

LIFE CYCLE ASSESSMENT REPORT

CLIENT

Sprung Structures - Fair Oaks Farms

ADDRESS

United States

AUTHOR

Anthony Pak

DATE

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1 Building description

The key parameters of the building are synthesized in the below table. Other buildings

Parameter	Description
Project Name	Sprung Structures – Fair Oak Farms
Building area	975.5 m ²
Required service life	Lifespan of 60 years. Technical service life (same for same material)
Construction year	2020
Assessment Date	Aug. 12, 2020
Assessor	Anthony Pak



2 Purpose of the assessment, assessor and tools

2.1 Purpose of the analysis

The purpose of the study and analysis key methodology can be found in the below table.

Parameter	Description
Purpose of the analysis	<p>For evaluate the embodied environmental impacts associated with materials used in this building. The whole-building LCA study takes into account a wide range of environmental impact categories. These include global warming potential, stratospheric ozone depletion, acidification of land and water sources, eutrophication, formation of tropospheric ozone, and depletion of nonrenewable energy sources.</p> <p>This is whole-building LCA in compliance with LEED v4 Full Reference Guide and credit MRc: Building Life-Cycle Impact Reduction. This LCA software and related datasets are fully compliant with ISO 14044. The impact assessment method used is TRACI 2.1. This LCA methodology follows LEED requirements and this software is third party verified.</p>

2.2 About the assessor

The report has been created by Anthony Pak. Anthony is the Principal at [Priopta](#), a Life Cycle Assessment (LCA) consulting firm that is one of the first in North America to offer a custom Parametric LCA service for new construction projects. Priopta provides Whole Building Life Cycle Assessment modelling services and has developed LCA studies for over 20 projects across a wide range of building types including residential, office, commercial, and institutional buildings, complying with various requirements such as the LEED v4.1 MRc1 and City of Vancouver’s rezoning requirement.

Anthony is also the founder of [ECN Vancouver](#)—the first local chapter of the Embodied Carbon Network—which organizes local events that empower building industry professionals to champion the topic of embodied carbon on their projects and within their firms. Since April 2019, ECN Vancouver has inspired over 20 other cities to start local chapters, and now Anthony serves as the Regional Director supporting local chapters in Western North America, Asia, and Australia.

He is a Professional Engineer with a Masters in Industrial Ecology from NTNU, which is a leading LCA research group in Norway. Anthony is passionate about building awareness around embodied carbon and frequently gives presentations locally and internationally at conferences, industry events, and lunch and learns at leading design firms.

2.3 About the assessment software

The assessment has been carried out with One Click LCA software. The software holds 11 third party certifications and complies with over 30 certifications and standards for Life Cycle Assessment and Life Cycle Costing, including all versions of LEED and BREEAM. The software includes curated and



verified global and local databases. The up to date list of integrated databases can be found here: <https://www.oneclicklca.com/support/faq-and-guidance/documentation/database/>.

One Click LCA has been third party verified by ITB for compliancy with the following LCA standards: EN 15978, ISO 21931–1 and ISO 21929, and data requirements of ISO 14040 and EN 15804. The full compliancy documentation is available at <https://www.oneclicklca.com/support/faq-and-guidance/documentation/compliancy-and-certifications/>.

ITB is a certification organization and a Notified Body (EC registration nr. 1488) to the European Commission designated for construction product certification. Polish Accreditation Board assures the independence and impartiality of ITB services (Accreditation Certificates are: AB 023, AC 020, AC 072, AP 113). ITB activities are conducted in accordance to the requirements of the following assurance standards: ISO 9001, ISO/IEC 27001, ISO/IEC 17025, EN 45011, and ISO/IEC 17021.

The tool supports CML characterization methodology as well as TRACI characterization methodology. All of the datasets in the tool comply with ISO 14040/14044 and most part also EN 15804 standard.



3 Life Cycle Assessment methodology

3.1 About Life Cycle Assessment for construction industry

As businesses, governments and consumers develop environmental awareness and sensitivity, focus of environmental impact reduction shifts to the industries responsible for the greatest impacts.

