Mannington COMMERCIAL

Environmental Product Declaration

Mannington Commercial crafts flooring with purpose. We offer a full range of products designed to inspire creativity and deliver advanced performance in all types of commercial spaces. Our fourth-generation, family-owned company is guided by a dedication to our customers and to making a positive impact on the environment and local communities.

rEvolve® Modular, our vinyl alternative modular carpet backing, works for specifiers and facility managers who want a high performance, non-vinyl option for backing carpet with high recycled content. The product of four years of research, development and extensive testing, rEvolve® is a thermoplastic polyolefin backing that carries the Mannington Commercial legacy of performance, innovation and commitment to the world we share.

NSF®
Certified
Environmental
Product Declaration
www.nsf.org

Mannington COMMERCIAL

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ENVIRONMENTAL PRODUCT DECLARATION VERIFICATION

EPD Information			
Program Operator	NSF Certification, LLC		
Declaration Holder	Mannington Commercial		
Date of Issue March 15, 2019	**Valid Until** March 14, 2024	**Declaration Number** EPD10180	
This EPD was independently verified by NSF Certification, LLC in accordance with ISO 14025: ☐ Internal ☒ External	Jenny Oorbeck joorbeck@nsf.org		
This life cycle assessment was independently verified in accordance with ISO 14044, ISO 21930, and the reference PCR:	Matt Van Duinen matt@wapsustainability.com		

LCA Information		
Basis LCA	Mannington Life Cycle Assessment November 11, 2018	
LCA Preparer	Jeremy Rafter Sustainable Solutions Corporation jeremy@sustainablesolutionscorporation.com	
This life cycle assessment was critically reviewed in accordance with ISO 14044 and ISO 21930 by:	Matt Van Duinen matt@wapsustainability.com	

PCR Information	
Program Operator	NSF International
Reference PCR	Flooring: Carpet, Resilient, Laminate, Ceramic, Wood Version 2
Date of Issue	June 23, 2014
PCR review was conducted by:	Dr. Michael Overcash Environmental Clarity movercash@earthlink.net

ENVIRONMENTAL PRODUCT DECLARATION: DETAILED VERSION

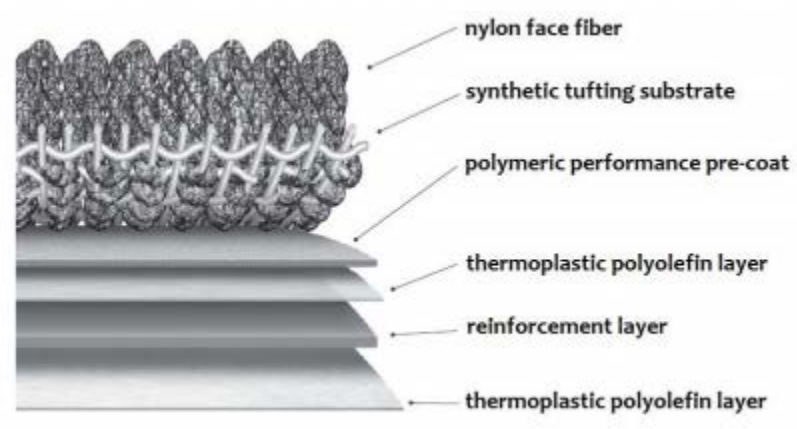
Product Description

Product Classification and Description

Products covered in this Environmental Product Declaration (EPD) are a broad variety of carpet styles and colors manufactured by Mannington Commercial, backed with our rEvolve® modular backing system and made with either nylon 6,6 or nylon 6 yarn. The fiber in these products (product wear layer) is constructed using nylon 6,6 or nylon 6 yarn that is either solution dyed, yarn dyed, space dyed, or a combination of these methods. rEvolve modular is a thermoplastic polyolefin backing that is engineered for strong performance, excellent tuft bind, and dimensional stability. rEvolve Modular contains both pre-consumer and post-consumer recycled content and is fully recyclable. rEvolve® modular is available in various modular sizes, making installation and replacement simple. Like most Mannington Commercial backing systems, these products are certified as environmentally preferable products to NSF/ANSI 140:2015 Sustainability Assessment for Carpet, to the Platinum level, and manufactured in the USA in an ISO 14001 registered facility.

The aggregate weight of rEvolve® modular backing system is approximately 92.8 oz/yd^2. The variation in weight across the rEvolve® modular carpet products is due to the yarn weight. The life cycle assessment for this product group was completed using a yarn weight of 19.2 oz/yd^2. Unless otherwise noted, data within this EPD represents an average yarn weight of 19.2 oz/yd^2 and the rEvolve® modular backing system weighing 92.8 oz/yd^2 for a total product weight of 112.0 oz/yd^2.

Figure 1: Diagram of rEvolve® Modular carpet



Definitions

- Nylon face fiber – Fibers of nylon 6,6 or nylon 6 yarn that are solution dyed, yarn dyed, space dyed or a combination of the two.
- Synthetic tufting substrate – The yarn is tufted into a polyester woven sheet or PET/nylon blended non-woven sheet, also known as *primary backing*. The polyester woven sheet is composed of 85% post-consumer recycled content.
- Polymeric performance pre-coat – A polymeric material which bonds the tufts to the primary backing, giving the yarn fibers strength and durability.
- Thermoplastic polyolefin compound layers – An olefin polymer backing containing both post-consumer and pre-consumer recycled content.
- Reinforcement layer – A fiberglass fabric embedded into the backing, which provides dimensional stability.

