



MORRISON HERSHFIELD

Final Report

Heritage Square Greenhouse Gas Inventory

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Calgary, Alberta

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Report No. 3113187

March 11, 2015

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EBOMEAC6 - GHG\REPORT\HERITAGE SQUARE GHG TABLES FINAL 2014
REVISED MAR 6 2014.DOCX

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1. SUMMARY

This report details the greenhouse gas (GHG) emissions inventory of Heritage Square located along MacLeod Trail South in Calgary, Alberta. The inventory includes direct emissions released at the building, and indirect emissions from electricity consumed on site but produced at another location.

Heritage Square is owned and managed by Artis REIT. The building has registered for the Canada Green Building Council's (CaGBC) Leadership in Energy and Environmental Design (LEED) for Existing Buildings: Operations and Maintenance (EBOM) program. Artis REIT will use the data from this report to disclose the building's emissions in the CSA CleanStart™ Registry and also as part of the LEED EBOM Credit Emission Reduction Reporting (EAc6) documentation package.

Morrison Hershfield Limited is the LEED Consultant engaged to complete the greenhouse gas (GHG) inventory and reporting in accordance with CAN/CSA-ISO Standard 14064-1:06. Brookfield Johnson Controls has been engaged to provide third party verification of this report.

This report has been written in accordance with CAN/CSA-ISO Standard 14064-1:06 Greenhouse Gases - Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals. In addition, the World Resource Institute (WRI)/World Business Council for Sustainable Development (WBCSD) Standard: Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard and CAN/CSA-ISO Standard 14064-3:06 Greenhouse Gases - Part 3: Specification with Guidance for the Validation of Greenhouse Gas Assertions have been used as additional resources.

Morrison Hershfield calculated the total tonnes of carbon dioxide equivalent (t CO₂e) emissions for Heritage Square between August 1, 2013, and July 31, 2014 was 6,849 t CO₂e. Approximately 843 t CO₂e are associated with natural gas combustion and diesel combustion, 19 t CO₂e are associated with emissions from refrigerants, and 5,987 t CO₂e are associated with indirect emissions from Alberta's predominately coal-based electricity generation. No other sources have been included for quantification.

Direct emissions account of 13% of annual emissions at Heritage Square. The remaining 87% are indirect emissions from electricity.

2. BUILDING PROFILE

Heritage Square is located at 8500 Macleod Trail SE, Calgary, Alberta, originally constructed in 1981. The building is owned and managed by Artis REIT. It consists of a five story building approximately 39,812 m² in gross area and consisting of leased spaces and an attached three level parkade. Space is predominately leasable area with an indoor atrium, restaurant, retail space and fitness facility for tenant use. The two major tenants are AMEC and Credit Union Central. The building generally follows regular occupancy patterns for an office (approximately 7am to 6pm Monday to Friday).

2.1 Heating and Cooling

The building is heated by a hydronic system supplied by two natural gas fired boilers. Boilers run on an outdoor air temperature reset and are locked out if the outdoor temperature exceeds 18C. Perimeter fin-tube radiation cabinets are the primary source of zone heating along with forced convection unit heaters in corridors, entryways and other service areas. There is no heating in the air handling units.

Primary cooling comes from a chilled water hydronic system supplied by a variable speed centrifugal chiller using R-134a as a refrigerant which is a potent greenhouse gas. The chiller rejects its heat to a cooling tower located on the roof. Chilled water is distributed to cooling coils in the air handling units. The chiller runs on an outdoor air temperature reset that is variable dependent on summer or shoulder season.

Ventilation is primarily provided by two variable air volume (VAV) air handling units. There are three supplemental units serving ancillary spaces. Zones are supplied with VAV boxes. Air handlers have economizers to take advantage of free outdoor cooling. Ventilation is reduced to a minimum setting based on mixed air temperature in the air handlers. The restaurant kitchen has its own exhaust and gas fired make-up system.

The building has four separate domestic hot water distribution systems served by six natural gas fired water heaters of various sizes. Primary usage is for washrooms, the kitchen and fitness areas.