Construction, maintenance and use of buildings and civil engineering works generate ca. 35 % of the carbon emissions globally. Furthermore, the industry is responsible for one half of raw material extraction, and very significant amount of mass replacements and transfers. The sector is not only requested to reduce the impact on global warming, but also to reduce the raw material depletion, especially for non-renewable materials via circular economy measures.

Life Cycle Assessment is a science-based methodology for measuring environmental performance. It's based on international standards and rigorously defined public methodologies for quantifying environmental impacts, expressed in form of potential harm caused by activities to the biosphere, including atmosphere, soil and water bodies. Those impacts are expressed as "equivalent to" normalized unit, for example, one kilogram of carbon dioxide in case of global warming potential.

Life Cycle Assessment considers the whole life cycle of the building, including manufacturing, transport, use and final disposal of the resources required for the delivery of the building functions for the whole period which the assessment covers.

Most common impact category covered by LCA is the global warming potential, also referred to as the carbon footprint. It quantifies the impact of greenhouse gases heating the planet. Other common impact categories are ozone depletion, acidification, eutrophication and smog formation.

LCA methodology also supports other indicators which describe the use of resources and energy. Those are more typically expressed as kilograms of material, or megajoules in case of energy.

3.2 Applicable International and European Standards

All building and civil engineering works Life Cycle Assessments delivered by One Click LCA platform comply with the following International Standards.

ISO 14040	Environmental management. Life cycle assessment. Principles and framework
ISO 14044	Environmental management -- Life cycle assessment -- Requirements and guidelines
ISO 21930	Sustainability in buildings and civil engineering works -- Core rules for environmental product declarations of construction products and services

One Click LCA platform tools used in European context comply with following European Standards:

EN 15978	Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method
EN 15804+A1	Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products



3.3 System boundary

The International Standard ISO 21930 and European Standard EN 15804 set out a common life-cycle model for building and construction works. The life-cycle model includes modular definitions for the life-cycle stages, allowing each stage to be compared in isolation with other projects.

The product stage information (A1-A3) is always represented combined for building level assessments, as are end of life stages (C1-C4) in most cases. Depending on the purpose of the LCA, other stages may be omitted or be replaced with a scenario in absence of detailed information.

The actual life cycle stages used in the report can be found in the LCA results in chapter 5.

