Creekview Housing Co-operative
Net Zero Retrofit vs. New Construction Study
Final Report

February 2025

Acknowledgements

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- Author: Affine Climate Solutions.

- Organizations consulted: Co-operative Housing Federation of BC, Community Land Trust, City of Vancouver Green & Resilient Building Branch, Zero Emissions Innovation Centre, Impact Engineering.

- Additional sources and study context are included in the Endnotes and Appendix.

Disclaimer

- Reasonable efforts have been made to ensure the accuracy of the information contained in this document and to clearly state all assumptions underlying future forecasts. However, as a forward-looking study, **this document relies on numerous assumptions and predictions**, inherently involving uncertainty.

- The information, concepts, and recommendations provided herein are based on the best available data at the time of preparation. **Any decisions, actions, or inactions taken based on the analysis and content of this document are solely at the reader's own risk.** The authors, client, and funding partners disclaim any liability for losses or damages arising from the use of the information or opinions presented in this document.

- All information is provided “as is,” without any warranty or guarantee of any kind**. This document may contain inaccuracies, omissions, or typographical errors**, and readers are encouraged to independently verify its contents before making any decisions.

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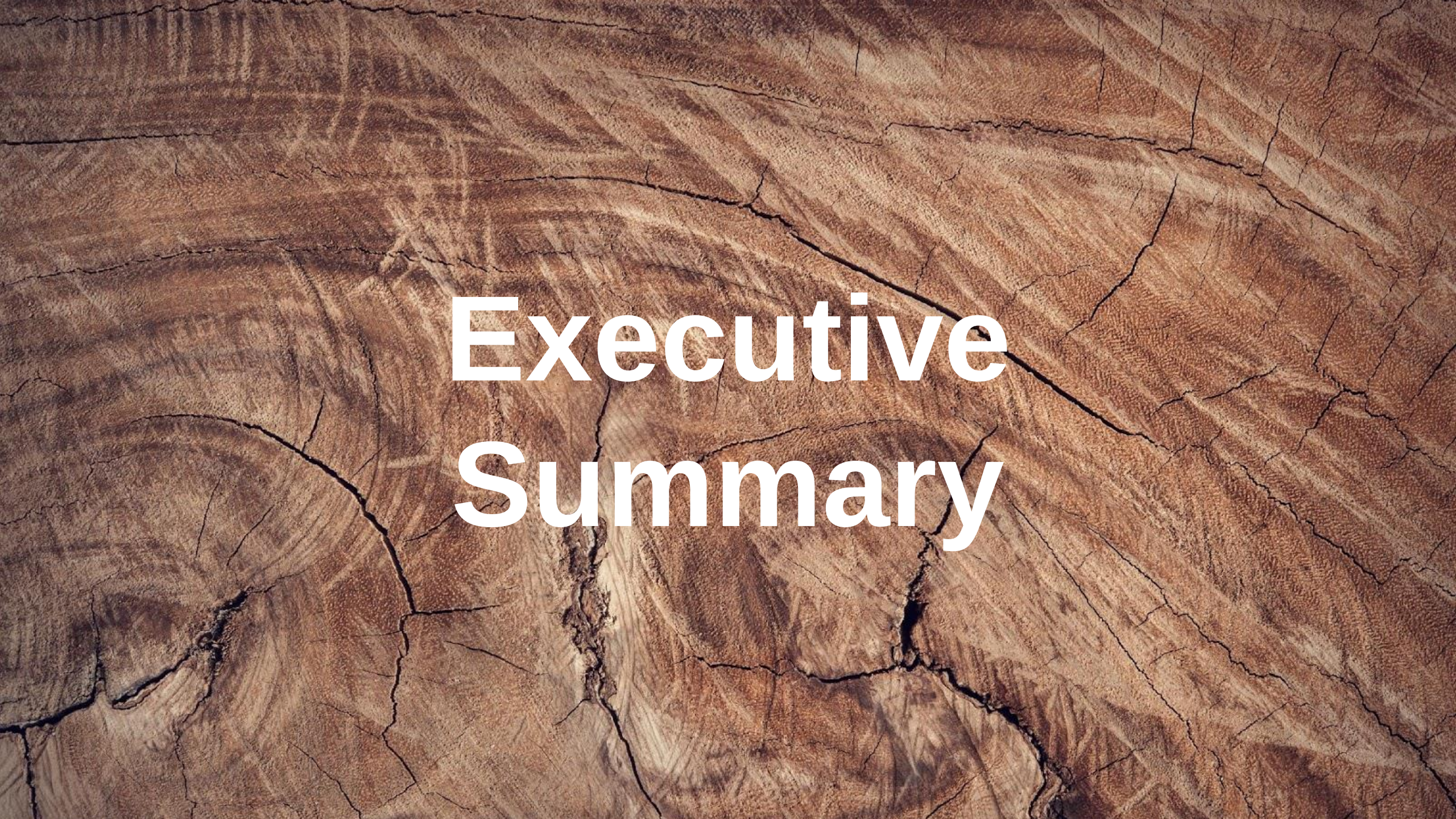
Executive
Summary

Executive Summary: Context

False Creek South (FCS) is a Vancouver neighbourhood where 2/3 of the housing is non-profit and co-op. Most of that housing is on land leased from the City of Vancouver, with leases expiring between 2021 and 2040.

To address concerns about lease expiry and future housing, the False Creek South Neighbourhood Association (FCSNA) tasked its RePlan committee with evaluating two housing scenarios: **retrofitting existing co-op housing** or **redeveloping with new affordable and market housing**.

This study uses Creekview, an FCS co-op building, to analyze 5 key drivers influencing decisions between redevelopment and net zero retrofit from a municipal and societal perspective. A “do-nothing” scenario is also included for comparison.

Study insights can guide FCS residents and the Association as well as municipal and provincial stakeholders, by enhancing decision-making and knowledge-sharing in sustainable housing practices.

