LIFE CYCLE ASSESSMENT (LCA) OF W. R. MEADOWS WATERPROOFING MEMBRANE PRODUCTS: HRM 714 and PRECON

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1 INTRODUCTION

1.1 Opportunity

W. R. MEADOWS is a well-established manufacturer in the concrete construction industry. It offers a wide range of products, from concrete protection and sealing solutions to expansion joints, concrete restoration, and moisture control systems. Sustainability and environmental responsibility lie at the heart of W. R. MEADOWS' operations, and the company continually integrates innovative and resource-efficient strategies into its processes and product offerings.

In response to the growing demand for transparency in the construction industry and to uphold its internal sustainability commitments, W. R. MEADOWS has embarked on an initiative to understand better the environmental impacts of its building envelope system product lines. This includes vapor barriers/retarders, waterproofing, and air and vapor barrier products. This effort involves conducting a cradle-to-gate life cycle assessment (LCA) to evaluate the environmental footprint of its products, focusing on stages from raw material acquisition to manufacturing. By utilizing plant-specific data from two facilities in North America, W. R. MEADOWS aims to assess the potential environmental impacts of:

- A hot-applied (liquid-applied) waterproofing membrane product: HRM 714
- Pre-applied/under slab (sheet-applied) waterproofing membrane products: PRECON

This approach to LCA underscores the company's dedication to making informed decisions that support sustainable practices across its operations.

To enhance transparency and environmental communication, W. R. MEADOWS is interested in having Sustainable Minds Transparency Reports [EPDs]™ (TRs) for its waterproofing products HRM 714 and PRECON. These TRs are ISO 14025 Type III [1] declarations can be used for communication with and amongst other companies, architects, and consumers, and can also be utilized in whole building LCA tools in conjunction with the LCA background report and life cycle inventory (LCI). This study conforms to the requirements of ISO 14044 [2], ISO 21930:2017 [3], and the SM Product Category Rule Part B for Water-Resistive and Air Barriers [4].

1.2 Life cycle assessment

LCA is performed to comprehensively explore, quantify, and interpret the potential environmental impacts associated with a product or service throughout its entire life cycle. A product's life cycle consists of various stages, starting from raw material acquisition and manufacturing to product use and maintenance, plus final product disposal. Depending on the inclusion and exclusion of life cycle stages, an LCA could be cradle to gate (from raw material acquisition to the manufactured product ready to be shipped), cradle to gate with options (which also optionally includes other modules such as shipment and installation), and cradle to grave (which includes all other stages including the use phase and disposal once the useful life is over).

Any LCA conducted with the intention of publishing EPDs needs to comply with the internationally accepted ISO 14040 and ISO 14040 standards. ISO 14040 provides principles and frameworks for conducting an LCA, while ISO 14044

specifies requirements and provides guidelines for an LCA. ISO 14040 sets out a four-phase methodology framework for completing a LCA, as depicted in Figure 1.

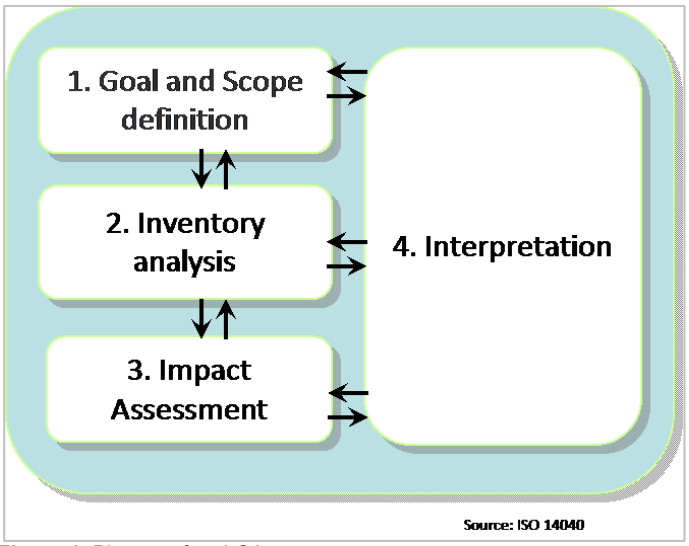


Figure 1. Phases of an LCA

- **Goal and scope definition:** Goals refer to establishing the purpose of the LCA, and they define the environmental aspects to be studied and the intended audience. Scope outlines the system boundaries, the declared unit of analysis, and the life cycle stages to be included. System boundaries set up inclusions and exclusions in an LCA. PCRs usually specify whether the boundary must be cradle-to-gate, cradle-to-installation, or cradle-to-grave.

- **Life cycle inventory analysis:** In this step, a detailed inventory of all the environmental inputs and outputs associated with each stage of the product's life cycle is compiled. Primary data about materials, energy, and emissions assessing the upstream supply chain, the company's manufacturing operations, and downstream processes (after the product leaves the factory gate) are collected via LCI data collection templates or tools. Annual data is suggested in most cases to be representative of the manufacturing operations. In the case of multi outputs, resources can be allocated to the product of interest via mass or volume, or as relevant. The inventory is then scaled to meet the declared unit of the LCA.

- **Life cycle impact assessment:** The compiled LCI is then modeled using LCA software like SimaPro, GaBi, openLCA, or others using suitable background data sets available in its databases. Each is assigned to categories according to different impact methodologies, and the software provides final impact values for those different environmental impact categories. Several LCIA methodologies exist in the market, including ReCiPe, TRACI, CML, and ILCD, which differ in terms of their approaches, characterization factors, evaluated impact categories, and modeling assumptions. Practitioners can choose a combination of LCIA methodologies to provide a holistic view of the environmental performance of a product.

- **Interpretation of results:** In this step, the LCIA results are analyzed and presented via an LCA report. This stage helps draw conclusions about the product's environmental performance, identify any environmental hotspots, make recommendations, and assess the significance of the findings. Sensitivity analysis, scenario studies, and uncertainty assessment are often

included as a part of the interpretation to ensure the reliability and robustness of the results. LCA, if well interpreted and evaluated, presents a number of opportunities for the manufacturer in developing sustainability goals and initiatives.

This LCA study follows an attributional approach and uses a cradle-to-grave system boundary. This report incorporates LCA terminology. To assist the readers in understanding LCA, special attention has been given to list definitions of important terms used at the end of this report.

A critical review of the LCA and an independent verification of the TR are required for ISO14025 Type III environmental declarations. Both are included in this project.

1.3 Team

This LCA report is the outcome of efforts by the project team led by Kimberly A. Lombardozzi and the plant managers on behalf of W. R. MEADOWS. Sustainable Minds led the development of the LCA modeling, results, report, and Transparency Reports [EPDs]™.

1.4 Status

All information in this report reflects the best possible inventory by W. R. MEADOWS at the time it was collected, and Sustainable Minds and W. R. MEADOWS adhered to best practices in transforming the inventory into this report.

Primary data was provided for manufacturing activities from CY2025 from the W. R. MEADOWS facilities in Hampshire, IL and Ft. Worth, TX. Where data was missing, assumptions were made from manufacturing data for the facility based upon expertise from the W. R. MEADOWS plant managers and their upstream suppliers. This study also includes background data to complete the inventory and fill gaps where necessary.

This is a supporting LCA report for the W. R. MEADOWS TRs and was evaluated for conformance to the PCR according to the ISO 14025 and ISO 14040/14044 standards. The LCA review and verification of the Sustainable Minds Transparency Reports [EPDs]™ were carried out by Lindita Bushi, Ph.D., Athena Sustainable Materials Institute to determine conformance to ISO 14040/14044, ISO 21930:2017, and the relevant PCRs. The critical review statement is included below.

1.5 Verification

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June 22, 2026

Verification Statement for EPDs of W. R. MEADOWS as per the Sustainable Minds EPD program

Introduction

The Athena Sustainable Materials Institute (www.athenasmi.org) was engaged to perform third-party verification of the W. R. MEADOWS LCA report and EPDs for Waterproofing membrane products conducted by Sustainable Minds (https://www.sustainableminds.com/).
Lindita Bushi, Ph.D., an approved third-party verifier by the Sustainable Minds EPD program, completed the verification.

The verifier reviewed the first draft and verified the final version of the W. R. MEADOWS LCA report and EPDs dated 22.06.2026, in accordance with the following:

1. Sustainable Minds Part B: Product group definition | Water-Resistive and Air Barriers | Part B #26-002, 04/24/2026 – 04/23/2031,
2. SM Transparency Report™ / EPD Framework Governance and Program Rules. Version 3.2 | August 2023,
3. *ISO standards* listed below –
   ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations - Principles and procedures,
   ISO 14044:2006/Amd1:2017/Amd2:2020 Environmental Management - Life Cycle Assessment - Requirements and Guidelines.
   ISO 14040:2006/Amd1:2020 Environmental Management – Life cycle assessment – Principles and Framework
   ISO 21930: 2017 Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services.

Verification Statement

After a detailed examination, the verifier confirms that *no relevant deviations* within the EPDs and their supporting project report have been established concerning:

- The underlying data collected as used for the LCA calculations,
- The way the LCA-based calculations have been carried out to comply with the calculation rules described in the reference PCR,
- The presentation of environmental performance included in the EPD and
- Other additional environmental information included in the declaration.

Further, no material deviations were found concerning the procedural and methodological requirements in ISO 14025:2006, ISO 14044:2006, ISO 21930:2017, and SM POR 2023.

EPD registration number(s):	*Provided by the Sustainable Minds EPD program*
Product(s):	HRM 714, and PRECON
Organization:	W.R. Meadows, Inc. 300 Industrial Drive P.O. Box 338 Hampshire, IL 60140-0338 wrmeadows.com
PCR:	Sustainable Minds Part B: Product group definition | Water-Resistive and Air Barriers | Part B #26-002, 04/24/2026 – 04/23/2031
Validity of EPD:	Five years

The verifier confirms that the LCA-based data has been examined for plausibility and consistency; the declaration owner is responsible for its factual integrity and that the product does not violate relevant legislation.

The verifier confirms that she has sufficient knowledge and experience of declared products, relevant standards, and the geographical area of the EPDs to carry out this verification.

The verifier confirms that she has been independent in her role as a verifier in accordance with the ISO 14025 requirements, e.g., she has not been involved in the execution of the LCA or the development of the declarations and has no conflicts of interest regarding this verification.

Based on the verification objectives, the LCA/LCI data were determined to conform to the relevant program operator rules, product category rules, and applicable ISO standards. The plausibility, quality, and accuracy of the LCA-based data, as well as additional environmental information and supporting information, are also confirmed.

A copy of the W. R. MEADOWS verification statement (in PDF) and verification report (in Excel) *from 22-06-2026* is provided to the Sustainable Minds EPD program operator. As per ISO 14025, Clause 8.1.4, the verification report shall be made available to any interested party upon request.

The verifier appreciates the professional responsiveness of the Sustainable Minds LCA team to all technical queries and comments and that of all parties involved in the verification process.

