Environmental Product Declaration

of multiple products based on the average result of the product group.

In accordance with ISO 14025 and EN 15804:2012+A2:2019/AC:2021 for

ECORR Recycled Densely Graded Roadbase & Subbase

Programme:	EPD Australasia https://epd-australasia.com/
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An EPD should provide current information and may be updated if conditions change.

The stated validity is therefore subject to the continued registration and publication at https://epd-australasia.com/

EPD® THE INTERNATIONAL EPD® SYSTEM

AUSTRALASIA EPD® ENVIRONMENTAL PRODUCT DECLARATION

ECO PLATFORM EPD VERIFIED

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General EPD Information

Programme	Declaration Owner	EPD Prepared by	Third Party Verifier
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CEN standard EN 15804+A2:2019/AC2021 serves as the Core Product Category Rules (PCR)

Product category rules (PCR): PCR 2019:14; Construction products (EN 15804+A2) (1.3.4)

PCR review was conducted by: The Technical Committee of the International EPD® System. A full list of members available on www.environdec.com for a list of members. The review panel may be contacted via info@environdec.com. Review chair: Claudia A. Peña, University of Concepción, Chile.

Independent third-party verification of the declaration and data, according to ISO 14025:2006:	☐ EPD process certification ☒ EPD verification
Procedure for follow-up of data during EPD validity involves third party verifier:	☐ Yes ☒ No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

About ECORR

ECORR was founded in 2011 and established itself as a fully circular business in 2020. With operations in Western Sydney, New South Wales, Australia, ECORR's goal is to produce sustainable quality materials through the recycling and reprocessing of construction waste creating performance-engineered construction materials and solutions.

Our approach comprises four components – Advisory, Products, People and Operations - each aligns to the United Nations Sustainable Development Goals they impact most.

As increased urbanization and population growth continues to drive the demand for construction materials ECORR is well placed to support this growth through the provision of its recycled material products.

As an operator of a 90,000m² NSW Environment Protection Authority (NSW EPA) licensed recycling facility at Wetherill Park, Western Sydney we are well placed to drive and deliver against Australia's circular economy aspirations, and those of our customers.

Our operation recycles construction waste to create performance-engineered circular construction materials and solutions for use by the infrastructure and civil construction industry.

Drawing on our decades of experience in civil construction and resource recovery, ECORR was founded to provide recycled alternatives to natural resource use. We recycle 99% of materials entering our facility, and materials produced for market contain 95% recycled content[1].

As a leading figure in the circular economy, we have evolved from an organisation purely focused on resource recovery to one that is grounded in advancing the uptake of circular practices within our client-base, becoming a solutions-focused strategic partner with the advent of our advisory services offering.

We demystify circularity, by streamlining our clients' efforts, and establishing the foundations to integrate more sustainable options throughout the project. Working closely with our clients from the design phase through to execution, we drive the identification of circular and sustainable solutions within projects, pathways for beneficial reuse and spoil management, and sourcing cost-competitive recycled alternatives to realise the competitive advantage of truly circular thinking.

Figure 1 – ECORR's commitments to material circularity

[1] As at FY23.

What is an Environmental Product Declaration (EPD)?

An Environmental Product Declaration (EPD) is an independent, verified, and transparent declaration of the environmental impact a product or suite of products determined using a life cycle assessment (LCA) and are developed in accordance with international standards.

Environmental impact data from ECORR's Wetherill Park products have been quantified using the life cycle assessment process.

This ECORR EPD is for our 20mm Recycled Densely Graded Roadbase and 40mm Densely Graded Subbase and covers the following life cycle stages:

Product Stage			Construction Installation Stage		Use Stage	End of life stages				Resource Recovery Stage
Raw material supply (sourcing waste materials)	Internal transport	Processing (manufacture)	Transport distribution to site	Construction installation phase	Not included	Deconstruction demolition	Waste transport	Waste processing	Waste disposal	Reuse-recovery-recycling potential
Module A1	Module A2	Module A3	Module A4	Module A5	Modules B1-7	Module C1	Module C2	Module C3	Module C4	Module D

Table 1 | Life cycle stages

EPD's are an important part of tendering for large infrastructure and building projects, recognising the increasing demand for recycled construction materials. The data in our EPD informs the Infrastructure Sustainability Council of Australia (ISCA) IS Rating tool and the Green Building Council of Australia (GBCA) Green Star tool, enabling our customers to best understand and measure the benefits using our products deliver against these leading industry frameworks.

The development of a recycled concrete waste EPD is a first in NSW. ECORR's product EPD provides vital information that can support our customers deliver sustainable solutions.

Products Covered by this EPD

This EPD is valid for 1 tonne of 20DGB / 40DGS manufactured at ECORR's site in Wetherill Park, NSW, Australia.