Executive Summary: Findings

Driver	Retrofit	Re-development	Discussion
1. Density		✓	Changes to Vancouver density requirements mean many more housing units could be created through Redevelopment than in the current building.
2. Operational Energy & GHG Emissions	✓	✓	Both Retrofit and Redevelopment would result in significant reductions in operational GHG emissions and energy.
3. Embodied Carbon & Circularity	✓		Retrofit is projected to produce 93% less embodied carbon than Redevelopment.
4. Costs	✓		Retrofit costs are estimated to be 53% less per unit than Redevelopment costs, without accounting for future inflation or discounting.
5. Affordability & Livability	See Recommendations for Further Study		Creekview rent charges are deeply affordable. Redevelopment would likely result in more accessible, but smaller and more expensive units. Further study is needed to understand Redevelopment unit mixes and affordability levels.

Executive Summary:
Recommendations for Further Study

Estimate **new construction revenue** and **net operating income by** analyzing the likely unit mix, affordability levels, and potential financing sources. Develop a preliminary pro forma that incorporates projected costs, anticipated revenue, and the applicable capitalization rate.

Further develop the **retrofit business case** by refining the project scope and confirming necessary code upgrades. The financial analysis could be enhanced by incorporating available affordable housing financing options.

Prioritize Creekview's **livability, social diversity, equity, and intergenerational community value**. Facilitate further stakeholder engagement to discuss the study's findings and assess how these aspects might be impacted by each scenario.

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Overview

Study Background

- False Creek South (FCS) is a Vancouver neighbourhood where 2/3 of the housing is non-profit and co-op. Most of that housing is on land leased from the City of Vancouver (CoV), with **leases expiring between 2021 and 2040**[1].
- False Creek South Neighbourhood Association (FCSNA) is a coalition of elected co-op and strata representatives serving as a liaison between the FCS community and the City of Vancouver. The FCSNA formed the RePlan committee in 2010 to address resident and community lease expiry concerns.
- RePlan sought an environmental, social, and economic cost-benefit analysis for **two potential housing futures** in the area:
    1. **Preserving & retrofitting** existing affordable co-op housing beyond lease expiry.
    2. **Demolishing current housing & redeveloping** new affordable and market housing.
- For operational and embodied carbon emission comparisons, the study also considers a third, “Do Nothing” scenario.

Study Objectives

1. Analyze **five key drivers influencing decision-making** between redevelopment and net-zero, climate resilient retrofit scenarios, using a False Creek South affordable housing co-op as a case study.

2. Investigate **whole-life carbon emission impacts** of building retrofit vs. redevelopment. Consider **circular economy principles** and demolition impacts.

3. **Disseminate data and study findings** to municipal decision-makers, community stakeholders, and green building researchers, facilitating knowledge-sharing and integration of relevant decision factors in other projects.

4. **Inform and influence the dialogue** with municipal and provincial stakeholders concerning the value and future of the FCS neighbourhood.

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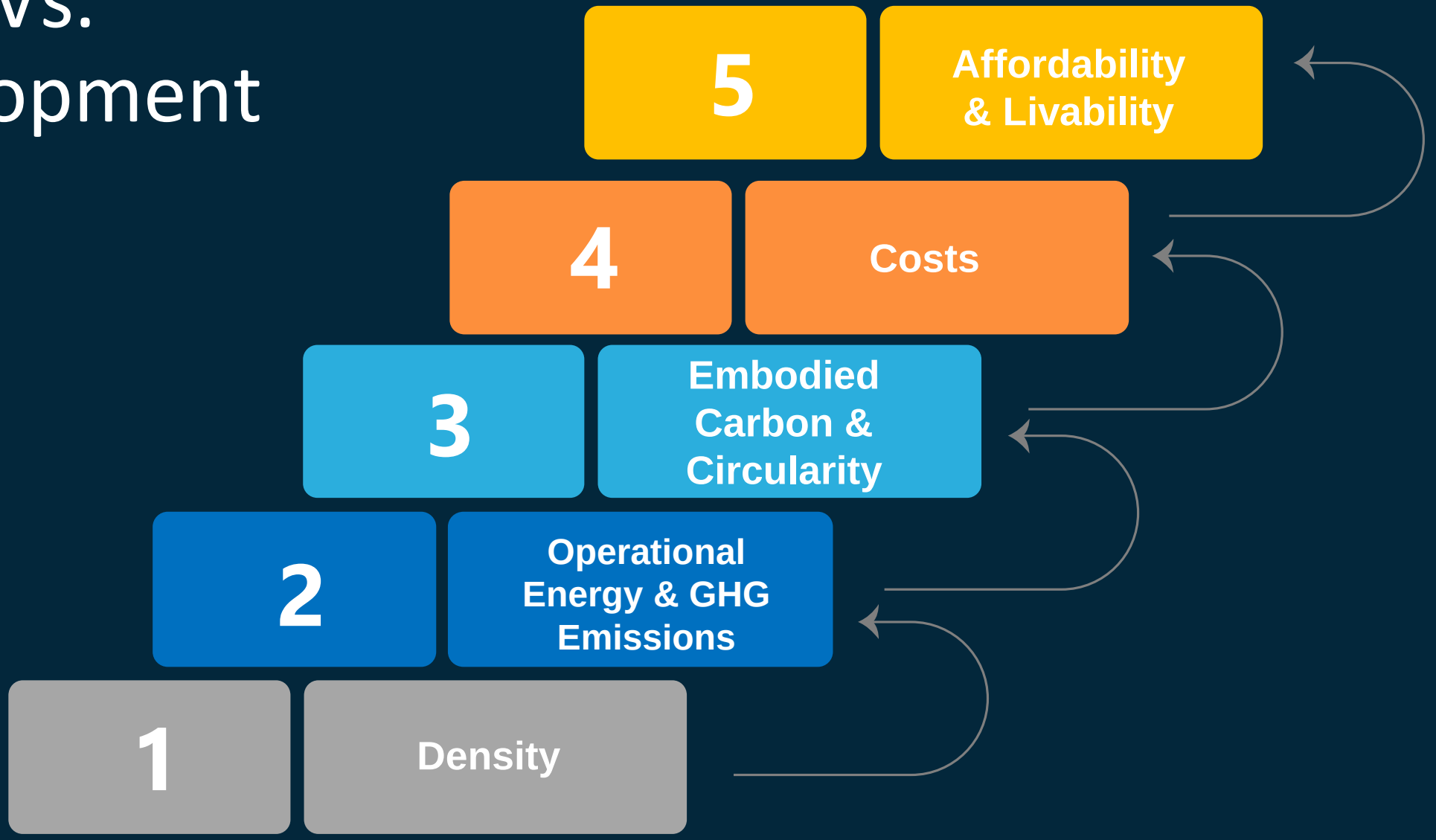
Retrofit Vs. Redevelopment Drivers



Case Study: Creekview Housing Co-operative

Creekview, located in False Creek South, was selected as a case study for two reasons:

1. It was among the earliest leases to expire, in December 2023, with the lease recently being extended by 12 years.
2. The building faces considerable deferred maintenance spending, making it a good candidate for a retrofit.

