SIKA CONCRETE ADMIXTURES AND CEMENT ADDITIVES

BUILDING TRUST
CONSTRUIRE LA CONFIANCE

PRODUCT-SPECIFIC TYPE III ENVIRONMENTAL PRODUCT DECLARATION (EPD)

Concrete Admixtures

Air Entrainers
Sika® Air-260

Dry-Cast Applications
Sikamix-512

Set Accelerators
Sika® Rapid-1
SikaSet® HE
SikaSet® HE^{CA}
SikaSet® NC

Set Accelerators (cont'd)
SikaSet® RHE

Set Retarders
Sika® Plastiment®
Sika® Plastiment®^{CA}
Sika® Plastiment® RX
SikaTard-930

Special Applications
Sika® Control-75

Water Reducers
Sika® Plastocrete-10N
Sika® Plastocrete-161^{CA}
Sika® Plastocrete-161N
Sika® Plastocrete-250

Water Reducers, Mid-Range
SikaPlast®-200
SikaPlast®-500

Water Reducers, High-Range
Sika® ViscoCrete®-1000
Sika® ViscoCrete®-2100
Sika® ViscoCrete®-2110
Sikament®-300N
Sikament®-475

Cement Additives

Grinding Aids
SikaGrind®-455GNT
SikaGrind®-710
SikaGrind®-721

The development of this environmental product declaration (EPD) for Sika concrete admixture and cement additives manufactured in Canada was commissioned by Sika Canada. This EPD was developed in compliance with CAN/CSA-ISO 14025 and ISO 21930:2017 by Groupe AGÉCO and has been verified by the Athena Sustainable Materials Institute.

This EPD includes life cycle assessment (LCA) results for the production stage only (cradle-to-gate).

For more information about Sika Canada, please go to www.sika.ca

Issue date: June 09, 2022

Environmental Product Declaration
CSA Group Registered Based on ISO 14025 and Other Requirements
For more information visit csaregistries.ca/epd
#7773-3526
June 2022 - 2027

This product-specific type III environmental product declaration (EPD) for Sika concrete admixtures and cement additives is in compliance with the requirements set out by ISO 14025:2006 and ISO 21930:2017. EPDs within the same product category but from different programs may not be comparable. Moreover, EPDs of construction products may not be comparable if they do not comply with EN 15804. Any EPD comparison must be performed in conformance with ISO 21930 guidelines. Care should be taken when comparing results since differences in certain assumptions, data quality and datasets are unavoidable, even when using the same product category rules (PCR). This declaration shall solely be used in a Business to Business (B2B) capacity.

Program operator	**CSA Group** 178 Rexdale Blvd, Toronto, ON, Canada M9W 1R3 │ www.csagroup.org
Product	Sika concrete admixtures and cement additives
EPD registration number	7773-3526
EPD recipient organization	**Sika Canada** 601 Delmar Ave., Pointe-Claire (Quebec) H9R 4A9 │ www.sika.ca
Reference PCR	2019:14 Construction products (version 1.11) UN CPC code: 375 The International EPD® System │ Valid until December 20, 2024
Date of issue (approval)	June 09, 2022
Period of validity	June 09, 2022 – June 08, 2027

The PCR review was conducted by	The Technical Committee of the International EPD® System Chair: Claudia A. Peña
The LCA and EPD were prepared by	**Groupe AGÉCO** │ www.groupeageco.ca │ ageco@groupeageco.ca
This EPD and related data were independently verified by an external verifier, Lindita Bushi, according to CAN/CSA-ISO 14025:2006 and ISO 21930:2017.	__ Internal **x External** Lindita Bushi Lindita Bushi, Ph.D. Athena Sustainable Materials Institute 280 Albert St., Suite 404, Ottawa, Ontario, Canada K1P 5G8 lindita.bushi@athenasmi.org │www.athenasmi.org

Declared unit	1 kg of product
Content of the products	See section 2 for complete description
Data quality assessment score	Good
Manufacturing locations	Cambridge, Ontario, Canada Edmonton, Alberta, Canada Surrey, British Columbia, Canada

Environmental Product Declaration Summary Sheet

Sika Canada | Sika Concrete Admixtures and Cement Additives

This is a summary of the product-specific type III environmental product declaration (EPD) describing the environmental performance of concrete admixtures and cement additives manufactured by Sika Canada inc. and used in the production of concrete and cement.

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EPD commissioner and owner	Period of validity	Program operator and registration number	Product Category Rule	LCA and EPD consultants
Sika Canada	June 09, 2022 – June 08, 2027	CSA Group 7773-3526	Construction products v.1.11 (2019)	Groupe AGÉCO

What is a Life Cycle Assessment (LCA)?

LCA is a science-based and internationally recognized tool to evaluate the relative potential environmental impacts of products and services throughout their life cycle, beginning with raw material extraction and including all aspects of transportation, production, use, and end-of-life treatment. The method is defined by the International Organization for Standardization (ISO) 14040 and 14044 standards. For EPD development, Product Category Rules (PCR) give additional guidelines on how to conduct the LCA of the product.

Why an EPD?

Sika Canada is seeking to provide the industry, decision makers, influencers, and the general public with more transparency, in terms of its sustainability efforts and environmental performance of its products, relying on a rigorous and recognized communication tool, the EPD. By selecting products with an EPD, building projects can earn credits towards the Leadership in Energy and Environmental Design (LEED) rating system certification. In the latest LEED versions (v4 and 4.1), points are awarded in the Materials and Resources category.

Product description

Concrete admixtures are liquid additives added to concrete during production to improve its specific properties in the fresh or hardened state, such as workability, set time, waterproofing, durability, load-bearing capacity, or initial and final strength. Cement additives are liquid solutions designed for the production of cement in order to optimise the grinding process, reduce the energy required to grind clinker and increase the overall quality and performance of cement.

Declared unit

One kilogram (1 kg) of concrete admixture or cement additive.

Scope and system boundary

Cradle-to-gate: production stage (A1-A3).

Products included in the EPD

See the product list on the next page.

Potential environmental impacts

The potential environmental impacts of **1 kg of concrete admixture or cement additive** are summarized below for each system assessed and for the main environmental indicators (based on life cycle impact assessment method TRACI 2.1). Refer to the LCA report or full EPD for more detailed results. Results on resource use, waste generated, and output flows are presented in the full EPD.

