Environmental Product Declaration

Environmental Product Declaration for various ready mix concrete products produced by Holcim México Operaciones, S.A. de C.V. at their Xochimilco Concrete Plant facility in Estado de México

ADMINISTRATIVE INFORMATION

International Certified Environmental Product Declaration

Declared Product:	This Environmental Product Declaration (EPD) covers ready mix concrete products produced by Holcim México Operaciones, S.A. de C.V. . Declared unit: 1 m3 of concrete
Declaration Owner:	Holcim México Operaciones, S.A. de C.V. Calz. México – Xochimilco No. 4879 Xochimilco, Estado de México, Mexico holcim.com.mx
Program Operator:	Labeling Sustainability Address, 11670 W Sunset Blvd. City, State, Los Angeles, CA http://labelinsustainability.com/
Product Category Rule:	ISO 21930:2017 Sustainability in Building Construction - Environmental Declaration of Building Products: serves as the core PCR. Product Category Rule for Environmental Product Declarations PCR for Concrete serves as the sub-category PCR. PCR Program Operator: NSF International Sub-category PCR review was conducted by: Thomas P. Gloria, Ph. D. of Industrial Ecology Consultants: 35 Bracebridge, Rd., Newton, MA 02459-1728, t.gloria@industrial-ecology.com. Dr. Michael Overcash of Environmental Clarity: 2908 Chipmunk Lane, Raleigh, NC 27607-3117, mrovercash@earthlink.net. Mr. Bill Stough of Sustainable Research Group: PO Box 1684, Grand Rapids, MI 49501-1684, bstough@sustainableresearchgroup.com .
Independent LCA Reviewer and EPD Verifier:	This EPD was independently verified in accordance with ISO 14025 and ISO 21930. The life cycle assessment was independently reviewed in accordance ISO 14044 and the referenced PCR. Independent verification of the declaration, according to ISO 14025:2006 Internal ☐ ; External ☐ X Third Party Verifier Geoffrey Guest, Certified 3rd Party Verifier under the CSA group (www.csaregistries.ca), Labeling Sustainability (www.labelingsustainability.com), P3Optima (www.P3Optima.com)
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TABLE OF CONTENTS

Administrative Information ... 1
Company Description ... 3
Study Goal ... 3
Description Of Product And Scope ... 4
Ready Mix Concrete Design Summary ... 4
Ready Mix Concrete Design Composition ... 5
A1 Raw Material Recycled Content And Material Losses ... 5
System Boundaries ... 6
Cut-Off Criteria ... 7
Data Sources And Data Quality Assessment ... 8
- Raw Material Transport ... 8
- Electricity ... 8
- Process/Space Heating ... 8
- Fuel Required For Machinery ... 8
- Waste Generation ... 8
- Recovered Energy ... 8
- Recycled/Reused Material/Components ... 9
- Module A1 Material Losses ... 9
- Direct A3 Emissions Accounting ... 9
- Waste Transport Requirements ... 9
- Product Transport Requirements ... 9

Data Quality Assessment ... 13
- Precision ... 14
- Completeness ... 14
- Consistency ... 14
- Reproducibility ... 14
- Representativeness ... 14

Environmental Indicators And Inventory Metrics ... 15
Total Impact Summary ... 18
Additional Environmental Info ... 19
References ... 19
- Astm Standards ... 19
- Csa Standards ... 20
- Iso Standards ... 20
- En Standards ... 21
- Other References ... 21

COMPANY DESCRIPTION

Holcim México Operaciones SA de CV produces and markets cement, ready-mix concrete, and other products and services for construction. The company has a nationwide presence through 7 cement plants with a current installed capacity to produce 12.6 million tons per year, 23 cement distribution centers, two maritime terminals, 1 Corporate Office, plus 35 ready-mix concrete plants, seven platforms, and a Geocycle transfer center, 26 commercial partners with more than 90 ready-mix concrete plants, more than 500 mixing pots, one aggregates plant and a Technological Innovation Center for Construction (CITEC).

Sustainable Development is an integral part of Holcim México Operaciones SA de CV strategy around the world. Holcim México Operaciones SA de CV has a clear vision of the future it wants for our country, which contributes to its development. Holcim México Operaciones SA de CV main objective is to create value. Creating value ensures long-term business success in covering the triple bottom line (i.e., social, economic, environmental values). Finally, good operating performance and a solid return on invested capital go hand in hand with sustainable development.

Holcim México Operaciones SA de CV continues to invest in research and development. They have the Innovation and Development Center, located in Lyon (France), with satellite locations in various regions developing a comprehensive portfolio of innovators and sustainable solutions. These include different categories: inclusive business models, water management solutions, urban mining solutions (recycled aggregates), waste treatment services, energy-efficient solutions (insulating building materials), resource-efficient solutions (high recycled content, bags soluble cement), and low CO_2 building materials.

Holcim México Operaciones SA de CV operates with the belief that they can gain an advantage by developing knowledge and brand equity in the green building segment.

STUDY GOAL

The intended application of this life cycle assessment (LCA) is to comply with the procedures for creating a Type III environmental product declaration (EPD) and publish the EPD for public review on the website, http://labelingsustainability.com/ . This level of study is in accordance with EPD Product Category Rule (PCR) for Ready Mix Concrete published by NSF International (2019) and is a sub-PCR of International Standards Organization (ISO) 21930:2017 Sustainability in buildings and civil works - Core rules for EPDs of construction products and services; International Standards Organization (ISO) 14025:2006 Environmental labels and declarations, Type III environmental declarations-Principles and procedures; ISO 14044:2006 Environmental management, Life cycle assessment- Requirements and guidelines; and ISO 14040:2006 Environmental management, Life cycle assessment-Principles and framework. The performance of this study and its subsequent publishing is in alignment with the business-to-business (B2B) communication requirements for the environmental assessment of building products. The study does not intend to support comparative assertions and is intended to be disclosed to the public.