Storeys	8
Units	109 (mix of one-, two-, and three- bedroom units)
Construction year	1986
Gross floor area	98,900 sq ft. (9,188 m^2)
Lot area	46,500 sq ft. (4,320 m^2)
Floor Space Ratio (FSR)	2.12

Key Findings

- **Density**: Lacking a community plan or urban design analysis, it is uncertain what density is likely for the long term of this site. However, in light of Provincial TOA and City spot rezonings, an aggressive redevelopment scenario has been adopted for this study.
- **Emissions**: The Retrofit Scenario has substantially lower emissions than Redevelopment. Over its assumed extended building lifetime of 45 years, **Retrofit produces 92% less carbon (including operational and embodied carbon) than the Redevelopment Scenario** over the same period. Most emissions in both scenarios come from embodied carbon.
- **Costs**: **Retrofit costs are estimated to be approximately 53% less per unit than Redevelopment**, even without accounting for future cost inflation or discounting.
- **Affordability**: Current Creekview rent charges are deeply affordable. While outside the scope of this study, it is recommended to establish greater clarity around the unit mix and affordability levels in the redevelopment scenario by developing a pro forma, estimating net operating income (NOI), and identifying potential funding and financing sources.
- **Livability**: Redevelopment would likely result in more accessible, but smaller units. The livability of a new building would depend on many factors including design and layout, building amenities, social interaction, noise levels, comfort, and safety and security.

Future Phases of Work

- **New Building Feasibility Assessment**: Estimate the revenue and net operating income by analyzing the unit mix, affordability levels, and potential financing sources. Develop a preliminary pro forma that incorporates projected costs, anticipated revenue, and the applicable capitalization rate.
- **Retrofit Business Case Development**: Develop the retrofit business case by refining the project scope, confirming necessary code upgrades, and building on the financial analysis to incorporate available affordable housing financing options.
- **Whole-Life Carbon Emission Assessment**: Conduct a full-scope life cycle assessment (LCA) per Vancouver rezoning requirements for the new construction scenario, evaluating embodied carbon across building systems and estimating carbon savings from recycling and salvaging Creekview construction waste. Further study embodied carbon reduction strategies and how to reuse building materials and reduce demolition waste.
- **Consider Creekview's livability and social value** in terms of family unit numbers and unit sizes, common areas and services, social diversity, inter-generational living, equity, and strong social and physical connections.


Retrofit &
Redevelopment
Scenarios

Net Zero Retrofit: Scope and Savings

Energy Conservation Measure (ECM)	Savings per Year	GHG Reductions per Year (tC02e)	GHG Reductions % Change
Air-Source Heat Pump Make-Up Air	$4,127	25.9	65%
Mini Split Heat Pump: In-suite Heating & Cooling	$49,731	4.9	12%
Hybrid Electric Water Heaters for Suites DHW	$37,566	3.7	9%
Air Source Heat Pumps for Laundry DHW	$696	0.1	0.2%
Window Upgrades	$5,561	0.5	1%
Total	**$97,681**	**35.1**	**88%**

- The Retrofit Scenario includes the above **ECMs** and associated cost and GHG savings, identified in an ASHRAE Level 2 Energy Audit produced by Impact Engineering in October 2024.
- The Retrofit is assumed to take place in 2026. Remaining emissions post retrofit are from electricity.

Redevelopment: Assumed Building Typology

	Building 1	Building 2
Building Type	Multi-family co-op housing and commercial space	Affordable co-op housing (with housing for seniors)
# of Storeys	22	32
Sq ft. and Layout	130,000 sq ft residential + 20,000 sq ft commercial (~14,000 m^2)	210,000 sq ft (~20,000 m^2)
Parking (Appendix A)	One underground level	One underground level

- There are many possibilities and potential timelines for redevelopment. This study assumed a **two-building scenario with a combined FSR of 3.64**. BC's provincial Transit Oriented Development[2] (TOD) minimum allowable FSR for the site is 3.
- Redevelopment would be assumed to begin in **2036** (at the earliest) in line with Creekview's current projected lease expiry.
- Geotechnical constraints from Granville Bridge will impact and limit building load and column layout for any new structure taller than the existing bridge.

Redevelopment: Possible Unit Numbers

Building	Studio	1 Bedroom	2 Bedroom	3+ Bedroom	Total
Building 1 Multi-family Co-op	9% of units 420 ft²	32% of units 500 ft²	37% of units 750 ft²	22% of units 950 ft²	**130,000 ft²** (not including commercial space)
Building 1 Multi-family Co-op	~17 units	~61 units	~70 units	~42 units	**~190 units**
Building 2 Affordable Housing Co-op	40% of units 420 ft²	20% of units 500 ft²	18% of units 750 ft²	22% of units 950 ft²	**210,000 ft²**
Building 2 Affordable Housing Co-op	~137 units	~69 units	~62 units	~75 units	**~343 units**

- The Redevelopment Scenario represents an approximately **80% increase in the number of units** and approximately **70% increase in sq ft**. from the current Creekview building (see **Appendix B**).