Cradle-to-gate (A1-A3) results for 1 kg of concrete admixture or cement additive

(complete results are available in the full EPD)

Concrete admixtures	**Global warming** kg CO_2 eq.	**Acidification** kg SO_2 eq.	**Eutrophication** kg N eq.	**Smog** kg O_3 eq.	**Ozone depletion** kg CFC-11 eq.
Air Entrainers					
Sika® Air-260	5.37E-01	1.93E-03	3.35E-03	2.12E-02	4.00E-08
Dry-Cast Applications					
Sikamix-512	1.97E+00	1.18E-02	6.67E-03	1.14E-01	2.20E-07
Set Accelerators					
SikaSet® HE CA	7.84E-01	6.82E-03	3.18E-03	5.99E-02	4.35E-08
SikaSet® HE	6.56E-01	6.05E-03	2.73E-03	5.06E-02	3.59E-08
SikaSet® NC	2.47E+00	9.96E-03	4.32E-03	1.30E-01	1.64E-07
Sika® Rapid-1	2.20E+00	8.90E-03	9.28E-03	1.07E-01	1.31E-07
SikaSet® RHE	3.24E+00	1.33E-02	9.34E-03	1.54E-01	7.25E-07
Set Retarders					
Sika® Plastiment®	2.05E+00	6.75E-03	3.40E-03	5.30E-02	7.07E-08
Sika® Plastiment® CA	7.57E-01	3.21E-03	1.67E-03	5.27E-02	1.17E-07
Sika® Plastiment®RX	1.88E+00	1.18E-02	6.71E-03	1.13E-01	2.69E-07
SikaTard-930	1.10E+00	8.15E-03	4.45E-03	7.31E-02	2.27E-07
Special Applications					
Sika® Control-75	1.76E+00	8.70E-03	5.10E-03	1.34E-01	1.29E-07
Water Reducers					
Sika® Plastocrete-10N	1.16E+00	8.16E-03	6.46E-03	6.91E-02	1.87E-07
Sika® Plastocrete-161 CA	1.40E+00	8.42E-03	5.22E-03	8.31E-02	1.47E-07
Sika® Plastocrete-161N	1.56E+00	9.36E-03	6.09E-03	8.35E-02	2.04E-07
Sika® Plastocrete-250	5.18E-01	4.20E-03	2.66E-03	4.06E-02	5.88E-08
Water Reducers, Mid-Range					
SikaPlast®-200	2.75E+00	1.10E-02	1.34E-02	1.14E-01	1.33E-07
SikaPlast®-500	1.34E+00	7.89E-03	4.92E-03	7.26E-02	1.54E-07
Water Reducers, High-Range					
Sika® ViscoCrete®-1000	1.02E+00	4.00E-03	2.62E-03	5.81E-02	2.25E-07
Sika® ViscoCrete®-2100	1.36E+00	5.64E-03	2.90E-03	8.65E-02	3.23E-07
Sika® ViscoCrete®-2110	1.35E+00	5.17E-03	3.11E-03	6.30E-02	3.21E-07
Sikament®-300N	2.07E+00	1.26E-02	6.97E-03	1.22E-01	2.39E-07
Sikament®-475	9.81E-01	3.33E-03	2.66E-03	5.61E-02	1.07E-07
Cement additives					
Grinding Aids					
SikaGrind®-455GNT	2.21E+00	8.72E-03	1.23E-02	9.34E-02	1.86E-07
SikaGrind®-710	2.12E+00	7.90E-03	8.68E-03	9.66E-02	1.04E-07
SikaGrind®-721	1.51E+00	5.34E-03	5.15E-03	7.03E-02	4.01E-08

Additional environmental information

This section provides additional relevant environmental information about the manufacturer and the products covered by this EPD that was not derived from the LCA.

Sika's Commitment to sustainability

Providing long lasting and high-performance solutions to the benefit of our customers, Sika is committed to pioneering sustainable solutions that are safer, have the lowest impact on resources and address global environmental challenges. Therefore, Sika assumes the responsibility to provide sustainable solutions in order to improve material, water and energy efficiency in construction and various industrial sectors. Sika strives to create more value for all its stakeholders with its products, systems, and solutions along the whole value chain and throughout the entire life span of its products. Sika is committed to measure, improve, and communicate sustainable value creation: "More value, less impact" refers to the company's commitment to maximize the value of its solutions to all stakeholders while reducing resource consumption and impact on the environment.

Waste packaging management

Most Sika concrete admixtures and cement additives are delivered to customers (ready-mix and precast/manufactured concrete producers and cement producers) in bulk with trucks or with reusable intermediate bulk containers (IBCs). Sika Canada encourages its customers to responsibly dispose of used packaging when its products are delivered in a single-use packaging such as drums.

For more information: www.sika.ca

1. Description of Sika Canada

Sika Canada Inc., a member of the Sika Group, is a leader in the field of specialty chemicals for construction. Sika's product portfolio encompasses a vast range of construction solutions, "From Foundations Upwards", including waterproofing solutions, concrete production (ready mix and precast), concrete repair and protection, joint sealing, elastic & structural bonding, specialized flooring including industrial, commercial, institutional & decorative systems and roofing systems. This extensive range of products enables tailor-made solutions, in new construction as well as refurbishment. Beyond the quality and performance of its products, Sika has earned its reputation by offering an unparalleled level of expertise and support, from conception to completion.

2. Description of product

2.1. Definition and product classification

This EPD developed with the Product Category Rule (PCR) for Construction products version 1.11 from The International EPD® System, covers 23 admixtures and 3 additives used in concrete production, in order to improve specific properties in the fresh or hardened state, such as workability, set time, waterproofing, durability, load-bearing capacity or initial and final strength, and 3 cement additives ("grinding aids") designed to improve the efficiency of the grinding process, reduce the energy consumption for grinding clinker, and ultimately increase the cement quality. (See Table 1 below)

Table 1: Sika concrete admixtures and cement additives covered by this EPD

Concrete admixtures			Cement additives
Air Entrainers	**Set Retarders**	**Water Reducers, Mid-Range**	**Grinding Aids**
Sika® Air-260	Sika® Plastiment®	SikaPlast®-200	SikaGrind®-455GNT
Dry-Cast Applications	Sika® Plastiment®^{CA}	SikaPlast®-500	SikaGrind®-710
Sikamix-512	Sika® Plastiment® RX	**Water Reducers, High-Range**	SikaGrind®-721
Set Accelerators	SikaTard-930	Sika® ViscoCrete®-1000	
Sika® Rapid-1	**Special Applications**	Sika® ViscoCrete®-2100	
SikaSet® HE	Sika® Control-75	Sika® ViscoCrete®-2110	
SikaSet® HE^{CA}	**Water Reducers**	Sikament®-300N	
SikaSet® NC	Sika® Plastocrete-10N	Sikament®-475	
SikaSet® RHE	Sika® Plastocrete-161^{CA}		
	Sika® Plastocrete-161N		
	Sika® Plastocrete-250		

More information on these solutions is available on Sika Canada's website:
https://can.sika.com/en/construction/concrete-admixtures.html

Figure 1: Applications for concrete admixtures
(from left to right: air entrainer, dry cast and set accelerator)

2.2. Material content

The material composition of each component as disclosed in SDS (Safety Data Sheets) are provided in Table 2. The complete product formulations were used to calculate the LCA results.

