ENVIRONMENTAL PRODUCT DECLARATION

Lafarge Brookfield Cement Plant

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About this EPD

This is a cradle-to-gate environmental product declaration for General Use Portland Cement (GU, Type I/II), General Use Portland Limestone Cement (GUL, Type IL), High Early Portland Cement (HE, Type III) and Ternary Blended Cement (TERCEM) as produced at Lafarge's Brookfield, NS plant. The life cycle assessment was prepared according to ISO 14025:2006, ISO 21930:2017 (the core PCR) and the NSF product category rules for Portland, Blended, Masonry, Mortar and Plastic (stucco) Cements (subcategory PCR). This environmental product declaration (EPD) is intended for business-to-business audiences.

General Summary

EPD Commissioner and Owner	**Lafarge Canada** 6509 Airport Road Mississauga, Ontario L4V 1S7 www.lafarge.ca
	Lafarge, a member of Holcim, provided both LCI and meta-data for limestone quarrying, clinker production and cement manufacture for reference year 2019. The owner of the declaration is liable for the underlying information and evidence. *For any explanatory material, regarding this EPD, please contact Marie-Andree Guindon (marie-andree.guindon@lafarge.com).*
Product Group and Name	*Cement, UN CPC 3744.*
Product Definition	***Portland Cement (GU, Type I/II, HE, Type III):*** *a product obtained by pulverizing clinker consisting essentially of hydraulic calcium silicates, to which the various forms of calcium sulphate, up to 5% limestone, water, and processing additions may be added at the option of the manufacturer (CSA A3000, ASTM C150 & AASHTO M85).* ***Portland Limestone Cement (GUL, Type IL):*** *a product obtained by intergrading portland cement clinker and limestone (5% to 15%), to which the various forms of calcium sulphate, water, and processing additions may be added at the option of the manufacturer (CSA A3000, ASTM C595 & AASHTO M240, ASTM C1157)* ***Ternary Blended Cement (TERCEM):*** A hydraulic cement consisting of two or more inorganic constituents (at least one of which is not portland cement or portland cement clinker) which separately or in combination contribute to the strength gaining properties of the cement, (made with or without other constituents, processing additions and functional additions, by intergrinding or other blending) *(CSA A3000, ASTM C595 & AASHTO M240, ASTM C1157)*.

Product Category Rules (PCR)	NSF International, Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021 [2].
Date of Issue & Validity Period	02.08.2022 – 5 years
Declared Unit	1 metric tonne of cement

EPD and Project Report Information

Program Operator	ASTM International
Declaration Number	EPD 340
Declaration Type	Cradle-to-gate (modules A1 to A3). Facility and product-specific.
Applicable Countries	Canada and United States
Product Applicability	Cement is the basic ingredient of concrete. Concrete, one of the most widely used construction materials in the world, is formed when Portland cement creates a paste with water that binds with sand and rock to harden.
Content of the Declaration	This declaration follows Section 9; Content of an EPD, NSF International, Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021 [2].
This EPD was independently verified by ASTM in accordance with ISO 14025 and the reference PCR: Internal External X	Tim Brooke ASTM International 100 Barr Harbor Drive PO Box C700 West Conshohocken PA 19428-2959, USA cert@astm.org
Notes	The EPD results are computed using the N.A. version 3.0 of GCCA Industry EPD tool for Cement and Concrete (https://concrete-epd-tool.org)
LCA report and EPD Prepared by:	James Salazar, Hannah Renaud, & Jamie Meil Athena Sustainable Materials Institute 280 Albert Street, Suite 404 Ottawa, Ontario, Canada K1P 5G8 info@athenasmi.org

This EPD verified in accordance with ISO 14025, ISO 14040/44, and the reference PCR.

PCR Information

Program Operator	NSF International
Reference PCR	Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021.
PCR review was conducted by:	Thomas P. Gloria, PhD (Chair), Industrial Ecology Consultants, t.gloria@industrial-ecology.com Mr. Jack Geibig, EcoForm Mr. Bill Stough, Sustainable Research Group

Lafarge Cement & Production Facility

Lafarge is a member of Holcim, the global leader in building materials and solutions. As the largest provider of diversified construction materials in Canada, Lafarge's ambition is to lead the industry in reducing carbon emissions and shifting towards low-carbon construction.