Name and organization of the independent verifier:	**Address:**
Lindita Bushi, Ph.D., LEED Green Associate Athena Sustainable Materials Institute D: 416 269 8571 E: lindita.bushi@athenasmi.org	280 Albert St., Suite 404, Ottawa ON, K1P 5G8 http://www.athenasmi.org

Signature:

Lindita Bushi

Enclosed:
Verification report- ISO 21930 SM WRM WPM LCA report, EPDs, 22062026, Final.

2 GOAL AND SCOPE

This chapter explains the goal and scope of the LCA study. The aim of the goal and scope is to define the product under study and the depth and breadth of the analysis.

2.1 Intended application and audience

This report aims to define the specific application of the LCA methodology to the life cycle of HRM 714 and PRECON. The report serves both internal and external purposes and is intended for a diverse audience. The intended audience includes the program operator (Sustainable Minds) and reviewers who will be assessing the LCA for conformance to the PCR, as well as W. R. MEADOWS' internal stakeholders involved in marketing and communications, operations, and design.

The results presented in this document are not meant to support comparative claims. The outcomes will be made available to the public in Sustainable Minds Transparency Reports [EPDs]™ (Type III environmental declarations per ISO 14025), which are intended for communication between businesses and consumers (B2C).

2.2 Product description

This LCA study covers three products manufactured in two W. R. MEADOWS facilities: Fort Worth TX, and Hampshire, IL. HRM 714 is manufactured in both locations, whereas PRECON is only manufactured in Hampshire, IL.

HRM 714 is fluid-applied rubberized waterproofing membrane with flexibility and low water-vapor permeance, ideal for use on plaza and outdoor amenity spaces, green roofs, protected membrane roofing assemblies (PMRA), split-slab and parking decks, tunnels and bridge decks, and similar types of construction where a monolithic waterproofing membrane is desirable. HRM 714 resists water, chemicals, fertilizers, and saltwater exposure, offering a durable solution where a continuous, monolithic waterproofing system is desired. It is liquid-applied rubberized asphalts applied hot on-site in multiple layers with reinforcing fabric and protection course materials to ensure long-term performance and reliable protection in demanding environments.

PRECON is sheet-applied waterproofing membranes designed to block or limit water vapor transmission through building assemblies. PRECON can go where conventional waterproofing products are impractical, such as positive-side waterproofing where access is prohibited due to the soil retention system. It is bond to poured concrete walls, creating a solid waterproofing barrier. A flexible, rubberized asphalt core also creates stronger protection than clay-type products currently used. Complete product descriptions for the covered products are provided in Table 1.

Table 1. Product descriptions

Product series	Product description
HRM 714	HRM 714 fluid-applied rubberized asphalt waterproofing is a 100% solids blend of asphalts, synthetic rubber polymers, and fillers formulated to provide a tough, seamless membrane with flexibility and low water-vapor permeance.

PRECON	PRECON is a (sheet-applied) pre-applied waterproofing membrane designed for blindside and underslab applications where access to the positive side is limited. It combines a durable elastomeric membrane a seven-layer matrix that delivers low water vapor transmission. When concrete is poured against it and cured, PRECON forms a strong mechanical bond to the structure, creating a seamless waterproof and vaporproof barrier.

Visual representations of the studied products are presented in Figure 2.

HRM 714	PRECON
	

Figure 2. Visual representation of waterproofing membrane products included in this study

Table 2 lists the product information including the declaration name, products included in the declaration, CSI MasterFormat® classification, manufacturing location, and the type of declaration. Table 3 summarizes the applicable product specifications for each product.

Table 2. Declared product information and type of declaration

Transparency Report [EPD]™ name	Included products	CSI MasterFormat®	Manufacturing location	Type of declaration
HRM 714	HRM 714	07 14 13	Hampshire, IL Ft. Worth, TX	Plant-specific, product-specific declaration for one manufacturer
PRECON	PRECON	07 13 00	Hampshire, IL	Plant-specific, product-specific declaration for one manufacturer

Table 3. Other product information

Product name	Product specifications
HRM 714	• Total system thickness: 1.23 lb./ ft.^{2} (6 kg/m^2) • Water Vapor Permeance: ASTM E96: 0.019 Perms <0.1 Perms • VOC Content: 0 g/L • Acid Resistance (ASTM D896 Procedure 7.1 (N-8)): 50% Sulfuric Acid w/o blistering, deterioration, delamination or re-emulsification • Salt Water Resistance (ASTM D896 similar): Passed 20% Sodium Chloride w/o blistering, deterioration, delamination or re-emulsification • Fertilizer Resistance (ASTM D896 similar): Passed 30/10/10 Fertilizer w/o blistering, deterioration, delamination or re-emulsification
PRECON	• Thickness: 73 mil (1.85 mm); ASTM D1000 • Application Temperature: 40° F (5° C) Min • Water Vapor Permeance: ASTM E96: 0.006 Perms <0.1 Perms • Low Temp Flexibility: ASTM D1970, 180° @ -20° F (-28.9° C), Pass • Resistance to Fungi in Soil: GSA-PBS 07115 – 16 Weeks, No Effect

For more information about the products, including details about the materials that conform to the relevant standards, visit the links below:

- HRM 714: https://www.wrmeadows.com/hrm-714-rubberized-asphalt-membrane/
- PRECON: https://www.wrmeadows.com/mel-rol-precon-blindside-underslab-membrane/

2.3 Declared unit

This LCA covers the cradle-to-gate life cycle stage. According to the PCR, the declared unit is one square meter (1 m^2) of sheet wraps/membranes or fluid-applied water and air barriers. For fluid-applied products, the mass of material required per declared unit is approximated by dividing the product density (kg/L) by the manufacturer's specified dry product thickness coverage rate (m^2/L), excluding waste.

The reference flow for each product is provided in Table 4. For fluid-applied HRM 714 products, the product density, manufacturer-specified dry product thickness, and product percent solids are also provided. The environmental impacts for fluid-applied HRM 714 products are proportional to dry product thickness. If applied for a specific application to a thickness other than as specified in the report, the results of the new thickness can be calculated proportionally to the reported results.

Table 4. Reference flow (mass per declared unit) for the studied products

Product name	Product type	Reference flow (kg/m^2)
HRM 714	Fluid-applied liquid rubberized waterproofing membrane	**Thickness:** HRM 714 is designed to be applied in multiple layers to achieve a total system dry thickness of 215 mils (5.5 mm). **Reference flow:** 1.23 lb/ft^2 (6 kg/m^2) **% solids by weight:** 100% Reinforcement materials are not included in the impact results.
PRECON	Pre-applied/under slab sheet waterproofing membrane	**Reference flow:** 2.34 kg/m^2 **Thickness:** 73 mil (1.85 mm)

2.4 System boundary

This section describes the system boundary for the analysis. The system boundary defines which life cycle stages are included and which are excluded.

Scope	PRODUCTION STAGE			CONSTRUC-TION STAGE		USE STAGE					END-OF-LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
	Extraction and upstream production	Transport to factory	Manufacturing	Transport to site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Deconstruction/Demolition	Transport to waste processing or disposal	Waste processing	Disposal of waste	Reuse, Recovery, Recycling Potential
						B6 Operational energy use									
						B7 Operational w ater use									
Cradle to gate	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Figure 3. Applied system boundary

Figure 3 illustrates all the life cycle phases included in this study. This LCA's system boundary is from cradle to gate. Therefore, the life cycle activities and related processes shall include modules A1, A2, and A3. This includes raw materials extraction and preprocessing, transportation, and manufacturing and final assembly for both the product and its associated packaging. Table 5 lists specific inclusions and exclusions for the system boundary. This study follows

the modularity principle, where all environmental impacts and potential impacts are declared in the life cycle stage where they can be attributed.

Table 5. System boundary inclusions and exclusions

Included	Excluded
● Raw material extraction for components ● Transport of raw materials and other inputs to the manufacturing facilities, and internal transport between facilities ● Processing of raw materials into components ● Packaging of raw materials and their disposal ● Generation of electricity, steam, and heat from primary energy resources used in manufacturing, including their extraction, refining, and transport ● Transport of components to assembly locations ● Packaging for the final product, including transportation and waste disposal to make product ready for shipment	● Manufacturing and maintenance of major capital equipment ● Human labor and employee transport

Production stage (A1-A3)

The production stage starts when raw materials are extracted from nature and ends when the product is packaged and ready to be loaded onto a transport vehicle at the W. R. MEADOWS facility.

The production stage includes three product life cycle modules:

I. **Extraction and upstream preprocessing (A1)**
   - Extraction and processing of raw materials
   - Transport of raw materials from extraction/production to manufacturer
   - Energy and water consumption for raw material manufacturing
   - Raw material packaging inputs

II. **Transport to factory (A2)**
   - Transportation of components to W.R. Meadow's manufacturing facility

III. **Manufacturing (A3)**
   - Energy and water consumption for product manufacturing
   - Product packaging inputs
   - Releases to environmental media (air, soil, ground, & surface water)
   - Manufacturing waste transportation from plant to disposal sites
   - Manufacturing waste disposal/recycling/reuse/energy recovery
   - Final product preparation for outbound shipment

3 LIFE CYCLE INVENTORY ANALYSIS

This chapter includes an overview of the obtained data and data quality that has been used in this study. A comprehensive life cycle inventory calculation workbook, which catalogs the flows crossing the system boundary and provides the starting point for life cycle impact assessment, can be found in the appendix.

3.1 Data collection procedures

Primary data was provided by W. R. MEADOWS representing the supply chain (A1-A2) and manufacturing processes (A3) for the products for two plants (Fort Worth, TX and Hampshire, IL). Data was collected in a consistent manner and level of detail to ensure high-quality data. All submitted data were checked for quality multiple times on the plausibility of inputs and outputs using mass balance and benchmarking. All questions regarding data, including gaps, outliers, and any inconsistencies, were resolved with the W. R. MEADOWS plant managers. Twelve months of data (CY2025) was collected. An analyst at Sustainable Minds developed the resulting inventory calculations and subsequently checked them internally.

Expert judgment was used in selecting appropriate data sets to model the associated activities in this study, including materials and energy, which have been noted in the following sections. Databases adopted in the model include ecoinvent v3.11 and US-EI 2.2 databases. Overall, the quality of the data used in this study is good and representative of the described systems. All appropriate means were employed to guarantee the data quality and representativeness, as described below.

3.2 Primary data

Primary data was collected for every process in the product system under W. R. MEADOWS's control. If direct measurements were unavailable, primary data was collected using the W. R. MEADOWS facility representative personnel's best engineering estimates based on actual production.

3.2.1. Raw materials acquisition and transportation (A1-A2)

These modules represent raw materials extraction, preprocessing/upstream processing, and transportation to the manufacturing facility. W. R. MEADOWS provided full bills of material (BOMs) with a detailed breakdown of each product's raw material mass percentage.

Waste and scrap created during raw material upstream processing, and the emissions associated with transporting waste and scrap to the point of disposal during upstream processing, were included in the background data sets used to model those raw materials. In addition, the number of raw materials needed to manufacture the final product was scaled up to account for production wastage.

These products do not contain hazardous materials as defined by the the Global Harmonized System (GHS) rules for safety data sheets (SDS).