Applicability

rEvolve® modular carpet is intended for use in high traffic commercial interior spaces. The type of manufacturing (see Table 1) will determine if the flooring is suitable for extra- heavy traffic, as defined in the guidelines developed by the Carpet and Rug Institute.[1]

[1] Carpet and Rug Institute

Product Characteristics

Table 1: Product Characteristic Table for rEvolve® modular Carpet

Type of manufacture	Tufted Textured Loop, Tufted Texture Cut Pile, Tufted Patterned Loop, Tufted Patterned Tip Sheared, Tufted Tip Sheared or Tufted Cut Pile	
Yarn type	Nylon 6,6 or Nylon 6	100%
Secondary backing	Thermoplastic polyolefin	100%
Characteristics	**Nominal Value**	**Unit**
Number of tufts or loops	628 – 2,738 (5,833 – 25,436)	per dm^2 (per ft^2)
Yarn weight	475 – 882 (14 - 26)	g/m^2 (oz/yd^2)
Backing weight	2,950 (87)	g/m^2 (oz/yd^2)
Total product weight	3,424 – 3,831 (101 – 113)	g/m^2 (oz/yd^2)
Pile thickness	2.134 – 6.858 (0.084 – 0.270)	mm (inch)
Backing thickness	1.27 (0.050)	mm (inch)
Total thickness	3.404 – 8.128 (0.134– 0.320)	mm (inch)
Pre-consumer recycle	23 – 29	%
Post-consumer recycle	10 – 15	%
Product Standard / Approval		**Results**
AATCC 134-2011 Electrostatic Propensity		≤3.0 kV
AATCC 16-2004 Colorfastness to Light		≥4 at 40 AFUs
ASTM E648 – Radiant Panel Test		CLASS 1
ASTM E662 – NBS Smoke Test (Flaming Mode)		≤ 450
ASTM D2859 – Methenamine Pill Test		PASSES
ASTM D3936 – Delamination Strength		≥ 3 lbs. / in
ASTM D5252, ASTM D7330, CRI TM-101 – Test for Surface Appearance Change (CRI-TARR rating)		≥ 3
ISO 2551/ASTM D7570 – Dimensional Stability (AACHEN TEST)		± .027 inches
The laboratories used for testing have NVLAP Accreditation (NIST)[2]		
Accreditation		
Carpet and Rug Institute Green Label Plus – Category 17X (CRI indoor air quality control green label plus ID: GLP7616)		
EN14041:2004 CE-Labeling		
NSF/ANSI 140:2015 Sustainability Assessment for Carpet: Gold		

[2] National Voluntary Laboratory Accreditation Program (NVLAP)

Material Content

Material Content of the Product

Table 2: Material Content Table for rEvolve® modular Carpet

Component	Material	Mass %	Availability (nature of resource, renewable/recycled, availability)	Origin
Nylon face fiber	Nylon 6,6 (products: 95%)	12 - 30 %	Fossil resource, non-renewable, limited	Global
	Nylon 6 (products: 5%)		Fossil resource, non-renewable, limited	Global
Synthetic tufting substrate	Polyester (products: 60%)	3 – 4 %	Fossil resource, non-renewable, limited (15%) Post-consumer recycled, abundant (85%)	Global
	PET/Nylon (products: 40%)		Fossil resource, non-renewable, limited	Global
Polymeric performance pre-coat	Vinyl Acetate/Ethylene copolymer	4 – 6 %	Fossil resource, non-renewable, limited	Global
	Calcium carbonate	10 – 15 %	Mineral, non-renewable, abundant	Global
Thermoplastic polyolefin layers	Polyethylene polymer	17 – 25 %	Fossil resource, non-renewable, limited	Global
	Glass filler	8 – 12 %	Post-consumer recycled material, abundant	US
	Calcium aluminosilicate glass	20 – 30 %	Pre-consumer recycled material, abundant	US
Reinforcement layer	Glass	2 – 3 %	Mineral resource, non-renewable, abundant	US
Modifiers	Various	1 – 2%		Global

Production of Main Materials

Nylon 6,6, CAS# 32131-17-2, is synthesized by polycondensation of hexamethylene diamine and adipic acid. (Nylon 6-6, 2007)

Nylon 6, CAS# 25038-54-4, is synthesized by ring opening polymerization of caprolactam. Caprolactam is comprised of six carbons creating the six in Nylon 6. (Nylon 6, 2005)

Polyester (PET), CAS# 25038-59-9, is a synthetic polymer made of purified terephthalic acid (PTA). (Polyester, 2002)

Vinyl Acetate/Ethylene copolymer, CAS# 24939-78-8, is prepared by polymerization of vinyl acetate monomer and ethylene.

Calcium carbonate, CAS# 1317-65-3, is an abundant mineral found worldwide and is the chief substance found in rocks (i.e., marble and limestone). This material can be ground into varying particle sizes and is widely used as filler material in formulated flooring systems.

Polyethylene polymer (PE), CAS# 25103-74-6, is prepared by either polymerizing ethylene through coordination polymerization which uses a catalyst or through radical polymerization which requires a high pressure apparatus. (Polyethylene, 2002).

Glass filler (Glass Cullet), CAS# 65997-17-3, is post-consumer recycled glass. This material can be ground into varying particle sizes.

