9%
Metal siding (cladding)	**Cold-formed single skin steel wall cladding, 0.36-1.27 mm, 4.17 kg/m2 (Metal Building Manufacturers Association)**		*****	**6017.0**	**62.5%**
4" EPS wall insulation	EPS insulation (generic)	101.6	16	185.3	1.9%
2" thick below grade fin		50.8			
Cement board	Cement board, 11.8 kg/m2, PLUS (PermaBASE Building Products)	6.35	0.5842	253.5	2.6%
Total				**9627.7**	100.0%
* Software calculates the impact based on the area provided			**Per m2**	**21.1**	**kg CO2/m2**

Roof Panel Assembly (R38)

Material (ReCover specification)	Description (from EPD)	Thickness (mm)	Volume of material (m3)	Carbon emissions (A1-A3) (KgCO2E)	% of total
Scissor trusses over existing	**Prefabricated light wood frame roof truss, 417 kg/m3, 99.6% softwood lumber, < 0.1% LVL, < 0.1% OSB, 0.4% metal connector plates (Quebec Wood Export Bureau (2020))**		55	**9,636.00**	**66.1%**
R40 loose fill cellulose	Loose fill cellulose insulation, RSI = 1 m2K/W, 40.5 mm (38 - 43 mm range), 24.31 kg/m3 (20.27-28.35 kg/m3 range) (Industry Average)	300	133	1,599.28	11.0%
New sheathing	Glass-mat gypsum boards, fire and moisture resistant, for exterior walls, 12.7 mm (1/2 inch), 9.75 kg/m2 (1.997 lb/ft2), 768 kg/m3, 1/2 DensGlass, 1/2 DensElementTM (Georgia-Pacific Gypsum LLC)	15	7.5	2,275.75	15.6%
New roofing	Asphalt roofing shingle, 2.8 mm, 9.49 kg/m2, Dura-Seal™ Shingles (Malarkey Roofing Products®)			1,062.00	7.3%
Total				**14,573.03**	100.0%
* Software calculates the impact based on the area provided			**Per m2**	**32.0**	**kg CO2/m2**

Windows and Doors

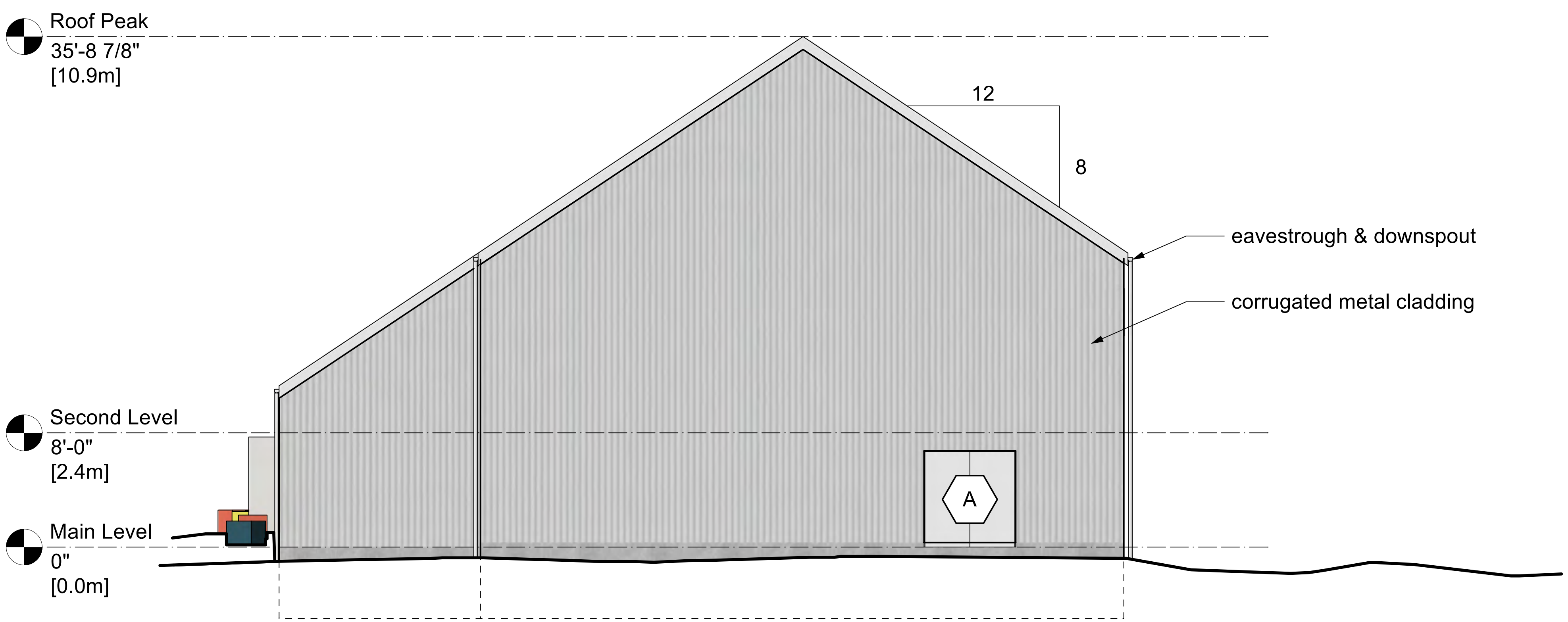
Material (ReCover specification)	Description (from EPD)	Thickness (mm)	Volume of material (m3)	Carbon emissions (A1-A3) (KgCO2E)	% of total
Insulated core steel doors	Galvanized steel door with polyurethane core, 44.5 mm (1.75 inch), 42.5 kg/unit, 490 kg/m3 (DE LA FONTAINE)	*	*	333.00	9.8%
High performance triple pane windows	Fiberglass windows, 1.5m x 1.3 m, 40 mm frame thickness, 1.42 m2 glazing area, 60.50 kg/m2, 300 Series Tilt and Turn, 300 Series Fixed, 325 Series Awning/Casement, 325 Series Fixed, 400 Series (Inline)	*	*	3,080.23	90.2%
Total				**3,413.23**	100.0%

* Quantity is calculated in software based on area and/or number of units	**Per m2**	**6.8**	**kg CO2/m2**

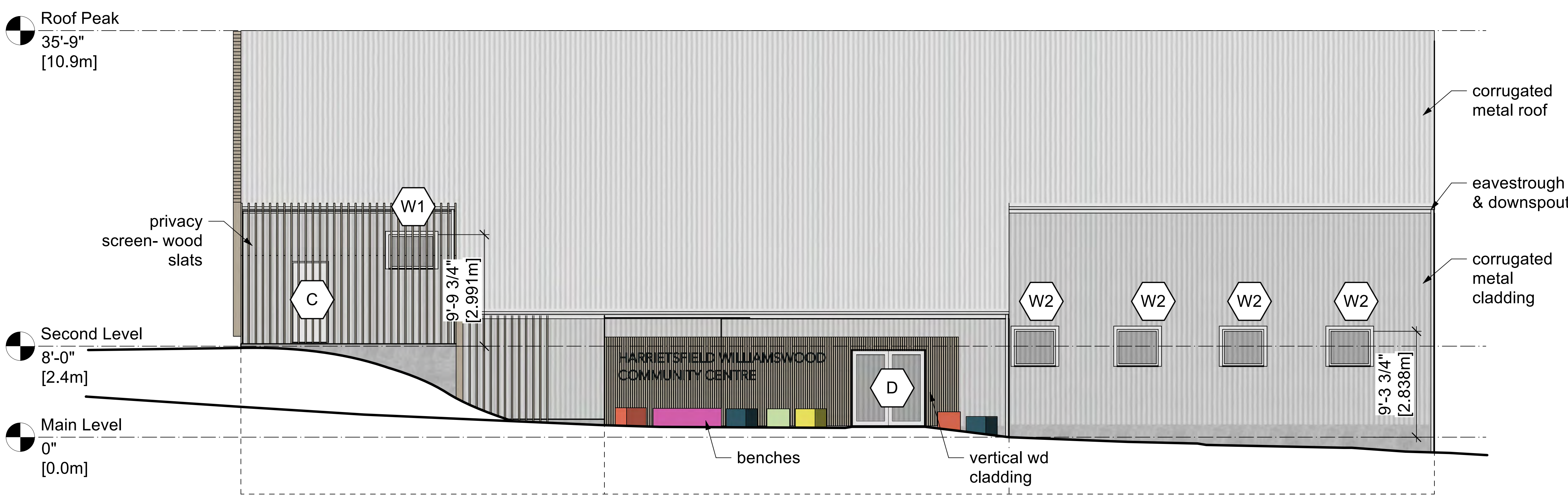
Environmental Emissions

Halifax Project		**A1 to C4**	**A1-A3**	**A4-A5**	**B1-B5**	**C1-C4**	**A1-A3**
Result category	**Units**	**Total**	**Construction Materials**	**Transportation to site & construction**	**Material replacement & refurbishment**	**Deconstruction**	**A1-A3 % of total**
Global warming	kg CO2e	39,606.50	27613.94	1001.12	8441.4	2550.04	69.7%
Ozone Depletion	kg CFC11e	0.00	0.0013	0.00026	0.00057	0.00019	56.0%
Acidification	kg SO_2e	292.15	185.6	5.7	61.23	39.62	63.5%
Eutrophication	kg Ne	67.67	47.49	0.8	9.11	10.27	70.2%
Formation of tropospheric ozone	kg O3e	3,651.32	2732.29	161.72	580.64	176.67	74.8%
Depletion of nonrenewable energy	MJ	454,100.07	321250.9	28466.26	102424	1958.91	70.7%
Biogenic carbon storage	kg CO2e	68,922.11	68922.11	0	0	0	

Appendix L
Architectural Elevation Drawings



1 North Elevation
3/32" = 1'-0"



2 East Elevation
3/32" = 1'-0"

0 4 8 12 16 20FT
graphic scale:
north arrow:

habit studio
6437 Cork St, Halifax, NS
email: lorrie@habitstudio.ca | tel: 902.448.6873

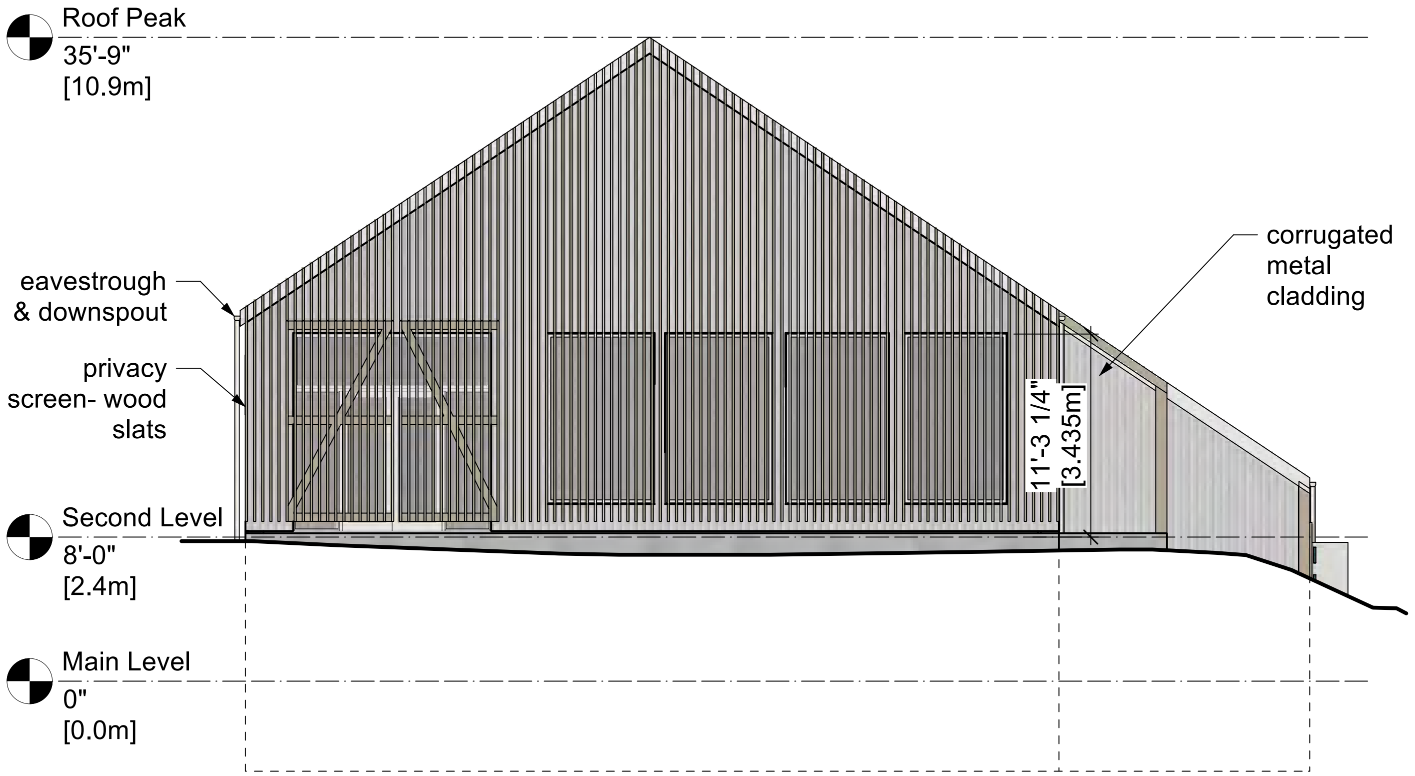
ReCover

Harrietsfield Williamswood Community Centre

Harrietsfield, NS
ReCover Initiative Panelized Deep Retrofit Study

drawing title: Proposed North & East Elevations		
phase: concept		sheet size: 17x11
drawn by: IG	checked by: LR	drawing number: A1
date: 2023-08-15	scale: scale	

halifax_CURRENT.vwx



3 South Elevation

3/32" = 1'-0"

4 West Elevation

3/32" = 1'-0"

0 4 8 12 16 20FT

graphic scale:

north arrow:

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email: lorrie@habitstudio.ca | tel: 902.448.6873

ReCover

Harrietsfield Williamswood Community Centre

Harrietsfield, NS

ReCover Initiative Panelized Deep Retrofit Study

drawing title:		
Proposed South & West Elevations		
phase: concept		sheet size: 17x11
drawn by: IG	checked by: LR	drawing number: A2
date: 2023-08-15	scale: scale	

halifax_CURRENT.vwx

APPLICABLE CODES AND STANDARDS

Building Code:	2020 Nova Scotia Building Code Regulations (NSBC) 2015 National Building Code of Canada (NBCC)
Fire Code:	2015 National Fire Code of Canada
Accessibility:	2020 Nova Scotia Building Code Regulations (NSBC) 2015 National Building Code of Canada (NBCC)

BUILDING DESCRIPTION

Harrietsfield Williamswood Community Centre

		NSBC Reference
Building Area (Footprint):	485 m²	
Gross Floor Area:	581m²	
Building Height:	2 Storey	1.4.1.2
Major Occupancy, Proposed:	Group A2 - assembly occupancy based on activities of community centre and child care (school age)	3.1.2.1.

CONSTRUCTION REQUIREMENTS

		NSBC Reference
Construction Governed by:	NSBC Part 3	1.3.3.2.
Building Area:	< 800 m²	3.2.2.25.(1) (b)
Building Height:	2 Storey	3.2.2.25.(1) (a)
Streets to Face:	1	3.2.2.25.(1)
Construction Type:	Combustible or Nomcombustible	3.2.2.25.(2)
Fire Resistance Ratings:		
Upper Floors (n/a):	45 Minute	3.2.2.25.(2)(a)
Loadbearing Elements supporting an assembly required to have a fire-resistance rating	45-minute FRR or noncombustible	3.2.2.25.(2)(d)
Roof, Occupied (n/a):	45-minute	3.2.2.25.(2)(c)
Loadbearing Elements supporting a fire separation:	N/A	
Sprinkler:	not required	3.2.2.25.
Standpipe:	not required	3.2.5.8.(1)
Fire Alarm:	Required	3.2.4.1.(4)(f)
Portable Fire Extinguisher:	Required within 22.9 m of travel from all points within	NFC 2.1.5.1. / NFPA 10
Fire Hydrant:	N/A	

SPATIAL SEPARATIONS

The type of construction, cladding and fire-resistance rating of the exposed building faces is summarized below.
NSBC References: Article 3.2.3.1. and NSBC Table 3.2.3.1.-E

Facing	Limiting Distance (m)	Wall Area (m²)	H:L Ratio	Unprotected Openings		Exposing Building Face		
				Permitted	Proposed	FRR	Construction	Cladding
North	6.5	130.0	1:7.1	34.0%	2.0%		Comb. or Noncomb.	Comb. or Noncomb.*
East	150.0	67.0	1:2.8	100.0%	0.0%	-	Comb. or Noncomb.	Comb. or Noncomb.
South	8.0	29.0	1:3.7	100.0%	6.0%	-	Comb. or Noncomb.	Comb. or Noncomb.
West	9.5	50.0	1:3.5	100.0%	0.0%		Comb. or Noncomb.	Comb. or Noncomb.

