Environmental Product Declaration

Declaration Owner

RedBuilt™ LLC
200 E. Mallard Drive Boise, Idaho 83706
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Products

RedBuilt™ Open-Web Trusses:
Red-L™; Red-W™; Red-S™ w/ LVL Chord; Red-M™, Red-M™ w/ LVL Chord; Red-H™; Red-H™ w/ LVL Chord

Declared Unit

The declared unit is 1 meter (one linear meter) of Open-Web Truss. The scope of this EPD is cradle-to-gate.

EPD Number and Period of Validity

SCS-EPD-07526
EPD Valid December 20, 2021 through December 19, 2026

Product Category Rule

PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Version 3.2. UL Environment. Dec. 2018

PCR Guidance for Building-Related Products and Services, Part B: Structural and Architectural Wood Products, EPD Requirements UL 10010-9 v.1.1. 2020.

Program Operator

SCS Global Services
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Declaration Owner:	Redbuilt™ LLC
Address:	200 E. Mallard Drive Boise, Idaho 83706
Declaration Number:	SCS-EPD-07526
Declaration Validity Period:	EPD Valid December 20, 2021 through December 19, 2026
Program Operator:	SCS Global Services
Declaration URL Link:	https://www.scsglobalservices.com/certified-green-products-guide
LCA Practitioner:	Gerard Mansell, Ph.D., SCS Global Services
LCA Software and LCI database:	OpenLCA 1.10 software and the Ecoinvent v3.7 database
Product RSL:	n/a
Markets of Applicability:	Global
EPD Type:	Product-Specific
EPD Scope:	Cradle-to-Gate
LCIA Method and Version:	TRACI 2.1
Independent critical review of the LCA and data, according to ISO 14044 and ISO 14071	☐ internal ☒ external
LCA Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants
Part A Product Category Rule:	PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Version 3.2. UL Environment. Dec. 2018
Part A PCR Review conducted by:	Lindita Bushi, PhD (Chair); Hugues Imbeault-Tétreault, ing., M.Sc.A.; Jack Geibig
Part B Product Category Rule:	PCR Guidance for Building-Related Products and Services, Part B: Structural and Architectural Wood Products, EPD Requirements UL 10010-9 v.1.1. 2020
Part B PCR Review conducted by:	Jack Geibig (chair), Ecoform; Thomas Gloria, Industrial Ecology Consultants; Thaddeus Owen
Independent verification of the declaration and data, according to ISO 14025 and the PCR	☐ internal ☒ external
EPD Verifier:	Thomas Gloria, Ph.D., Industrial Ecology Consultants
Declaration Contents:	

Disclaimers: *This EPD conforms to ISO 14025, 14040, 14044, and 21930.*

Scope of Results Reported: *The PCR requirements limit the scope of the LCA metrics such that the results exclude environmental and social performance benchmarks and thresholds, and exclude impacts from the depletion of natural resources, land use ecological impacts, ocean impacts related to greenhouse gas emissions, risks from hazardous wastes and impacts linked to hazardous chemical emissions.*

Accuracy of Results: *Due to PCR constraints, this EPD provides estimations of potential impacts that are inherently limited in terms of accuracy.*

Comparability: *The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled.*

In accordance with ISO 21930:2017, EPDs are comparable only if they comply with the core PCR, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

1. About RedBuilt™

RedBuilt™ designs and manufactures engineered structural wood products for commercial and multi-family applications. Products include Open-Web trusses, Red-I™ I-Joists, RedLam™ LVL, complementary components, as well as product engineering and technical on-site support. RedBuilt™ is headquartered in Boise, Idaho and operates four manufacturing plants and thirteen design and sales offices throughout the United States.

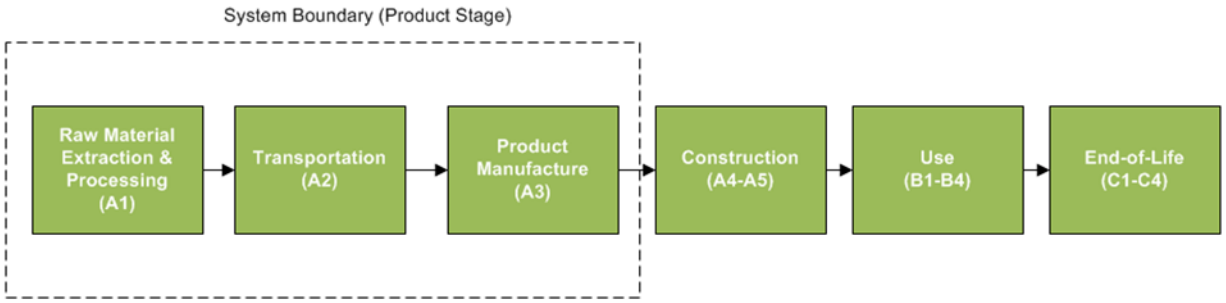
2. Product

2.1 PRODUCT DESCRIPTION

Open-Web Trusses are Warren-style trusses that have either parallel, tapered or pitched chord members. The trusses have sawn lumber or engineered wood chords, steel-tube webs, and solid-steel pins used as web-chord connectors. Open-Web trusses are designated Red-L™, Red-W™, Red-S™, Red-M™, and Red-H™. Sheathing materials are nailed directly to the top chord members. Ceilings are either attached directly to the bottom chord, applied to stripping or resilient (or hat) channels attached to the bottom chord, or are suspended from the bottom chord.

2.2 PRODUCT FLOW DIAGRAM

A flow diagram illustrating the life cycle phases included in the scope of the EPD is provided below.



2.3 APPLICATION

The products are intended for use as building material for floor, wall, roof, or core construction for residential and commercial applications.

2.4 DECLARATION OF METHODOLOGICAL FRAMEWORK

The scope of the EPD is cradle-to-gate, including raw material extraction and processing, upstream transportation and product manufacture, including packaging. The life cycle phases included in the product system boundary are shown below.

Cut-off and allocation procedures are described below and conform to the PCR and ISO standards.

