

Environmental Product Declaration Vinyl Composition Tile

Vinyl Composition Tile (VCT)

According to ISO 14025



Brookwood Baptist Church, Mountain Brook, AL
CTSM Architects, Inc.

Committed to Sustainability.

Armstrong Flooring is committed to delivering solutions that reduce the environmental impact of the buildings you create, from product design and raw material selection, to how our products are produced and delivered.

This Environmental Product Declaration (EPD) was developed to document the sustainability of our products. Inside this ASTM certified ISO compliant EPD is the following:

- Product application and use
- Product ingredients and their sources
- Information on how VCT flooring is produced
- Life Cycle Assessment (LCA) results including global warming potential and primary energy usage
- Total impacts over the life cycle of the product
- Performance attributes

VCT is designed to be both durable and beautiful, making it a great product for commercial applications.

Vinyl Composition Tile

Functional Unit – 1 m² of VCT 1 year service life

LCA IMPACT* MEASURES	TOTAL
Primary Energy (MJ)	153.6
Global Warming Potential (kg CO ₂ equivalent)	7.00
Acidification Potential (kg SO ₂ equivalent)	2.74E-02
Eutrophication Potential (kg PO ₄ ³⁻ equivalent)	2.50E-03
Ozone Depletion Potential (kg R11 equivalent)	8.57E-09
Photochem Ozone Creation Potential (kg Ethene equivalent)	2.60E-03
PERFORMANCE ATTRIBUTES	
Acoustics NRC (Absorption)	0.05
Static Load (psi)	125
Light Reflectance	up to 74%
ASTM F1066	Meets

Flooring Ingredients: Limestone, Polyvinyl Chloride, Benzoate, Di (2-ethylhexyl) terephthalate (DEHT), Titanium Dioxide, Calcium Phosphate (stabilizer), Color Pigments


* Based on CML2010 Impact Factors

Visit ArmstrongFlooring.com/transparency for further information.

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This document is a Type III Environmental Product Declaration by Armstrong Flooring, Inc. that is certified by ASTM as conforming to the requirements of ISO 14025. ASTM has assessed that the Life Cycle Assessment (LCA) information fulfills the requirements of ISO 14040 in accordance with the instructions listed in the Product Category Rules (PCR) cited below. The intent of this document is to further the development of environmentally compatible and sustainable construction methods by providing comprehensive environmental information related to potential impacts in accordance with international standards.

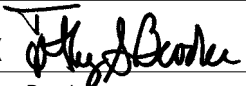

Declaration Number:	EPD-0001	
Program Operator:	ASTM International - 100 Barr Harbor Drive, West Conshohocken, PA, USA www.astm.org	
Declaration Holder:	Armstrong Flooring, Inc. - 2500 Columbia Avenue, Lancaster, PA 17603	
Declared Product	Armstrong® Vinyl Composition Tile (VCT) is a widely popular flooring tile option that is extremely durable, budget friendly, and available in multiple color options and design patterns to create virtually any tile design using straight patterning or quarter turn installation methods. In many venues such as retail groceries, educational classrooms and hallways, shopping centers, healthcare and more, VCT products continue to be selected due to their true-through pattern construction. Patterns are preserved even after years of wear, meaning that even after years of foot and rolling load traffic, the pattern of the flooring is preserved; wear is less visible and can be restored using simple maintenance methods. Armstrong VCT flooring tiles are manufactured using limestone, an abundant natural resource. The strength of the limestone characteristics help to improve the durability of the product.	
Declaration Type	Cradle-to-Grave. Intended for Business-to-Business (B-to-B) audiences. Represents Average Performance.	
Applicable Countries	U.S. and Canada, consistent with Product Category Rules for Environmental Product Declarations. Flooring: Carpet, Resilient, Laminate, Ceramic, Wood. NSF International.	
Product Application	Floor covering choice in commercial spaces: <ul style="list-style-type: none">• Hospitality• Education• Healthcare• Office• Retail• Assisted Living	
Content of the Declaration	This declaration is complete and contains in its full form: <ul style="list-style-type: none">• Product Definition• Material Content• Production of the Flooring Systems• Installation of Flooring Systems• Use Stage• Extraordinary Effects• End of Life Stage• Life Cycle Assessment• Additional Information, Evidence, Test Certificates• PCR Documentation and Verification• References	
PCR Development	<input type="checkbox"/> New or Revised <input checked="" type="checkbox"/> Existing - For details on PCR Review, contact ncss@nsf.org	
PCR Reference	Product Category Rules for Environmental Product Declarations. Flooring: Carpet, Resilient, Laminate, Ceramic, Wood. NSF International, Michael Overcash, PCR Review Chair. Per ISO 14025, environmental declarations from different programs (PCR) may not be comparable.	

EPD Date of Issue: April 4, 2014

EPD Period of Validity: April 4, 2019

Verification and Authorization of the Declaration

This declaration and the rules on which this EPD is based have been examined by an independent external verifier in accordance with ISO 14025.

			
Tim Brooke Vice President, Certification	Date April 4, 2014	Tom Gloria External Verifier	Date April 4, 2014

ASTM certification of this EPD is not to be construed as representing aesthetics or any other attributes not specifically addressed, nor should it be construed as an ASTM endorsement of the subject of the EPD or a recommendation for its use. There is no warranty by ASTM, express or implied, as to any finding or other matter in the EPD, or as to any product covered by the EPD. The EPD holder is liable for the information and evidence on which the EPD is based.

Vinyl Composition Tile (VCT)

According to ISO 14025

Summary LCA Results

Scope and Boundaries of the Life Cycle Assessment

The Life Cycle Assessment (LCA) was performed according to ISO 14040 and followed the PCR instructions. The cradle-to-grave LCA encompasses raw material production; transport of raw materials to the production facility; manufacturing of flooring; packaging; transportation to job site; use phase; and end of life including disposal or recycling. Detailed information regarding the LCA is found in Section 10.