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ReCover

Harrietsfield Williamswood Community Centre
Harrietsfield, NS
ReCover Initiative Panelized Deep Retrofit Study

drawing title: Code review		
phase: concept		sheet size: 17x11
drawn by: IG	checked by: LR	drawing number: A3
date: 2023-08-15	scale: scale	

graphic scale: north arrow:

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Appendix M

Cost Estimate

Retrofit 1138 Old Sambro Road

Halifax, Nova Scotia

ELEMENTAL COST PLAN
CLASS D - FEASIBILITY ESTIMATE
JULY 20, 2023

QSolv

163 Village Road, Herring Cove, Nova Scotia, Canada, B3V 1H2
www.qsolv.ca

Preamble

INTRODUCTION

The Class D - Feasibility Estimate enclosed represents the construction costs for the proposed energy retrofit options to the existing daycare and community centre located at 1138 Old Sambro Road in Halifax, Nova Scotia as design by RSI Projects Inc.

Four scenario cost options are presented in this report as follows:

Scenario One Code Minimum generally includes the replacement of the existing facade with new metal siding on prefab insulated panels, roof replacement on new pre-eng scissor roof trusses with cellulose insulation, replacement of windows; upgrade to electric boiler, addition of ERVs, upgrade lighting with LED lights, and new electric DHWT.

Scenario Two Net Zero Ready - ASHP generally includes the replacement of the existing facade with metal siding on prefab insulated panels, insulation on foundation walls, replacement of windows, roof replacement on new pre-eng scissor roof trusses with cellulose insulation, change HVAC to an air source heat pump system and ERVs, upgrade service entrance, replacement of lighting with LED fixtures, and add heat pump hot water heaters.

Scenario Three Net Zero Ready - GSHP generally includes the replacement of the existing with metal siding on prefab insulated panels, insulation on foundation walls, replacement of windows, roof replacement on new pre-eng scissor roof trusses with cellulose insulation, change HVAC to a ground source heat pump system and ERVs, upgrade service entrance, replacement of lighting with LED fixtures, and add heat pump hot water heaters.

Scenario Four Net Zero generally includes all scope items from Scenario Three plus adds photovoltaics.

APPROACH

The construction costs for this report include all materials, labour, equipment, overheads, general conditions, plus markups and contractor's profit, for the retrofit options as presented in the project documents.

Preamble

APPROACH

The estimated **Construction Value** per Scenario is as follows:

Scenario One Minimum Code	$1,155,000.00
Scenario Two Net Zero Ready - ASHP	$1,269,000.00
Scenario Three Net Zero Ready - GSHP	$1,473,000.00
Scenario Four Net Zero	$1,663,000.00

Quantities were measured based on the Canadian Institute of Quantity Surveyors (CIQS) standards for Method of Measurement and presented in elemental format.

Pricing reflects competitive bids for every element of the work for a project of this type procured under an open market stipulated lump sum bid contract in Halifax, Nova Scotia. Unit costs are developed and expressed as typical sub-contractor pricing and are inclusive of subcontractor's overheads and profits.

This estimate is an indication of the probable construction costs and is intended to represent fair market value of the construction costs. This estimate should not be considered a prediction of the lowest bid.

SPACE MEASUREMENT

The Gross Floor Area (GFA) was measured at 6,392 square feet (sf) based on the Canadian Institute of Quantity Surveyors (CIQS) Method of Measurement and the International Construction Measurement Standards (ICMS).

COST BASE

All costs are expressed in third quarter 2023 Canadian dollars (3Q2023).

All costs are shown exclusive of the 13% Harmonized Sales Tax (HST).

Preamble

ESCALATION

An Escalation Allowance is excluded from this report as no project schedule was provided.

Nova Scotia is experiencing significant construction escalation currently with no signs of easing moving forward. It is recommended the Owner carry a Construction Escalation allowance of 10% per annum to the mid point of construction and should be monitored and reviewed continuously during the remaining design phase.

CONTINGENCIES

A Design Development Contingency Allowance of 10% is included in this report to allow for scope and budget adjustments during the remaining design phase.

A Construction Contingency Allowance of 10% is included in this report to allow for scope changes and possible change orders during the construction phase.

EXCLUSIONS

The following have been excluded from this cost report:

Premium for single source materials or equipment unless noted otherwise
Third party commissioning
Professional and design fees
Project management fees
Interim financing
Legal fees and surveys
Owners risk allowance
Moving costs or swing space
Furniture and equipment unless noted otherwise
Hazardous materials abatement
Rock excavation
Accelerated schedule premiums
Shift premiums or after-hours work

Preamble

EXCLUSIONS

Cash allowances
Testing and inspections
Cost premiums due to new tariffs placed on material and equipment
Cost premiums due to changes in COVID-19 protocols
Allowances for rebates

DOCUMENTATION

This Class D estimate is based on the following documentation:

Drawings/Specifications/Reports	Dated:
A101 - A102	December 11, 2013
A101 - A102	July 14, 2022
Mechanical Outline Specification	February 14, 2023
Electrical Outline Specification	November 24, 2023
Structural Analysis	No Date
Retrofit Scenarios Details	No Date
Wall Panel Schematics	February 27, 2023

PROJECT COST SUMMARY

PROJECT:	RETROFIT 1138 OLD SAMBRO ROAD	DATE:	JULY 20, 2023
LOCATION:	HALIFAX, NS	CLASS:	D - FEASIBILITY
CLIENT:		FILE	13453
DESIGNER:	RSI PROJECTS		

Class D Estimate

DESCRIPTION		ELEMENTAL QUANTITY		ELEMENTAL UNIT RATE	ELEMENTAL AMOUNT	NOTES
1	SCENARIO 1 CODE MINIMUM	6392	sf	$ 181.00	$ 1,155,000	
2	SCENARIO 2 NET ZERO READY, ASHP	6392	sf	$ 199.00	$ 1,269,000	
3	SCENARIO 3 NET ZERO READY, GSHP	6392	sf	$ 230.00	$ 1,473,000	
4	SCENARIO 4 NET ZERO	6392	sf	$ 260.00	$ 1,663,000	

ELEMENTAL COST SUMMARY

PROJECT:	RETROFIT 1138 OLD SMABRO ROAD	DATE:	JULY 20, 2023
LOCATION:	HALIFAX, NS	CLASS:	D - FEASIBILITY
CLIENT:		FILE	13453
DESIGNER:	RSI PROJECTS	GFA:sf	6392

Scenario 1 Code Minimum

GROSS FLOOR AREA 6392 sf

ELEMENT	RATIO TO GFA	ELEMENTAL QUANTITY		ELEMENTAL UNIT RATE	ELEMENTAL AMOUNT	RATE PER GFA	TOTAL AMOUNT	%
A SHELL						$ 95	$ 609,392	52.76
A1 SUBSTRUCTURE						$ -	$ -	0.00
A11 Foundations	1.000	6392	sf	$ -	$ -	$ -		0.00
A12 Basement Excavation	1.000	6392	sf	$ -	$ -	$ -		0.00
A2 STRUCTURE						$ -	$ -	0.00
A21 Lowest Floor Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A22 Upper Floor Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A23 Roof Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A3 EXTERIOR ENCLOSURE						$ 95	$ 609,392	52.76
A31 Walls Below Grade	1.000	6392	sf	$ -	$ -	$ -		0.00
A32 Walls Above Grade	0.747	4772	sf	$ 82.54	$ 393,881	$ 62		34.10
A33 Windows and Entrances	0.010	64	sf	$ 125.00	$ 8,022	$ 1		0.69
A34 Roof Coverings	0.937	5989	sf	$ 34.64	$ 207,489	$ 32		17.96
A35 Projections	1.000	6392	sf	$ -	$ -	$ -		0.00
B INTERIORS						$ 3	$ 19,176	1.66
B1 PARTITIONS AND DOORS						$ -	$ -	0.00
B11 Partitions	1.000	6392	sf	$ -	$ -	$ -		0.00
B12 Doors	1.000	6392	sf	$ -	$ -	$ -		0.00
B2 INTERIOR FINISHES						$ 3	$ 19,176	1.66
B21 Floor Finishes	1.000	6392	sf	$ -	$ -	$ -		0.00
B22 Ceiling Finishes	1.000	6392	sf	$ 1.50	$ 9,588	$ 2		0.83
B23 Wall Finishes	1.000	6392	sf	$ 1.50	$ 9,588	$ 2		0.83
B3 FITTINGS AND EQUIPMENT						$ -	$ -	0.00
B31 Fittings and Fixtures	1.000	6392	sf	$ -	$ -	$ -		0.00
B32 Equipment	1.000	6392	sf	$ -	$ -	$ -		0.00
B33 Conveying Systems	1.000	6392	sf	$ -	$ -	$ -		0.00
SERVICES						$ 20	$ 125,568	10.87
C1 MECHANICAL						$ 13	$ 80,000	6.93
C11 Plumbing and Drainage	1.000	6392	sf	$ 1.49	$ 9,500	$ 1		0.82
C12 Fire Protection	1.000	6392	sf	$ -	$ -	$ -		0.00
C13 HVAC	1.000	6392	sf	$ 10.25	$ 65,500	$ 10		5.67
C14 Controls	1.000	6392	sf	$ 0.78	$ 5,000	$ 1		0.43
C2 ELECTRICAL						$ 7	$ 45,568	3.95
C21 Services and Distribution	1.000	6392	sf	$ 3.13	$ 20,000	$ 3		1.73
C22 Lighting, Devices and Heating	1.000	6392	sf	$ 4.00	$ 25,568	$ 4		2.21
C23 Systems and Ancillaries	1.000	6392	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - LESS SITE						$ 118	$ 754,136	65.29
D SITE & ANCILLARY WORK						$ -	$ -	0.00
D1 SITEWORK						$ -	$ -	0.00
D11 Site Development	1.000	6392	sf	$ -	$ -	$ -		0.00
D12 Mechanical Site Services	1.000	6392	sf	$ -	$ -	$ -		0.00
D13 Electrical Site Services	1.000	6392	sf	$ -	$ -	$ -		0.00
D2 ANCILLARY WORK						$ -	$ -	0.00
D21 Demolition	1.000	6392	sf	$ -	$ -	$ -		0.00
D22 Alterations	1.000	6392	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - INCLUDING SITE						$ 118	$ 754,136	65.29
Z GENERAL REQUIREMENTS AND ALLOWANCES						$ 63	$ 400,182	34.65
Z1 GENERAL REQUIREMENTS AND FEES						$ 31	$ 199,846	17.30
Z11 General Requirements and Overheads		15%			$ 113,120	$ 18		9.79
Z12 Contractors Profit		10%			$ 86,726	$ 14		7.51
Z2 ALLOWANCES						$ 31	$ 200,336	17.35
Z21 Design Allowance		10%			$ 95,398	$ 15		8.26
Z22 Escalation Allowance TBD		0%			$ -	$ -		0.00
Z23 Construction Allowance		10%			$ 104,938	$ 16		9.09
TOTAL CONSTRUCTION COST (HST EXTRA)				$181 per sf			$ 1,155,000	100.00

Element	Quantities		Unit Rates		Sub-totals	
EXTERIOR ENCLOSURE						
A32 Walls Above Grade						
▪ remove existing façade	4772	sf	$	3.00	$	14,315
▪ structural upgrades including base angle	9000	lbs	$	4.00	$	36,000
Bent Pl 1/2X24	8550					
▪ supply and install r11 prefab insulated wall panels	4772	sf	$	27.00	$	128,837
▪ supply and install prefinished metal siding	4772	sf	$	45.00	$	214,729
A32 Walls Above Grade Total	**4772**	**sf**	**$**	**82.54**	**$**	**393,881**
A33 Windows and Entrances						
▪ replace windows with triple pane	64	sf	$	125.00	$	8,022
A33 Windows and Entrances Total	**64**	**sf**	**$**	**125.00**	**$**	**8,022**
A34 Roof Coverings						
▪ remove existing roof finish	5989	sf	$	1.00	$	5,989
▪ 3/4 T&G plywood sheathing	6887	sf	$	10.00	$	68,874
▪ install new pre-engineered roof trusses above existing	5989	sf	$	13.00	$	77,857
▪ new knee wall construction, hurricane clips	505	sf	$	15.00	$	7,572
▪ additional gable end sheathing	659	sf	$	8.00	$	5,274
▪ new R11 loose fill insulation	5989	sf	$	2.00	$	11,978
▪ new asphalt shingle roof system	5989	sf	$	5.00	$	29,945
A34 Roof Coverings Total	**5989**	**sf**	**$**	**5.50**	**$**	**207,489**
FINISHES						
B22 Ceiling Finishes						
▪ cut and patch ceilings for new mechanical/electrical	6392	sf	$	1.50	$	9,588
B22 Ceiling Finishes Total	**6392**	**sf**	**$**	**1.50**	**$**	**9,588**
B23 Wall Finishes						
▪ cut and patch walls for new mechanical/electrical	6392	sf	$	1.50	$	9,588
B23 Wall Finishes Total	**6392**	**sf**	**$**	**1.50**	**$**	**9,588**
MECHANICAL						
C11 Plumbing and Drainage						
▪ add insulation to internal rwl and vent piping	1	sum	$	7,500.00	$	7,500
▪ new 50gal electric dhwt	1	sum	$	2,000.00	$	2,000
C11 Plumbing and Drainage Total	**6392**	**sf**	**$**	**1.49**	**$**	**9,500**
C13 Heating, Ventilation, Air Conditioning						
▪ new 0.5 ton mini split heat pump	1	no	$	5,000.00	$	5,000
▪ new 1.0 ton mini split heat pump	1	no	$	6,000.00	$	6,000
▪ new 25kW electric boiler	1	sum	$	5,000.00	$	5,000
▪ electric boiler pump	1	no	$	2,500.00	$	2,500
▪ modify piping	1	sum	$	5,000.00	$	5,000

Element	Quantities		Unit Rates		Sub-totals	
▪ ERV 1144cfm	1	sum	$	15,000.00	$	15,000
▪ ERV 890cfm	1	sum	$	9,000.00	$	9,000
▪ new ERV ductwork connected to existing	1000	lbs	$	18.00	$	18,000
C13 Heating, Ventilation, Air Conditioning Total	6392	sf	$	10.25	$	65,500
C14 Controls						
▪ individual controls	1	sum	$	5,000.00	$	5,000
C14 Controls Total	6392	sf	$	0.78	$	5,000
ELECTRICAL						
C21 Services and Distribution						
▪ new 400A service entrance	1	sum	$	20,000.00	$	20,000
C21 Services and Distribution Total	6392	sf	$	3.13	$	20,000
C22 Lighting, Devices and Heating						
▪ upgrade remaining lighting to LED	6392	sf	$	4.00	$	25,568
C22 Lighting and Heating Total	6392	sf	$	4.00	$	25,568
GENERAL REQUIREMENTS AND FEES						
Z11 General Requirements and Overheads						
▪ contractor's overheads				15.00%	$	113,120
Z11 General Requirements and Overheads Total	6392	sf	$	17.70	$	113,120
Z12 Contractor's Profit						
▪ contractor's profit				10.00%	$	86,726
Z12 Contractor's Profit Total	6392	sf	$	13.57	$	86,726
ALLOWANCES						
Z21 Design Allowance						
▪ design development contingency				10.00%	$	95,398
Z21 Design Allowance Total	6392	sf	$	14.92	$	95,398
Z23 Construction Contingency						
▪ construction contingency				10.00%	$	104,938
Z23 Construction Contingency	6392	sf	$	16.42	$	104,938

ELEMENTAL COST SUMMARY

PROJECT:	RETROFIT 1138 OLD SMABRO ROAD	DATE:	JULY 20, 2023
LOCATION:	HALIFAX, NS	CLASS:	D - FEASIBILITY
CLIENT:		FILE	13453
DESIGNER:	RSI PROJECTS	GFA:sf	6392

