ENVIRONMENTAL PRODUCT DECLARATION

CERAMIC TILE – FLOOR AND WALL

Certified Environmental Product Declaration
www.nsf.org

FIRECLAY TILE

Program Operator	NSF Certification LLC 789 N. Dixboro, Ann Arbor, MI 48105 www.nsf.org
General Program Instructions and Version Number	Part A: Life Cycle Assessment Calculation Rules and Report Requirements, Version 3.2
Manufacturer Name and Address	Fireclay Tile 901 Brannan Street San Francisco, CA 94019
Declaration Number	EPD10355
Declared Product and Functional Unit	Ceramic Floor and Wall Tile manufactured at Aromas, CA 1 square meter of installed flooring and with a building service life of 75 years
Reference PCR and Version Number	Part A: Life Cycle Assessment Calculation Rules and Report Requirements, Version 3.2 Part B: Flooring EPD Requirements. UL 10010-7, September 28, 2018
Product's intended Application and Use	Flooring Applications
Product RSL	75 years
Markets of Applicability	North America
Date of Issue	05/22/2020
Period of Validity	5 years from date of issue
EPD Type	Product Specific
Range of Dataset Variability	N/A
EPD Scope	Cradle-to-Grave
Year of reported manufacturer primary data	2019
LCA Software and Version Number	GaBi 9.2.0.58
LCI Database and Version Number	GaBi Database Version 9.2, Service Pack 39
LCIA Methodology and Version Number	TRACI 2.1 CML 2001-Jan 2016
The sub-category PCR review was conducted by:	• Jack Geibig (Chair), Ecoform Consultants, jgeibig@ecoform.com • Thomas Gloria, PhD, Industrial Ecology Consultants, t.gloria@industrial-ecology.com • Thaddeus Owen, hiper4m@gmail.com

This declaration was independently verified in accordance with ISO 14025: 2006. The UL Environment "Part A: Life Cycle Assessment Calculation Rules and Report Requirements" v3.2 (December 2018), based on CEN Norm EN 15804 (2012) and ISO 21930:2017, serves as the core PCR, with additional considerations from the USGBC/UL Environment Part A Enhancement (2017) ☐ Internal ☒External	Jenny Oorbeck joorbeck@nsf.org
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	WAP Sustainability Consulting, LLC
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Terrie Boguski, Harmony Environmental, LLC

Limitations:
Environmental declarations from different programs (ISO 14025) may not be comparable.
Comparison of the environmental performance of Flooring Products using EPD information shall be based on the product's use and impacts at the building level, and therefore EPDs may not be used for comparability purposes when not considering the building energy use phase as instructed under this PCR.
Full conformance with the PCR for Products allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

1. DESCRIPTION OF COMPANY

Since 1986, Fireclay has been reinventing, redefining, and radicalizing the industry. As the first tile company to be certified as a Benefit Corporation, Fireclay is proud to continue standing on its founding principles. Fireclay does this by committing to using sustainable manufacturing practices, using recycled materials, and taking care of its employees, while putting customers first. Additionally, in 2019, Fireclay was enlisted by the non-profit, Climate Neutral, as a Climate Neutral Certified company due it's efforts in measuring, reducing, and offsetting its entire carbon footprint.

2. PRODUCT DESCRIPTION

This EPD includes representative products derived from Fireclay's line of products produced at the facility located in Aromas, California. Ceramic tiles are primarily made up of clays, silica and other additives and then molded into shape followed by firing into a kiln. Ceramic tiles can be glazed or unglazed. There are several advantages to ceramic tiles. They are fire resistant, non-combustible, durable (lasts a lifetime) and extremely easy to maintain. The UNSPSC code for this flooring product is 301617 and the CSI code is 09 30 00.

Results in this EPD are presented based on a representative product that is based on the total materials purchased during 2019 and annual production data. All ceramic tiles made at this facility contain recycled content. For more information on specific products, please visit: https://www.fireclaytile.com/.

This EPD is applicable to all color options and collections in Fireclay's Tile, Non-Slip and Hand painted lines.