Life Cycle Assessment Summary

Declared Unit: 1 m² of installed flooring tiles for use over 1 year, impacts based on CML 2010 Impact Factors

Table 1. Life Cycle Assessment of VCT

IMPACT MEASURE ^{1,2}	SOURCING / EXTRACTION	PRODUCTION	INSTALLATION	USE STAGE ³	END OF LIFE	TOTAL
Primary Energy (MJ)	78.0	34.1	26.4	13.3	1.8	153.6
Global Warming Potential (kg CO ₂ equivalent)	3.25	2.15	0.88	0.60	0.12	7.00
Acidification Potential (kg SO ₂ equivalent)	1.50E-02	5.20E-03	4.50E-03	2.00E-03	8.00E-04	2.74E-02
Eutrophication Potential (kg PO ₄ ³⁻ equivalent)	1.20E-03	3.00E-04	6.00E-04	2.00E-04	1.00E-04	2.50E-03
Ozone Depletion (kg R11 equivalent)	7.83E-09	5.17E-10	6.08E-11	1.59E-10	1.44E-12	8.57E-09
Photochem Ozone Creation Potential (kg Ethene equivalent)	1.60E-03	4.00E-04	1.00E-04	4.00E-04	0.00E+00	2.60E-03

¹ Additional Impact Measures are included in Section 10.

² Impact as based on CML 2001-Nov. 2010.

³ Use stage impacts are based on medium intensity maintenance practices as described in Section 7.

Additional Information

This declaration contains additional information, as listed below, that is outside the scope of the LCA. This additional information, provided by Armstrong®, has not been evaluated by ASTM, but is considered useful for the purpose of comparing this EPD to other EPDs developed from the same PCR. Guidance is recommended in comparing performance data and LCA information for products that perform the same in the areas of Acoustics, Fire Performance, Stain Resistance, Light Reflectance, Durability, Maintenance and End of Life Recyclability. Please refer to page 4 for a summary of performance attributes by item number and note the website references listed below for additional information.

- Closed Loop Recycling Program: ArmstrongFlooring.com/vctrecycling
- Resistance to Staining and Reagents: ArmstrongFlooring.com/stainresistance
- Health, Safety, and Installation Information

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Detailed LCA Results

1.0 Product Definition

1.1 Product Definition and Description

Armstrong® Vinyl Composition Tile (VCT) are limestone-based flooring tiles with a PVC binder, featuring a through-pattern construction throughout the thickness of the tile. So, after years of foot and rolling load traffic, the pattern of the flooring is preserved; wear is less visible and can be restored using simple maintenance methods. VCT is manufactured by Armstrong Flooring, Inc. in Jackson, Mississippi (39204), Kankakee, Illinois (60901), and South Gate, California (90280).

2.0 Product Application






Commercial Interior Finish. To achieve consistent, high-quality installation of all products in our flooring portfolio, we have created the Armstrong® Guaranteed Installation Systems manual, F-5061. This comprehensive guide to Armstrong flooring installation provides all the information needed to properly install Armstrong VCT and ensure it will look great and perform exactly as it should. This document can be referenced at: <http://www.ArmstrongFlooring.com/commflooringna/guaranteed-installation-systems.html>

3.0 Product Performance Attributes

All Armstrong® Vinyl Composition Tile meets or exceeds the performance requirements of ASTM F1066, Standard Specification for Vinyl Composition Floor Tile and ISO 10595, Resilient floor coverings – Semi-flexible/vinyl composition (VCT) floor tiles – Specification. VCT is the most economical and widely used commercial resilient flooring option and is routinely used with great success in the mercantile and education segments. Properly installed and maintained, VCT provides decades of proven performance across all commercial segments.

3.1 Performance Selection

Table 2. Performance of VCT

ITEMS INCLUDED IN THIS EPD	ATTRIBUTES	
Armstrong® Vinyl Composition Tile (Note: Premium High Recycled Content Products including Raffia and Chromaspin are included in a separate EPD)	 NRC 0.05	 PSI - 125
Installation Materials: Armstrong S-700 and S-750 Tile Adhesives and S-515 or S-525 High Moisture Tile Adhesives	 Light Reflectance up to 74%	 R-Value = 0.07 [ft² F h/Btu]
Maintenance Materials: Armstrong S-495 Commercial Floor Sealer, S-480 Commercial Floor Finish and S-485 Commercial Floor Cleaner (Neutral Detergent)	 Recyclable	

3.2 Key Selection Attributes

Armstrong® VCT is designed for high traffic areas and durable performance against static load (bookcases, desks, retail product shelving, display racks, etc.) and heavy rolling loads (medical equipment, patient beds, produce carts, inventory, book carts, etc). The durable, through-pattern construction means that even in the highest traffic venues, the wear is less visible. The vibrant colors and stylish pigmentation chips add style to this well-known product brand sold throughout the world. All Armstrong VCT flooring products are FloorScore® certified and are tested and comply with the requirements of the California Department of Public Health Standard Method for the Testing & Evaluation of VOC Emissions (CDPH V1.1., 2010). Armstrong's commitment to the environment includes periodic review of current processes as new technologies become available along with the inclusion of recycled content in all VCT products. Armstrong VCT can be recycled through our Armstrong® Reclamation Program, a takeback program that takes product out of landfill channels and incorporates these post-consumer products into new products.

Vinyl Composition Tile (VCT)

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4.0 Product Characteristics

Table 3. Product Characteristics of Vinyl Composition Tile

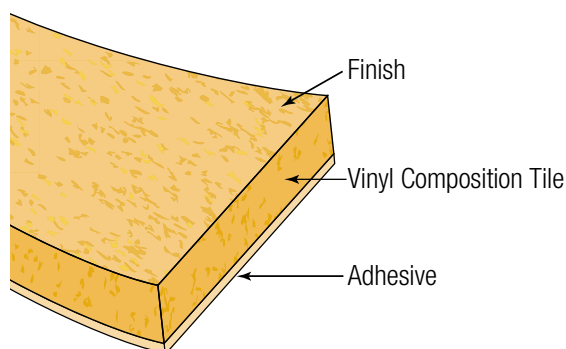
COMMERCIAL TILE CHARACTERISTICS				
PRODUCT	TILE DIMENSION (IN.)	THICKNESS (IN.)	AVERAGE WEIGHT (LBS/FT ²)	AVERAGE WEIGHT (kg/m ²)
Vinyl Composition Tile	12 x 12	0.125	1.4	6.84
	18 x 18			

5.0 Material Content

5.1 Definitions

- **Finish** – A field applied finish to protect the flooring.
- **Vinyl Composition Tile** – Through-pattern homogenous composite tile consisting of limestone (filler), polyvinyl chloride (binder), plasticizers, stabilizers, and color pigment.
- **Adhesive** – A field applied substance used to fasten the VCT to the subfloor.