2.2 Control System

A direct digital control (DDC) system controls major energy using systems in the building including:

- Boilers
- Chillers
- Air Handlers

This system was manufactured by Siemens and is capable of trending point information and storing historical data.

3. GHG INVENTORY DESIGN AND DEVELOPMENT

3.1 Organizational Boundary

As per the requirements of LEED EBOM EAc6, projects must track their emissions from building level consumption. This is consistent with ISO 14064-1 section 4.1 which states

“The organization may use a different consolidation methodology where specific arrangements are defined by a GHG programme or legal contract.”

Therefore, Heritage Square has been selected as the site boundary. This includes the multiuse office building and the adjacent parking area.

3.2 Operational Boundary

Operational boundaries prevent double counting by ensuring that all emissions associated with the project are separated in Direct (Scope 1), Energy Indirect (Scope 2), or Optional Indirect (Scope 3).

3.2.1 Direct GHG Emissions and Removals – Scope 1

Direct Emissions are derived primarily from the combustion on site of natural gas for providing building heating and domestic hot water. Natural gas is purchased from ENMAX.

Secondary sources include:

- Fugitive emissions from a chiller using refrigerant R-134a
- Combustion of diesel fuel from the emergency generator

There are no major sources of emission removals or combustion of biomass within the facility boundary.

3.2.2 Energy Indirect GHG Emissions – Scope 2

Energy indirect emissions related to the facility are from electricity production off site. Electricity is purchased from ENMAX. Alberta's grid is primarily supplied by coal fired power plants which has a high greenhouse gas output.

There are no other imported sources of emissions such as chilled water, steam or hot water used at the facility.

3.2.3 Other Indirect GHG Emissions – Scope 3

Scope 3 emissions are released from activities outside the organizational boundaries. Optional Indirect Emissions have not been included.

3.3 Emission Reporting Period

Emissions were calculated for the time period between August 1st, 2013 and July 31st, 2014 to comply with LEED EBOMs requirement of a twelve month performance period.

As this is the first year that Heritage Square is submitting GHG data to the CSA Cleanstart™ GHG registry, this inventory will become the 'base year' emissions, future emission inventories should use this base year to track future results.

4. QUANTIFICATION OF GHG EMISSIONS

As it is typically not practical to directly measure greenhouse gas emissions, emission factor calculations have been utilized to determine emissions.

GHG emissions for each source are calculated using the following formula:

$$GHG\ Emissions = Activity\ Data \times Emissions\ Factor \times Global\ Warming\ Potential$$

Activity data is information relating to the magnitude of some human activity that causes the release of an emission.

Emission Factors are representative values relating the quantity of an emission with an activity associated with the release of that emission.

Global Warming Potentials are representative values relating the emission to an equivalent CO₂ of that emission.

Activity data was obtained from utility bills and maintenance information. Emission Factors were obtained from NPRI Data and Canada's National Inventory Report (1990-2012). Global Warming Potentials are obtained from CAN/CSA-ISO Standard 14064-1:06. Detailed information on activity data can be found in Appendix A. Detailed information on emission factors, global warming potential and their sources can be found in Appendix B.

4.1.1 Natural Gas

Activity Data: Activity data was calculated based on monthly utility bills from ENMAX. Natural gas consumption is measured by one main meter report in GJ and are located in Appendix A. The GJ were converted to cubic meters using the Alberta Energy natural gas conversion factor of 26.8 m³/GJ (www.energy.alberta.ca).

Emission factor: Emission factors were obtained from Canada's National Inventory Report (1990-2012), Annex 8 for Alberta. Factors are represented in tonnes of emissions per m³ and are located in Appendix B.

4.1.2 Diesel

Activity Data: Consumption information in litres was not available during the reporting or period. Generator runtime was used to estimate consumption. Industry estimates related to the fuel consumption of a 500 kW diesel generator at full load was used. Runtime for the diesel generator over the year was 20.82 hours according to maintenance reports.

Quantities are averaged monthly from a single year period. Diesel quantities are reported in liters and are located in Appendix A.

Emission factor: The emission factors used were obtained from Canada's National Inventory Report (1990 - 2012), Annex 8 for Alberta. The factors are represented as tonnes of emissions per liter and are located in Appendix B.