Table 2: Composition of concrete admixtures and cement additives included in this EPD

Components	Ingredients	CAS No.	Concentration (%w/w)
Sika® Air-260	Sulfonic-acids,-C14-16-alkane-hydroxy-and-C14-16-alkene, -sodium-salts	68439-57-6	>= 1 - < 5
	Sodium hydroxide	1310-73-2	>= 1 - < 5
	Diethylene glycol	111-46-6	>= 1 - < 5
Sika® Control-75	2-(2-butoxyethoxy)ethanol	112-34-5	>= 30 - < 60
	2,2-dimethyl-1,3-propanediol	126-30-7	>= 10 - < 30
Sika® Plastiment®	No hazardous ingredients reported		
Sika® Plastiment®CA	No hazardous ingredients reported		
Sika® Plastiment® RX	No hazardous ingredients reported		
Sika® Plastocrete-10N	No hazardous ingredients reported		
Sika® Plastocrete-161CA	2,2-iminodiethanol	111-42-2	>= 0 - < 1
	Chlorocresol (4-chloro 3-methylphenol)	59-50-7	>= 0 - < 1
Sika® Plastocrete-161N	2,2-iminodiethanol	111-42-2	>= 1 - < 2
Sika® Plastocrete-250	No hazardous ingredients reported		
Sika® Rapid-1	Sodium nitrate	7631-99-4	>= 10 - < 30
	Sodium thiocyanate	540-72-7	>= 5 - < 10
	2,2'-(methylimino)diethanol	105-59-9	>= 1 - < 5
Sika® ViscoCrete®-1000	No hazardous ingredients reported		
Sika® ViscoCrete®-2100	No hazardous ingredients reported		
Sika® ViscoCrete®-2110	Tributyl phosphate	126-73-8	>= 0.1 - < 1
SikaGrind®-455GNT	Diethylene glycol	111-46-6	>= 10 - < 30
SikaGrind®-710	Diethylene glycol	111-46-6	>= 10 - < 30
	1,1',1''-nitrilotripropan-2-ol	122-20-3	>= 5 - < 10
	2,2'-iminodiethanol	111-42-2	>= 1 - < 5
SikaGrind®-721	1,1,1-nitrilotripropan-2-ol	122-20-3	>= 10 - < 20
	2,2-iminodiethanol	111-42-2	>= 3 - < 5
Sikament®-300N	No hazardous ingredients reported		
Sikamix-512	2,2-iminodiethanol	111-42-2	>= 0 - < 1
SikaPlast®-200	Sodium nitrate	7631-99-4	>= 10 - < 30
	Sodium thiocyanate	540-72-7	>= 1 - < 5
	2,2-iminodiethanol	111-42-2	>= 0.1 - < 1
SikaPlast®-500	2,2-iminodiethanol	111-42-2	>= 0.1 - < 1
	Tributyl phosphate	126-73-8	>= 0.1 - < 1
SikaSet® HECA	2,2'-iminodiethanol	111-42-2	>= 0.1 -< 1
SikaSet® HE	Calcium chloride	10043-52-4	>= 25 - < 35
SikaSet® NC	Calcium nitrate tetrahydrate	13477-34-4	>= 50 - < 60
	Sodium thiocyanate	540-72-7	>= 2 - < 5
	Calcium nitrate tetrahydrate	13477-34-4	>= 30 - < 60
	Sodium thiocyanate	540-72-7	>= 1 - < 5
SikaSet® RHE	Calcium nitrate tetrahydrate	13477-34-4	>= 30 - < 60
	Sodium thiocyanate	540-72-7	>= 5 - < 10
	Methenamine	100-97-0	>= 1 - < 5
SikaTard-930	2-phosphonobutane-1,2,4-tricarbocylic acid	37971-36-1	>= 10 - < 30
	Citric acid monohydrate	5949-29-1	>= 5 - < 10
Sikament®-475	Tributyl phosphate	126-73-8	>= 0.1 - < 1

3. Scope of EPD

3.1. Declared unit

A declared unit is used in lieu of a functional unit in accordance with the PCR since the precise function of some products cannot be defined. The declared unit is defined as follows:

One kilogram (1 kg) of concrete admixtures or cement additives

Since this is cradle-to-gate EPD, which does not include the use stage, no service lives are reported.

3.2. System boundaries

This cradle-to-gate LCA includes modules related to the production stage as shown Table 3 and described in this section. Modules not declared are considered not relevant for the covered systems. Figure 2 on page 10 shows the cradle-to-gate processes for the manufacturing of concrete admixtures included in this EPD. Module A3 is representative of Canada, while A1 and A2 have a global representation. The A1-A3 variation between production sites is less than 10% for the global warming indicator.

Table 3: Life cycle stages included or not considered in the system boundaries

Production stage			Construction stage		Use stage							End-of-life stage				
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw materials	Transport	Manufacturing	Transport	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
x	x	x	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Legend:

X: considered in the system boundaries *MND: Module not declared*

A1 – Raw material supply

Several different ingredients are required for the manufacturing concrete admixtures. They include antifoam agents, salts, biocides, acids, amines, and other products. They are manufactured in other parts of Canada, the United States as well as Europa and Asia in liquid or powder forms. Their manufacturing location was provided by Sika. This module includes the production of the ingredients needed for the mixing at the Sika plants, including raw material extraction and transformation, and energy production.

A2 – Transport to manufacturing plants

Materials are transported from suppliers to the Sika's manufacturing plants by truck, and boat if shipped from oversees. This module includes the transport air emissions as well as fuel, vehicle, and infrastructure production.

