

EN 15804+A2 EPD



## ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804+A2  
Owner of the Declaration – Chemoran

Declaration number: EPDIE-22-80  
Issue date 16th June 2022  
Valid to 16th June 2027

EPD Programme - EPD Ireland  
Programme Operator - Irish Green Building Council  
[www.epdireland.org](http://www.epdireland.org)







**GAP, MDC, CPM-P, TT, TLC**  
**Mixing Grade Emulsifiers**

# 1. General information

PROGRAMME OPERATOR	OWNER OF DECLARATION
Irish Green Building Council 19 Mountjoy Square, Dublin, D01 E8P5, Ireland	COLAS Ireland - Chemoran Deerpark Industrial Estate, Oranmore, Co. Galway, H91 D934, Ireland
DECLARATION NUMBER	PRODUCTION SITE
EPDIE-22-80	Chemoran Deerpark Industrial Estate, Oranmore, Co. Galway, H91 D934, Ireland
ECO PLATFORM EPD	DECLARED UNIT
Yes	1 kg of Mixing Grade Emulsifier
APPLICABLE PRODUCT CATEGORY RULES	DECLARED PRODUCT
1. EN 15804:2012+A2:2019 2. Product Category Rules: Part A, Implementation and use of EN 15804:2012+A2:2019 and CEN TR 16970:2016 in Ireland, Version 2.0	1 kg of GAP, MDC, CPM-P, TT, TLC Mixing Grade Emulsifiers
DATE OF ISSUE	SCOPE OF EPD
16th June 2022	A1 - A3 Cradle to gate
DATE OF EXPIRY	LCA CONSULTANT OR PERSON RESPONSIBLE FOR LCA
16th June 2027	Ecoreview, Kilkenny, Ireland. +353 (087) 258 9783 www.ecoreview.ie
TYPE OF EPD: SINGLE OR MULTI PRODUCT	LCA SOFTWARE AND DEVELOPER IF APPLICABLE
Multi product EPD	Ecochain LCA tool version 2.10
PRODUCT CLASSIFICATION OR NACE CODE	NAME AND VERSION OF INVENTORY USED
Nace code 22.14	Ecoinvent version 3.6
COMPARABILITY	
Environmental Product Declarations from different programmes may not be directly comparable if not compliant with EN 15804:2012+A2:2019. Comparability is further dependent on the specific product category rules, system boundaries and allocations, and background data sources. See clause 5.3 of EN 15804:2012+A2:2019	
The CEN Norm /EN 15804 serves as the core PCR	
Independent verification of the declaration according to ISO 14025	

Internally  Externally

SIGNATURE OF PROGRAMME OPERATOR	SIGNATURE VERIFIER
Pat Barry - CEO - Irish Green Building Council    	Kim Allbury - Ricardo Energy & Environment    

## 2. Scope and Type of EPD

### Scope

This is a Cradle to Gate. EPD. The Modules that are declared are shown in the table below.

PRODUCT STAGE			CONSTRUCTION ON PROCESS STAGE		USE STAGE								END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse – Recovery – Recycling potential	
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	
X	X	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
MDT	MDT	MDT	OP	OP	OP	OP	OP	OP	OP	OP	OP	MDT	MDT	MDT	MDT	MDT	

X = Module declared; ND = Module not declared; MDT = Mandatory; OP = Optional.

In this version of the EPD (dated June, 2022), modules C and D are not declared. This non-compliance is due to the fact that at this time the Irish asphalt PCR is not yet published and there are no agreed scenarios established for modules C and D. When the PCR is published, and these scenarios are established, this EPD will be updated to include these modules C and D.

Notwithstanding this, it is noted that the biogenic carbon in this/these products (given in Section 6) at the end of life of the product, is to be accounted for in the appropriate end of life of the product using this additive.

### Declared Functional Unit

1 kg of Mixing Grade Emulsifier. Primary production data from the year 2019 has been used.

### System Boundaries

This LCA covers the Product stage (A1 - A3).

## 3. Detailed product description

These products are a mix of fatty imidazoline derivatives and amidoamines designed for bitumen emulsions used in the manufacture of mixing grade bitumen emulsions for cold mixes, grave emulsion and microsurfacing with either paraffinic or naphthenic bitumen. They are produced and supplied, by Chemoran, in liquid form. They are usually supplied to customers in returnable/re-useable intermediate bulk containers (IBCs).

The mixing grade emulsifiers are manufactured by the reacting and blending of a variety of bio-based and organic chemicals.

