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145 ST. GEORGE CARBON ANALYSIS REPORT

FOR

TENBLOCK

145 ST. GEORGE ST.

TORONTO, ON

OUR PROJECT NUMBER:

21196.002.F.001

DATE:

Friday, August 06, 2021

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GLOSSARY OF TERMS

Carbon Emissions: The release of carbon into the atmosphere.

Existing Building: The building currently standing at 145 St. George

Proposed Construction: The building that will be constructed at 145 St. George

Annual Consumption: The amount of energy consumed by a building in a calendar year

Consumption Intensity: The amount of annual consumption normalized to a universal factor. For this report, the factor is number of suites.

Carbon Intensity: The amount of annual carbon emissions normalized to a universal factor. For this report, the factor is number of suites.

Cumulative Emissions: The addition of annual carbon emissions for a given number of years.

Carbon Positive: The point of time where the Cumulative Emissions of the Proposed Construction are lower than the Cumulative Emissions of the Existing Building.

Embodied Carbon: The carbon emissions associated with creating the building products, construction of a building, and disposal of building materials after demolition.

Life Cycle Assessment: A method to assess the overall environmental impact associated with all stages of the life cycle of a building.

kWh: Denotes kilowatt hours (ekWh denotes equivalent kWh hours. Used only when comparing natural gas use and electricity use directly).

$kgCO_{2e}$: Denotes kilograms of equivalent carbon dioxide emissions. Used to combine all different greenhouse gas emissions into one term.

m^3:Denotes cubic meters. Used to describe natural gas consumption

EXECUTIVE SUMMARY

Authorization

This report was prepared at the request of Tenblock.

Purpose

This report presents the findings of a carbon analysis performed at 145 St. George Street in Toronto, Ontario. The analysis compares the building's carbon emissions with the proposed construction to determine the amount of time it will take for the proposed construction to become carbon positive. The analysis also compares the carbon emissions of the proposed construction to a similar-sized suburban development. The embodied carbon of the proposed construction and the estimated annual emissions were taken into consideration in this analysis.

Existing Asset Overview

145 St. George is a multi-unit residential building (MURB) located near the intersection of St. George Street and Bloor Street. The building has twelve storeys above grade and one level of below grade parking and mechanical and electrical rooms.

Building heating is provided by two hot water boilers and distributed to the suites fan coils. Residents have control of the heat at the fan coil units. Domestic hot water is provided by six hot water heaters and tanks. Three tanks are reserved for the lower section of the building and three are reserved for the upper portion.

The facility currently has a total of 130 rental suites – the majority of which are studios. The facility follows a general multi-residential building schedule. The building equipment is well maintained by knowledgeable and conscientious building operators.

Key Findings

The report identifies and compares the carbon emissions of the existing building and the proposed building at various tiers of the Toronto Green Standard (v3). The buildings were compared on a per-suite basis. The following key results were found:

- The existing building emits 3,716 $kgCO_{2e}$/suite annually.
- The embodied carbon emissions of the proposed building totaled 10,770Ton CO_{2e} or 31,584$kgCO_{2e}$/suite.
- The annual emissions of the proposed building range based on which Toronto Green Standard Tier is considered from 1,355 $kgCO_{2e}$/suite (Tier 1) to 337 $kgCO_{2e}$/suite (Tier 4) annually.
- The proposed building becomes carbon positive compared to the existing building between 13 years (Tier 1) and 9 years (Tier 4) after construction.

1. BENCHMARKING

Utility Consumption

Tenblock provided monthly utility data as tabular data. For benchmarking purposes, the utility bills from January 2016-December 2020 were used. The annual consumption of electricity and natural gas was averaged to determine a typical year's energy consumption. Table 1 below summarizes the utility consumption and greenhouse gas emissions for the property.

Table 1: Utility Data for 145 St. George (January 2016 – December 2020)

Utility	Annual Consumption	Consumption Intensity	Carbon Emissions	Carbon Intensity
Electricity Consumption	203,154 kWh	1,563 kWh/suite	8,736 $kgCO_{2e}$	67.2 $kgCO_{2e}$/suite
Natural Gas	245,502 m^3	1,888 m^3/suite	474,343 $kgCO_{2e}$	3,649 $kgCO_{2e}$/suite

Over the course of the year, the monthly carbon emissions vary. This is dependent on the natural gas consumption as it is the main driver of carbon emissions in the building. The figure below shows the annual emissions pattern for each analysed year.