3. PRODUCT SPECIFICATION AND APPLICATION RULES

The products considered in the EPD meet the following technical specifications:

- ANSI A137.1: American National Standard Specifications for Ceramic Tile
- Fire Testing: Classification: A, Flame Spread: 0, Smoke Developed: 0

4. APPLICATION

Ceramic tile products are commonly used in a variety of applications including commercial, light commercial, institutional, and residential interior and exterior applications.

5. TECHNICAL DATA

Table 1: Technical Details

Parameter	Fireclay Tile
Nominal Area (mm^2)	5161.28, 11612.9, 20645.1, 46451.5, 7741.92, 17419.3, 10322.6, 23225.8, 5806.44, 10322.6, 23225.8, 41290.2, 92903
Nominal Value Sizes (in)	2x4, 3x6, 4x8, 6x12, 2x6, 3x9, 2x8, 3x12, 3x3, 4x4, 6x6, 8x8, 12x12
Average Fired Weight (g/m^2)	17576.74
Average Fired Weight (lb/ft^2)	3.6
Thickness value (mm)	7.9375
Class	E1
Tile Type	Ceramic
Grade	Includes Standard and Second
Dimensional Categories	Natural

6. DECLARATION OF METHODOLOGIAL FRAMEWORK

This EPD is considered a Cradle-to-Grave study. A summary of the life cycle stages included in this EPD is presented in Table 8. The reference service life is outlined in Table 1 and is only applicable if all manufacturing guidelines are followed regarding site-selection and installation, found online. No known flows are deliberately excluded from this EPD. Third party verified ISO 14040/44 secondary LCI datasets contribute more than 67% of total impacts in all impact categories required by the PCR.