Scenario 2 Net Zero Ready - ASHP

GROSS FLOOR AREA 6392 sf

ELEMENT	RATIO TO GFA	ELEMENTAL QUANTITY		ELEMENTAL UNIT RATE	ELEMENTAL AMOUNT	RATE PER GFA	TOTAL AMOUNT	%
A SHELL						$ 103	$ 657,832	51.84
A1 SUBSTRUCTURE						$ -	$ -	0.00
A11 Foundations	1.000	6392	sf	$ -	$ -	$ -		0.00
A12 Basement Excavation	0.586	3747	sf	$ -	$ -	$ -		0.00
A2 STRUCTURE						$ -	$ -	0.00
A21 Lowest Floor Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A22 Upper Floor Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A23 Roof Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A3 EXTERIOR ENCLOSURE						$ 103	$ 657,832	51.84
A31 Walls Below Grade	0.144	922	sf	$ 30.51	$ 28,135	$ 4		2.22
A32 Walls Above Grade	0.747	4772	sf	$ 85.54	$ 408,196	$ 64		32.17
A33 Windows and Entrances	0.010	64	sf	$ 125.00	$ 8,022	$ 1		0.63
A34 Roof Coverings	0.937	5989	sf	$ 35.64	$ 213,478	$ 33		16.82
A35 Projections	1.000	6392	sf	$ -	$ -	$ -		0.00
B INTERIORS						$ 3	$ 19,176	1.51
B1 PARTITIONS AND DOORS						$ -	$ -	0.00
B11 Partitions	1.000	6392	sf	$ -	$ -	$ -		0.00
B12 Doors	1.000	6392	sf	$ -	$ -	$ -		0.00
B2 INTERIOR FINISHES						$ 3	$ 19,176	1.51
B21 Floor Finishes	1.000	6392	sf	$ -	$ -	$ -		0.00
B22 Ceiling Finishes	1.000	6392	sf	$ 1.50	$ 9,588	$ 2		0.76
B23 Wall Finishes	1.000	6392	sf	$ 1.50	$ 9,588	$ 2		0.76
B3 FITTINGS AND EQUIPMENT						$ -	$ -	0.00
B31 Fittings and Fixtures	1.000	6392	sf	$ -	$ -	$ -		0.00
B32 Equipment	1.000	6392	sf	$ -	$ -	$ -		0.00
B33 Conveying Systems	1.000	6392	sf	$ -	$ -	$ -		0.00
SERVICES						$ 24	$ 151,744	11.96
C1 MECHANICAL						$ 14	$ 87,000	6.86
C11 Plumbing and Drainage	1.000	6392	sf	$ 1.80	$ 11,500	$ 2		0.91
C12 Fire Protection	1.000	6392	sf	$ -	$ -	$ -		0.00
C13 HVAC	1.000	6392	sf	$ 10.72	$ 68,500	$ 11		5.40
C14 Controls	1.000	6392	sf	$ 1.10	$ 7,000	$ 1		0.55
C2 ELECTRICAL						$ 10	$ 64,744	5.10
C21 Services and Distribution	1.000	6392	sf	$ 3.13	$ 20,000	$ 3		1.58
C22 Lighting, Devices and Heating	1.000	6392	sf	$ 7.00	$ 44,744	$ 7		3.53
C23 Systems and Ancillaries	1.000	6392	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - LESS SITE						$ 130	$ 828,752	65.31
D SITE & ANCILLARY WORK						$ -	$ -	0.00
D1 SITEWORK						$ -	$ -	0.00
D11 Site Development	1.000	6392	sf	$ -	$ -	$ -		0.00
D12 Mechanical Site Services	1.000	6392	sf	$ -	$ -	$ -		0.00
D13 Electrical Site Services	1.000	6392	sf	$ -	$ -	$ -		0.00
D2 ANCILLARY WORK						$ -	$ -	0.00
D21 Demolition	1.000	6392	sf	$ -	$ -	$ -		0.00
D22 Alterations	1.000	6392	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - INCLUDING SITE						$ 130	$ 828,752	65.31
Z GENERAL REQUIREMENTS AND ALLOWANCES						$ 69	$ 439,777	34.66
Z1 GENERAL REQUIREMENTS AND FEES						$ 34	$ 219,619	17.31
Z11 General Requirements and Overheads		15%			$ 124,313	$ 19		9.80
Z12 Contractors Profit		10%			$ 95,306	$ 15		7.51
Z2 ALLOWANCES						$ 34	$ 220,158	17.35
Z21 Design Allowance		10%			$ 104,837	$ 16		8.26
Z22 Escalation Allowance TBD		0%			$ -	$ -		0.00
Z23 Construction Allowance		10%			$ 115,321	$ 18		9.09
TOTAL CONSTRUCTION COST (HST EXTRA)				$199 per sf			$ 1,269,000	100.00

Element	Quantities		Unit Rates		Sub-totals	
EXTERIOR ENCLOSURE						
A31 Walls Below Grade						
▪ remove grass landscaping	666	sf	$	3.50	$	2,330
▪ remove asphalt paving and dispose	549	sf	$	3.50	$	1,920
▪ excavate to 2 feet below grade	67	cyd	$	40.00	$	2,696
▪ new 4" EPS insulation	315	sf	$	3.50	$	1,102
▪ new 2" EPS insulation	607	sf	$	3.50	$	2,125
▪ cement board	607	sf	$	5.00	$	3,036
▪ backfill to subgrade	67	cyd	$	50.00	$	3,370
▪ reinstate grass landscaping	666	sf	$	5.00	$	3,328
▪ reinstate asphalt paving	549	sf	$	15.00	$	8,229
A31 Walls Below Grade Total	922	sf	$	30.51	$	28,135
A32 Walls Above Grade						
▪ remove existing façade	4772	sf	$	3.00	$	14,315
▪ structural upgrades including base angle	9000	lbs	$	4.00	$	36,000
▪ supply and install r28 prefab insulated wall panels	4772	sf	$	30.00	$	143,152
▪ supply and install prefinished metal siding	4772	sf	$	45.00	$	214,729
A32 Walls Above Grade Total	4772	sf	$	85.54	$	408,196
A33 Windows and Entrances						
▪ replace windows with triple pane	64	sf	$	125.00	$	8,022
A33 Windows and Entrances Total	64	sf	$	125.00	$	8,022
A34 Roof Coverings						
▪ remove existing roof finish	5989	sf	$	1.00	$	5,989
▪ 3/4 T&G plywood sheathing	6887	sf	$	10.00	$	68,874
▪ install new pre-engineered roof trusses above existing	5989	sf	$	13.00	$	77,857
▪ new knee wall construction, hurricane clips	505	sf	$	15.00	$	7,572
▪ additional gable end sheathing	659	sf	$	8.00	$	5,274
▪ new R40 loose fill insulation	5989	sf	$	3.00	$	17,967
▪ new asphalt shingle roof system	5989	sf	$	5.00	$	29,945
A34 Roof Coverings Total	5989	sf	$	35.64	$	213,478
FINISHES						
B22 Ceiling Finishes						
▪ cut and patch ceilings for new mechanical/electrical	6392	sf	$	1.50	$	9,588
B22 Ceiling Finishes Total	6392	sf	$	1.50	$	9,588
B23 Wall Finishes						
▪ cut and patch walls for new mechanical/electrical	6392	sf	$	1.50	$	9,588
B23 Wall Finishes Total	6392	sf	$	1.50	$	9,588
MECHANICAL						
C11 Plumbing and Drainage						

Element	Quantities		Unit Rates	Sub-totals
▪ add insulation to internal rwl and vent piping	1	sum	$ 7,500.00	$ 7,500
▪ new 50gal HP dhwt	1	sum	$ 4,000.00	$ 4,000
C11 Plumbing and Drainage Total	**6392**	**sf**	**$ 1.80**	**$ 11,500**
C13 Heating, Ventilation, Air Conditioning				
▪ new 0.5 ton mini split heat pump	1	no	$ 5,000.00	$ 5,000
▪ new 1.0 ton mini split heat pump	1	no	$ 6,000.00	$ 6,000
▪ new 10kW electric boiler	1	sum	$ 8,000.00	$ 8,000
▪ electric boiler pump	1	no	$ 2,500.00	$ 2,500
▪ modify piping	1	sum	$ 5,000.00	$ 5,000
▪ ERV 1144cfm	1	sum	$ 15,000.00	$ 15,000
▪ ERV 890cfm	1	sum	$ 9,000.00	$ 9,000
▪ new ERV ductwork connected to existing	1000	lbs	$ 18.00	$ 18,000
C13 Heating, Ventilation, Air Conditioning Total	**6392**	**sf**	**$ 10.72**	**$ 68,500**
C14 Controls				
▪ individual controls	1	sum	$ 5,000.00	$ 5,000
▪ CO2 sensors	1	sum	$ 2,000.00	$ 2,000
C14 Controls Total	**6392**	**sf**	**$ 1.10**	**$ 7,000**
ELECTRICAL				
C21 Services and Distribution				
▪ new 400A service entrance, 300A main breaker	1	sum	$ 20,000.00	$ 20,000
C21 Services and Distribution Total	**6392**	**sf**	**$ 3.13**	**$ 20,000**
C22 Lighting, Devices and Heating				
▪ upgrade remaining lighting to LED	6392	sf	$ 4.00	$ 25,568
▪ lighting controls	6392	sf	$ 3.00	$ 19,176
C22 Lighting and Heating Total	**6392**	**sf**	**$ 7.00**	**$ 44,744**
GENERAL REQUIREMENTS AND FEES				
Z11 General Requirements and Overheads				
▪ contractor's overheads			15.00%	$ 124,313
Z11 General Requirements and Overheads Total	**6392**	**sf**	**$ 19.45**	**$ 124,313**
Z12 Contractor's Profit				
▪ contractor's profit			10.00%	$ 95,306
Z12 Contractor's Profit Total	**6392**	**sf**	**$ 14.91**	**$ 95,306**
ALLOWANCES				
Z21 Design Allowance				
▪ design development contingency			10.00%	$ 104,837
Z21 Design Allowance Total	**6392**	**sf**	**$ 16.40**	**$ 104,837**

Element	Quantities		Unit Rates		Sub-totals
Z23 Construction Contingency					
▪ construction contingency			10.00%	$	115,321
Z23 Construction Contingency	**6392**	**sf**	**$ 18.04**	**$**	**115,321**

ELEMENTAL COST SUMMARY

Scenario 3 Net Zero Ready - GSHP

PROJECT:	RETROFIT 1138 OLD SMABRO ROAD	DATE:	JULY 20, 2023
LOCATION:	HALIFAX, NS	CLASS:	D - FEASIBILITY
CLIENT:		FILE	13453
DESIGNER:	RSI PROJECTS	GFA:sf	6392

GROSS FLOOR AREA 6392 sf

ELEMENT		RATIO TO GFA	ELEMENTAL QUANTITY		ELEMENTAL UNIT RATE	ELEMENTAL AMOUNT	RATE PER GFA	TOTAL AMOUNT	%
A	SHELL						$ 103	$ 657,832	44.66
A1	SUBSTRUCTURE						$ -	$ -	0.00
A11	Foundations	1.000	6392	sf	$ -	$ -	$ -		0.00
A12	Basement Excavation	0.586	3747	sf	$ -	$ -	$ -		0.00
A2	STRUCTURE						$ -	$ -	0.00
A21	Lowest Floor Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A22	Upper Floor Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A23	Roof Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A3	EXTERIOR ENCLOSURE						$ 103	$ 657,832	44.66
A31	Walls Below Grade	0.144	922	sf	$ 30.51	$ 28,135	$ 4		1.91
A32	Walls Above Grade	0.747	4772	sf	$ 85.54	$ 408,196	$ 64		27.71
A33	Windows and Entrances	0.010	64	sf	$ 125.00	$ 8,022	$ 1		0.54
A34	Roof Coverings	0.937	5989	sf	$ 35.64	$ 213,478	$ 33		14.49
A35	Projections	1.000	6392	sf	$ -	$ -	$ -		0.00
B	INTERIORS						$ 3	$ 19,176	1.30
B1	PARTITIONS AND DOORS						$ -	$ -	0.00
B11	Partitions	1.000	6392	sf	$ -	$ -	$ -		0.00
B12	Doors	1.000	6392	sf	$ -	$ -	$ -		0.00
B2	INTERIOR FINISHES						$ 3	$ 19,176	1.30
B21	Floor Finishes	1.000	6392	sf	$ -	$ -	$ -		0.00
B22	Ceiling Finishes	1.000	6392	sf	$ 1.50	$ 9,588	$ 2		0.65
B23	Wall Finishes	1.000	6392	sf	$ 1.50	$ 9,588	$ 2		0.65
B3	FITTINGS AND EQUIPMENT						$ -	$ -	0.00
B31	Fittings and Fixtures	1.000	6392	sf	$ -	$ -	$ -		0.00
B32	Equipment	1.000	6392	sf	$ -	$ -	$ -		0.00
B33	Conveying Systems	1.000	6392	sf	$ -	$ -	$ -		0.00
	SERVICES						$ 45	$ 285,244	19.36
C1	MECHANICAL						$ 34	$ 220,500	14.97
C11	Plumbing and Drainage	1.000	6392	sf	$ 1.96	$ 12,500	$ 2		0.85
C12	Fire Protection	1.000	6392	sf	$ -	$ -	$ -		0.00
C13	HVAC	1.000	6392	sf	$ 30.66	$ 196,000	$ 31		13.31
C14	Controls	1.000	6392	sf	$ 1.88	$ 12,000	$ 2		0.81
C2	ELECTRICAL						$ 10	$ 64,744	4.40
C21	Services and Distribution	1.000	6392	sf	$ 3.13	$ 20,000	$ 3		1.36
C22	Lighting, Devices and Heating	1.000	6392	sf	$ 7.00	$ 44,744	$ 7		3.04
C23	Systems and Ancillaries	1.000	6392	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - LESS SITE							$ 151	$ 962,252	65.33
D	SITE & ANCILLARY WORK						$ -	$ -	0.00
D1	SITEWORK						$ -	$ -	0.00
D11	Site Development	1.000	6392	sf	$ -	$ -	$ -		0.00
D12	Mechanical Site Services	1.000	6392	sf	$ -	$ -	$ -		0.00
D13	Electrical Site Services	1.000	6392	sf	$ -	$ -	$ -		0.00
D2	ANCILLARY WORK						$ -	$ -	0.00
D21	Demolition	1.000	6392	sf	$ -	$ -	$ -		0.00
D22	Alterations	1.000	6392	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - INCLUDING SITE							$ 151	$ 962,252	65.33
Z	GENERAL REQUIREMENTS AND ALLOWANCES						$ 80	$ 510,619	34.67
Z1	GENERAL REQUIREMENTS AND FEES						$ 40	$ 254,997	17.31
Z11	General Requirements and Overheads		15%			$ 144,338	$ 23		9.80
Z12	Contractors Profit		10%			$ 110,659	$ 17		7.51
Z2	ALLOWANCES						$ 40	$ 255,622	17.35
Z21	Design Allowance		10%			$ 121,725	$ 19		8.26
Z22	Escalation Allowance TBD		0%			$ -	$ -		0.00
Z23	Construction Allowance		10%			$ 133,897	$ 21		9.09
TOTAL CONSTRUCTION COST (HST EXTRA)					$230 per sf			$ 1,473,000	100.00

Element	Quantities			Unit Rates		Sub-totals
EXTERIOR ENCLOSURE						
A31 Walls Below Grade						
▪ remove grass landscaping	666	sf	$	3.50	$	2,330
▪ remove asphalt paving and dispose	549	sf	$	3.50	$	1,920
▪ excavate to 2 feet below grade	67	cyd	$	40.00	$	2,696
▪ new 4" EPS insulation	315	sf	$	3.50	$	1,102
▪ new 2" EPS insulation	607	sf	$	3.50	$	2,125
▪ cement board	607	sf	$	5.00	$	3,036
▪ backfill to subgrade	67	cyd	$	50.00	$	3,370
▪ reinstate grass landscaping	666	sf	$	5.00	$	3,328
▪ reinstate asphalt paving	549	sf	$	15.00	$	8,229
A31 Walls Below Grade Total	922	sf	$	30.51	$	28,135
A32 Walls Above Grade						
▪ remove existing façade	4772	sf	$	3.00	$	14,315
▪ structural upgrades including base angle	9000	lbs	$	4.00	$	36,000
▪ supply and install r28 prefab insulated wall panels	4772	sf	$	30.00	$	143,152
▪ supply and install prefinished metal siding	4772	sf	$	45.00	$	214,729
A32 Walls Above Grade Total	4772	sf	$	85.54	$	408,196
A33 Windows and Entrances						
▪ replace windows with triple pane	64	sf	$	125.00	$	8,022
A33 Windows and Entrances Total	64	sf	$	125.00	$	8,022
A34 Roof Coverings						
▪ remove existing roof finish	5989	sf	$	1.00	$	5,989
▪ 3/4 T&G plywood sheathing	6887	sf	$	10.00	$	68,874
▪ install new pre-engineered roof trusses above existing	5989	sf	$	13.00	$	77,857
▪ new knee wall construction, hurricane clips	505	sf	$	15.00	$	7,572
▪ additional gable end sheathing	659	sf	$	8.00	$	5,274
▪ new R40 loose fill insulation	5989	sf	$	3.00	$	17,967
▪ new asphalt shingle roof system	5989	sf	$	5.00	$	29,945
A34 Roof Coverings Total	5989	sf	$	35.64	$	213,478
FINISHES						
B22 Ceiling Finishes						
▪ cut and patch ceilings for new mechanical/electrical	6392	sf	$	1.50	$	9,588
B22 Ceiling Finishes Total	6392	sf	$	1.50	$	9,588
B23 Wall Finishes						
▪ cut and patch walls for new mechanical/electrical	6392	sf	$	1.50	$	9,588
B23 Wall Finishes Total	6392	sf	$	1.50	$	9,588
MECHANICAL						
C11 Plumbing and Drainage						