Figure 1. Composition of Installed VCT



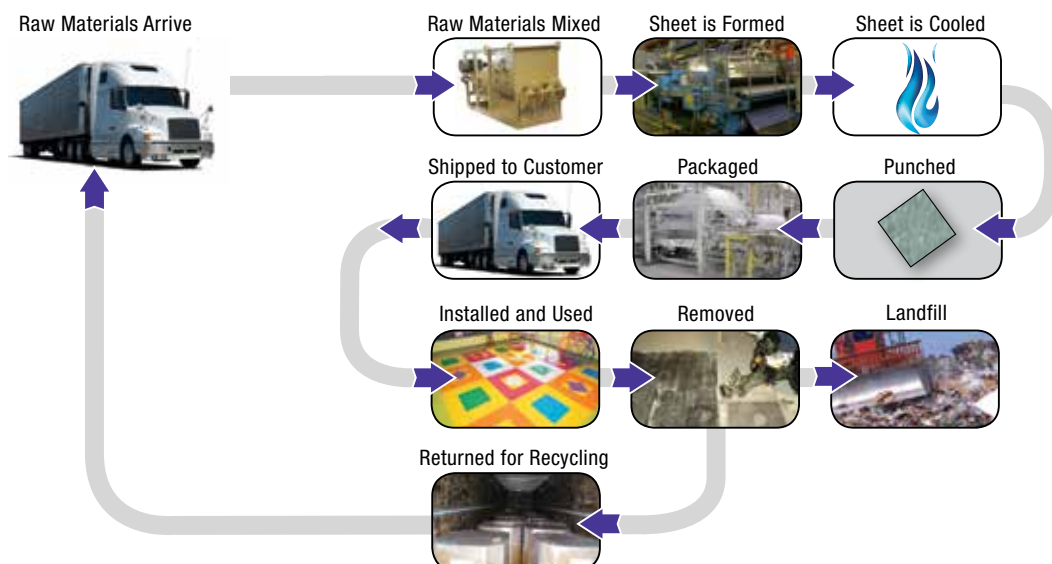
5.2 Production of Main Materials

- **Calcium Carbonate** (Limestone) – An abundant mineral used as an inert filler.
- **Polyvinyl Chloride (PVC)** – A synthetic resin made from the polymerization of vinyl chloride.
- **Plasticizer** – Makes vinyl soft and flexible.
- **Titanium Dioxide** – An abundant mineral used as a pigment for whitening.
- **Pigments** – Coloring agents.
- **Stabilizer** – Prevents degradation associated with direct or indirect impacts of heat and ultraviolet light.
- **Recycled Material** – Consist of either pre- or post- consumer materials as defined by ISO 14021 and may contain a combination of one or more product ingredients such as binder, filler or plasticizer.

Vinyl Composition Tile (VCT)
According to ISO 14025
5.0 Material Content (continued)
Table 4. Material Content of Vinyl Composition Tile to a Concentration of a 1,000 ppm (0.1%)

COMPONENT*	MATERIAL	CASRN	MASS %	AVAILABILITY		ORIGIN	TRANSPORTATION MODE
Filler	Calcium Carbonate (Limestone)	1317-65-3	84%	Abundant Mineral	Non-renewable	U.S.	Truck/Rail
Binder	Polyvinyl Chloride (PVC)	9002-86-2 9003-22-9	10%	Fossil Limited	Non-renewable	U.S.	Truck/Rail/Ship
Plasticizer	Di (2-ethylhexyl) terephthalate (DEHT)	6422-86-2	4.5%	Fossil Limited	Non-renewable	U.S.	Truck
	Blended Dibenzoates	120-55-8 21738-31-4 19224-26-1					
	Dibutyl terephthalate (DBT)	1962-75-0					
Pigment	Titanium Dioxide	13463-67-7	0.5%	Abundant Mineral	Non-renewable	U.S.	Truck
	Colored Pigments	Various	<0.1%	Abundant Mineral	Non-renewable	U.S.	Various
Stabilizer	Calcium Zinc Compound	1305-62-0 553-72-0 120-46-8	<0.1%	Abundant Mineral	Non-renewable	U.S.	Truck

*On average, recycled materials make up 1% of this product and are a combination of one or more of the above materials.

5.2 Production of VCT
Figure 2. Process for Manufacturing VCT


Vinyl Composition Tile is floor tile primarily used in commercial flooring applications and is comprised mostly of limestone in a vinyl binder matrix. The manufacturing process involves the hot mixing of the raw materials milled and calendered into a hot sheet that is then cooled before punching into floor tiles. The most popular size today is the 12" x 12" tile. Most VCT will have a factory applied finish to protect the tile face during packaging and installation.

After packaging, the VCT is shipped and installed. At the end of its useful life, the VCT can be recycled or directed to an approved landfill site. In addition, recycled VCT can be returned to Armstrong as part of a closed loop recycling process to be used to produce new Vinyl Composition Tiles.

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5.3 Health, Safety, and Environmental Aspects During Production

Armstrong has a comprehensive Environmental, Health, and Safety Management Program. Risk reduction begins in the product design process. All products go through a safety, health, and environmental review prior to sale. Armstrong also has a long standing commitment to the safety and health of all our employees. The company's Safety Management Program is considered to be World Class. Our OSHA recordable incident rate is below 1.0, meaning there is less than one injury per 100 employees per year. All employees view safety as a key responsibility of their jobs. In 2010, Armstrong was named one of "America's Safest Companies" by EHS Today.

Armstrong is equally committed to reducing our environmental impact. As with safety goals, each manufacturing facility has annual environmental plans, tailored to meet goals on energy, water, and waste reduction. Armstrong is a registered member with The Climate Registry. This means the company gets third-party verification of our global greenhouse gas (GHG) inventories, which are then made publicly available. As part of this effort, the cumulative energy usage by our facilities is reported in the Armstrong® Climate Registry certification.

6.0 Installation of Vinyl Composition Flooring Tiles

6.1 Installation Recommendations

The Vinyl Composition Tile must be installed in strict accordance with the current edition of the Armstrong® Guaranteed Installation Systems manual, F-5061. This comprehensive guide to Armstrong flooring installation provides all the information needed to properly install Armstrong VCT and ensure it will look great and perform exactly as it should. You can reference this document at: <http://www.ArmstrongFlooring.com/commflooringna/guaranteed-installation-systems.html>

6.2 Health, Safety, and Environmental Aspects During Installation

There are no recognized systemic hazards associated with installing VCT flooring.