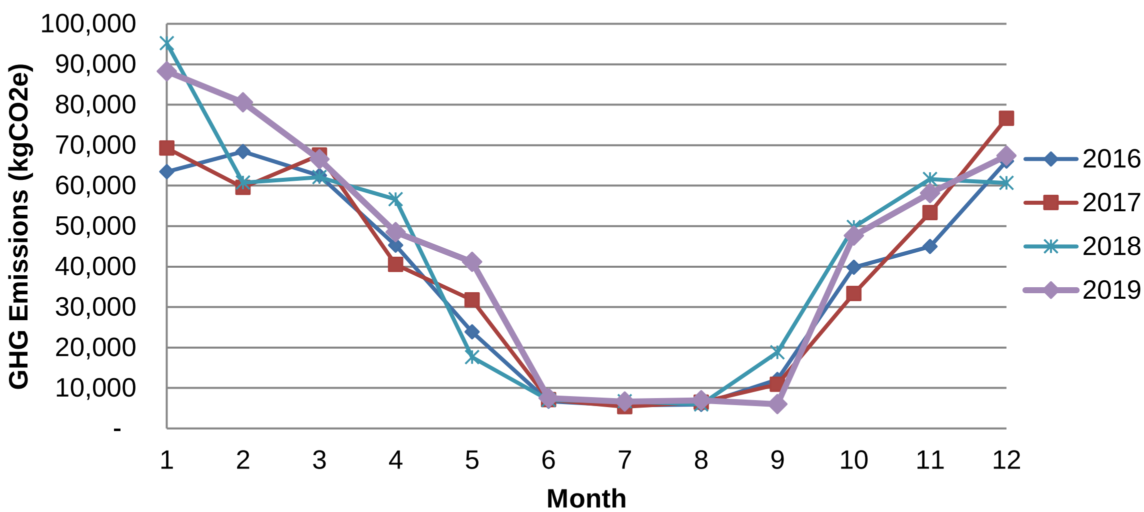


Figure 1: Total Monthly Emissions 145 St. George

Energy Use Intensity

To directly compare the greenhouse gas emissions of the existing building with the proposed construction, the total emissions of the existing building needed to be normalized based on the number of existing suites. 145 St. George currently has 130 rental suites – resulting in average annual emissions of 3,716 $kgCO_{2e}$/suite.

2. PROPOSED BUILDING ANALYSIS

The proposed building will consist of a single residential tower with significant indoor and outdoor space. The total number of available suites will increase from 130 in the existing building to 341. The proposed building will have 29 storeys above ground and two levels of underground vehicle and bicycle parking. The emissions of the proposed building will be compared to the emissions of the existing building and to a typical suburban development of similar size.