Table 6 presents the material composition and percentage of the fluid-applied waterproofing membrane HRM 714. All incoming raw materials and their respective packaging methods are listed below. Materials arrive at both facilities primarily through bulk tankers, and in such cases no incoming packaging is included. Other materials are transported through super sack, tote, and plastic pallet. In such cases, the incoming plastic packaging is included. There are slight differences in raw material amounts between the two manufacturing locations, which are reflected using a production-weighted average. The synthetic rubbers were sourced from suppliers that produce with post-consumer recycled content from tires. A weighted average of 80% post-consumer recycled content was used to reflect the amounts provided by the different suppliers.

Table 6. Fluid-applied waterproofing membrane HRM 714 material composition by weight per declared unit (Fort Worth, TX and Hampshire, IL)

Raw material	Weight (kg/DU)	Percentage
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
Total	**6.00**	**100%**

Table 7 presents the material composition of the sheet-applied waterproofing membranes PRECON. PRECON applies synthetic PP fabric as the pre-applied sheet. Incoming packaging in plastic pails and cardboard boxes are considered in the study.

Table 7. Pre-applied waterproofing membrane PRECON material composition by weight per declared unit (Hampshire, IL)

Raw material	Weight (kg/DU)	Percentage
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Raw materials are first extracted and manufactured by material suppliers. Suppliers then transport raw materials to the manufacturing plants. All ingredients are sourced in North America and are transported by tanker truck, LTL truck, or semi-truck, which are modeled as a 16–32-ton lorry truck. Materials were assumed to come directly from the supplier or through a distribution center. Incoming plastic pallets were assumed to be landfilled. Transportation modes and distances for each of the raw materials supplied, and the total transportation (lbmi) for each product, are provided from Table 8 to Table 10.

Table 8. Raw material supplier transportation modes and distances (HRM 714; Fort Worth, TX)

Raw material	Road distance (miles)	Means of transportation
[redacted]	[redacted]	Tanker truck
[redacted]	[redacted]	Tanker truck
[redacted]	[redacted]	Tanker truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	LTL truck
[redacted]	[redacted]	LTL truck

Table 9. Raw material supplier transportation modes and distances (HRM 714, Hampshire, IL)

Raw material	Road distance (miles)	Means of transportation
[redacted]	[redacted]	Tanker truck
[redacted]	[redacted]	Tanker truck
[redacted]	[redacted]	Tanker truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck

Table 10. Raw material supplier transportation modes and distances (PRECON; Hampshire, IL)

Raw material	Road distance (miles)	Means of transportation
[redacted]	[redacted]	Tanker truck
[redacted]	[redacted]	Tanker truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Tanker truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck
[redacted]	[redacted]	Semi-truck

Table 11. Raw material transportation quantities per declared unit

Product	Raw material transportation (lbmi)	Plant location
HRM 714	[redacted]	Fort Worth, TX
HRM 714	[redacted]	Hampshire, IL
PRECON	[redacted]	Hampshire, IL

3.2.2. Manufacturing (A3)

The raw material batches are transported to W. R. MEADOWS facilities and stored before processing. Manufacturing inputs and outputs are reported based on fluid-applied and sheet-applied product types. For HRM 714, the raw materials are prepared and staged near the mixing tank. Raw materials are

measured using load cell weight systems to ensure precise dosing. The mixer motor is activated to initiate blending, and additional bagged raw materials are manually added from the top of the tank. Once mixing is complete, the product is transferred into let-down (packaging) tank. During the packaging process, final products are filled via conveyor and moving fill nozzles. The operator then fills the box with the final product and twists and folds over the liner bag. The packaged product then travels via conveyor to be auto-sealed with tape, and then it is stacked and unitized. Per the PCR, pallets are excluded from the scope of this study.

Table 12 and Table 13 present the manufacturing inputs and waste outputs per declared unit for HRM 714 at each production site. Waste generated is primarily from incoming packaging materials, with plastic waste assumed to be landfilled in an open sanitary landfill, and cardboard packaging waste are recycled and landfilled in different plants. Waste transportation distances are calculated based on the proximity of each manufacturing facility to the nearest waste processing site.

Table 12. HRM 714 manufacturing inputs per declared unit ($1m^2$) per plant

Product	Electricity (kWh)	Natural gas (therms)	Cardboard box (kg)	Plastic (kg)	Plant location
HRM 714	[redacted]	[redacted]	[redacted]	[redacted]	Fort Worth, TX
	[redacted]	[redacted]			Hampshire, IL

Table 13. HRM 714 waste outputs per declared unit ($1m^2$) per plant

Product	Waste plastic (kg)	Waste transport (lbmi)	Plant location
HRM 714	[redacted]	[redacted]	Fort Worth, TX
	[redacted]	[redacted]	Hampshire, IL

[redacted]. Table 14 through Table 16 show the manufacturing inputs and waste outputs per declared unit, as well as the packaging accounted for per declared unit for each sheet-applied product.

Table 14. Sheet-applied PRECON manufacturing inputs per declared unit

Product	Electricity (kWh)	Natural gas (therm)	Plant location
PRECON	[redacted]	[redacted]	Hampshire, IL

Table 15. Sheet-applied PRECON final packaging inputs (kg) per declared unit

Product	Cardboard	Plastic core	Plant location
PRECON	[redacted]	[redacted]	Hampshire, IL

Table 16. Sheet-applied PRECON waste plastic, waste cardboard and waste transport (kg) per declared unit

Product	Waste plastic (kg)	Waste cardboard (kg)	Waste transport (lbmi)	Plant location
PRECON	[redacted]	[redacted]	[redacted]	Hampshire, IL

Figure 4 illustrates the cradle-to-gate process flow diagram for W. R. MEADOWS HRM 714 and PRECON. This study has included all upstream energy and material flows related to production.

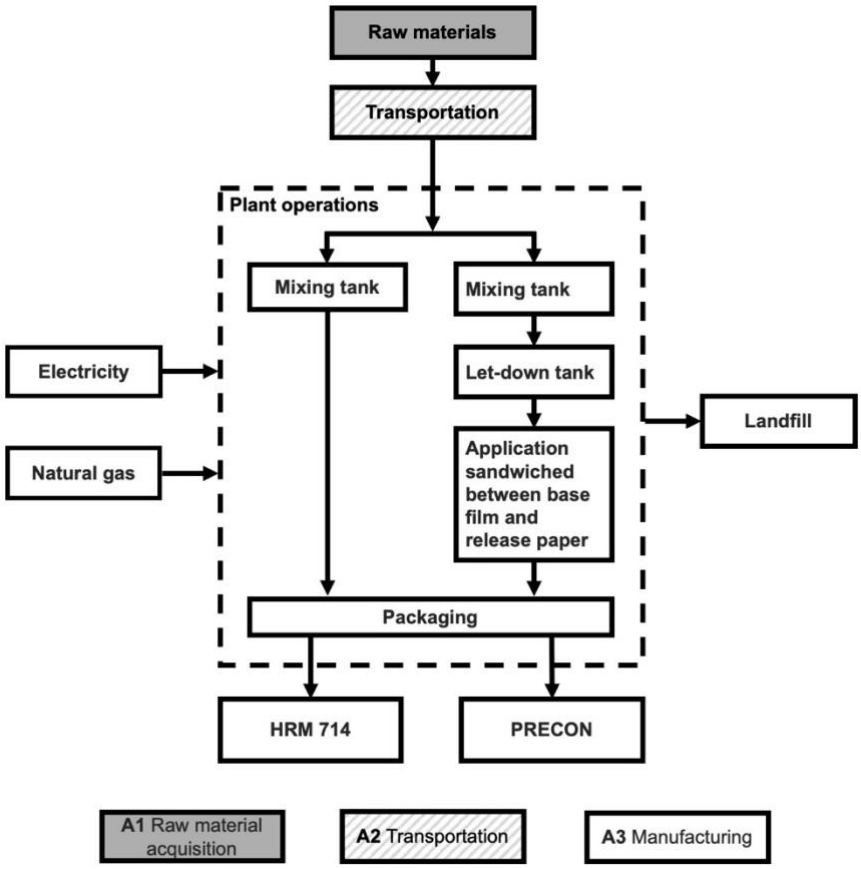


Figure 4. System boundary and product flow diagram for water resistive barriers membrane product manufacturing

3.2.3. Additional information for biogenic carbon disclosure

This section discloses the biogenic carbon emissions from packaging associated with the final product in the installation stage (A5). While the impacts from installation are out of the scope of this cradle-to-gate study, ISO 21930:2017 requires that biogenic carbon emissions associated with packaging disposed of after product installation are separately reported. The biogenic carbon removals from packaging in the manufacturing stage (A3) are later accounted for as biogenic carbon emissions in the installation stage (A5). The biogenic carbon emissions from packaging are detailed in Table 17.

Table 17. Biogenic carbon disclosure per declared unit

Product name	Biogenic carbon emission from packaging (A5)	Unit
HRM 714 (Forth Worth, TX)	3.89E-01	kg CO_2
HRM 714 (Hampshire, IL)	3.67E-01	kg CO_2
PRECON	2.82E-01	kg CO_2

3.3 Background data

This section details background data sets used for modeling all relevant activities associated with the cradle-to-gate life cycle of the barrier products. Each table lists the data set name, database, reference year, and geography. The LCA model was created using SimaPro Analyst 10.2.0.2. The ecoinvent v3.11 and

US-EI 2.2 databases provided the life cycle inventory data of the raw materials and processes for modeling the products.

3.3.1. Raw materials production

Data representing upstream and downstream raw materials were included. Table 18 lists the most relevant LCI data sets used in modeling the raw materials.

Table 18. Key material data sets used in inventory analysis

Material name	Data set	Database	Technology	Reference year	Geography
[redacted]	[redacted]	ecoinvent v3.11	Appropriate technology	*2011	Global (GLO)
[redacted]	[redacted]	ecoinvent v3.11	Appropriate technology	2024	Rest of World (non-Europe))
[redacted]	[redacted]	ecoinvent v3.11	Appropriate technology	*2011	Global (GLO)
[redacted]	[redacted]	ecoinvent v3.11	Appropriate technology	2024	Global (GLO)
[redacted]	[redacted]	ecoinvent v3.11	Appropriate technology	2019	Global (GLO)
[redacted]	[redacted]	ecoinvent v3.11	Appropriate technology	*2011	Rest of World (non-Europe)
[redacted]	[redacted]	ecoinvent v3.11	Appropriate technology	2019	Global (GLO)
[redacted]	[redacted]	ecoinvent v3.11	Appropriate technology	*2011	Rest of World (non-Europe) Global (GLO)
[redacted]	[redacted]	ecoinvent v3.11	Appropriate technology	2019	Global (GLO)
[redacted]	[redacted]	ecoinvent v3.11	Appropriate technology	2024	Global (GLO)
[redacted]	[redacted]	ecoinvent v3.11	Appropriate technology	2023	Global (GLO)
Packaging, cardboard	Corrugated board box {US}| market for corrugated board box | Cut-off, U	ecoinvent v3.11	Appropriate technology	*2011	United States
Packaging, plastic	Polyethylene, high density, granulate {GLO}| market for polyethylene, high density, granulate | Cut-off, U	ecoinvent v3.11	Appropriate technology	*2011	Global (GLO)

*Data sets older than 10 years were chosen because they closest represent the technology used to manufacture the material and are assumed to be more accurate than other potential proxies with more precise geography and temporal representativeness. Proxy datasets are used when materials are different.