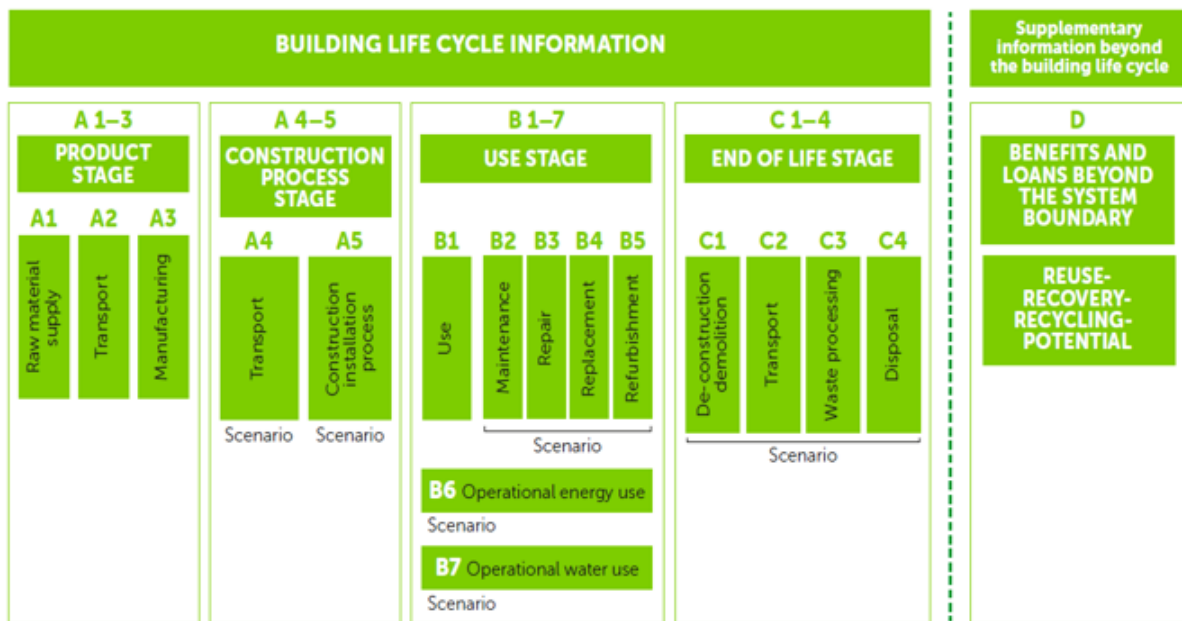


Illustration: Building Life Cycle Information and life cycle stages

3.4 Methodology and impact categories

LCA results are obtained using methodology called characterisation, which describes environmental impact of a given emission. One Click LCA implements multiple characterisation methodologies. When no specific methodology is mandated, One Click LCA implements for European customers the CML 4.1. IA characterisation methodology (as set out in EN 15804+A1), and for North American customers the TRACI 2.1. methodology defined by United States Environmental Protection Agency.

Impact category	Unit(s)	Description
Global warming potential	kgCO ₂ eq	Describes changes in local, regional, or global surface temperatures caused by an increased concentration of greenhouse gases in the atmosphere. Greenhouse gas emissions from fossil fuel burning is strongly correlated with acidification & smog. Called “carbon footprint”.
Acidification potential	kgSO ₂ eq	Describes the acidifying effect of substances in the environment. Substances such as carbon dioxide dissolve readily in water, increasing the acidity and leading to damage to water ecosystems.



Impact category	Unit(s)	Description
Eutrophication potential	CML: kgPO ₄ -eq TRACI: kgNeq	Describes the effect of adding mineral nutrients to soil or water, which causes certain species to dominate an ecosystem, compromising the survival of other species and sometimes resulting in die-off of entire animal populations.
Ozone depletion potential	kgCFC ₁₁ eq	Describes the effect of substances in the atmosphere to degrade the ozone layer, which absorbs and prevents harmful solar UV rays from reaching Earth's surface.
Formation of ozone of lower atmosphere ("tropospheric")	CML: kgC ₂ H ₄ eq TRACI: kgO ³ eq	Describes the effect of substances in the atmosphere to create photochemical smog. Also known as summer smog.

Other impact categories follow the requirements of their respective certification systems or tools.



4 Analysis scope, data sources and assumptions

4.1 Scope applied for this study

The scope of this study follows the following requirements:

LEED v4 Whole Building Life Cycle Assessment requirements, including structure and envelope materials for the building for 60 years duration. This scope excludes operational energy and water use, as well as construction site impacts.

4.2 Data sources

The analysis has been performed relying on the following data sources for building information:

Data type	Data source
Material quantities (A1-A3)	Construction drawings, bills of quantities and BIM models as delivered by the client and the designers acting on the clients behalf.
Material transport distances (A4)	Regionally applicable transportation scenarios from One Click LCA. Those represent regionally typical transportation distances and methods for product types, which are relevant when no decisions on suppliers are made.
Construction and installation (A5)	Impacts are omitted from this analysis.
Material impacts in use (B1-B5)	Material service lives are based on the typical values for the materials in question, which have been reviewed for relevance for the project. The values have been adjusted where necessary. Material maintenance and repair activities have not been included in the scope, materials have been assumed to be replaced in their entirety at the end of their service life.
Use phase energy consumption (B6)	Impacts are omitted from this analysis.
Use phase water consumption (B7)	Impacts are omitted from this analysis.
End of life impacts (C1-C4)	End of life impacts are based on One Click LCA's scenarios which represent the typical end of life processing for material types in compliance with the requirements of the EN 15804+A1.



5 Life Cycle Assessment Results

5.1 LCA results in table form

The life cycle assessment results are summarized in the following table. The results represent the total life cycle impact during Technical service life (same for same material) year service life of the building. The calculation complies with .