Technical and functional characteristics are given in the table below:

Product	Physical state at 20 °C		Alkalinity index (mg HCl/g)		Density at 20 °C (g/cm <sup>3</sup> )		Flash point, closed cup (°C)		Viscosity at 25 °C (mPa.s)		Cloud point	
	Specification	Typical values	Specification	Typical values	Specification	Typical values	Specification	Typical values	Specification	Typical values	Specification	Typical values
GAP	Liquid	Liquid	>220	250	0.99 +/- 0.05	0.99	>100		475	480	< 0 °C	
MDC	Liquid	Liquid	>215	240	0.97 +/- 0.05	0.97	>100		320	325	< 0 °C	
CPM-P	Liquid	Liquid	>120	138	0.92 +/- 0.05	0.92	>100		155	160	< 0 °C	
TLC	Liquid	Liquid	>220	235	0.95 +/- 0.05	0.95	>100		235	235	< 0 °C	
TT	Liquid	Liquid	>180	200	0.93 +/- 0.05	0.93	>100		190	190	< 5 °C	

Further technical details can be found at:

<http://www.chemoran.ie/dl/pdf/products/GAP.pdf>

<http://www.chemoran.ie/dl/pdf/products/MDC.pdf>

<http://www.chemoran.ie/dl/pdf/products/CPM-P.pdf>

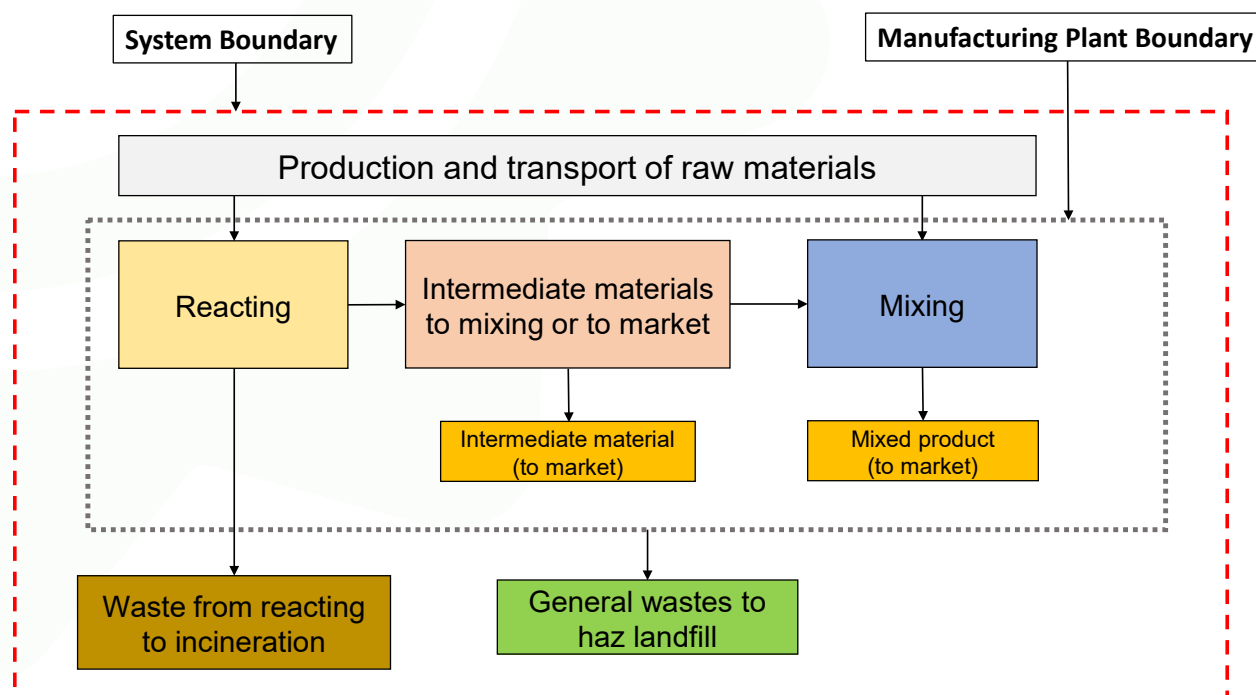
<http://www.chemoran.ie/dl/pdf/products/TLC.pdf>

<http://www.chemoran.ie/dl/pdf/products/TT.pdf>

### 3.1 Manufacturing Process Description

There are two processes in the manufacturing of the admixtures. The first process is Reacting, where organic oils are reacted with amines at temperature in sealed containers. Ancillary devices such as pumps, motors, PLCs, etc., are powered by electricity. The second process is Blending, where the reacted products are further blended with other reaction products or raw materials purchased from external manufacturers.

The manufacturing process flowchart is shown below:



**GAP**  
**Mixing Grade Emulsifer**



## 4.1.A. LCA results - GAP Mixing Grade Emulsifer

### Core Environmental impact per 1 kg of GAP Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	[kg CO <sub>2</sub> eq.]	2.51E+00	3.69E-02	8.41E-03	2.56E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-fossil	[kg CO <sub>2</sub> eq.]	3.17E+00	3.69E-02	8.62E-03	3.21E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-biogenic	[kg CO <sub>2</sub> eq.]	-6.61E-01	1.31E-05	-2.18E-04	-6.62E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-luluc	[kg CO <sub>2</sub> eq.]	3.03E-03	1.16E-05	7.01E-06	3.05E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ODP	[kg CFC-11 eq.]	5.57E-07	8.38E-09	3.80E-10	5.65E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AP	[mol H+ eq.]	1.70E-02	1.72E-04	2.17E-05	1.72E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-freshwater <sup>[1]</sup>	[kg P eq.]	1.05E-04	5.62E-07	5.74E-08	1.05E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-marine	[kg N eq.]	7.57E-03	3.28E-05	4.18E-06	7.61E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-terrestrial	[mol N eq.]	4.15E-02	3.72E-04	4.63E-05	4.19E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
POCP	[kg NMVOC eq.]	1.15E-02	1.22E-04	1.52E-05	1.16E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADP-minerals&metals <sup>[2]</sup>	[kg Sb eq.]	5.36E-05	1.04E-07	5.80E-08	5.37E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADP-fossils <sup>[2]</sup>	[MJ] ncv	6.71E+01	5.61E-01	1.29E-01	6.78E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
WDP <sup>[2]</sup>	m <sup>3</sup> world eq. deprived	2.38E+00	4.30E-03	7.79E-04	2.38E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