Element	Quantities			Unit Rates		Sub-totals
▪ add insulation to internal rwl and vent piping	1	sum	$	7,500.00	$	7,500
▪ new 70gal HP dhwt	1	sum	$	5,000.00	$	5,000
C11 Plumbing and Drainage Total	6392	sf	$	1.96	$	12,500
C13 Heating, Ventilation, Air Conditioning						
▪ geothermal wells, testing	2	no	$	25,000.00	$	50,000
▪ gshp exterior piping, trenching, backfill, reinstatement	1	sum	$	15,000.00	$	15,000
▪ gshp interior piping	1	sum	$	7,500.00	$	7,500
▪ gshp-5 tons	1	no	$	10,000.00	$	10,000
▪ electric boiler 5kW	1	no	$	3,000.00	$	3,000
▪ circulation pumps	2	no	$	3,500.00	$	7,000
▪ electric boiler pump	1	no	$	2,500.00	$	2,500
▪ air separators	2	no	$	3,500.00	$	7,000
▪ expansion tanks	2	no	$	2,500.00	$	5,000
▪ distribution piping	250	lf	$	100.00	$	25,000
▪ indoor units - 1 ton	2	no	$	5,000.00	$	10,000
▪ indoor units - 1.5 ton	2	no	$	6,000.00	$	12,000
▪ ERV 1144cfm	1	sum	$	15,000.00	$	15,000
▪ ERV 890cfm	1	sum	$	9,000.00	$	9,000
▪ new ERV ductwork connected to existing	1000	lbs	$	18.00	$	18,000
C13 Heating, Ventilation, Air Conditioning Total	6392	sf	$	30.66	$	196,000
C14 Controls						
▪ individual controls	1	sum	$	10,000.00	$	10,000
▪ CO2 sensors	1	sum	$	2,000.00	$	2,000
C14 Controls Total	6392	sf	$	1.88	$	12,000
ELECTRICAL						
C21 Services and Distribution						
▪ new 400A service entrance, 300A main breaker	1	sum	$	20,000.00	$	20,000
C21 Services and Distribution Total	6392	sf	$	3.13	$	20,000
C22 Lighting, Devices and Heating						
▪ upgrade remaining lighting to LED	6392	sf	$	4.00	$	25,568
▪ lighting controls	6392	sf	$	3.00	$	19,176
C22 Lighting and Heating Total	6392	sf	$	7.00	$	44,744
GENERAL REQUIREMENTS AND FEES						
Z11 General Requirements and Overheads						
▪ contractor's overheads				15.00%	$	144,338
Z11 General Requirements and Overheads Total	6392	sf	$	22.58	$	144,338
Z12 Contractor's Profit						
▪ contractor's profit				10.00%	$	110,659
Z12 Contractor's Profit Total	6392	sf	$	17.31	$	110,659

Element	Quantities		Unit Rates		Sub-totals	
ALLOWANCES						
Z21 Design Allowance						
▪ design development contingency				10.00%	$	121,725
Z21 Design Allowance Total	6392	sf	$	19.04	$	121,725
Z23 Construction Contingency						
▪ construction contingency				10.00%	$	133,897
Z23 Construction Contingency	6392	sf	$	20.95	$	133,897

ELEMENTAL COST SUMMARY

Scenario 4 Net Zero

PROJECT:	RETROFIT 1138 OLD SMABRO ROAD	DATE:	JULY 20, 2023
LOCATION:	HALIFAX, NS	CLASS:	D - FEASIBILITY
CLIENT:		FILE	13453
DESIGNER:	RSI PROJECTS	GFA:sf	6392

GROSS FLOOR AREA 6392 sf

ELEMENT		RATIO TO GFA	ELEMENTAL QUANTITY		ELEMENTAL UNIT RATE	ELEMENTAL AMOUNT	RATE PER GFA	TOTAL AMOUNT	%
A	SHELL						$ 103	$ 657,832	39.56
A1	SUBSTRUCTURE						$ -	$ -	0.00
A11	Foundations	1.000	6392	sf	$ -	$ -	$ -		0.00
A12	Basement Excavation	0.586	3747	sf	$ -	$ -	$ -		0.00
A2	STRUCTURE						$ -	$ -	0.00
A21	Lowest Floor Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A22	Upper Floor Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A23	Roof Construction	1.000	6392	sf	$ -	$ -	$ -		0.00
A3	EXTERIOR ENCLOSURE						$ 103	$ 657,832	39.56
A31	Walls Below Grade	0.144	922	sf	$ 30.51	$ 28,135	$ 4		1.69
A32	Walls Above Grade	0.747	4772	sf	$ 85.54	$ 408,196	$ 64		24.55
A33	Windows and Entrances	0.010	64	sf	$ 125.00	$ 8,022	$ 1		0.48
A34	Roof Coverings	0.937	5989	sf	$ 35.64	$ 213,478	$ 33		12.84
A35	Projections	1.000	6392	sf	$ -	$ -	$ -		0.00
B	INTERIORS						$ 3	$ 19,176	1.15
B1	PARTITIONS AND DOORS						$ -	$ -	0.00
B11	Partitions	1.000	6392	sf	$ -	$ -	$ -		0.00
B12	Doors	1.000	6392	sf	$ -	$ -	$ -		0.00
B2	INTERIOR FINISHES						$ 3	$ 19,176	1.15
B21	Floor Finishes	1.000	6392	sf	$ -	$ -	$ -		0.00
B22	Ceiling Finishes	1.000	6392	sf	$ 1.50	$ 9,588	$ 2		0.58
B23	Wall Finishes	1.000	6392	sf	$ 1.50	$ 9,588	$ 2		0.58
B3	FITTINGS AND EQUIPMENT						$ -	$ -	0.00
B31	Fittings and Fixtures	1.000	6392	sf	$ -	$ -	$ -		0.00
B32	Equipment	1.000	6392	sf	$ -	$ -	$ -		0.00
B33	Conveying Systems	1.000	6392	sf	$ -	$ -	$ -		0.00
	SERVICES						$ 64	$ 409,244	24.61
C1	MECHANICAL						$ 34	$ 220,500	13.26
C11	Plumbing and Drainage	1.000	6392	sf	$ 1.96	$ 12,500	$ 2		0.75
C12	Fire Protection	1.000	6392	sf	$ -	$ -	$ -		0.00
C13	HVAC	1.000	6392	sf	$ 30.66	$ 196,000	$ 31		11.79
C14	Controls	1.000	6392	sf	$ 1.88	$ 12,000	$ 2		0.72
C2	ELECTRICAL						$ 30	$ 188,744	11.35
C21	Services and Distribution	1.000	6392	sf	$ 22.53	$ 144,000	$ 23		8.66
C22	Lighting, Devices and Heating	1.000	6392	sf	$ 7.00	$ 44,744	$ 7		2.69
C23	Systems and Ancillaries	1.000	6392	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - LESS SITE							$ 170	$ 1,086,252	65.32
D	SITE & ANCILLARY WORK						$ -	$ -	0.00
D1	SITEWORK						$ -	$ -	0.00
D11	Site Development	1.000	6392	sf	$ -	$ -	$ -		0.00
D12	Mechanical Site Services	1.000	6392	sf	$ -	$ -	$ -		0.00
D13	Electrical Site Services	1.000	6392	sf	$ -	$ -	$ -		0.00
D2	ANCILLARY WORK						$ -	$ -	0.00
D21	Demolition	1.000	6392	sf	$ -	$ -	$ -		0.00
D22	Alterations	1.000	6392	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - INCLUDING SITE							$ 170	$ 1,086,252	65.32
Z	GENERAL REQUIREMENTS AND ALLOWANCES						$ 90	$ 576,419	34.66
Z1	GENERAL REQUIREMENTS AND FEES						$ 45	$ 287,857	17.31
Z11	General Requirements and Overheads		15%			$ 162,938	$ 25		9.80
Z12	Contractors Profit		10%			$ 124,919	$ 20		7.51
Z2	ALLOWANCES						$ 45	$ 288,563	17.35
Z21	Design Allowance		10%			$ 137,411	$ 21		8.26
Z22	Escalation Allowance TBD		0%			$ -	$ -		0.00
Z23	Construction Allowance		10%			$ 151,152	$ 24		9.09
TOTAL CONSTRUCTION COST (HST EXTRA)					$260 per sf			$ 1,663,000	100.00

Element	Quantities		Unit Rates		Sub-totals	
EXTERIOR ENCLOSURE						
A31 Walls Below Grade						
▪ remove grass landscaping	666	sf	$	3.50	$	2,330
▪ remove asphalt paving and dispose	549	sf	$	3.50	$	1,920
▪ excavate to 2 feet below grade	67	cyd	$	40.00	$	2,696
▪ new 4" EPS insulation	315	sf	$	3.50	$	1,102
▪ new 2" EPS insulation	607	sf	$	3.50	$	2,125
▪ cement board	607	sf	$	5.00	$	3,036
▪ backfill to subgrade	67	cyd	$	50.00	$	3,370
▪ reinstate grass landscaping	666	sf	$	5.00	$	3,328
▪ reinstate asphalt paving	549	sf	$	15.00	$	8,229
A31 Walls Below Grade Total	922	sf	$	30.51	$	28,135
A32 Walls Above Grade						
▪ remove existing façade	4772	sf	$	3.00	$	14,315
▪ structural upgrades including base angle	9000	lbs	$	4.00	$	36,000
▪ supply and install r28 prefab insulated wall panels	4772	sf	$	30.00	$	143,152
▪ supply and install prefinished metal siding	4772	sf	$	45.00	$	214,729
A32 Walls Above Grade Total	4772	sf	$	85.54	$	408,196
A33 Windows and Entrances						
▪ replace windows with triple pane	64	sf	$	125.00	$	8,022
A33 Windows and Entrances Total	64	sf	$	125.00	$	8,022
A34 Roof Coverings						
▪ remove existing roof finish	5989	sf	$	1.00	$	5,989
▪ 3/4 T&G plywood sheathing	6887	sf	$	10.00	$	68,874
▪ install new pre-engineered roof trusses above existing	5989	sf	$	13.00	$	77,857
▪ new knee wall construction, hurricane clips	505	sf	$	15.00	$	7,572
▪ additional gable end sheathing	659	sf	$	8.00	$	5,274
▪ new R40 loose fill insulation	5989	sf	$	3.00	$	17,967
▪ new asphalt shingle roof system	5989	sf	$	5.00	$	29,945
A34 Roof Coverings Total	5989	sf	$	35.64	$	213,478
FINISHES						
B22 Ceiling Finishes						
▪ cut and patch ceilings for new mechanical/electrical	6392	sf	$	1.50	$	9,588
B22 Ceiling Finishes Total	6392	sf	$	1.50	$	9,588
B23 Wall Finishes						
▪ cut and patch walls for new mechanical/electrical	6392	sf	$	1.50	$	9,588
B23 Wall Finishes Total	6392	sf	$	1.50	$	9,588
MECHANICAL						
C11 Plumbing and Drainage						

Element	Quantities		Unit Rates		Sub-totals	
▪ add insulation to internal rwl and vent piping	1	sum	$	7,500.00	$	7,500
▪ new 70gal HP dhwt	1	sum	$	5,000.00	$	5,000
C11 Plumbing and Drainage Total	**6392**	**sf**	**$**	**1.96**	**$**	**12,500**
C13 Heating, Ventilation, Air Conditioning						
▪ geothermal wells, testing	2	no	$	25,000.00	$	50,000
▪ gshp exterior piping, trenching, backfill, reinstatement	1	sum	$	15,000.00	$	15,000
▪ gshp interior piping	1	sum	$	7,500.00	$	7,500
▪ gshp-5 tons	1	no	$	10,000.00	$	10,000
▪ electric boiler 5kW	1	no	$	3,000.00	$	3,000
▪ circulation pumps	2	no	$	3,500.00	$	7,000
▪ electric boiler pump	1	no	$	2,500.00	$	2,500
▪ air separators	2	no	$	3,500.00	$	7,000
▪ expansion tanks	2	no	$	2,500.00	$	5,000
▪ distribution piping	250	lf	$	100.00	$	25,000
▪ indoor units - 1 ton	2	no	$	5,000.00	$	10,000
▪ indoor units - 1.5 ton	2	no	$	6,000.00	$	12,000
▪ ERV 1144cfm	1	sum	$	15,000.00	$	15,000
▪ ERV 890cfm	1	sum	$	9,000.00	$	9,000
▪ new ERV ductwork connected to existing	1000	lbs	$	18.00	$	18,000
C13 Heating, Ventilation, Air Conditioning Total	**6392**	**sf**	**$**	**30.66**	**$**	**196,000**
C14 Controls						
▪ individual controls	1	sum	$	10,000.00	$	10,000
▪ CO2 sensors	1	sum	$	2,000.00	$	2,000
C14 Controls Total	**6392**	**sf**	**$**	**1.88**	**$**	**12,000**
ELECTRICAL						
C21 Services and Distribution						
▪ new 400A service entrance, 300A main breaker	1	sum	$	20,000.00	$	20,000
▪ photovoltaic system complete with racking, inverters	31	kW	$	4,000.00	$	124,000
C21 Services and Distribution Total	**6392**	**sf**	**$**	**22.53**	**$**	**144,000**
C22 Lighting, Devices and Heating						
▪ upgrade remaining lighting to LED	6392	sf	$	4.00	$	25,568
▪ lighting controls	6392	sf	$	3.00	$	19,176
C22 Lighting and Heating Total	**6392**	**sf**	**$**	**7.00**	**$**	**44,744**
GENERAL REQUIREMENTS AND FEES						
Z11 General Requirements and Overheads						
▪ contractor's overheads				15.00%	$	162,938
Z11 General Requirements and Overheads Total	**6392**	**sf**	**$**	**25.49**	**$**	**162,938**
Z12 Contractor's Profit						
▪ contractor's profit				10.00%	$	124,919

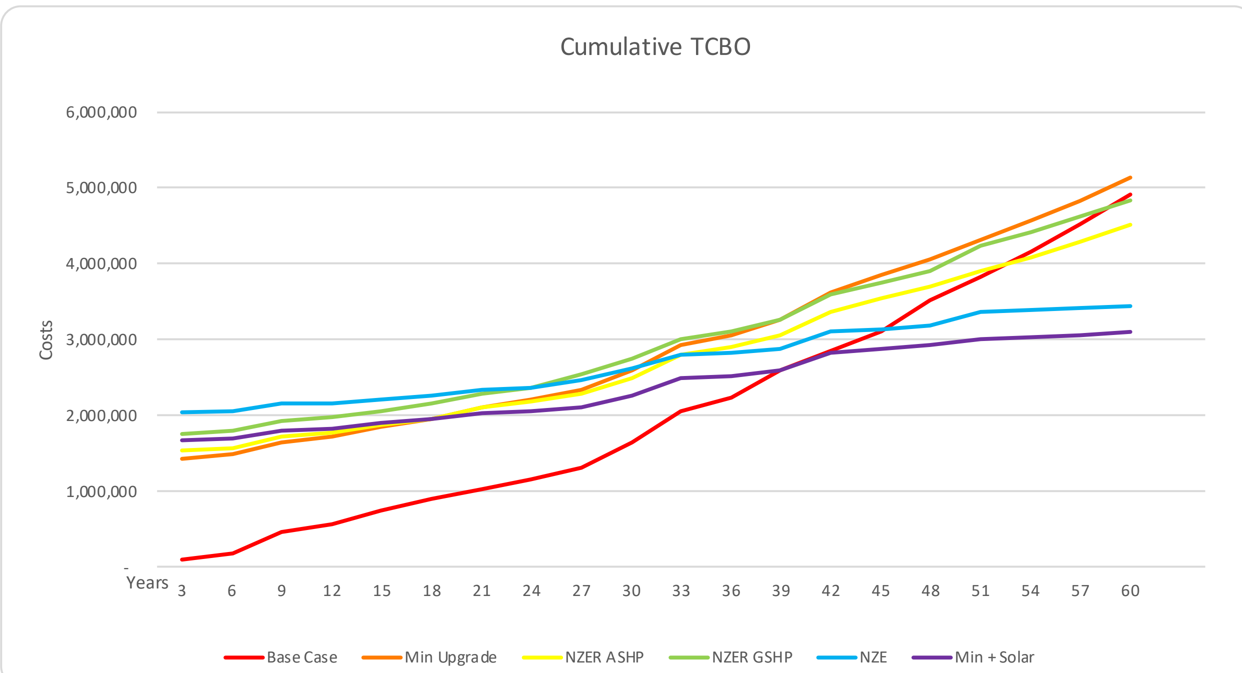
Element		Quantities			Unit Rates		Sub-totals
Z12	Contractor's Profit Total	6392	sf	$	19.54	$	124,919
ALLOWANCES							
Z21	Design Allowance						
	▪ design development contingency				10.00%	$	137,411
Z21	Design Allowance Total	6392	sf	$	21.50	$	137,411
Z23	Construction Contingency						
	▪ construction contingency				10.00%	$	151,152
Z23	Construction Contingency	6392	sf	$	23.65	$	151,152

Appendix N

Total Cost of Building Ownership

NS Community Centre - Deep Retrofit

	Base Case	Min. Upgrade	NZER - ASHP	NZER - GSHP	NZE	Min + Solar
GHG emissions (kg) (60 Years)	1,854,060	1,762,328	1,302,802	1,298,862	0	0
EUI (kWh/m2/year)	146.0	80.9	59.8	59.6	0.0	0.0
TCBO at 60 years	**$4,917,000**	**$5,140,000**	**$4,517,000**	**$4,839,000**	**$3,442,000**	**$3,102,000**
TCBO Savings at 60 years	$0	-$223,000	$400,000	$78,000	$1,475,000	$1,815,000
60 Year TCBO savings compared to Base Case		**-5%**	**8%**	**2%**	**30%**	**37%**