Table 1. *Life cycle phases included in the RedBuilt™ Open-Web Truss product system boundary.*

Product			Construction Process		Use							End-of-life				Benefits and loads beyond the system boundary
A1	A2	A3	A4	A5	B1	B1	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material extraction and processing	Transport to manufacturer	Manufacturing	Transport	Construction - installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse, recovery and/or recycling potential
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

X = Module Included | MND = Module Not Declared

The EPD conforms to ISO 14040/44 and the PCR. The impact indicators considered for the assessment include:

- Potential for Global Warming,
- Acidification Potential,
- Eutrophication Potential,
- Photochemical Ozone (Smog) Formation Potential,
- Ozone Depletion Potential,
- Fossil Fuel Depletion Potential.

2.5 TECHNICAL DATA

Technical specifications of the RedBuilt™ products included in the LCA scope, as well as product performance testing results, are available on the manufacturer's website (www.redbuilt.com/products).

2.6 MATERIAL COMPOSITION

The primary materials include softwood lumber, steel, and various resins and adhesives.

Table 2. *Material content for the RedBuilt™ products as a percentage of total mass per declared unit.*

Component	Red-L	Red-W	Red-S with LVL	Red-M	Red-M with LVL	Red-H	Red-H with LVL
Wood	3.80	4.63	5.37	8.07	8.70	10.4	11.3
	64%	64%	69%	64%	69%	64%	69%
Resin/Adhesive/Wax	$1.49x10^{-3}$	$1.49x10^{-3}$	$1.49x10^{-3}$	$1.49x10^{-3}$	$1.49x10^{-3}$	$1.49x10^{-3}$	$1.49x10^{-3}$
	0.025%	0.021%	0.019%	0.012%	0.012%	0.0091%	0.0091%
Steel Hardware	2.15	2.63	2.44	4.58	3.95	5.93	5.12
	36%	36%	31%	36%	31%	36%	31%
Total Product	**5.95**	**7.26**	**7.81**	**12.7**	**12.7**	**16.4**	**16.4**
	100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

No substances required to be reported as hazardous are associated with the production of this product

2.7 MANUFACTURING

The RedBuilt™ products are manufactured at the company's production facilities in Hillsboro, Oregon; Chino, California; and Delaware, Ohio. Resource use at the production facilities are allocated to the product based on product sales price (economic-based allocation). Impact results represented as a production-weighted average across manufacturing facilities for each product

Electricity use at the manufacturer's facility is modeled based on the regional electricity supply mix for the applicable NERC subregion using the USEPA eGRID emissions database. Electricity and resources (e.g., natural gas, propane) used at the manufacturing facility are allocated to the products based on annual production data for 2019.

2.8 PACKAGING

The RedBuilt™ products are packaged for shipment using plastic wrap and banding.

Table 3. *Material content for the product packaging in kg per declared unit and as a percentage of total mass.*

Component	Red-L	Red-W	Red-S with LVL	Red-M	Red-M with LVL	Red-H	Red-H with LVL
Plastic strapping	$1.74x10^{-3}$	$1.74x10^{-3}$	$1.49x10^{-3}$	$1.74x10^{-3}$	$1.49x10^{-3}$	$1.74x10^{-3}$	$1.49x10^{-3}$
	100%	100%	100%	100%	100%	100%	100%
Total Packaging	**$1.74x10^{-3}$**	**$1.74x10^{-3}$**	**$1.49x10^{-3}$**	**$1.74x10^{-3}$**	**$1.49x10^{-3}$**	**$1.74x10^{-3}$**	**$1.49x10^{-3}$**
	100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

2.9 FURTHER INFORMATION

Further information on the products can be found on the manufacturers' website at www.redbuilt.com/products.

3. LCA: Calculation Rules

3.1 DECLARED UNIT

The declared unit for the product system is one linear meter (1m) of structural wood product. The reference flow and declared unit for the products are summarized in Table 4.

Table 4. *Declared unit and reference flows for the Redbuilt™ Open-Web Truss products.*

Property	Unit	Red-L	Red-W	Red-S with LVL Chord	Red-M with LVL Chord	Red-H with LVL Chord
Mass	kg	5.95	7.26	7.81	12.65	16.37
Thickness to achieve declared unit	mm	n/a	n/a	n/a	n/a	n/a
Density	kg/m	5.95	7.26	7.81	12.65	16.37
Moisture content	%	9 ±3%	9 ±3%	9 ±3%	9 ±3%	9 ±3%

3.2 SYSTEM BOUNDARY

The scope of the EPD is cradle-to-gate, including raw material extraction and processing, transportation, and product manufacture, including packaging. The life cycle phases included in the EPD scope are described in Table 5 and illustrated in Figure 1.

Table 5. *The modules and unit processes included in the scope for the RedBuilt™ product system.*

Module	Module description from the PCR	Unit Processes Included in Scope
A1	Extraction and processing of raw materials; any reuse of products or materials from previous product systems; processing of secondary materials; generation of electricity from primary energy resources; energy, or other, recovery processes from secondary fuels	Extraction and processing of raw materials for the structural lumber product system components.
A2	Transport (to the manufacturer)	Transport of component materials to the manufacturing facilities
A3	Manufacturing, including ancillary material production	Manufacturing of products and packaging (incl. upstream unit processes)
A4	Transport (to the building site)	Module Not Declared
A5	Construction-installation process	Module Not Declared
B1	Product use	Module Not Declared
B2	Product maintenance	Module Not Declared
B3	Product repair	Module Not Declared
B4	Product replacement	Module Not Declared
B5	Product refurbishment	Module Not Declared
B6	Operational energy use by technical building systems	Module Not Declared
B7	Operational water uses by technical building systems	Module Not Declared
C1	Deconstruction, demolition	Module Not Declared
C2	Transport (to waste processing)	Module Not Declared
C3	Waste processing for reuse, recovery and/or recycling	Module Not Declared
C4	Disposal	Module Not Declared
D	Reuse-recovery-recycling potential	Module Not Declared