In Canada, Lafarge companies include 400 sites across Canada and employ 6,000 people. Our customers rely on us to help them design and build better communities with innovative solutions that deliver structural integrity and eco-efficiency.

Facility Name:	Lafarge Brookfield Cement Plant, 87 Cement Plant Rd, Brookfield, NS B0N 1C0

Product Description

This EPD reports environmental transparency information for General Use Portland Cement (GU, Type I/II), General Use Portland Limestone Cement (GUL, Type IL), High Early Portland Cement (HE, Type III), and Ternary Blended Cements (TERCEM) cements produced by Lafarge at its Brookfield, NS plant. Cements are hydraulic binders and are manufactured by grinding cement clinker and other main or minor constituents into a finely ground, usually grey colored mineral powder. When mixed with water, cement acts as a glue to bind together the sand, gravel, or crushed stone to form concrete, one of the most durable, resilient, and widely used construction materials in the world. The Table below sets out each cement type constituents and applicable standards. All Brookfield cements are sold in bulk.

Products and Standards

Applicable Standards:
CSA A3000-18 Cementitious Materials Compendium
ASTM C150 / C150M – 21 Standard Specification for Portland Cement
ASTM C595 / C595M – 21 Standard Specification for Blended Hydraulic Cements
ASTM C1157 / C1157M – 20a Standard Performance Specification for Hydraulic Cement
AASHTO M85-20 Standard Specification for Portland Cement
AASHTO M240-20 Standard Specification for Blended Hydraulic Cement

Applicable Standards	Portland Cement General Use GU - Type I/II	Portland Limestone General Use GUL - Type IL OneCem	Portland Cement High Early HE - Type III	Ternary Blended Cement GUb-S/SF - Type IT TERCEM
CSA A3000-18	X	X	X	X
ASTM C150 / C150M – 21	X		X	
ASTM C595 / C595M – 21		X		X
ASTM C1157 / C1157M – 20a	X	X	X	X
AASHTO M85-20	X		X	
AASHTO M240-20		X		X

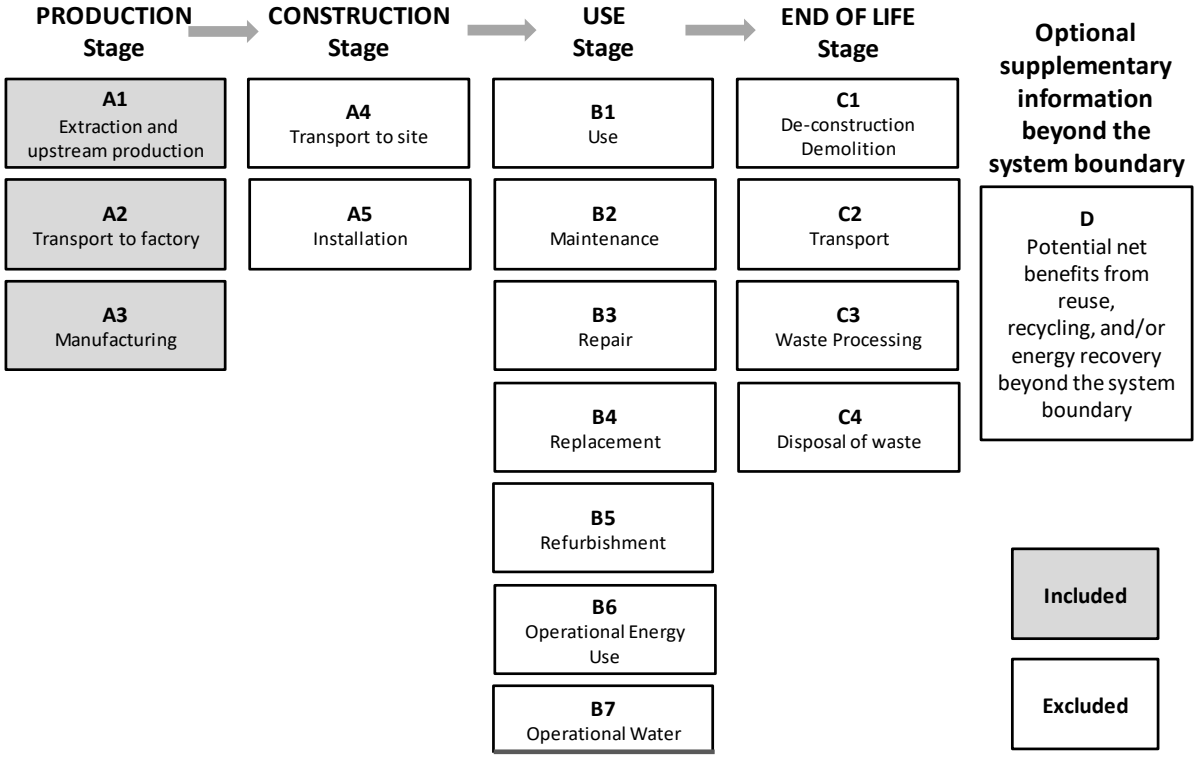
Inputs	GU Type I/II	GUL Type IL OneCem	HE Type III	GUb-S/SF Type IT TERCEM
Clinker	92%	83%	95%	65%
Gypsum	4%	4%	5%	4%
Limestone	4%	13%	<1%	<1%
Other	<1%	<1%	<1%	31%
Total	100%	100%	100%	100%