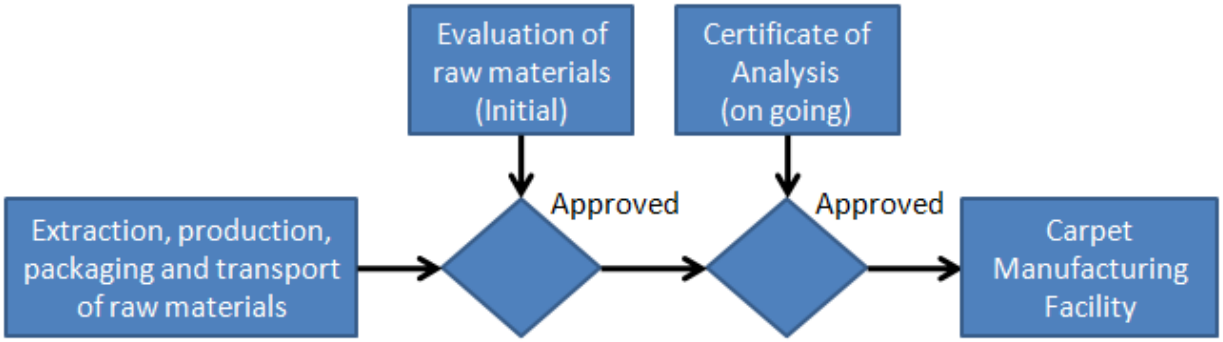
Calcium aluminosilicate glass, CAS# 68131-74-8, is a byproduct of energy production from the combustion of coal.

Glass, CAS# 65997-17-3, is produced by fusing silicon dioxide (sand).

Life Cycle Assessment Stages and Reported EPD Information

Sourcing/extraction (Raw Material Acquisition) Stage

Figure 2: Diagram of the raw material sourcing and extraction stage

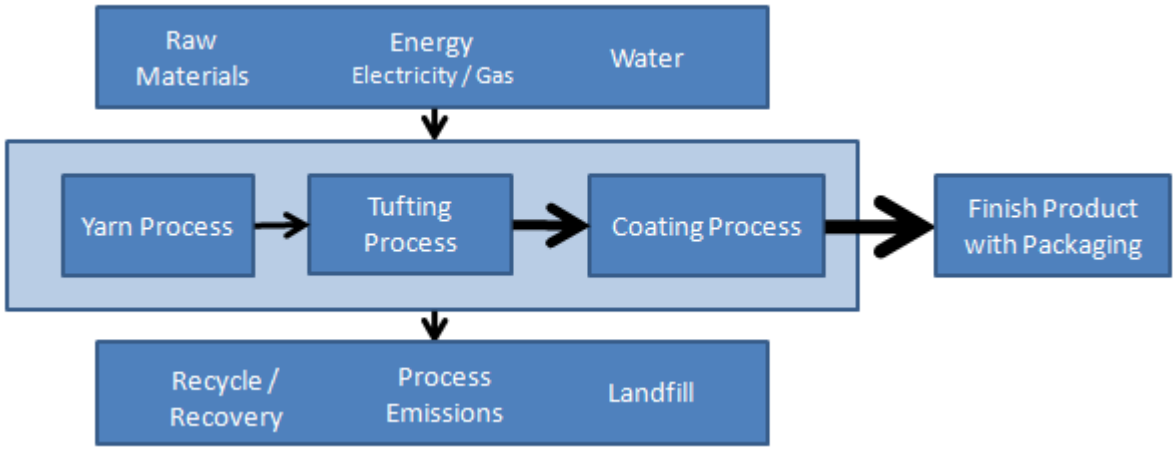


The life cycle assessment stage for sourcing and extraction begins at the point of the raw material being extracted and ends at the point when the packaged raw material is received by the carpet manufacturing facility.

Before a raw material is used, the material must first be evaluated for quality, availability, consistency, performance and value before the material will be considered acceptable. Once the material has passed the initial evaluation process; future shipments are evaluated using the suppliers' certificate of analysis.

Manufacturing Stage

Figure 3: Diagram of the Manufacturing Stage



The manufacturing stage begins with the yarn process. The yarn is processed by converting the raw yarns (singles) into a finished yarn that is sent to the tufting process. The processing of raw yarn usually requires electricity, gas and water.

The tufting process involves using a tufting machine utilizing needles to insert the finished yarn into a synthetic tufting substrate (primary backing) to produce various aesthetically pleasing products which are generically referred to as greige carpet. The tufting process requires electricity.

The coating process is the final manufacturing step. The coating process applies a polymeric performance pre-coat that bonds the finished yarn into the primary backing and applies two polymeric compound layers along with a reinforcement layer to complete the product. The product is cut, packaged and ready for shipment at the end of the coating process. The coating process requires electricity, gas and water.

The life cycle assessment modeled a 5% raw material loss during the manufacturing process.

Health, Safety, and Environmental Aspects During Production

Mannington has an established EHS program including:

- ISO 14001:2015 Environmental Management System
- Better Plants Partner in the U.S. Department of Energy's Better Plants Program
- NSF/ANSI 140:2015 Sustainability Assessment for Carpet – Section Public health and environment
- Aggressive water conservation program.