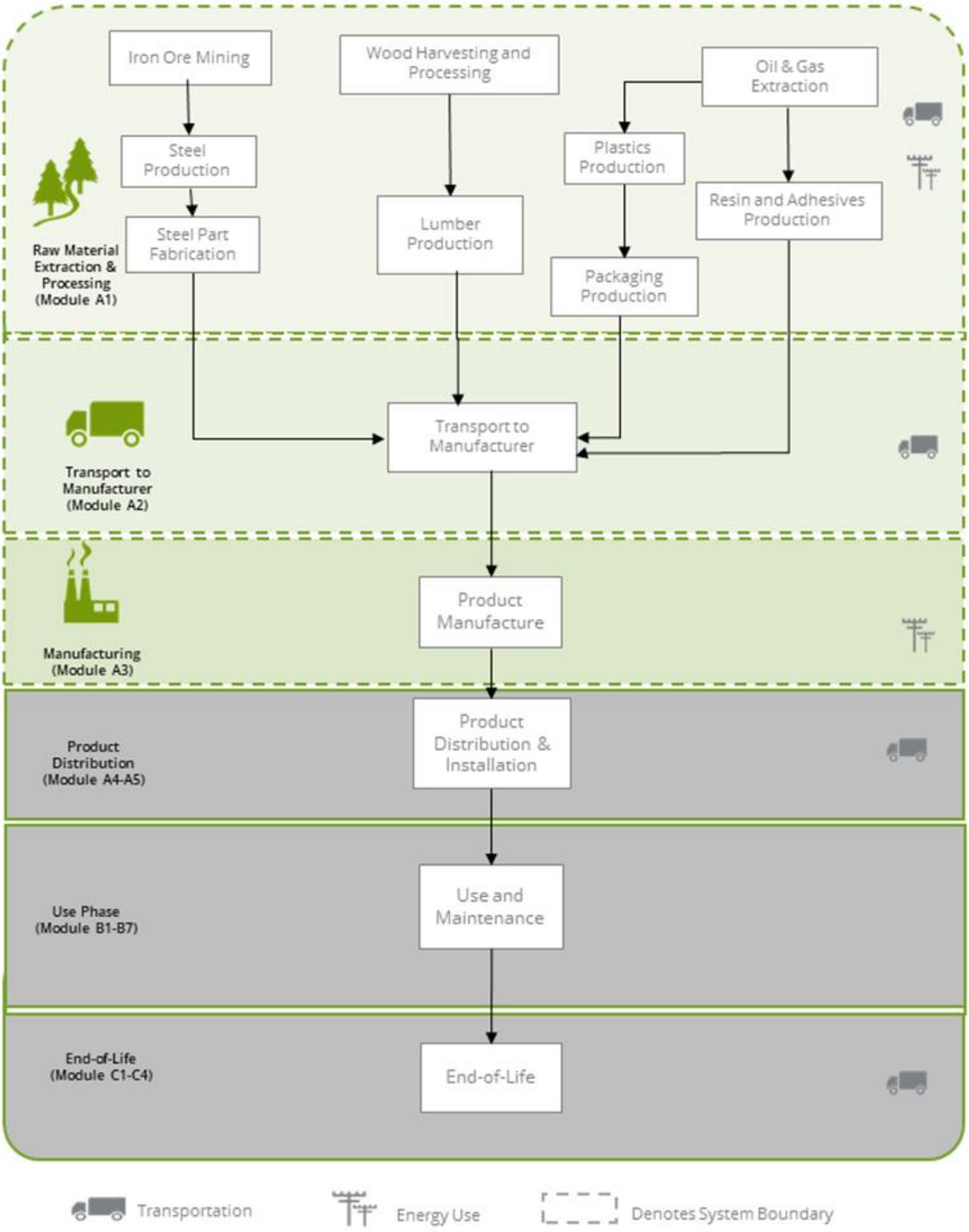


Figure 1. *Flow Diagram for the life cycle of the RedBuilt™ Open-Web Truss product system.*

3.3 UNITS

All data and results are presented using SI units.

3.4 ESTIMATES AND ASSUMPTIONS

- Redbuilt's manufacturing facilities are located in Oregon, California and Ohio. Ecoinvent inventory datasets for the applicable eGRID electricity grid mixes were used to model resource use and emissions from electricity use at the manufacturing facilities.
- Electricity and resource use at the production facilities were allocated to the products based on the product sales price utilizing annual facility sales data for calendar year 2019 provided by the manufacturer. Impacts are allocated to the product based on cost (i.e., economic allocation).
- LCI data for the dimensional lumber used as raw material for the products are based on the most recent data for regionally sourced softwood lumber in the US.
- Primary data for upstream component materials were not available. Representative LCI datasets from the ecoinvent LCI database and published literature were used as appropriate.

The PCR requires the results for several inventory flows related to construction products to be reported including energy and resource use and waste and outflows. These are aggregated inventory flows, and do not characterize any potential impact; results should be interpreted considering this limitation.

3.5 CUT-OFF RULES

According to the PCR, processes contributing greater than 1% of the total environmental impact indicator for each impact are included in the inventory. No data gaps were allowed which were expected to significantly affect the outcome of the indicator results. No known flows are deliberately excluded from this EPD.

3.6 PERIOD UNDER REVIEW

The period of review is calendar year 2019.

3.7 ALLOCATION

Manufacturing resource use was allocated to the products based on sale price (i.e., economic allocation). Impacts from transportation were allocated based on the mass of material and distance transported.

3.8 COMPARABILITY

The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled.

3.9 DATA SOURCES

Primary data were provided by RedBuilt™ for their manufacturing facilities. The sources of secondary LCI data are the Ecoinvent LCI database and published literature.

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Table 6. *Data sources for the RedBuilt™ product system.*

Component	Dataset	Data Source	Publication Date
PRODUCT			
Wood	Softwood lumber, planed, dry - CORRIM - INW/kg	CORRIM	2020
	Softwood lumber, planed, dry - CORRIM - SE/kg	CORRIM	2020
	structural timber production | structural timber | Cutoff, S/RoW	EI v3.7	2020
Resin/Adhesive/Wax	paraffin production | paraffin | Cutoff, S/RoW	EI v3.7	2020
	phenolic resin production | phenolic resin | Cutoff, S/RoW	EI v3.7	2020
	polyurethane adhesive production | polyurethane adhesive | Cutoff, S/GLO	EI v3.7	2020
Steel Hardware	steel production, converter, low-alloyed | steel, low-alloyed | Cutoff, S/RoW	EI v3.7	2020
PACKAGING			
Strapping	polypropylene production, granulate | polypropylene, granulate | Cutoff, S/RoW	EI v3.7	2020
RESOURCES			
Grid electricity - Hillsboro	Electricity, medium voltage, per kWh - NWPP/NWPP	EI v3.7	2018; 2020
Grid electricity - Chino	Electricity, medium voltage, per kWh - CAMX/CAMX	EI v3.7	2018; 2020
Grid electricity - Delaware	Electricity, medium voltage, per kWh - RFCW/RFCW	EI v3.7	2018; 2020
Natural gas	heat production, natural gas, at boiler modulating >100kW | heat, district or industrial, natural gas | Cutoff, S/RoW	EI v3.7	2020
Diesel	diesel, burned in building machine | diesel, burned in building machine | Cutoff, S/GLO	EI v3.7	2020
Gasoline	diesel, burned in building machine | diesel, burned in building machine | Cutoff, S/GLO	EI v3.7	2020
Propane	propane, burned in building machine | propane, burned in building machine | Cutoff, S/GLO	EI v3.7	2020
TRANSPORTATION			
Road	transport, freight, lorry 16-32 metric ton, EURO4 | transport, freight, lorry 16-32 metric ton, EURO4 | Cutoff, S/RoW	EI v3.7	2020
Rail	market for transport, freight train | transport, freight train | Cutoff, S/US	EI v3.7	2020