3.3.2. Transportation

Transportation distances and modes of transport were included for transporting raw materials to the manufacturing facility. The typical vehicle used for shipment is a semi-truck. As the transportation data sets represent load factors as an average of empty and fully loaded (i.e., average load factor), empty backhauls are accounted for in the model. Table 19 shows the most relevant LCI data sets used in modeling transportation.

Table 19. Transportation data sets used in inventory analysis

Vehicle type	Data set	Database	Technology	Reference year	Geography
Tanker truck, LTL, and semi-truck	Transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 {RoW}| market for transport, freight, lorry, 16-32 metric ton, diesel, EURO 6 | Cut-off, U	ecoinvent v3.11	Appropriate technology	*2014	Rest of World (non-Europe)

*Data sets older than 10 years were chosen because they closest represent the technology used to manufacture the material and are assumed to be more accurate than other potential proxies with more precise geography and temporal representativenes.

3.3.3. Fuels and energy

Electricity at the facility was modeled using regionally specific inventory data based on the electricity market consumption mix in the specific plant region. The grid mixes used were the most recent from eGRID for the disclosed subregions. Table 20 shows the most relevant LCI data sets used in fuels and energy.

Table 20. Key energy data sets used in inventory analysis

Energy source	Data set	Database	Technology	Reference year	Facility location
Electricity	Electricity mix, eGrid subregion, ERCT/US U	eGrid, EPA US-EI 2.2	Appropriate technology	2023	Fort Worth, TX
Electricity	Electricity mix, eGrid subregion, MROE/US U	eGrid, EPA US-EI 2.2	Appropriate technology	2023	Hampshire, IL
Natural gas	Heat, district or industrial, natural gas {RoW}| market for heat, district or industrial, natural gas | Cut-off, U	ecoinvent v3.11	Appropriate technology	*2011	United States

*Data sets older than 10 years were chosen because they closest represent the technology used to manufacture the material and are assumed to be more accurate than other potential proxies with more precise geography and temporal representativeness

3.3.4. Disposal

Disposal processes were obtained from the ecoinvent v3.11 database. These processes were selected to correspond to disposal of production and packaging waste. Table 21 lists the relevant disposal data sets used in the model.

Table 21. Key disposal data sets used in inventory analysis

Disposal activity	Data set	Database	Technology	Reference year	Geography
Landfill of cardboard	Waste paperboard {GLO}| treatment of waste paperboard, unsanitary landfill, dry infiltration class (100mm) | Cut-off, U	ecoinvent v3.11	Appropriate technology	2024	Global (GLO)
Landfill of plastic	Waste plastic, mixture {GLO}| treatment of waste plastic, mixture, unsanitary landfill, dry infiltration class (100mm) | Cut-off, U	ecoinvent v3.11	Appropriate technology	2024	Global (GLO)
Landfill of solid waste	Municipal solid waste {RoW}| treatment of municipal solid waste, sanitary landfill | Cut-off, U	ecoinvent v3.11	Appropriate technology	2024	Rest of World (non-Europe)
Road transport for collecting municipal waste	Municipal waste collection service by 21 metric ton lorry {GLO}| market for municipal waste collection service by 21 metric ton lorry | Cut-off, U	ecoinvent v3.11	Appropriate technology	2024	Global (GLO)

3.4 Cut-off criteria

The cut-off criteria on a unit process level can be summarized as follows:

- All inputs and outputs to a (unit) process shall be included in the calculation of the pre-set parameters results for which data are available. Data gaps shall be filled by conservative assumptions with average, generic, or proxy data. Any assumptions for such choices shall be documented. Assumptions and proxies, whenever used, have been explained in this report.
- Mass – If a flow is less than 1% of the cumulative mass of the model it may be excluded, providing its environmental relevance is not a concern. Select mass flows have been omitted in this study where they were deemed environmentally irrelevant.
- Energy – If a flow is less than 1% of the cumulative energy of the model it may be excluded, providing its environmental relevance is not a concern. No known energy flow has been omitted in this study.
- Environmental relevance – If a flow meets the above criteria for exclusion, yet it is thought to potentially have a significant environmental impact, it is included. Polydimethylsiloxane, which was present at <1%, was included for its environmental relevance.
- Hazardous and toxic materials – The study shall include all hazardous and toxic materials in the inventory; therefore, the cutoff rules shall not apply to such substances. No substances required to be reported as hazardous are associated with the production of this product, including upstream raw material supply and raw material manufacturing.
- The sum of the neglected material flows does not exceed 5% of mass, energy, or environmental relevance for flows indirectly related to the process (e.g., operating materials).

In this report, flows of less than 1% of the cumulative mass were excluded from modeling when their environmental relevance was not a concern, and the sum of excluded mass and energy flows was below 5%; therefore, these criteria have been met. The completeness of the bill of materials defined in this report satisfies the above-defined cut-off criteria.

3.5 Allocation

Whenever a system boundary is crossed, environmental inputs and outputs must be assigned to the different products. Where multi-inputs or multi-outputs are considered, the same applies. The PCR prescribes to report where and how allocation occurs in modeling the LCA.

Each W. R. MEADOWS facility produces multiple types of products each year. To allocate electricity and natural gas consumption accurately to each product, total annual energy consumption was distributed based on the proportion of each product's annual production (by mass) relative to the total plant production. This approach assigns manufacturing activities proportionally to each product type.

The facility produces different products. Therefore, electricity and natural gas inputs were allocated using annual production quantities in mass. Similarly, waste disposal outputs were allocated based on the ratio of total plant production to each product's production and then normalized to declared unit mass. There are no co-products produced during their manufacturing processes. Useable output flows such as scrap are not considered co-products but are considered waste, and no allocation to secondary material, secondary fuels, or recovered energy was applied.

The model used in this report ensures that the sum of the allocated inputs and outputs of a unit process shall be equal to the inputs and outputs of the unit process before allocation. This means that no double counting or omissions of inputs or outputs through allocation is occurring. The allocation procedures used in background data sets were accepted without modification.

3.6 Discussion of data quality

Inventory data quality is judged by its precision (measured, calculated, or estimated), completeness (e.g., unreported emissions), consistency (degree of uniformity of the methodology applied on a study serving as a data source), and representativeness (geographical, temporal, and technological).

To cover these requirements and to ensure reliable results, first-hand industry data, in combination with consistent background LCA information from the ecoinvent v3.11 and US-EI 2.2 databases, were used.

Precision and completeness

- *Precision:* As the relevant foreground data is primary data or modeled based on primary information sources of the owner of the technology, precision is considered to be high. Background data are from the ecoinvent v3.11 and US-EI 2.2 databases with documented precision to the extent available.

- *Completeness:* Sustainable Minds worked with each plant manager to obtain a comprehensive set of primary data associated with the manufacturing processes. The product system was checked for mass balance and completeness of the inventory. The data set was considered complete based on our understanding of the manufacturing site and a review with key stakeholders on the W. R. MEADOWS team, and cut-off criteria were observed consistent with those prescribed in the PCR. Besides capital equipment, no data was knowingly omitted.

Consistency and reproducibility

- *Consistency*: Primary data were collected with a similar level of detail, while background data were sourced primarily from the ecoinvent database. Other databases were used if data were not available in ecoinvent or the data set was judged to be more representative. Other methodological choices were made consistently throughout the model.

- *Reproducibility*: Reproducibility is warranted as much as possible through the disclosure of input-output data, data set choices, and modeling approaches in this report. Based on this information, a knowledgeable third party should be able to approximate the results of this study using the same data and modeling approaches.

Representativeness

- *Temporal:* All primary data were collected for CY2025, ensuring the representativeness of the manufacturing process. Secondary data were obtained from the ecoinvent v3.11 and US-EI 2.2 databases and are typically representative of the recent years.

- *Geographical:* The geographical coverage for this study is based on United States system boundaries for all processes and products. Whenever US background data was not readily available, rest of world (non-Europe) data or global data were used. Input and output data for modeling come from the manufacturing facility which is responsible for production.

- *Technological*: All primary and secondary data were modeled to be specific to the technologies under study. Technological representativeness is considered to be high.

3.7 Comparability

ISO 21930:2017 section 5.5 highlights the following limitations and clarifications in EPD comparability: EPDs are comparable only if they use the same PCR (or sub-category PCR where applicable), include all relevant information modules, and are based on equivalent scenarios with respect to the context of construction works.

EPDs can only be compared when the same functional requirements between products are ensured, and the requirements of ISO 21930:2017 section 5.5 are met. However, variations and deviations are possible. For example, different LCA software and background LCI data sets may lead to different results for the life cycle stages declared.

3.8 Assumptions and limitations

A life cycle assessment of a product system is broad and complex, and it inherently requires assumptions and simplifications. The following limitations of the study should be recognized:

- Primary data was modeled based on the information provided by W. R. MEADOWS and supplemented by data contained in the technical and safety data sheets provided. Proxy materials were used when matching secondary data sets were not identified.
- Since energy inputs were not available per product, electricity and natural gas consumption were allocated proportionately based on the annual mass of production for individual products versus total site production.
- Generic data sets used for material inputs, transport, and waste processing are considered good quality, but actual impacts from material suppliers, transport carriers, and local waste processing may vary.
- The impact assessment methodology categories do not represent all possible environmental impact categories.
- Characterization factors used within the impact assessment methodology may contain varying levels of uncertainty.
- LCA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins, or risks.
- No "green power" is used in this LCA.
- No renewable certificates or purchased CO_2 offsets are included in the LCA.

4 IMPACT ASSESSMENT METHODS

4.1 Impact assessment characterization

The environmental indicators as required by the PCR are included as well as other indicators required to use the SM2026 Methodology [6] (see Table 22). The impact indicators are derived using the 100-year time horizon[1] factors, where relevant, as defined by TRACI 2.2 classification and characterization [7]. Long-term emissions (>100 years) are not taken into consideration in the impact estimate. The impact assessment is based on the TRACI methodology [7] and the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6, 2021) [8]. USEtox indicators[2] are used to evaluate toxicity-related impact categories, namely ecotoxicity, carcinogenics, and non-carcinogenics. Emissions from waste disposal are considered part of the product system under study, according to the "polluter pays principle".