Life Cycle Assessment Methodology

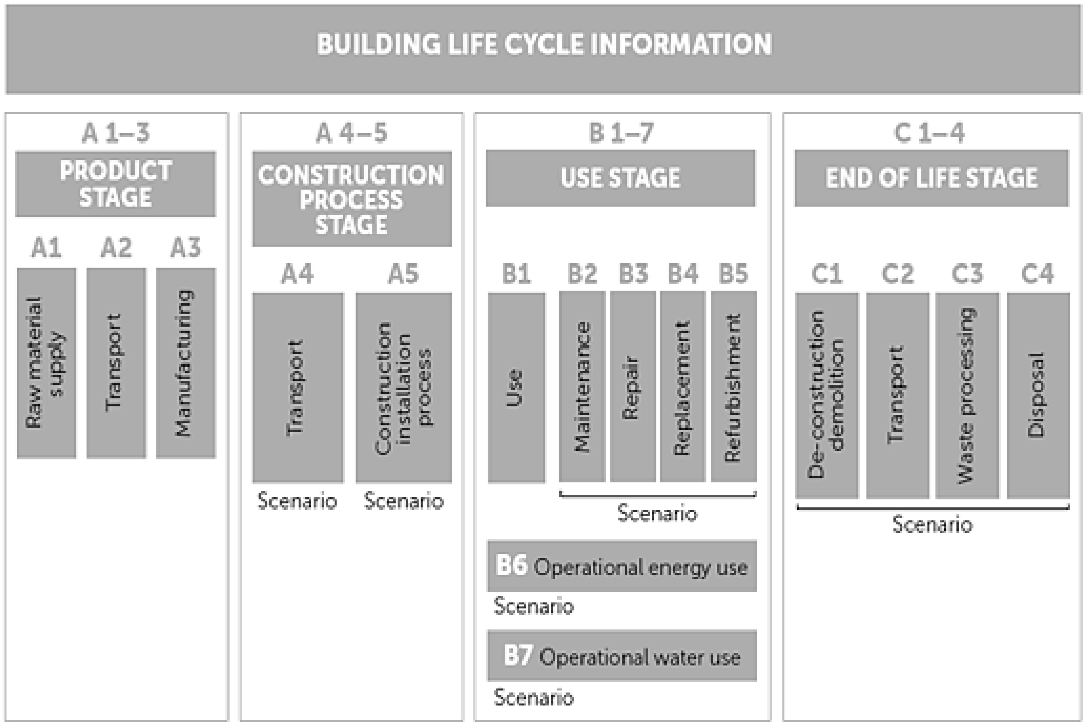
Life Cycle Assessment ("LCA") is the method of measuring a project's environmental impact through the whole life cycle of the building including the manufacturing, construction, and final use of the resources required for the delivery of the building function.

The analysis of the proposed building and the typical suburb development life cycle impact and was completed using One Click LCA. The program is in accordance with ISO 14044 and US EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI).

The project model assumes a building lifetime of 60 years and includes the following assemblies and elements:

- building envelope
- footings
- foundations
- structural wall assemblies
- structural floors and ceilings
- roof assemblies
- parking structures
- stair construction
- interior partitions (an optional addition)

The process of LCA follows multiple stages of production, construction, use, and life as shown in the image below:



Source: One Click LCA

Figure 2: Life Cycle Stages

Proposed Building Life Cycle Assessment

By quantifying the impact not associated with building operations, a project can aim to make reductions to an area that greatly affects the environment, and allow for a more sustainable building. LCA scopes can vary depending on the project needs and goals, but must always include the complete enclosure and structure. The Section numbers indicated in the table below refers to the process described in Figure 2.

Table 2: Embodied Carbon Emissions Breakdown of Proposed Building Once Constructed

Section	Result Category	Emissions (Ton CO_{2e})
C1-C4	End of Life – Existing Building	165.4
A1-A3	Construction Materials	9,233.1
A4	Transportation to Site	704.7
A5	Construction & Installation	286.4
B4-B5	Material Replacement & Refurbishment	20.7
C1-C4	End of Life of Proposed Building (Demolition)	359.6
Total		**10,770.0**

Table 2 above shows the emissions from various stages of the life cycle of the proposed building. The breakdown includes the emissions from demolishing the existing building, constructing the proposed building, and the demolition of the proposed building. The total emissions found by the LCA was 10,770Ton CO_{2e}. This value was used to perform the carbon emissions analysis comparing the proposed building's emissions to the existing building. Dividing the total emissions by the proposed number of suites, the embodied carbon has a total of 31,583kgCO_{2e}/suite. That value was used as the first-year carbon emissions of the proposed building.

Proposed Building Carbon Emissions

The proposed building's annual carbon emissions were calculated in four separate scenarios – representing Tiers 1-4 of the Toronto Green Standard Version 3. The carbon emission intensity of the proposed building was calculated based on the acceptable emissions for each tier and the number of suites in the proposed building design. The results of the calculations are summarized in the table below. These represent the estimated annual emissions of the proposed building after the building is constructed and operational.

Table 3: Proposed Building's Annual Carbon Emissions Breakdown

	TGS v3 Tier 1	TGS v3 Tier 2	TGS v3 Tier 3	TGS v3 Tier 4
GHG Intensity (kgCO_{2e}/m^2)	20	15	10	5
Total Emissions (ton CO_{2e})	462	346	231	115
Emissions per suite (kgCO_{2e}/suite)	1,355	1,015	675	337

Typical Suburban Development

Another consideration to take into account is the alternative to constructing a new multi-unit residential building. In the second half of the 20th century, new housing developments have commonly been single-family homes in suburban regions outside of the city centre. The emissions of the proposed building can be better understood when compared to this alternative form of housing development.