3.10 DATA QUALITY

The data quality assessment addressed the following parameters: time-related coverage, geographical coverage, technological coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, and uncertainty.

Table 7. *Data quality assessment for the RedBuilt™ product system.*

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage Age of data and the minimum length of time over which data should be collected	The most recent available data are used, based on other considerations such as data quality and similarity to the actual operations. Typically, these data are less than 5 years old (typically 2016). All of the data used represented an average of at least one year's worth of data collection, and up to three years in some cases. Manufacturer-supplied data (primary data) are based on annualized production for 2019.
Geographical Coverage Geographical area from which data for unit processes should be collected to satisfy the goal of the study	The data used in the analysis provide the best possible representation available with current data. Electricity use for product manufacture is modeled using representative data for the regional electricity mix. Surrogate data used in the assessment are representative of global or US and North American operations. Data representative of global operations are considered sufficiently similar to actual processes.
Technology Coverage Specific technology or technology mix	For the most part, data are representative of the actual technologies used for processing, transportation, and manufacturing operations.
Precision Measure of the variability of the data values for each data expressed (e.g., variance)	Precision of results are not quantified due to a lack of data. Data collected for operations were typically averaged for one or more years and over multiple operations, which is expected to reduce the variability of results.
Completeness Percentage of flow that is measured or estimated	The LCA model included all known mass and energy flows for production of the products. In some instances, surrogate data used to represent upstream operations may be missing some data which is propagated in the model. No known processes or activities contributing to more than 1% of the total environmental impact for each indicator are excluded.
Representativeness Qualitative assessment of the degree to which the data set reflects the true population of interest (i.e., geographical coverage, time period, and technology coverage)	Data used in the assessment represent typical or average processes as currently reported from multiple data sources and are therefore generally representative of the range of actual processes and technologies for production of these materials. Considerable deviation may exist among actual processes on a site-specific basis; however, such a determination would require detailed data collection throughout the supply chain back to resource extraction.
Consistency Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	The consistency of the assessment is considered to be high. Data sources of similar quality and age are used; with a bias towards Ecoinvent v3.7 data where available. Different portions of the product life cycle are equally considered.
Reproducibility Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	Based on the description of data and assumptions used, this assessment would be reproducible by other practitioners. All assumptions, models, and data sources are documented.
Sources of the Data Description of all primary and secondary data sources	Data representing energy use at Redbuilt's manufacturing facilities represent an annual average and are considered of high quality due to the length of time over which these data are collected, as compared to a snapshot that may not accurately reflect fluctuations in production. For secondary LCI datasets, Ecoinvent v3.7 LCI data are used.
Uncertainty of the Information Uncertainty related to data, models, and assumptions	Uncertainty related to materials in the product and packaging is low. Actual supplier data for upstream operations was not available for all suppliers and the study relied upon the use of existing representative datasets. These datasets contained relatively recent data (<10 years) but lacked geographical representativeness. Uncertainty related to the impact assessment methods used in the study are high. The impact assessment method required by the PCR includes impact potentials, which lack characterization of providing and receiving environments or tipping points.

4. LCA: Results

Results of the Life Cycle Assessment are presented below. It is noted that LCA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

The following environmental impact category indicators are reported using characterization factors based on the U.S. EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts – TRACI 2.1.

TRACI 2.1 Impact Category	Unit
Global Warming Potential **(GWP)**	kg CO_2 eq
Ozone Depletion Potential **(ODP)**	kg CFC 11 eq
Acidification Potential **(AP)**	kg SO_2 eq
Eutrophication Potential **(EP)**	kg N eq
Smog Formation Potential **(SFP)**	kg O_3 eq
Fossil Fuel Depletion Potential **(FFD)**	MJ Surplus, LHV

These 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.

The following inventory parameters, specified by the PCR, are also reported.

Resources	Unit	Waste and Outflows	Unit
RPR_E: Renewable primary resources used as energy carrier (fuel)	MJ, LHV	**HWD:** Hazardous waste disposed	kg
RPR_M: Renewable primary resources with energy content used as material	MJ, LHV	**NHWD:** Non-hazardous waste disposed	kg
$NRPR_E$: Non-renewable primary resources used as an energy carrier (fuel)	MJ, LHV	**HLRW:** High-level radioactive waste, conditioned, to final repository	kg
$NRPR_M$: Non-renewable primary resources with energy content used as material	MJ, LHV	**ILLRW:** Intermediate- and low-level radioactive waste, conditioned, to final repository	kg
SM: Secondary materials	MJ, LHV	**CRU:** Components for re-use	kg
RSF: Renewable secondary fuels	MJ, LHV	**MR:** Materials for recycling	kg
NRSF: Non-renewable secondary fuels	MJ, LHV	**MER:** Materials for energy recovery	kg
RE: Recovered energy	MJ, LHV	**EE:** Recovered energy exported from the product system	MJ, LHV
FW: Use of net freshwater resources	m^3	-	-

Table 8. *Production-weighted average Life Cycle Impact Assessment (LCIA) results for the **Red-L™ Open-Web Truss** products per declared unit. Results reported in MJ are calculated using lower heating values.*