Energy & GHG
Emissions

GHG Comparison: Assumptions and Findings

- The “Carbon Avoided: Retrofit Estimator” (CARE) tool[5] was used to compare embodied emissions across the three scenarios (Do Nothing, Net Zero Retrofit, and Redevelopment). Data from an ASHRAE Level 2 Energy Audit was used to project operational emissions (see **Appendix C**).
- The Retrofit Scenario has substantially lower emissions. **Over 45 years[6], Retrofit produces 92% less total carbon (operational + embodied) than the Redevelopment Scenario**.
- Most emissions in both the Retrofit and Redevelopment scenarios are from embodied carbon.
- With regards to circularity, the Redevelopment Scenario would require demolition of the existing building, producing significant construction waste.
- The Retrofit Scenario brings comfort and improved climate resilience for residents as well as having a better climate outcome than doing nothing.

City of Vancouver Climate Targets

- The City of Vancouver Council has set the following GHG emissions reductions targets by 2030[3]:
  - By 2030: Target of **zero Operational emissions** for all new buildings.
  - By 2030: Target of **40% less embodied emissions** from new buildings and construction projects (compared to 2018).
- Further targets for net zero carbon construction will be set beyond 2030.

Policies Impacting Future Redevelopment

- In alignment with these targets, several CoV policy changes will impose new operational energy, GHG emissions, and embodied carbon limits that will impact new large (Part 3) buildings in False Creek South:

- May 2022: Changes to the **Green Buildings Policy for Rezonings**.
    - Sets out requirements for all applicable developments applying for rezoning, to help transition industry toward more sustainable building practices.

- Jan 2025: Changes to the **Vancouver Building By-law (VBBL)** come into effect.
    - Projects applying for building permits after this date will need to comply with the new standards.

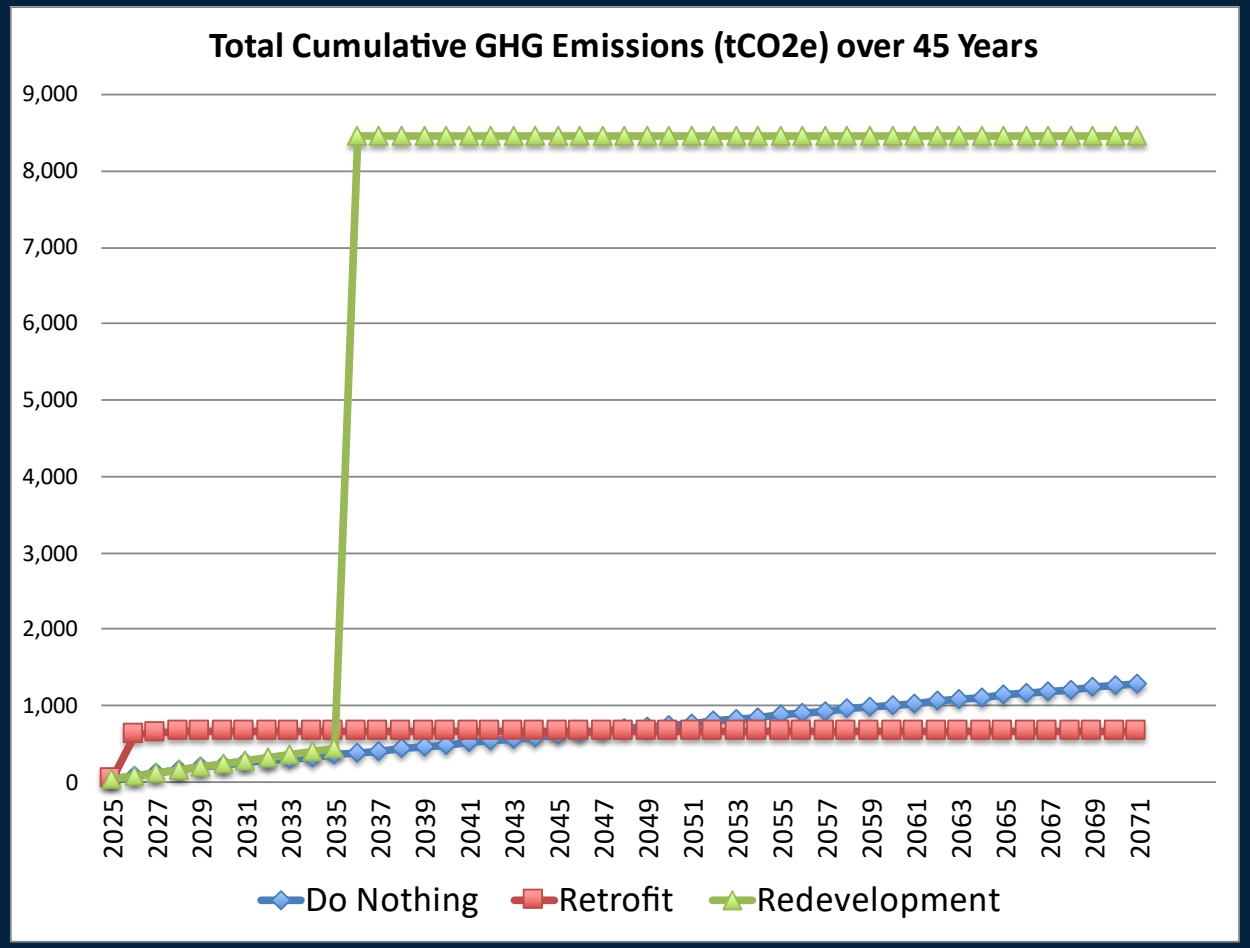
Operational Energy and GHG Emissions Limits

- Current CoV limits are as follows, and are assumed to be the minimum requirements that new buildings will need to meet in 2036 (see **Glossary**):
  - Max. **Total Energy Use Intensity** (TEUI): 120 kWh/m2.
  - Max. **Total Energy Demand Intensity** (TEDI): 30 kWh/m2.
  - Max. **Greenhouse Gas Intensity** (GHGI): 3.0 kgCO2e/m2 for 7+ storey residential occupancies. This is likely to change to 1.8 kgCO2e/m2 in March 2025. To meet this GHGI target, all major building systems will need to be electrified.