4.1.3 Refrigerant Fugitive Emissions

Activity Data: Activity data was calculated based on the refrigerant charge of the facilities refrigeration and air conditioning equipment containing listed gases, as reported by the Operations Manager. Emissions were based on an assumed loss of 2% of capacity/year based on LEED EB EAc5. Refrigerant quantities are measured in lbs and are located in Appendix A. The lbs were converted to tonnes by a factor of 2204.62 lb/tonne.

Emission factor: Emission factors were obtained Source: CAN/CSA-ISO 14064-1:06 Part 1: Specification with guidance at the organization level for quantification and reporting of GHG emissions and removals, Annex C. Factors are represented in tonnes CO₂eq of emissions per tonne and are located in Appendix B.

4.1.4 Electricity

Activity Data: Activity data was calculated based on interval meter utility data from ENMAX. Electricity consumption is measured by one main meter and report in kWh and are located in Appendix A.

Emissions factors: The emission factors used were obtained from Canada's National Inventory Report (1990 - 2012), Annex 13 for Alberta. The factors are represented as tonnes of emission per kWh and are located in Appendix B.

4.2 Base-Year GHG Inventory

4.2.1 Selection and Establishment of Base Year

This is the first year for Heritage Square's GHG inventory so the baseline year will be set as August 1, 2013 to July 31, 2014.

4.2.2 Recalculation of GHG Inventory

Morrison Hershfield will recalculate the baseline year for Heritage Square whenever there is a change in the operational boundaries, the ownership or control of the GHG sources, or changes to the quantification methodologies. After evaluating the inventory against this recalculation policy it was determined that no recalculation was required.

5. GHG INVENTORY COMPONENTS

5.1 Emissions

The total emissions from direct and energy indirect GHG emissions sources during the reporting year are 6,772.98 t CO₂e. The facility's natural gas, diesel, refrigerants and electricity consumption accounts for 100% of annual reported emissions. Annual emissions by scope and source can be found in Table 5.1. Monthly emissions by source are provided in Figure 5.1. Annual emissions by scope can be found in Figure 5.2. A further breakdown of emissions is located in Appendix A.

Table 5.1 Emission Sources

Scope	Source	CO ₂ (t)	CH ₄ (t CO ₂ e)	N ₂ O (t CO ₂ e)	GHG (t CO ₂ e)	% of Total
Direct	Natural Gas	830.09	0.34	4.70	835.12	12.2%
Direct	Diesel	7.48	0.01	0.35	7.84	0.1%
Direct	Refrigerant (HFC 134a)	N/A	N/A	N/A	19.20	0.3%
Energy Indirect	Electricity	5,935.41	6.16	45.43	5,986.99	87.4%
Total		6,772.98	6.50	50.48	6,849.15	100%