GWP-total = Global Warming Potential total; GWP-fossil= Global Warming Potential fossil fuels (GWP-fossil); GWP-biogenic= Global Warming Potential biogenic; GWP-luluc= Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP =Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&fossils = Abiotic depletion potential for non-fossil resources; ADP-fossils= Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential, deprivation-weighted water consumption.

The measurement of environmental impacts uses the recommended default LCIA methods for the PEF 3.0 method. These methods include amongst others: USEtox® 2.0, ReCiPe (2016), CML-2001, EDIP 2003, IPCC.

<sup>[1]</sup>To express EP freshwater as kg of PO43- eq, multiply the value for kg P eq. by 3.067.

<sup>[2]</sup>The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

ND = Module not declared; INA = Indicator not assessed.

## 4.1.B. LCA results - GAP Mixing Grade Emulsifer

### Resource use per 1 kg of GAP Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	[MJ]	1.85E+01	6.49E-03	3.93E-02	1.86E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERM	[MJ]	2.61E+00	0.00E+00	0.00E+00	2.61E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERT	[MJ]	2.11E+01	6.49E-03	3.93E-02	2.12E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRE	[MJ]	7.19E+01	5.96E-01	1.40E-01	7.26E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRM	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRT	[MJ]	7.19E+01	5.96E-01	1.40E-01	7.26E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SM	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RSF	[MJ]	4.57E-03	0.00E+00	0.00E+00	4.57E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NRSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FW	[m <sup>3</sup> ]	6.19E-02	9.26E-05	2.26E-05	6.21E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water.

ND = Module not declared; INA = Indicator not assessed.

## 4.1.C. LCA results - GAP Mixing Grade Emulsifer

### Output flows and waste categories per 1 kg of GAP Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	[kg]	5.27E-05	3.55E-07	3.42E-03	3.47E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NHWD	[kg]	3.38E-01	2.49E-02	2.04E-04	3.63E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RWD	[kg]	1.89E-04	3.78E-06	2.06E-08	1.92E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CRU	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
MFR	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
MER	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
EEE	[MJ]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
EET	[MJ]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy.

CRU, MFR, MER, EEE, EET are not calculated by the EcoChain software.

ND = Module not declared; INA = Indicator not assessed.



## 4.1.D. LCA results - GAP Mixing Grade Emulsifer

### Additional Environmental impact per 1 kg of GAP Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	1.98E-07	2.26E-09	1.14E-10	2.00E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
IRP <sup>[1]</sup>	kBq U235 eq	1.48E-01	2.41E-03	2.09E-05	1.51E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETP-fw <sup>[2]</sup>	CTUe	1.95E+02	3.96E-01	7.10E-02	1.96E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-c <sup>[2]</sup>	CTUe	7.14E-09	1.17E-11	5.10E-12	7.16E-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-nc <sup>[2]</sup>	CTUe	6.34E-08	4.32E-10	8.41E-11	6.39E-08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SQP <sup>[2]</sup>	dimensionless	1.21E+02	3.61E-01	3.19E-02	1.22E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PM = Potential incidence of disease due to PM emissions, IRP = Potential Human exposure efficiency relative to U235, ETP-fw = Potential Comparative Toxic Unit for ecosystems; HTP-c: Potential Comparative Toxic Unit for humans, HTP-nc = Potential Comparative Toxic Unit for humans, SQP = Potential soil quality index.

<sup>[1]</sup> This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

<sup>[2]</sup> The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

ND = Module not declared; INA = Indicator not assessed.

**MDC**  
**Mixing Grade Emulsifer**



## 4.2.A. LCA results - MDC Mixing Grade Emulsifer

### Core Environmental impact per 1 kg of MDC Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	[kg CO <sub>2</sub> eq.]	2.17E+00	2.46E-02	8.38E-03	2.20E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-fossil	[kg CO <sub>2</sub> eq.]	3.04E+00	2.46E-02	8.60E-03	3.08E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-biogenic	[kg CO <sub>2</sub> eq.]	-8.80E-01	8.69E-06	-2.17E-04	-8.80E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-luluc	[kg CO <sub>2</sub> eq.]	3.14E-03	7.75E-06	6.99E-06	3.15E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ODP	[kg CFC-11 eq.]	5.79E-07	5.59E-09	3.79E-10	5.85E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AP	[mol H+ eq.]	1.68E-02	1.14E-04	2.16E-05	1.69E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-freshwater <sup>[1]</sup>	[kg P eq.]	1.03E-04	3.74E-07	5.73E-08	1.03E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-marine	[kg N eq.]	7.91E-03	2.17E-05	4.17E-06	7.93E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-terrestrial	[mol N eq.]	4.22E-02	2.46E-04	4.62E-05	4.25E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
POCP	[kg NMVOC eq.]	1.14E-02	8.11E-05	1.52E-05	1.15E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADP-minerals&metals <sup>[2]</sup>	[kg Sb eq.]	5.21E-05	6.92E-08	5.78E-08	5.22E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADP-fossils <sup>[2]</sup>	[MJ] ncv	6.39E+01	3.74E-01	1.29E-01	6.44E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
WDP <sup>[2]</sup>	m <sup>3</sup> world eq. deprived	2.43E+00	2.87E-03	7.78E-04	2.43E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