Redevelopment: Embodied Carbon Limits

- Embodied carbon limits for the Redevelopment Scenario have been calculated as follows (converted from kilograms to metric tons):
  - Building 1: 3,345 tCO2e
  - Building 2: 4,682 tCO2e
- This is based on the CoV's current Absolute Path, which stipulates that a building's whole-building embodied carbon intensity (ECI) cannot be more than 400 kgCO2e/m2[4].
- However, is anticipated that the ECI Absolute Path limit will decrease by 40% by 2030, in line with CoV embodied carbon reduction targets. Thus, a conservative assumption for redevelopment in 2036 would set the limit at 240 kgCO2e/m2.
  - This figure was used for calculating the embodied carbon limits for the Redevelopment Scenario above (converted from kg to tonnes).

Operational and Embodied Emissions



- The graph shows cumulative tons of operational and embodied CO_2 emissions for each of the three scenarios, over 45 years.
- Retrofit embodied carbon spikes when the retrofit occurs in 2026.
- Redevelopment embodied carbon spikes when the redevelopment occurs in 2036.
- The Redevelopment Scenario includes operational emissions from the existing building, prior to new construction.
- Operational emissions assume the BC electricity grid will be fully decarbonized from 2030.

Operational and Embodied Emissions

Measure	Do Nothing	Net Zero Retrofit	Re-development
Operational Emissions (Cumulative tons CO2e until 2071)	1,252	56	160
Embodied Emissions (Tons CO2e / Cradle to Gate)	0	574	8,027
Total Emissions per unit (Tons CO2e)	11.5	5.8	15.4
Total Emissions (Tons CO2e)	1,252	630	8,187

- **Both net-zero retrofit and redevelopment result in low operational emissions**. The Redevelopment scenario would produce 3 times as many emissions from operations as a deep retrofit, including emissions from the current building between now and the assumed construction date.
- **There are significant embodied emissions from new construction**. This means the Redevelopment Scenario is projected to produce 14 times more embodied emissions and nearly 3 times the total emissions per unit compared to Net Zero Retrofit.
- **Deep emissions reductions can be achieved with a Net Zero Retrofit**. This makes it the lowest total emissions scenario, as well as the lowest emissions per unit.

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Costs

Costs: Assumptions and Findings

- The overall lifetime cost for the Retrofit Scenario is projected to be 90% lower than the Redevelopment Scenario.
- Units in the Retrofit Scenario are estimated to cost 53% less per unit and 64% less per square foot than in the Redevelopment Scenario. Total costs range from an estimated $214/square foot for the Retrofit Scenario, to $591/sq ft for Building 1 and $580/sq ft for Building 2 in the Redevelopment Scenario (averaged across Low and High estimated costs – see **Appendix E**).
- Cost projections are estimates and based on 2024 dollars. They do not account for future inflation or discounting. “Soft costs” included in the Redevelopment Scenario are exhaustive (see **Appendix E**).
- Additional costs for code upgrades that may be triggered by the retrofit are not included (see **Appendix F**).

Redevelopment Costs

Building	Cost (Millions)	Low Base Year	High Base Year
Building 1 Multi-family Co-op	Hard Costs	$52.5	$66.0
	Soft Costs	$26.3	$26.3
	Below-grade Parking (10,000 ft²)	$2.7	$3.6
	Total	**$81.5**	**$95.9**
Building 2 Affordable Housing Co-op	Hard Costs	$73.5	$92.4
	Soft Costs	$36.8	$36.8
	Below-grade Parking (6,563 ft²)	$1.8	$2.4
	Total	**$112.0**	**$131.5**
Building 1 + 2 Total		**$193.5 million**	**$227.4 million**

- Hard costs (including Parking) are from the 2024 Altus Group Canadian Cost Guide.
- Soft costs are based on interviews with a private market developer (see **Appendix E**).

Retrofit Costs: Maintenance

Scope	Cost
Structure	$70K
Exterior	$4.4 million
Common Areas Interior	$110K
Suite Interiors*	$3.2 million
Systems	$1.4 million
Site and Grounds	$170K
Professional Fees	$2.0 million
Total	**$11.4 million**

**Includes new appliances and upgrades to kitchens, bathrooms & carpets/flooring.*

- Costs are based on a depreciation report including deferred as well as future maintenance needs until 2052.

Retrofit Costs: Energy Conservation Measures

Scope	Cost	Potential Incentive*
Air-Source Heat Pump Make-Up Air	$180K	$100K
Mini-Split Heat Pumps for Heating & Cooling in Suites	$3.1 million	$210K
Electric Water Heaters for Suites DHW	$1.2 million	$210K
Air-Source Heat Pumps for Laundry DHW	$160K	$9K
Window Upgrade	$440K	$14K
Total	**$5.1 million**	**$543K**

**Incentives include BC Hydro SHIP and SHRSP programs. CMHC may cover up to 80% of energy retrofit costs under the Canada Greener Affordable Homes Program (CGAH).*

- Costs are based on an ASHRAE Level 2 Energy Audit completed in October 2024.

Retrofit Costs: Lifetime

Scope	Cost (Millions)
Maintenance	$11.4
Energy Conservation Measures	$5.1
Replacements (includes one replacement of mechanical equipment)	$4.7
Total	**$21.1 million**

- Total retrofit costs include all deferred and future maintenance costs.

Retrofit Vs. Redevelopment Costs

Building	Retrofit: Upfront Costs	Retrofit: Lifetime Costs	Redevelopment: Low Base Year	Redevelopment: High Base Year
Cost / Sq Ft	$166	$214	Building 1: $543	Building 1: $639
			Building 2: $533	Building 2: $626
Cost / Unit	$151K	$194K	Building 1: $429K	Building 1: $504K
			Building 2: $327K	Building 2: $383K

- Costs are estimates and based on 2024 Canadian dollars without accounting for inflation between 2026 (assumed year of retrofit) and 2036 (assumed year of redevelopment).
- No Discount Rate has been applied (see **Glossary**), and potential incentives have not been included.

Retrofit Vs. Redevelopment: Total Costs

Overall Cost	Retrofit (Lifetime Extended 45 Years)	Redevelopment: Low Base Year	Redevelopment: High Base Year
Total	**$21.1 million**	**$193.5 million**	**$227.4 million**

- Total retrofit costs include all deferred and future maintenance costs across extended building lifetime, as well as initial ECM upgrade costs plus one additional replacement of mechanical equipment.
- Redevelopment costs include hard cost ranges from the 2024 Altus Group Canadian Cost Guide as well as soft costs based on interviews with a private market developer (see **Appendix E**).