For this analysis, the proposed new suites were replaced with single-family homes located 35km from Toronto's city centre. As there are 211 new suites in the proposed building, it was assumed that 211 houses would be constructed. It was found that the total emissions to construct 211 single-family houses is about 7,940Ton CO_{2e}. This was calculated using the same calculation method outlined in the Life Cycle Assessment Methodology Section. The breakdown of emissions for constructing the suburban development is summarized in the table below. Each house was assumed to be 1,700ft^2 and have three bedrooms.

Table 4: Embodied Carbon Emissions of an Equivalent Suburban Development

Section	Result Category	Emissions (Ton CO_{2e})
A1-A3	Construction Materials	5,009.1
A4	Transportation to Site	618.3
A5	Construction & Installation	351.0
B4-B5	Material Replacement & Refurbishment	1,262.8
C1-C4	End of Life of Equivalent Suburban Development (Demolition)	698.2
Total		**7,939.3**

Another important consideration is the GHG emissions of a typical suburban development compared to the proposed building. Two major factors contribute to annual carbon emissions: the house, and transportation. To determine the emissions from the house, emissions factors from a report by Natural Resources Canada titled *Achieving Real Net Zero Emission Homes: Embodied carbon scenario analysis of the upper tiers of performance in the 2020 Canadian National Building* Code. The report cites the average emissions of a two-storey home in Toronto to be 3.5tonCO_{2e} annually. This value was used for the house's annual emissions.

The greenhouse gas emissions associated with transportation were also considered. People living in transit-oriented housing have different commuting patterns than those living in suburban communities. These differences are reflected in their transportation-related emissions. Therefore, this should be considered to develop a more complete picture of the carbon emissions. To complete the analysis, the number of commuters needed to be established.

The *Transportation Study*, prepared by RJ Burnside, dated May 2021 for the 145 St. George Street Official Plan and Zoning By-lay amendment applications, establishes the number of commuters by mode anticipated for the proposed development, which are incorporated into this analysis. Table 5 summarizes the number of trips taken on peak hours in the morning and afternoon. These numbers were used to calculate the emissions from transportation.

Table 5: Number of Commuters by Mode (from Transportation Study)

Mode	AM Peak Hour			PM Peak Hour		
	Inbound	Outbound	Total	Inbound	Outbound	Total
Automobile	7	22	29	21	13	34
Transit	8	25	33	23	15	38
Cycling	2	6	8	6	4	48
Walking	10	33	43	29	19	10
Total	27	86	113	79	51	130

To determine the number of commuters in each mode for the suburban development, results from the 2016 census were used for the City of Toronto. The census results are summarized in Table 6. The suburban development was assumed to be 35 kilometers from the city centre. The number of commuters for each mode of transportation was based on the total commuters from Table 5 and the distribution of commuting types in Table 6. The number of commuters for each mode in the suburban development is shown in Table 7.

Table 6: Commuter Statistics for Toronto, 2016

Commute Distance	Car	Transit	Walking	Bicycle	Other
0-4.9 km	24.9%	58.1%	11.9%	4.2%	1.0%
5-9.9 km	57.2%	31.6%	8.1%	1.9%	1.3%
10-14.9 km	68.7%	26.1%	3.8%	0.5%	0.9%
15-19.9 km	80.5%	16%	2.4%	0.4%	0.7%
20-24.9 km	86.7%	10.7%	1.8%	0.3%	0.6%
25+ km	**88.7%**	**6.4%**	3.5%	0.5%	0.9%

Table 7: Number of Commuters by Mode - Suburban Development

Mode	AM Peak Hour			PM Peak Hour		
	Inbound	Outbound	Total	Inbound	Outbound	Total
Automobile	24	76	100	70	45	115
Transit	2	6	7	5	3	8
Cycling	0	1	1	0	1	1
Walking	1	3	4	3	2	5
Total	27	85	112	78	51	129

To determine how the number of commuters translates into carbon emissions, emissions factors needed to be determined. The carbon emissions from driving were based on the emissions factor of the Honda Civic. The Honda Civic produces 0.165kgCO_{2e} per kilometer driven. The suburban transit riders were assumed to be using the GO train network, which currently uses diesel-powered trains. The emissions factor for these trains is 0.091kgCO_{2e} per passenger per kilometer. The electrified subway system and streetcars result in a per passenger emissions factor of just 0.005kgCO_{2e} per kilometer. Because of its central location within downtown, it was assumed that the residents of the proposed development are within 5 kilometers of work. The emissions factors for transportation are summarized in Table 8 and Table 9.