Table 22. Selected impact categories and units

Impact category	Unit	Description
Acidification	kg SO_2 eq (sulphur dioxide)	Acidification processes increase the acidity of water and soil systems and causes damage to lakes, streams, rivers and various plants and animals as well as building materials, paints and other human-built structures.
Ecotoxicity	CTUe	Ecotoxicity causes negative impacts to ecological receptors and, indirectly, to human receptors through the impacts to the ecosystem.
Eutrophication: freshwater	kg P eq (nitrogen)	Freshwater eutrophication refers to the enrichment of lakes, rivers, and other inland water bodies with nutrients—primarily phosphorus—which stimulates excessive growth of algae and aquatic plants. This process can lead to oxygen depletion, loss of biodiversity, and degradation of water quality, particularly in slow-moving or stagnant systems where nutrient accumulation is more pronounced.
Eutrophication: marine	kg N eq (nitrogen)	Marine eutrophication occurs in coastal and ocean environments and is mainly driven by nitrogen inputs from agricultural runoff, wastewater, and atmospheric deposition. The increased nutrient availability promotes algal blooms, which can result in hypoxic or anoxic conditions (dead zones), negatively impacting marine ecosystems, fisheries, and overall water quality.
Global warming (IPCC, AR6)	kg CO_2 eq (carbon dioxide)	Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere.
Ozone depletion	kg CFC-11 eq	Ozone depletion is the reduction of ozone in the stratosphere caused by the release of ozone depleting chemicals.
Carcinogenics	CTUh	Carcinogens have the potential to form cancers in humans.
Non-carcinogenics	CTUh	Non-Carcinogens have the potential to causes non-cancerous adverse impacts to human health.
Respiratory effects	kg $PM_{2.5}$ eq (fine particulates)	Particulate matter concentrations have a strong influence on chronic and acute respiratory symptoms and mortality rates.
Smog	kg O_3 eq (ozone)	Smog formation (photochemical oxidant formation) is the formation of ozone molecules in the troposphere by complex chemical reactions.

[1]The 100-year period relates to the period in which the environmental impacts are modeled. This is different from the period of the declared unit. The two periods are related as follows: all environmental impacts that are created in the period of the declared unit are modeled through life cycle impact assessment using a 100-year time horizon to understand the impacts that take place.
[2] USEtox is available in TRACI and at http://www.usetox.org/

With respect to global warming potential, biogenic carbon uptake and removal are included in impact category calculations. The biogenic carbon measured in this study originates from packaging materials. Greenhouse gas emissions from land-use change are expected to be insignificant and were not reported. Carbon emissions during carbonation and calcination were also considered in this study, and no carbonation or calcination are expected to occur.

No delayed emissions from a temporary carbon sequestration are expected to occur. It shall be noted that the above impact categories represent impact potentials. They are approximations of environmental impacts that could occur if the emitted molecules follow the underlying impact pathway and meet certain conditions in the receiving environment while doing so. In addition, the inventory only captures that fraction of the total environmental load that corresponds to the chosen declared unit (relative approach).

The results from the impact assessment indicate potential environmental effects and do not predict actual impacts on category endpoints, the exceedance of thresholds, or safety margins or risks.

4.2 Normalization and weighting

To arrive at a single score indicator, normalization [9] and weighting [10] as shown in Table 23 conforming to the SM2026 Methodology were applied. The SM2026 Methodology uses IPCC AR6 GWP and TRACI 2.2 impact categories developed by the U.S. EPA, and North American normalization and weighting values developed by the EPA and NIST, respectively, were used to calculate single-figure LCA results. Sustainable Minds recognizes that weighting is socially defined based on the importance that society attaches to the different environmental impact categories. However, these single score indicators serve as an easy starting point to get to know the product under consideration across all impact categories, rather than focusing all efforts on just one impact category (like global warming potential). The interpretation of the results starts with the Sustainable Minds single score results and then allows users to further explore the underlying impact categories individually. Details including the characterization models, factors, and methods used, including all assumptions and limitations, can be found in the SM2026 Methodology Report [6].

Table 23. Normalization and weighting factors

Impact category	Normalization	Weighting (%)
Global warming (IPCC AR6)	24200	39.8
Acidification	90.8	4.1
Eutrophication: freshwater	0.438	4.1
Eutrophication: marine	19.1	4.1
Ozone depletion	0.161	2.7
Smog	1390	5.5
Respiratory effects	24.2	12.3
Carcinogenics	5.07E-05	10.9
Non-carcinogenics	1.05E-03	6.8
Ecotoxicity	11100	9.6

5 ASSESSMENT AND INTERPRETATION

This chapter includes the results from the LCA for the products studied. It details the results per declared unit, outlines the sensitivity analysis, and concludes with recommendations.

5.1 Data quality assessment

The quality of inventory data is evaluated based on its precision, completeness, consistency, and representativeness. The data used in this study is regarded as reliable and representative of the described systems, as well as their geographical, temporal, and technological contexts. When direct measurements were unavailable, the best engineering estimates based on actual production were applied. Every effort was made to ensure the highest data quality.

5.2 Resource use and waste flows

Resource use indicators, output flows and waste category indicators, and carbon emissions and removals are presented in this section. These life cycle inventory (LCI) indicators reflect the flows from and to nature for the product system prior to characterization using an impact assessment methodology to calculate life cycle impact assessment (LCIA) results (as shown in section 5.3).

LCI flows were calculated with the help of the American Center for Life Cycle Assessment's (ACLCA) guidance to the ISO 21930:2017 metrics [11]. The consumption of freshwater indicator, which was calculated in accordance with this guidance, is reported in compliance with ISO 14046. The use of renewable and non-renewable energy resources with energy content was calculated using the Cumulative Energy Demand (LHV) impact assessment methodology [12]. Abiotic depletion potential was calculated using the CML impact assessment methodology [13]. LCI flows were reported in conformance to ISO 21930:2017.

Resource use indicators represent the amount of materials consumed to produce not only the product itself but also the raw materials, electricity, natural gas, etc., that go into the product's life cycle.

Primary energy is an energy form found in nature that has not been subjected to any conversion or transformation process and is expressed in energy demand from renewable and non-renewable resources. Efficiencies in energy conversion are considered when calculating primary energy demand from process energy consumption. Water use represents the total water used over the entire life cycle. No renewable energy was used in production beyond that accounted for in the selected eGRID data sets for each subregion, and no energy was recovered.

Non-hazardous waste is calculated based on the amount of waste generated during manufacturing based on W.R. Meadows' record. All waste treatments in models were considered based on the local waste management code and the assumptions prescribed by the PCR. Waste treatments included within the system boundary are reported. Unrecyclable waste is disposed of in landfills.

Resource use, output flows, waste categories, and carbon emissions & removals for the studied products have been tabulated in the sections below.

5.2.1. HRM 714 (Fort Worth, TX)

Table 24. Resource use and waste flows for HRM 714 (Fort Worth, TX) per declared unit

Parameter	Unit	A1	A2	A3	Total
Resource use indicators					
Renewable primary energy used as energy carrier (fuel)	MJ, NCV	1.77E+00	9.82E-03	6.52E+01	**6.70E+01**
Renewable primary resources with energy content used as material	MJ, NCV	0	0	0	**0**
Total use of renewable primary resources with energy content	MJ, NCV	1.77E+00	9.82E-03	6.52E+01	**6.70E+01**
Non-renewable primary resources used as an energy carrier (fuel)	MJ, NCV	1.59E+01	5.19E+00	1.63E+01	**3.73E+01**
Non-renewable primary resources with energy content used as material	MJ, NCV	6.53E+01	0	0	**6.53E+01**
Total use of non-renewable primary resources with energy content	MJ, NCV	8.12E+01	5.19E+00	1.63E+01	**1.03E+02**
Secondary materials	kg	0	0	0	**0**
Renewable secondary fuels	MJ, NCV	0	0	0	**0**
Non-renewable secondary fuels	MJ, NCV	0	0	0	**0**
Recovered energy	MJ, NCV	0	0	0	**0**
Use of net freshwater resources	m3	2.94E+00	3.12E-02	1.91E+00	**4.88E+00**
Abiotic depletion (fossil fuels)	MJ, LHV	7.48E+01	4.87E+00	1.43E+01	**9.39E+01**
Output flows and waste category indicators					
Hazardous waste disposed	kg	3.64E-02	3.87E-03	3.72E-02	**7.75E-02**
Non-hazardous waste disposed	kg	7.33E-01	6.18E-03	4.30E-01	**1.17E+00**
High-level radioactive waste, conditioned, to final repository	kg	4.21E-06	6.69E-08	3.52E-06	**7.80E-06**
Intermediate- and low-level radioactive waste, conditioned, to final repository	kg	2.05E-05	0	1.10E-05	**3.15E-05**
Components for re-use	kg	0	0	0	**0**
Materials for recycling	kg	0	0	0	**0**
Materials for energy recovery	kg	0	0	0	**0**
Exported energy	MJ	0	0	0	**0**
Carbon emissions and removals					
Biogenic Carbon Removal from Product	kg CO_2	0	0	0	**0**
Biogenic Carbon Emission from Product	kg CO_2	0	0	0	**0**
Biogenic Carbon Removal from Packaging	kg CO_2	0	0	-3.89E-01	**-3.89E-01**
Biogenic Carbon Emission from Packaging	kg CO_2	0	0	0	**0**
Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes	kg CO_2	0	0	0	**0**
Calcination Carbon Emissions	kg CO_2	0	0	0	**0**
Carbonation Carbon Removals	kg CO_2	0	0	0	**0**
Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes	kg CO_2	0	0	0	**0**

5.2.2. HRM 714 (Hampshire, IL)

Table 25. Resource use and waste flows for HRM 714 (Hampshire, IL) per declared unit

Parameter	Unit	A1	A2	A3	Total
Resource use indicators					
Renewable primary energy used as energy carrier (fuel)	MJ, NCV	1.77E+00	7.55E-03	3.79E+00	**5.57E+00**
Renewable primary resources with energy content used as material	MJ, NCV	0	0	0	**0**
Total use of renewable primary resources with energy content	MJ, NCV	1.77E+00	7.55E-03	3.79E+00	**5.57E+00**
Non-renewable primary resources used as an energy carrier (fuel)	MJ, NCV	1.93E+01	3.99E+00	1.02E+01	**3.36E+01**
Non-renewable primary resources with energy content used as material	MJ, NCV	6.19E+01	0	0	**6.19E+01**
Total use of non-renewable primary resources with energy content	MJ, NCV	8.12E+01	3.99E+00	1.02E+01	**9.54E+01**
Secondary materials	kg	0	0	0	**0**
Renewable secondary fuels	MJ, NCV	0	0	0	**0**
Non-renewable secondary fuels	MJ, NCV	0	0	0	**0**
Recovered energy	MJ, NCV	0	0	0	**0**
Use of net freshwater resources	m3	2.93E+00	2.40E-02	6.43E-01	**3.60E+00**
Abiotic depletion (fossil fuels)	MJ, LHV	7.50E+01	3.74E+00	7.53E+00	**8.63E+01**
Output flows and waste category indicators					
Hazardous waste disposed	kg	3.61E-02	2.98E-03	4.67E-03	**4.37E-02**
Non-hazardous waste disposed	kg	7.33E-01	4.75E-03	2.01E-01	**9.39E-01**
High-level radioactive waste, conditioned, to final repository	kg	4.21E-06	5.15E-08	6.03E-06	**1.03E-05**
Intermediate- and low-level radioactive waste, conditioned, to final repository	kg	2.61E-05	0	1.10E-05	**3.71E-05**
Components for re-use	kg	0	0	0	**0**
Materials for recycling	kg	0	0	0	**0**
Materials for energy recovery	kg	0	0	0	**0**
Exported energy	MJ	0	0	0	**0**
Carbon emissions and removals					
Biogenic Carbon Removal from Product	kg CO_2	0	0	0	**0**
Biogenic Carbon Emission from Product	kg CO_2	0	0	0	**0**
Biogenic Carbon Removal from Packaging	kg CO_2	0	0	-3.67E-01	**-3.67E-01**
Biogenic Carbon Emission from Packaging	kg CO_2	0	0	0	**0**
Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes	kg CO_2	0	0	0	**0**
Calcination Carbon Emissions	kg CO_2	0	0	0	**0**
Carbonation Carbon Removals	kg CO_2	0	0	0	**0**
Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes	kg CO_2	0	0	0	**0**