Affordability

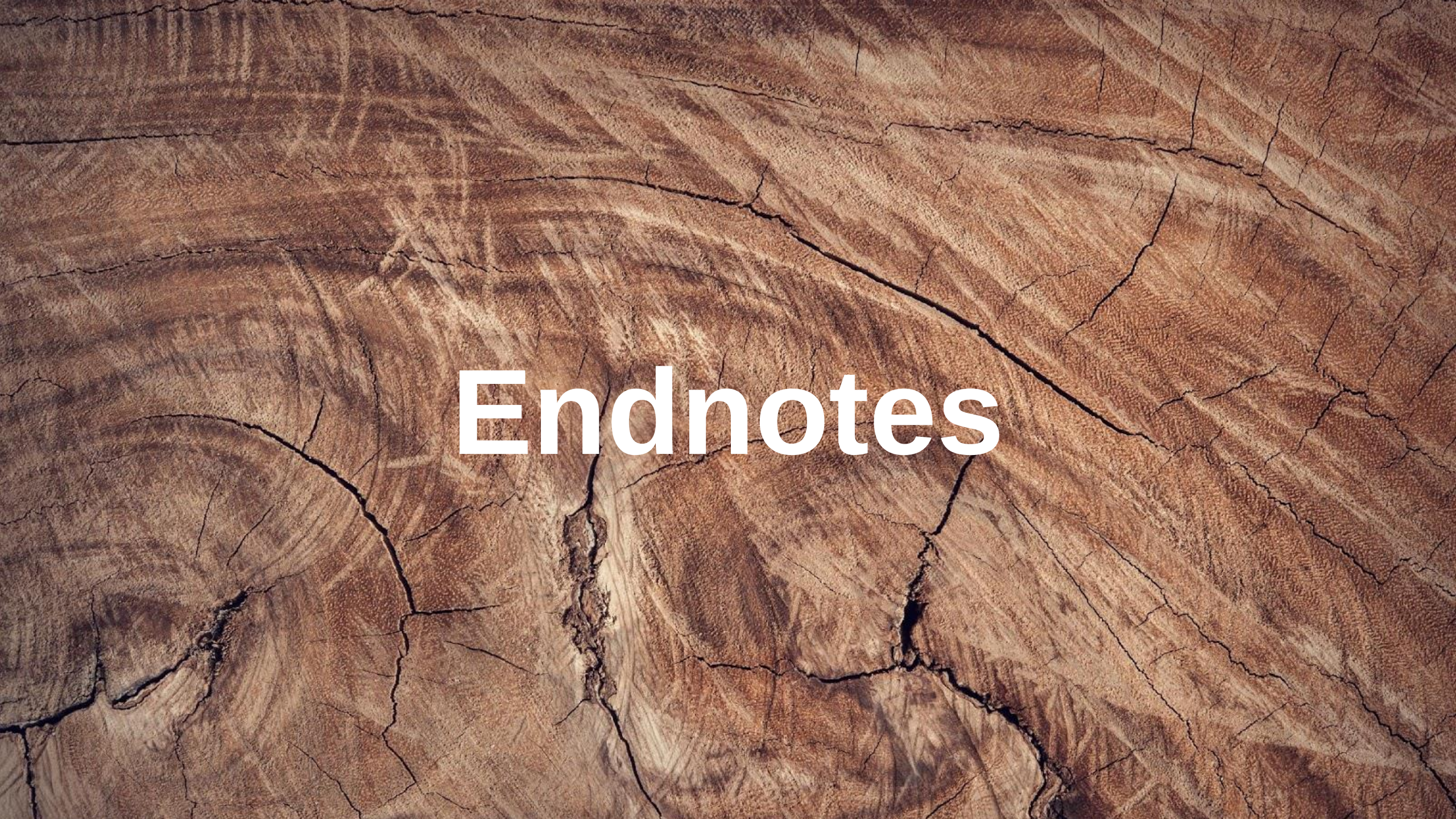
Affordability: Assumptions and Findings

- Co-ops are non-profit housing organizations. Members purchase a share when they move in and receive no equity when they move out. Housing charges are set each year based on the operations and capital budget that is approved by members.
- Creekview housing charges are deeply affordable compared to both rental market prices and to CMHC's affordable rent thresholds (see **Appendix G**).
- In a redevelopment scenario, affordability levels would need to align with thresholds set by the relevant funding program/s (BC Housing, CMHC, and/or FCM).

Creekview: Market Rent Comparison

Unit Size	CMHC Rental Market Statistics (South Granville / Oak, 2023)	CMHC Affordable Rent Threshold (South Granville / Oak, 2020)	CMHC Affordable Rent Threshold % Above Creekview Max. Housing Charges	CMHC Affordable Rent Threshold % Above Similar Co-op* Min. Housing Charges
Studio	$1,441	$1,100	-	-
1 Bed	$1,715	$1,350	+22%	+84%
2 Bed	$2,256	$1,750	+26%	+83%
3 Bed	$3,036 (West End/Stanley Park)	$2,100 (3+ bedroom)	+31%	+85%

**Minimum housing charges were not available for Creekview.*


Endnotes

Endnotes

1. In July 2021, CoV Council reviewed the *Methodology for Co-operative Housing Lease Renewals*, which outlined the framework for renewing leases for co-op housing on city-owned land. This report indicated that the city intends to renew these leases, maintaining their status as co-ops, but with certain conditions and potential changes. However, there is also mention of redeveloping some sites to include denser, non-co-op housing.

   Sources:

   - *CoV Report to Standing Committee on Policy and Strategic Priorities, "Methodology for Co-operative Housing Lease Renewals", June 14, 2021*
   - *CoV "Lease Renewal Methodology for Co-operative Housing on City Land, July 7, 2021*
   - *CoV Report to Council "Standing Committee of Council on Policy and Strategic Priorities", July 7 and 8, 2021*

2. BC's Transit Oriented Development (TOD) requirements were formalized through legislation in 2023, following release of the Vancouver Plan in 2021. The new regulations mandate that municipalities designate TOD areas around rapid transit stations and major bus exchanges, with a focus on increasing housing density in these zones. Creekview falls within 800 meters of South Granville Station.