Product Type	Product Characteristics	Declared Unit	Products Included	20DGB Applications	40DGS Applications
20mm Densely Graded Roadbase and 40mm Densely Graded Subbase	Recycled densely graded base and subbase produced from construction waste. Suitable alternate for structural fill material.	1 tonne	20DGB and 40DGS	• Used as an unbound or bound (with the addition of binder) base pavement material in the construction of State, Council and civil infrastructure and hardstand applications. • Used as compactible select structural fill material. • Used in the construction or hardstands requiring high load bearing strength and low shrinkage well properties.	• Used in Road Construction as a subbase pavement layer. • Used as an unbound or bound (with the addition of binder) subbase pavement material in the construction of State, Council and Civil Infrastructure and hardstand applications. • Used as compactible select material.

Table 2 | Product characteristics of recycled roadbase and subbase

This report delineates the methodology, data compilation, findings, and analysis of the lifecycle assessment for products listed in Table 2.

Recycled Densely Graded Base (20DGB)

ECORR produces its 20mm Recycled Densely Graded Base from locally sourced construction waste concrete and is a Transport for NSW (TfNSW) specified material in accordance with the RMS 3051 Edition 7 Specification.

Recycled specified road base is widely used in road construction as a base coarse under asphalt or concrete pavements.

Recycled Densely Graded Subbase (40DGS)

ECORR produces its 40mm Recycled Densely Graded Subbase from locally sourced construction waste concrete, asphalt and brick and is a Transport for NSW (TfNSW) specified material in accordance with the RMS 3051 Edition 7 Specification.

Data quality and validation

The LCA used primary data wherever possible. The primary data used for the study is based on direct utility bills or feedstock quantities from ECORR's procurement records. Primary data was carefully reviewed in order to ensure completeness, accuracy and representativeness of the data supplied. Contribution analysis was used to focus on the key pieces of data contributing to the environmental impact categories. The data was benchmarked against relevant benchmark data in ecoinvent. Overall, the data was deemed to be of high quality for the core module.

Declared Unit

The declared unit for the EPD is 1 tonne of product.

The UN CPC code for all products is 89420: Non-metal waste and scrap recovery (recycling) services, on a fee or contract basis. The ANZSIC Business industry code is 29220 (Recycling of other non-metal waste and scrap).

Quality of Material

Our production of high-quality recycled products begins with the careful selection of appropriately recovered construction waste. ECORR selects and accepts construction wastes from a diverse range of waste streams and this stringent process ensures that the wastes ECORR receives do not contain synthetic materials.

Acceptable waste streams delivered into our Wetherill Park facility are visually inspected at three inspection points to ensure no contamination. The waste is systematically sorted in specified areas, based on its type, before initiating the crushing process.

Waste materials are then distributed into our crushing and screening plant for processing various material types. These include base, subbase, bedding sand and various aggregate sizes.

Stringent testing measures are in place throughout the production cycle: before, during, and post-production. We engage in specialised product stockpiling and testing tailored to individual projects and material standards. Our testing framework extends to environmental evaluations, which include checks for recovered aggregates, asbestos, and PFAS, and quality assessments compliant with client requirements including those prescribed by Transport for NSW, the State Rail Authority and various Local Councils, and specific project requirements.

Our quality and environmental compliance tests are performed by independent, NATA Accredited third-party laboratories and we are also JAS_ANZ accredited to ISO9001.2015 Quality Management System, ISO14001:2015 Environmental Management System & IS045001:2018 Workplace Health and Safety System.

ECORR operates crushing, separating and sorting plants to create high value resources from waste. The recovered granular materials ECORR produce cover a wide range of applications and specifications.

Content Declaration

ECORR produced materials are 100% recycled concrete, brick and asphalt waste from post- consumer waste. All materials produced are sold in bulk, and packaging materials are not relevant for all products.

Table 3 | Content declaration (20DGB)

Product component	Weight, kg	Post-consumer recycled material, weight %	Biogenic material, weight % and kg C/kg
Asphalt	20-80	2-8	0 resp. 0
Concrete	750-900	75-90	0 resp. 0
General Solid Waste	50-150	5-15	0 resp. 0

Table 4 | Content declaration (40DGS)

Product component	Weight, kg	Post-consumer recycled material, weight %	Biogenic material, weight % and kg C/kg
Bricks	880-950	80-95	0 resp. 0
General Solid Waste	10-50	1-5	0 resp. 0
Sand	0.5-10	0.05-1	0 resp. 0
Sandstone	10-50	1-5	0 resp. 0
Spadable washout[2]	10-100	1-10	0 resp. 0

Products do not contain one or more substances that are listed in the “Candidate List of Substances of Very High Concern for Authorisation”. Therefore, in accordance with the PCR 1.3.4 for Construction Products, if one or more substances of the “Candidate List of Substances of Very High Concern (SVHC) for Authorisation” are present in a product and their total content exceeds 0.1% of the weight of the product, they need to be reported.