5.2.3. PRECON

Table 26. Resource use and waste flows for PRECON per declared unit

Parameter	Unit	A1	A2	A3	Total
Resource use indicators					
Renewable primary energy used as energy carrier (fuel)	MJ, NCV	2.99E+00	5.08E-03	2.01E+00	**5.00E+00**
Renewable primary resources with energy content used as material	MJ, NCV	1.95E-02	0	0	**1.95E-02**
Total use of renewable primary resources with energy content	MJ, NCV	3.01E+00	5.08E-03	2.01E+00	**5.02E+00**
Non-renewable primary resources used as an energy carrier (fuel)	MJ, NCV	5.74E+01	2.69E+00	7.81E+00	**6.79E+01**
Non-renewable primary resources with energy content used as material	MJ, NCV	5.11E+01	0	0	**5.11E+01**
Total use of non-renewable primary resources with energy content	MJ, NCV	1.08E+02	2.69E+00	7.81E+00	**1.19E+02**
Secondary materials	kg	0	0	0	**0**
Renewable secondary fuels	MJ, NCV	0	0	0	**0**
Non-renewable secondary fuels	MJ, NCV	0	0	0	**0**
Recovered energy	MJ, NCV	0	0	0	**0**
Use of net freshwater resources	m3	7.31E+00	9.92E-03	4.23E-01	**7.75E+00**
Abiotic depletion (fossil fuels)	MJ, LHV	9.81E+01	2.52E+00	6.23E+00	**1.07E+02**
Output flows and waste category indicators					
Hazardous waste disposed	kg	1.98E-01	0	3.55E-03	**2.01E-01**
Non-hazardous waste disposed	kg	7.20E+00	0	3.86E-01	**7.59E+00**
High-level radioactive waste, conditioned, to final repository	kg	1.19E-05	3.47E-08	3.18E-06	**1.52E-05**
Intermediate- and low-level radioactive waste, conditioned, to final repository	kg	3.95E-05	0	3.17E-05	**7.12E-05**
Components for re-use	kg	0	0	0	**0**
Materials for recycling	kg	0	0	0	**0**
Materials for energy recovery	kg	0	0	0	**0**
Exported energy	MJ	0	0	0	**0**
Carbon emissions and removals					
Biogenic Carbon Removal from Product	kg CO_2	0	0	0	**0**
Biogenic Carbon Emission from Product	kg CO_2	0	0	0	**0**
Biogenic Carbon Removal from Packaging	kg CO_2	-2.26E-03	0	-2.82E-01	**-2.85E-01**
Biogenic Carbon Emission from Packaging	kg CO_2	0	0	2.26E-03	**2.26E-03**
Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes	kg CO_2	0	0	0	**0**
Calcination Carbon Emissions	kg CO_2	0	0	0	**0**
Carbonation Carbon Removals	kg CO_2	0	0	0	**0**
Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes	kg CO_2	0	0	0	**0**

Significant data limitations currently exist within the LCI data used to generate waste metrics for Life Cycle Assessments and Environmental Product Declarations. The waste metrics were calculated in a way conformant with the requirements of ISO 21930:2017, but these values represent rough estimates and are for informational purposes only. As such, no decisions regarding actual cradle-gate waste performance between products should be derived from these reported values.

5.3 Life cycle impact assessment (LCIA)

It shall be reiterated at this point that the reported impact categories represent impact potentials; they are approximations of environmental impacts that could occur if the emitted molecules follow the underlying impact pathway and meet certain conditions in the receiving environment while doing so. In addition, the inventory only captures that fraction of the total environmental load that corresponds to the chosen declared unit (relative approach). LCIA results are therefore relative expressions only and do not predict actual impacts, the exceeding of thresholds, safety margins, or risks.

Life cycle impact assessment (LCIA) results are shown for the fluid-applied product HRM 714, as well as sheet-applied products PRECON. Unlike life cycle inventories, which only report sums for individual inventory flows, the LCIA includes a classification of individual emissions with regard to the impacts they are associated with and subsequently a characterization of the emissions by a factor expressing their respective contribution to the impact category indicator. The end result is a metric for quantifying each potential impact, such as “Global Warming Potential”.

The impact assessment results are calculated using the TRACI impact assessment methodology developed by the EPA, as it is a well-respected and widely used impact assessment methodology in North America, and the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report for global warming, since it provides an updated to the methodology used by TRACI for global warming potential. The SM2026 Methodology is also applied to come up with single score results for the sole purpose of representing total impacts per life cycle phase to explain where in the product life cycle greatest impacts are occurring and what is contributing to the impacts.

The required 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. All impact categories from TRACI are used to calculate single score millipoints using the SM2026 Methodology, but it should be noted that there are known limitations related to these impact categories due to their high degree of uncertainty.

It is important to note that the LCIA indicators for carcinogenics, non carcinogenics (CTUh), and ecotoxicity (CTUe) are subject to significant uncertainty. EN 15804 includes the following disclaimer: *“The results of this environmental impact indicator shall be used with care, as the uncertainties associated with these results are high, or there is limited experience with the indicator.”*

5.3.1. HRM 714 (Fort Worth, TX)

Table 27 shows the LCIA results, and Table 28 and Figure 5 show the percent contribution of each stage of the production of HRM 714, in the Fort Worth location. The raw material acquisition stage dominates the results for most impact categories followed by the manufacturing stage.

The total potential CO_2-equivalent emissions generated during the cradle-to-gate stage of 1 m^2 of HRM 714 production is 3.81 kg CO_2-eq. Raw material supply contributes 2.39 kg CO_2-eq, accounting for 62.6% of the total results. Among all

raw materials, alkylbenzene has the highest impact and asphalt followed as second. The manufacturing stage was the second dominant stage over cradle to gate, with 27.6% of the total results. The raw material acquisition stage has a larger contribution than the manufacturing stage for most impact categories. Transportation accounts for the least of the impacts among all impact categories.

Table 27 Life cycle impact assessment results for HRM 714 (Fort Worth, TX) per declared unit (1 m^2)

Impact category	Unit	A1	A2	A3	Total
Total global warming potential, GWP_{total}	kg CO_2 eq	2.39E+00	3.73E-01	1.05E+00	**3.81E+00**
Global warming potential from fossil fuels, GWP_{fossil}	kg CO_2 eq	2.36E+00	3.73E-01	1.02E+00	**3.75E+00**
Global warming potential from biogenic, $GWP_{biogenic}$	kg CO_2 eq	2.68E-02	2.28E-05	2.54E-02	**5.23E-02**
Global warming potential from land use and land use change, GWP_{luluc}	kg CO_2 eq	1.19E-03	1.99E-05	3.28E-03	**4.49E-03**
Acidification	kg SO_2 eq	9.63E-03	5.11E-04	5.70E-03	**1.58E-02**
Eutrophication: freshwater	kg P eq	6.84E-05	1.19E-06	2.17E-05	**9.12E-05**
Eutrophication: marine	kg N eq	1.07E-03	6.30E-05	9.46E-04	**2.07E-03**
Ozone depletion	kg CFC-11 eq	1.68E-07	5.05E-09	2.11E-08	**1.94E-07**
Smog	kg O_3 eq	1.24E-01	7.33E-03	1.07E-01	**2.39E-01**
Respiratory effects	kg PM2.5 eq	1.42E-03	1.13E-04	1.49E-03	**3.02E-03**
Additional environmental information					
Carcinogenics	CTUh	62.57%	0.62%	36.81%	**100%**
Non carcinogenics	CTUh	27%	9.69%	63.31%	**100%**
Ecotoxicity	CTUe	36.81%	32.13%	31.07%	**100%**

Table 28. Percent contributions of each stage to each impact category for HRM 714 (Fort Worth, TX)

Impact category	A1	A2	A3	Total
Total global warming potential, GWP_{total}	62.63%	9.79%	27.59%	**100%**
Global warming potential from fossil fuels, GWP_{fossil}	62.83%	9.93%	27.24%	**100%**
Global warming potential from biogenic, $GWP_{biogenic}$	51.34%	0.04%	48.61%	**100%**
Global warming potential from land use and land use change, GWP_{luluc}	26.46%	0.44%	73.09%	**100%**
Acidification	60.80%	3.22%	35.97%	**100%**
Eutrophication: freshwater	74.93%	1.30%	23.76%	**100%**
Eutrophication: marine	51.36%	3.04%	45.60%	**100%**
Ozone depletion	86.55%	2.60%	10.85%	**100%**
Smog	52.03%	3.06%	44.91%	**100%**
Respiratory effects	46.94%	3.76%	49.30%	**100%**
Additional environmental information				
Carcinogenics	62.57%	0.62%	36.81%	**100%**
Non carcinogenics	27%	9.69%	63.31%	**100%**
Ecotoxicity	36.81%	32.13%	31.07%	**100%**

The SM2026 Methodology single figure millipoint (mPts) score by life cycle phase for this product is presented below (Table 29). Across all 10 impact categories, the SM single-figure score indicates that raw materials acquisition accounts for around 53% of the total impacts, manufacturing for 38%, and transportation for 8.9%.

Table 29. SM millipoint scores for HRM 714 (Fort Worth, TX) per declared unit (1 m^2)

Impact category	Unit	A1	A2	A3	Total
SM single figure score	mPts	1.11E-01	1.85E-02	7.96E-02	**2.09E-01**

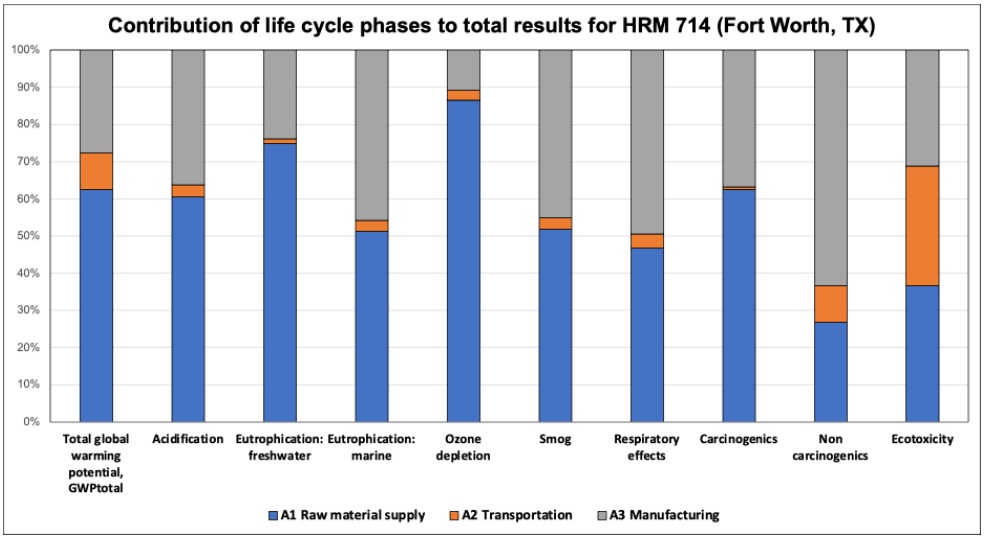


Figure 5. Contribution analysis of each impact category for HRM 714 (Fort Worth, TX)

5.3.2. HRM 714 (Hampshire, IL)

Table 30 shows the LCIA results, and Table 31 and Figure 6 shows the percent contribution of each stage of the production of HRM 714 in Hampshire, IL. The raw material acquisition stage dominates the results for all impact categories, followed by the manufacturing stage.