   Sources:

   - *"Vancouver Plan", 2021*
   - *"Provincial Policy Manual: Transit-Oriented Areas"*
   - *"Attachment 3: Bill 47 Transit-Oriented Development Areas Distances, Transit Stations and Densities by Category"*

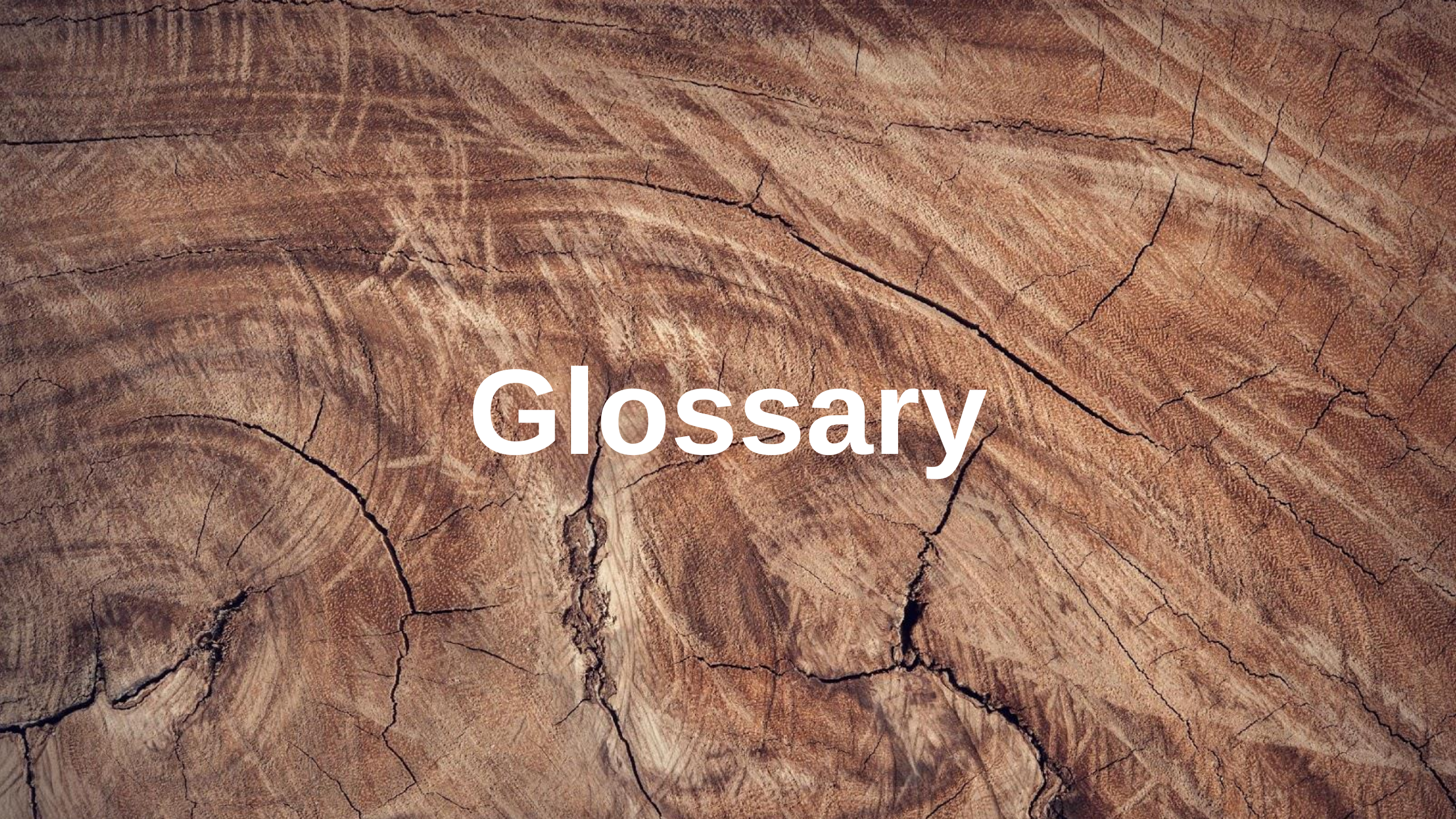
Endnotes

3. CoV GHG targets have been developed and described in the following sources:
   - *"Climate Change Adaptation Strategy"*
   - *"Climate Emergency Action Plan"*
   - *"Embodied Carbon Strategy"*
   - *"Zero Emissions Building Plan"*

4. The Absolute Path and Baseline Path are two methods for calculating embodied carbon benchmarks in the CoV's Building Bylaw 2025. Without a proposed redevelopment design, this study assumed an Absolute Path comparison:
   - **Absolute Path**: This method calculates the embodied carbon benchmark using a fixed value of absolute embodied carbon intensity (currently 400 $kgCO_2e/m^2$). It provides a straightforward, standardized approach that applies uniformly across all buildings, irrespective of their specific characteristics like parking area.
   - Additional embodied carbon requirements include a Life Cycle Assessment (LCA) and meeting one responsible source materials category OR increasing the minimum embodied carbon reduction from 10% to 20%.

5. Limitations exist to the CARE tool data's accuracy and applicability. For example, the tool currently only includes locations in the United States - the nearest urban center to Vancouver was used for modeling purposes.

6. The new building would be assumed to have a lifetime of approx. 60 years, which includes a single mechanical equipment replacement cycle. A retrofit in 2026 would be assumed to add 45 years to the current building's lifetime. To enable a comparison of the Retrofit and Redevelopment scenarios, the period under study covers 2025 – 2071.


Glossary

Glossary

Discount Rate: interest rate used to determine the present value of future cash flows. It reflects the opportunity cost of capital and accounts for risk and inflation, helping investors assess the value of investments or projects over time. Some experts argue for using a zero or near-zero discount rate for climate-related projects to fully value long-term benefits and reflect environmental goals.