Production Waste

Production waste is handled as follows:

- All packaging materials (cardboard, stretch wrap, shrink wrap and pallets) are recycled/repurposed.
- All scraps and trimmings of yarn, primary backing and backing material are recycled/repurposed.
- Any finished modular carpet waste is recycled/repurposed.
- Trim material generated during the modular cutting process is being landfilled.

Delivery and Installation Stage

Delivery

rEvolve® modular carpet and sundries are typically transported to the installation site using a diesel-powered semi-truck. Truck transportation plays a significant role in the distribution of the product.

This life cycle assessment has modeled the delivery using an average distance of 500 miles (805 km) with the diesel-powered semi-truck having an 85% utilization of its payload.

Installation

The recommended method for installing rEvolve® modular carpet is to use the full adhesive method with Mannington Commercial rEvolve adhesive. The instructions for this installation procedure can be found on the Mannington Commercial web site (Mannington/Commercial Flooring/Technical/Carpet Installation).[3]

The life cycle assessment modeled the installation stage with rEvolve adhesive being applied at a rate of 0.176 kg/m^2 or 0.324 lb./yd^2.

Health, Safety, and Environmental Aspects during Installation

The Mannington Commercial rEvolve adhesive is CRI Green Label Plus (GLP# 70522) certified.[4] The SDS for rEvolve can be found on the Mannington Commercial web site (Mannington/Commercial Flooring/Technical/Carpet Adhesives).[5]

Waste

Product packaging wastes can be recycled at local recycling centers.

The life cycle assessment modeled a 3% loss of modular carpet during the installation process. This life cycle assessment modeled all of the installation waste as being disposed of in a commercial landfill.

Packaging

Each bundle contains a cardboard tray cap secured with polyethylene shrink wrap covering. The wrapped bundles are then stacked on to a wooden pallet and secured with polyethylene stretch wrap. Each pallet contains 124.8 m^2 (149.3 yd^2) of product. The material, category and weight of packaging are identified in Table 3.

[3] rEvolve™ Installation Procedure
[4] CRI Green Label Plus Flooring Adhesive Certification
[5] Mannington Safety Data Sheet

Table 3: Packaging Material

Material	Category	Weight
Pallet	wood	15.3 kg (33.8 lbs.)
Tray caps	cardboard	7.8 kg (17.1 lbs.)
Shrink wrap (bundles), Stretch wrap	plastics	2.7 kg (5.9 lbs.)
Labeling and Instructions	paper	128.9 gr (0.3 lbs.)

Use Stage

Use of the Floor Covering

The service life for rEvolve® modular backing system will vary depending on the amount of floor traffic, level of maintenance and the desired appearance of the floor covering. The reference service life for rEvolve® modular backing system is 15 years.

The EPD must present results for both a one-year and sixty-year period; impacts are calculated for both time periods. The standard assumes that the life of a building is sixty years.

- The one-year impacts are based on the initial installation of one square meter of flooring (production, transport, installation and end-of-life) and the use phase impacts are based on annual (i.e. – one year of) cleaning and maintenance model.

- The sixty-year impacts are based on four replacements (occurring once every 15 years) of one square meter of flooring (production, transport, installation and end-of-life) and the use phase impacts for 60 years of total floor maintenance.

rEvolve® modular backing system is guaranteed by Mannington's warrantied performance.

Cleaning and Maintenance

The level of cleaning and maintenance varies depending on the amount of floor traffic and the desired appearance of the floor that the end user is seeking. The Carpet and Rug Institute's publication titled *Carpet Maintenance Guidelines for Commercial Applications* offers guidance on how to maintain the carpet at various floor traffic levels.[6] Mannington Commercial's web site also has guidance on the maintenance of carpet (Mannington/Commercial Flooring/Technical/Carpet Maintenance).[7]

The cleaning and maintenance for the life cycle assessment was modeled as shown in Table 4.

[6] CRI Carpet Maintenance Guidelines
[7] Mannington Commercial Maintenance Guidelines

Table 4: Cleaning and Maintenance

Maintenance Type	Annual Cleanings	Electricity Use			Water Use		
		kWh/year	kWh/15 years	kWh/60 years	g/year	g/15 years	g/60 years
Vacuum (industrial)	100	0.38	5.65	22.6	-	-	-
Hot Water Extraction	2	0.07	1.10	4.40	87.79	1,316.88	5267.52

Structural Damage

The subfloor requirements and instructions for floor preparation can be found on the Mannington Commercial website (Mannington/Commercial Flooring/Technical/Carpet Installation).[8]

End of Life Stage

Recycling, Reuse, or Repurpose

Recycling, reuse, and repurpose of carpet is the preferred method of disposal for used carpet. According to the Carpet America Recovery Effort℠ (CARE) latest annual report, over 3.6 billion pounds of carpet have been diverted from U.S. landfills since the program's inception in 2002.[9] The CARE website provides information on recycling, reuse and repurposing opportunities across the U.S. Mannington Commercial is an original and long-standing member of CARE.

Mannington Commercial LOOP® carpet reclamation program allows for the recycling of used carpet.[10]

Disposal

Another method of disposal for used carpet is through a local municipal landfill or commercial incinerator facility.

The life cycle assessment modeled the end of life stage with 100%% of carpet being disposed of in a commercial landfill. Although other disposal options are available, this scenario was chosen as it is the most common method of disposal. The transport of the used carpet to a commercial landfill was modeled using an average distance of 75 miles (121 km) with a diesel power semi-truck.