[2] ECORR uses water to settle dusts. The water used to for settling dust carries fine particles. The particles settle in a basin and is then recycled to the product stream. This washout fine particles is termed as spadable washout.

System Boundaries

This EPD has a 'cradle to gate' scope with options, including the modules A1-A5, module C1-C4, and module D included as shown in the table below.

The following modules have not been declared as they are deemed not applicable for ECORR products: B1 – material emissions from usage, B2 – maintenance, B3 – repair, B4 – replacement, B5 – refurbishment, B6 – operational energy use and B7 – operational water use.

	Product stage			Construction process stages		Use stage	End of life stage				Resource recovery stage
Module	A1	A2	A3	A4	A5	B1-7	C1	C2	C3	C4	D
Modules declared	X	X	X	X	X	ND[3]	X	X	X	X	X
Geography	AU	AU	AU	AU	AU	-	AU	AU	AU	AU	AU
Specific data used			>90%			-	-	-	-	-	-
Variation – products			<10%			-	-	-	-	-	-
Variation – sites			Not applicable			-	-	-	-	-	-

Table 5 | Life Cycle of building products: stage and modules included in this EPD

[3] ND = not declared.

Criteria for Polluter's Pay Principle matching with ECORR

According to PCR 1.3.4, products originating from waste materials need to meet four criteria in order to apply polluter-pays principle. ECORR products are found to match against each criterion below:

Criterion 1: the recovered material or product (including, e.g., energyware such as fuel, electricity and heat) is commonly used for specific purposes.

All ECORR products, have use in the construction industry. 20DGB and 40DGS are used as an unbound or bound (with the addition of binder) base pavement material in the construction of State, Council and Civil Infrastructure and hardstand applications. 20DGB and 40DGS are also suitable to use as high quality easily compactible structural fill material. 20DGB is additionally suitable for use in the construction or hardstands requiring high load bearing strength and low shrinkage swell properties.

Criterion 2: a market or demand, identified for example by a positive economic value, exists for such a recovered material or product.

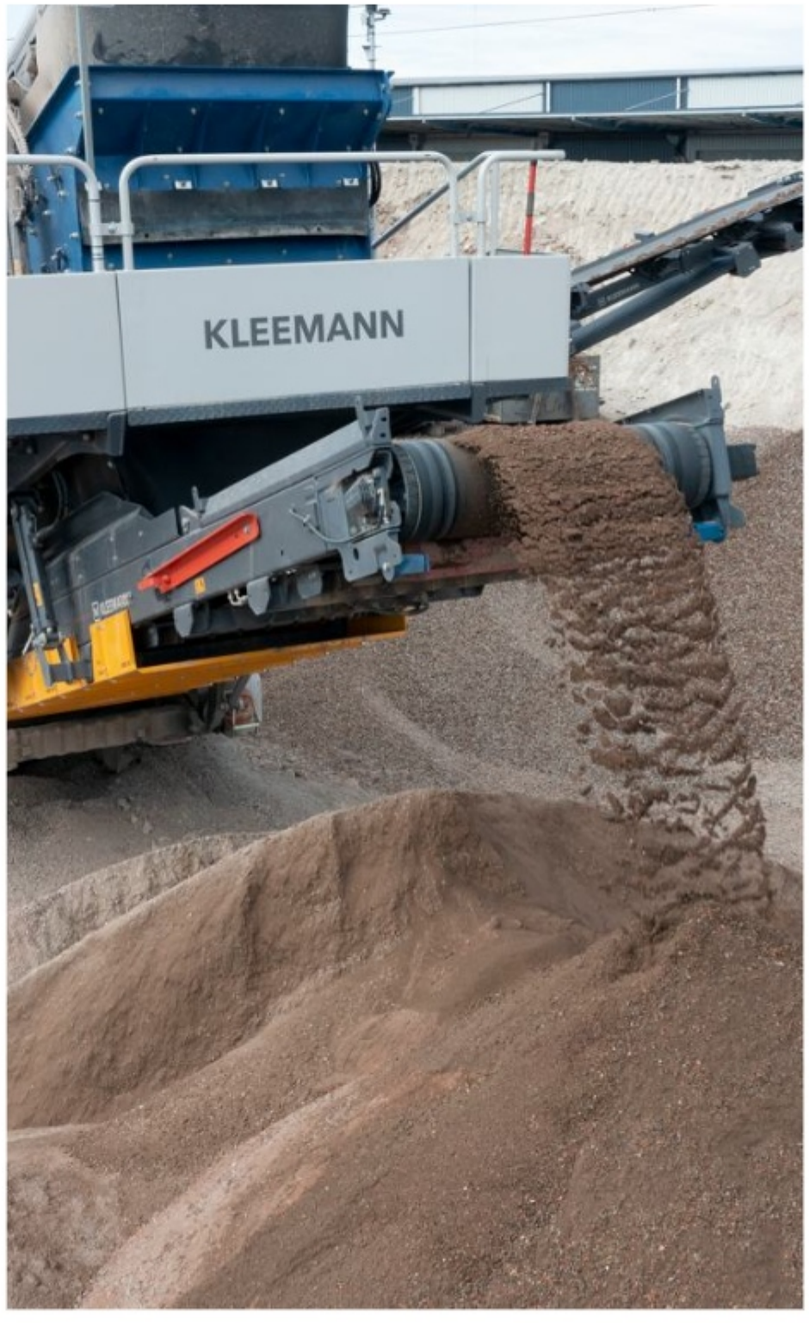
There is a high demand of ECORR products.