Table 8: Emissions Factors for Each Transportation Mode

Transport Mode	kgCO_{2e}/passenger per kilometer	kgCO_{2e}/passenger per day	kgCO_{2e}/passenger per year
Single Car	0.165	11.55	4,215
Subway	0.005	0.05	18.1
GO Train	0.091	6.4	2,321

Table 9: Per-suite Emissions Factors for Transportation

	Current Building	**Proposed Building**	**Suburban Development**
Single Car ($kgCo_{2e}$/suite)	171.7	121.1	2152.9
Subway ($kgCo_{2e}$/suite)	5.8	4.1	
GO Train ($kgCo_{2e}$/suite)			85.8
Total Transportation Emissions ($kgCO_{2e}$/suite)	177.5	125.2	2,239

The emissions from the home and from transportation can be combined to get the total emissions for the proposed building and the suburban development. Total annual emissions – including transportation emissions – for a suburban home are 5,739$kgCO_{2e}$/suite. The comparison of the emission differences is summarized in Table 10.

Table 10: Proposed Building's Emissions Compared to a Suburban Home

		Proposed Building			
	Suburban Development	**TGS v3 Tier 1**	**TGS v3 Tier 2**	**TGS v3 Tier 3**	**TGS v3 Tier 4**
GHG Intensity ($kgCO_{2e}$/suite)	3,500	1,355	1,015	677.4	337.2
Transportation GHG ($kgCO_{2e}$/suite)	2,239	125.2	125.2	125.2	125.2
Total Annual GHG ($kgCO_{2e}$/suite)	**5,739**	**1,480**	**1,140**	**802.6**	**462.4**
Percent Savings of Annual GHG		74.2%	80.1%	86.0%	91.9%
Embodied Carbon ($kgCO_{2e}$/suite)	37,627	31,584	31,584	31,584	31,584

3. CARBON EMISSIONS ANALYSIS

The purpose of this analysis is to understand how the current building's greenhouse gas emissions compared to the proposed building's emissions. Table 11 below shows how the existing building compares to the emissions of the proposed building. The proposed building is represented in four scenarios – each representing a different tier of Toronto Green Standard v3.

Table 11: Existing Building Emissions compared to Proposed Building

		Proposed Building			
	Existing Building	**TGS v3 Tier 1**	**TGS v3 Tier 2**	**TGS v3 Tier 3**	**TGS v3 Tier 4**
GHG Intensity ($kgCO_{2e}$/suite)	3,716	1,355	1,015	677.4	337.2
Transportation GHG ($kgCO_{2e}$/suite)	177.5	125.2	125.2	125.2	125.2
Total Annual GHG ($kgCO_{2e}$/suite)	**3,894**	**1,480**	**1,140**	**802.6**	**462.4**
Embodied Carbon ($kgCO_{2e}$/suite)	N/A	31,584	31,584	31,584	31,584

Quantifying the embodied carbon emissions of the existing building was also investigated. Since the existing building was constructed in 1959 (62 years ago), carbon emissions associated with the materials and construction of the existing building have already been emitted and are not impacted by the construction of the proposed building. However, the emissions associated with the demolition of the existing building have been included in the embodied carbon calculations for the proposed building. The purpose of this analysis is to determine the time it will take for the proposed building to become carbon positive. The emissions associated with the construction of the existing building do not impact that timeline and are excluded from this analysis.

Figure 3 below show the accumulated carbon emissions over time. While the embodied carbon of the proposed building is significant, the improved energy performance of the proposed buildings mean that the proposed building will be carbon-positive between 9 and 13 years after construction.