A3 – Manufacturing

The manufacturing of concrete admixtures involves liquids in aqueous solution. Ingredients are shipped to the Sika plant and stored until their use. Then, materials are mixed according to a recipe. The result goes under quality control and is transferred to a tanker truck or intermediate bulk containers (IBCs) for delivery. Drums are rarely used for packaging.

Natural gas and electricity are the main source of energy used at the manufacturing plants. In British Columbia, the electricity grid mix is mainly composed of hydroelectricity.

Non-hazardous generated on-site is sent to landfills. Hazardous waste is recycled or sent to a specialized landfill.

This module also includes the production and transport of primary packaging for the final products as described in Table 4.

Table 4: Packaging description*

Packaging type	End-of-life treatment	Mass (kg)	Source	Biogenic carbon content (kg C)
205-litre steel drum	Landfill**	17	Manufacturer	0

** Sika concrete admixtures are mainly delivered bulk with compartmentalized tanker trucks or IBCs directly to the concrete plant. They are not considered primary packaging and are therefore excluded from this EPD.*
*** Metallic containers may be recycled at the construction site, especially in a LEED project. However, it was judge that it would not be a representative case of how this packaging waste is usually treated.*

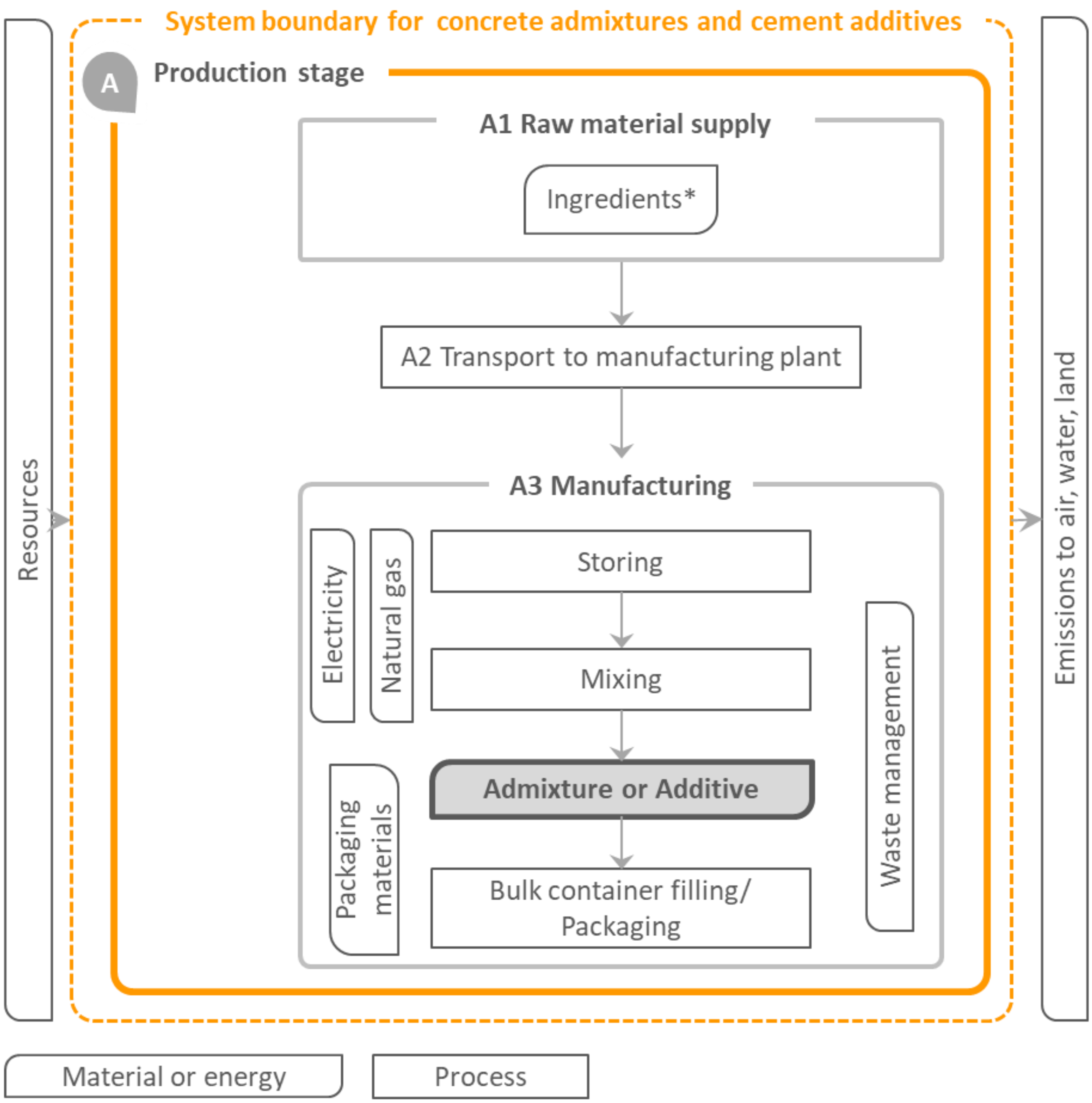

Figure 2: Process flow for all life cycle modules considered

*Note: ingredients include antifoam agents, salts, biocides, acids, amines, and others

3.3. Geographical and temporal boundaries

The geographical boundaries are representative of current equipment and processes associated with concrete admixture manufacturing in Canada. Since the data were collected for the year 2020 (12 consecutive months), they are considered temporally representative (i.e. less than 5 years old). A weighed average of production volume (on a mass basis) at each location is utilized for calculation purposes. All data were modelled using the ecoinvent 3.7 database released in 2020 (ecoinvent, 2020), which meets the PCR requirements.

4. Potential environmental impacts assessment

This cradle-to-gate life cycle assessment has been conducted according to ISO 14040 and 14044 standards and the PCR for Construction products, version 1.11 (The International EPD® System, 2019). Potential environmental impacts were calculated with the impact assessment method TRACI 2.1 (US EPA, 2012). The description of these indicators reported are provided in the glossary (section 6.2).

4.1. Assumptions

When specific data was not available, generic data which fulfilled the minimum criteria of the PCR were used. The ecoinvent database v3.7 recycled content allocation served as the main source of secondary data. It should be noted that most, though not all, of the data within ecoinvent is of European origin and developed to represent European industrial conditions and processes. Therefore, in some cases, these modules were further adapted in order to enhance their representativeness of the products and contexts being examined. However, in the recent updates of the ecoinvent database, a lot of efforts have been put into creating market groups for regions, countries, and products. Other assumptions included in this LCA were related to raw material modelling and transportation.