[8] rEvolve™ Installation Guidelines
[9] Carpet America Recovery Effort℠
[10] Mannington LOOP® Carpet Reclamation Program

Life Cycle Assessment (LCA)

General

A cradle to grave life cycle assessment (LCA) was completed on this product group in accordance with ISO 14040 (ISO, 2017), ISO 14044 (ISO, 2017), ISO 21930 (ISO, 2017) and *Product Category Rule for Environmental Product Declarations Flooring: Carpet, Resilient, Laminate, Ceramic, Wood*. (NSF International, 2014)

The life cycle stages for this study were:

- Production stage – sourcing/extraction stage and manufacturing stage
- Delivery and installation stage
- Use stage
- End of life stage

All life cycles stages as described in System Boundaries, section 6.7 of the Product Category Rule (PCR) have been included. (NSF International, 2014)

Description of the Functional Unit

The functional unit has been defined as one square meter (m^2) for a 60-year building lifetime as defined in *Section 6.10 Life cycle impact assessment* of the PCR. (NSF International, 2014) The reference service life for this product group is 15 years while the reference service life for a building is 60 years.

Cut-off Criteria

The mass/energy flows and environmental impacts consisting of less than 1% may be omitted from the inventory analysis. Cumulative omitted mass/energy flows or environmental impacts shall not exceed 5%.
This does not apply to background data. Variations of these rules shall be documented and justification provided.

To avoid complicating the analysis, this study did not omit any mass/energy flows or environmental impacts from the life cycle inventories.

Allocation

The allocation procedure used in this study focused on mass of output. For example: gallons of process water metered, pounds of griege waste, or finished carpet generated would be allocated proportionately to the mass of carpet produced by the production line.

The principle of modularity was maintained throughout the study by modeling the material and energy flows to/from the environment at each material, or process element, where they occurred.

An open-loop allocation procedure was used for the packaging of raw materials. An example would be the stretch wrap used to unitize the bags of raw material on a pallet. The stretch wrap life cycle inventory includes transport to the recycle vendor. However, none of the life cycle inventories required to prepare the recycled material for its new life are included nor any credits are taken for the recycled material.

Open-loop allocation procedure was used for the recycled raw materials. An example would be the calcium aluminosilicate glass. The life cycle inventory includes the transportation from the recycle center to the vendor, energies to transform, wastes, packaging and transport to the Calhoun, GA facility. However, none of the life cycle inventories of the materials former life were included.

Background Data

As a general rule, specific data derived from specific production processes and/or average data derived from specific production processes was the first choice for the basis of creating this environmental product declaration.

SimaPro 8.2.0, developed by PRe Consultants, was used to create the model used for this life cycle assessment.[11] ecoinvent v3.5 software database was used in most of the background datasets required for this model.[12] ecoinvent v3.5 software database were used for energy, transportation and auxiliary materials to ensure comparability of the results in the life cycle assessment, see Table 5.

Table 5: Background Data Sources

Material	Data Source	Date
Nylon 6,6	US ecoinvent database v2.2	2016
Nylon 6	US ecoinvent database v2.2	2016
Polyester	ecoinvent database v3.5	2016
Vinyl Acetate/Ethylene Copolymer	ecoinvent database v3.5	2016
Calcium Carbonate	ecoinvent database v3.5	2016
Polyethylene Polymer	ecoinvent database v3.5	2016
Glass Filler	ecoinvent database v3.5	2016
Calcium aluminosilicate glass	ecoinvent database v3.5	2016
Glass	ecoinvent database v3.5	2016
Modifiers	ecoinvent database v3.5	2016

[11] Pre' Sustainability
[12] SimaPro LCI Databases

Data Quality

The data used in the life cycle assessment represents current products and processes. This data is considered to be good to very good which meets the requirements of the product category rules. (NSF International, 2014) A variety of checks were built into the model. Additionally, a series of tests were conducted on the model to ensure that the model quality is very good.

Time related coverage – The process data (foreground data) was based on one year of data between 2017 and 2018. The background data sources are based on data less than 10 years old. All of the background data sources are modeled using 2010 or newer North American energies. The time related coverage is good.

Geographical coverage – The process data was based on North America. The background data sources were first selected based on technological appropriateness and then geographical appropriateness was considered. An example of this is calcium carbonate. Calcium carbonate was modeled on a technological equivalent process while the geographical location of the process was Europe and the energies were modeled for North America. The geographical coverage is good.

Technology coverage – Process data was collected from the actual processes and thus the technology coverage is very good. The background data was selected for technology relevance to ensure the best fit of the life cycle inventory to the real world. The technology coverage is very good.