7. FLOW DIAGRAM

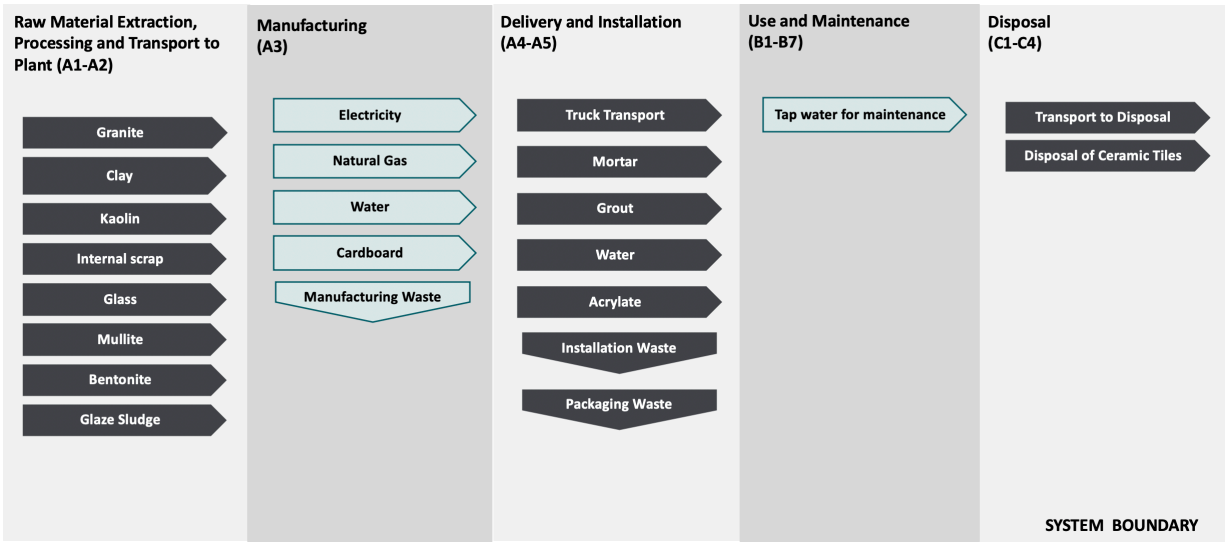

Figure 1: System Boundary

8. MANUFACTURING

The manufacturing begins with mining of raw materials such as clay, granite, mullite and other natural minerals. These raw materials are then mixed with water in a ball mill. The slurry formed in this process is the body slip which will form the bulk of the ceramic tile. Next the slip is pumped to the spray dryer. This device uses burners and gravity to form a powder. The resulting powder is then extruded into the form of a pre-fired or "green" tile. The green tiles pass through a drying apparatus to further reduce moisture content. From there the tiles proceed down the glaze line for application. Tiles are then stored in a buffer area for a short time before proceeding to another dryer. After the final dryer, the product is then fed into the kiln. Inside the kiln thermochemical reactions take place that remove all VOCs and fuse the ceramic tile into the familiar solid and durable product.

The entire process incorporates extensive recycling. Fireclay collects glass bottles through municipal recycling programs and crushes them, procures granite fines from quarries and uses internal scrap from their manufacturing process into their product.

Once the tiles are manufactured, they are packaged in cardboard boxes.

9. MATERIAL COMPOSITION

Table 2: Material Composition

Component	Material	Ceramic Tile (with recycled content)
Body	Granite	17.06%
	Clay	19.19%
	Kaolin	6.40%
	Internal Scrap	16.47%
	Glass (Post- Consumer)	16.47%
	Mullite	23.46%
	Bentonite	0.7%
Glaze Sludge	Frits	0.23%
	Kaolin	0.02%
	Alumina	0.003%
	Iron Oxide	0.001%
	Stain	0.006%
	Additives	0.004%

10. PACKAGING

Table 3: Packaging Inputs

Input per sq. m	Values	Unit
Cardboard	0.2	kg

Packaging waste disposal have been modeled as per guidelines in section 2.8.5 of Part A: Life Cycle Assessment Calculation Rules and Report Requirements.

11. PRODUCT INSTALLATION

Product installation requirements and procedure are provided in guidelines by Tile Council of North America (TCNA). Mortar is used to adhere tile to the floor substrate while grout is used to fill in gaps between the tiles. 4.5% of waste is assumed for mortar and grout. Apart from these, installation solution made of acrylate and water are also recommended for installation. Installation inputs are detailed in Table 4.

Table 4: Installation Inputs

Material	Amount	Unit	Amount	Unit
Mortar (density - 1282 kg/m^3)	4.07	kg/m2	0.83	lb/ft2
Grout	0.212	kg/m2	0.043	lb/ft2
Water	0.37	kg/m2	0.075	lb/ft2
Acrylate	0.043	kg/m2	0.008	lb/ft2
Waste for mortar	4.5	%	4.5	%
Waste for grout	4.5	%	4.5	%

12. USE CONDITIONS

As recommended by the Tile Council of North America (TCNA), ceramic tile floors are cleaned with dust mops daily and with a damp mop 36 times a year for commercial flooring applications. Damp mopping requires the use of tap water for cleaning. The impacts from the mops itself as multi-use tools are considered to be negligible per functional unit. Since the reference service life of porcelain tiles is 75 years, which is as long as the estimated service life of the building, there are no replacements of tiles over the course of the lifetime of the building. Use phase conditions and inputs are provided in Tables 5 and 6 respectively.

Table 5: Use Phase Parameters

Use	Cleaning Process	Cleaning Frequency	Consumption of energy and resources
Commercial	Dust mop	365 times/ year	-
	Damp mop	36 times/ year (Commercial)	Tap water

Table 6: Use Phase Inputs

	Amount	Unit
Tap water	0.783	l/m2/yr

13. PRODUCT REFERENCE SERVICE AND BUILDING ESTIMATED SERVICE LIFE

According to Part A: Life Cycle Assessment Calculation Rules and Report Requirements, UL Environment, V3.2, 2018, the Estimated Service Life (ESL) of the building is assumed to be 75 years. Since ceramic tiles are expected to last as long as the building itself, the Reference Service Life (RSL) of ceramic tiles is taken to be 75 years.