Impact Category	Unit	Raw Materials	Upstream Transport	Manufacturing
TRACI				
Global Warming Potential	kg CO_2 eq	9.57	1.32	0.206
	%	86%	12%	1.9%
Ozone Depletion Potential	kg CFC-11 eq	$6.24x10^{-7}$	$3.00x10^{-7}$	$1.28x10^{-8}$
	%	67%	32%	1.4%
Acidification Potential	kg SO_2 eq	$3.75x10^{-2}$	$6.75x10^{-3}$	$9.39x10^{-4}$
	%	83%	15%	2.1%
Eutrophication Potential	kg N eq	$4.13x10^{-2}$	$1.57x10^{-3}$	$5.08x10^{-4}$
	%	95%	3.6%	1.2%
Smog Formation Potential	kg O_3 eq	0.580	0.171	$1.22x10^{-2}$
	%	76%	22%	1.6%
Fossil Fuel Depletion Potential	MJ surplus	7.46	2.73	0.348
	%	71%	26%	3.3%
Resources				
Renewable primary resources used as energy carrier (fuel)	MJ	26.1	0.249	0.784
	%	96%	0.92%	2.9%
Renewable primary resources with energy content used as material	MJ	56.6	0.00	0.00
	%	100%	0.00%	0.00%
Non-renewable primary resources used as an energy carrier (fuel)	MJ	INA	INA	INA
Non-renewable primary resources with energy content used as material	MJ	INA	INA	INA
Secondary materials	kg	0.00	0.00	0.00
Renewable secondary fuels	MJ	Neg.	Neg.	Neg.
Non-renewable secondary fuels	MJ	Neg.	Neg.	Neg.
Recovered energy	MJ	Neg.	Neg.	Neg.
Use of net freshwater resources	m^3	0.361	$1.49x10^{-2}$	$1.59x10^{-2}$
	%	92%	3.8%	4.1%
Wastes				
Hazardous waste disposed	kg	$4.47x10^{-4}$	$5.22x10^{-5}$	$2.97x10^{-6}$
	%	89%	10%	0.59%
Nonhazardous waste disposed	kg	2.85	0.858	$1.11x10^{-2}$
	%	77%	23%	0.30%
High-level radioactive waste, conditioned, to final repository	kg	$2.93x10^{-5}$	$1.16x10^{-6}$	$1.78x10^{-6}$
	%	91%	3.6%	5.5%
Intermediate- and low-level radioactive waste, conditioned, to final repository	kg	$2.05x10^{-4}$	$1.27x10^{-4}$	$1.14x10^{-5}$
	%	60%	37%	3.3%
Components for re-use	kg	0.00	0.00	0.00
Materials for recycling	kg	0.00	0.00	0.00
Materials for energy recovery	kg	Neg.	Neg.	Neg.
Recovered energy exported from the product system	MJ	Neg.	Neg.	Neg.

Neg. = Negligible | INA = Indicator not Assessed

Table 9. *Production-weighted average Life Cycle Impact Assessment (LCIA) results for the **Red-W™ Open-Web Truss** products per declared unit. Results reported in MJ are calculated using lower heating values.*

Impact Category	Unit	Raw Materials	Upstream Transport	Manufacturing
TRACI				
Global Warming Potential	kg CO_2 eq	11.7	1.56	0.239
	%	87%	12%	1.8%
Ozone Depletion Potential	kg CFC-11 eq	$7.60x10^{-7}$	$3.56x10^{-7}$	$1.43x10^{-8}$
	%	67%	31%	1.3%
Acidification Potential	kg SO_2 eq	$4.57x10^{-2}$	$7.80x10^{-3}$	$1.16x10^{-3}$
	%	84%	14%	2.1%
Eutrophication Potential	kg N eq	$5.03x10^{-2}$	$1.83x10^{-3}$	$6.36x10^{-4}$
	%	95%	3.5%	1.2%
Smog Formation Potential	kg O_3 eq	0.708	0.196	$1.48x10^{-2}$
	%	77%	21%	1.6%
Fossil Fuel Depletion Potential	MJ surplus	9.12	3.24	0.376
	%	72%	25%	3.0%
Resources				
Renewable primary resources used as energy carrier (fuel)	MJ	31.2	0.288	0.900
	%	96%	0.89%	2.8%
Renewable primary resources with energy content used as material	MJ	69.0	0.00	0.00
	%	100%	0.00%	0.00%
Non-renewable primary resources used as an energy carrier (fuel)	MJ	INA	INA	INA
Non-renewable primary resources with energy content used as material	MJ	INA	INA	INA
Secondary materials	kg	0.00	0.00	0.00
Renewable secondary fuels	MJ	Neg.	Neg.	Neg.
Non-renewable secondary fuels	MJ	Neg.	Neg.	Neg.
Recovered energy	MJ	Neg.	Neg.	Neg.
Use of net freshwater resources	m^3	0.440	$1.73x10^{-2}$	$1.78x10^{-2}$
	%	93%	3.7%	3.8%
Wastes				
Hazardous waste disposed	kg	$5.44x10^{-4}$	$6.16x10^{-5}$	$3.24x10^{-6}$
	%	89%	10%	0.53%
Nonhazardous waste disposed	kg	3.47	1.03	$1.25x10^{-2}$
	%	77%	23%	0.28%
High-level radioactive waste, conditioned, to final repository	kg	$3.57x10^{-5}$	$1.34x10^{-6}$	$2.07x10^{-6}$
	%	91%	3.4%	5.3%
Intermediate- and low-level radioactive waste, conditioned, to final repository	Kg	$2.50x10^{-4}$	$1.50x10^{-4}$	$1.32x10^{-5}$
	%	60%	36%	3.2%
Components for re-use	kg	0.00	0.00	0.00
Materials for recycling	kg	0.00	0.00	0.00
Materials for energy recovery	kg	Neg.	Neg.	Neg.
Recovered energy exported from the product system	MJ	Neg.	Neg.	Neg.