Criterion 3: the recovered material or product fulfils the technical requirements for the specific purposes for which it is used and meets the existing legislation and standards applicable to its use.

ECORR products meet the technical specifications set by New South Wales Government, Transport for New South Wales (TfNSW), councils and specific projects.

Criterion 4: the use of the recovered material or product will not lead to overall adverse environmental or human health impacts, which shall be understood as content of hazardous substances below limit values in applicable legislation.

ECORR products are tested to NSW Environment Protection Authority (EPA) guidelines as per Environment Protection Licence (EPL) requirements. These products replace their virgin counterparts and are not expected to lead to overall adverse environmental or human health impacts.



Manufacturing Process of ECORR Products

The construction waste consists of brick, asphalt, and concrete waste sourced from different projects throughout the New South Wales region, Australia. The construction waste is transported to the ECORR site. The unprocessed materials are sorted into designated areas. The material is then pushed by front loader to an excavator. The excavator loads the material into a combined crusher and screen process. The materials are separated into several products at the end of crusher and screen processes and the end-of-waste state for the waste materials is achieved.

Once the end-of-waste state is achieved, the products are relocated by means of front loader operation into a dump truck where materials are stockpiled based on the desired product type. As a conservative approach, on-site activities including water used for dust suppression, electricity used in the workshop and office buildings as well as disposal of waste.

Electricity Mix

The electricity consumption mix model was sourced from AusLCI database for grid electricity of New South Wales consisting of coal (75%), photovoltaic (16.6%) natural gas (3.1%), hydro (3%), bagasse (1.4%), biogas (0.6%), heat pump (0.2%) and oil (0.1%) with a GWP-GHG impact of 0.8 kg CO_2 eq./kWh.

Product Stage

PRODUCTION MANUFACTURING

CONSTRUCTION INSTALLATION

END OF LIFE + RECOVERY

A1 - Raw Material Supply
A2 - Transport
A3 - Manufacturing

A1

Sourcing of waste raw materials

The production stage covers the sourcing of raw materials, any movement of materials onsite and the production stage of recycled densely graded base and recycled densely graded subbase products. The construction waste consists of brick, asphalt, and concrete waste sourced from different projects throughout the New South Wales region. The construction waste is transported to the ECORR site.

A2

Transportation of construction waste to facility

The raw materials consumed in the case of ECORR products are sourced from construction wastes. As post-consumer material, the environmental upstream impact for construction wastes was set to zero according to PCR 1.3.4 for construction products. In addition, the transport of construction waste to ECORR site as well as their sorting and crushing of construction wastes were excluded from the LCA.

A3

Unprocessed materials fed into crusher and screen for processing

The unprocessed materials are sorted into designated areas and then fed by an excavator into the crusher for processing.

Since Module C is included in the EPD, the use of Module A1-A3 results without considering the results of Module C is discouraged

A3

Water, electricity and disposal of waste

Water is used for dust suppression. Electricity is used in the workshop and office buildings. In addition to water and electricity, the disposal of wastes is included in the LCA.

A3

Materials relocated to designated stockpile areas

Once processed, products are relocated by means of front loader operation into a dump truck where materials are stockpiled based on the desired product type.

Manufacturing process of ECORR was applied to the above A3 module.

Polluter's pay principle (PPP) was applied to the above 3 modules (A1-A3).

Construction Installation Stage

A4 - Transportation to Site
A5 - Construction Installation

Transportation from ECORR facility to site

The transport distances from manufacturing gate to customers' location were calculated based on primary data from percentage of total products shipped to customers.

Construction Installation of materials on site

Recycled densely graded base and densely graded subbase products are installed by a motor grader and roller at a rate of 500 tonnes per day.

End Of Life + Recovery

PRODUCTION MANUFACTURING

CONSTRUCTION INSTALLATION

END OF LIFE + RECOVERY

The end-of-life stage considers the environmental impacts associated with the ECORR products after it has reached the end of its useful life in a building or other infrastructure asset.