Greenhouse Gas Intensity (GHGI): quantifies the amount of GHGs produced by a building per unit area, usually measured in kilograms of CO2 equivalent per sq meter per year (kg CO2e/m²/year). GHGI is used to assess the environmental impact of buildings and track progress toward reducing carbon emissions in line with sustainability goals.

Market rental: refers to units rented at rates determined by the open market, without subsidies or affordability criteria. Units are priced based on supply and demand dynamics in the local rental market.

Renting at/below HILs: these units are classified as affordable housing for households earning up to the HILs threshold, which represents the income required to afford rent for an appropriately sized unit in the private market. HILs are set annually by BC Housing and vary based on region and unit size.

Glossary

Supportive rental units: designed for individuals or families who require additional supports beyond affordable housing. These units typically include services such as mental health and addiction support, life skills training, or other assistance to help tenants achieve stability and independence.

Thermal Energy Demand Intensity (TEDI): measures the amount of thermal energy, specifically heat, required by a building for space heating and ventilation, expressed in kWh/m²/year. This metric is used to assess and improve energy efficiency in buildings, aiming to reduce heating requirements and associated GHGs.

Total Energy Use Intensity (TEUI): refers to the total energy consumption of a building expressed per unit area, typically measured in kWh per sq.m. per year (kWh/m²/year). It serves as a metric to evaluate the energy efficiency of buildings, helping to identify opportunities for reducing energy use and improving sustainability.


Appendix

Appendix A: Parking

- Creekview is <800 meters from South Granville Station and falls under the new Provincial guidelines for Transit-Oriented Areas (TOAs).
- CoV Parking Bylaw requirements do not apply in TOAs, which remove restrictive parking minimums and allow parking to be determined on a project-by-project basis.
    - Builders & developers can propose projects that include residential off-street parking but cannot be required to provide it (other than parking spaces for use by people with disabilities).
- Creekview was built with one parking stall per unit. Considering the changes to parking requirements plus the challenge and expense of increasing below-grade parking on glacial till, we assumed the current number of stalls will be retained rather than increased.

Appendix B: Redevelopment Density

- The BC Provincial Guidance Housing Targets Order issued to the City of Vancouver sets minimum targets for net new housing units to be completed from 2023 to 2028. These targets aim to increase availability of diverse housing options in the city. The order mandates the construction of a total of 28,900 net new units over this period, with a unit type breakdown as follows:
    - Studio units and one-bedroom units: 17,459 (60% of units)
    - 2-bedroom units: 5,231 (18%)
    - 3+ bedroom units: 6,209 (22%)
- Redevelopment density figures in this study assume 85% of residential floor space, with 15% of the building floor area accounting for hallways, elevators, etc.
- **Building 1**:
    - Relative proportions of unit types are based on an average unit mix across 5 co-ops recently constructed in the Fraser River District and Olympic Village. Figures represent a higher % of 2- and 3- bedroom units than CoV targets, but a lower % than the current Creekview mix.
    - Unit sizes are based on stakeholder input and feedback.
- **Building 2**:
    - Relative proportions of unit types are based on the Provincial Housing Directions for new units.
    - Unit sizes are based on stakeholder input and feedback.

Appendix C: Carbon Assumptions

- Across the three scenarios, the Carbon Avoided: Retrofit Estimator (CARE) tool[5] was used to compare embodied carbon produced over 45 years[6]. Data from an ASHRAE Level 2 Energy Audit produced by Impact Engineering in October 2024 was used to project operational emissions.

    1. **Do Nothing**: The baseline scenario uses data from the existing Creekview building, with no assumed upgrades.

    2. **Net Zero Retrofit Scenario**: Assumes net zero, resilient building upgrades to the existing Creekview building, including full electrification, installation of efficient mechanical and plumbing systems, and some upgrades to envelope.

    3. **Redevelopment Scenario**: Includes sum of square footage and number of floors from Building 1 and Building 2 and assumes full electrification and installation of efficient mechanical and plumbing systems.

Appendix D: Refrigerants

- Currently assumed refrigerant in mechanical equipment for retrofit: R-410a
  - High GWP: 2,088
  - Expected to be phased out in the next few years (US phasing out in 2025)
- Potential future refrigerant R-32
  - Lower GWP: 675
  - Expected to be available in Canada in late 2025, being phased out in the UK by 2027
  - More flammable; future code considerations unknown

Appendix E: New Construction Costs

- “Hard costs” are from the 2024 Altus Group Canadian Cost Guide:
  - Covers multi-unit residential buildings 13 – 39 storeys.
  - The cost range is $350 / square foot for the “low” end and 440 per square foot for the “high” end.
  - Includes above-grade scope of work + foundations, plus separate costing for below-grade (parking).
  - Accounts for location-specific labour and material costs and design and climatic/code requirements.
- “Soft costs” are from a developer interview:
  - Costs are exhaustive and include municipal charges, engineering and development soft costs, insurance, marketing, management and overhead, contingency, financing costs, etc. (above grade).
- Costs are in today’s Canadian dollars and do not account for likely ~5% annual inflation.

Appendix F: Code Triggered Retrofit Costs

Scope	Design Level	Likelihood of Upgrades Beyond Proposed Retrofit Scope Being Required
Fire & Life Safety	F2	Low
Structural	S2	Low
Non-Structural	N3	Low
Accessibility	A3	Low
Energy	E4	Low

- The Vancouver Building By-law requires buildings undergoing retrofits to be upgraded to an “acceptable level”. Voluntary upgrades to fire systems, accessibility, or efficiency will not require further improvements, however if other work is included in the retrofit scope, upgrades may be required.
    - *VBBL, Notes to Part 11 - effective July 1, 2022*

Appendix G: Affordability

- Currently, around 30% of Creekview residents receive a CMHC subsidy contribution. Residents pay between min. and max. housing charge, based on 30% of their income.
- Data was not available for Creekview's minimum housing charge, so a similar Co-op's data was used.
- The Provincial Housing Target Order (issued Sept. 2023) includes guidance and targets on the following unit categories: tenure, affordability, supportive rental units, and unit type. Although these categories are not requirements, municipalities have been encouraged to strive toward meeting and monitoring the unit breakdown.