This project report was commissioned to differentiate Holcim México Operaciones, S.A. de C.V. from their competition for the following reasons: generate an advantage for the organization; offer customers information to help them make informed product decisions; improve the environmental

performance of Holcim México Operaciones, S.A. de C.V. by continuously measuring, controlling and reducing the environmental impacts of their products; help project facilitators working on Leadership in Energy and Environmental Design (LEED) projects achieve their credit goal; and to strengthen Holcim México Operaciones, S.A. de C.V.'s license to operate in the community. The intended audience for this LCA report is Holcim México Operaciones, S.A. de C.V.'s employees, their suppliers, project specifiers of their products, architects, and engineers. The EPD report is also available for policy makers, government officials interested in sustainability, academic professors, and LCA professionals. This LCA report does not include product comparisons from other facilities.

DESCRIPTION OF PRODUCT AND SCOPE

This EPD is primary reported Holcim data from the reference year 2020 and uses direct reported Holcim information whenever possible. This includes both the cement plant and the concrete plant. This EPD accounts for primary information and greenhouse gas (GHG) emission reports for the Apaxco cement plant, used for the cement raw material input for all concrete mixes listed in this EPD.

This LCA assumes the impacts from products manufactured in accordance with the standards outlined in this report. This LCA is a cradle-to-gate study, and therefore, stages extending beyond the plant gate are not included in this LCA. Excluded stages include transportation of the manufactured material to the construction site; on-site construction processes and components; building (infrastructure) use and maintenance; and "end-of-life" effects.

READY MIX CONCRETE DESIGN SUMMARY

The following tables provide a list of the ready-mix concrete products considered in this EPD along with key performance parameters.

Table 1: **Declared products with All declared products considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio	UUID
1	04250NB2012	2.96 MPa 28d strength ready mix concrete. SCMs, Cement Kiln Dust,are used in this mix.	Ready Mix	2.96	0.8866279	67fea230-041a-41e7-ab7f-008ea681d55e
2	04300NB2012	3.56 MPa 28d strength ready mix concrete. SCMs, Cement Kiln Dust,are used in this mix.	Ready Mix	3.56	0.7804569	ae6ce29e-59d6-4219-8550-b9314247675b
3	04300NB2018	3.09 MPa 28d strength ready mix concrete. SCMs, Cement Kiln Dust,are used in this mix.	Ready Mix	3.09	0.7846715	e0daae94-9c51-4284-81b2-aece5a98f14c
4	04300RB2012	3.5 MPa 28d strength ready mix concrete. SCMs, Cement Kiln Dust,are used in this mix.This is an estimate MPa.	Ready Mix	3.50	0.7213210	4fc279ac-6897-4ace-a2d0-a2bebe9480e5

5	04350NB2012	4.32 MPa 28d strength ready mix concrete. SCMs, Cement Kiln Dust,are used in this mix.	Ready Mix	4.32	0.6818182	49508bf5-77be-4bee-ab15-d8f1e6018eb6
6	04350NB2018	3.34 MPa 28d strength ready mix concrete. SCMs, Cement Kiln Dust,are used in this mix.	Ready Mix	3.34	0.6890180	a858ad69-0583-45be-b87f-91a8ffc8e437

READY MIX CONCRETE DESIGN COMPOSITION

The following figures provide mass breakdown (kg per functional unit) of the material composition of each ready-mix concrete design considered. Please note that the presented breakdown has been randomly altered by +/-10% and is therefore only an approximation; this manipulation is to ensure confidentiality.

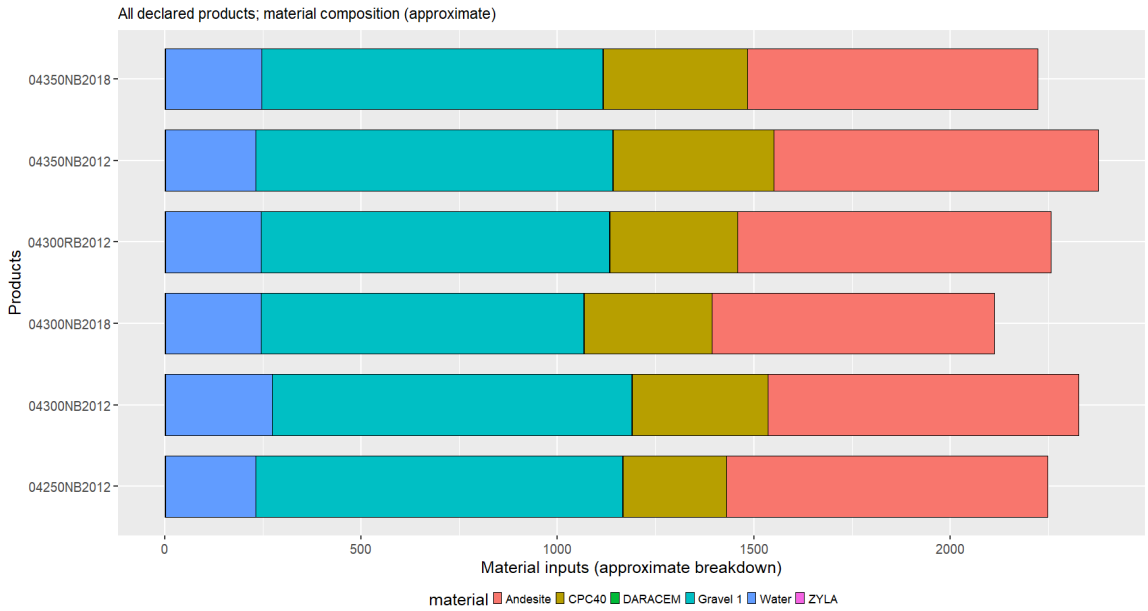

Figure 1: **Approximate material composition - All declared products per 1 m3 of concrete. Note: presented breakdown is approximate to ensure confidentiality.**

A1 RAW MATERIAL RECYCLED CONTENT AND MATERIAL LOSSES –

The following table provides a list of the raw material inputs (module A1) across all products considered, their recyclability content and assumed material losses.