4.2. Criteria for the exclusion of inputs and outputs

Input and output flows have been excluded if they represented less than 1% of the cumulative mass input, renewable primary energy or non-renewable primary energy of a unit process and its environmental contribution to the total impacts was estimated to be less than 1%. Processes or elementary flows may be excluded if the life cycle inventory (LCI) data amounts to a minimum of 95% of total inflows in terms of mass and energy to the upstream and core module. The following processes were excluded from the study due to their expected low contribution and the lack of readily available data:

- Personnel impacts
- Research and development activities
- Business travel
- Any secondary or tertiary packaging
- For ingredients contributing to less than 0.01 kg/kg of product, transport was not taken into account. As a result, ingredient transport was excluded for between 0.0% and 1.2% of the product mass.

4.3. Data quality

Data sources

Specific data were collected from Sika Canada for operations occurring in 2020 (less than 5 years old). **Generic data** collected for the upstream processes were representative of the Canadian context and technologies used.

The LCA model was developed with the SimaPro 9.3 software using ecoinvent 3.7 database, which was released in 2020. Since most of the data within ecoinvent is of European origin and produced to represent European industrial conditions and processes, several data were adapted to enhance their representativeness of the products and contexts being examined.

Data quality

The overall data quality ratings show that the data used were good. This data quality assessment confirms the high reliability, representativeness (technological, geographical, and time-related), completeness, and consistency of the information and data used for this study.

4.4. Allocation

Allocation of multi-output processes

When unavoidable allocation was done by mass, or other physical relationship. Economic value allocation was not used.

Allocation at Sika's manufacturing plant

Sika's plants produce many different products, including several that are not part of the scope of this study. Product ingredients were available for each product and did not need to be allocated. However, general inputs such as electricity and natural gas were allocated based on the production volume in tonnes. Percentages were calculated by the manufacturers through the data collection.

ecoinvent processes with allocation

Many of the processes in the ecoinvent database also provide multiple functions, and allocation is required to provide inventory data per function (or per process). This study accepts the allocation method used by ecoinvent for those processes. The ecoinvent system model used was "Allocation, cut-off". It should be noted that the allocation methods used in ecoinvent for background processes (i.e. processes representing the complete supply chain of a good or service used in the life cycle of a concrete admixture) may be inconsistent with the approach used to model the foreground system (i.e. to model the manufacturing of a concrete admixture with data collected in the literature and from manufacturers). While this allocation is appropriate for foreground processes, continuation of this methodology into the background datasets would add complexity without substantially improving the quality of the study.

4.5. Life cycle impact assessment - results

Table 5 and Table 6 present the results for 1 kg of concrete admixture and cement additive over the production stage (A1 to A3).

Table 5: Results for 1 kg of concrete admixtures over the production stage (A1 to A3)

Indicators	Units	Air Entrainer	Dry-Cast Applications	Set Accelerators		
		Sika® Air-260	Sikamix-512	SikaSet® HECA	SikaSet® HE	SikaSet® NC
Environmental indicators						
Global warming potential	kg CO_2 eq.	5.37E-01	1.97E+00	7.84E-01	6.56E-01	2.47E+00
Ozone depletion potential	kg CFC-11 eq.	4.00E-08	2.20E-07	4.35E-08	3.59E-08	1.64E-07
Eutrophication potential	kg N eq.	3.35E-03	6.67E-03	3.18E-03	2.73E-03	4.32E-03
Acidification potential	kg SO_2 eq.	1.93E-03	1.18E-02	6.82E-03	6.05E-03	9.96E-03
Smog formation potential	kg O_3 eq.	2.12E-02	1.14E-01	5.99E-02	5.06E-02	1.30E-01
GWP-GHG indicator	kg CO_2 eq.	5.36E-01	1.96E+00	7.96E-01	6.66E-01	2.41E+00
Resource use						
Renewable primary energy	MJ, net calorific value	4.76E+00	1.73E+00	1.26E+00	1.06E+00	1.01E+00
Renewable primary materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable primary energy	MJ, net calorific value	3.18E+00	2.27E+01	8.57E+00	6.60E+00	2.12E+01
Non-renewable primary materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Secondary materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Recovered energy	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	2.64E-02	4.10E-02	2.42E-02	2.15E-02	2.44E-02
Waste and output flows						
Hazardous waste disposed	kg	1.10E-03	0.00E+00	2.25E-03	6.13E-04	1.57E-03
Non-hazardous waste disposed	kg	3.40E-03	8.33E-04	6.11E-03	2.25E-03	5.04E-03
High-level radioactive waste	m^3	1.85E-10	7.54E-10	4.70E-10	4.12E-10	1.05E-09
Intermediate/low-level radioactive waste	m^3	2.29E-09	1.22E-08	9.62E-09	8.77E-09	1.37E-08
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ per energy carrier	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 5 (cont'd): Results for 1 kg of concrete admixtures over the production stage (A1 to A3)

Indicators	Units	Set Accelerators		Set Retarders		
		Sika® Rapid-1	SikaSet® RHE	Sika® Plastiment®	Sika® Plastiment®CA	Sika® Plastiment® RX
Environmental indicators						
Global warming potential	kg CO_2 eq.	2.20E+00	3.24E+00	2.05E+00	7.57E-01	1.88E+00
Ozone depletion potential	kg CFC-11 eq.	1.31E-07	7.25E-07	7.07E-08	1.17E-07	2.69E-07
Eutrophication potential	kg N eq.	9.28E-03	9.34E-03	3.40E-03	1.67E-03	6.71E-03
Acidification potential	kg SO_2 eq.	8.90E-03	1.33E-02	6.75E-03	3.21E-03	1.18E-02
Smog formation potential	kg O_3 eq.	1.07E-01	1.54E-01	5.30E-02	5.27E-02	1.13E-01
GWP-GHG indicator	kg CO_2 eq.	2.20E+00	3.19E+00	1.98E+00	7.78E-01	1.87E+00
Resource use						
Renewable primary energy	MJ, net calorific value	1.15E+00	1.69E+00	8.20E-01	4.86E-01	3.05E+00
Renewable primary materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.73E-02
Non-renewable primary energy	MJ, net calorific value	2.81E+01	3.10E+01	1.33E+01	2.03E+01	2.09E+01
Non-renewable primary materials	MJ, net calorific value	0.00E+00	1.50E+00	0.00E+00	0.00E+00	0.00E+00
Secondary materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Recovered energy	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	2.80E-02	1.61E-02	2.11E-02	1.32E-02	3.87E-02
Waste						
Hazardous waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	2.64E-03	0.00E+00
Non-hazardous waste disposed	kg	3.22E-03	8.33E-04	8.33E-04	6.61E-03	8.33E-04
High-level radioactive waste	m^3	5.43E-10	1.12E-09	1.11E-09	9.42E-12	7.29E-10
Intermediate/low-level radioactive waste	m^3	4.12E-09	1.43E-08	1.45E-08	1.25E-10	1.24E-08
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ per energy carrier	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Note: "E±Y" means "× 10 $^{\pm Y}$". E.g. "2.8E-1" means 0.28.