Neg. = Negligible | INA = Indicator not Assessed

Table 10. *Production-weighted average Life Cycle Impact Assessment (LCIA) results for the **Red-S™ Open-Web Truss** products per declared unit. Results reported in MJ are calculated using lower heating values.*

Impact Category	Unit	Raw Materials	Upstream Transport	Manufacturing
TRACI				
Global Warming Potential	kg CO_2 eq	11.9	1.85	0.334
	%	84%	13%	2.4%
Ozone Depletion Potential	kg CFC-11 eq	$7.65x10^{-7}$	$4.07x10^{-7}$	$1.76x10^{-8}$
	%	64%	34%	1.5%
Acidification Potential	kg SO_2 eq	$4.73x10^{-2}$	$1.08x10^{-2}$	$1.81x10^{-3}$
	%	79%	18%	3.0%
Eutrophication Potential	kg N eq	$4.95x10^{-2}$	$2.39x10^{-3}$	$1.04x10^{-3}$
	%	94%	4.5%	2.0%
Smog Formation Potential	kg O_3 eq	0.760	0.288	$2.05x10^{-2}$
	%	71%	27%	1.9%
Fossil Fuel Depletion Potential	MJ surplus	11.4	3.71	0.441
	%	73%	24%	2.8%
Resources				
Renewable primary resources used as energy carrier (fuel)	MJ	30.5	0.400	0.673
	%	97%	1.3%	2.1%
Renewable primary resources with energy content used as material	MJ	80.0	0.00	0.00
	%	100%	0.00%	0.00%
Non-renewable primary resources used as an energy carrier (fuel)	MJ	INA	INA	INA
Non-renewable primary resources with energy content used as material	MJ	INA	INA	INA
Secondary materials	kg	0.00	0.00	0.00
Renewable secondary fuels	MJ	Neg.	Neg.	Neg.
Non-renewable secondary fuels	MJ	Neg.	Neg.	Neg.
Recovered energy	MJ	Neg.	Neg.	Neg.
Use of net freshwater resources	m^3	0.448	$2.26x10^{-2}$	$2.79x10^{-2}$
	%	90%	4.5%	5.6%
Wastes				
Hazardous waste disposed	kg	$5.23x10^{-4}$	$7.35x10^{-5}$	$3.85x10^{-6}$
	%	87%	12%	0.64%
Nonhazardous waste disposed	kg	3.35	1.05	$1.45x10^{-2}$
	%	76%	24%	0.33%
High-level radioactive waste, conditioned, to final repository	kg	$3.48x10^{-5}$	$1.84x10^{-6}$	$4.54x10^{-6}$
	%	85%	4.5%	11%
Intermediate- and low-level radioactive waste, conditioned, to final repository	Kg	$2.48x10^{-4}$	$1.72x10^{-4}$	$2.69x10^{-5}$
	%	55%	38%	6.0%
Components for re-use	kg	0.00	0.00	0.00
Materials for recycling	kg	0.00	0.00	0.00
Materials for energy recovery	kg	Neg.	Neg.	Neg.
Recovered energy exported from the product system	MJ	Neg.	Neg.	Neg.

Neg. = Negligible | INA = Indicator not Assessed

Table 11. *Production-weighted average Life Cycle Impact Assessment (LCIA) results for the **Red-M™ Open-Web Truss** products per declared unit. Results reported in MJ are calculated using lower heating values.*

Impact Category	Unit	Raw Materials	Upstream Transport	Manufacturing
TRACI				
Global Warming Potential	kg CO_2 eq	19.8	2.25	0.392
	%	88%	10%	1.7%
Ozone Depletion Potential	kg CFC-11 eq	$1.28x10^{-6}$	$5.12x10^{-7}$	$2.17x10^{-8}$
	%	71%	28%	1.2%
Acidification Potential	kg SO_2 eq	$7.82x10^{-2}$	$1.14x10^{-2}$	$2.20x10^{-3}$
	%	85%	12%	2.4%
Eutrophication Potential	kg N eq	$8.38x10^{-2}$	$2.66x10^{-3}$	$1.23x10^{-3}$
	%	96%	3.0%	1.4%
Smog Formation Potential	kg O_3 eq	1.23	0.288	$2.68x10^{-2}$
	%	80%	19%	1.7%
Fossil Fuel Depletion Potential	MJ surplus	17.2	4.66	0.511
	%	77%	21%	2.3%
Resources				
Renewable primary resources used as energy carrier (fuel)	MJ	50.6	0.420	1.42
	%	96%	0.80%	2.7%
Renewable primary resources with energy content used as material	MJ	125	0.00	0.00
	%	100%	0.00%	0.00%
Non-renewable primary resources used as an energy carrier (fuel)	MJ	INA	INA	INA
Non-renewable primary resources with energy content used as material	MJ	INA	INA	INA
Secondary materials	kg	0.00	0.00	0.00
Renewable secondary fuels	MJ	Neg.	Neg.	Neg.
Non-renewable secondary fuels	MJ	Neg.	Neg.	Neg.
Recovered energy	MJ	Neg.	Neg.	Neg.
Use of net freshwater resources	m^3	0.745	$2.52x10^{-2}$	$2.74x10^{-2}$
	%	93%	3.2%	3.4%
Wastes				
Hazardous waste disposed	kg	$8.98x10^{-4}$	$8.89x10^{-5}$	$4.54x10^{-6}$
	%	91%	9.0%	0.46%
Nonhazardous waste disposed	kg	5.74	1.47	$1.88x10^{-2}$
	%	79%	20%	0.26%
High-level radioactive waste, conditioned, to final repository	kg	$5.93x10^{-5}$	$1.95x10^{-6}$	$3.49x10^{-6}$
	%	92%	3.0%	5.4%
Intermediate- and low-level radioactive waste, conditioned, to final repository	Kg	$4.18x10^{-4}$	$2.16x10^{-4}$	$2.21x10^{-5}$
	%	64%	33%	3.4%
Components for re-use	kg	0.00	0.00	0.00
Materials for recycling	kg	0.00	0.00	0.00
Materials for energy recovery	kg	Neg.	Neg.	Neg.
Recovered energy exported from the product system	MJ	Neg.	Neg.	Neg.