Table 2: **Module A1 raw material inputs, the recyclability content and assumed material losses (dry basis)**

product.name	mix.category	primary.content	post.industrial.content	post.consumer.content	material.losses
CPC40	Cement	1	0	0	0.02
Gravel 1	Fine.Aggregate	1	0	0	0.02
Andesite	Fine.Aggregate	0	0	1	0.02
Water	Water	1	0	0	0.02
DARACEM	otherEcoinvent	1	0	0	0
ZYLA	otherEcoinvent	1	0	0	0

SYSTEM BOUNDARIES

The following figure depicts the cradle-to-gate system boundary considered in this study:

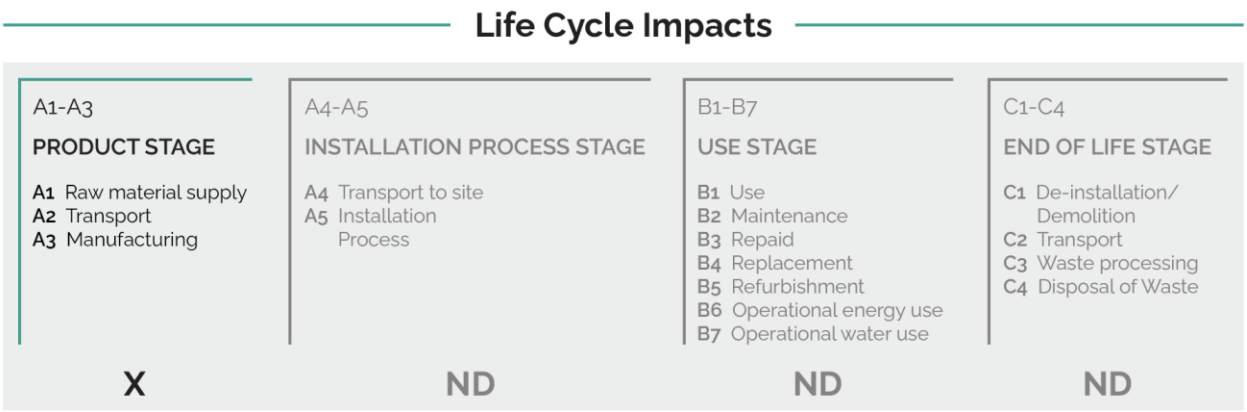

Figure 2: **General life cycle phases for consideration in a construction works system**

This is a Cradle-to-gate life cycle assessment and the following life cycle stages are included in the study:

- A1: Raw material supply (upstream processes) - Extraction, handling, and processing of the materials used in manufacturing the declared products in this LCA.
- A2: Transportation - Transportation of A1 materials from the supplier to the "gate" of the manufacturing facility (i.e. A3).
- A3: Manufacturing (core processes)- The energy and other utility inputs used to store, move, and manufacturer the declared products and to operate the facility.

As according to the PCR, the following figure illustrates the general activities and input requirements for producing ready mix concrete products and is not necessarily exhaustive.

System Boundary

Raw Material Supply (A1)	Transport (A2)	Manufacturing (A3)
Cements & SCMs Aggregates Admixtures Batch Water Fibers & Pigments	Truck, Rail, Ship Energy Carriers (fuels)	Energy Carriers (electricity and fuels) Ancillary Materials (lubricants, motor oil, cleaning chemicals, other consumables) Water (manufacturing water, including wash water for cement trucks, but excluding batch water) Waste (end of life treatment of ancillary materials and any packaging) 30% total fleet energy transit mix plants only

Figure 3: **General system inputs considered in the product system and categorized by modules in scope**

In addition, as according to the relevant PCR, the following requirements are excluded from this study:

- Production, manufacture and construction of A3 building/capital goods and infrastructure;
- Production and manufacture of steel production equipment, steel delivery vehicles, earthmoving equipment, and laboratory equipment;
- Personnel-related activities (travel, furniture, office supplies);
- Energy use related to company management and sales activities.

For this LCA the manufacturing plant, owned and operated by Holcim México Operaciones, S.A. de C.V., is located at their Xochimilco Concrete Plant facility in Mexico. All operating data is formulated using the actual data from Holcim México Operaciones, S.A. de C.V.'s plant at the above location, including water, energy consumption and waste generation. All inputs for this system boundary are calculated for the plant.

This life cycle inventory was organized in a spreadsheet and was then input into an RStudio environment where pre-calculated LCIA results for relevant products/activities stemming from the ecoinvent v3.6 database and a local EPD database in combination with primary data from Holcim México Operaciones, S.A. de C.V. were utilized. Explanations of the contribution of each data source to this study are outlined in the section 'Data Sources and Quality'. Further LCI details for each declared product are provided in the sections 'Detailed LCI tables' and 'Transport tables' of the detailed LCA report. A parameter uncertainty analysis was also performed where key statistical results (e.g. min/mean/max etc.) are provided in the detailed LCA report.

CUT-OFF CRITERIA

ISO 14044:2006 and the focus PCR requires the LCA model to contain a minimum of 95% of the total inflows (mass and energy) to the upstream and core modules be included in this study. The cut-off criteria were applied to all other processes unless otherwise noted above as follows. A 1% cut-off is considered for all renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process where the total of the neglected inputs does not exceed 5%.