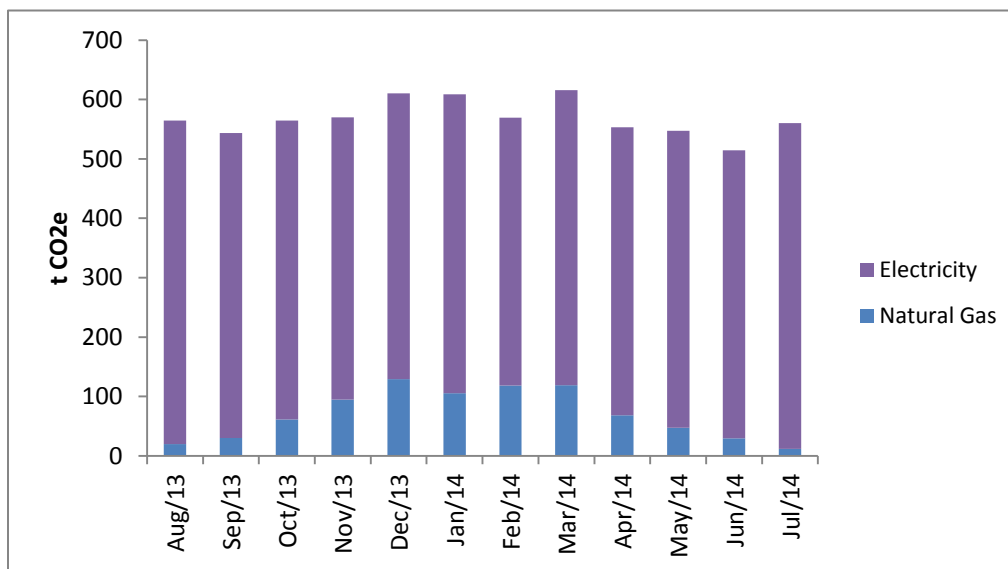


Figure 5.1 Significant (>1%) Monthly Emissions by Source

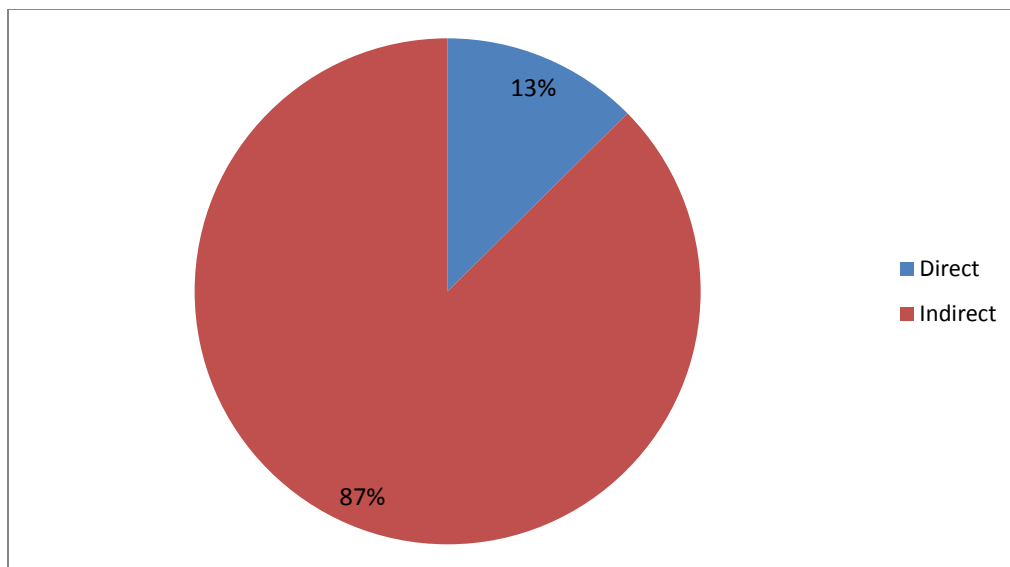


Figure 5.2 Annual Emissions by Scope

5.2 Activities to Reduce GHG Emissions

GHG reduction strategies for the facility have mainly focused on energy reduction measures. The building had an ASHRAE Level 2 energy audit conducted in 2005. The implemented measures from that audit were modifications to the chiller system and domestic water system.

That audit recommended the addition of a second, smaller capacity chiller to provide better part load performance and estimated a reduction in electricity usage and resulting reduction in indirect electricity emissions of 90 t CO₂e/yr. This measure was not directly implemented as recommended; instead the original chiller was replaced with one new variable speed drive chiller in 2009. Not enough information is known to determine the resulting GHG reduction but it should be at least as much as the proposed measure.

The new chiller utilizes HFC-134a refrigerant replacing the CFC-11 refrigerant used in the original chiller. HFC-134a has a lower emission factor than CFC-11. With the assumption that the original chiller had the same amount of refrigerant as the new chiller results in a 74% reduction in direct refrigerant emissions, or 55 t CO₂e/yr.

The domestic water system recommendation was to remove the two, older, inefficient heaters and connect that distribution system into the remaining, higher efficient heaters. The estimated reduction in natural gas usage and resulting GHG reduction was 3.4 t CO₂e/yr.