GWP-total = Global Warming Potential total; GWP-fossil= Global Warming Potential fossil fuels (GWP-fossil; GWP-biogenic= Global Warming Potential biogenic; GWP-luluc= Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP =Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&fossils = Abiotic depletion potential for non-fossil resources; ADP-fossils= Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential, deprivation-weighted water consumption.

The measurement of environmental impacts uses the recommended default LCIA methods for the PEF 3.0 method. These methods include amongst others: USEtox® 2.0, ReCiPe (2016), CML-2001, EDIP 2003, IPCC.

<sup>[1]</sup>To express EP freshwater as kg of PO4<sup>3-</sup> eq, multiply the value for kg P eq. by 3.067.

<sup>[2]</sup>The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

ND = Module not declared; INA = Indicator not assessed.

## 4.2.B. LCA results - MDC Mixing Grade Emulsifer

### Resource use per 1 kg of MDC Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	[MJ]	2.05E+01	4.32E-03	3.92E-02	2.06E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERM	[MJ]	4.91E+00	0.00E+00	0.00E+00	4.91E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERT	[MJ]	2.54E+01	4.32E-03	3.92E-02	2.55E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRE	[MJ]	6.83E+01	3.97E-01	1.40E-01	6.89E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRM	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRT	[MJ]	6.83E+01	3.97E-01	1.40E-01	6.89E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SM	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RSF	[MJ]	8.60E-03	0.00E+00	0.00E+00	8.60E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NRSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FW	[m <sup>3</sup> ]	6.31E-02	6.17E-05	2.25E-05	6.32E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water.

ND = Module not declared; INA = Indicator not assessed.

## 4.2.C. LCA results - MDC Mixing Grade Emulsifer

### Output flows and waste categories per 1 kg of MDC Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	[kg]	5.41E-05	2.37E-07	3.41E-03	3.46E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NHWD	[kg]	3.20E-01	1.66E-02	2.04E-04	3.37E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RWD	[kg]	2.22E-04	2.52E-06	2.05E-08	2.24E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CRU	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
MFR	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
MER	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
EEE	[MJ]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
EET	[MJ]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy.

CRU, MFR, MER, EEE, EET are not calculated by the EcoChain software.

ND = Module not declared; INA = Indicator not assessed.

## 4.2.D. LCA results - MDC Mixing Grade Emulsifer

### Additional Environmental impact per 1 kg of MDC Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	2.04E-07	1.51E-09	1.14E-10	2.05E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
IRP <sup>[1]</sup>	kBq U235 eq	1.53E-01	1.60E-03	2.08E-05	1.54E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETP-fw <sup>[2]</sup>	CTUe	2.04E+02	2.64E-01	7.08E-02	2.04E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-c <sup>[2]</sup>	CTUe	7.44E-09	7.82E-12	5.09E-12	7.45E-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-nc <sup>[2]</sup>	CTUe	6.47E-08	2.89E-10	8.39E-11	6.51E-08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SQP <sup>[2]</sup>	dimensionless	1.51E+02	2.41E-01	3.18E-02	1.51E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PM = Potential incidence of disease due to PM emissions, IRP = Potential Human exposure efficiency relative to U235, ETP-fw = Potential Comparative Toxic Unit for ecosystems; HTP-c: Potential Comparative Toxic Unit for humans, HTP-nc = Potential Comparative Toxic Unit for humans, SQP = Potential soil quality index.

<sup>[1]</sup> This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

<sup>[2]</sup> The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

ND = Module not declared; INA = Indicator not assessed.