14. DISPOSAL

All waste has been classified according to regional-specific legislation as laid out in Section 2.8.6 in Part A: Life Cycle Assessment Calculation Rules and Report Requirements from UL Environment. Ceramic being a non-metal, all of it is landfilled at end-of-life as per the aforementioned PCR.

1. FUNCTIONAL UNIT

The functional unit according to the PCR is 1 m^2 of finished flooring. The function of a floor covering is to cover and protect the flooring substrate.

Table 7: Functional Unit

	Fireclay
Functional Unit [m^2]	1
Average Weight [kg]	17.57

2. SYSTEM BOUNDARY

This EPD is considered a Cradle-to-Grave study. A summary of the life cycle modules included in this EPD is presented in Table 8. Infrastructure flows have been excluded.

Table 8: Summary of Included Life Cycle Modules

Module Name	Description	Analysis Period	Summary of Included Elements
A1	Product Stage: Raw	2019	Raw Material sourcing and processing as defined by secondary data.
A2	Product Stage: Transport	2019	Shipping from supplier to manufacturing site. Fuel use requirements estimated based on product weights and measured and calculated distance.
A3	Product Stage: Manufacturing	2019	Energy, water and material inputs required for manufacturing products from raw materials. Packaging materials and manufacturing waste are included as well.
A4	Construction Process Stage: Transport	2019	Shipping from manufacturing site to project site. Fuel use requirements estimated based on assumed distance recommended by the PCR (Part B).
A5	Construction Process Stage: Installation	2019	Installation materials, installation waste and packaging material waste.
B1	Use Stage: Use	2019	Use of the product.
B2	Use Stage: Maintenance	2019	Cleaning water.
B3	Use Stage: Repair	2019	Ceramic tile typically does not need to be repaired.
B4	Use Stage: Replacement	2019	No inputs required for replacement manufacturing. Ceramic tile does not need to be replaced for over 75 years.
B5	Use Stage: Refurbishment	2019	Ceramic tile is typically not refurbished.
B6	Operational Energy Use	2019	Operational Energy Use of Building Integrated System During Product Use not affected due to ceramic tiles
B7	Operational Water Use	2019	Operational Water Use of Building Integrated System During Product Use not affected due to ceramic tiles
C1	EOL: Deconstruction	2019	No inputs required for deconstruction.
C2	EOL: Transport	2019	Shipping from project site to landfill. Fuel use requirements estimated based on product weight and assumed distance recommended by the PCR (Part B).
C3	EOL: Waste Processing	2019	Waste processing not required. All waste can be processed as is.
C4	EOL: Disposal	2019	Assumes all products are sent to landfill. Landfill impacts modeled based on secondary data.
D	Benefits beyond system	MND	Credits from energy or material capture.

3. ESTIMATES AND ASSUMPTIONS

All estimates and assumptions are within the requirements of ISO 14040/44. The majority of the estimations are within the primary data. Some assumptions made in the study that may have affected the results are:

- The primary data was collected as annual totals including all utility usage and production information. For the LCA, the usage information was divided by the production to create an energy and water use per square meter.
- Installation tools are used enough times that the per square meter impacts are negligible.
- Materials required for installation were assumed to be as recommended by Tile Council of North America (TCNA). In reality, these material quantities and application rates may not be used thus changing the overall impact.
- Use phase scenarios are also taken as per TCNA guidelines from the industry wide EPD. However, use phase scenarios have a high degree of variability based on user preferences which might affect overall results.
- The disposal pathways and the corresponding transportation distances of unused product waste, packaging waste, and post-consumer product waste are assumed in accordance with the PCR.
- The inclusion of overhead energy, water and waste data was determined appropriate due to the inability to sub-meter and isolate manufacturing energy from overhead energy.
- The use and selection of secondary datasets from GaBi – The selection of which generic dataset to use to represent an aspect of a supply chain is a significant value choice. Collaboration between LCA practitioner, Fireclay associates and GaBi data experts was valuable in determining best-case scenarios in the selection of data. However, no generic data can be a perfect fit. Improved supply chain specific data would improve the accuracy of results, however budgetary and time constraints have to be taken into account.