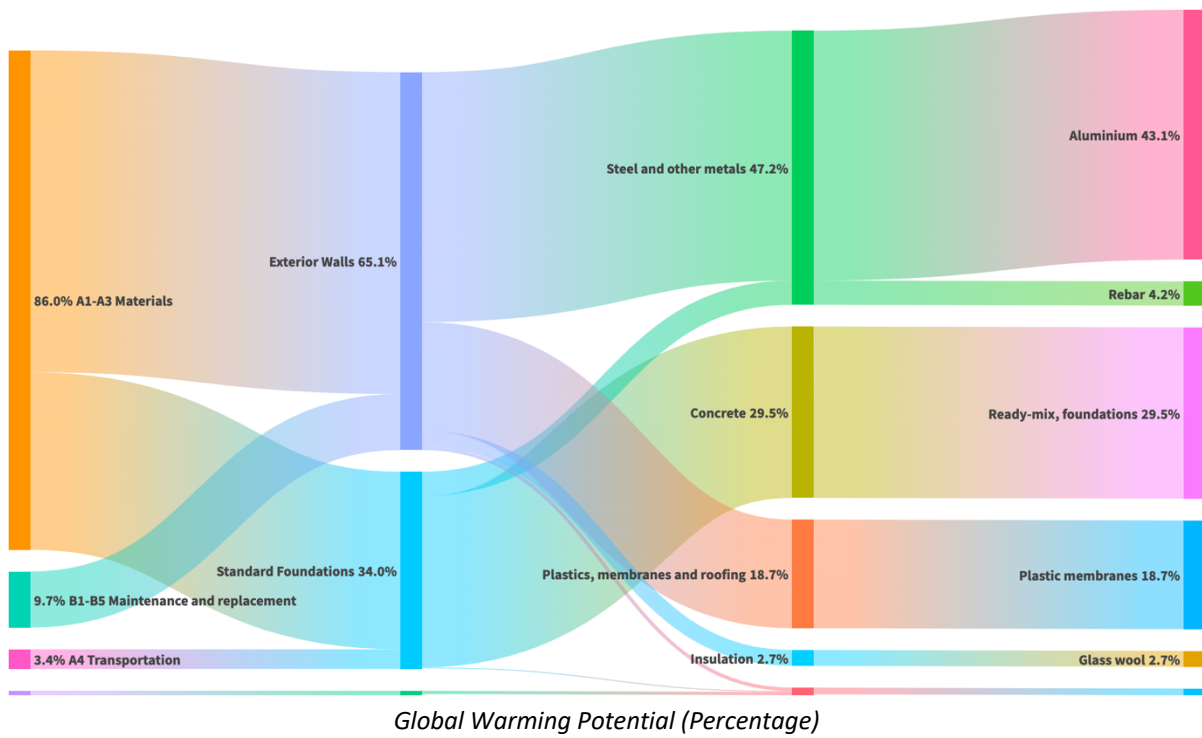
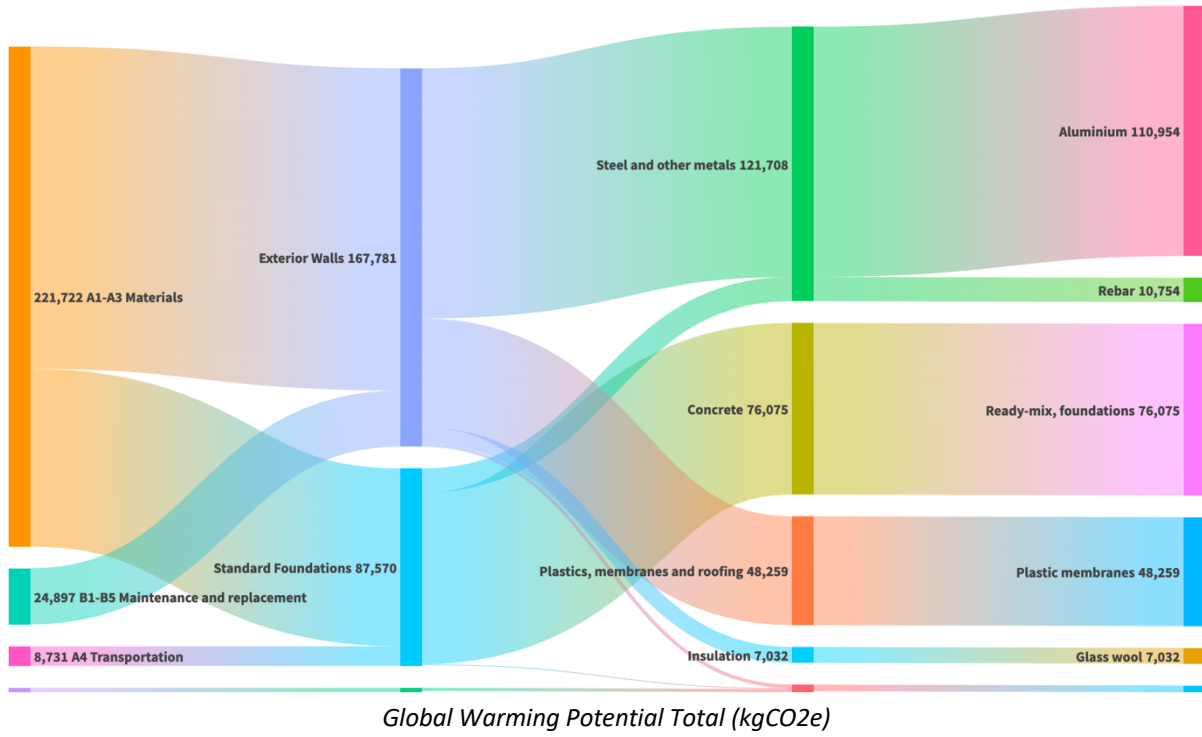
	Result category	Global warming kg CO2e	Ozone Depletion kg CFC11e	Acidification kg SO2e	Eutrophication kg Ne	Formation of tropospheric ozone kg O3e	Depletion of nonrenewable energy MJ	Mass of raw materials kg
A1-A3	Construction Materials	221,721.91	0.01	1,103.01	443.14	12,935.04	1,221,288.25	758,087.01
A4	Transportation to site	9,096.14	0	15.52	6.32	217.71	139,618.65	
B1-B5	Maintenance and material replacement	24,897.41	0	134.17	331.58	1,449.54	438,336.34	7,309.24
C1-C4	Deconstruction	1,982.36	0	7.45	1.77	89.24	40,006.65	
C1-C4	End of life	1,982.36	0	7.45	1.77	89.24	40,006.65	
	Total	257,697.82	0.01	1,260.15	782.8	14,691.54	1,839,249.89	765,396.25
	Results per denominator							
	Gross Internal Floor Area (IPMS/RICS) 975.48 m2	264.18	0	1.29	0.8	15.06	1,885.48	784.64