# CPM-P Mixing Grade Emulsifer



### 4.3.A. LCA results - CPM-P Mixing Grade Emulsifer

#### Core Environmental impact per 1 kg of CPM-P Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	[kg CO <sub>2</sub> eq.]	3.69E-01	0.00E+00	8.34E-03	3.78E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-fossil	[kg CO <sub>2</sub> eq.]	1.93E+00	0.00E+00	8.55E-03	1.94E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-biogenic	[kg CO <sub>2</sub> eq.]	-1.56E+00	0.00E+00	-2.16E-04	-1.56E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-luluc	[kg CO <sub>2</sub> eq.]	2.80E-03	0.00E+00	6.96E-06	2.80E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ODP	[kg CFC-11 eq.]	3.76E-07	0.00E+00	3.77E-10	3.76E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AP	[mol H+ eq.]	1.19E-02	0.00E+00	2.15E-05	1.19E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-freshwater <sup>[1]</sup>	[kg P eq.]	6.75E-05	0.00E+00	5.70E-08	6.76E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-marine	[kg N eq.]	7.46E-03	0.00E+00	4.15E-06	7.47E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-terrestrial	[mol N eq.]	3.50E-02	0.00E+00	4.60E-05	3.50E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
POCP	[kg NMVOC eq.]	9.31E-03	0.00E+00	1.51E-05	9.33E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADP-minerals&metals <sup>[2]</sup>	[kg Sb eq.]	3.37E-05	0.00E+00	5.75E-08	3.37E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADP-fossils <sup>[2]</sup>	[MJ] ncv	3.93E+01	0.00E+00	1.28E-01	3.95E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
WDP <sup>[2]</sup>	m <sup>3</sup> world eq. deprived	1.83E+00	0.00E+00	7.73E-04	1.83E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

GWP-total = Global Warming Potential total; GWP-fossil= Global Warming Potential fossil fuels (GWP-fossil; GWP-biogenic= Global Warming Potential biogenic; GWP-luluc= Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP =Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&fossils = Abiotic depletion potential for non-fossil resources; ADP-fossils= Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential, deprivation-weighted water consumption.

The measurement of environmental impacts uses the recommended default LCIA methods for the PEF 3.0 method. These methods include amongst others: USEtox® 2.0, ReCiPe (2016), CML-2001, EDIP 2003, IPCC.

<sup>[1]</sup>To express EP freshwater as kg of PO4<sup>3-</sup> eq, multiply the value for kg P eq. by 3.067.

<sup>[2]</sup>The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

ND = Module not declared; INA = Indicator not assessed.



### 4.3.B. LCA results - CPM-P Mixing Grade Emulsifer

#### Resource use per 1 kg of CPM-P Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	[MJ]	2.75E+01	0.00E+00	3.89E-02	2.76E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERM	[MJ]	1.11E+01	0.00E+00	0.00E+00	1.11E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERT	[MJ]	3.86E+01	0.00E+00	3.89E-02	3.86E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRE	[MJ]	4.23E+01	0.00E+00	1.39E-01	4.25E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRM	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRT	[MJ]	4.23E+01	0.00E+00	1.39E-01	4.25E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SM	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RSF	[MJ]	1.94E-02	0.00E+00	0.00E+00	1.94E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NRSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FW	[m <sup>3</sup> ]	4.64E-02	0.00E+00	2.24E-05	4.64E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water.

ND = Module not declared; INA = Indicator not assessed.

### 4.3.C. LCA results - CPM-P Mixing Grade Emulsifer

#### Output flows and waste categories per 1 kg of CPM-P Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	[kg]	4.87E-05	0.00E+00	3.39E-03	3.44E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NHWD	[kg]	2.37E-01	0.00E+00	2.03E-04	2.37E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RWD	[kg]	2.57E-04	0.00E+00	2.04E-08	2.57E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CRU	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
MFR	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
MER	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
EEE	[MJ]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
EET	[MJ]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy.

CRU, MFR, MER, EEE, EET are not calculated by the EcoChain software.

ND = Module not declared; INA = Indicator not assessed.

### 4.3.D. LCA results - CPM-P Mixing Grade Emulsifer

#### Additional Environmental impact per 1 kg of CPM-P Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	1.87E-07	0.00E+00	1.13E-10	1.87E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
IRP <sup>[1]</sup>	kBq U235 eq	1.06E-01	0.00E+00	2.07E-05	1.06E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETP-fw <sup>[2]</sup>	CTUe	9.79E+01	0.00E+00	7.04E-02	9.80E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-c <sup>[2]</sup>	CTUe	3.08E-09	0.00E+00	5.06E-12	3.08E-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-nc <sup>[2]</sup>	CTUe	3.40E-08	0.00E+00	8.34E-11	3.41E-08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SQP <sup>[2]</sup>	dimensionless	2.44E+02	0.00E+00	3.16E-02	2.44E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PM = Potential incidence of disease due to PM emissions, IRP = Potential Human exposure efficiency relative to U235, ETP-fw = Potential Comparative Toxic Unit for ecosystems; HTP-c: Potential Comparative Toxic Unit for humans, HTP-nc = Potential Comparative Toxic Unit for humans, SQP = Potential soil quality index.

<sup>[1]</sup> This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

<sup>[2]</sup> The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

ND = Module not declared; INA = Indicator not assessed.