Total Cost of Building Ownership (TCBO)

	Base Case	Min. Upgrade	NZER - ASHP	NZER - GSHP	NZE	Min + Solar
GHG emissions (kg) (60 Years)	1854060	1762328	1302802	1298862	0	0
EUI (kWh/m2/year)	146	81	60	60	0	0
TCBO at 60 years	$ 4,917,000	$ 5,140,000	$ 4,517,000	$ 4,839,000	$ 3,442,000	$ 3,102,000
TCBO Savings at 60 years		$ (223,000)	$ 400,000	$ 78,000	$ 1,475,000	$ 1,815,000
60 Year TCBO savings compared to Base Case		0	0	0	0	0
TCBO/Year/m2	$ 151	$ 158	$ 139	$ 149	$ 106	$ 95
TCBO/Year/ft2	$ 14	$ 15	$ 13	$ 14	$ 10	$ 9
60-Year TCBO/m2	$ 9,070	$ 9,482	$ 8,332	$ 8,926	$ 6,349	$ 5,722
60-YearTCBO/ft2	$ 843	$ 881	$ 774	$ 830	$ 590	$ 532
60 Year Energy Cost / m2	$ 3,669	$ 3,046	$ 2,272	$ 2,265	$ 77	$ 77

CAPITAL COST SUMMARY

	Base Case	Min. Upgrade	NZER - ASHP	NZER - GSHP	NZE	Min + Solar
Initial Retrofit / HPB CostYear 1						
Initial Cost	$ 13,000	$ 1,369,000	$ 1,491,000	$ 1,708,000	$ 2,018,000	$ 1,646,000
Difference in Cost from A		$ 1,356,000	$ 1,478,000	$ 1,695,000	$ 2,005,000	$ 1,633,000
% Change Over Base Cost		10431%	11369%	13038%	15423%	12562%
Cost ($/ft2)	$ 2.23	$ 234.70	$ 255.61	$ 292.82	$ 345.96	$ 282.19
Maintenance Capital Costs 60 Years						
Cost	$ 1,083,000	$ 1,001,000	$ 965,000	$ 1,075,000	$ 1,075,000	$ 1,001,000
Difference in Cost from A		$ (82,000)	$ (118,000)	$ (8,000)	$ (8,000)	$ (82,000)
% Change Over Base Cost		-7.57%	-10.90%	-0.74%	-0.74%	-7.57%
Cost ($/ft2)	$ 185.67	$ 171.61	$ 165.44	$ 184.30	$ 184.30	$ 171.61
Retrofit / HPB + Maintenance Capital Costs 60 Years						
Total Costs	$ 1,096,000	$ 2,370,000	$ 2,456,000	$ 2,783,000	$ 3,093,000	$ 2,647,000
Difference in Cost from A		$ 1,274,000	$ 1,360,000	$ 1,687,000	$ 1,997,000	$ 1,551,000
% Change Over Base Cost		116.24%	124.09%	153.92%	182.21%	141.51%

OPERATING COST SUMMARY

	Base Case	Min. Upgrade	NZER - ASHP	NZER - GSHP	NZE	Min + Solar
Utilities (including carbon tax)						
Cost	$ 2,972,000	$ 2,585,000	$ 1,922,000	$ 1,916,000	$ 42,000	$ 42,000
Difference in Cost from A		$ (387,000)	$ (1,050,000)	$ (1,056,000)	$ (2,930,000)	$ (2,930,000)
% Change Over Base Cost		-13%	-35%	-36%	-99%	-99%
Energy Cost ($/ft2)	$ 509.51	$ 443.17	$ 329.50	$ 328.48	$ 7.20	$ 7.20
Maintenance						
Cost	$ 849,000	$ 186,000	$ 140,000	$ 140,000	$ 308,000	$ 414,000
Difference in Cost from A		$ (663,000)	$ (709,000)	$ (709,000)	$ (541,000)	$ (435,000)
% Change Over Base Cost		-78%	-84%	-84%	-64%	-51%
Maintenance Cost ($/ft2)	$ 145.55	$ 31.89	$ 24.00	$ 24.00	$ 52.80	$ 70.98
Insurance & Taxes						
Costs	$ -	$ -	$ -	$ -	$ -	$ -
Difference in Cost from A		$ -	$ -	$ -	$ -	$ -
% Change Over Base Cost		0%	0%	0%	0%	0%
First Year Annual Maintenance						
Cost	$ 4,800	$ 1,600	$ 1,300	$ 1,200	$ 2,644	$ 3,559
Difference in Cost from A		$ (3,200)	$ (3,500)	$ (3,600)	$ (2,156)	$ (1,241)
% Change Over Base Cost		-67%	-73%	-75%	-45%	-26%
First Year Maintenance Cost ($/ft2)	$ 0.82	$ 0.27	$ 0.22	$ 0.21	$ 0.45	$ 0.61

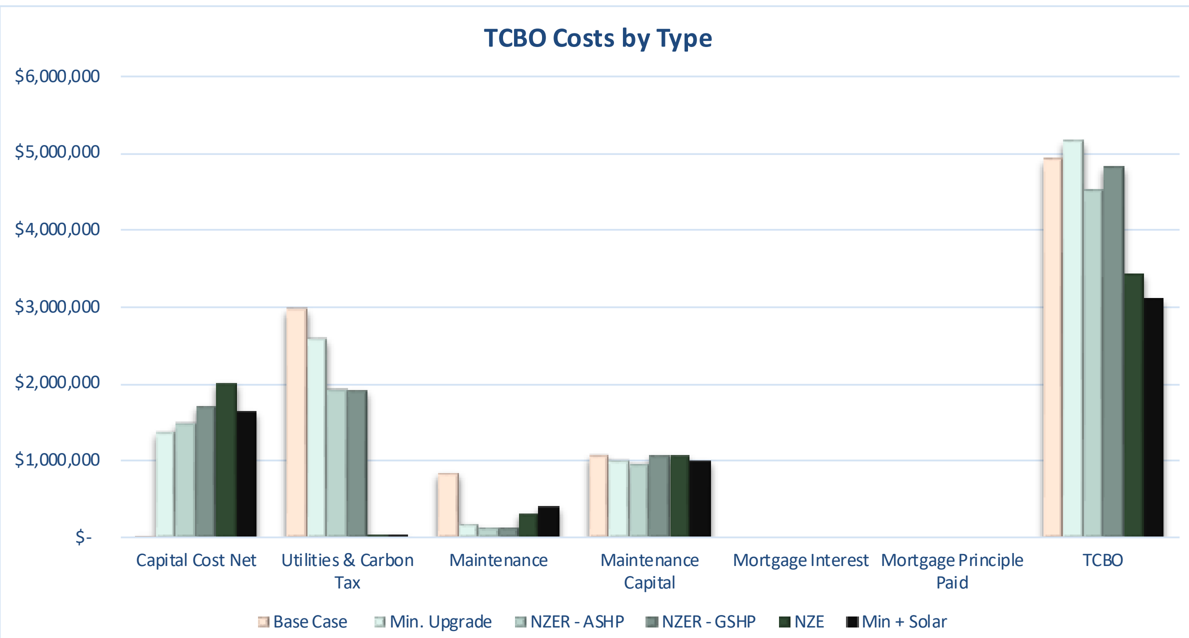
Annual Energy Consumption and GHG Emissions

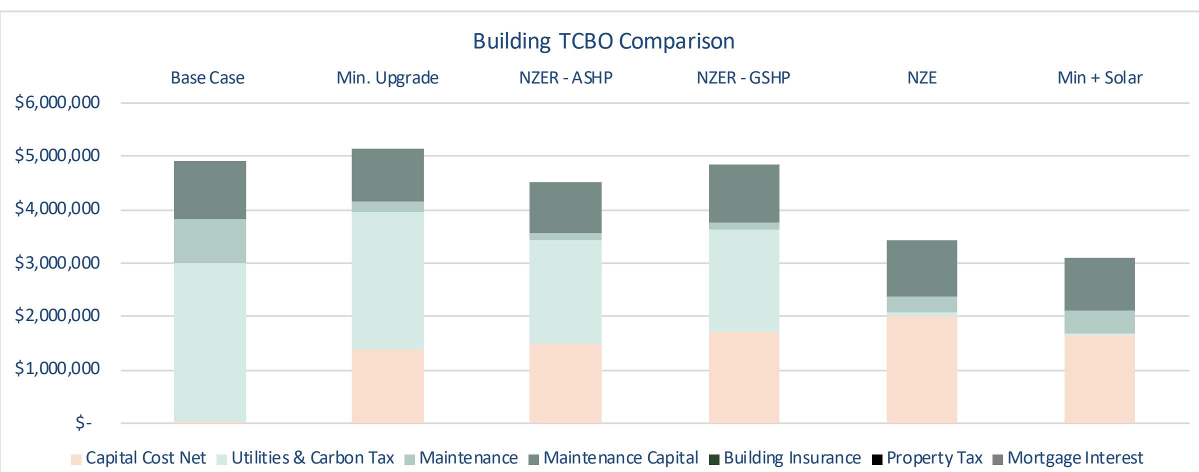
	Units	Base Case	Min. Upgrade	NZER - ASHP	NZER - GSHP	NZE	Min + Solar
Annual Water Consumption	m3	0.0	0.0	0.0	0.0	0.0	0.0
Annual Sewer Discharge	m3	0.0	0.0	0.0	0.0	0.0	0.0
Annual Electric Consumption	kWh	26,995.00	43,839.00	32,408.00	32,310.00	32,310.00	43,839.00
Annual Gas Consumption	m3	-	-	-	-	-	-
Annual Heating Oil Consumption	Litres	4,812.00	-	-	-	-	-
GHG emissions	kg CO2 eq	30,901.01	29,372.13	21,713.36	21,647.70	-	-
Annual Solar PV generated	kWh	-	-	-	-	32,310.00	43,839.00
Total Annual Energy Consumption	ekWh	79,125.00	43,839.00	32,408.00	32,310.00	-	-
Total Annual Energy Consumption	GJ	284.85	157.82	116.67	116.32	-	-
EUI	kWh/m2/yr	145.96	80.87	59.78	59.60	-	-

60 Year Cost of Ownership Comparison

		Base Case		Min. Upgrade		NZER - ASHP		NZER - GSHP		NZE		Min + Solar
Capital Cost	$	13,200	$	1,368,774	$	1,490,536	$	1,708,138	$	2,018,268	$	1,645,566
Utility Subsidy	$	-	$	-	$	-	$	-	$	-	$	-
Capital Cost Net	$	13,200	$	1,368,774	$	1,490,536	$	1,708,138	$	2,018,268	$	1,645,566
Utilities & Carbon Tax	$	2,971,518	$	2,584,882	$	1,921,732	$	1,916,047	$	41,637	$	41,637
Maintenance	$	849,228	$	186,132	$	139,599	$	139,599	$	307,556	$	414,020
Maintenance Capital	$	1,082,602	$	1,000,584	$	965,247	$	1,074,736	$	1,074,736	$	1,000,584
Building Insurance	$	-	$	-	$	-	$	-	$	-	$	-
Property Tax	$	-	$	-	$	-	$	-	$	-	$	-
Mortgage Interest	$	-	$	-	$	-	$	-	$	-	$	-
Mortgage Principle Paid	$	-	$	-	$	-	$	-	$	-	$	-
Mortgage Principal Received	$	-	$	-	$	-	$	-	$	-	$	-
TCBO	$	4,916,548	$	5,140,372	$	4,517,115	$	4,838,521	$	3,442,197	$	3,101,807

Cost as a Percentage of TCBO						
Capital Cost Net	0.3%	26.6%	33.0%	35.3%	58.6%	53.1%
Utilities & Carbon Tax	60.4%	50.3%	42.5%	39.6%	1.2%	1.3%
Maintenance	17.3%	3.6%	3.1%	2.9%	8.9%	13.3%
Maintenance Capital	22.0%	19.5%	21.4%	22.2%	31.2%	32.3%
Building Insurance	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Property Tax	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Mortgage Interest	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TCBO	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%





INPUTS : General

	Units	Base Case	Min. Upgrade	NZER - ASHP	NZER - GSHP	NZE	Min + Solar
Utility Costs							
Water							
unit water cost	$/m3						
annual water escalation rate	%	3%	3%	3%	3%	3%	3%
include annual "Basic Charge Water" for active service, else 0	$/year						
"Basic Charge Water" escalation rate	%	4%	4%	4%	4%	4%	4%
annual consumption	m3						
refrofit reduction	%	0%	20%	20%	20%	20%	20%
Sewer							
unit sewer cost	$/m3						
annual sewer escalation rate	%	3%	3%	3%	3%	3%	3%
include annual "Basic Charge Sewer" for active service, else 0	$/year						
"Basic Charge Sewer" escalation rate	%	3%	3%	3%	3%	3%	3%
annual consumption	m3						
refrofit reduction	%	0					
Electricity							
unit cost	$/kWh	$ 0.17	$ -	$ -	$ -	$ -	$ -
annual escalation rate	%	3%	3%	3%	3%	3%	3%
include annual "Basic Charge" for active service, else 0	$/year	460.08	255.36	255.36	255.36	255.36	255.36
"Basic Charge" escalation rate	%	3%	3%	3%	3%	3%	3%
GHG emission factor	kg/kWh	0.67	0.67	0.67	0.67	0.67	0.67
Is Carbon Tax ADDED TO energy cost?	No = 0 or Yes = 1	1	1	1	1	1	1
annual consumption	kWh	26995	43839	32408	32310	32310	43839
refrofit reduction (only use this when TCPO calculation)	%	0%	0%	0%	0%	0%	0%
Natural Gas							
unit cost	$/m3						
annual escalation rate	%						
include annual "Basic Charge" for active service, else 0	$/year						
"Basic Charge" escalation rate	%						
GHG emission factor	kg/m3	1.902355	1.902355	1.902355	1.902355	1.902355	1.902355
Is Carbon Tax ADDED TO energy cost?	No = 0 or Yes = 1	1	1	1	1	1	1
annual consumption	m3						
refrofit reduction	%	0%	100%	100%	100%	100%	100%
No 2 Heating Oil							
unit cost	$/Litre	$ 1.46					
annual escalation rate	%	3%	3%	3%	3%	3%	3%
include annual "Basic Charge" for active service, else 0	$/year						
"Basic Charge" escalation rate	%	3%	3%	3%	3%	3%	3%
GHG emission factor	kg/L	2.663	2.663	2.663	2.663	2.663	2.663
Is Carbon Tax ADDED TO energy cost?	No = 0 or Yes = 1	1					
annual consumption	Litres	4812					
refrofit reduction	%	0					

GHG Emissions

Carbon Tax escalation rate - after carbon tax finishes	%	4%	4%	4%	4%	4%	4%
Carbon Tax Year	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
GHG unit cost ($/tonne)	$ 30.00	$ 170.00	$ 251.64	$ 372.49	$ 551.38	$ 816.17	$ 1,208.14
Carbon Tax for Project Year	$ 80.00	$ 198.88	$ 294.38	$ 435.76	$ 645.03	$ 954.81	$ 1,413.35

Mortgage Financing of New Investment

1st Year New Investment Capital Amount	$						No input here - See Value Tab Calculation
Percent of 1st Year Capital Investment Financed with Mortgage	%						
Mortgage Financing of New Investment							No input here - See Value Tab Calculation
Interest Rate	%						
Amortization in Years	#	25	25	25	25	25	25
Start Date (yyyy-mm-dd)		2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31

Property Tax

property tax lump sum OR	$						
property tax rate (% of building value) (e.g. .43%)	%						
property tax escalation rate	%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%

Insurance

property insurance annual cost lump sum OR	$						
property insurance rate (% of building value) (e.g. .27%)	%						
property insurance escalation rate	%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%

Property Market Value Forecast by Decade:

0-10 years	%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%
11-20 years	%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%
21-30 years	%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%
31-40 years	%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%
41-50 years	%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%
51-60 years	%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%

Market Value Inputs

Project Type - Either Retrofit or New Build only	Input	**Retrofit**	**Retrofit**	**Retrofit**	**Retrofit**	**Retrofit**	**Retrofit**
Current Building Value (normally existing building at current status (before new capital investment) or New Code Built Building). Include Comments on the source of Market Value Information.							replacement cost $300/ft2
Market Value Base Case For Retrofits only (else Zero)	Input $	$	1,749,900.00				
New Investment Project Cost - A thru F							No input here - See Value Tab Calculation
New Investment over Current Market Value							No input here - See Value Tab Calculation
Rate of Inclusion of New Investment for Mkt Val Calc.	Input %	75.00%	75.00%	75.00%	75.00%	75.00%	75.00%
Market Value Estimate Upon Completion of the Project							No input here - See Value Tab Calculation
Net Present Value Rate (NPV) for Discounting Results		0.0242					
Annual Service Cost Escalation Rate		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Annual Capital Cost Escalation Rate		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%