6.3 Waste

Installation waste is minimized by the modular aspect of the VCT flooring. A conservative 3% waste factor was assumed on-site during construction. This value is based on historic internal studies which have documented the quantity of scrap that is generated at the job site due to needed border cuts, penetrations, or installer mistakes. While this material can be and is recycled from some jobs, in this case, it is assumed that all of the on-site scrap material will be sent to a landfill located within 50 miles of the job site.

6.4 Packaging

Armstrong® Vinyl Composition Tiles are packaged in a recyclable corrugated box. Wooden pallets are used to protect unit loads during shipping.

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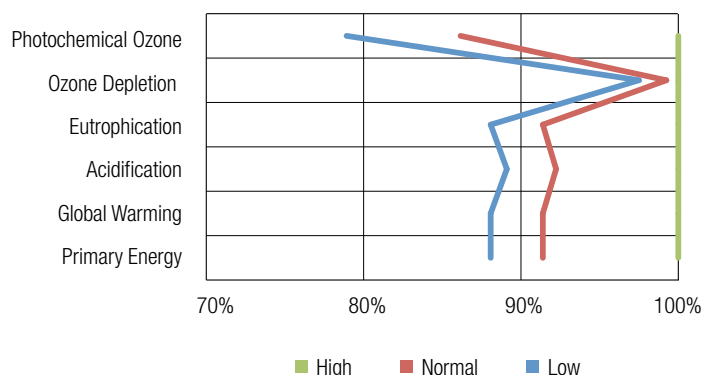
7.0 Use Stage

For this study, it was assumed that VCT would last 25 years and therefore would need to be replaced 2.4 times over the building's useful life if properly installed and maintained. The useful life indicated in the PCR for flooring is 60 years. Recommended maintenance practices are provided in the Armstrong® Installation Guide and required as part of the warranty. Warranty details can be found at <http://www.ArmstrongFlooring.com/commflooringna/technical-downloadcenter.asp>. For VCT, the recommended maintenance is representative of medium intensity maintenance, as shown in Table 5 and Figure 3. Because maintenance procedures often vary depending on the building owner's maintenance practices, level of use, and traffic conditions, Table 5 provides low, medium and high maintenance scenarios. The normalized environmental impacts associated with these hypothetical scenarios are shown in Figure 3. The low intensity maintenance scenario results in lower environmental impacts. For example, less scrubbing means less water consumption and a lower eutrophication potential.

Table 5. Estimated Maintenance Intensity for VCT

MAINTENANCE SCHEDULE	NUMBER OF TIMES PERFORMED IN 1 YEAR (365 DAYS)		
	LOW	MEDIUM	HIGH
Sweep /Dry Mop	260	260	260
Damp Mop	26	52	104
Scrubbing	6	12	24
Stripping / Floor Finish	1	2	4

Figure 3. LCA Results for Estimated Maintenance Intensity (1 Year)



7.1 Cleaning and Maintenance

Recommended cleaning and maintenance can be found in Armstrong® Installation and Maintenance Guides: http://www.armstrong.com/commflooringna/product_details_toolbox_magnify.jsp?item_id=47126

7.2 Health Aspects During Usage

All Armstrong® VCT flooring products are FloorScore® certified and are tested and comply with the requirements of the California Department of Public Health Standard Method for the Testing & Evaluation of VOC Emissions (CDPH V1.1., 2010).

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8.0 Extraordinary Effects

8.1 Fire Performance

Vinyl Composition Tile demonstrates the following fire performance:

- Class 1 when tested in accordance with ASTM E 648/NFPA 253, Standard Test Method for Critical Radiant Flux
- Meets 450 or less when tested in accordance with ASTM E 662/NFPA 258, Standard Test Method for Smoke Density
- Flame Spread Index – 25 and Smoke Developed Index 50 or less when tested in accordance with CAN/ULC S102.2, Standard Test Method for Flame Spread Rating and Smoke Development

8.2 Insulation Value

ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Flow Meter Apparatus

R-value = 0.07 [ft² F h/Btu] R-value = 0.013 [m² K/W]

9.0 End of Life Stage

9.1 Recycling or Reuse

The preferred method for Vinyl Composition Tiles is to be recycled through the Armstrong® Reclamation Program for VCT. Contact our Recycling Center at 877 276 7876 (press option 2, then 7), or visit www.ArmstrongFlooring.com/VCTRecycling. Armstrong started reclaiming and recycling flooring tiles in 2007 in Australia and in 2009 in North America. Through 2013, Armstrong has recycled over 10 million pounds of post consumer VCT flooring tiles into Vinyl Composition Tiles.

9.2 Disposal

Disposal in municipal landfill or commercial incineration facilities is permissible and should be done in accordance with local, state, and federal regulations.

10.0 Life Cycle Assessment

This study provides life cycle inventory and environmental impacts relevant to Armstrong® flooring systems. This LCA was conducted to 1) better understand the environmental impacts of the life cycle of flooring systems; 2) learn how the impacts of raw material selection, product formulation, and manufacturing process influence the life cycle impacts of flooring systems, and 3) use innovation to drive reduction in the product.

The methods for conducting the life cycle assessments, upon which this EPD is based, were consistent with ISO 14040 and 14044. This report is intended to fulfill the reporting requirements in Section 5 of ISO 14044 and the Product Category Rules for Flooring: Carpet, Resilient, Laminate, Ceramic, Wood.

10.1 Information on the Product System Definition and Modeling of the Life Cycle

The functional unit for this EPD is 1 m² of VCT for use over 1 year.

Flooring System View: In order to understand the complete view of a flooring system, life cycle information is included for the total flooring system based on 1 square meter (m²) view. This includes the flooring tile, adhesives and finishes applied during the use stage.

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10.0 Life Cycle Assessment (continued)

System Boundaries:

The system boundaries studied as part of this life cycle assessment include extraction of primary materials, raw materials manufacture, flooring panel production, installation, and end of life.

The phases below outline a “cradle-to-grave” life cycle assessment for flooring tiles (Figure 4).