4. CUT-OFF RULES

Material inputs greater than 1% (based on total mass of the final product) were included within the scope of analysis. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impact. Cumulative excluded material inputs and environmental impacts are less than 5% based on total weight of the functional unit. Tools used during installation are reused after each install, thus the per-declared unit impacts are considered negligible and not included. All GaBi datasets have been critically reviewed and conform to the exclusion requirement of the PCR, Part A: “Calculation Rules for the Life Cycle Assessment and Requirements on the Background Report”.

No known flows are deliberately excluded from this EPD.

5. DATA SOURCES

Primary data was collected onsite by Fireclay associates. All calculation procedures adhere to ISO14044. Data collection forms were used to survey Fireclay of the materials inputs, energy inputs, waste outputs, and raw material supplier information as well as packaging inputs for the year 2019.

6. DATA QUALITY

The geographical scope of the manufacturing portion of the life cycle is the United States. All primary data were collected from the manufacturer for the calendar year 2019. The geographic coverage of primary data is considered excellent.

In selecting secondary data (i.e. GaBi Datasets), priority was given to the accuracy and representativeness of the data. Geographic coverage was considered in assessing representativeness. When available and deemed of significant quality, country-specific data was used. However, priority was given to technological relevance and accuracy in selecting secondary data. This often led to the substitution of regional and/or global data for country-specific data. Overall geographic data quality is considered good. No known processes or flows have been deliberately excluded from the study.

7. PERIOD UNDER REVIEW

The period under review is calendar year 2019.

8. ALLOCATION

General principles of allocation were based on ISO 14040/44. There are no products other than porcelain tiles that are produced as part of the manufacturing processes studied in the LCA. Since there are no co-products, no allocation based on co-products is required. To derive a per unit value for manufacturing inputs such as electricity, natural gas and water, allocation based on total production in square meters was adopted. Discussions with Fireclay staff divulged this was a more representative way than via mass to allocate the manufacturing inputs based on the manufacturing processes used and the types of products created. As a default, secondary GaBi datasets use a physical mass basis for allocation. Throughout the study recycled materials were accounted for via the cut-off method. Under this method, impacts and benefits associated with the previous life of a raw material from recycled stock are excluded from the system boundary. Additionally, impacts and benefits associated with secondary functions of materials at end of life are also excluded (i.e. production into a third life or energy generation from the incineration plant). The study does include the impacts associated with reprocessing and preparation of recycled materials that are part of the bill of materials of the products under study.

9. COMPARABILITY AND BENCHMARKING

The user of the EPD should take care when comparing EPDs from different companies. Assumptions, data sources, and assessment tools may all impact the variability of the final results and make comparisons misleading. Without understanding the specific variability, the user is therefore, not encouraged to compare EPDs. Even for similar products, differences in use and end-of-life stage assumptions, and data quality may produce incomparable results. Comparison of the environmental performance of flooring products using EPD information shall be based on the product's use and impacts at the building level, and therefore EPDs may not be used for comparability purposes when not considering the building energy use phase as instructed under this PCR. Full conformance with the PCR for flooring products allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

Table 9: Transport to building site (A4)

Name	Truck	Plane	Ship	Unit
Fuel type	Diesel	Kerosene	Heavy Fuel Oil	-
Liters of fuel	39.06	0.67	0.004	l/100km
Vehicle type	Heavy duty diesel truck/ 50,000 lb payload	Cargo plane, 65 t payload	Container Ship 5000 to 200,000 dwt payload capacity, ocean going	-
Transport distance	2,250.90	406	242	km
Capacity utilization	65	66	70	%
Weight of products transported	20,411.657	65,000	311.03	kg
Capacity utilization volume factor	1	1	1	-

Table 1: Reference Service Life

Name	Value	Unit
RSL	75	years
Declared product properties (at the gate) and finishes, etc.	See Table 1	-
Design application	Installation per recommendation by manufacturer	-
An assumed quality of work, when installed in accordance with the manufacturer's instructions	Accepted industry standard	-
Indoor environment (if relevant for indoor applications)	Normal building operating conditions	-
Use conditions, e.g. frequency of use, mechanical exposure	Normal building operating conditions	-