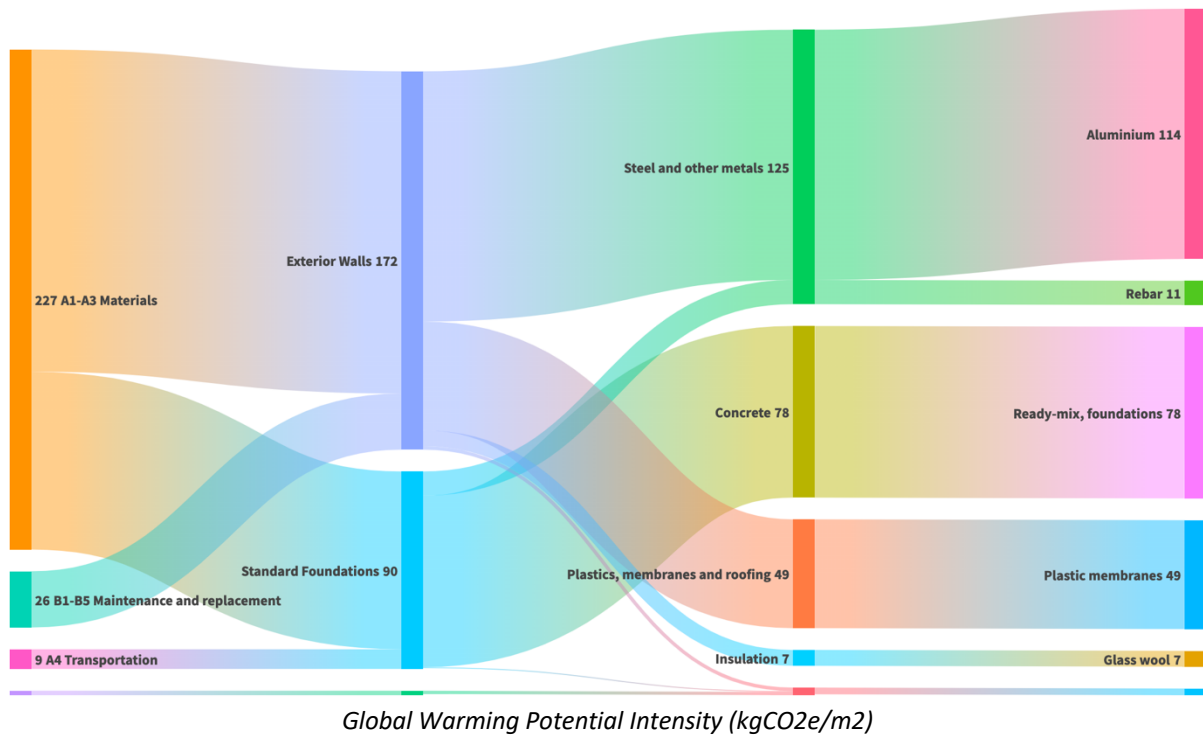
5.2 Global Warming Potential (GWP) Sankey Diagram - Distribution by Life-Cycle Stage, Building Element, and Material.