Table 5 (cont'd): Results for 1 kg of concrete admixtures over the production stage (A1 to A3)

Indicators	Units	Set Retarders	Special Applications	Water Reducers		
		SikaTard-930	Sika® Control-75	Sika® Plastocrete-10N	Sika® Plastocrete-161CA	Sika® Plastocrete-161N
Environmental indicators						
Global warming potential	kg CO_2 eq.	1.10E+00	1.76E+00	1.16E+00	1.40E+00	1.56E+00
Ozone depletion potential	kg CFC-11 eq.	2.27E-07	1.29E-07	1.87E-07	1.47E-07	2.04E-07
Eutrophication potential	kg N eq.	4.45E-03	5.10E-03	6.46E-03	5.22E-03	6.09E-03
Acidification potential	kg SO_2 eq.	8.15E-03	8.70E-03	8.16E-03	8.42E-03	9.36E-03
Smog formation potential	kg O_3 eq.	7.31E-02	1.34E-01	6.91E-02	8.31E-02	8.35E-02
GWP-GHG indicator	kg CO_2 eq.	1.10E+00	1.80E+00	1.16E+00	1.40E+00	1.56E+00
Resource use						
Renewable primary energy	MJ, net calorific value	3.24E+00	8.78E-01	9.63E+00	3.11E+00	4.07E+00
Renewable primary materials	MJ, net calorific value	0.00E+00	0.00E+00	4.87E-01	1.03E-01	1.50E-01
Non-renewable primary energy	MJ, net calorific value	1.17E+01	4.23E+01	1.24E+01	1.73E+01	2.03E+01
Non-renewable primary materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Secondary materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Recovered energy	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	1.89E-02	2.14E-02	2.17E-02	2.81E-02	3.11E-02
Waste						
Hazardous waste disposed	kg	9.67E-04	0.00E+00	0.00E+00	1.53E-03	0.00E+00
Non-hazardous waste disposed	kg	4.46E-03	3.22E-03	8.33E-04	5.18E-03	8.33E-04
High-level radioactive waste	m^3	9.65E-10	1.52E-10	5.60E-10	5.97E-10	6.86E-10
Intermediate/low-level radioactive waste	m^3	1.30E-08	4.55E-09	1.12E-08	9.56E-09	1.08E-08
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ per energy carrier	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Note: "E±Y" means "× 10 $^{\pm Y}$". E.g. "2.8E-1" means 0.28.

Table 5 (cont'd): Results for 1 kg of concrete admixtures over the production stage (A1 to A3)

Indicators	Units	Water Reducers	Water Reducers, Mid-Range		Water Reducers, High-Range
		Sika® Plastocrete-250	SikaPlast®-200	SikaPlast®-500	Sika® ViscoCrete®-1000
Environmental indicators					
Global warming potential	kg CO_2 eq.	5.18E-01	2.75E+00	1.34E+00	1.02E+00
Ozone depletion potential	kg CFC-11 eq.	5.88E-08	1.33E-07	1.54E-07	2.25E-07
Eutrophication potential	kg N eq.	2.66E-03	1.34E-02	4.92E-03	2.62E-03
Acidification potential	kg SO_2 eq.	4.20E-03	1.10E-02	7.89E-03	4.00E-03
Smog formation potential	kg O_3 eq.	4.06E-02	1.14E-01	7.26E-02	5.81E-02
GWP-GHG indicator	kg CO_2 eq.	5.20E-01	2.73E+00	1.34E+00	1.03E+00
Resource use					
Renewable primary energy	MJ, net calorific value	4.30E+00	5.17E+00	1.18E+00	9.22E-01
Renewable primary materials	MJ, net calorific value	2.10E-01	1.97E-01	0.00E+00	0.00E+00
Non-renewable primary energy	MJ, net calorific value	7.18E+00	2.64E+01	1.58E+01	2.32E+01
Non-renewable primary materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Secondary materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Recovered energy	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	8.73E-03	3.52E-02	2.83E-02	8.90E-03
Waste					
Hazardous waste disposed	kg	5.64E-04	0.00E+00	0.00E+00	1.84E-03
Non-hazardous waste disposed	kg	3.94E-03	8.33E-04	8.33E-04	4.85E-03
High-level radioactive waste	m^3	2.09E-10	1.06E-09	5.57E-10	1.08E-11
Intermediate/low-level radioactive waste	m^3	4.34E-09	1.07E-08	8.47E-09	1.73E-10
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ per energy carrier	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Note: "E±Y" means "× 10 $^{\pm Y}$". E.g. "2.8E-1" means 0.28.

Table 5 (cont'd): Results for 1 kg of concrete admixtures over the production stage (A1 to A3)

Indicators	Units	Water Reducers, High-Range			
		Sika® ViscoCrete®-2100	Sika® ViscoCrete®-2110	Sikament® -300N	Sikament®-475
Environmental indicators					
Global warming potential	kg CO_2 eq.	1.36E+00	1.35E+00	2.07E+00	9.81E-01
Ozone depletion potential	kg CFC-11 eq.	3.23E-07	3.21E-07	2.39E-07	1.07E-07
Eutrophication potential	kg N eq.	2.90E-03	3.11E-03	6.97E-03	2.66E-03
Acidification potential	kg SO_2 eq.	5.64E-03	5.17E-03	1.26E-02	3.33E-03
Smog formation potential	kg O_3 eq.	8.65E-02	6.30E-02	1.22E-01	5.61E-02
GWP-GHG indicator	kg CO_2 eq.	1.38E+00	1.37E+00	2.06E+00	9.98E-01
Resource use					
Renewable primary energy	MJ, net calorific value	5.68E-01	5.00E-01	1.79E+00	5.73E-01
Renewable primary materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable primary energy	MJ, net calorific value	3.36E+01	3.51E+01	2.27E+01	2.09E+01
Non-renewable primary materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Secondary materials	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Recovered energy	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	1.01E-02	1.03E-02	4.32E-02	9.75E-03
Waste					
Hazardous waste disposed	kg	2.05E-03	0.00E+00	0.00E+00	0.00E+00
Non-hazardous waste disposed	kg	5.59E-03	9.13E-04	8.33E-04	2.44E-03
High-level radioactive waste	m^3	1.00E-11	1.44E-11	7.70E-10	9.60E-12
Intermediate/low-level radioactive waste	m^3	1.54E-10	2.07E-10	1.28E-08	1.41E-10
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ per energy carrier	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Note: "E±Y" means "× 10 $^{\pm Y}$". E.g. "2.8E-1" means 0.28.