Total Cost of Portfolio Ownership

Is this a TCPO calculation	No = 0 or Yes = 1	0	0	0	0	0	0
Year 1 Retrofit Capital Unit Cost	$/ft2	Base Case					
Year 1 Retrofit Capital Total Cost	$	See Value Tab					
Maintenance Capital Cost Reduction for Retrofit	%	0%					

Solar PV Array

Array Unit Cost	$/kWdc					$ 4,000.00	$ 4,000.00
Array Size	kWdc	0	0	0	0	51.0	69.2
Total System Cost	$					$204,000.00	$276,792.20
System Annual Maintenance Cost (1)	$/kWdc/year					$ 28.31	$ 28.31
Total System Annual Maintenance Cost	$/year					$ 1,443.76	$ 1,958.93
Annual Solar Energy Output Degradation	%					0	0
Unit cost of solar energy displacing utility energy	$/kWac	$ 0.17	$ -	$ -	$ -	$ -	$ -
Annual Solar Energy Produced, Displacing Utility Energy	kWh/year					32310	43839
Unit cost of solar energy generated back to the grid	$/kWhac						
Annual Solar Energy Generated Back to the Grid	kWh/year						

Input : Base Case

Line No.	Building Components Subject to M&R	Include in Option	Cost	Useful Life (years)	Current Age	Annual Service Cost	Annual Service Cost Escalation Rate	Annual Capital Cost Escalation Rate
	Units	0=no or 1=yes	$	Years	Years	$	2.00%	2.00%
1	Building Mounted Lighting	0	$ -				2.00%	2.00%
2	Concrete Footings and Frost Wall	0	$ -				2.00%	2.00%
3	Superstructure	0	$ -				2.00%	2.00%
4	Asphalt Shingles	1	$ 36,300	20	12		2.00%	2.00%
5	Asphalt Shingle Repair	1				$ 2,500	2.00%	2.00%
6	Gutters & Downspouts	1	$ 6,120	40	12		2.00%	2.00%
7	Wood Siding	1	$ 27,075	30	22	$ 1,000	2.00%	2.00%
8	Exterior Doors (Rear double door)	1	$ 2,500	25	0		2.00%	2.00%
9	Exterior Door (Front)	1	$ 1,500	25	12		2.00%	2.00%
10	Exterior Door (Front ramp access)	1	$ 1,500	25	7		2.00%	2.00%
11	Exterior Door (Side entrance double door)	1	$ 2,500	25	12		2.00%	2.00%
12	Vinyl Windows	1	$ 5,400	35	17		2.00%	2.00%
13	Brick Columns	1	$ 100	25	17		2.00%	2.00%
14	VCT Flooring- Upper floor	1	$ 28,390	25	17		2.00%	2.00%
15	VCT Flooring- Lower floor	1	$ 18,788	25	17		2.00%	2.00%
16	Hard Tile (Washrooms)	1	$ 4,640	40	7		2.00%	2.00%
17	Adhesive Tile	1	$ 3,025	15	17		2.00%	2.00%
18	Gypsum Wall Board	1	$ -				2.00%	2.00%
19	Suspended ceiling tile	1	$ -	20	12		2.00%	2.00%
20	Millwork (Kitchen and Bar)	1	$ 10,800	25	17		2.00%	2.00%
21	Washroom Vanities	1	$ 2,925	20	7		2.00%	2.00%
22	Above Ground Oil Storage Tanks	1	$ 4,000	15	4		2.00%	2.00%
23	Kerr Comet Boiler	1	$ 8,500	25	17	$ 500	2.00%	2.00%
24	Hot Water Radiators	1	$ 7,500	40	40		2.00%	2.00%
25	Heat Pump, Mini Splits 2t units	1	$ 13,200	20	7		2.00%	2.00%
26	Well and well pump	0	$ -			$ 100	2.00%	2.00%
27	Domestic Water Treatment System	1	$ -	25	22	$ 100	2.00%	2.00%
28	Domestic Hot Water Heater	1	$ 1,500	10	2	$ 200	2.00%	2.00%
29	Plumbing Fixtures - Washrooms	1	$ 12,000	35	7	$ 100	2.00%	2.00%
30	Exhaust Fans - Washrooms	1	$ -	15	12	$ 100	2.00%	2.00%
31	Siemens 100A (Panel A)	1	$ 3,500	40	22		2.00%	2.00%
32	Square D 200A (Panel A)	1	$ 4,500	40	27		2.00%	2.00%
33	Lighting and branch wiring florescent fixtures	1	$ 14,025	20	22		2.00%	2.00%
34	Lighting and branch wiring pot lights	1	$ 9,300	25	22		2.00%	2.00%
35	Emergency Lighting	1	$ -	20	22		2.00%	2.00%
36	Fire alarm panel Mircom FA-300	1	$ 5,000	20	12		2.00%	2.00%
37	Fire Extinguisher	1	$ -	12	7		2.00%	2.00%
38	Automatic Door Openers (Interior)	1	$ 7,500	20	7	$ 100	2.00%	2.00%
39	Boiler circ pumps	1	$ 2,000	25	17	$ 100	2.00%	2.00%
40		1					2.00%	2.00%
170	construction contingency for 2024 - 10%	1	$ -				2.00%	2.00%
171		1					2.00%	2.00%

BASE CASE

Input : Min Upgrade

Section	Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
BASE CASE	1	Building Mounted Lighting	0	$ -				2.00%	2.00%
	2	Concrete Footings and Frost Wall	0	$ -				2.00%	2.00%
	3	Superstructure	0	$ -				2.00%	2.00%
	4	Asphalt Shingles	0	$ 36,300	20	12		2.00%	2.00%
	5	Asphalt Shingle Repair	0					2.00%	2.00%
	6	Gutters & Downspouts	1	$ 6,120	40	12		2.00%	2.00%
	7	Wood Siding	0	$ 27,075	30	22		2.00%	2.00%
	8	Exterior Doors (Rear double door)	1	$ 2,500	25	0		2.00%	2.00%
	9	Exterior Door (Front)	1	$ 1,500	25	0		2.00%	2.00%
	10	Exterior Door (Front ramp access)	1	$ 1,500	25	0		2.00%	2.00%
	11	Exterior Door (Side entrance double door)	1	$ 2,500	25	0		2.00%	2.00%
	12	Vinyl Windows	0	$ 5,400	35	17		2.00%	2.00%
	13	Brick Columns	1	$ 100	25	17		2.00%	2.00%
	14	VCT Flooring- Upper floor	1	$ 28,390	25	17		2.00%	2.00%
	15	VCT Flooring- Lower floor	1	$ 18,788	25	17		2.00%	2.00%
	16	Hard Tile (Washrooms)	1	$ 4,640	40	7		2.00%	2.00%
	17	Adhesive Tile	1	$ 3,025	15	17		2.00%	2.00%
	18	Gypsum Wall Board	1	$ -				2.00%	2.00%
	19	Suspended ceiling tile	1	$ -	20	12		2.00%	2.00%
	20	Millwork (Kitchen and Bar)	1	$ 10,800	25	17		2.00%	2.00%
	21	Washroom Vanities	1	$ 2,925	20	7		2.00%	2.00%
	22	Above Ground Oil Storage Tanks	1	$ 4,000	15	4		2.00%	2.00%
	23	Kerr Comet Boiler	0					2.00%	2.00%
	24	Hot Water Radiators	1	$ 7,500	40	40		2.00%	2.00%
	25	Heat Pump, Mini Splits 2t units	1	$ 13,200	20	7		2.00%	2.00%
	26	Well and well pump	0	$ -			$ 100	2.00%	2.00%
	27	Domestic Water Treatment System	1	$ -	25	22	$ 100	2.00%	2.00%
	28	Domestic Hot Water Heater	1	$ 1,500	10	2	$ 200	2.00%	2.00%
	29	Plumbing Fixtures - Washrooms	1	$ 12,000	35	7	$ 100	2.00%	2.00%
	30	Exhaust Fans - Washrooms	1	$ -	15	12	$ 100	2.00%	2.00%
	31	Siemens 100A (Panel A)	0					2.00%	2.00%
	32	Square D 200A (Panel A)	0					2.00%	2.00%
	33	Lighting and branch wiring florescent fixtures	1	$ 14,025	20	22		2.00%	2.00%
	34	Lighting and branch wiring pot lights	1	$ 9,300	25	22		2.00%	2.00%
	35	Emergency Lighting	1	$ -	20	22		2.00%	2.00%
	36	Fire alarm panel Mircom FA-300	1	$ 5,000	20	12		2.00%	2.00%
	37	Fire Extinguisher	1	$ -	12	7		2.00%	2.00%
	38	Automatic Door Openers (Interior)	1	$ 7,500	20	7	$ 100	2.00%	2.00%
	39	Boiler circ pumps	1	$ 2,000	25	17	$ 100	2.00%	2.00%
	40		1					2.00%	2.00%
	109		1					2.00%	2.00%
RETROFIT	110	A32 Walls Above Grade	1					2.00%	2.00%
	111	remove existing façade	1	$ 14,315	61	0		2.00%	2.00%
	112	structural upgrades including base angle	1	$ 36,000	61	0		2.00%	2.00%
	113	supply and install r11 prefab insulated wall panels	1	$ 128,837	61	0		2.00%	2.00%
	114	supply and install prefinished metal siding	1	$ 214,729	61	0		2.00%	2.00%
	115	A33 Windows and Entrances	1			0		2.00%	2.00%
	116	replace windows with triple pane	1	$ 8,022	30	0		2.00%	2.00%
	117	A34 Roof Coverings	1			0		2.00%	2.00%
	118	remove existing roof finish	1	$ 5,989	61	0		2.00%	2.00%
	119	3/4 T&G plywood sheathing	1	$ 68,874	61	0		2.00%	2.00%
	120	install new pre-engineered roof trusses above existing	1	$ 77,857	61	0		2.00%	2.00%
	121	new knee wall construction, hurricane clips	1	$ 7,572	61	0		2.00%	2.00%
	122	additional gable end sheathing	1	$ 5,274	61	0		2.00%	2.00%
	123	new R11 loose fill insulation	1	$ 11,978	61	0		2.00%	2.00%
	124	new metal roof	1	$ 137,747	61	0	$ -	2.00%	2.00%
	125	B22 Ceiling Finishes	1			0		2.00%	2.00%
	126	cut and patch ceilings for new mechanical/electrical	1	$ 9,588	61	0		2.00%	2.00%
	127	B23 Wall Finishes	1			0		2.00%	2.00%
	128	cut and patch walls for new mechanical/electrical	1	$ 9,588	61	0		2.00%	2.00%
	129	C11 Plumbing and Drainage	1			0		2.00%	2.00%
	130	add insulation to internal rwl and vent piping	1	$ 7,500	61	0		2.00%	2.00%
	131	new 50gal electric dhwt	1	$ 2,000	14	0		2.00%	2.00%
	132	C13 HVAC	1			0		2.00%	2.00%
	133	new 0.5 ton mini split heat pump	1	$ 5,000	15	0	$ 100	2.00%	2.00%
	134	new 1.0 ton mini split heat pump	1	$ 6,000	15	0	$ 100	2.00%	2.00%
	135	new 25kW electric boiler	1	$ 5,000	30	0	$ 100	2.00%	2.00%
	136	electric boiler pump	1	$ 2,500	20	0		2.00%	2.00%
	137	modify piping	1	$ 5,000	61	0		2.00%	2.00%
	138		1			0		2.00%	2.00%

Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
145	ERV 1144cfm	1	$ 15,000	20	0	$ 200	2.00%	2.00%
146	ERV 890cfm	1	$ 9,000	20	0	$ 200	2.00%	2.00%
147	new ERV ductwork connected to existing	1	$ 18,000		0		2.00%	2.00%
148	C14 Controls	1			0		2.00%	2.00%
149	individual controls	1	$ 5,000	20	0	$ 100	2.00%	2.00%
150		1			0		2.00%	2.00%
151	C21 Services and Distribution	1			0		2.00%	2.00%
152	new 400A service entrance	1	$ 20,000	40	0		2.00%	2.00%
153		1			0		2.00%	2.00%
154	C22 Lighting, Devices and Heating	1			0		2.00%	2.00%
155	upgrade remaining lighting to LED	1	$ 25,568	20	0		2.00%	2.00%
156		1			0		2.00%	2.00%
157	Z11 General Requirements and Overheads	1			0		2.00%	2.00%
158	contractor's overheads	1	$ 113,120	61	0		2.00%	2.00%
159	Z12 Contractors Profit	1			0		2.00%	2.00%
160	contractor's profit	1	$ 86,726	61	0		2.00%	2.00%
161	Z21 Design Allowance	1			0		2.00%	2.00%
162	design development contingency	1	$ 95,398	61	0		2.00%	2.00%
163	Z23 Construction Allowance	1			0		2.00%	2.00%
164	construction contingency	1	$ 104,938	61	0		2.00%	2.00%
165		1					2.00%	2.00%
170	construction contingency for 2024 - 10%	1	$ 86,194	61	0		2.00%	2.00%

Input : NZR - ASHP

	Line No.	Building Components Subject to M&R / Units	Include in Option (0=no or 1=yes)	Cost ($)	Useful Life (years)	Current Age (Years)	Annual Service Cost ($)	Annual Service Cost Escalation Rate (2.00%)	Annual Capital Cost Escalation Rate (2.00%)
BASE CASE	1	Building Mounted Lighting	0	$ -				2.00%	2.00%
	2	Concrete Footings and Frost Wall	0	$ -				2.00%	2.00%
	3	Superstructure	0	$ -				2.00%	2.00%
	4	Asphalt Shingles	0					2.00%	2.00%
	5	Asphalt Shingle Repair	0					2.00%	2.00%
	6	Gutters & Downspouts	1	$ 6,120	40	12		2.00%	2.00%
	7	Siding	0					2.00%	2.00%
	8	Exterior Doors (Rear double door)	1	$ 2,500	25	0		2.00%	2.00%
	9	Exterior Door (Front)	1	$ 1,500	25	0		2.00%	2.00%
	10	Exterior Door (Front ramp access)	1	$ 1,500	25	0		2.00%	2.00%
	11	Exterior Door (Side entrance double door)	1	$ 2,500	25	0		2.00%	2.00%
	12	Vinyl Windows	0					2.00%	2.00%
	13	Brick Columns	0					2.00%	2.00%
	14	VCT Flooring- Upper floor	1	$ 28,390	25	17		2.00%	2.00%
	15	VCT Flooring- Lower floor	1	$ 18,788	25	17		2.00%	2.00%
	16	Hard Tile (Washrooms)	1	$ 4,640	40	7		2.00%	2.00%
	17	Adhesive Tile	1	$ 3,025	15	17		2.00%	2.00%
	18	Gypsum Wall Board	1	$ -				2.00%	2.00%
	19	Suspended ceiling tile	1	$ -	20	12		2.00%	2.00%
	20	Millwork (Kitchen and Bar)	1	$ 10,800	25	17		2.00%	2.00%
	21	Washroom Vanities	1	$ 2,925	20	7		2.00%	2.00%
	22	Above Ground Oil Storage Tanks	0					2.00%	2.00%
	23	Kerr Comet Boiler	0					2.00%	2.00%
	24	Hot Water Radiators	1	$ 7,500	40	40		2.00%	2.00%
	25	Heat Pump, Mini Splits 2t units	1	$ 13,200	20	7		2.00%	2.00%
	26	Well and well pump	0	$ -			$ 100	2.00%	2.00%
	27	Domestic Water Treatment System	1	$ -	25	22	$ 100	2.00%	2.00%
	28	Domestic Hot Water Heater	0					2.00%	2.00%
	29	Plumbing Fixtures - Washrooms	1	$ 12,000	35	7	$ 100	2.00%	2.00%
	30	Exhaust Fans - Washrooms	1	$ -	15	12	$ 100	2.00%	2.00%
	31	Siemens 100A (Panel A)	0					2.00%	2.00%
	32	Square D 200A (Panel A)	0					2.00%	2.00%
	33	Lighting and branch wiring florescent fixtures	1	$ 14,025	20	22		2.00%	2.00%
	34	Lighting and branch wiring pot lights	1	$ 9,300	25	22		2.00%	2.00%
	35	Emergency Lighting	1	$ -	20	22		2.00%	2.00%
	36	Fire alarm panel Mircom FA-300	1	$ 5,000	20	12		2.00%	2.00%
	37	Fire Extinguisher	1	$ -	12	7		2.00%	2.00%
	38	Automatic Door Openers (Interior)	1	$ 7,500	20	7	$ 100	2.00%	2.00%
	39	Boiler circ pumps	0					2.00%	2.00%
	40		1					2.00%	2.00%
RETROFIT	100	A31 Walls Below Grade	1		0	0	$ -	2.00%	2.00%
	101	remove grass landscaping	1	$ 2,330	61	0	$ -	2.00%	2.00%
	102	remove asphalt paving and dispose	1	$ 1,920	61	0	$ -	2.00%	2.00%
	103	excavate to 2 feet below grade	1	$ 2,696	61	0	$ -	2.00%	2.00%
	104	new 4" EPS insulation	1	$ 1,102	61	0	$ -	2.00%	2.00%
	105	new 2" EPS insulation	1	$ 2,125	61	0	$ -	2.00%	2.00%
	106	cement board	1	$ 3,036	61	0	$ -	2.00%	2.00%
	107	backfill to subgrade	1	$ 3,370	61	0	$ -	2.00%	2.00%
	108	reinstate grass landscaping	1	$ 3,328	61	0	$ -	2.00%	2.00%
	109	reinstate asphalt paving	1	$ 8,229	61	0	$ -	2.00%	2.00%
	110	A32 Walls Above Grade	1		0	0	$ -	2.00%	2.00%
	111	remove existing façade	1	$ 14,315	61	0	$ -	2.00%	2.00%
	112	structural upgrades including base angle	1	$ 36,000	61	0	$ -	2.00%	2.00%
	113	supply and install r28 prefab insulated wall panels	1	$ 143,152	61	0	$ -	2.00%	2.00%
	114	supply and install prefinished metal siding	1	$ 214,729	61	0	$ -	2.00%	2.00%
	115	A33 Windows and Entrances	1		0	0	$ -	2.00%	2.00%
	116	replace windows with triple pane	1	$ 8,022	30	0	$ -	2.00%	2.00%
	117	A34 Roof Coverings	1		0	0	$ -	2.00%	2.00%
	118	remove existing roof finish	1	$ 5,989	61	0	$ -	2.00%	2.00%
	119	3/4 T&G plywood sheathing	1	$ 68,874	61	0	$ -	2.00%	2.00%
	120	install new pre-engineered roof trusses above existing	1	$ 77,857	61	0	$ -	2.00%	2.00%
	121	new knee wall construction, hurricane clips	1	$ 7,572	61	0	$ -	2.00%	2.00%
	122	additional gable end sheathing	1	$ 5,274	61	0	$ -	2.00%	2.00%
	123	new R40 loose fill insulation	1	$ 17,967	61	0	$ -	2.00%	2.00%
	124	new metal roof	1	$ 137,747	61	0	$ -	2.00%	2.00%
	125	B22 Ceiling Finishes	1		0	0	$ -	2.00%	2.00%
	126	cut and patch ceilings for new mechanical/electrical	1	$ 9,588	61	0	$ -	2.00%	2.00%
	127	B23 Wall Finishes	1		0	0	$ -	2.00%	2.00%
	128	cut and patch walls for new mechanical/electrical	1	$ 9,588	61	0	$ -	2.00%	2.00%
	129	C11 Plumbing and Drainage	1		0	0	$ -	2.00%	2.00%
	130	add insulation to internal rwl and vent piping	1	$ 7,500	61	0	$ -	2.00%	2.00%

Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
131	new 50gal HP dhwt	1	$ 4,000	14	0	$ -	2.00%	2.00%
132	C13 HVAC	1		0	0	$ -	2.00%	2.00%
133	new 0.5 ton mini split heat pump	1	$ 5,000	15	0	$ 100	2.00%	2.00%
134	new 1.0 ton mini split heat pump	1	$ 6,000	15	0	$ 100	2.00%	2.00%
135	new 10kW electric boiler	1	$ 8,000	30	0	$ 100	2.00%	2.00%
136	electric boiler pump	1	$ 2,500	25	0	$ -	2.00%	2.00%
137	modify piping	1	$ 5,000	61	0	$ -	2.00%	2.00%
138		1		0	0	$ -	2.00%	2.00%
145	ERV 1144cfm	1	$ 15,000	20	0	$ 200	2.00%	2.00%
146	ERV 890cfm	1	$ 9,000	20	0	$ 200	2.00%	2.00%
147	new ERV ductwork connected to existing	1	$ 18,000	0	0	$ -	2.00%	2.00%
148	C14 Controls	1		0	0	$ -	2.00%	2.00%
149	individual controls	1	$ 5,000	20	0	$ 100	2.00%	2.00%
150	CO2 sensors	1	$ 2,000	0	0	$ -	2.00%	2.00%
151	C21 Services and Distribution	1		0	0	$ -	2.00%	2.00%
152	new 400A service entrance, 300A main breaker	1	$ 20,000	40	0	$ -	2.00%	2.00%
153		1		0	0	$ -	2.00%	2.00%
154	C22 Lighting, Devices and Heating	1		0	0	$ -	2.00%	2.00%
155	upgrade remaining lighting to LED	1	$ 25,568	20	0	$ -	2.00%	2.00%
156	lighting controls	1	$ 19,176	0	0	$ -	2.00%	2.00%
157	Z11 General Requirements and Overheads	1		0	0	$ -	2.00%	2.00%
158	contractor's overheads	1	$ 124,313	61	0	$ -	2.00%	2.00%
159	Z12 Contractors Profit	1		0	0	$ -	2.00%	2.00%
160	contractor's profit	1	$ 95,396	61	0	$ -	2.00%	2.00%
161	Z21 Design Allowance	1		0	0	$ -	2.00%	2.00%
162	design development contingency	1	$ 104,837	61	0	$ -	2.00%	2.00%
163	Z23 Construction Allowance	1		0	0	$ -	2.00%	2.00%
164	construction contingency	1	$ 115,321	61	0	$ -	2.00%	2.00%
165		1		0	0	$ -	2.00%	2.00%
170	construction contingency for 2024 - 10%	1	$ 93,655	61	0	$ -	2.00%	2.00%

Input : NZR - GSHP

	Line No.	Building Components Subject to M&R / Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
	1	Building Mounted Lighting	0	$ -				2.00%	2.00%
	2	Concrete Footings and Frost Wall	0	$ -				2.00%	2.00%
	3	Superstructure	0	$ -				2.00%	2.00%
	4	Asphalt Shingles	0					2.00%	2.00%
	5	Asphalt Shingle Repair	0					2.00%	2.00%
	6	Gutters & Downspouts	1	$ 6,120	40	12		2.00%	2.00%
	7	Siding	0					2.00%	2.00%
	8	Exterior Doors (Rear double door)	1	$ 2,500	25	0		2.00%	2.00%
	9	Exterior Door (Front)	1	$ 1,500	25	0		2.00%	2.00%
	10	Exterior Door (Front ramp access)	1	$ 1,500	25	0		2.00%	2.00%
	11	Exterior Door (Side entrance double door)	1	$ 2,500	25	0		2.00%	2.00%
	12	Vinyl Windows	0					2.00%	2.00%
	13	Brick Columns	0					2.00%	2.00%
	14	VCT Flooring- Upper floor	1	$ 28,390	25	17		2.00%	2.00%
	15	VCT Flooring- Lower floor	1	$ 18,788	25	17		2.00%	2.00%
	16	Hard Tile (Washrooms)	1	$ 4,640	40	7		2.00%	2.00%
	17	Adhesive Tile	1	$ 3,025	15	17		2.00%	2.00%
	18	Gypsum Wall Board	1	$ -				2.00%	2.00%
	19	Suspended ceiling tile	1	$ -	20	12		2.00%	2.00%
BASE CASE	20	Millwork (Kitchen and Bar)	1	$ 10,800	25	17		2.00%	2.00%
	21	Washroom Vanities	1	$ 2,925	20	7		2.00%	2.00%
	22	Above Ground Oil Storage Tanks	0					2.00%	2.00%
	23	Kerr Comet Boiler	0					2.00%	2.00%
	24	Hot Water Radiators	1	$ 7,500	40	40		2.00%	2.00%
	25	Heat Pump, Mini Splits 2t units	0					2.00%	2.00%
	26	Well and well pump	0	$ -			$ 100	2.00%	2.00%
	27	Domestic Water Treatment System	1	$ -	25	22	$ 100	2.00%	2.00%
	28	Domestic Hot Water Heater	0					2.00%	2.00%
	29	Plumbing Fixtures - Washrooms	1	$ 12,000	35	7	$ 100	2.00%	2.00%
	30	Exhaust Fans - Washrooms	1	$ -	15	12	$ 100	2.00%	2.00%
	31	Siemens 100A (Panel A)	0					2.00%	2.00%
	32	Square D 200A (Panel A)	0					2.00%	2.00%
	33	Lighting and branch wiring florescent fixtures	1	$ 14,025	20	22		2.00%	2.00%
	34	Lighting and branch wiring pot lights	1	$ 9,300	25	22		2.00%	2.00%
	35	Emergency Lighting	1	$ -	20	22		2.00%	2.00%
	36	Fire alarm panel Mircom FA-300	1	$ 5,000	20	12		2.00%	2.00%
	37	Fire Extinguisher	1	$ -	12	7		2.00%	2.00%
	38	Automatic Door Openers (Interior)	1	$ 7,500	20	7	$ 100	2.00%	2.00%
	39	Boiler circ pumps	0					2.00%	2.00%
	40		1					2.00%	2.00%
	100	A31 Walls Below Grade	1		0	0	$ -	2.00%	2.00%
	101	remove grass landscaping	1	$ 2,330	61	0	$ -	2.00%	2.00%
	102	remove asphalt paving and dispose	1	$ 1,920	61	0	$ -	2.00%	2.00%
	103	excavate to 2 feet below grade	1	$ 2,696	61	0	$ -	2.00%	2.00%
	104	new 4" EPS insulation	1	$ 1,102	61	0	$ -	2.00%	2.00%
	105	new 2" EPS insulation	1	$ 2,125	61	0	$ -	2.00%	2.00%
	106	cement board	1	$ 3,036	61	0	$ -	2.00%	2.00%
	107	backfill to subgrade	1	$ 3,370	61	0	$ -	2.00%	2.00%
	108	reinstate grass landscaping	1	$ 3,328	61	0	$ -	2.00%	2.00%
	109	reinstate asphalt paving	1	$ 8,229	61	0	$ -	2.00%	2.00%
	110	A32 Walls Above Grade	1		0	0	$ -	2.00%	2.00%
	111	remove existing façade	1	$ 14,315	61	0	$ -	2.00%	2.00%
	112	structural upgrades including base angle	1	$ 36,000	61	0	$ -	2.00%	2.00%
	113	supply and install r28 prefab insulated wall panels	1	$ 143,152	61	0	$ -	2.00%	2.00%
	114	supply and install prefinished metal siding	1	$ 214,729	61	0	$ -	2.00%	2.00%
	115	A33 Windows and Entrances	1		0	0	$ -	2.00%	2.00%
	116	replace windows with triple pane	1	$ 8,022	30	0	$ -	2.00%	2.00%
	117	A34 Roof Coverings	1		0	0	$ -	2.00%	2.00%
	118	remove existing roof finish	1	$ 5,989	61	0	$ -	2.00%	2.00%
	119	3/4 T&G plywood sheathing	1	$ 68,874	61	0	$ -	2.00%	2.00%
	120	install new pre-engineered roof trusses above existing	1	$ 77,857	61	0	$ -	2.00%	2.00%
	121	new knee wall construction, hurricane clips	1	$ 7,572	61	0	$ -	2.00%	2.00%
	122	additional gable end sheathing	1	$ 5,274	61	0	$ -	2.00%	2.00%
	123	new R40 loose fill insulation	1	$ 17,967	61	0	$ -	2.00%	2.00%
	124	new metal roof	1	$ 137,747	61	0	$ -	2.00%	2.00%
	125	B22 Ceiling Finishes	1		0	0	$ -	2.00%	2.00%
	126	cut and patch ceilings for new mechanical/electrical	1	$ 9,588	61	0	$ -	2.00%	2.00%
	127	B23 Wall Finishes	1		0	0	$ -	2.00%	2.00%
	128	cut and patch walls for new mechanical/electrical	1	$ 9,588	61	0	$ -	2.00%	2.00%
	129	C11 Plumbing and Drainage	1		0	0	$ -	2.00%	2.00%
OFIT	130	add insulation to internal rwl and vent piping	1	$ 7,500	61	0	$ -	2.00%	2.00%

Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
131	new 70gal HP dhwt	1	$ 5,000	14	0	$ -	2.00%	2.00%
132	C13 HVAC	1		0	0	$ -	2.00%	2.00%
133	geothermal wells, testing	1	$ 50,000	61	0	$ -	2.00%	2.00%
134	gshp exterior piping, trenching, backfill, reinstatement	1	$ 15,000	61	0	$ -	2.00%	2.00%
135	gshp interior piping	1	$ 7,500	61	0	$ -	2.00%	2.00%
136	gshp-5 tons	1	$ 10,000	25	0	$ 100	2.00%	2.00%
137	electric boiler 5kW	1	$ 3,000	30	0	$ 100	2.00%	2.00%
138	circulation pumps	1	$ 7,000	25	0	$ -	2.00%	2.00%
139	electric boiler pump	1	$ 2,500	25	0	$ -	2.00%	2.00%
140	air separators	1	$ 7,000	30	0	$ -	2.00%	2.00%
141	expansion tanks	1	$ 5,000	25	0	$ -	2.00%	2.00%
142	distribution piping	1	$ 25,000	61	0	$ -	2.00%	2.00%
143	indoor units - 1 ton	1	$ 10,000	25	0	$ -	2.00%	2.00%
144	indoor units - 1.5 ton	1	$ 12,000	25	0	$ -	2.00%	2.00%
145	ERV 1144cfm	1	$ 15,000	20	0	$ 200	2.00%	2.00%
146	ERV 890cfm	1	$ 9,000	20	0	$ 200	2.00%	2.00%
147	new ERV ductwork connected to existing	1	$ 18,000	61	0	$ -	2.00%	2.00%
148	C14 Controls	1		0	0	$ -	2.00%	2.00%
149	individual controls	1	$ 10,000	20	0	$ 100	2.00%	2.00%
150	CO2 sensors	1	$ 2,000	15	0	$ -	2.00%	2.00%
151	C21 Services and Distribution	1		0	0	$ -	2.00%	2.00%
152	new 400A service entrance, 300A main breaker	1	$ 20,000	40	0	$ -	2.00%	2.00%
153		1		0	0	$ -	2.00%	2.00%
154	C22 Lighting, Devices and Heating	1		0	0	$ -	2.00%	2.00%
155	upgrade remaining lighting to LED	1	$ 25,568	20	0	$ -	2.00%	2.00%
156	lighting controls	1	$ 19,176	0	0	$ -	2.00%	2.00%
157	Z11 General Requirements and Overheads	1		0	0	$ -	2.00%	2.00%
158	contractor's overheads	1	$ 144,338	61	0	$ -	2.00%	2.00%
159	Z12 Contractors Profit	1		0	0	$ -	2.00%	2.00%
160	contractor's profit	1	$ 110,659	61	0	$ -	2.00%	2.00%
161	Z21 Design Allowance	1		0	0	$ -	2.00%	2.00%
162	design development contingency	1	$ 121,725	61	0	$ -	2.00%	2.00%
163	Z23 Construction Allowance	1		0	0	$ -	2.00%	2.00%
164	construction contingency	1	$ 133,897	61	0	$ -	2.00%	2.00%
170	construction contingency for 2024 - 10%	1	$ 107,005	61	0	$ -	2.00%	2.00%