# TT Mixing Grade Emulsifer



## 4.4.A. LCA results - TT Mixing Grade Emulsifer

### Core Environmental impact per 1 kg of TT Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	[kg CO <sub>2</sub> eq.]	6.85E-01	6.11E-02	2.43E-01	9.89E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-fossil	[kg CO <sub>2</sub> eq.]	2.11E+00	6.11E-02	2.43E-01	2.41E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-biogenic	[kg CO <sub>2</sub> eq.]	-1.42E+00	4.21E-05	-4.90E-05	-1.42E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-luluc	[kg CO <sub>2</sub> eq.]	3.14E-03	2.51E-05	2.00E-05	3.19E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ODP	[kg CFC-11 eq.]	4.70E-07	1.33E-08	3.86E-08	5.22E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AP	[mol H <sup>+</sup> eq.]	1.20E-02	6.18E-04	1.90E-03	1.45E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-freshwater <sup>[1]</sup>	[kg P eq.]	8.59E-05	6.61E-07	8.66E-07	8.75E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-marine	[kg N eq.]	6.38E-03	1.21E-04	7.83E-04	7.28E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-terrestrial	[mol N eq.]	2.98E-02	1.37E-03	8.60E-03	3.98E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
POCP	[kg NMVOC eq.]	7.57E-03	3.91E-04	2.37E-03	1.03E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADP-minerals&metals <sup>[2]</sup>	[kg Sb eq.]	4.06E-05	1.15E-06	8.55E-07	4.26E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADP-fossils <sup>[2]</sup>	[MJ] ncv	4.40E+01	9.07E-01	3.47E+00	4.84E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
WDP <sup>[2]</sup>	m <sup>3</sup> world eq. deprived	2.25E+00	4.07E-03	9.45E-03	2.27E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

GWP-total = Global Warming Potential total; GWP-fossil= Global Warming Potential fossil fuels (GWP-fossil; GWP-biogenic= Global Warming Potential biogenic; GWP-luluc= Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP =Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&fossils = Abiotic depletion potential for non-fossil resources; ADP-fossils= Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential, deprivation-weighted water consumption.

The measurement of environmental impacts uses the recommended default LCIA methods for the PEF 3.0 method. These methods include amongst others: USEtox® 2.0, ReCiPe (2016), CML-2001, EDIP 2003, IPCC.

<sup>[1]</sup>To express EP freshwater as kg of PO<sub>43</sub>- eq, multiply the value for kg P eq. by 3.067.

<sup>[2]</sup>The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

ND = Module not declared; INA = Indicator not assessed.

## 4.4.B. LCA results - TT Mixing Grade Emulsifer

### Resource use per 1 kg of TT Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	[MJ]	2.57E+01	1.54E-02	3.84E-01	2.61E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERM	[MJ]	1.01E+01	0.00E+00	0.00E+00	1.01E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERT	[MJ]	3.58E+01	1.54E-02	3.84E-01	3.62E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRE	[MJ]	4.70E+01	9.62E-01	3.72E+00	5.17E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRM	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRT	[MJ]	4.70E+01	9.62E-01	3.72E+00	5.17E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SM	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RSF	[MJ]	1.78E-02	0.00E+00	0.00E+00	1.78E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NRSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FW	[m <sup>3</sup> ]	5.82E-02	1.19E-04	3.06E-04	5.86E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water.

ND = Module not declared; INA = Indicator not assessed.

## 4.4.C. LCA results - TT Mixing Grade Emulsifer

### Output flows and waste categories per 1 kg of TT Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	[kg]	4.30E-05	1.80E-06	6.10E-06	5.09E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NHWD	[kg]	2.18E-01	3.08E-02	5.80E-03	2.54E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RWD	[kg]	2.55E-04	6.10E-06	1.56E-05	2.77E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CRU	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
MFR	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
MER	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
EEE	[MJ]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
EET	[MJ]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy.

CRU, MFR, MER, EEE, EET are not calculated by the EcoChain software.

ND = Module not declared; INA = Indicator not assessed.

## 4.4.D. LCA results - TT Mixing Grade Emulsifer

### Additional Environmental impact per 1 kg of TT Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	1.55E-07	3.22E-09	4.48E-08	2.03E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
IRP <sup>[1]</sup>	kBq U235 eq	1.27E-01	4.00E-03	9.69E-03	1.41E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETP-fw <sup>[2]</sup>	CTUe	1.78E+02	6.93E-01	1.87E+00	1.80E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-c <sup>[2]</sup>	CTUe	6.45E-09	2.03E-11	6.69E-11	6.54E-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-nc <sup>[2]</sup>	CTUe	5.39E-08	6.72E-10	1.80E-09	5.64E-08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SQP <sup>[2]</sup>	dimensionless	2.23E+02	4.81E-01	4.32E-01	2.24E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PM = Potential incidence of disease due to PM emissions, IRP = Potential Human exposure efficiency relative to U235, ETP-fw = Potential Comparative Toxic Unit for ecosystems; HTP-c: Potential Comparative Toxic Unit for humans, HTP-nc = Potential Comparative Toxic Unit for humans, SQP = Potential soil quality index.

<sup>[1]</sup> This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuelcycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

<sup>[2]</sup> The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

ND = Module not declared; INA = Indicator not assessed.