The facility is currently undergoing a LEED for Existing Buildings program, which includes a new ASHRAE Level 2 energy audit. From this recent audit a number of energy conservation measures (ECMs) have been recommended for implementation which will reduce the energy intensity and associated GHG intensity. The following is a list of the measures recommended:

- Air Sealing
- Replace inlet vanes with VSDs on SF-1 and SF-9
- Replacement of 32 W T8 lamps with 28 W T8 lamps
- Optimize or delay start during mild weather
- Replace existing natural gas boilers with multiple staged boilers
- Kitchen tenant sub-metering
- Vending machine 'Vending-Miser' control

From these measures the estimated reduction in natural gas usage and resulting direct GHG reduction is 174 t CO₂e/yr, the estimated reduction in electricity usage and resulting indirect emissions of GHG is 243 t CO₂e/yr

5.3 Emissions Uncertainty

Activity data for natural gas and electricity are taken from the utilities meters' and represent a low uncertainty. Diesel activity data is estimated based on generator runtime and represent a fair uncertainty. Refrigerant activity data are conservatively derived from LEED EB EAc5 guidelines and represent a high uncertainty.

Emission factors for natural gas, diesel fuel and electricity are taken from the latest version of Canada's National Inventory Report (1990-2012) and represent a low uncertainty.

Global warming potential (GWP) are taken from standard CAN/CSA-ISO 14064-1:06 and represent a low uncertainty.

Table 5.2 indicates the uncertainty ranking of all emission sources.

Table 5.2 Uncertainty Ranking

Activity	Uncertainty Ranking
Natural Gas	Low - The meter is calibrated and verified by the utility provider. The emission factors are based on Canada's National Inventory Report (1990-2012).
Electricity	Low - The meter is calibrated and verified by the utility provider. The emission factors are based on Canada's National Inventory Report (1990-2012).
Diesel	Fair - Consumption is estimated based on generator runtime. The emission factors are based on Canada's National Inventory Report (1990-2012).
Refrigerant	High - Emissions are conservatively derived from LEED EB EAc5 guidelines. The emission factors are based on CAN/CSA-ISO 14064-1-06.

6. GHG INVENTORY QUALITY MANAGEMENT

6.1 GHG Information Management

To develop and maintain a credible GHG inventory, roles and responsibilities were assigned to ensure consistency, accuracy, completeness, transparency and conformance with CAN/CSA-ISO 14064-1:06 as indicated in Table 6.1.

Table 6.1 Roles and Responsibilities

Name	Role	Company
Stephanie Burke	Property Manager	Artis REIT
Oldrich Berger	Senior Building Operator	Artis REIT
Responsibilities:	-Provide required energy data (utility bills) -Provide diesel and refrigerant data -Approve and sign CSA CleanStart Registry application form	
Name	Role	Company
Kalum Galle	LEED Project Manager	Morrison Hershfield Limited
Trent Theaker, P.Eng.	GHG Reviewer	Morrison Hershfield Limited
Wayne Keenan	Peer Reviewer	Morrison Hershfield Limited
Responsibilities:	-Request and analyze activity data for acceptable accuracy -Collect appropriate emission factors and perform GHG calculations -Produce a report consistent with both CSA CleanStart™ Registry requirements and CAN/CSA-ISO 14064-1-06	
Name	Role	Company
Evan Jones	Third Party Verifier	Brookfield Johnson Controls
Responsibilities:	-Verify the GHG report meets CSA CleanStart™ Registry requirements and CAN/CSA-ISO 14064-1-06 -Issue a verification statement	

6.2 Document Retention and Record Keeping

Artis REIT will maintain a credible GHG inventory and reporting through the following activities:

- Compile and maintain a permanent record of Heritage Square’s electricity and natural gas utility bills.
- Maintain a permanent record of diesel supplied to Heritage Square.
- Maintain a permanent record of refrigerant type, quantity and replacement at Heritage Square.

7. ORGANIZATION'S ROLE IN VERIFICATION

Evan Jones of Brookfield Johnson Controls was engaged to provide third party verification as per standard CAN/CSA-ISO 14064-1-06. The verification is to be completed to a reasonable level of assurance.

Morrison Hershfield prepared for the verification by:

- Have Artis REIT engage an objective third party verifier to provide a reasonable level of assurance
- Review each section using the CSA Registry checklist
- Using an internal QA/QC process of the GHG inventory and report

A summary of reporting information for declaration to the CSA standard can be found in Appendix C.