DATA SOURCES AND DATA QUALITY ASSESSMENT

The following table summarizes the facility's (i.e. A3) electricity consumption and generation (if applicable), process/space heating requirements, fuel inputs for on-site machinery, and waste generation.

Table 3: **Inputs required by facility from 2020-01-01 to 2020-12-31 (365 days) to produce 122206 m3 of concrete**

Activity	Value	Units
Electricity consumption and generation (if applicable)		
Gross grid electricity:	42183	kWh
Fuel requirements for machinery		
Utility vehicle, diesel	9.264	m3
Waste generation		
Wash water	3897.821	m3
Hazardous waste	0	kg
Non-hazardous waste	441.6	kg
High-level radioactive waste	0	kg

No recovered on-site energy occurs at this facility.

Table 4: **Reused or recycled components/materials at the A3 facility site**

Component/material for re-use/recycling	Value	Units	Re-used/recycled on-site or off-site
concrete returned	0	m3	off-site

The following statements explain how the above facility requirements/generation were derived:

Raw material transport: A combination of actual mode/distance combinations were assumed for key bulk materials whereas ecoinvent default multi-modal market mix distances were assumed for other inputs where no original data could be provided.

Electricity: Electricity generation and consumption values were based on monthly utility bills. By constitutional law, electricity for public service consumption was provided by state-owned CFE and LFC until October 2009. Prior to October 2009, LFC served Mexico City and the surrounding areas and CFE served the rest of the country. LFC bought approximately 95 percent of its electricity from CFE. In October 2009 CFE took over LFC's operations.

Process/space heating: All values for energy, water and waste are Holcim direct reporting for the year 2020.

Fuel required for machinery: Waste values were based on waste management receipts for 2020. The types of hazardous waste include: absorbent material impregnated with hazardous chemicals; containers, tow, fabrics impregnated with solvents, oil, spent grease; residual liquids from solvents or hazardous chemicals; empty containers; and personal protective equipment impregnated with oils, greases or dangerous chemicals. Non-hazardous waste includes both organic and inorganic waste.

Waste generation: Volume of concrete returned from truck washing using a retention pond system.

Recovered energy: Due to lack of data, default loss factors were assumed.

Recycled/reused material/components: Market values were used for waste due to the undetermined nature of the waste's final destination. Not all materials are a simple landfill solution. Wash water returned is through a retention pond system.

Module A1 material losses: Primary transportation for delivering the concrete in mixing trucks was calculated using the following formula; Total concrete transported/(concrete/load) *(km per load)*L/km.

Direct A3 emissions accounting: NA

Waste transport requirements: NA

Product transport requirements: NA

The following tables depict a list of assumed life cycle inventory utilized in the LCA modeling to generate the impact results across the life cycle modules in scope. An assessment of the quality of each LCI activities utilized from various sources is also provided.

Table 5: **LCI inputs assumed for module A1 (i.e. raw material supply)** ***Data Quality Assessment Key Poor= 0, Fair=1, Good=2, Very Good =3.***

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Gravel 1	gravel and sand quarry operation/sand/RoW/kg; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.6	State of Mexico	v3.6 in 2019	2	2	2	3	3
DARACEM	market for chemical, organic/chemical, organic/GLO/kg	ecoinvent v3.6	State of Mexico	v3.6 in 2019	2	2	2	3	3
CPC40	Cement production, CPC 40, Ramos.Arizpe.Cement. Plant, Holcim.Apasco.SA.de.CV/Saltillo, MX/1 tonne of cement	Progam Operator: Labeling Sustainability- EPD ID: ab22ee19-4f97-41a2-bf8a-4297c635a5d6	State of Mexico	very good, 3rd party verfied facility - specific EPD dataset	2	NA	2	3	3

Water	market for tap water/tap water/RoW/kg	ecoinvent v3.6	State of Mexico	v3.6 in 2019	2	2	2	3	3

Table 6: **LCI inputs assumed for module A2 (i.e. transport of A1 inputs)** ***Data Quality Assessment Key Poor= 0, Fair=1, Good=2, Very Good =3.***

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Andesite-freight transport via Truck	market for transport, freight, lorry 3.5-7.5 metric ton, EURO6/transport, freight, lorry 3.5-7.5 metric ton, EURO6/RoW/tkm	ecoinvent v3.6	RoW	v3.6 in 2019	2	2	1	3	3
CPC40-freight transport via Rail	market for transport, freight train/transport, freight train/RoW/tkm	ecoinvent v3.6	RoW	v3.6 in 2019	2	2	1	3	3
CPC40-freight transport via Truck	market for transport, freight, lorry 7.5-16 metric ton, EURO6/transport, freight, lorry 7.5-16 metric ton, EURO6/RoW/tkm	ecoinvent v3.6	RoW	v3.6 in 2019	2	2	1	3	3
DARACEM-freight transport via Truck	market for transport, freight, lorry 3.5-7.5 metric ton, EURO6/transport, freight, lorry 3.5-7.5 metric ton, EURO6/RoW/tkm	ecoinvent v3.6	RoW	v3.6 in 2019	2	2	1	3	3
Gravel 1-freight transport via Truck	market for transport, freight, lorry 7.5-16 metric ton, EURO6/transport, freight, lorry 7.5-16 metric ton, EURO6/RoW/tkm	ecoinvent v3.6	RoW	v3.6 in 2019	2	2	1	3	3
ZYLA-freight transport via Truck	market for transport, freight, lorry 3.5-7.5 metric ton, EURO6/transport, freight, lorry 3.5-7.5	ecoinvent v3.6	RoW	v3.6 in 2019	2	2	1	3	3

	metric ton, EURO6/RoW/tkm								

Table 7: **LCI inputs assumed for module A3.** ***Data Quality Assessment Key Poor= 0, Fair=1, Good=2, Very Good =3.***