Declared Unit

The declared unit is one metric tonne of cement.

System Boundary

This EPD is a cradle-to-gate EPD covering the production stage (A1-A3) as depicted in the figure below. The production stage includes extraction of raw materials (cradle) through the manufacture of cements ready for shipment (gate). The Brookfield, NS cement plant sources its limestone supply from an adjacent quarry.



Items *excluded* from the system boundary include:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure
- Production and manufacture of production equipment, delivery vehicles, and laboratory equipment
- Personnel-related activities (travel, furniture, and office supplies)
- Energy and water use related to company management and sales activities that may be located either within the factory site or at another location

Cut-off Criteria

The cut-off criteria as per NSF PCR, Section 7.1.8 [2] and ISO 21930, 7.1.8 [3] were followed. Per ISO 21930, 7.1.8 [3], all input/output data required were collected and included in the LCI modelling. No substances with hazardous and toxic properties that pose a concern for human health and/or the environment were identified in the framework of this EPD. Any plant specific data gaps for the reference year 2019 e.g. amount of lubricants and refractory were filled in with industry data (secondary data).

Data Collection

Gate-to-gate input/output flow data were collected for the following processes for the reference year 2019:

- Limestone quarry, clinker production and cement manufacture – Brookfield, NS.

Allocation Rules

Allocation follows the requirements and guidance of ISO 14044 Clause 4.3.4 [5], NSF PCR [2], and ISO 21930 section 7.2 [3]. Recycling and recycled content are modeled using the cut-off rule. The sub-category PCR recognizes fly ash, furnace bottom ash, bypass dust, mill scale, polluted soils, spent catalyst, aluminum oxide waste, silica fume, granulated blast furnace slag, iron rich waste, cement kiln dust (CKD), flue gas desulfurization (FGD) gypsum, and calcium fluoride rich waste as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a cement material input. Further, used tires, plastics, solvents, used oil and oily waste, coal/carbon waste, roofing asphalt, household refuse-derived waste and non-hazardous liquid waste are considered non-renewable and/or renewable secondary fuels. Only the materials, water, energy, emissions, and other elemental flows associated with reprocessing, handling, sorting and transportation from the point of the generating industrial process to their use in the production process are considered. All emissions from combustion at the point of use are considered.