TLC  
Mixing Grade Emulsifer



## 4.5.A. LCA results - TLC Mixing Grade Emulsifer

### Core Environmental impact per 1 kg of TLC Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	[kg CO <sub>2</sub> eq.]	1.18E+00	6.63E-02	2.43E-01	1.49E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-fossil	[kg CO <sub>2</sub> eq.]	2.49E+00	6.63E-02	2.43E-01	2.80E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-biogenic	[kg CO <sub>2</sub> eq.]	-1.31E+00	4.53E-05	-4.91E-05	-1.31E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWP-luluc	[kg CO <sub>2</sub> eq.]	3.31E-03	2.72E-05	2.00E-05	3.36E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ODP	[kg CFC-11 eq.]	5.70E-07	1.44E-08	3.87E-08	6.23E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AP	[mol H+ eq.]	1.39E-02	6.54E-04	1.90E-03	1.64E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-freshwater <sup>[1]</sup>	[kg P eq.]	9.79E-05	7.11E-07	8.67E-07	9.95E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-marine	[kg N eq.]	7.65E-03	1.28E-04	7.84E-04	8.57E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EP-terrestrial	[mol N eq.]	3.36E-02	1.44E-03	8.61E-03	4.36E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
POCP	[kg NMVOC eq.]	8.41E-03	4.15E-04	2.38E-03	1.12E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADP-minerals&metals <sup>[2]</sup>	[kg Sb eq.]	4.72E-05	1.26E-06	8.54E-07	4.93E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ADP-fossils <sup>[2]</sup>	[MJ] ncv	5.29E+01	9.85E-01	3.48E+00	5.74E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
WDP <sup>[2]</sup>	m <sup>3</sup> world eq. deprived	2.51E+00	4.37E-03	9.45E-03	2.52E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

GWP-total = Global Warming Potential total; GWP-fossil= Global Warming Potential fossil fuels (GWP-fossil); GWP-biogenic= Global Warming Potential biogenic; GWP-luluc= Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP =Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&fossils = Abiotic depletion potential for non-fossil resources; ADP-fossils= Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential, deprivation-weighted water consumption.

The measurement of environmental impacts uses the recommended default LCIA methods for the PEF 3.0 method. These methods include amongst others: USEtox® 2.0, ReCiPe (2016), CML-2001, EDIP 2003, IPCC.

<sup>[1]</sup>To express EP freshwater as kg of PO43- eq, multiply the value for kg P eq. by 3.067.

<sup>[2]</sup>The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

ND = Module not declared; INA = Indicator not assessed.

## 4.5.B. LCA results - TLC Mixing Grade Emulsifer

### Resource use per 1 kg of TLC Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	[MJ]	2.43E+01	1.66E-02	3.84E-01	2.47E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERM	[MJ]	9.36E+00	0.00E+00	0.00E+00	9.36E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PERT	[MJ]	3.36E+01	1.66E-02	3.84E-01	3.40E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRE	[MJ]	5.80E+01	1.05E+00	3.72E+00	6.28E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRM	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PENRT	[MJ]	5.80E+01	1.05E+00	3.72E+00	6.28E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SM	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RSF	[MJ]	1.64E-02	0.00E+00	0.00E+00	1.64E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NRSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FW	[m <sup>3</sup> ]	6.52E-02	1.29E-04	3.06E-04	6.56E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water.

ND = Module not declared; INA = Indicator not assessed.

## 4.5.C. LCA results - TLC Mixing Grade Emulsifer

### Output flows and waste categories per 1 kg of TLC Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	[kg]	4.91E-05	1.98E-06	6.11E-06	5.71E-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NHWD	[kg]	2.45E-01	3.40E-02	5.74E-03	2.85E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RWD	[kg]	2.64E-04	6.62E-06	1.56E-05	2.87E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CRU	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
MFR	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
MER	[kg]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
EEE	[MJ]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA
EET	[MJ]	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA	INA

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy.

CRU, MFR, MER, EEE, EET are not calculated by the EcoChain software.

ND = Module not declared; INA = Indicator not assessed.

## 4.5.D. LCA results - TLC Mixing Grade Emulsifer

### Additional Environmental impact per 1 kg of TLC Mixing Grade Emulsifer

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	1.67E-07	3.52E-09	4.49E-08	2.15E-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
IRP <sup>[1]</sup>	kBq U235 eq	1.47E-01	4.34E-03	9.70E-03	1.61E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETP-fw <sup>[2]</sup>	CTUe	2.18E+02	7.54E-01	1.88E+00	2.21E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-c <sup>[2]</sup>	CTUe	7.94E-09	2.21E-11	6.70E-11	8.03E-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-nc <sup>[2]</sup>	CTUe	6.48E-08	7.34E-10	1.80E-09	6.73E-08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SQP <sup>[2]</sup>	dimensionless	2.08E+02	5.29E-01	4.31E-01	2.09E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

PM = Potential incidence of disease due to PM emissions, IRP = Potential Human exposure efficiency relative to U235, ETP-fw = Potential Comparative Toxic Unit for ecosystems; HTP-c: Potential Comparative Toxic Unit for humans, HTP-nc = Potential Comparative Toxic Unit for humans, SQP = Potential soil quality index.

<sup>[1]</sup> This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

<sup>[2]</sup> The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

ND = Module not declared; INA = Indicator not assessed.

## 5. Calculation rules

The measurement of environmental impacts in this EPD uses the LCIA methodologies recommended for PEF3.0.

The process descriptions and quantities in this study are reproducible in accordance to the reference standards that have been used. The references of all sources, both primary and public sources and literature, have been documented in the LCA report. The 'polluter pays' and 'modularity' principles have been followed.

In addition, to facilitate the reproducibility of this LCA, a full set of data records has been generated which can be accessed via the LCA tool. This data portfolio contains a summary of all the data used in this LCA.