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Diesel truck	transport, freight, lorry 16-32 metric ton, EURO6/transport, freight, lorry 16-32 metric ton, EURO6/RoW/tkm	ecoinvent v3.6	RoW	v3.6 in 2019	1	2	1	3	3
Grid electricity	market for electricity, medium voltage/electricity, medium voltage/MX/kWh; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.6	MX	v3.6 in 2019	3	2	3	3	3
Non-hazardous waste	treatment of municipal solid waste, sanitary landfill/municipal solid waste/RoW/kg	ecoinvent v3.6	RoW	v3.6 in 2019	2	2	1	3	3
Transport of Non-hazardous waste	market for transport, freight, lorry, unspecified/transport, freight, lorry, unspecified/RoW/tkm	ecoinvent v3.6	RoW	v3.6 in 2019	2	2	2	3	3
Utility vehicle, diesel	machine operation, diesel, < 18.64 kW, low load factor/machine operation, diesel, < 18.64 kW, low load factor/GLO/hr	ecoinvent v3.6	GLO	v3.6 in 2019	2	2	2	3	3
Wash water	treatment of wastewater from concrete production, capacity 5E9l/year/wastewater from concrete production/RoW/m3	ecoinvent v3.6	RoW	v3.6 in 2019	2	2	2	3	3

The following table depicts every modifcation undertaken to the ecoinvent activities assumed in the tables above:

Table 8: **All technosphere input changes made to any ecoinvent activities used in the system model**

ID	product	updateType	activityName ToChange	name_input Activity	value	units	explanation
1	Sand	Remove	gravel and sand quarry operation/sand/RoW/kg	market for electricity, medium voltage/electricity, medium voltage/MX/kWh	0.0027199	kWh	Regarding activity 'gravel and sand quarry operation/sand/RoW/kg', the input 'market for electricity, medium voltage/electricity, medium voltage/MX/kWh', was removed assuming 2.72E-3 kWh
2	Sand	Add	gravel and sand quarry operation/sand/RoW/kg	market for electricity, medium voltage/electricity, medium voltage/MX/kWh	0.0027199	kWh	Regarding activity 'gravel and sand quarry operation/sand/RoW/kg', the input 'market for electricity, medium voltage/electricity, medium voltage/MX/kWh', was added assuming 2.72E-3 kWh
7	Electricity	Remove	market for electricity, medium voltage/electricity, medium voltage/MX/kWh	market for electricity, high voltage/electricity, high voltage/MX/kWh	0.0000000	kWh	Regarding activity 'market for electricity, medium voltage/electricity, medium voltage/MX/kWh', the input 'market for electricity, high voltage/electricity, high voltage/MX/kWh', was removed assuming 0.00E+0 kWh
8	Electricity	Add	market for electricity, medium	electricity production, photovoltaic	0.0000000	kWh	Regarding activity 'market for electricity, medium

			voltage/electricity, medium voltage/MX/kWh	, 570kWp open ground installation, multi-Si/electricity, low voltage/MX/kWh			voltage/electricity, medium voltage/MX/kWh', the input 'electricity production, photovoltaic, 570kWp open ground installation, multi-Si/electricity, low voltage/MX/kWh', was added assuming 0.00E+0 kWh
9	Electricity	Add	market for electricity, medium voltage/electricity, medium voltage/MX/kWh	electricity production, wind, 1-3MW turbine, onshore/electricity, high voltage/MX/kWh	0.0000000	kWh	Regarding activity 'market for electricity, medium voltage/electricity, medium voltage/MX/kWh', the input 'electricity production, wind, 1-3MW turbine, onshore/electricity, high voltage/MX/kWh', was added assuming 0.00E+0 kWh
10	Electricity	Add	market for electricity, medium voltage/electricity, medium voltage/MX/kWh	electricity production, natural gas, combined cycle power plant/electricity, high voltage/MX/kWh	0.0000000	kWh	Regarding activity 'market for electricity, medium voltage/electricity, medium voltage/MX/kWh', the input 'electricity production, natural gas, combined cycle power plant/electricity, high voltage/MX/kWh', was added assuming 0.00E+0 kWh

DATA QUALITY ASSESSMENT

Data quality/variability requirements, as specified in the PCR, are applied. This section describes the achieved data quality relative to the ISO 14044:2006 requirements. Data quality is judged based on its precision (measured, calculated or estimated), completeness (e.g., unreported emissions),

consistency (degree of uniformity of the methodology applied within a study serving as a data source) and representativeness (geographical, temporal, and technological).

Precision: Through measurement and calculation, the manufacturers collected and provided primary data on their annual production. For accuracy, the LCA practitioner and 3rd Party Verifier validated the plant gate-to-gate data.

Completeness: All relevant specific processes, including inputs (raw materials, energy and ancillary materials) and outputs (emissions and production volume) were considered and modeled to represent the specified and declared products. The majority of relevant background materials and processes were taken from ecoinvent v3.6 LCI datasets where relatively recent region-specific electricity inputs were utilized. The most relevant EPDs requiring key A1 inputs were also utilized where readily available.

Consistency: To ensure consistency, the same modeling structure across the respective product systems was utilized for all inputs, which consisted of raw material inputs and ancillary material, energy flows, water resource inputs, product and co-products outputs, returned and recovered Ready Mix Concrete materials, emissions to air, water and soil, and waste recycling and treatment. The same background LCI datasets from the ecoinvent v3.6 database were used across all product systems. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the plant and selected process level to maintain a high level of consistency.