Data Quality Requirements and Assessment

Data Quality Requirements	Description
Technology Coverage	Data represents the prevailing technology in use at the Brookfield, NS facility. The Brookfield, NS plant utilizes *a long dry kiln technology*. *Technological representativeness is characterized as "high".*
Geographic Coverage	The geographic region considered is Canada. The electricity was modeled based on the Nova Scotia provincial grid mix. *Geographical representativeness is characterized as "high".*
Time Coverage	Activity (primary) data are representative of 2019 calendar year (12 months). - Brookfield, NS limestone extraction, - Brookfield, NS clinker production, - Brookfield, NS cement manufacturing, - In-bound/out-bound transportation data - primary data collected for Brookfield, NS quarry site and cement manufacturing plant. - Total carbon dioxide emissions from fuel use and calcination were reported for clinker production as part of the facility data collection. - Generic data: the most appropriate LCI datasets were used as found in the ecoinvent v.3.6 database for US and global, December 2019 and US LCI Database.
Completeness	All relevant, specific processes, including inputs (raw materials, energy, and ancillary materials) and outputs (emissions and production volume) were considered and modeled to complete production profile for Brookfield cement products.

Consistency	To ensure consistency, the modeling of the production input and output LCI data for the Brookfield cement products of interest used the same LCI modeling structure, which consisted of input material and intermediate products, ancillary and packaging materials (if applicable), energy flows, water resource inputs, product outputs, co-products, by-products, emissions to air, water and soil, and solid and liquid waste disposal. The calculated LCI was subsequently inputted into the N.A. version of GCCA Industry EPD tool for Cement and Concrete (https://concrete-epd-tool.org) Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the facility level and selected process levels to maintain a high level of consistency.
Reproducibility	Internal reproducibility is possible since the data and the models are stored the N.A. version of GCCA Industry EPD tool for Cement and Concrete (https://concrete-epd-tool.org). Key primary (manufacturer specific) and secondary (generic) LCI data sources are also summarized in the GCCA Tool documentation. External reproducibility is not possible as the background report is confidential.
Transparency	Activity and LCI datasets are disclosed in the project report, including all data sources.

Life Cycle Impact Assessment Results: Brookfield, NS Cements

This section summarizes the production stage life cycle impact assessment (LCIA) results including resource use and waste generated metrics based on the cradle-to-gate life cycle inventory inputs and outputs analysis. The results are calculated based on 1 metric tonne of each cement type as produced at the Brookfield, NS plant. *It should be noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks [4], [5]. Further, a number of LCA impact categories and inventory items are still emerging or under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting results for these categories – identified with an "*"* [2].

Only EPDs prepared from cradle-to-grave life-cycle results and based on the same function, quantified by the same functional unit, and taking account of replacement based on the product reference service life (RSL) relative to an assumed building service life, can be used to assist purchasers and users in making informed comparisons between products [2]. Environmental declarations from different programs may not be comparable [7]. EPDs are comparable only if they comply with ISO 21930, use the same, sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works [3].