APPENDIX A: Activity Data and Greenhouse Gas Inventory

Tables A.1, A.2 and A.3 show a breakdown of the direct emissions including natural gas, diesel and refrigerants.

Table A.1 GHG Inventory – Natural Gas

Date	Consumption (GJ)	Consumption (m ³)	CO ₂ (t)	CH ₄ (t CO ₂ e)	N ₂ O (t CO ₂ e)	GHG (t CO ₂ e)
Aug-13	389	10,416	19.98	0.01	0.11	20.10
Sep-13	585	15,681	30.08	0.01	0.17	30.26
Oct-13	1,183	31,694	60.79	0.02	0.34	61.16
Nov-13	1,828	49,001	93.98	0.04	0.53	94.55
Dec-13	2,496	66,903	128.32	0.05	0.73	129.10
Jan-14	2,043	54,744	105.00	0.04	0.59	105.64
Feb-14	2,287	61,289	117.55	0.05	0.66	118.26
Mar-14	2,304	61,751	118.44	0.05	0.67	119.16
Apr-14	1,327	35,564	68.21	0.03	0.39	68.62
May-14	913	24,482	46.96	0.02	0.27	47.24
Jun-14	569	15,252	29.25	0.01	0.17	29.43
Jul-14	224	6,011	11.53	0.00	0.07	11.60
Total	16,149	432,788	830.09	0.34	4.70	835.12

Table A.2 GHG Inventory – Diesel

Date	Consumption (l)	CO ₂ (t)	CH ₄ (t CO ₂ e)	N ₂ O (t CO ₂ e)	GHG (t CO ₂ e)
Aug-13	234.1	0.62	0.00	0.03	0.65
Sep-13	234.1	0.62	0.00	0.03	0.65
Oct-13	234.1	0.62	0.00	0.03	0.65
Nov-13	234.1	0.62	0.00	0.03	0.65
Dec-13	234.1	0.62	0.00	0.03	0.65
Jan-14	234.1	0.62	0.00	0.03	0.65
Feb-14	234.1	0.62	0.00	0.03	0.65
Mar-14	234.1	0.62	0.00	0.03	0.65
Apr-14	234.1	0.62	0.00	0.03	0.65
May-14	234.1	0.62	0.00	0.03	0.65
Jun-14	234.1	0.62	0.00	0.03	0.65
Jul-14	234.1	0.62	0.00	0.03	0.65
Total	2,809.6	7.48	0.01	0.35	7.84

Table A.3 GHG Inventory – Refrigerants

Equipment	Total Capacity (lbs)	Total Capacity (tonne)	Emissions (tonne)	GHG (t CO ₂ e)
CH-1	1628	0.74	0.01	19.20
Total	1628	0.74	0.01	19.20

Table A.4 shows a breakdown of the indirect direct emissions including electricity.

Table A.4 GHG Inventory – Electricity

Date	Consumption (kWh)	CO ₂ (t)	CH ₄ (t CO ₂ e)	N ₂ O (t CO ₂ e)	GHG (t CO ₂ e)
Aug-13	666,509	539.87	0.56	4.13	544.56
Sep-13	628,495	509.08	0.53	3.90	513.51
Oct-13	616,237	499.15	0.52	3.82	503.49
Nov-13	581,959	471.39	0.49	3.61	475.48
Dec-13	588,878	476.99	0.49	3.65	481.14
Jan-14	615,572	498.61	0.52	3.82	502.95
Feb-14	552,256	447.33	0.46	3.42	451.22
Mar-14	607,995	492.48	0.51	3.77	496.76
Apr-14	592,801	480.17	0.50	3.68	484.34
May-14	612,157	495.85	0.51	3.80	500.16
Jun-14	593,463	480.71	0.50	3.68	484.88
Jul-14	671,341	543.79	0.56	4.16	548.51
Total	7,327,663	5,935.41	6.16	45.43	5,986.99