There are two possible end of life outcomes:

- Scenario 1: recycling
- Scenario 2: disposal

A recent report by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) suggests that the building material recycling rate is 81% in Australia[4]. According this data, scenario 1 (recycling at the end-of-life) has been considered as the main scenario.

C1 - Deconstruction
C2 - Waste Transport
C3 - Waste Processing

C4 - Waste Disposal
D - Reuse-Recovery-Recycling Potential

C1

Following the use of the product, construction materials are demolished on site for removal

Module C1 refers to deconstruction or demolition. In module C1, two excavation methods front loading and hydraulic digging are used.

C2

Demolition materials are transported from site following the use of the product

In module C2, the material is moved to a waste processing facility. In the first scenario, all material is recycled, shifting the responsibility to module C3. In Sydney, the recycling scenario is increasingly preferred and adopted due to the costs to transport waste and virgin aggregates long distances. Recycling is also the scenario that matches the end-of-life of the previous life cycle for the ECORR product.

Resource Recovery Stage **D**

Module D starts at the "end of waste" state, when the material is no longer a product in the current life cycle and starts to be a potential input for the next life cycle. Module D gives benefits or creates loads to the next system from the net recycling of a product, as prescribed in EN 15804+A2.

Scenario 2 - Disposal **C4**

In the second scenario, all materials sent to this facility end up in landfills, putting the load on module C4.

The following assumptions have been used in this scenario:

- C4 takes all the burden due to all material going to landfill.
- 25 km delivery distance for waste material to waste processing plant / landfilling site.

Scenario 1 - Recycling **C3**

In the first scenario, all material is recycled, shifting the responsibility to module C3.

The following assumptions have been used in this scenario:

- C3 takes all the burden due to all material is recycled.
- 25 km delivery distance for waste material to waste processing plant / landfilling site.

[4] https://minister.dcceew.gov.au/plibersek/media-releases/australias-latest-waste-figures-new-report

Life Cycle Assessment Methodology

Life Cycle Inventory Data

The specific data used is based on direct utility bills or feedstock quantities from ECORR's procurement records. The application of generic and specific data follows the EN 15804+A2 requirements and approach, which are entered into the SimaPro (v9.5) LCA software program and linked to the pre-existing data for the upstream feedstocks and services selected in order of preference from:

- For Australia, the Australian Life Cycle Inventory (AusLCI) v1.42 compiled by the Australian Life Cycle Assessment Society (ALCAS, 2023). The AusLCI database at the time of this report was less than a year old.
- Other authoritative sources (e.g., ecoinvent v3.8, (Wernet, et al., 2021), where necessary adapted for relevance to Australian conditions (energy sources, transport distances and modes and so on, and documented to show how the data is adapted for national relevance). At the time of reporting, the ecoinvent v3.8 database was 2 years old.

Average Product and Allocation

ECORR's Roadbase and Subbase products incorporate varying levels of recycled materials such as concrete, asphalt, and bricks. Based on the guidelines from polluter's pay principle, the transportation and processing impacts for construction wastes have not been allocated to ECORR.

The following stepwise allocation principles shall be applied for multi-input/output allocations:

- The initial allocation step includes dividing up the system sub-processes and collecting the input and output data related to these sub-processes.
- The first (preferably) allocation procedure step for each sub-process is to partition the inputs and outputs of the system into their different products in a way that reflects the underlying physical relationships between them.
- The second (worst case) allocation procedure step is needed when physical relationship alone cannot be established or used as the basis for allocation. In this case, the remaining environmental inputs and outputs from a sub-process must be allocated between the products in a way that reflects other relationships between them, such as the economic value of the products.

Electricity used for workshop and office building, petrol for water pump, water (sourced from town water) used to wet yard to control dust as well as processing manufacturing wastes were economically allocated based on the economic values of various products of FY21-22.

Cut Off Criteria

It is common practice in LCA/LCI protocols to propose exclusion limits for inputs and outputs that fall below a threshold % of the total, but with the exception that where the input/output has a "significant" impact it should be included.
According to the PCR 2019:14, Life cycle inventory data shall according to EN 15804 + A2 include a minimum of 95% of total inflows (mass and energy) per module. Data gaps in included stages in the downstream modules shall be reported in the EPD, including an evaluation of their significance. In accordance with the PCR 2019:14 Construction Products (v1.3.4), the following system boundaries are applied to manufacturing equipment and employees:

- Environmental impact from infrastructure, construction, production equipment, and tools that are not directly consumed in the production process are not accounted for. Capital equipment and buildings typically account for less than a few percent of nearly all life cycle inventories and this is usually smaller than the error in the inventory data itself. For this project, it is assumed that capital equipment makes a negligible contribution to the impacts as per Frischknecht et al. (Frischknecht, 2007) with no further investigation.
- Personnel-related impacts, such as transportation to and from work, are also not accounted for. The impacts of employees are also excluded from inventory impacts on the basis that if they were not employed for this production or service function, they would be employed for another. It is very hard to decide what proportion of the impacts from their whole lives should count towards their employment. For this project, the impacts of employees are excluded.
- The transport of the excavator, bobcat, grader, and roller are excluded.