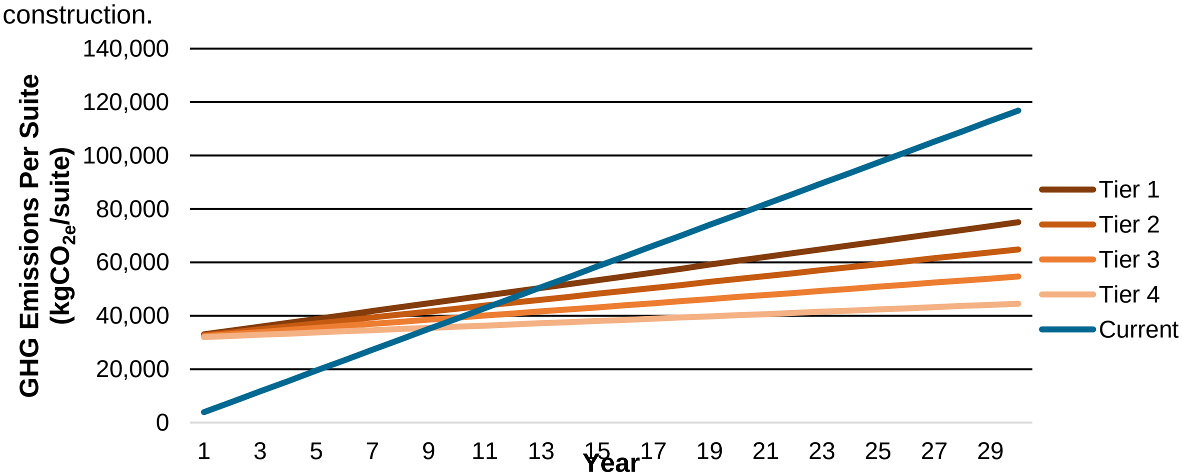


Figure 3: Cumulative Carbon Emissions per suite

Assumptions and Limitations

The LCA was done based on available drawings provided on 2021-06-15. Due to the stage of the development, default values or assumptions based on project experience were used in areas where information was limited or not available. These assumptions are noted in Appendix B of this report.

Site work, including but not limited to excavation, landscaping, and other site development are not part of the scope of the LCA for the proposed building and suburban dwelling scenarios. The investigation into the embodied carbon on interior finishes can be investigated as the project design develops.

The selection for each building material was selected to be industry wide environmental product declarations or data sets as available by One Click LCA whenever possible, including typical selections such as recycled content. Any product specific environmental product data used is noted within Appendix B.

For the initial LCA exercise, industry average data was used based on available documentation within One Click LCA, as such the associated emissions values may be expected to be conservative in most cases. The design development for the project efforts will be made to provide the most accurate data available.

In order to project the future performance of the existing building, a number of assumptions were made. The most significant of which is the assumption that the current operation of the existing building does not change in the near future. The per-suite carbon emissions were calculated based on the previous 5 years of utility data. In order to estimate the future emissions, it was assumed that the operations would not significantly change from the current performance.

The hot water boilers at 145 St. George are operating well. However, they are not high-efficiency condensing boilers. This analysis assumes there are no retrofits of the heating system that would increase the overall efficiency. It also assumes that the current equipment does not lose efficiency through wear and deterioration.

LIMITS OF LIABILITY ASSOCIATED WITH THIS REPORT

1. It is understood that hazardous materials may be present (e.g. asbestos, mould, PCB's, etc.) within the existing building. The identification of and abatement recommendations with respect to hazardous materials is outside the scope of services provided. Any costs associated with hazardous materials were not evaluated as part of this report.

2. The review of existing installations was general in nature and limited to casual, visual observation without removal of ceilings, chases, destructive testing or dismantling. The review was not exhaustive and was performed to acquire a general understanding of the condition of existing systems. Very limited existing drawings were made available for the review of existing systems.

3. This report has been prepared solely for the use of the Client. The material contained in this report reflects our best judgement in light of the information available at the time of preparation. There is no warranty expressed or implied. Professional judgement was exercised in gathering and assessing information. The results presented are the product of professional care and competence and cannot be construed as an absolute guarantee.

4. Where expected or anticipated equipment life is provided it is based on ASHRAE Median Service Life statistics. Actual life of equipment will vary depending on variables such as operation, service and maintenance frequency.