The Sankey Diagrams below shows the Global Warming Potential (GWP) distribution by life cycle stage, building element, and material.

The first diagram shows total GWP emissions for the project, the second shows GWP percentage distribution, and the third shows the GWP emissions per unit floor area.

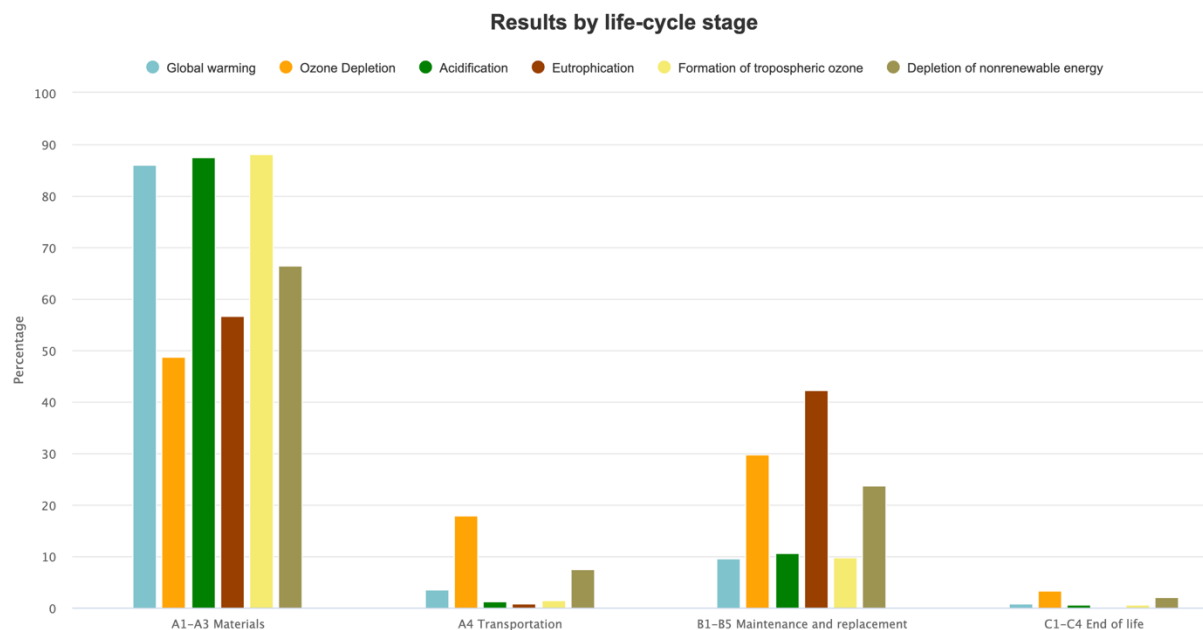






5.3 Breakdown of all environmental impact categories by Life-Cycle Stage

The chart below visualises the impact breakdowns for all considered impact categories by life-cycle stages. When no specific impact classification system is applied, the data is grouped using One Click LCA section definitions.