The total potential CO_2-equivalent emissions generated during the cradle-to-gate stage of 1 m^2 of HRM 714 production is 3.24 kg CO_2-eq. Raw material supply contributes 2.39 kg CO_2-eq, accounting for 73.6% of the total results. Among all raw materials, alkylbenzene has the highest impact and asphalt followed as second. The manufacturing stage was the second dominant stage over cradle to gate, with 17.5% of the total results. The raw material acquisition stage has a larger contribution than the manufacturing stage for most impact categories. Transportation accounts for the least of the impacts among all impact categories.

Table 30**.** Life cycle impact assessment results for HRM 714 (Hampshire, IL) per declared unit (1 m^2)

Impact category	Unit	A1	A2	A3	Total
Total global warming potential, GWP_{total}	kg CO_2 eq	2.39E+00	2.87E-01	5.63E-01	**3.24E+00**
Global warming potential from fossil fuels, GWP_{fossil}	kg CO_2 eq	2.36E+00	2.87E-01	5.43E-01	**3.19E+00**
Global warming potential from biogenic, $GWP_{biogenic}$	kg CO_2 eq	2.68E-02	1.75E-05	1.92E-02	**4.61E-02**
Global warming potential from land use and land use change, GWP_{luluc}	kg CO_2 eq	1.19E-03	1.53E-05	1.02E-03	**2.22E-03**
Acidification	kg SO_2 eq	9.63E-03	3.93E-04	2.04E-03	**1.21E-02**
Eutrophication: freshwater	kg P eq	6.84E-05	9.14E-07	1.54E-05	**8.47E-05**
Eutrophication: marine	kg N eq	1.07E-03	4.85E-05	2.54E-04	**1.37E-03**
Ozone depletion	kg CFC-11 eq	1.68E-07	3.88E-09	2.18E-08	**1.94E-07**
Smog	kg O_3 eq	1.24E-01	5.64E-03	2.73E-02	**1.57E-01**
Respiratory effects	kg PM2.5 eq	1.41E-03	8.73E-05	3.45E-04	**1.84E-03**
Additional environmental information					
Carcinogenics	CTUh	91.02%	0.70%	8.28%	**100%**
Non carcinogenics	CTUh	36.21%	10.07%	53.72%	**100%**
Ecotoxicity	CTUe	49.94%	33.68%	16.38%	**100%**

Table 31. Percent contributions of each stage to each impact category for HRM 714 (Hampshire, IL)

Impact category	A1	A2	A3	Total

Total global warming potential, GWP_{total}	73.63%	8.89%	17.48%	**100%**
Global warming potential from fossil fuels, GWP_{fossil}	73.87%	9.03%	17.10%	**100%**
Global warming potential from biogenic, $GWP_{biogenic}$	58.25%	0.04%	41.71%	**100%**
Global warming potential from land use and land use change, GWP_{luluc}	53.42%	0.69%	45.89%	**100%**
Acidification	79.71%	3.28%	17.01%	**100%**
Eutrophication: freshwater	80.68%	1.08%	18.24%	**100%**
Eutrophication: marine	77.76%	3.56%	18.68%	**100%**
Ozone depletion	86.73%	2.00%	11.27%	**100%**
Smog	78.99%	3.60%	17.41%	**100%**
Respiratory effects	76.51%	4.75%	18.75%	**100%**
Additional environmental information				
Carcinogenics	91.02%	0.70%	8.28%	**100%**
Non carcinogenics	36.21%	10.07%	53.72%	**100%**
Ecotoxicity	49.94%	33.68%	16.38%	**100%**

The SM2026 Methodology single figure millipoint (mPts) score by life cycle phase for this product is presented below (Table 32). Across all 10 impact categories, the SM single-figure score indicates that raw materials acquisition accounts for around 70.3% of the total impacts, manufacturing for 20.6%, and transportation for 9%.

Table 32. SM millipoint scores for HRM 714 (Hampshire, IL) per declared unit (1 m^2)

Impact category	Unit	A1	A2	A3	Total
SM single figure score	mPts	1.11E-01	1.42E-02	3.25E-02	**1.58E-01**

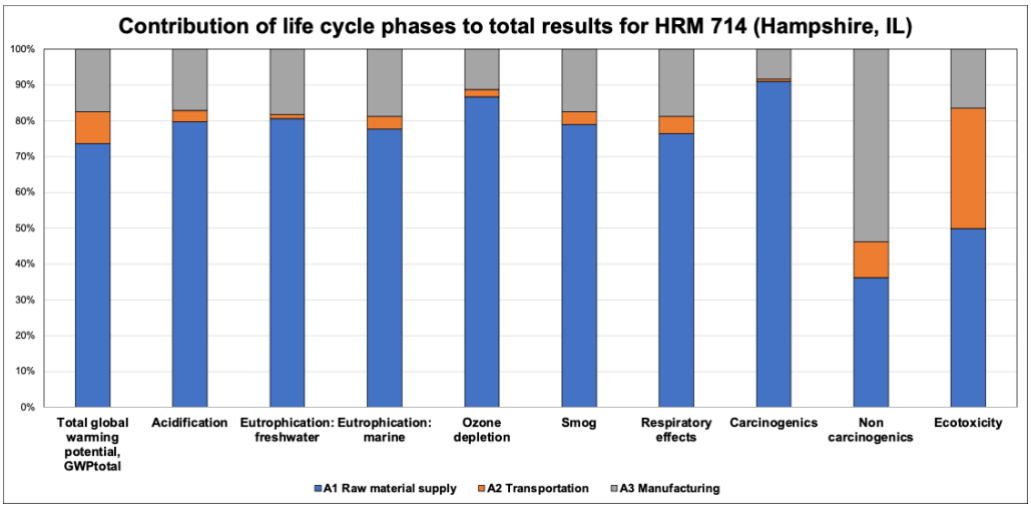


Figure 6. Contribution analysis of each impact category for HRM 714 (Hampshire, IL)

5.3.3. PRECON

Table 33 shows the LCIA results, and Table 34 and Figure 7 show the percent contribution of each stage of the production of the PRECON. The raw material acquisition stage dominates the results for all impact categories, followed by the manufacturing stage.

The total potential CO_2-equivalent emissions generated during the cradle-to-gate stage of 1 m^2 of PRECON production is 4.71 kg CO_2-eq. Raw material supply contributes 4.14 kg CO_2-eq, accounting up to 88% of the total results. This is primarily due to PP fabric used as a raw material input for this product. The manufacturing stage was the second highest contributor (at 8% to GWP), mostly due to the energy required for production at the facility. Transportation accounts for the least of the impacts among all impact categories.

The Fort Worth facility covered in this TR produced [redacted] of W. R. MEADOWS total production of HRM714 during the year of data collection. And the Hampshire facility covered in this TR produced [redacted] of W. R. MEADOWS total production of HRM714.

Embodied carbon is defined as the cradle-to-gate (A1-A3) global warming potential. HRM 714 is manufactured at two facilities, and facility-specific results are reported in the tables above: 3.81E+00 kg CO2-eq (Fort Worth, TX) and 3.24E+00 kg CO2-eq (Hampshire, IL). Weighted by each facility's share of HRM 714 production during the data-collection year (Fort Worth 2.8%, Hampshire 97.2%), the production-weighted manufacturer-average embodied carbon is 3.26E+00 kg CO2-eq per declared unit (1 m^2).

Table 33. Life cycle impact assessment results for PRECON per declared unit (1 m^2)

Impact category	Unit	A1	A2	A3	Total
Total global warming potential, GWP_{total}	kg CO_2 eq	4.14E+00	1.93E-01	3.77E-01	**4.71E+00**
Global warming potential from fossil fuels, GWP_{fossil}	kg CO_2 eq	4.13E+00	1.93E-01	3.65E-01	**4.68E+00**
Global warming potential from biogenic, $GWP_{biogenic}$	kg CO_2 eq	8.01E-03	1.18E-05	1.19E-02	**1.99E-02**
Global warming potential from land use and land use change, GWP_{luluc}	kg CO_2 eq	2.53E-03	1.03E-05	4.88E-04	**3.03E-03**
Acidification	kg SO_2 eq	1.71E-02	2.65E-04	1.24E-03	**1.86E-02**
Eutrophication: freshwater	kg P eq	7.19E-05	6.15E-07	6.86E-06	**7.94E-05**
Eutrophication: marine	kg N eq	1.63E-03	3.26E-05	1.68E-04	**1.83E-03**
Ozone depletion	kg CFC-11 eq	1.20E-07	2.62E-09	1.40E-08	**1.37E-07**
Smog	kg O_3 eq	1.94E-01	3.80E-03	1.87E-02	**2.16E-01**
Respiratory effects	kg PM2.5 eq	2.79E-03	5.88E-05	1.81E-04	**3.03E-03**
Additional environmental information					
Carcinogenics	CTUh	93.70%	0.65%	5.65%	**100%**
Non carcinogenics	CTUh	62.42%	9.61%	27.97%	**100%**
Ecotoxicity	CTUe	62.44%	28.56%	9.00%	**100%**

Table 34. Percent contributions of each stage to each impact category for PRECON

Impact category	A1	A2	A3	Total
Total global warming potential, GWP_{total}	87.89%	4.10%	8.01%	**100%**
Global warming potential from fossil fuels, GWP_{fossil}	88.09%	4.12%	7.79%	**100%**
Global warming potential from biogenic, $GWP_{biogenic}$	40.26%	0.06%	59.68%	**100%**
Global warming potential from land use and land use change, GWP_{luluc}	83.56%	0.34%	16.10%	**100%**
Acidification	91.88%	1.42%	6.69%	**100%**
Eutrophication: freshwater	90.58%	0.78%	8.65%	**100%**
Eutrophication: marine	89.05%	1.78%	9.16%	**100%**
Ozone depletion	87.87%	1.91%	10.22%	**100%**
Smog	89.61%	1.76%	8.63%	**100%**
Respiratory effects	92.08%	1.94%	5.98%	**100%**
Additional environmental information				
Carcinogenics	93.70%	0.65%	5.65%	**100%**
Non carcinogenics	62.42%	9.61%	27.97%	**100%**
Ecotoxicity	62.44%	28.56%	9.00%	**100%**

The SM2026 Methodology single-figure millipoint (mPts) score by life cycle phase for this product is presented below (Table 35). Across all 10 impact categories, the SM single-figure score indicates that raw materials acquisition accounts for around 88.5% of the total impacts, manufacturing for 8.4%, and transportation for 3.1%.