Compliance with Standards

The methodology and report format has been modified to comply with:

- ISO 14040:2006 and ISO14044:2006+A1:2018 which describe the principles, framework, requirements and provides guidelines for life cycle assessment (LCA).
- ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations - Principles and procedures, which establishes the principles and specifies the procedures for developing Type III environmental declaration programmes and Type III environmental declarations.
- EN 15804:2012+A1:2013; Sustainability of construction works — Environmental product declarations.
- EN 15804:2012+A2:2019; Sustainability of construction works — Environmental product declarations.
- Product Category Rules (PCR) 2019:14, v1.3.4 – Construction products – Hereafter referred to as PCR 2019:14.
- General Programme Instructions (GPI) for the International EPD System V4.0 – containing instructions regarding methodology and the content that must be included in EPDs registered under the International EPD System.
- Instructions of EPD Australasia V4.2 – a regional annex to the general programme instructions of the International EPD System.

Assessment Indicators

The estimated impact results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks. The characterisation factors applied to the calculation of potential environmental impacts (Table 6) are based on version 3.1 of the reference package for CFs used in the Product Environmental Footprint (PEF) framework (EF 3.1). Most LCA tools have libraries of impact assessment methods that can completely automate the impact assessment. The following potential environmental impacts, use of resources and waste categories have been calculated in the SimaPro (v9.5) tool.

Table 6 | Life cycle impact, resource and waste assessment categories, measurements and methods in accordance with EN15804+A2

Impact Category	Indicator (Abbreviation)	Measurement Unit	Assessment Method and Implementation
Potential Environmental Impact			
Climate change - fossil	Global Warming Potential fossil fuels (GWP-fossil)	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2021
Climate change – biogenic	Global Warming Potential biogenic (GWP-biogenic)	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2021
Climate change – land use and land use change	Global Warming Potential land use and land use change (GWP-luluc)	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2021
Climate change – total	Global Warming Potential total (GWP-total)	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2021
Acidification potential	AP	mol H^+ eq.	Accumulated Exceedance, Seppälä et al. 2006, Posch et al., 2008
Ozone depletion	Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11 equivalents	Steady-state ODPs, WMO 2014
Eutrophication – aquatic freshwater	Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP – freshwater)	kg P equivalent	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe
Eutrophication – aquatic marine	Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP – marine)	kg N equivalent	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe
Eutrophication – terrestrial	Eutrophication potential, Accumulated Exceedance (EP – terrestrial)	mol N equivalent	Accumulated Exceedance, Seppälä et al. 2006, Posch et al.

Table 6 | Life cycle impact, resource and waste assessment categories, measurements and methods in accordance with EN15804+A2

Impact Category	Indicator (Abbreviation)	Measurement Unit	Assessment Method and Implementation
Potential Environmental Impact			
Photochemical ozone formation	Formation potential of tropospheric ozone (POCP)	kg NMVOC equivalents	LOTOS-EUROS, Van Zelm et al., 2008, as applied in ReCiPe
Depletion of abiotic resources – minerals and metals*	Abiotic depletion potential for non-fossil resources (ADP- minerals&metals)	kg Sb equivalents	CML (v4.1)
Depletion of abiotic resources – fossil fuels*	Abiotic depletion potential for fossil resources (ADP-fossil)	MJ net calorific value	CML (v4.1)
Water Depletion Potential*	WDP	m^3 equivalent deprived	Available Water Remaining (AWARE) Boulay et al., 2016
Resource use			
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	PERE	MJ, net calorific value	Manual for direct inputs
Use of renewable primary energy resources used as raw materials	PERM	MJ, net calorific value	Manual for direct inputs[5]
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	PERT	MJ, net calorific value	ecoinvent version 3.8 and expanded by PRé Consultants[6]
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	MJ, net calorific value	Manual for direct inputs

[5] Calculated based on the lower heating value of renewable raw materials.
[6] Calculated as sum of renewables, biomass; renewable, wind, solar and geothermal, and renewable, water.