Appendix: documentation of LCA data used in the study

The following data points have been used as sources for this assessment. All data used complies with ISO 14040 and 14044 and is drawn from One Click LCA database and has been verified following the BRE-verified data qualification methodology by LCA data specialists.

Resource name	Country	Product	Density	Year	Environment Data Source	Standard	EPD number	EPD program	Manufacturer	Product Category Rules (PCR)	Notes about PCR	Technical specification	Upstream database	Verification
Aggregate (crushed gravel), generic, dry bulk density	[LOCAL]		1600	2018	One Click LCA	EN15804	-	One Click LCA		EN15804	-	1600 kg/m3	ecoinvent	-
Aluminum extrusions	[USA]		2750	2014	EPD INDUSTRY-AVERAGE EXTRUDED ALUMINUM	ISO14040	4786092064.102.1	UL Environment	The Aluminium Association	IBU PCR Products of Aluminum and Aluminum Alloys (July 2012)	Only with EN15804	2660-2840 kg/m3	GaBi	Verified
Concrete, ready mix	[USA, canada]	3000-20-FA	2400	2019	EPD NRMCA MEMBER INDUSTRY-AVERAGE EPD FOR READY MIXED CONCRETE	ISO14040	NRMCAEPD:10294	NRMCA	NRMCA	NSF PCR for Concrete Version 1 (February 22, 2019)	Only with EN15804	2501 - 3000 psi (C18/20)	ecoinvent	Verified
Insulation, glass wool, foil faced	[USA]	EcoTouch Technology	48.92	2014	EPD EcoTouch Foil Faced Insulation	ISO14040	4786077032.103.1	UL Environment	Owens Corning	PCR for Building Envelope Thermal Insulation v1.2	Only with ISO14040	30 m2K/W, 9 1/2in	ecoinvent	Verified
Reinforcement steel bar	[northAmerica]		7850	2017	EPD Fabricated Steel Reinforcement	ISO14040	EPD-070	ASTM	CRSI	SCS PCR for Designated Steel Construction Products	Only with ISO14040	490 lb/ft3	GaBi	Verified



Resource name	Country	Product	Density	Year	Environment Data Source	Standard	EPD number	EPD program	Manufacturer	Product Category Rules (PCR)	Notes about PCR	Technical specification	Upstream database	Verification
SPPR PVC roofing membrane, single-ply	[USA, canada]			2020	-	ISO14040	EPD-126	ASTM	Chemical Fabrics and Film Association	ASTM PCR for Preparing an EPD for Single Ply Roofing Membranes, October 2019	Only with EN15804	80 mil, 2.460 kg/m ²	ecoinvent	Verified
SPPR PVC roofing membrane, single-ply	[USA, canada]			2020	-	ISO14040	EPD-126	ASTM	Chemical Fabrics and Film Association	ASTM PCR for Preparing an EPD for Single Ply Roofing Membranes, October 2019	Only with EN15804	40 mil, 1.141 kg/m ²	ecoinvent	Verified
Steel door with polystyrene core, per unit	[USA]			2018	EPD Steel Door Institute® Heavy Duty Steel Door	ISO14040	SCS-EPD-05019	SCS Global	Steel Door Institute	UL PCR 9005 for Product Group: Commercial Steel Doors and/or Steel Frames. Version: March 10, 2015	Only with EN15804 (TRACI 2.1 units only)	0.91 x 2.1 m (3 x 7 feet), 44 kg/unit	ecoinvent	Verified



One Click LCA is a construction sustainability performance solution that delivers carbon, Life Cycle Assessments and Life Cycle costing for buildings and civil works globally.

Read more at www.oneclicklca.com.