### Cut-off criteria

The cut-off criteria of section 6.3.6 of EN15804:2012+A2:2019 have been followed, where 99% of the total energy and materials are included, and the total neglected input flows for the modules reported on in the LCA are less than 5% of the energy usage and mass.

### Data Quality

The dataset is representative for the production processes used in 2019. The data Quality Level, according to Table E.1 of EN 15804 +A2, Annex E, is 'very good'.

### Allocations

Allocation of electricity types and amounts to the various manufacturing processes has been provided by Chemoran Ltd along with production waste. Allocation of impacts to the products is based on the product composition mass.

Flows related to human activities such as employee transport are excluded. The construction of capital assets such as buildings, manufacture of machines and transportation systems are also excluded since the related flows are assumed to be negligible compared to the manufacture of the building material when compared to these systems over a full lifetime of operation.

## 6. Scenarios and additional technical information

In this version of the EPD (dated June, 2022), modules C and D are not declared. This non-compliance is due to the fact that at this time the Irish asphalt PCR is not yet published and there are no agreed scenarios established for modules C and D. When the PCR is published, and these scenarios are established, this EPD will be updated to include these modules C and D.

Notwithstanding this, it is noted that the biogenic carbon in this/these products (given below) at the end of life of the product, is to be accounted for in the appropriate end of life of the product using this additive.

### C1. De-construction demolition

See note above

### C2. Transport

See note above

### C3. Waste processing

See note above

### C4. Disposal

See note above

### D. Reuse – Recovery – Recycling potential

See note above

### Declaration of biogenic carbon content at the production gate

The biogenic carbon (C) and biogenic CO<sub>2</sub> of the products is given in the table below:

Biogenic carbon (C) and biogenic CO <sub>2</sub> per declared unit	Product	Biogenic C (material only)	Biogenic CO <sub>2</sub> (material only)	Biogenic CO <sub>2</sub> (material + indirect)	Unit
Biogenic carbon content in product	GAP	0.09	0.33	0.66	kg
Biogenic carbon content in product	MDC	0.17	0.62	0.88	kg
Biogenic carbon content in product	CPM-P	0.37	1.36	1.56	kg
Biogenic carbon content in product	TT	0.34	1.25	1.42	kg
Biogenic carbon content in product	TLC	0.32	1.17	1.31	kg
Biogenic carbon content in packaging		N/A	N/A	N/A	N/A

The mass of biogenic carbon contained in the bio-based materials is assumed to be 50% of the mass of the material – based on the default carbon content of woody biomass of 50%. The direct mass values for biogenic CO<sub>2</sub> are calculated from this carbon mass. Note that these calculated biogenic CO<sub>2</sub> values ('material only', above) do not include other indirect biogenic CO<sub>2</sub> uptakes/emissions along the supply chain such as biofuels or other bio-based materials. These additional indirect sources of biogenic CO<sub>2</sub> are also included in the LCA tool calculation, and are given above as 'Biogenic CO<sub>2</sub> - direct and indirect'. These GWP biogenic values are also given in the Core Environmental Impacts tables in this EPD.

Based on the GWP-biogenic values (direct and indirect) noted above, the table below presents the net CO<sub>2</sub> eq., or "GWP-Total" for each product, at the factory gate.

Product	A1 - A3 Fossil + luluc CO <sub>2</sub>	A1 - A3 Biogenic CO <sub>2</sub>	A1 - A3 Net CO <sub>2</sub> at factory gate
GAP	3.22	-0.66	2.56
MDC	3.08	-0.88	2.20
CPM-P	1.94	-1.56	0.38
TT	2.41	-1.42	0.99
TLC	2.80	-1.31	1.49

Packaging is not assessed, as the products are delivered in reuseable/returnable IBCs, and do not form part of this LCA.

### Additional Technical Information

To estimate the additional CO<sub>2</sub> impact of transport of products, the following factors can be used:

Transport method	kg CO <sub>2</sub> per t.km
Sea (freight)	0.011
Sea (tanker)	0.006
Road (freight)	0.162
Rail (freight)	0.045

## 7. Mandatory additional information on release of dangerous substances to indoor air, soil and water

None of the substances contained in the product are listed in the "Candidate List of Substances of Very High Concern for authorisation", or they do not exceed the limit for registration with the European Chemicals Agency.

## 8. Other optional additional environmental information

N/A.



## 9. References

- [1] 'ISO 14040: Environmental management - Life cycle assessment – Principles and Framework', International Organization for Standardization, ISO 14040:2006.
- [2] 'ISO 14044: Environmental management - Life cycle assessment - Requirements and guidelines', International Organization for Standardization, ISO 14044:2006.
- [3] 'ISO 14025: Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures', International Organization for Standardization, ISO 14025:2006.
- [4] 'EN 15804: Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products', NEN-EN 15804:2012+A1:2013.
- [5] EcoChain, 2017, web: <http://app.ecochain.com>.
- [6] Product Category Rules: Part A, version 2, developed for Ireland, by the Irish Green Building Council on 17.08.2021.
- [7] PEF methodology final draft.pdf (europa.eu)

## 10. Annex

N/A.