APPENDIX B: Emission Factors, Global Warming Potential and Sources

Table B.1 Emission Factors and Global Warming Potential

Type	Province	Emission Factor	Unit	GWP
Natural Gas	Alberta	1.918	kg CO ₂ /m ³	1
		0.000037	kg CH ₄ /m ³	21
		0.000035	kg N ₂ O/m ³	310
Diesel		2.663	kg CO ₂ /L	1
		0.000133	kg CH ₄ /L	21
		0.0004	kg N ₂ O/L	310
Refrigerant (HFC 134a)		N/A		1300
Electricity	Alberta	810	g CO ₂ /kWh	1
		0.04	g CH ₄ /kWh	21
		0.02	g N ₂ O/kWh	310

Table B.2 Sources

Emission	Source
Natural Gas	Canada's National Inventory Report (1990-2012), Annex 8, Tables A8-1, A8-2
Diesel	Canada's National Inventory Report (1990-2012), Annex 8, Table A8-4
Refrigerant	CAN/CSA-ISO 14064-1-06, Part 1, Annex C
Electricity	Canada's National Inventory Report (1990-2012), Annex 13, Table A13-10
GWP	CAN/CSA-ISO 14064-1-06

APPENDIX C: Standard Reporting Declaration

Table C.1 Standard Reporting Declaration

No.	CSA Reporting Requirement Declaration	Declaration
A	Describe the reporting organization	Heritage Square is owned and managed by Artis REIT. The building is registered in the CaGBC's LEED for Existing Buildings: Operations and Maintenance Protocol, and Energy and Atmosphere credit 6: Emission Reduction Reporting. The building is a five storey, 27,900 m ² office building. The facility emits GHGs by their use of natural gas, electricity, diesel and potential refrigerant leakage.
B	Person Responsible	Stephanie Burke, of Artis REIT, is the Property Manager of Heritage Square.
C	Reporting Period	August 1, 2013 - July 31, 2014
D	Documentation of organizational boundary	LEED EBOM uses the "physical facility approach" in order to quantify GHG emissions under EAc6. This is consistent with CSA/ISO14604-4 guidelines.
E	Direct GHG emissions are quantified for each GHG in CO ₂ e	See Appendix A
F	Description of how biomass derived emissions are treated by the inventory	Not applicable
G	Description of how GHG removals were quantified	Not applicable
H	Description of how any GHG sources or sinks were excluded from the quantification	This inventory includes onsite emissions from natural gas combustion; electricity consumed; diesel combusted; and potential leakage from refrigerant. GHG sinks are not applicable to this inventory.
I	Energy indirect emissions associated with electricity generation are quantified in t CO ₂ e	See Appendix A
J	Historical base year selected for inventory	Base year was chosen to be consistent with other LEED energy credits. This report represents the base year for future reporting.

Table C.1 Standard Reporting Declaration (continued)

No.	CSA Reporting Requirement Declaration	Declaration
K	Explanation of change to the base year, or other historical GHG data	Not applicable
L	Description of quantification methodologies include reasons for their selection	Calculations based on activity data multiplied by emission factors consistent with LEED EBOM EAc6.
M	Explanation of changes to quantification methodologies previously used	Not applicable
N	Reference to emission factors used	See Appendix B
O	Description of the impact of uncertainties on the accuracy of GHG emissions and removals data	Emission factors were referenced from the most current sources at the time of quantification, and were determined sources at the time of quantification, and were determined by the most local and credible sources. Electricity consumption was supplied directly from ENMAX's online tracking tool. Natural Gas consumption was based on data provided on ENMAX's utility bills. Diesel consumption was estimated by ARTIS REIT Operations Manager. Refrigerant data is based on total refrigerant charge capacity received from ARTIS REIT and EPA default rates. Based on these sources, the level of uncertainty is assumed to be fair.
P	A statement that the GHG report has been prepared in accordance with ISO Standard 14064-1	This report has been prepared in accordance with the following standard: CAN/CSA-ISO Standard 14064-1:06 - Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals.
Q	A statement describing whether the GHG inventory, report or assertion has been verified, including the type of verification and level of assurance achieved	Evan Jones of Brookfield Johnson Controls will provide third party verification of this report at a reasonable level of assurance.