Table 35. SM millipoint scores for PRECON per declared unit (1 m^2)

Impact category	Unit	A1	A2	A3	Total
SM single figure score	mPts	1.48E-01	9.58E-03	1.64E-02	**1.74E-01**

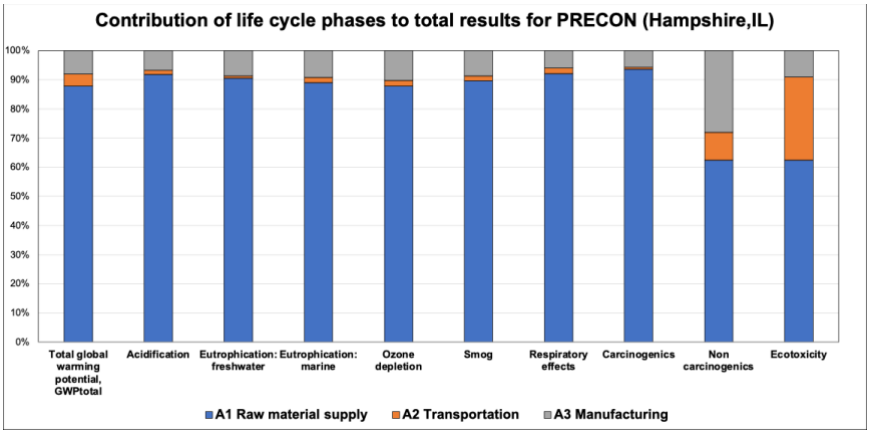


Figure 7. Contribution analysis of each impact category for PRECON

5.4 Calculating supply-chain-specificity

The ACLCA PCR Open Standard addendum outlining Guidance for Determining EPD Types and Calculating and Communicating Data Specificity Through the Supply Chain[3] was used to calculate the supply-chain-specificity score for each set of results. Table 36 includes the supply-chain-specificity for each unit process.

Table 36. Determination of supply-chain-specificity for each unit process

Product(s) and location	Module	Unit process name	Background data source	Background data reporting period	Specificity score of the unit process (%)	Justification
HRM 714 (Fort Worth, TX)	**A3**	Electricity production	Electricity mix, eGrid subregion, ERCT/US U	2023	100%	-Electricity quantity is primary data -LCI data meets requirements
HRM 714, PRECON (Hampshire, IL)	**A3**	Electricity production	Electricity mix, eGrid subregion, MROE/US U	2023	100%	-Electricity quantity is primary data -LCI data meets requirements
All	**A1-A3**	All other unit processes	All other data sets used	N/A	0%	Utilized proxies, generic LCI data other than for energy or transportation, or LCI data not meeting the requirements

The GWP supply chain specificity ($GWP\text{-}SCS_{A1\text{-}A3}$) of the entire product from cradle to gate is presented in Table 37.

Table 37. Supply-chain-specificity of each product

Product	$GWP\text{-}SCS_{A1\text{-}A3}$ (%)
HRM 714 (Fort Worth, TX)	1.56%
HRM 714 (Hampshire, IL)	6.00%
PRECON	2.13%

[3] ACLCA Guidance for Determining EPD Types and Calculating and Communicating Data Specificity Through the Supply Chain https://cdn.prod.website-files.com/685abecf52079050b589879c/685abecf52079050b58988f5_EPD%20Classifications%20Addendum%20Final%202025.pdf

5.5 Sensitivity analyses

Since there were two raw materials which contributed the most to total impacts across the products evaluated, sensitivity analyses were conducted on their usage to assess the impact of decreasing their presence in those products. Global warming potential was the key impact category chosen to be evaluated since the raw material acquisition stage contributed highly to those impact categories.

5.5.1. HRM 714

A sensitivity analysis on fluid-applied waterproofing membrane HRM 714 assessed a 10% reduction in the mass of [redacted] present in the product, using manufacturing location in Fort Worth as baseline. The results are presented in Table 38.

Table 38. Sensitivity analysis decreased [redacted]

HRM 714	Global warming potential		Freshwater eutrophication	
	kg CO_2 eq emissions	% change	kg P eq	% change
Baseline	3.81 E+00	-	9.12E-05	-
10% decrease in [redacted]	3.66 E+00	-3.95%	8.57E-05	-6.41%

The results indicate that the decrease in this raw material could reduce global warming potential by around 4%, which shows that the products are relatively sensitive to changes in the amount of [redacted] present in the products.

5.5.2. PRECON

Another sensitivity analysis was conducted on PRECON to assess a 10% reduction in the mass of [redacted] and [redacted]. The results are presented Table 39.

Table 39. Sensitivity analysis of PRECON

PRECON	Global warming potential		Eutrophication freshwater	
	kg CO_2 eq emissions	% change	kg P eq	% change
Baseline	4.71E+00	-	7.94E-05	-
10% decrease in [redacted]	4.46E+00	-5.16%	7.66E-05	-3.52%

The results indicate that reducing [redacted] by 10% could reduce global warming potential by ~5-6%, which shows that products are relatively sensitive to changes in the amount present in the products.

5.6 Overview of relevant findings

This study evaluated the environmental performance of HRM 714 in two manufacturing locations (Fort Worth, TX and Hampshire, IL) and PRECON. Across all products and locations, the dominant contributor to environmental impacts is consistently the raw material acquisition stage, followed by manufacturing, with transportation contributing the least.

The manufacturing stage was typically the second-largest contributor for all products, particularly to some impact categories for HRM 714 and to ozone

depletion and acidification for PRECON. Notably, some impact categories such as smog, eutrophication (marine), and respiratory effects show a more balanced split between raw materials and manufacturing, indicating sensitivity to both material composition and process energy.

For HRM 714, both plants show similar results patterns. The Fort Worth plant has a higher total GWP (3.81 kg CO_2-eq) compared to Hampshire (3.64 kg CO_2-eq). In both cases, raw material supply is the largest contributor (~62.6% for Fort Worth and ~73.6% for Hampshire). Manufacturing is the second-largest contributor (~27.6% for Fort Worth and ~17.5% for Hampshire), while transportation remains below ~11%. Notably, some impact categories such as smog, eutrophication (marine), and respiratory effects show a more balanced split between raw materials and manufacturing, indicating sensitivity to both material composition and process energy.

For most products, the least significant contributor is transportation, where the weight of the raw materials and the distance traveled via truck to the manufacturing facility accounts for less than 20% of the total impacts across all categories except for the Fort Worth, TX facility, where transportation accounted for closer to 25% for some impact categories.

5.7 Conclusions and recommendations

The goal of this study was to perform a cradle-to-gate life cycle assessment (LCA) on W. R. MEADOWS' HRM 714, and PRECON products to develop Transparency Reports [EPDs]™. The creation of these Transparency Reports [EPDs]™ will allow consumers in the building and construction industry to make better informed decisions about the environmental impacts associated with the products they choose.

The results indicate that raw material acquisition is the primary driver of environmental impacts across all products and impact categories, with the magnitude of influence varying by product formulation. HRM 714 shows a relatively balanced contribution between raw materials and manufacturing, whereas PRECON is highly dominated by raw material impacts due to polymer-intensive inputs. Manufacturing consistently represents the second-largest contributor, while transportation has a minor influence across all scenarios. Differences between plant locations (for HRM 714) suggest that facility-specific electric grid use and process efficiency influence total impacts, with the Hampshire plant demonstrating lower overall GWP compared to Fort Worth. Nonetheless, the differences in manufacturing activities are secondary to raw material effects.

With the raw material acquisition stage generally being the most impactful, the greatest opportunity for improving the environmental performance of these products is to focus on the most impactful raw materials. Efforts can focus on sourcing more sustainable alternatives. Efforts can also be focused on working with suppliers to explore low-carbon alternatives.

Even though the manufacturing stage accounts for a high share of potential impacts for HRM 714, it should be note that the raw material stage contributes to a lower share due to the post-consumer recycled content. Therefore, energy efficiency in manufacturing could further reduce impacts, but for products like HRM 714, the effects may be limited.

Lastly, transportation was the smallest contributor. Identifying additional local sources would help reduce the potential impacts for products made at that location, but it would have a minimal effect on the overall result.

For future LCA updates, it is recommended that W. R. MEADOWS considers focusing on reducing reliance on high-impact raw materials. Exploring suppliers that provide alternative materials, post-consumer recycled content, or lower-impact supplier options would yield a higher impact of reductions. It is also recommended that W. R. MEADOWS continuously works with key suppliers to obtain more specific environmental data and evaluate lower-carbon material options. This is particularly critical for PRECON impacts.

Additionally, regular updates to this LCA and the associated Transparency Reports [EPDs]™ would enable high-quality year-over-year comparisons and serve as the basis for a potential optimized EPD, which is assigned a higher credit value under the Materials and Resources category in LEED and would help those looking to increase the performance of their building projects. A post-study review may provide opportunities for improving the data collection process in future years and for continuing to align with the W. R. MEADOWS goals for sustainability.

6 REFERENCES

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ACRONYMS

BOM	Bill of materials
ISO	International Standardization Organization
LCA	Life cycle assessment
LCI	Life cycle inventory
LCIA	Life cycle impact analysis
MND	Module Not Declared
PCR	Product Category Rule document
TR	Transparency Report [EPD]™

GLOSSARY

For the purposes of this report, the terms and definitions given in ISO 14020, ISO 14025, the ISO 14040 series, and ISO 21930 apply. The most important ones are included here:

Allocation	Partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems
Close loop & open loop	A closed-loop allocation procedure applies to closed-loop product systems. It also applies to open-loop product systems where no changes occur in the inherent properties of the recycled material. In such cases, the need for allocation is avoided since the use of secondary material displaces the use of virgin (primary) materials. An open-loop allocation procedure applies to open-loop product systems where the material is recycled into other product systems and the material undergoes a change to its inherent properties.
Cradle to grave	Addresses the environmental aspects and potential environmental impacts (e.g., use of resources and environmental consequences of releases) throughout a product's life cycle from raw material acquisition until the end of life
Cradle to gate	Addresses the environmental aspects and potential environmental impacts (e.g. use of resources and environmental consequences of releases) throughout a product's life cycle from raw material acquisition until the end of the production process (“gate of the factory”). It may also include transportation until use phase
Declared unit	Quantity of a product for use as a reference unit in an EPD based on one or more information modules
Functional unit	Quantified performance of a product system for use as a reference unit
Life cycle	Consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal
Life cycle assessment - LCA	Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle
Life cycle impact assessment - LCIA	Phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product
Life cycle inventory - LCI	phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle
Life cycle interpretation	Phase of life cycle assessment in which the findings of either the inventory analysis or the impact assessment, or both, are evaluated in relation to the defined goal and scope in order to reach conclusions and recommendations

APPENDIX

- [redacted]