Table 6: Process data quality (foreground data)

Process	Type of data	Period	Origin of data	Data source	Completeness	Accuracy
Yarn Process	Primary	2017 - 2018	North America	Manufacturing Plant	Very Good	Very Good
Tufting Process	Primary	2017 - 2018	North America	Manufacturing Plant	Very Good	Very Good
Coating Process	Primary	2017 - 2018	North America	Manufacturing Plant	Very Good	Very Good

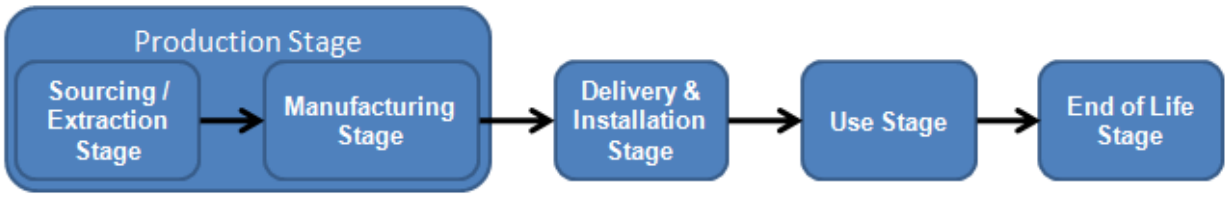
System Boundaries

The life cycle assessment for rEvolve® modular backing system was a cradle to grave study. The system boundaries for this study are as follows:

- Sourcing/extraction stage – This stage begins with the design of product concepts, selection and sourcing or materials, evaluation of optimum alternatives, and the results of design decisions through the extraction of materials. This includes extraction of virgin materials from the earth (pre-consumer supply chain). This may include the growth or extraction of all raw materials, and their delivery to the production site. Packaging materials are included.

- Manufacturing stage – This includes all relevant manufacturing processes once the optimum materials to manufacture a product have been selected. Packaging is included. Production of capital goods, infrastructure, production of manufacturing equipment, and personnel-related activities are not included. Heating, artificial lighting, and transport within the production site are excluded, unless they are directly used for the production process.
- Delivery and installation stage – This stage includes the delivery of the floor covering to the point of installation, fitting, and the raw material extraction, and manufacturing of all sundry material for the fitting, if relevant.
- Use stage – The use stage includes the cleaning and maintenance of the floor covering during its life time as well as extraction, manufacturing and transport of all sundry material, it relevant (e.g. cleaning materials, floor finishes) for the maintenance.
- End of life stage – The end of life stage includes the transport of the floor covering to end of life processes such as incineration, recycling and final disposition. All waste management processes are included in the calculation until final disposition, with the exception of the disposition of nuclear waste, which cannot be modeled due to its extremely long disposition times.

Figure 4: System Boundaries



Note on Use Stage

"The estimated service of a floor covering and references thereof depend on the type of floor covering, its application, the user, and required maintenance of the product. Comparisons of different floor coverings are allowed only if these parameters are considered in a consistent way and if LCA impacts are evaluated under the same normalized conditions. For this purpose, the use stage impacts shall be reported for a single year (1/60th of the total) of use and for the expected life of the building (60 years)." (NSF International, 2014)

rEvolve® modular carpet has a reference service life of 15 years. The recommended maintenance schedule for rEvolve® modular carpet can be reviewed in Table 4.

Impact Declaration and Use Stage Normalization

The Life Cycle Impact Assessments (LCIA) were calculated for multiple model scenarios of one square meter of rEvolve® modular carpet as per *Section 6.10 Life cycle impact assessment*. (NSF International, 2014)

- **Table A:** The impacts for 1 m^2 of floor covering shall be given for each of the following life cycle stages: sourcing/extraction, manufacturing, delivery and installation, and end-of-life.
- **Table B:** The impacts for the use stage for 1 m^2 of the floor covering shall be given for an average one-year use.
- **Table C:** The total impacts of all life cycle stages based on the estimated replacement schedule for 1 m^2 of floor covering over a 60-year reference service life (RSL) of a building. (NSF International, 2014)

These results are presented below.

Results of the Assessment

The CML 2001 methodology (CML) was used to calculate the LCIA values.[13] The LCIA results were calculated for the Production Stage, Installation & Delivery Stage, Use Stage and the End of Life Stage. The following categories from the CML methodology were selected for the assessment. (NSF International, 2014)

- Global warming potential (GWP) – 100 year
- Acidification potential (AP)
- Ozone depletion potential (ODP) – Steady State/Infinite
- Photochemical oxidant formation potential (POCP)
- Eutrophication (NP)
- Abiotic resource depletion potential, elements (ADPe),
- Abiotic resource depletion potential, fossil fuels (ADPf)
- Primary energy demand – non-renewable (PEDr)
- Primary energy demand – renewable (PEDnr)

[13] Universiteit Leiden CLM-IA Characterization Factors

Life Cycle Inventory Analysis

The following inventory data is calculated based on one square meter of rEvolve® modular carpet product over a 60-year building lifetime including replacement. Table 7 below shows the primary and secondary resources use inventory data:

Table 7: Primary and Secondary Resources Use

Indicator	Unit per m^2	Sourcing and Extraction	Manufacturing	Installation and Delivery	Use	End of Life	Total
Renewable Primary Energy (Energy)	MJ, LHV	1.2E+01	1.3E+00	9.3E-01	1.4E+01	1.2E-01	2.8E+01
Non-renewable Primary Energy (Energy)	MJ, LHV	9.9E+02	1.4E+02	1.1E+02	3.0E+02	6.2E+00	1.6E+03
Renewable Primary Energy (Materials)	MJ, LHV	5.4E+00	1.9E+01	1.6E-01	1.7E+00	7.6E-02	2.7E+01
Non-renewable Primary Energy (Materials)	MJ, LHV	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Secondary Fuel (Renewable)	MJ, LHV	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Secondary Fuel (Non-renewable)	MJ, LHV	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Recovered Energy (MJ)	MJ, LHV	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Secondary Material	kg	1.3E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E+00

Table 8 below shows additional resources use data and carbon emissions inventory:

Table 8: Additional Resources Use and Carbon Emissions

Indicator	Unit per m^2	Sourcing and Extraction	Manufacturing	Installation and Delivery	Use	End of Life	Total
Abiotic Depletion Potential (Fossil Fuels)	MJ, LHV	8.8E+02	1.2E+02	9.9E+01	2.2E+02	5.9E+00	1.3E+03
Freshwater Consumption	m^3	6.1E+01	1.2E-01	1.1E-01	8.4E-02	3.8E-04	6.1E+01
Carbon Removals Associated with Biogenic Carbon Content of Packaging	kg CO_2 eq	1.8E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E-02
Carbon Emissions Associated with Biogenic Carbon Content of Packaging	kg CO_2 eq	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00	1.8E-02

Finally, Table 9 below shows the waste and output flow inventory data:

Table 9: Waste and Output Flow Inventory

Indicator	Unit per m^2	Sourcing and Extraction	Manufacturing	Installation and Delivery	Use	End of Life	Total
Hazardous Waste	kg	8.4E-04	2.2E-04	1.3E-02	5.3E-04	1.2E-05	1.5E-02
Non-hazardous Waste	kg	1.4E+00	1.1E+00	1.2E+00	4.5E-01	1.1E+01	1.6E+01
Radioactive Waste	kg	8.4E-04	4.2E-04	2.7E-06	1.3E-03	2.2E-05	2.5E-03

Life Cycle Impact Assessment

The CML methodology was used to calculate the impact assessments for one square meter of rEvolve® modular carpet product. Table 10 below shows Table A as required by the PCR – the total impacts associated with the activities necessary to bring the product to market including end of life impacts. These results do not include maintenance or replacement impacts.

Table 10: A - CML Impacts Excluding Use and Replacement

Impact Category		Life Cycle Stage				
Parameter	Unit per m^2	Sourcing and Extraction	Manufacturing	Delivery and Installation	End of Life	Total
Abiotic Depletion Potential, Elements	kg Sb Eq.	6.9E-05	1.0E-06	2.7E-07	5.8E-08	7.0E-05
Abiotic Depletion Potential, Fossil Fuels	MJ	2.2E+02	2.9E+01	2.5E+01	1.5E+00	2.7E+02
Acidification Potential	kg SO_2-Eq.	7.2E-02	5.6E-03	8.4E-03	6.2E-04	8.7E-02
Eutrophication Potential	kg PO_4 Eq.	1.4E-02	5.6E-03	2.1E-03	7.4E-03	2.9E-02
Global Warming Potential	kg CO_2 Eq.	1.5E+01	2.2E+00	1.6E+00	1.5E+00	2.1E+01
Ozone Depletion Potential	kg CFC_{-11} Eq.	2.1E-07	1.2E-07	1.1E-09	8.9E-09	3.4E-07
Photochemical Oxidation Potential	kg C_2H_4	3.3E-03	3.2E-04	3.0E-04	4.0E-04	4.3E-03
Primary Energy Demand - Non-Renewable	MJ Eq.	2.5E+02	3.6E+01	2.7E+01	1.6E+00	3.1E+02
Primary Energy Demand - Renewable	MJ Eq.	4.5E+00	5.1E+00	2.7E-01	5.0E-02	9.9E+00

Table 11 below shows Table 11: Table B as required by the PCR – the average 1-year impacts associated with the use and maintenance of the product.

Table 11: B – CML Impacts for Average Annual Use and Maintenance

Impact Category		Life Cycle Stage
Parameter	Unit per m^2	Average 1-year Use and Maintenance Impacts
Abiotic Depletion Potential, Elements	kg Sb Eq.	2.3E-07
Abiotic Depletion Potential, Fossil Fuels	MJ	3.7E+00
Acidification Potential	kg SO_2-Eq.	1.2E-03
Eutrophication Potential	kg PO_4 Eq.	1.1E-03
Global Warming Potential	kg CO_2 Eq.	3.1E-01
Ozone Depletion Potential	kg CFC-11 Eq.	2.6E-08
Photochemical Oxidation Potential	kg C_2H_4	5.2E-05
Primary Energy Demand - Non-Renewable	MJ Eq.	5.1E+00
Primary Energy Demand - Renewable	MJ Eq.	2.5E-01