Figure 4. Life cycle phases included for the Vinyl Composition Tile in study:

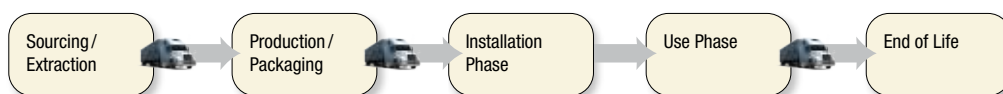
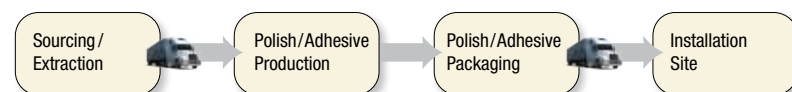


Figure 5. Life cycle phases included in the adhesive and polish used during the use stage of the study:



As Shown in Figures 4 and 5, the Cradle-to-Grave Assessment Includes:

- Raw materials production including raw material and packaging materials for Vinyl Composition Tiles, adhesive and polish
- Transportation of raw materials to the manufacturing facility
- Manufacturing of the tiles at the manufacturing facility
- Packaging of finished products including energy to operate packaging equipment
- Transportation from manufacturing facility to distribution centers, retailers, and job site (assumed to be 500 miles by truck)
- Use phase covers a useful life of 60 years as required by the PCR and includes the transportation and installation of the system including adhesive, polish and maintenance
- End of life includes landfill disposal of Vinyl Composition Tiles with assumed 50 miles by truck

The Cradle-to-Grave Assessment Excludes:

- Overhead energy usage (heating, lighting) of manufacturing facilities
- Maintenance and operation of support equipment

Vinyl Composition Tile (VCT)

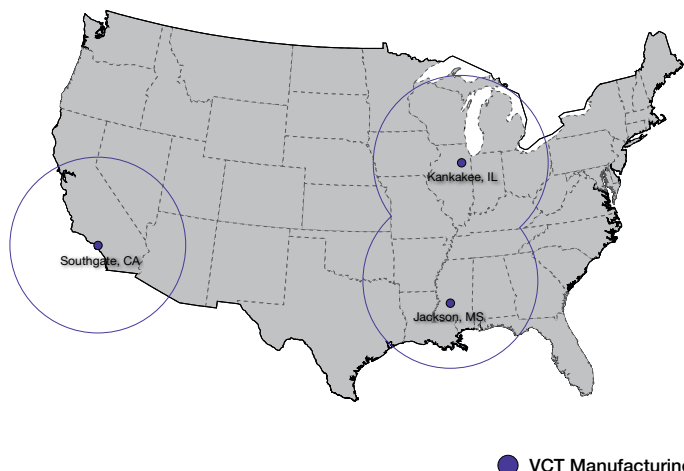
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10.0 Life Cycle Assessment (continued)

Assumptions:

Armstrong Flooring, Inc. began conducting life cycle assessments in 2006 and completed a baseline LCA of key flooring products in 2012. All data is reported as a North American weighted average across our flooring plant locations. The majority of Armstrong® flooring products are distributed within 500 miles of the respective manufacturing plants. The same distribution trucks that take material to distribution centers backhaul post-consumer flooring tiles to the manufacturing plants as part of our closed loop reclamation program. If product is not recycled, disposal transportation at end of life is assumed to be 50 miles.

This map shows the location of Armstrong manufacturing facilities with a circle denoting a 500-mile radius from each location. Transportation emissions and fuels throughout the life cycle phases are included. All transportation associated with raw materials reflects the actual modes of transportation and mileage with the exception of recycled flooring which assumes a transportation distance of 500 miles by truck.



Cutoff Criteria:

The cutoff criteria for the study are as follows:

- Mass – If a flow is less than 1% of the cumulative mass of the model, it is excluded, providing its environmental relevance is not a concern.
- Energy – If a flow is less than 1% of the cumulative energy of the model, it is excluded, providing its environmental relevance is not a concern.
- Environmental relevance – If a flow meets the above criteria for exclusion, yet is believed to potentially have a significant environmental impact, it is included.

Data Quality:

The LCA model was created using the GaBi 6 Software system for life cycle engineering, developed by PE INTERNATIONAL GmbH. The GaBi database provides the life cycle inventory data for several of the raw and process materials obtained from the background system. The data quality is considered to be good to high quality. With the exception of supplier specific data, all other relevant background data was taken from the GaBi database software. No data set was over 10 years old.

All gate-to-gate, primary foreground data was collected for the flooring manufacturing process. This foreground data was from annual production for the year of 2011. Background data was collected from suppliers or generic data was used. When generic data was used, it was verified and triangulated against several sources.

Allocation:

Co-Product Allocation – No co-product allocation occurs in the product system.

Multi-Input Processes Allocation – No multi-input allocation occurs in the product system.

Reuse, Recycling, and Recovery Allocation – The cut-off allocation approach is adopted in the case of any recycled content, which is assumed to enter the system burden-free. Only environmental impacts from the point of recovery and forward (e.g., collection, sorting, processing, etc.) are considered.

Product and packaging waste is modeled as being disposed in a landfill rather than incinerated or recycled. Plastic and other construction waste is assumed to be inert in landfills so no system expansion or allocation is necessary as landfill gas is not produced. In the case of bio-based packaging waste disposed during installation, landfill gas from the decomposition of this waste is assumed to be collected and used to produce electricity. It is assumed that this recovered energy offsets energy produced by the US average grid.

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10.0 Life Cycle Assessment (continued)

10.2 Results of the Life Cycle Assessment

The LCA results are documented separately for the following stages:

1. Sourcing/Extraction
2. Production
3. Installation
4. Use Phase
5. End of Life

Table 6 shows the results for 1 m² of Vinyl Composition Tile installed and maintained for one year.