Table 6: Results for 1 kg of cement additives over the production stage (A1 to A3)

Indicators	Units	Grinding Aids SikaGrind®-455GNT	SikaGrind®-710	SikaGrind®-721
Environmental indicators				
Global warming potential	kg CO_2 eq.	2.21E+00	2.12E+00	1.51E+00
Ozone depletion potential	kg CFC-11 eq.	1.86E-07	1.04E-07	4.01E-08
Eutrophication potential	kg N eq.	1.23E-02	8.68E-03	5.15E-03
Acidification potential	kg SO_2 eq.	8.72E-03	7.90E-03	5.34E-03
Smog formation potential	kg O_3 eq.	9.34E-02	9.66E-02	7.03E-02
GWP-GHG indicator	kg CO_2 eq.	2.21E+00	2.15E+00	1.55E+00
Resource use				
Renewable primary energy	MJ, net calorific value	9.28E+00	4.42E+00	9.67E-01
Renewable primary materials	MJ, net calorific value	5.19E-01	2.00E-01	0.00E+00
Non-renewable primary energy	MJ, net calorific value	2.19E+01	3.77E+01	3.38E+01
Non-renewable primary materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00
Secondary materials	kg	0.00E+00	0.00E+00	0.00E+00
Renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00
Recovered energy	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	2.66E-02	2.72E-02	2.07E-02
Waste and output flows				
Hazardous waste disposed	kg	0.00E+00	0.00E+00	0.00E+00
Non-hazardous waste disposed	kg	8.33E-04	8.33E-04	8.33E-04
High-level radioactive waste	m^3	1.02E-09	1.46E-09	6.81E-10
Intermediate/low-level radioactive waste	m^3	1.31E-08	1.42E-08	4.84E-09
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ per energy carrier	0.00E+00	0.00E+00	0.00E+00

Note: "E±Y" means "× 10 $^{\pm Y}$". E.g. "2.8E-1" means 0.28.

4.6. Life cycle impact assessment – interpretation

Sika® ViscoCrete®-2110

The interpretation of the Sika® ViscoCrete®-2110 environmental results (Figure 3) is presented in this section. It was chosen with the manufacturer as a typical concrete admixture.

Potential environmental impact indicators

As observed in Figure 3, the raw material supply (A1) is the main contributor to most ISO 21930 (TRACI 2.1) indicators (81% to 95% of all impact indicators). This is mainly due to the inputs required to produce the chemical products used in the ViscoCrete® formulation. The transport of raw materials to the manufacturing plant (A2) contributes between 2% and 15%, and the manufacturing stage (A3) has the lowest contribution at 1% to 8% contribution for all indicators.

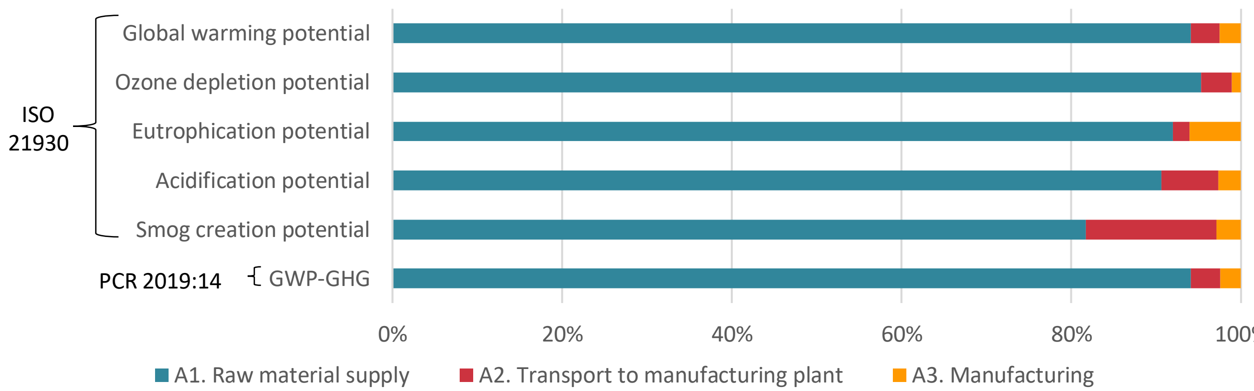

Figure 3: Relative contribution of life cycle modules to potential environmental impacts for 1 kg of Sika® ViscoCrete®-2110

Resource use indicators

The raw material supply (A1) stage dominates the resource use categories, ranging from 93% to 97% The transport to manufacturing plant (A2) and manufacturing (A3) stages have minimal contribution to the overall energy use.

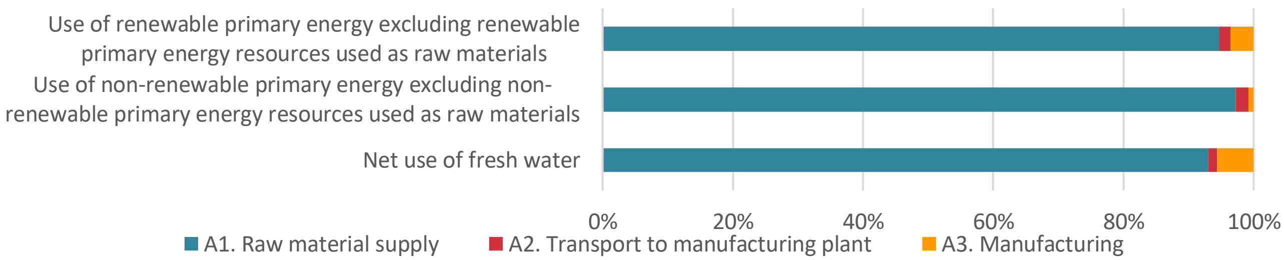

Figure 4: Relative contribution of life cycle modules to resource use indicators for 1 kg of Sika® ViscoCrete®-2110

Waste generation indicators

The waste and output flows are minimal but are mainly generated by the manufacturing (A3) stage in the form of hazardous and non-hazardous waste.