Production Stage EPD Results: Brookfield, NS– per Metric Tonne

Impact category and inventory indicators	Unit	GU Type I/II	GUL Type IL OneCem	HE Type III	GUb-S/SF Type IT TERCEM
Global warming potential, GWP 100, AR5	kg CO2 eq	**943.08**	**859.44**	**975.36**	**745.94**
Ozone depletion potential, ODP	kg CFC-11	**1.49E-05**	**1.39E-05**	**1.55E-05**	**2.28E-05**
Smog formation potential, SFP	kg O3 eq	**4.16**	**4.28**	**4.15**	**7.58**
Acidification potential, AP	kg SO2 eq	**0.63**	**0.61**	**0.64**	**0.87**
Eutrophication potential, EP	kg N eq	**0.84**	**0.82**	**0.85**	**0.89**
Abiotic depletion potential for non-fossil mineral resources, ADP elements*	kg Sb eq	**8.48E-05**	**8.38E-05**	**8.69E-05**	**1.44E-04**
Abiotic depletion potential for fossil resources, ADP fossil	MJ LHV	**141.40**	**1437.62**	**144.59**	**216.59**
Renewable primary resources used as an energy carrier (fuel), RPRE*	MJ LHV	**74.20**	**72.73**	**74.97**	**97.99**
Renewable primary resources with energy content used as material, RPRM *	MJ LHV	**0.00**	**0.00**	**0.00**	**0.00**
Non-renewable primary resources used as an energy carrier (fuel), NRPRE*	MJ LHV	**1928.71**	**1821.75**	**1984.73**	**2463.13**
Non-renewable primary resources with energy content used as material, NRPRM *	MJ LHV	**0.00**	**0.00**	**0.00**	**0.00**
Secondary materials, SM *	kg	**0.00**	**0.00**	**0.00**	**310.00**
Renewable secondary fuels, RSF *	MJ LHV	**104.61**	**94.55**	**108.38**	**74.31**
Non-renewable secondary fuels, NRSF*	MJ LHV	**680.42**	**614.98**	**704.96**	**483.36**
Recovered energy, RE *	MJ LHV	**0.00**	**0.00**	**0.00**	**0.00**
Consumption of freshwater, FW	m3	**0.63**	**0.58**	**0.64**	**0.70**
Hazardous waste disposed, HWD *	kg	**0.00**	**0.00**	**0.00**	**0.00**
Non-hazardous waste disposed, NHWD*	kg	**0.36**	**0.32**	**0.37**	**0.25**
High-level radioactive waste, conditioned, to final repository, HLRW *	m3	**x**	**x**	**x**	**x**
Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW *	m3	**x**	**x**	**x**	**x**
Components for re-use, CRU *	kg	**0.00**	**0.00**	**0.00**	**0.00**
Materials for recycling, MR *	kg	**0.00**	**0.00**	**0.00**	**0.00**
Materials for energy recovery, MER *	kg	**0.00**	**0.00**	**0.00**	**0.00**
Recovered energy exported from the product system, EE *	MJ LHV	**0.00**	**0.00**	**0.00**	**0.00**
Additional Inventory Parameters for Transparency					
Emissions from calcination	kg CO_2 eq	**493.19**	**445.75**	**510.97**	**350.35**
Biogenic CO2, reporting the removals and emissions of biogenic carbon within biobased products	kg CO_2 eq	**0.19**	**0.18**	**0.19**	**0.21**

Table Notes:

1) (x) Not all LCA datasets for upstream materials include these impact categories and thus results may be incomplete.
2) (*) Use caution when interpreting results for these categories.

LCA Interpretation

The Manufacturing module (A3) drives most of the potential environmental impacts. Manufacturing impacts are primarily driven by energy use (electricity and thermal fuels) used during the pyro processing of limestone in the production of clinker. Clinker content in cement similarly defines the relative environmental profile of the final cement product. Raw material extraction (A1) is the second largest contributor to the Production stage EPD results, followed by the transportation (A2).

References

1. CSA A3000-18 Cementitious materials compendium
2. ASTM C150/C150M-21, Standard Specification for Portland Cement
3. ASTM C595/C595M-21, Standard Specification for Blended Hydraulic Cements
4. ASTM C1157/C1157M-20a, Standard Performance Specification for Hydraulic Cement
5. AASTHO M85 - 20, Standard Specification for Portland Cement
6. AAHTO M240M/M240 -20, Standard Specification for Blended Hydraulic Cement
7. NSF International, Product Category Rule Environmental Product Declarations, PCR for Portland, Blended, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021.
8. ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.
9. ISO 14040:2006/Amd1:2020 Environmental management - Life cycle assessment - Principles and framework.
10. ISO 14044:2006/Amd1:2017/Amd2:2020 Environmental management - Life cycle assessment - Requirements and guidelines.
11. NSF International, Product Category Rule Environmental Product Declarations, PCR for Concrete, V2.1, August 2021.
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14. ASTM General Program Instructions. V.8.0, April 29, 2020.
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16. ACLCA 2019, Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017. The American Centre for Life Cycle Assessment. May, 2019. https://aclca.org/aclca-iso-21930-guidance/, https://aclca.org/wp-content/uploads/ISO-21930-Final.pdf, accessed 08-2020.
17. LEED v4, Building Design and Construction Guide (BD+C), MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations, Option 2 Multi-attribute optimization (1 point). https://www.usgbc.org/node/2616376?return=/credits/new-construction/v4/material-%26amp%3B-resources, accessed 08-2020.
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21. Global Cement and Concrete Association (GCCA) and Portland Cement Association (PCA), *GCCA Industry EPD Tool for Cement and Concrete (V3.0), Users Manual, North American version*, Prepared by Quantis, April 2021. https://demo.gcca.quantis.solutions/us