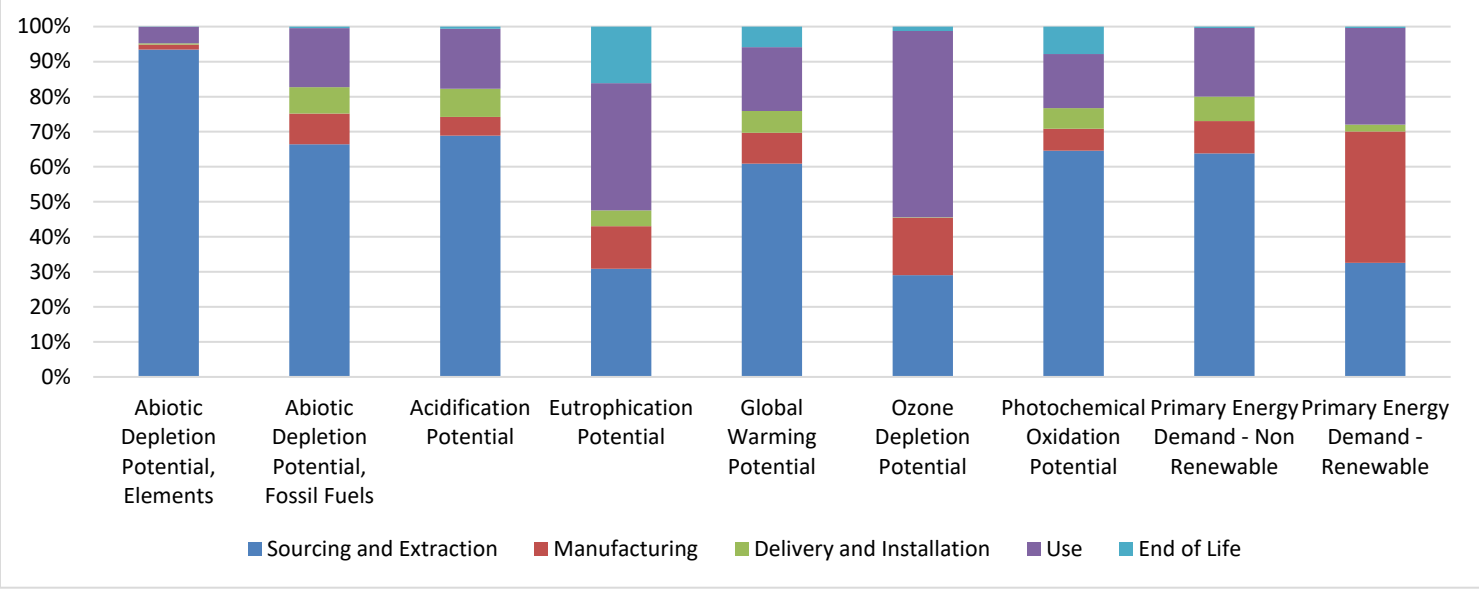
Finally, Table 12 below shows Table C as required by the PCR – the total impacts associated with all stages of the product, including the use stage over the entire 60-year building lifetime, as well as product replacement required to fulfill the functional unit over that building lifetime.

Table 12: C – CML Impacts Over 60-year Building Lifetime Including Use and Replacement

Impact Category		Life Cycle Stage					
		User Defined Reference Service Life of Product = 15 years Number of Installations over 60 years = 4					
Parameter	Unit per m^2	Sourcing and Extraction	Manufacturing	Delivery and Installation	Use	End of Life	Total
Abiotic Depletion Potential, Elements	kg Sb Eq.	2.7E-04	4.1E-06	1.1E-06	1.4E-05	2.3E-07	2.9E-04
Abiotic Depletion Potential, Fossil Fuels	MJ	8.8E+02	1.2E+02	9.9E+01	2.2E+02	5.9E+00	1.3E+03
Acidification Potential	kg SO_2-Eq.	2.9E-01	2.2E-02	3.3E-02	7.2E-02	2.5E-03	4.2E-01
Eutrophication Potential	kg PO_4 Eq.	5.6E-02	2.2E-02	8.3E-03	6.6E-02	2.9E-02	1.8E-01
Global Warming Potential	kg CO_2 Eq.	6.2E+01	8.9E+00	6.3E+00	1.8E+01	6.0E+00	1.0E+02
Ozone Depletion Potential	kg CFC.11 Eq.	8.4E-07	4.7E-07	4.5E-09	1.5E-06	3.6E-08	2.9E-06
Photochemical Oxidation Potential	kg C_2H_4	1.3E-02	1.3E-03	1.2E-03	3.1E-03	1.6E-03	2.0E-02
Primary Energy Demand - Non-Renewable	MJ Eq.	9.9E+02	1.4E+02	1.1E+02	3.0E+02	6.2E+00	1.6E+03
Primary Energy Demand - Renewable	MJ Eq.	1.8E+01	2.1E+01	1.1E+00	1.5E+01	2.0E-01	5.5E+01

Figure 5 below shows the percent contribution of each life cycle stage in each selected impact category.

Figure 5 – Cradle to Grave Impact Contribution



Interpretation

The interpretation of the LCIA results for one square meter of rEvolve® modular carpet yields several observations. As shown above in Figure 5, the largest contributor in most of the studied impact categories is the production stage.

Based on the results from the life cycle assessment, the life cycle impacts are strongly driven by the production stage, specifically the yarn and the backing material on both product types. Within the manufacturing phase, electricity use, as well as additional raw material burdens incurred by the scrap rate, have the highest impacts. Increasing energy efficiency and decreasing process losses would be the best way to reduce overall environmental impacts in the manufacturing phase. Extending the life of modular carpets or identifying alternate uses or recycling options of the modular carpet will reduce the end-of-life impacts.

Over the life of the building, the second largest contributor to the impact categories is typically the use stage. Specifically, the hot water extraction deep cleaning drives the impacts in this stage. Therefore, the level of use and associated required maintenance is an important consideration to understanding the environmental impacts of the rEvolve® product.

Comparability

This report is not intended to support any comparative assertions to be disclosed to the public nor will this study make value choices related to normalization, grouping, or weighting during the life cycle impact assessment.

This declaration represents an average performance of rEvolve® modular carpet. The manufacturing stage represents 12 months of manufacturing data while also including the average face weight of all the various products that could be produced with the rEvolve® modular carpet backing. The LCI data of the raw ingredients represent industry averages collected by various groups.

It should be noted by the reader that declarations from different programs may not be comparable.

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