Reproducibility: Internal reproducibility is possible since the data and the models are stored and available in a machine-readable project file for all foreground and background processes, and in Eco-Purpose's proprietary Ready Mix Concrete LCA calculator* for all production facility and product-specific calculations. A considerable level of transparency is provided throughout the detailed LCA report as the specifications and material quantity make-up for the declared products are presented and key primary and secondary LCI data sources are summarized. The provision of more detailed publicly accessible data to allow full external reproducibility was not possible due to reasons of confidentiality.

*Eco-Purpose has developed a proprietary tool that allows the calculation of PCR-compliant LCA results for Ready Mix Concrete product designs. The tool auto-calculates results by scaling base-unit Technosphere inputs (i.e. 1 kg sand, 1 kWh electricity, etc.) to replicate the reference flow conversions that take place in any typical LCA software like openLCA or SimaPro. The tool was tested against several LCAs performed in openLCA and the tool generated identical results to those realized in openLCA across every impact category and inventory metric (where comparisons could be readily made).

Representativeness: The representativeness of the data is summarized as follows.

- Time related coverage of the manufacturing processes' primary collected data from 2020-01-01 to 2020-12-31.
- Upstream (background) LCI data was either the PCR specified default (if applicable) or more appropriate LCI datasets as found in the country-adjusted ecoinvent v3.6 database.

- Geographical coverage for inputs required by the A3 facility(ies) is representative of its region of focus; other upstream and background processes are based on US, North American, or global average data and adjusted to regional electricity mixes when relevant.
- Technological coverage is typical or average and specific to the participating facilities for all primary data.

ENVIRONMENTAL INDICATORS AND INVENTORY METRICS

Per the PCR, this EPD supports the life cycle impact assessment indicators and inventory metrics as listed in the tables below. As specified in the PCR, the most recent US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), impact categories were utilized as they provide a North American context for the mandatory category indicators to be included in the EPD. Additionally, the PCR requires a set of inventory metrics to be reported with the LCIA indicators (see tables below).

Table 9: **Life cycle impact categories and life cycle inventory metrics**

ID	LCIA.indicators	Abbreviations	Units
1	environmental impact: acidification	AP	kg SO2eq
2	environmental impact: ecotoxicity	ETP	kg 2,4-D-.
3	environmental impact: global warming	GWP	kg CO2-Eq
4	environmental impact: ozone depletion	ODP	kg CFC-11.
5	environmental impact: photochemical oxidation	PCOP	kg O3eq
6	Abiotic Depletion-elements	ADPe	kg Sbeq
7	Abiotic Depletion-fossil fuels	ADPf	kg Sbeq
Inventory metrics			
8	Total primary energy	TPE	MJ-Eq
9	Non-Renewable Resources	NRR	kg
10	Renewable energy	RE	MJ-Eq
11	environmental impact: land filling, bulk waste	LFW	kg waste
12	environmental impact: land filling, hazardous waste	LFHW	kg waste
13	water depletion: WDP	WDP	m3 water-.
14	Concrete batching water consumption	CBWC	m3
15	Concrete washing water consumption	CWWC	m3
16	Concrete hazardous waste	CHW	kg
17	Concrete non-hazardous waste	CNHW	kg

A summary description of each of the impact categories and inventory metrics is provided in the following table:

Table 10: **Definitions of life cycle impact categories and life cycle inventory metrics**

Midpoint impact categories	
Global Warming Potential (GWP) (units: kg CO2-eq)	Global Warming Potential or climate change can be defined as the change in global temperature caused by the greenhouse effect that the release of greenhouse gases by human activity creates. The Environmental Profiles characterization model is based on factors developed by the United Nations Intergovernmental Panel on Climate Change (IPCC). Factors are expressed as Global Warming Potential over the time horizon of different years, being the

	most common 100 years (GWP100), measured in the reference unit, kg CO2 equivalent.
Ozone Depletion Potential (ODP) (kg CFC-11-eq)	Ozone-depleting gases cause damage to stratospheric ozone or the ozone layer. CFCs, halons and HCFCs are the major causes of ozone depletion. The characterization model has been developed by the World Meteorological Organization (WMO) and defines the ozone depletion potential of different gases relative to the reference substance chlorofluorocarbon-11 (CFC-11), expressed in kg CFC-11 equivalent.
Acidification Potential (AP) (kg SO2-eq)	Acidic gases such as Sulphur dioxide (SO2) react with water in the atmosphere to form acid rain, a process known as acid deposition. Acidification potential is expressed using the reference unit, kg SO2 equivalent. The model does not take account of regional differences in terms of which areas are more or less susceptible to acidification. It accounts only for acidification caused by SO2 and NOx. This includes acidification due to fertilizer use, according to the method developed by the Intergovernmental Panel on Climate Change (IPCC). CML has based the characterization factor on the RAINS model developed by the University of Amsterdam.
Eutrophication Potential (EP) (PO4 3- -eq)	Eutrophication is the build-up of a concentration of chemical nutrients in an ecosystem which leads to abnormal productivity. This causes excessive plant growth like algae in rivers which causes severe reductions in water quality and animal populations. This category is based on the work of Heijungs, and is expressed using the reference unit, kg PO4 3- equivalents. Direct and indirect impacts of fertilizers are included in the method. The direct impacts are from production of the fertilizers and the indirect ones are calculated using the IPCC method to estimate emissions to water causing eutrophication.
Photochemical Ozone Creation/Smog Potential (POCP) (kg O3-eq)	Ozone is protective in the stratosphere, but on the ground-level, it is toxic to humans in high concentration. Photochemical ozone, also called ground-level ozone, is formed by the reaction of volatile organic compounds and nitrogen oxides in the presence of heat and sunlight. The impact category depends largely on the amounts of carbon monoxide (CO), Sulphur dioxide (SO2), nitrogen oxide (NO), ammonium and NMVOC (non-methane volatile organic compounds). Photochemical ozone creation potential (also known as summer smog) for emission of substances to air is calculated with the United Nations Economic Commission for 22 Europe (UNECE) trajectory model (including fate) and expressed using the reference unit, kg ethylene (C2H4) equivalent.
Abiotic Depletion Potential (ADPel and ADPff) (kg Sb-eq)	The main concern of this category is the health of humans and the ecosystem and how it is affected by the extraction of minerals and fossil fuels, which are inputs into the system. For each extraction of minerals and fossil fuels, the abiotic depletion factor is determined. This indicator is on a global scale and is based on the concentration reserves and rate of deaccumulation. The results are presented in units of the reference element strontium (i.e. Sb). For the purposes of this EPD, this impact category is split between mineral elements (i.e. ADPel) and fossil fuels (i.e. ADPff).
Inventory metrics	
Depletion of non-renewable material resources (NRM) (kg)	This indicator covers the cumulative life cycle consumption of non-renewable resources that are extracted from the ground but not including energy resources like coal, oil and natural gas. This indicator includes the consumption of metallic ores, aggregates and other minerals. The units of measure are in terms of kilograms material extracted and utilzied/wasted in the life cycle system considered.