Table 6 | Life cycle impact, resource and waste assessment categories, measurements and methods in accordance with EN15804+A2

Impact Category	Indicator (Abbreviation)	Measurement Unit	Assessment Method and Implementation
Resource use			
Use of non- renewable primary energy resources used as raw materials	PENRM	MJ, net calorific value	Manual for direct inputs[7]
Total use of non- renewable primary energy resources (primary energy and primary energy resources used as raw materials)	PENRT	MJ, net calorific value	ecoinvent version 3.8 and expanded by PRé Consultants[8]
Use of secondary material	SM	kg	Manual for direct inputs
Use of renewable secondary fuels	RSF	MJ, net calorific value	Manual for direct inputs
Use of non-renewable secondary fuels	NRSF	MJ, net calorific value	Manual for direct inputs
Use of net fresh water	FW	m^3	ReCiPe 2016
Waste categories			
Hazardous waste disposed	HWD	kg	EDIP 2003 (v1.05)
Non-hazardous waste disposed	NHWD	kg	EDIP 2003 (v1.05)[9]
Radioactive waste disposed/stored	RWD	kg	EDIP 2003 (v1.05)

[7] Calculated based on the lower heating value of non-renewable raw materials.
[8] Calculated as sum of non-renewables, fossil and non-renewable, nuclear.
[9] Calculated as sum of Bulk waste and Slags/ash.

Table 6 | Life cycle impact, resource and waste assessment categories, measurements and methods in accordance with EN15804+A2

Impact Category	Indicator (Abbreviation)	Measurement Unit	Assessment Method and Implementation
Additional environmental impact indicators			
Global warming potential, excluding biogenic uptake, emissions and storage	GWP-GHG	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2021[10]
Global warming potential, IPCC 2013 AR5	GWP-GHG (IPCC AR5)	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013 (AR5)
Particulate matter emissions	Potential incidence of disease due to PM emissions (PM)	Disease incidence	SETAC-UNEP, Fantke et al. 2016
Ionising radiation – human health**	Potential Human exposure efficiency relative to U235 (IRP)	kBq U-235 eq	Human Health Effect model
Eco-toxicity (freshwater)*	Potential Comparative Toxic Unit for ecosystems (ETP-fw)	CTUe	USEtox
Human toxicity – cancer effects*	Potential Comparative Toxic Unit for humans (HTP-c)	CTUh	USEtox
Human toxicity potential - non cancer effects*	Potential Comparative Toxic Unit for humans (HTP-nc)	CTUh	USEtox
Soil quality*	Potential soil quality index (SQP)	dimensionless	Soil quality index (LANCA®)

**Disclaimer – The results of these environmental impact indicators shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.*

***Disclaimer – This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.*

[10] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO2 is set to zero.

Table 7 | Environmental impact indicators in accordance with EN15804+A1

Impact Category	Abbreviation	Measurement Unit (eq. = equivalence)	Assessment Method and Implementation
Global warming potential (GWP100)	GWP	kg CO_2 eq.	CML (v4.02) based on IPCC AR4
Ozone depletion potential	ODP	kg CFC 11 eq.	CML (v4.02) based on WMO 1999
Acidification potential	AP	kg SO_2 e eq.	CML (v4.02)
Eutrophication potential	EP	kg PO_4^{3-} eq.	CML (v4.02)
Photochemical ozone creation potential	POCP	kg C_2H_4 eq.	CML (v4.2)
Abiotic depletion potential for non-fossil resources	ADPE	kg Sb eq.	CML (v4.2)
Abiotic depletion potential for fossil resources	ADPF	MJ net calorific value	CML (v4.2)

Table 8 | Environmental impact indicators in accordance with Green Star v1.3

Impact Category	Abbreviation	Measurement Unit (eq. = equivalence)	Assessment Method and Implementation
Human toxicity cancer	HTP-c	CTUh	USEtox – cancer effect
Human toxicity noncancer	HTP-nc	CTUh	USEtox – noncancer effect
Land use	LU	kg C deficit-eq.	Soil Organic Matter method
Resource depletion - water	RDW	m^3	Water Stress Indicator
Ionising radiation	IR	kBq U-235-eq.	Human Health Effect model
Particulate matter	PM	kg PM2.5-eq.	RiskPoll