Table 6. LCA of VCT for 1 m² of installed VCT flooring including medium intensity maintenance for 1 year

IMPACT MEASURE ^{1,2}	SOURCING / EXTRACTION	PRODUCTION	INSTALLATION	USE PHASE ³	END OF LIFE	TOTAL
1 Year Use						
Primary Energy (MJ)	78.0	34.1	26.4	13.3	1.8	153.6
Global Warming Potential (kg CO ₂ equivalent)	3.25	2.15	0.88	0.60	0.12	7.00
Acidification Potential (kg SO ₂ equivalent)	1.50E-02	5.20E-03	4.50E-03	2.00E-03	8.00E-04	2.74E-02
Eutrophication Potential (kg PO ₄ ³⁻ equivalent)	1.20E-03	3.00E-04	6.00E-04	2.00E-04	1.00E-04	2.50E-03
Ozone Depletion Potential (kg R11 equivalent)	7.83E-09	5.17E-10	6.08E-11	1.59E-10	1.44E-12	8.57E-09
Photochem Ozone Creation Potential (kg Ethene equivalent)	1.60E-03	4.00E-04	1.00E-04	4.00E-04	0.00E+00	2.60E-03
60 Year Use						
Primary Energy (MJ)	187.0	81.7	63.2	800.9	4.3	1137.1
Global Warming Potential (kg CO ₂ equivalent)	7.80	5.20	2.10	36.20	0.30	51.50
Acidification Potential (kg SO ₂ equivalent)	3.59E-02	1.24E-02	1.09E-02	1.23E-01	1.80E-03	1.84E-01
Eutrophication Potential (kg PO ₄ ³⁻ equivalent)	2.80E-03	8.00E-04	1.60E-03	1.29E-02	3.00E-04	1.83E-02
Ozone Depletion Potential (kg R11 equivalent)	1.88E-08	1.24E-09	1.46E-10	9.56E-09	3.46E-12	2.97E-08
Photochem Ozone Creation Potential (kg Ethene equivalent)	3.90E-03	1.00E-03	3.00E-04	2.58E-02	0.00E+00	3.10E-02

¹ Additional Impact Measures are included in Section 10.

² Impact as based on CML 2001-Nov. 2010.

³ Use phase impacts are based on medium intensity maintenance practices as described in Section 7.

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10.0 Life Cycle Assessment (continued)

Table 7. Cradle to Gate Life Cycle Assessment Results for 1 m² of VCT for 1 Year

IMPACT MEASURE (CML 2001-Nov. 2010)	SOURCING / EXTRACTION	PRODUCTION	CRADLE-GATE TOTAL
Primary Energy (MJ)	78.0	34.1	112.1
Global Warming Potential (kg CO ₂ equivalent)	3.25	2.15	5.40
Acidification Potential (kg SO ₂ equivalent)	0.0150	0.0052	0.0202
Eutrophication Potential (kg PO ₄ ³⁻ equivalent)	0.0012	0.0003	0.0015
Ozone Depletion Potential (kg R11 equivalent)	7.83E-09	5.17E-10	8.35E-09
Photochem Ozone Creation Potential (kg Ethene equivalent)	0.0016	0.0004	0.0020
Abiotic Depletion, Elements (kg Sb-equivalent)	1.19E-05	4.98E-07	1.24E-05
Abiotic Depletion, Fossil (MJ)	7.00E+01	2.80E+01	98.0

Table 8. Cradle to Grave Life Cycle Assessment Results for 1 m² of VCT for 1 Year

IMPACT MEASURE (CML 2001-Nov. 2010)	CRADLE-GATE	INSTALLATION	MAINTENANCE INTENSITY			END OF LIFE	TOTAL IMPACTS (Cradle-Grave)		
			LOW	MED	HIGH		LOW	MED	HIGH
Primary Energy (MJ)	112.1	26.4	6.7	13.3	26.6	1.8	147.0	153.6	166.9
Global Warming Potential (kg CO ₂ equivalent)	5.40	0.88	0.30	0.60	1.20	0.12	6.70	7.00	7.60
Acidification Potential (kg SO ₂ equivalent)	0.0202	0.0045	0.0010	0.0020	0.0040	0.0008	0.0265	0.0275	0.0295
Eutrophication Potential (kg PO ₄ ³⁻ equivalent)	0.0015	0.0006	0.0001	0.0002	0.0004	0.0001	0.0023	0.0024	0.0026
Ozone Depletion Potential (kg R11 equivalent)	8.35E-09	6.08E-11	7.95E-11	1.59E-10	3.18E-10	1.44E-12	8.49E-09	8.57E-09	8.73E-09
Photochem Ozone Creation Potential (kg Ethene equivalent)	0.0020	0.0001	0.0002	0.0004	0.0008	0.0000	0.0023	0.0025	0.0029
Abiotic Depletion, Elements (kg Sb-equivalent)	1.24E-05	2.85E-07	3.41E-07	6.81E-07	1.36E-06	3.83E-08	1.31E-05	1.34E-05	1.41E-05
Abiotic Depletion, Fossil (MJ)	98.0	26.0	6.0	12.0	24.0	2.0	132.0	138.0	150.0

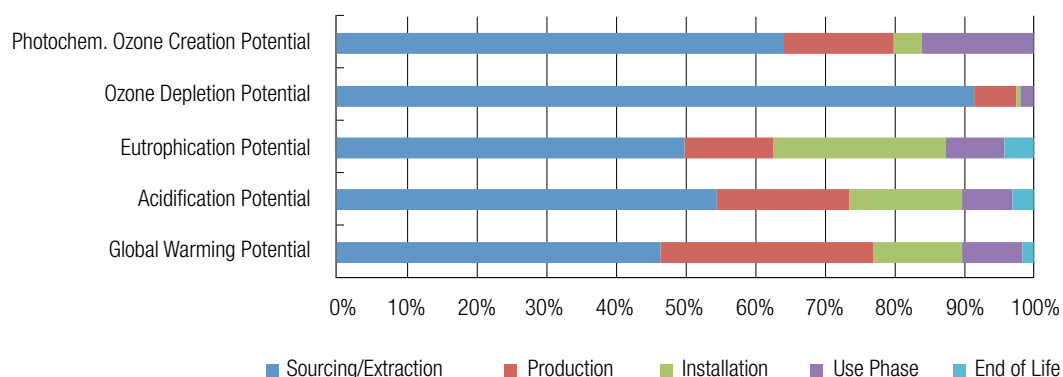
Vinyl Composition Tile (VCT)

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10.0 Life Cycle Assessment (continued)

Figure 6. Life Cycle Impact Results for VCT (1 year)*

Figure 6 shows the relative importance in percentage terms for the raw material Sourcing/Extraction, Production, Installation, Use, and End of Life stages for Vinyl Composition Tile.



*Based on U.S. EPA TRACI 2.0 Impact Factors.