Neg. = Negligible | INA = Indicator not Assessed

Table 12. *Production-weighted average Life Cycle Impact Assessment (LCIA) results for the **Red-H™ Open-Web Truss** products per declared unit. Results reported in MJ are calculated using lower heating values.*

Impact Category	Unit	Raw Materials	Upstream Transport	Manufacturing
TRACI				
Global Warming Potential	kg CO_2 eq	25.6	3.05	0.507
	%	88%	10%	1.7%
Ozone Depletion Potential	kg CFC-11 eq	$1.66x10^{-6}$	$6.95x10^{-7}$	$2.98x10^{-8}$
	%	70%	29%	1.2%
Acidification Potential	kg SO_2 eq	0.101	$1.55x10^{-2}$	$2.58x10^{-3}$
	%	85%	13%	2.2%
Eutrophication Potential	kg N eq	0.109	$3.62x10^{-3}$	$1.42x10^{-3}$
	%	96%	3.2%	1.3%
Smog Formation Potential	kg O_3 eq	1.59	0.392	$3.23x10^{-2}$
	%	79%	19%	1.6%
Fossil Fuel Depletion Potential	MJ surplus	22.2	6.32	0.746
	%	76%	22%	2.5%
Resources				
Renewable primary resources used as energy carrier (fuel)	MJ	66.8	0.571	1.89
	%	96%	0.83%	2.7%
Renewable primary resources with energy content used as material	MJ	162	0.00	0.00
	%	100%	0.00%	0.00%
Non-renewable primary resources used as an energy carrier (fuel)	MJ	INA	INA	INA
Non-renewable primary resources with energy content used as material	MJ	INA	INA	INA
Secondary materials	kg	0.00	0.00	0.00
Renewable secondary fuels	MJ	Neg.	Neg.	Neg.
Non-renewable secondary fuels	MJ	Neg.	Neg.	Neg.
Recovered energy	MJ	Neg.	Neg.	Neg.
Use of net freshwater resources	m^3	0.964	$3.42x10^{-2}$	$3.75x10^{-2}$
	%	93%	3.3%	3.6%
Wastes				
Hazardous waste disposed	kg	$1.16x10^{-3}$	$1.21x10^{-4}$	$6.60x10^{-6}$
	%	90%	9.4%	0.51%
Nonhazardous waste disposed	kg	7.43	1.99	$2.53x10^{-2}$
	%	79%	21%	0.27%
High-level radioactive waste, conditioned, to final repository	kg	$7.68x10^{-5}$	$2.66x10^{-6}$	$4.51x10^{-6}$
	%	91%	3.2%	5.4%
Intermediate- and low-level radioactive waste, conditioned, to final repository	Kg	$5.41x10^{-4}$	$2.93x10^{-4}$	$2.87x10^{-5}$
	%	63%	34%	3.3%
Components for re-use	kg	0.00	0.00	0.00
Materials for recycling	kg	0.00	0.00	0.00
Materials for energy recovery	kg	Neg.	Neg.	Neg.
Recovered energy exported from the product system	MJ	Neg.	Neg.	Neg.

Neg. = Negligible | INA = Indicator not Assessed

5. LCA: Interpretation

The interpretation phase conforms to ISO 14044 with further guidance from the ILCD General Guide for Life Cycle Assessment. The interpretation included the use of evaluation and sensitivity checks to steer the iterative process during the assessment, and a final evaluation including completeness, sensitivity, and consistency checks, at the end of the study.

Figure 2 presents the contribution analyses for the Redbuilt structural lumber products. The raw material and processing phase (A1) is the primary contributor to estimated impacts for all products and impact indicators assessed. Impacts from upstream material transport (A2) are generally the next highest contributor followed by product manufacturing.

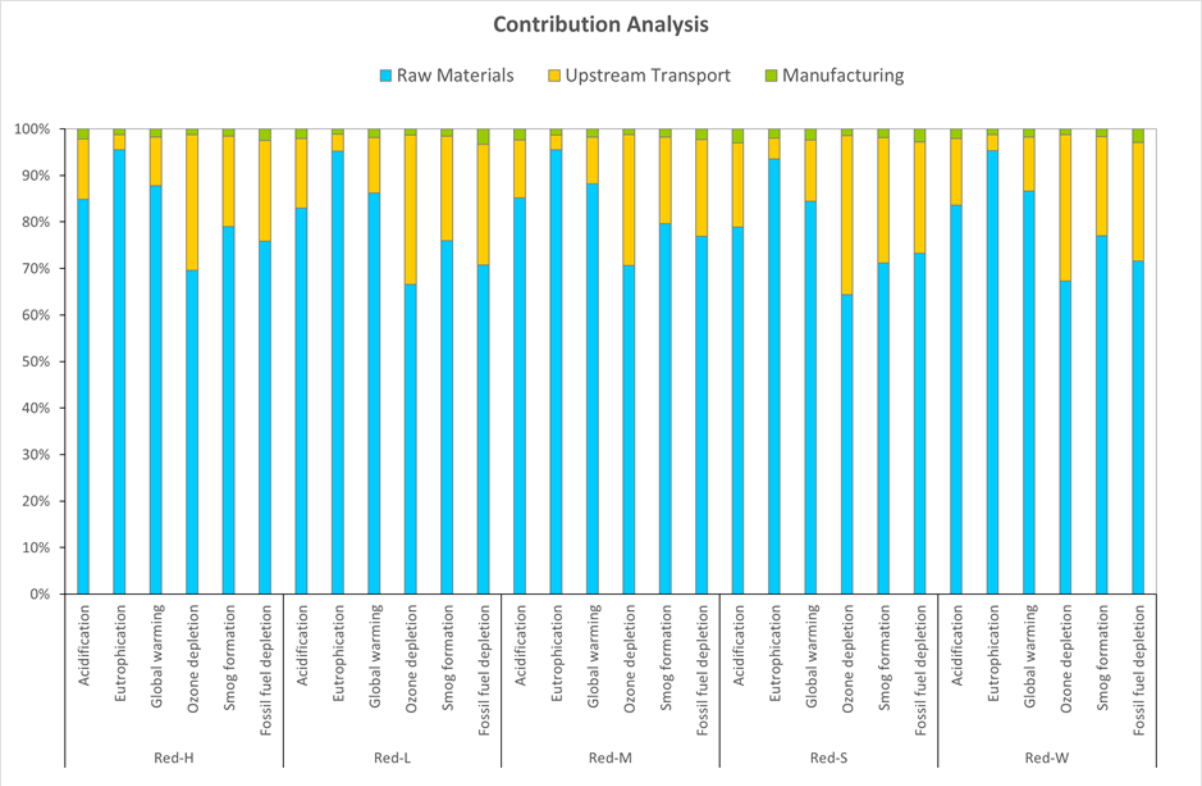

Figure 2. *Contribution analysis for the Redbuilt Open-Web Truss products.*

6. Biogenic Carbon Accounting

6.1 BIOGENIC CARBON EMISSIONS AND REMOVALS

Biogenic carbon emissions and removals are reported in accordance with ISO 21930 §7.2.7. and §7.2.12. The biogenic carbon emissions across the declared modules (A1-A3) are zero (carbon neutral). Based on ISO 21930 accounting rules for cradle-to-gate life cycle assessment, all carbon removed from the atmosphere (characterized in the LCIA as -1 kg CO_2e/kg CO_2) in module A1 is assumed emitted to the atmosphere in other modules (characterized in the LCIA as +1 kg CO_2e/kg CO_2). Total GWP_{BIO} includes biogenic carbon emissions and removals from the information modules A1-A3 and also reports values for modules A5 and C3/C4 to account for the biogenic carbon that is not emitted in the declared modules to ensure a net neutral biogenic carbon balance. The following inventory parameters related to biogenic carbon removals and emissions are considered:

Parameter	Unit	Description
BCRP	kg CO_2e	Biogenic CO_2 removals associated with the product
BCEP	kg CO_2e	Biogenic CO_2 emissions associated with the product
BCRK	kg CO_2e	Biogenic CO_2 removals associated with the packaging
BCEK	kg CO_2e	Biogenic CO_2 emissions associated with the packaging
BCEW	kg CO_2e	Biogenic CO_2 emissions from combustion of waste from renewable sources

Table 13 summarizes the biogenic carbon inventory parameters for the Redbuilt™ product systems. For the Redbuilt product systems, no biogenic CO_2 emissions are associated with the packaging nor are there any emissions from combustion of waste from renewable sources. Although the study scope included only modules A1-A3, in accordance with ISO 21930, BCEK for the packaging is reported in A5 and BCEP for the product in C3/C4. ISO 21930 requires a demonstration of forest sustainability to characterize carbon removals with a factor of -1 kg CO_2e/kg CO_2.

Table 13. *Carbon emissions and removals for the Redbuilt structural lumber products, per declared unit.*

Parameter	Total	A1	A2	A3	A5	C3/C4
Red-H						
BCRP (kg CO2e)	-17.1	-17.1	0.00	0.00	0.00	0.00
BCEP (kg CO2e)	17.1	0.00	0.00	0.00	0.00	17.1
Red-H with LVL Chord						
BCRP (kg CO2e)	-18.4	-18.4	0.00	0.00	0.00	0.00
BCEP (kg CO2e)	18.4	0.00	0.00	0.00	0.00	18.4
Red-L						
BCRP (kg CO2e)	-6.21	-6.21	0.00	0.00	0.00	0.00
BCEP (kg CO2e)	6.21	0.00	0.00	0.00	0.00	6.21
Red-M						
BCRP (kg CO2e)	-13.2	-13.2	0.00	0.00	0.00	0.00
BCEP (kg CO2e)	13.2	0.00	0.00	0.00	0.00	13.2
Red-M with LVL Chord						
BCRP (kg CO2e)	-14.2	-14.2	0.00	0.00	0.00	0.00
BCEP (kg CO2e)	14.2	0.00	0.00	0.00	0.00	14.2
Red-S with LVL Chord						
BCRP (kg CO2e)	-8.78	-8.78	0.00	0.00	0.00	0.00
BCEP (kg CO2e)	8.78	0.00	0.00	0.00	0.00	8.78
Red-W						
BCRP (kg CO2e)	-7.57	-7.57	0.00	0.00	0.00	0.00
BCEP (kg CO2e)	7.57	0.00	0.00	0.00	0.00	7.57

ISO 21930 Section 7.2.11 Note 2 states the following regarding demonstrating forest sustainability: "Other evidences such as national reporting under the United Nations Framework Convention on Climate Change (UNFCCC) can be used to identify forests with stable or increasing forest carbon stocks." The UNFCCC annual report of the US provide annual net GHG Flux Estimates for different land use categories. This reporting indicates national increasing and/or neutral forest

carbon stocks in recent years. Thus, North American forests meet the conditions for characterization of removals with a factor of -1 kg CO_2e/kg CO_2.

6.2 CRADLE-TO-GRAVE CARBON SEQUESTRATION

The scope of the product system is cradle-to-gate, including the information modules: A1 - Extraction and upstream production; A2 - Transport to factory; and A3 - Manufacturing. As per ISO 21930, the net biogenic carbon emissions across the reported modules are zero (carbon neutral). This conservative assumption excludes the permanent sequestration of biogenic carbon if the LCA were to consider the typical end-of-life treatment for wood products, landfilling.

UL Environment published an addendum to the reference PCR that estimates the emissions from landfilling of wood products. The carbon sequestration addendum is based on the United States EPA WARM model and aligns with the biogenic accounting rules in ISO 21930 §7.2.7 and §7.2.12. Lacking specific data, the products are assumed disposed in a landfill at end-of-life. Table 14 summarizes the results of the application of the UL PCR addendum methodology to the biogenic carbon present in the Redbuilt products as they leave the manufacturer in Module A3.

Table 14. *Cradle-to-Grave Carbon Sequestration summary for the Redbuilt™ structural lumber products, per declared unit.*

Product	Mass of Dry Wood (kg)	Mass of Carbon In Dry Wood (kg C)	Mass of CO_2 in Dry Wood (kg CO_2)	Carbon sequestered in product (kg CO_2e)	Methane emitted from landfill gas (kg CO_2e)	Carbon dioxide emitted from landfill gas (kg CO_2e)	Permanent carbon sequestration, net of biogenic carbon emissions (kg CO_2e)
Red-H	9.50	4.66	17.1	-17.1	0.839	1.96	14.3
Red-H with LVL	10.2	5.02	18.4	-18.4	0.904	2.11	15.4
Red-L	3.46	1.69	6.21	-6.21	0.305	0.712	5.19
Red-M	7.34	3.60	13.2	-13.2	0.648	1.51	11.0
Red-M with LVL	7.91	3.88	14.2	-14.2	0.698	1.63	11.9
Red-S with LVL	4.89	2.40	8.78	-8.78	0.431	1.01	7.34
Red-W	4.21	2.06	7.57	-7.57	0.372	0.868	6.33

7. Additional Environmental Information

For more information related to RedBuilt's sustainability initiatives, please visit www.redbuilt.com/services/sustainability/

8. References

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