Table 10: Installation into the building (A5)

Name	Fireclay	Unit
Net freshwater consumption specified by water source and fate	0.0004 m^3 tap water, installation solution	m^3
Grout	0.212	kg/m^2
Mortar	4.07	kg/m^2
Acrylate	0.043	kg/m^2
Waste materials at the construction site before waste processing, generated by product installation	2.09	kg/m^2
Product loss per functional unit	5	%
Packaging waste, cardboard	0.887	kg/m^2
Packaging waste, plastic strap	0.0503	kg/m^2
Biogenic carbon contained in packaging	3.14	kg CO_2
Direct emissions to ambient air, soil and water	0	kg
VOC emissions	N/A	$\mu g/m^3$

Table 11: A5 Product Packaging Waste (per m^2)

Module	Parameter	Disposal mechanism	Value	Unit
A5 Installation of the product	Cardboard packaging waste	Recycled (75%), Landfilled (20%), Incinerated (5%)	0.2	kg

Table 2: Maintenance (B2)

Name	Value	Unit
Maintenance process information	Use phase parameters as recommended by TCNA guidelines	
Dust mop	27,375	Cycles/ RSL and Cycles/ ESL
Damp mop (Commercial)	2,700	Cycles/ RSL and Cycles/ ESL
Damp mop (Residential)	300	Cycles/ RSL and Cycles/ ESL
Net freshwater consumption specified by water source and fate	0.05 m^3 tap water, evaporated	m^3
Further assumptions for scenario development	Floor cleaned with dust mop daily and with damp mop 36 times/year for commercial applications and 4 times/year for residential applications	

Table 13: End-of-Life Parameters (C1-C4)

	Disposal Mechanism	Values	Unit
Collected as mixed construction waste	-	22.3	kg
Waste to be processed	100% Landfilled	22.3	kg

Tile is not routinely recycled or incinerated, and as such, module D is not declared in this study.

All results are given per functional unit, which is 1 m^2 of installed flooring over an estimated building life of 75 years. Environmental impacts were calculated using the GaBi software platform. Impact results have been calculated using both TRACI 2.1 and CML 2001-Jan 2016 characterization factors. LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. These six impact categories are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development, however the EPD users shall not use additional measures for comparative purposes.

	PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
Cradle to Grave	X			X	X	X	X	X	X	X	X	X	X	X	X	X	MND

An X in the table above signifies that a module was included in the life cycle assessment. MND stands for Module Not Declared and signifies that a life cycle stage was not evaluated in the life cycle assessment.

Figure 2: Description of the system boundary modules

See Impact Category Key below for definition of acronyms.

Table 14: Acronym Key

Acronym	Text	Acronym	Text
Impact Categories			
ADP-elements	Abiotic depletion potential for non-fossil resources	**GWP**	Global warming potential
ADP-fossil	Abiotic depletion potential for fossil resources	**ODP**	Depletion of stratospheric ozone layer
AP	Acidification potential of soil and water	**POCP**	Photochemical ozone creation potential
EP	Eutrophication potential	**Resources**	Depletion of non-renewable fossil fuels
LCI Indicators			
RPR_E	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	**SM**	Use of secondary materials
RPR_M	Use of renewable primary energy resources used as raw materials	**RSF**	Use of renewable secondary fuels
$NRPR_E$	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	**NRSF**	Use of non-renewable secondary fuels
$NRPR_M$	Use of non-renewable primary energy resources used as raw materials	**FW**	Net use of fresh water
HWD	Disposed-of-hazardous waste	**MR**	Materials for recycling
NHWD	Disposed-of non-hazardous waste	**MER**	Materials for energy recovery
HLRW	High-level radioactive waste, conditioned, to final repository	**EE**	Exported energy
ILLRW	Intermediate- and low-level radioactive waste, conditioned, to final repository	**CRU**	Components for reuse
RE	Recovered energy		