Use of renewable material resources (RM) (kg)	This indicator covers the cumulative life cycle consumption of renewable resources that are extracted from nature like sustainably harvested biomass. The units of measure are in terms of kilograms material extracted and utilzied/wasted in the life cycle system considered.
Depletion of non-renewable energy resources (NRE) (MJ HHV)	This indicator considers the cumulative life cycle consumption of non-renewable energy resources like oil, natural gas, and coal. The units of measure are in terms of Mega-Joules of energy resource extracted and utilzied/wasted in the life cycle system considered.
Use of renewable primary energy (RE) (MJ HHV)	This indicator considers the cumulative life cycle extraction of renewable energy resources from nature like solar and wind energy as well as biomass for energy purposes. The units of measure are in terms of Mega-Joules of energy resource extracted and utilzied/wasted in the life cycle system considered.
Total primary energy consumption (PEC) (MJ HHV)	This indicator is the summatation of non-renewable and renewable energy extracted from nature, where the units of measure are in terms of Mega-Joules of energy resource extracted/utilized/wasted in the life cycle system considered.
Concrete batching water consumption (CBWC) (m3)	This indicator is defined as the direct water used in concrete mix batches. The units of measure are in cubic meters of water consumed.
Concrete washing water consumption (CWWC) (m3)	This inidcator is defined as the direct washing water used at the facility. The units of measure are in cubic meters of wash water consumed.
Total water consumption (TWC) (m3)	This indicator considers the cumulative life cycle consumption of water required to produced the declared functional unit of a given product. The units of measure are in cubic meters of water consumed.
Concrete hazardous waste (CHW) (kg)	This indicator considers the amount of hazardous waste waste generated at the concrete facility. The units of measure are in kilograms of waste generated.
Concrete non-hazardous waste (CNHW) (kg)	This indicator considers the direct amount of non-hazardous waste generated at the concrete facility. The units of measure are in kilograms of waste generated.

It should be noted that emerging LCA impact categories and inventory items are still under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in any of the following categories.

- Renewable primary energy resources as energy (fuel);
- Renewable primary resources as material;
- Non-renewable primary resources as energy (fuel);
- Non-renewable primary resources as material;
- Secondary Materials;
- Renewable secondary fuels;
- Non-renewable secondary fuels;
- Recovered energy;
- Abiotic depletion potential for non-fossil mineral resources.
- Land use related impacts, for example on biodiversity and/or soil fertility;
- Toxicological aspects;
- Emissions from land use change [GWP 100 (land-use change)];
- Hazardous waste disposed;
- Non-hazardous waste disposed;
- High-level radioactive waste;

- Intermediate and low-level radioactive waste;
- Components for reuse;
- Materials for recycling;
- Materials for energy recovery;
- Recovered energy exported from the product system.

TOTAL IMPACT SUMMARY

The following table reports the total LCA results for each product produced at the given ready mix concrete facility on a per 1 m3 of concrete basis.

Table 11: **Total life cycle (across modules in scope) impact results for All declared products, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	**kg SO2eq**	**kg N**	**kg CO2-Eq**	**kg CFC-11.**	**kg O3eq**	**kg Sbeq**	**kg Sbeq**
Minimum	1.24	0.0557	308	2.35e-05	0.53	0.00609	1.08
Maximum	1.56	0.0684	399	2.81e-05	0.671	0.00629	1.3
Mean	1.43	0.0631	360	2.62e-05	0.611	0.0062	1.21
Median	1.44	0.0633	362	2.62e-05	0.614	0.00622	1.21
04250NB2012	1.24	0.0557	308	2.35e-05	0.53	0.00609	1.08
04300NB2012	1.37	0.0608	343	2.54e-05	0.585	0.00618	1.17
04300NB2018	1.41	0.0622	355	2.58e-05	0.602	0.00614	1.19
04300RB2012	1.46	0.0644	370	2.67e-05	0.626	0.00625	1.23
04350NB2012	1.52	0.0669	388	2.76e-05	0.654	0.00629	1.28
04350NB2018	1.56	0.0684	399	2.81e-05	0.671	0.00626	1.3