5. Additional environmental information

This section provides additional relevant environmental information about the manufacturer and the concrete admixtures that was not derived from the LCA.

Sika's Commitment to sustainability

Providing long lasting and high-performance solutions to the benefit of our customers, Sika is committed to pioneering sustainable solutions that are safer, have the lowest impact on resources and address global environmental challenges. Therefore, Sika assumes the responsibility to provide sustainable solutions in order to improve material, water and energy efficiency in construction and transportation. Sika strives to create more value for all its stakeholders with its products, systems and solutions along the whole value chain and throughout the entire life span of its products. Sika is committed to measure, improve and communicate sustainable value creation: "More value, less impact" refers to the company's commitment to maximize the value of its solutions to all stakeholders while reducing resource consumption and impact on the environment.

With the aim of enhancing utility and reducing impacts, the company continues to work on its six strategic target areas, namely economic performance, sustainable solutions, local communities/society, energy, waste/water, and occupational safety. Year after year, Sika honors its responsibility through reporting its performance in a sustainability report in line with the highest standards, the Global Reporting Initiative (GRI). More particularly, the implementation of life cycle thinking throughout all phases from product development to the use of the products by customers marks Sika's goal to move away from being a mere product supplier to a provider of innovative solutions which enhances the efficiency, durability, and aesthetic appeal of buildings, infrastructure, and installations.

Waste packaging management

Most Sika concrete admixtures are delivered bulk with a tanker truck or with a reusable intermediate bulk container (IBC) directly to concrete plants. Sika Canada encourages its customers to responsibly dispose of used packaging when its products are delivered in a single-use packaging such as drums.

6. GLOSSARY

6.1. Acronyms

AP	Acidification potential
CSA	Canadian Standards Association
EP	Eutrophication potential
GHG	Greenhouse gas
GWP	Global warming potential
ISO	International Organization for Standardization
kg CFC-11 eq.	Kilogram of trichlorofluoromethane equivalent
kg CO_2 eq.	Kilogram of carbon dioxide equivalent
kg N eq.	Kilogram of nitrogen equivalent
kg O_3 eq.	Kilogram of ozone equivalent
kg Sb eq.	Kilogram of antimony equivalent
kg SO_2 eq.	Kilogram of sulphur dioxide equivalent
L	litre
LCA	Life cycle assessment
LEED	Leadership in Energy and Environmental Design
LHV	Lower heating value
MJ	Megajoule
m^3	Cubic meter
ODP	Ozone depletion potential
PCR	Product category rules
SFP	Smog formation potential

6.2. Environmental impact categories and parameters assessed

The **acidification potential** refers to the change in acidity (i.e. reduction in pH) in soil and water due to human activity. The increase in NO_x and SO_2 emissions generated by the transportation, manufacturing and energy sectors are the main causes of this impact category. The acidification of land and water has multiple consequences: degradation of aquatic and terrestrial ecosystems, endangering numerous species and food security. The concentration of the gases responsible for the acidification is expressed in sulphur dioxide equivalents (**kg SO_2 equivalent**).

The **eutrophication potential** measures the enrichment of an aquatic or terrestrial ecosystem due to the release of nutrients (e.g. nitrates, phosphates) resulting from natural or human activity (e.g. the discharge of wastewater into watercourses). In an aquatic environment, this activity results in the growth of algae which consume dissolved oxygen present in water when they degrade and thus affect species sensitive to the concentration of dissolved oxygen. Also, the increase in nutrients in soils makes it difficult for the terrestrial environment to manage the excess of biomass produced. The concentration of nutrients causing this impact is expressed in nitrogen equivalents (**kg N equivalent**).

Net freshwater consumption accounts for the imbalance in the natural water cycle created by the water evaporated, consumed by a system or released to a different watershed (i.e. not its original source). This imbalance can cause water scarcity and affect biodiversity. This indicator refers to the waste of the resource rather than its pollution. Also, it does not refer to water that is used but returned to the original source (e.g., water for hydroelectric turbines, cooling or river transportation) or lost from a natural system (e.g. due to evaporation of rainwater). The quantity of freshwater consumed is expressed as a volume of water in meter cube (**m^3 of water consumed**).

The **global warming potential** refers to the impact of a temperature increase on the global climate patterns (e.g., severe flooding and drought events, accelerated melting of glaciers) due to the release of greenhouse gases (GHG) (e.g. carbon dioxide and methane from fossil fuel combustion). GHG emissions contribute to the increase in the absorption of radiation from the sun at the earth's surface. These emissions are expressed in units of kg of carbon dioxide equivalents (**kg CO_2 equivalent**).

The **ozone depletion potential** indicator measures the potential of stratospheric ozone level reduction due to the release of some molecules such as refrigerants used in cooling systems (e.g., chlorofluorocarbons). When they react with ozone (O_3), the ozone concentration in the stratosphere diminishes and is no longer sufficient to absorb ultraviolet (UV) radiation which can cause high risks to human health (e.g., skin cancers and cataracts) and the terrestrial environment. The concentration of molecules that are responsible of ozone depletion is expressed in kilograms of trichlorofluoromethane equivalents (**kg CFC-11 equivalent**).

The **smog formation potential** indicator covers the emissions of pollutants such as nitrogen oxides and volatile organic compounds (VOCs) into the atmosphere. They are mainly generated by motor vehicles, power plants and industrial facilities. When reacting with the sunlight, these pollutants create smog which can affect human health and cause various respiratory problems. The concentration of pollutants causing smog are expressed in kg of ozone equivalents (**kg O_3 equivalent**).

The **renewable/non-renewable primary energy consumption** parameters refer to the use of energy from renewable resources (e.g., wind, solar, hydro) and non-renewable resources (e.g., natural gas, coal, petroleum). The quantity of primary energy used is expressed in megajoules, on the basis of the lower heating value of the resources (**MJ, LHV**).

The **renewable/non-renewable material resources consumption** parameters represent the quantity of material made from renewable resources or non-renewable resources used to manufacture a product, excluding recovered or recycled materials. The quantity of these resources is reported in megajoules (**MJ**).

7. REFERENCES

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