1. FIRECLAY CERAMIC TILES

1.1 CML Results

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
ADP-elements [kg Sb eq]	2.57E-05	2.07E-06	6.78E-06	0.00E+00	2.90E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.09E-08	0.00E+00	3.84E-07	MND
ADP-fossil fuel [MJ]	7.42E+02	1.62E+02	6.82E+01	0.00E+00	1.34E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.77E+00	0.00E+00	1.45E+01	MND
AP [kg SO_2 eq]	5.40E-02	3.55E-02	9.52E-03	0.00E+00	2.33E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.30E-04	0.00E+00	3.92E-03	MND
EP [kg Phosphate eq]	8.21E-03	9.04E-03	1.53E-03	0.00E+00	8.54E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.79E-04	0.00E+00	5.15E-04	MND
GWP [kg CO_2 eq]	4.64E+01	1.15E+01	5.95E+00	0.00E+00	2.52E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.67E-01	0.00E+00	9.33E-01	MND
ODP [kg CFC 11 eq]	4.60E-08	7.62E-16	2.58E-09	0.00E+00	3.22E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-17	0.00E+00	3.39E-15	MND
POCP [kg Ethene eq]	4.99E-03	1.07E-03	1.08E-03	0.00E+00	1.96E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.14E-04	0.00E+00	3.32E-04	MND

1.2 TRACI Results

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
AP [kg SO2 eq]	6.28E-02	4.66E-02	1.10E-02	0.00E+00	2.91E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.43E-04	0.00E+00	4.26E-03	MND
EP [kg N eq]	3.66E-03	3.09E-03	8.22E-04	0.00E+00	1.23E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.79E-05	0.00E+00	2.18E-04	MND
GWP [kg CO2 eq]	4.59E+01	1.15E+01	5.91E+00	0.00E+00	2.51E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.67E-01	0.00E+00	9.28E-01	MND
ODP [kg CFC 11 eq]	5.01E-08	-5.10E-14	2.86E-09	0.00E+00	-3.55E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.44E-15	0.00E+00	-4.88E-14	MND
Resources [MJ]	1.07E+02	2.17E+01	8.71E+00	0.00E+00	1.50E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.04E-01	0.00E+00	1.86E+00	MND
POCP [kg O3 eq]	1.38E+00	1.34E+00	8.35E-02	0.00E+00	5.62E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E-02	0.00E+00	8.54E-02	MND

1.3 Resource Use

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
RPR_E [MJ]	2.67E+00	2.95E-03	1.52E+00	0.00E+00	7.76E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.43E-04	0.00E+00	2.12E+01	MND
RPR_M [MJ]	9.12E-02	6.75E-03	1.48E-02	0.00E+00	5.89E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.54E-04	0.00E+00	1.76E-03	MND
$NRPR_E$ [MJ]	7.57E+02	1.63E+02	7.20E+01	0.00E+00	1.40E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.79E+00	0.00E+00	1.48E+01	MND
$NRPR_M$ [MJ]	5.98E-03	2.56E-04	1.48E-03	0.00E+00	2.34E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.39E-06	0.00E+00	1.44E-04	MND
SM [kg]	0.00E+00	0.00E+00	2.35E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RE [MJ]	0.00E+00	0.00E+00	-6.19E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
FW [m^3]	5.99E+01	1.80E+00	6.92E+00	0.00E+00	7.62E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-01	0.00E+00	1.13E+00	MND

1.4 Output Flows and Waste

Impact Category	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD [kg]	1.52E-05	4.14E-07	8.57E-07	0.00E+00	2.37E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.07E-08	0.00E+00	5.20E-08	MND
NHWD [kg]	7.51E-06	3.09E-07	1.83E-06	0.00E+00	3.47E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-08	0.00E+00	1.80E-07	MND
HLRW [kg]	5.79E+00	0.00E+00	2.90E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
ILLRW [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
CRU [kg]	0.00E+00	0.00E+00	1.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
MR [kg]	0.00E+00	0.00E+00	2.06E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+00	0.00E+00	MND
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
EE [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND

Table 15: Biogenic Carbon Uptake and Emissions

Parameter	Parameter	Ceramic Tile	Unit
BCRP	Biogenic Carbon Removal from Product	0.0824	kg CO_2
BCEP	Biogenic Carbon Emission from Product	0.0628	kg CO_2
BCRK	Biogenic Carbon Removal from Packaging	0.709	kg CO_2
BCEK	Biogenic Carbon Emission from Packaging	0.326	kg CO_2

LIFE CYCLE ASSESSMENT INTERPRETATION

Overall, the dominance analysis shows that the vast majority of the impacts for all products are in the aggregated A1-A3 phase. A1-A3 includes raw material sourcing, transportation and manufacturing. Within the sourcing and extraction phase, the largest contributors to the impacts are mullite, clay and granite in terms of raw materials. In manufacturing the largest impacts are caused by the electricity used in the facility and thermal energy used to fire the tiles in kilns. Following the A1-A3 phase is the A4 phase which includes transport of the product. Global warming impacts from the transport phase is due to heavy products being transported through air freight.

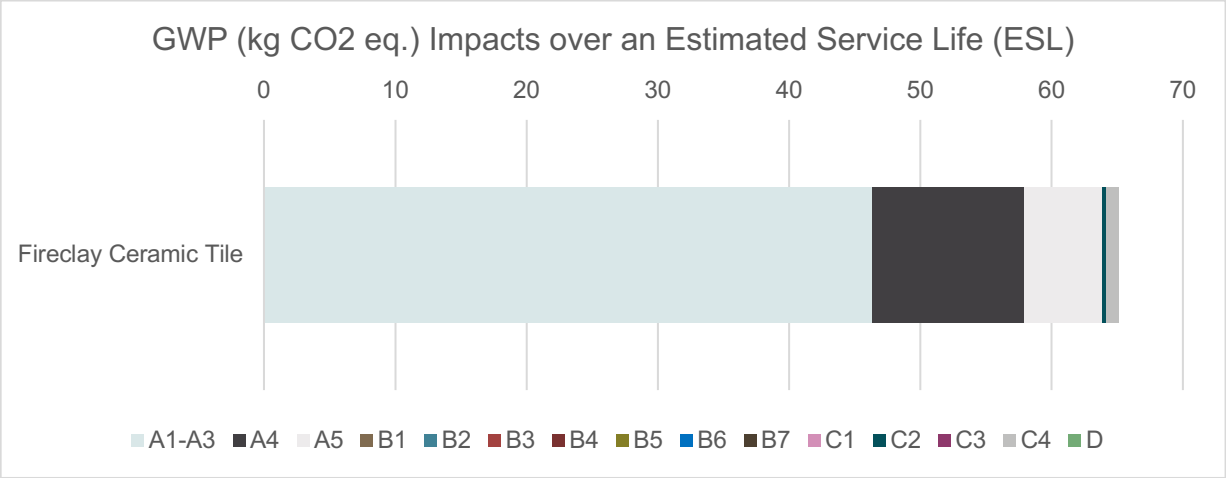

Figure 3: Dominance Analysis for GWP

Some limitations to the study have been identified as follows:

- Availability of geographically more accurate datasets would have improved the accuracy of the study.
- Since this LCA uses cut-off approach to recycled material in the product, no credit is given to product system but rather is exempted from the burden of extracting virgin material in place of using recycled material.
- Only known and quantifiable environmental impacts are considered.

Due to the assumptions and value choices listed above, these do not reflect real-life scenarios and hence they cannot assess actual and exact impacts, but only potential environmental impacts.

ADDITIONAL ENVIRONMENTAL INFORMATION

ENVIRONMENTAL ACTIVITIES AND CERTIFICATIONS:

Historically, Fireclay has offset carbon emissions from its manufacturing and shipping (scope 1) as well as emissions from the purchase and use of energy and gas (scope 2). In 2019, Fireclay took its efforts one step further by achieving a Climate Neutral Certification from the non-profit Climate Neutral.

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