RETRO

Input : NZR - GSHP + Solar

BASE CASE

Line No.	Building Components Subject to M&R / Units	Include in Option (0=no or 1=yes)	Cost ($)	Useful Life (years) (Years)	Current Age (Years)	Annual Service Cost ($)	Annual Service Cost Escalation Rate (2.00%)	Annual Capital Cost Escalation Rate (2.00%)
1	Building Mounted Lighting	0	$ -				2.00%	2.00%
2	Concrete Footings and Frost Wall	0	$ -				2.00%	2.00%
3	Superstructure	0	$ -				2.00%	2.00%
4	Asphalt Shingles	0					2.00%	2.00%
5	Asphalt Shingle Repair	0					2.00%	2.00%
6	Gutters & Downspouts	1	$ 6,120	40	12		2.00%	2.00%
7	Siding	0					2.00%	2.00%
8	Exterior Doors (Rear double door)	1	$ 2,500	25	0		2.00%	2.00%
9	Exterior Door (Front)	1	$ 1,500	25	0		2.00%	2.00%
10	Exterior Door (Front ramp access)	1	$ 1,500	25	0		2.00%	2.00%
11	Exterior Door (Side entrance double door)	1	$ 2,500	25	0		2.00%	2.00%
12	Vinyl Windows	0					2.00%	2.00%
13	Brick Columns	0					2.00%	2.00%
14	VCT Flooring- Upper floor	1	$ 28,390	25	17		2.00%	2.00%
15	VCT Flooring- Lower floor	1	$ 18,788	25	17		2.00%	2.00%
16	Hard Tile (Washrooms)	1	$ 4,640	40	7		2.00%	2.00%
17	Adhesive Tile	1	$ 3,025	15	17		2.00%	2.00%
18	Gypsum Wall Board	1	$ -				2.00%	2.00%
19	Suspended ceiling tile	1	$ -	20	12		2.00%	2.00%
20	Millwork (Kitchen and Bar)	1	$ 10,800	25	17		2.00%	2.00%
21	Washroom Vanities	1	$ 2,925	20	7		2.00%	2.00%
22	Above Ground Oil Storage Tanks	0					2.00%	2.00%
23	Kerr Comet Boiler	0					2.00%	2.00%
24	Hot Water Radiators	1	$ 7,500	40	40		2.00%	2.00%
25	Heat Pump, Mini Splits 2t units	0					2.00%	2.00%
26	Well and well pump	0	$ -			$ 100	2.00%	2.00%
27	Domestic Water Treatment System	1	$ -	25	22	$ 100	2.00%	2.00%
28	Domestic Hot Water Heater	0					2.00%	2.00%
29	Plumbing Fixtures - Washrooms	1	$ 12,000	35	7	$ 100	2.00%	2.00%
30	Exhaust Fans - Washrooms	1	$ -	15	12	$ 100	2.00%	2.00%
31	Siemens 100A (Panel A)	0					2.00%	2.00%
32	Square D 200A (Panel A)	0					2.00%	2.00%
33	Lighting and branch wiring florescent fixtures	1	$ 14,025	20	22		2.00%	2.00%
34	Lighting and branch wiring pot lights	1	$ 9,300	25	22		2.00%	2.00%
35	Emergency Lighting	1	$ -	20	22		2.00%	2.00%
36	Fire alarm panel Mircom FA-300	1	$ 5,000	20	12		2.00%	2.00%
37	Fire Extinguisher	1	$ -	12	7		2.00%	2.00%
38	Automatic Door Openers (Interior)	1	$ 7,500	20	7	$ 100	2.00%	2.00%
39	Boiler circ pumps	0					2.00%	2.00%
40		1					2.00%	2.00%
100	A31 Walls Below Grade	1		0	0	$ -	2.00%	2.00%
101	remove grass landscaping	1	$ 2,330	61	0	$ -	2.00%	2.00%
102	remove asphalt paving and dispose	1	$ 1,920	61	0	$ -	2.00%	2.00%
103	excavate to 2 feet below grade	1	$ 2,696	61	0	$ -	2.00%	2.00%
104	new 4" EPS insulation	1	$ 1,102	61	0	$ -	2.00%	2.00%
105	new 2" EPS insulation	1	$ 2,125	61	0	$ -	2.00%	2.00%
106	cement board	1	$ 3,036	61	0	$ -	2.00%	2.00%
107	backfill to subgrade	1	$ 3,370	61	0	$ -	2.00%	2.00%
108	reinstate grass landscaping	1	$ 3,328	61	0	$ -	2.00%	2.00%
109	reinstate asphalt paving	1	$ 8,229	61	0	$ -	2.00%	2.00%
110	A32 Walls Above Grade	1		0	0	$ -	2.00%	2.00%
111	remove existing façade	1	$ 14,315	61	0	$ -	2.00%	2.00%
112	structural upgrades including base angle	1	$ 36,000	61	0	$ -	2.00%	2.00%
113	supply and install r28 prefab insulated wall panels	1	$ 143,152	61	0	$ -	2.00%	2.00%
114	supply and install prefinished metal siding	1	$ 214,729	61	0	$ -	2.00%	2.00%
115	A33 Windows and Entrances	1		0	0	$ -	2.00%	2.00%
116	replace windows with triple pane	1	$ 8,022	30	0	$ -	2.00%	2.00%
117	A34 Roof Coverings	1		0	0	$ -	2.00%	2.00%
118	remove existing roof finish	1	$ 5,989	61	0	$ -	2.00%	2.00%
119	3/4 T&G plywood sheathing	1	$ 68,874	61	0	$ -	2.00%	2.00%
120	install new pre-engineered roof trusses above existing	1	$ 77,857	61	0	$ -	2.00%	2.00%
121	new knee wall construction, hurricane clips	1	$ 7,572	61	0	$ -	2.00%	2.00%
122	additional gable end sheathing	1	$ 5,274	61	0	$ -	2.00%	2.00%
123	new R40 loose fill insulation	1	$ 17,967	61	0	$ -	2.00%	2.00%
124	new metal roof	1	$ 137,747	61	0	$ -	2.00%	2.00%
125	B22 Ceiling Finishes	1		0	0	$ -	2.00%	2.00%
126	cut and patch ceilings for new mechanical/electrical	1	$ 9,588	61	0	$ -	2.00%	2.00%
127	B23 Wall Finishes	1		0	0	$ -	2.00%	2.00%
128	cut and patch walls for new mechanical/electrical	1	$ 9,588	61	0	$ -	2.00%	2.00%
129	C11 Plumbing and Drainage	1		0	0	$ -	2.00%	2.00%
130	add insulation to internal rwl and vent piping	1	$ 7,500	61	0	$ -	2.00%	2.00%
131	new 70gal HP dhwt	1	$ 5,000	14	0	$ -	2.00%	2.00%

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RETROFIT

Line No.	Building Components Subject to M&R	Include in Option	Cost	Useful Life (years)	Current Age	Annual Service Cost	Annual Service Cost Escalation Rate	Annual Capital Cost Escalation Rate
	Units	0=no or 1=yes	$	Years	Years	$	2.00%	2.00%
132	C13 HVAC	1		0	0	$ -	2.00%	2.00%
133	geothermal wells, testing	1	$ 50,000	61	0	$ -	2.00%	2.00%
134	gshp exterior piping, trenching, backfill, reinstatement	1	$ 15,000	61	0	$ -	2.00%	2.00%
135	gshp interior piping	1	$ 7,500	61	0	$ -	2.00%	2.00%
136	gshp-5 tons	1	$ 10,000	25	0	$ 100	2.00%	2.00%
137	electric boiler 5kW	1	$ 3,000	30	0	$ 100	2.00%	2.00%
138	circulation pumps	1	$ 7,000	25	0	$ -	2.00%	2.00%
139	electric boiler pump	1	$ 2,500	25	0	$ -	2.00%	2.00%
140	air separators	1	$ 7,000	30	0	$ -	2.00%	2.00%
141	expansion tanks	1	$ 5,000	25	0	$ -	2.00%	2.00%
142	distribution piping	1	$ 25,000	61	0	$ -	2.00%	2.00%
143	indoor units - 1 ton	1	$ 10,000	25	0	$ -	2.00%	2.00%
144	indoor units - 1.5 ton	1	$ 12,000	25	0	$ -	2.00%	2.00%
145	ERV 1144cfm	1	$ 15,000	20	0	$ 200	2.00%	2.00%
146	ERV 890cfm	1	$ 9,000	20	0	$ 200	2.00%	2.00%
147	new ERV ductwork connected to existing	1	$ 18,000	61	0	$ -	2.00%	2.00%
148	C14 Controls	1		0	0	$ -	2.00%	2.00%
149	individual controls	1	$ 10,000	20	0	$ 100	2.00%	2.00%
150	CO2 sensors	1	$ 2,000	15	0	$ -	2.00%	2.00%
151	C21 Services and Distribution	1		0	0	$ -	2.00%	2.00%
152	new 400A service entrance, 300A main breaker	1	$ 20,000	40	0	$ -	2.00%	2.00%
153	photovoltaic system complete with racking, inverters 50kW	1		0	0	$ -	2.00%	2.00%
154	C22 Lighting, Devices and Heating	1		0	0	$ -	2.00%	2.00%
155	upgrade remaining lighting to LED	1	$ 25,568	20	0	$ -	2.00%	2.00%
156	lighting controls	1	$ 19,176	0	0	$ -	2.00%	2.00%
157	Z11 General Requirements and Overheads	1		0	0	$ -	2.00%	2.00%
158	contractor's overheads	1	$ 174,338	61	0	$ -	2.00%	2.00%
159	Z12 Contractors Profit	1		0	0	$ -	2.00%	2.00%
160	contractor's profit	1	$ 133,659	61	0	$ -	2.00%	2.00%
161	Z21 Design Allowance	1		0	0	$ -	2.00%	2.00%
162	design development contingency	1	$ 147,025	61	0	$ -	2.00%	2.00%
163	Z23 Construction Allowance	1		0	0	$ -	2.00%	2.00%
164	construction contingency	1	$ 161,727	61	0	$ -	2.00%	2.00%
169		1		0	0	$ -	2.00%	2.00%
170	construction contingency for 2024 - 10%	1	$ 107,005	61	0	$ -	2.00%	2.00%
171		1		0	0	$ -	2.00%	2.00%
200	Array Size 51 kWdc	1	$ 204,000			$ 1,444	2.00%	2.00%

Input : Min + Solar

BASE CASE

Line No.	Building Components Subject to M&R / Units	Include in Option (0=no or 1=yes)	Cost ($)	Useful Life (years)	Current Age (Years)	Annual Service Cost ($)	Annual Service Cost Escalation Rate (2.00%)	Annual Capital Cost Escalation Rate (2.00%)
1	Building Mounted Lighting	0	$ -				2.00%	2.00%
2	Concrete Footings and Frost Wall	0	$ -				2.00%	2.00%
3	Superstructure	0	$ -				2.00%	2.00%
4	Asphalt Shingles	0	$ 36,300	20	12		2.00%	2.00%
5	Asphalt Shingle Repair	0					2.00%	2.00%
6	Gutters & Downspouts	1	$ 6,120	40	12		2.00%	2.00%
7	Wood Siding	0	$ 27,075	30	22		2.00%	2.00%
8	Exterior Doors (Rear double door)	1	$ 2,500	25	0		2.00%	2.00%
9	Exterior Door (Front)	1	$ 1,500	25	0		2.00%	2.00%
10	Exterior Door (Front ramp access)	1	$ 1,500	25	0		2.00%	2.00%
11	Exterior Door (Side entrance double door)	1	$ 2,500	25	0		2.00%	2.00%
12	Vinyl Windows	0	$ 5,400	35	17		2.00%	2.00%
13	Brick Columns	1	$ 100	25	17		2.00%	2.00%
14	VCT Flooring- Upper floor	1	$ 28,390	25	17		2.00%	2.00%
15	VCT Flooring- Lower floor	1	$ 18,788	25	17		2.00%	2.00%
16	Hard Tile (Washrooms)	1	$ 4,640	40	7		2.00%	2.00%
17	Adhesive Tile	1	$ 3,025	15	17		2.00%	2.00%
18	Gypsum Wall Board	1	$ -				2.00%	2.00%
19	Suspended ceiling tile	1	$ -	20	12		2.00%	2.00%
20	Millwork (Kitchen and Bar)	1	$ 10,800	25	17		2.00%	2.00%
21	Washroom Vanities	1	$ 2,925	20	7		2.00%	2.00%
22	Above Ground Oil Storage Tanks	1	$ 4,000	15	4		2.00%	2.00%
23	Kerr Comet Boiler	0					2.00%	2.00%
24	Hot Water Radiators	1	$ 7,500	40	40		2.00%	2.00%
25	Heat Pump, Mini Splits 2t units	1	$ 13,200	20	7		2.00%	2.00%
26	Well and well pump	0	$ -			$ 100	2.00%	2.00%
27	Domestic Water Treatment System	1	$ -	25	22	$ 100	2.00%	2.00%
28	Domestic Hot Water Heater	1	$ 1,500	10	2	$ 200	2.00%	2.00%
29	Plumbing Fixtures - Washrooms	1	$ 12,000	35	7	$ 100	2.00%	2.00%
30	Exhaust Fans - Washrooms	1	$ -	15	12	$ 100	2.00%	2.00%
31	Siemens 100A (Panel A)	0					2.00%	2.00%
32	Square D 200A (Panel A)	0					2.00%	2.00%
33	Lighting and branch wiring florescent fixtures	1	$ 14,025	20	22		2.00%	2.00%
34	Lighting and branch wiring pot lights	1	$ 9,300	25	22		2.00%	2.00%
35	Emergency Lighting	1	$ -	20	22		2.00%	2.00%
36	Fire alarm panel Mircom FA-300	1	$ 5,000	20	12		2.00%	2.00%
37	Fire Extinguisher	1	$ -	12	7		2.00%	2.00%
38	Automatic Door Openers (Interior)	1	$ 7,500	20	7	$ 100	2.00%	2.00%
39	Boiler circ pumps	1	$ 2,000	25	17	$ 100	2.00%	2.00%
40		1					2.00%	2.00%
110	A32 Walls Above Grade	1		0	0	$ -	2.00%	2.00%
111	remove existing façade	1	$ 14,315	61	0	$ -	2.00%	2.00%
112	structural upgrades including base angle	1	$ 36,000	61	0	$ -	2.00%	2.00%
113	supply and install r11 prefab insulated wall panels	1	$ 128,837	61	0	$ -	2.00%	2.00%
114	supply and install prefinished metal siding	1	$ 214,729	61	0	$ -	2.00%	2.00%
115	A33 Windows and Entrances	1		0	0	$ -	2.00%	2.00%
116	replace windows with triple pane	1	$ 8,022	30	0	$ -	2.00%	2.00%
117	A34 Roof Coverings	1		0	0	$ -	2.00%	2.00%
118	remove existing roof finish	1	$ 5,989	61	0	$ -	2.00%	2.00%
119	3/4 T&G plywood sheathing	1	$ 68,874	61	0	$ -	2.00%	2.00%
120	install new pre-engineered roof trusses above existing	1	$ 77,857	61	0	$ -	2.00%	2.00%
121	new knee wall construction, hurricane clips	1	$ 7,572	61	0	$ -	2.00%	2.00%
122	additional gable end sheathing	1	$ 5,274	61	0	$ -	2.00%	2.00%

Input : Min + Solar

Line No.	Building Components Subject to M&R / Units	Include in Option (0=no or 1=yes)	Cost ($)	Useful Life (years) (Years)	Current Age (Years)	Annual Service Cost ($)	Annual Service Cost Escalation Rate (2.00%)	Annual Capital Cost Escalation Rate (2.00%)
123	new R11 loose fill insulation	1	$ 11,978	61	0	$ -	2.00%	2.00%
124	new metal roof	1	$ 137,747	61	0	$ -	2.00%	2.00%
125	B22 Ceiling Finishes	1		0	0	$ -	2.00%	2.00%
126	cut and patch ceilings for new mechanical/electrical	1	$ 9,588	61	0	$ -	2.00%	2.00%
127	B23 Wall Finishes	1		0	0	$ -	2.00%	2.00%
128	cut and patch walls for new mechanical/electrical	1	$ 9,588	61	0	$ -	2.00%	2.00%
129	C11 Plumbing and Drainage	1		0	0	$ -	2.00%	2.00%
130	add insulation to internal rwl and vent piping	1	$ 7,500	61	0	$ -	2.00%	2.00%
131	new 50gal electric dhwt	1	$ 2,000	14	0	$ -	2.00%	2.00%
132	C13 HVAC	1		0	0	$ -	2.00%	2.00%
133	new 0.5 ton mini split heat pump	1	$ 5,000	15	0	$ 100	2.00%	2.00%
134	new 1.0 ton mini split heat pump	1	$ 6,000	15	0	$ 100	2.00%	2.00%
135	new 25kW electric boiler	1	$ 5,000	30	0	$ 100	2.00%	2.00%
136	electric boiler pump	1	$ 2,500	20	0	$ -	2.00%	2.00%
137	modify piping	1	$ 5,000	61	0	$ -	2.00%	2.00%
138		1		0	0	$ -	2.00%	2.00%
145	ERV 1144cfm	1	$ 15,000	20	0	$ 200	2.00%	2.00%
146	ERV 890cfm	1	$ 9,000	20	0	$ 200	2.00%	2.00%
147	new ERV ductwork connected to existing	1	$ 18,000	0	0	$ -	2.00%	2.00%
148	C14 Controls	1		0	0	$ -	2.00%	2.00%
149	individual controls	1	$ 5,000	20	0	$ 100	2.00%	2.00%
150		1		0	0	$ -	2.00%	2.00%
151	C21 Services and Distribution	1		0	0	$ -	2.00%	2.00%
152	new 400A service entrance	1	$ 20,000	40	0	$ -	2.00%	2.00%
153		1		0	0	$ -	2.00%	2.00%
154	C22 Lighting, Devices and Heating	1		0	0	$ -	2.00%	2.00%
155	upgrade remaining lighting to LED	1	$ 25,568	20	0	$ -	2.00%	2.00%
156		1		0	0	$ -	2.00%	2.00%
157	Z11 General Requirements and Overheads	1		0	0	$ -	2.00%	2.00%
158	contractor's overheads	1	$ 113,120	61	0	$ -	2.00%	2.00%
159	Z12 Contractors Profit	1		0	0	$ -	2.00%	2.00%
160	contractor's profit	1	$ 86,726	61	0	$ -	2.00%	2.00%
161	Z21 Design Allowance	1		0	0	$ -	2.00%	2.00%
162	design development contingency	1	$ 95,398	61	0	$ -	2.00%	2.00%
163	Z23 Construction Allowance	1		0	0	$ -	2.00%	2.00%
164	construction contingency	1	$ 104,938	61	0	$ -	2.00%	2.00%
165		1		0	0	$ -	2.00%	2.00%
170	construction contingency for 2024 - 10%	1	$ 86,194	61	0	$ -	2.00%	2.00%
171		1		0	0	$ -	2.00%	2.00%
200	Array Size 69 kWdc	1	$ 276,792			$ 1,959	2.00%	2.00%

RETROFIT