Table 9. TRACI 2.0 LCA Results for 1 m² of VCT for 1 year

IMPACT MEASURE (TRACI 2.0)	SOURCING / EXTRACTION	PRODUCTION	INSTALLATION	USE PHASE (1 yr)	END OF LIFE	TOTAL
Global Warming Potential (kg CO ₂ equivalent)	3.25	2.15	0.88	0.60	0.12	7.00
Acidification Potential (kg mol H ⁺ equivalent)	0.79	0.26	0.26	0.11	0.04	1.46
Eutrophication Potential (kg PO ₄ ³⁻ equivalent)	6.00E-04	2.00E-04	3.00E-04	2.00E-04	1.00E-04	1.30E-03
Ozone Depletion Potential (kg CFC11 equivalent)	9.52E-09	5.50E-10	6.30E-11	1.88E-10	1.54E-12	1.03E-08
Smog (kg O ₃ equivalent)	0.19	0.05	0.07	0.02	0.02	0.34

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10.0 Life Cycle Assessment (continued)

Figure 7 shows the sources of primary energy separated into non-renewable and renewable resources. Figures 8 and 9 show the contribution of different resources to renewable and non-renewable primary energy. All figures refer to energy sources used to manufacture Vinyl Composition Tile in 2011.

Figure 7. Sources of Primary Energy

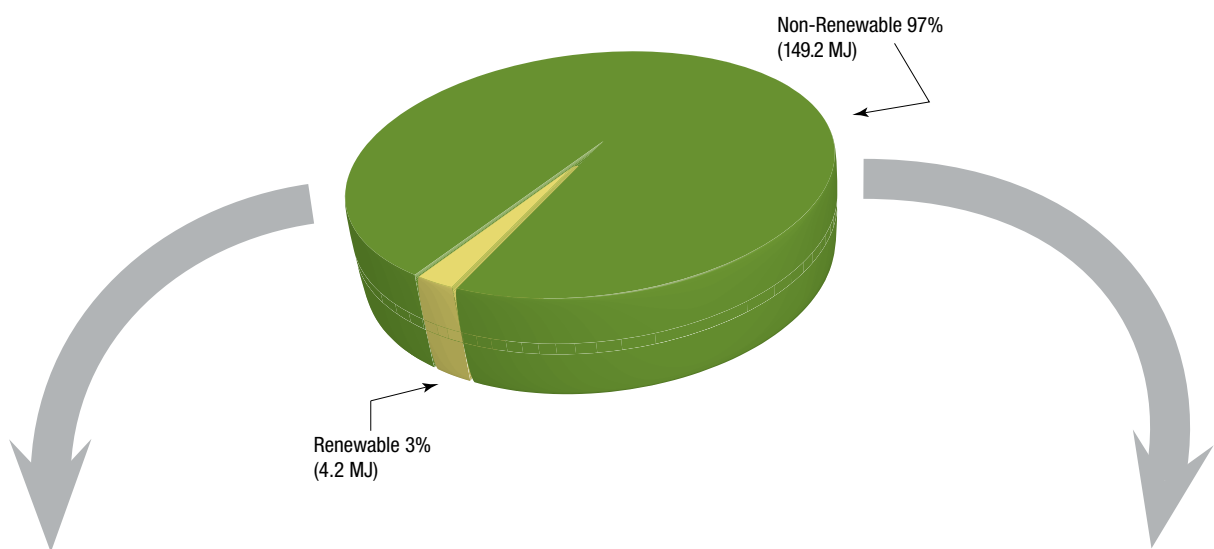


Figure 8. Renewable Energy by Source

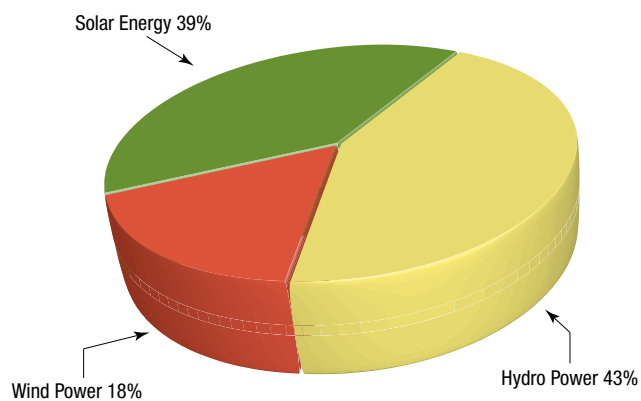
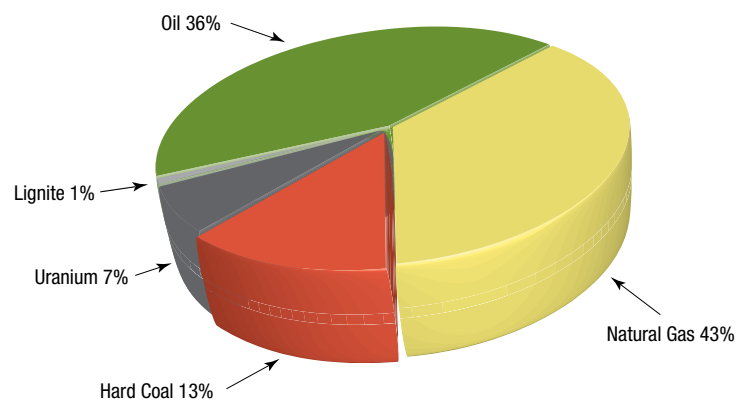


Figure 9. Non-Renewable Energy by Source



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10.0 Life Cycle Assessment (continued)

Waste and Water Consumption

The waste shown in Table 10 accounts for the waste generated at Armstrong® manufacturing facilities ("Production"). The "Use" phase waste accounts for the disposal of the packaging and scrap materials generated during installation; the quantity of flooring disposed of following removal from a building is shown in the "End of Life" phase. These waste values do not include the waste generated in the upstream processes. Other waste categories specified in the PCR were excluded due to data quality.

The life cycle of this product consumes water during production while producing non-hazardous wastes. The quantities are separated into contribution per life cycle stage as shown in Table 10 for 1 m² of Vinyl Composition Tile.