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNHW
Unit	**MJ-Eq**	**MJ-Eq**	**MJ-Eq**	**kg**	**kg**	**m3 water-.**	**kg waste**	**kg waste**	**m3**	**m3**	**kg**	**kg**
Minimum	2360	86.2	2270	2250	0.00563	0.395	32.1	0.00296	0.249	0.000203	0	0.0231
Maximum	2850	108	2730	2300	0.00745	0.469	33.4	0.00314	0.266	0.000203	0	0.0231
Mean	2640	99	2540	2280	0.00668	0.438	32.8	0.00307	0.256	0.000203	0	0.0231
Median	2660	99.3	2550	2280	0.00672	0.44	33	0.00307	0.254	0.000203	0	0.0231
04250NB2012	2360	86.2	2270	2260	0.00563	0.395	32.1	0.00296	0.249	0.000203	0	0.0231

04300NB2012	2560	94.9	2460	2280	0.00634	0.427	32.7	0.00304	0.251	0.000203	0	0.0231
04300NB2018	2610	97.6	2510	2250	0.00657	0.436	32.5	0.00304	0.263	0.000203	0	0.0231
04300RB2012	2700	101	2590	2290	0.00687	0.444	33.2	0.0031	0.254	0.000203	0	0.0231
04350NB2012	2790	106	2680	2300	0.00722	0.46	33.4	0.00314	0.254	0.000203	0	0.0231
04350NB2018	2850	108	2730	2270	0.00745	0.469	33.2	0.00314	0.266	0.000203	0	0.0231

ADDITIONAL ENVIRONMENTAL INFO

No regulated substances of very high concern are utilized on site.

REFERENCES

ASTM Standards:

- ASTM A36/A36M Standard Specification for Carbon Structural Steel
- ASTM A108 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
- ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- ASTM A184 Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
- ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
- ASTM A416/A416M Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
- ASTM A555/A555M Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods
- ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- ASTM A706/A706M Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
- ASTM A767/A767M Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
- ASTM A775/A775M Standard Specification for Epoxy-Coated Steel Reinforcing Bars
- ASTM A820/A820M Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
- ASTM A884/A884M Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement

- ASTM A934/A934M Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
- ASTM A1064/A1064M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- ASTM C33/C33M Standard Specification for Concrete Aggregates
- ASTM C94 Standard Specification for Ready-Mixed Concrete
- ASTM C150/C150M Standard Specification for Portland Cement
- ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete
- ASTM C595 Standard Specification for Blended Hydraulic Cements
- ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- ASTM C979/C979M Standard Specification for Pigments for Integrally Colored Concrete
- ASTM C989/C989M Standard Specification for Slag Cement for Use in Concrete and Mortars
- ASTM C1017/C1017M Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
- ASTM C1116/C1116M Standard Specification for Fiber-Reinforced Concrete
- ASTM C1157/C1157M Standard Performance Specification for Hydraulic Cement
- ASTM C1240 Standard Specification for Silica Fume Used in Cementitious Mixtures
- ASTM C1602/C1602M Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
- ASTM G109 Standard Test Method for Determining Effects of Chemical Admixtures on Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments
- ASTM C330/C330M Standard Specification for Lightweight Aggregates for Structural Concrete
- ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete

CSA Standards:

- CAN/CGSB-1.40 Anticorrosive Structural Steel Alkyd Primer
- CAN/CSA G30.18 Carbon steel bars for concrete reinforcement
- CAN/CSA A3000 Cementitious Materials Compendium
- CAN/CSA G40.20/G40.21 General requirements for rolled or welded structural quality steel / Structural quality steel
- CAN/CSA A23.1/A23.2 Concrete Materials and Methods of Concrete Construction/Test methods and Standard Practices for Concrete
- CAN/CSA A23.4 Precast concrete - Materials and construction
- CSA S806 Design and construction of building structures with fibre-reinforced polymers

ISO Standards:

- ISO 6707-1: 2014 Buildings and Civil Engineering Works - Vocabulary - Part 1: General Terms
- ISO 14021:1999 Environmental Labels and Declarations - Self-declared Environmental Claims (Type II Environmental Labeling)
- ISO 14025:2006 Environmental Labels and Declarations - Type III Environmental Declarations - Principles and Procedures
- ISO 14040:2006 Environmental Management - Life Cycle Assessment - Principles and Framework
- ISO 14044:2006 Environmental Management - Life Cycle Assessment - Requirements and Guidelines
- ISO 14067:2018 Greenhouse Gases - Carbon Footprint of Products - Requirements and Guidelines for Quantification
- ISO 14050:2009 Environmental Management - Vocabulary
- ISO 21930:2017 Sustainability in Building Construction - Environmental Declaration of Building Products

EN Standards:

- EN 16757 Sustainability of construction works - Environmental product declarations - Product Category Rules for concrete and concrete elements
- EN 15804 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products

Other References:

- US EPA Waste Reduction Model (WARM), Fly Ash Chapter: http://epa.gov/climatechange/wycd/waste/downloads/fly-ash-chapter10-28-10.pdf
- American Concrete Institute (ACI) 211: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- ACI 318-14 Building Code Requirements for Structural Concrete and Commentary. American Concrete Institute. Farmington Hills, MI, USA available at https://www.concrete.org/store/
- Mather, B & Ozyildirim, C. (2002). SP-1(02) : Concrete Primer. American Concrete Institute : SP0102. American Concrete Institute. Farmington Hills, MI, USA available at https://www.concrete.org/store/
- NSF International (February, 2019). Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) of Concrete v1.2.
- Product Category Rules for Preparing an Environmental Product Declaration for Precast Concrete (UN CPC 37550), ASTM International, March 2015. https://www.astm.org/CERTIFICATION/DOCS/266.PCR_for_Precast_Concrete.pdf
- USGBC LEED v4 for Building Design and Construction, 11 Jan 2019 available at https://www.usgbc.org/resources/pcr-committee-process-resources-part-b
- USGBC PCR Committee Process & Resources: Part B, USGBC, 7 July 2017 available at https://www.usgbc.org/resources/pcr-committee-process-resources-part-b.