5. Capital cost estimates are made are equivalent to Class D order of magnitude estimates. Actual costs will vary depending on final design solution and contractor pricing.

APPENDIX A – UTILITY ANALYSIS

Electricity Analysis

At 145 St. George, a single electricity meter measures all electrical consumption on the site. Electricity data was sent for the last five years for analysis. In that time, the electricity consumption remained consistent from January 2016 to September 2019. Since then and throughout 2020, there has been a notable decrease in electricity consumption. In 2020, the electricity consumption was 28% lower than the previous four years. The expectation is that due to the COVID-19 lockdowns throughout 2020 the electricity consumption would have increased. The significant decrease in consumption will need to be explained through some other means.

The month-to-month energy consumption in the building remains consistent throughout the year. The building does not have any air conditioning systems, therefore there is no summer peak in electricity consumption as is typical of residential buildings.

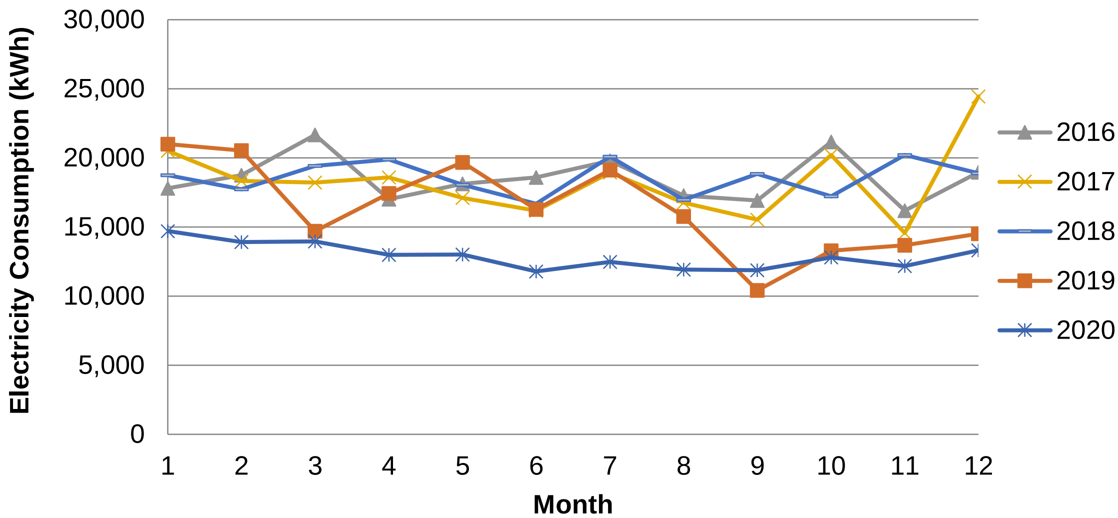


Figure 4: Electricity Consumption

Greenhouse gas emissions due to electricity consumption were estimated based on the current greenhouse emissions from electricity in Ontario. The factor that was used for the calculations was 43kgCO_{2e}/MWh. To that end, the greenhouse gas emissions of the existing building from electricity consumption was estimated. Figure 5 below shows the monthly greenhouse gas emissions. The average annual emissions from electricity is 8,736kgCO_{2e}.