Table 10. Resources and Wastes for VCT (1 m²)

RESOURCES AND WASTES	UNIT	SOURCING / EXTRACTION	PRODUCTION	INSTALLATION	USE PHASE (1 YR)	END-OF-LIFE	TOTAL
Non Renewable Material Sources	kg	9.00	2.40	0.50	0.50	0.80	13.20
Water Use	kg	579.0	820.0	178.0	136.0	65.0	1778.0
Hazardous Waste Production	kg	0.00	0.00	0.00	0.00	0.00	0.00
Non Hazardous Waste Production	kg	2.16	2.32	0.45	0.40	7.05	12.38
Secondary Fuels (Net)	MJ	0.00	0.00	0.00	0.00	0.00	0.00

10.3 Interpretation of Life Cycle Assessment

From the results of the flooring system life cycle covered in this study, it was concluded that the flooring manufacturing process and raw materials – specifically, polyvinyl chloride in the binder – have the greatest impact on Primary Energy Demand (PED) and "carbon footprint" (represented by Global Warming Potential [GWP]).

10.4 Flooring Impacts:

As shown in Table 6 on page 12, the majority of the environmental impacts for this product occurs during the extraction and processing of raw materials detailed in the Production Stage. For most flooring, the opportunity for reduction is in the manufacturing process as well as reductions associated with raw materials.

10.5 Use Stage:

The use stage is defined in the PCR at 60 years and this is what was used in the LCA. The assumption is that the flooring requires normal maintenance as shown in Table 5. Additional details regarding the assumptions and details of how the use phase was modeled in this study can be found in Section 7. Impacts associated with the Use Stage vary depending on the building owner's maintenance practices, level of use, and traffic conditions. Figure 5 provides details of three (3) maintenance scenarios and the impacts resulting from the scenarios are provided in Table 8. The low intensity maintenance scenario results in lower environmental impacts. For example, less scrubbing means less water consumption and a lower eutrophication potential.

10.6 End of Life Impacts:

End of Life Impacts associated with landfilling of Vinyl Composition Tile flooring had the greatest impact on eutrophication and global warming potential. When the impacts associated with end of life and raw materials that would be derived are considered, recycling a VCT flooring can reduce the GWP by over 50% and eutrophication by 48%.

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11.0 Additional Information, Evidence, Test Certificates

11.1 VOC Emissions

All Armstrong® VCT flooring products are FloorScore® certified and are tested and comply with the requirements of the California Department of Public Health Standard Method for the Testing & Evaluation of VOC Emissions (CDPH V1.1., 2010).

12.0 References

12.1 PCR

Product Category Rules for Environmental Product Declarations. Flooring: Carpet, Resilient, Laminate, Ceramic, Wood. NSF International. (2012)

12.2 Standards

ISO 14025:2006 Environmental labels and declarations – Type III – environmental declarations - Principles and procedures

ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework

ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines

ASTM E648-10 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

ASTM E662-13 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials

ASTM C518-10 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

ASTM C423-09a Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

2010 Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers – Version 1.1 – California

13.0 Third Party Evaluations

- Certificate of Compliance for VOC Emissions: Berkeley Analytical and FloorScore
- Climate Registry certification of our greenhouse gas (GHG) inventories



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14.0 Quality Assurance

Armstrong has a robust internal Quality Assurance process that is based on industry-accepted best practices and is led by a team of quality professionals who have been certified by the American Society for Quality. The process involves several hundred different measures made throughout the manufacturing processes. All Armstrong® Vinyl Composition Tiles are manufactured in ISO 9001 certified plants.

15.0 References

Table 11. Life Cycle Impact Assessment Categories, Indicators of Contribution to Environmental Issues, Units of Measure, and Brief Descriptions

IMPACT CATEGORY	INDICATOR	DESCRIPTION	UNIT	REFERENCE
Acidification	Acidification Potential (AP)	A measure of emissions that cause acidifying effects to the environment. The acidification potential is assigned by relating the existing S, N, and halogen atoms to the molecular weight.	mol H ⁺ equivalent	J. Bare, TRACI: The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts 2.0, 2011.
Climate Change	Global Warming Potential (GWP)	A measure of greenhouse gas emissions, such as CO ₂ and methane. These emissions are causing an increase in the absorption of radiation emitted by the earth, magnifying the natural greenhouse effect.	kg CO ₂ equivalent	Intergovernmental Panel on Climate Change (IPCC). IPCC Guidelines for National Greenhouse Gas Inventories 2006.
Eutrophication	Eutrophication Potential (EP)	An indicator of the potential to cause an increase in biomass production. In water, this can lead to algal blooms resulting in oxygen depletion that affects higher species such as fish. Undesirable shifts in numbers of species can also occur, resulting in a threat to biodiversity.	kg Nitrogen equivalent	J. Bare, TRACI: The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts 2.0, 2011.
Ozone Creation	Photochemical Oxidant Potential (POCP)/Smog Potential	A measure of emissions of precursors that contribute to low level smog, produced by the reaction of nitrogen oxides and VOC's under the influence of UV light.	kg NO _x equivalent	J. Bare, TRACI: The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts 2.0, 2011.
	Primary Energy Demand	A measure of the total amount of primary energy extracted from the earth. PED is expressed in energy demand from non-renewable resources (e.g., petroleum, natural gas, etc.) and energy demand from renewable resources (e.g., hydropower, wind energy, solar, etc.). Efficiencies in energy conversion (e.g., power, heat, steam, etc.) are taken into account.	MJ	
	Water Consumed	Water consumption is the sum of all water inputs to the life cycle. Includes water required for production of raw materials, upstream datasets, and manufacturing processes. Does not capture the end of life of the water consumed.	gal/ft ²	
	Waste Disposed	Waste disposed is the sum of all waste outputs from the life cycle. This includes hazardous and non-hazardous wastes and does not capture end of life of the waste generated.	lbs/ft ²	

15.1 Definitions

GaBi 6.0 – LCA Modeling Software

CML-2010 – is an impact assessment tool developed by the Center of Environmental Science of Leiden University (CML). The CML methodology groups the LCI results into midpoint categories, according to themes. These themes are common mechanisms (e.g. climate change) or groupings. The impact categories used in this report are Global Warming Potential (GWP), Acidification Potential (AP), Eutrophication Potential (EP), Ozone Depletion Potential (ODP), Photochemical Ozone Creation Potential (POCP), Abiotic Depletion Elements (ADE) and Abiotic Depletion Fossil (ADF).

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