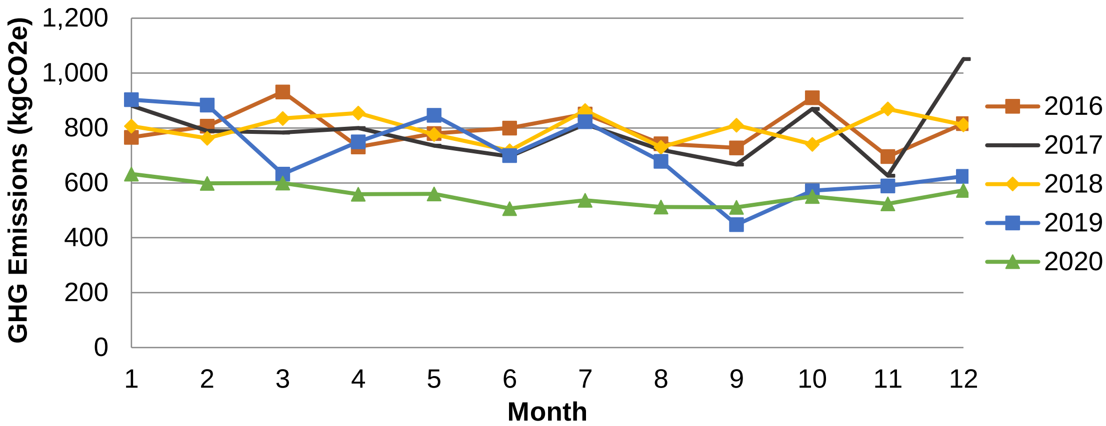


Figure 5: Total Electricity Greenhouse Gas Emissions

Natural Gas Analysis

Natural gas consumption at 145 St. George is measured by a single meter. The monthly consumption patter follows a typical residential building with natural gas heating. The consumption is high during the winter months and low during summer months. Much like electricity consumption, the natural gas consumption has been consistent in the last few years.

A factor of 1,891kgCO_{2e}/m^3 was used to calculate the greenhouse gas emissions from natural gas consumption. The average greenhouse gas emissions from natural gas is 474,343kgCO_{2e} annually.

Total emissions from the site are therefore 483,078kgCO_{2e} annually. 145 St. George currently has 130 suites. This means that the building currently emits 3,716kgCO_{2e}/suite per year. Natural gas contributes to 98% of the building's total greenhouse gas emissions.

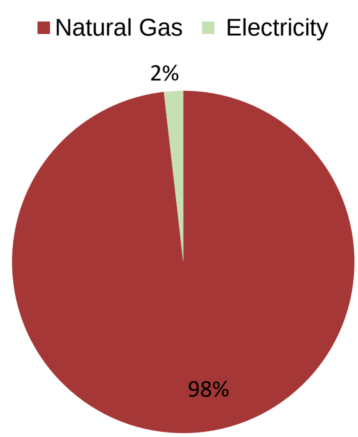


Figure 6: Greenhouse Gas Emissions by Source

APPENDIX B – PROPOSED BUILDING LCA MODEL INPUTS SUMMARY

ENVELOPE AND GLAZING

System	Information
Walls	Window Wall (Kawneer), with vision glazing and opaque spandrels Curtain Wall (Kawneer), with vision glazing and opaque spandrels Pre-cast concrete wall with XPS Insulation
Glazing	Assumed an overall 40% window-to-wall ratio
Roof	Concrete structure with concrete topper, XPS insulation, and modified bitumen membrane
Comments	Additional green roof materials are not accounted for in analysis Curtain and window wall systems use specific products from Kawneer Deep caps are not accounted for in analysis Glazing fritting, coatings, and gas fill are not accounted for in analysis

STRUCTURE

System	Information
Interior Floor	Concrete slab with rebar
Slab on Grade	Concrete slab with rebar
Foundations	*See parking structure*
Columns and Beams	Concrete, as per One Click LCA Carbon Designer
Stairs / Elevator Cores	As per One Click LCA Carbon Designer
Comments	As structural details are not fully available, the One Click LCA Carbon Designer tool was utilized for the calculation of potential structural details including amount of rebar, volume of concrete required for columns and concrete core for stairs and elevator

MISCELLANEOUS

System	Information
Interior Partitions	Metal stud framing with drywall, as per One Click LCA Carbon Designer
Balcony Railing	Glass railings, does not account for framing Pre-cast concrete colonnade
Parking Structure	Concrete structure, strip footings, and limited insulation near grade connections and slabs. Created using the One Click LCA Carbon Designer

ENVIRONMENTAL PRODUCT DECLARATIONS

The selection for each building material was selected to be industry wide environmental product declarations or data sets as available by One Click LCA whenever possible, including typical selections such as recycled content. Any product specific environmental product data used is noted within this appendix.

For the initial LCA exercise, industry average data was used based on available documentation within One Click LCA, as such the associated emissions values may be expected to be conservative in most cases. The design development for the project efforts will be made to provide the most accurate data available.

APPENDIX C – PROPOSED BUILDING LCA MODEL INPUTS MATERIALS

See the following pages for bill of materials.