Main Environmental Performance Results - recycling at the end-of-life

Table 9 | Environmental impacts per tonne of recycled densely graded base or recycled densely graded subbase / recycling at the end-of-life (results are in accordance with EN15804+A2:2019)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Global warming potential - fossil	GWP - Fossil	kg CO_2 eq.	4.92E-01	1.99E+00	1.21E+00	5.05E-01	1.82E+00	4.13E+00	0.00E+00	0.00E+00
Global warming potential - biogenic	GWP - Biogenic	kg CO_2 eq.	3.00E-04	1.61E-04	3.57E-04	1.43E-04	1.48E-04	4.93E-03	0.00E+00	0.00E+00
Global warming potential - land use/ land transformation	GWP - Luluc	kg CO_2 eq.	1.16E-05	9.27E-07	2.98E-05	1.35E-05	8.48E-07	1.90E-06	0.00E+00	0.00E+00
Global warming potential - total	**GWP - Total**	kg CO_2 eq.	4.92E-01	1.99E+00	1.21E+00	5.05E-01	1.82E+00	4.13E+00	0.00E+00	0.00E+00
Ozone depletion potential	ODP	kg CFC 11 eq.	1.00E-07	3.09E-07	2.71E-07	1.12E-07	2.83E-07	5.18E-07	0.00E+00	0.00E+00
Acidification potential	AP	mol H^+ eq.	5.06E-03	1.41E-02	1.30E-02	5.45E-03	1.16E-02	1.13E-02	0.00E+00	0.00E+00
Eutrophication – freshwater	EP - F	kg P eq.	2.77E-06	2.02E-07	7.25E-06	2.93E-06	1.85E-07	1.97E-05	0.00E+00	0.00E+00
Eutrophication – marine	EP - M	kg N eq.	2.20E-03	3.71E-03	5.84E-03	2.45E-03	2.69E-03	2.01E-03	0.00E+00	0.00E+00
Eutrophication – terrestrial	EP - T	mol N eq.	2.41E-02	4.11E-02	6.41E-02	2.69E-02	3.01E-02	2.19E-02	0.00E+00	0.00E+00
Photochemical ozone creation potential	POCP	kg NMVOC eq.	6.65E-03	1.01E-02	1.75E-02	7.34E-03	7.41E-03	5.86E-03	0.00E+00	0.00E+00
Abiotic depletion potential - minerals and metals	ADP	kg Sb eq.	2.37E-08	2.27E-09	6.24E-08	2.60E-08	2.08E-09	1.02E-06	0.00E+00	0.00E+00
Abiotic depletion potential - fossil fuels	ADPF	MJ	6.63E+00	2.68E+01	1.67E+01	6.98E+00	2.46E+01	5.56E+01	0.00E+00	0.00E+00
Water Depletion Potential	WDP	m^3	7.99E-03	1.73E-01	4.31E-03	2.17E-03	1.58E-01	1.19E+00	0.00E+00	0.00E+00

Main Environmental Performance Results - recycling at the end-of-life

Table 10 | Resource use per tonne of recycled densely graded base or recycled densely graded subbase / recycling at the end-of-life (results are in accordance with EN15804+A2:2019)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	PERE	MJ	5.55E-02	3.86E-02	2.71E-02	1.08E-02	3.54E-02	1.01E+00	0.00E+00	0.00E+00
Use of renewable primary energy resources used as raw materials	PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Primary renewable energy - total	**PERT**	MJ	5.55E-02	3.86E-02	2.71E-02	1.08E-02	3.54E-02	1.01E+00	0.00E+00	0.00E+00
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	MJ	6.63E+00	2.68E+01	1.67E+01	6.98E+00	2.46E+01	5.56E+01	0.00E+00	0.00E+00
Use of non- renewable primary energy resources used as raw materials	PENRM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Primary non-renewable energy - total	**PENRT**	MJ	6.63E+00	2.68E+01	1.67E+01	6.98E+00	2.46E+01	5.56E+01	0.00E+00	0.00E+00
Use of secondary material	SM	kg	1.00E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels	RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels	NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water	FW	m^3	2.04E-04	3.90E-03	2.68E-04	1.27E-04	3.57E-03	2.08E-02	0.00E+00	0.00E+00

Table 11 | Waste generated per tonne of recycled densely graded base or recycled densely graded subbase / recycling at the end-of-life (results are in accordance with EN15804+A2:2019)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	HWD	kg	1.65E-05	6.37E-06	4.38E-05	1.83E-05	5.83E-06	1.66E-05	0.00E+00	0.00E+00
Non-hazardous waste disposed	NHWD	kg	3.77E-03	1.22E-03	1.25E-03	5.29E-04	1.11E-03	5.64E-02	0.00E+00	0.00E+00
Radioactive waste disposed/stored	RWD	kg	4.44E-05	1.66E-09	1.20E-04	5.00E-05	1.51E-09	3.23E-07	0.00E+00	0.00E+00

Main Environmental Performance Results - recycling at the end-of-life

Table 12 | Output flows per tonne of recycled densely graded base or recycled densely graded subbase / recycling at the end-of-life (results are in accordance with EN15804+A2:2019)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Components for reuse	CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	MFR	kg	5.47E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+03	0.00E+00	0.00E+00
Materials for energy recovery	MFRE	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy - electricity	EE - e	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy - thermal	EE - t	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 13 | Additional environmental impacts per tonne of recycled densely graded base or recycled densely graded subbase / recycling at the end-of-life (results are in accordance with EN15804+A2:2019)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Global warming potential, excluding biogenic uptake, emissions and storage	GWP-GHG	kg CO_2 eq	4.92E-01	1.99E+00	1.21E+00	5.05E-01	1.82E+00	4.13E+00	0.00E+00	0.00E+00
Global warming potential, IPCC 2013 AR5	GWP-GHG (IPCC AR5)	kg CO_2 eq	4.85E-01	1.96E+00	1.20E+00	5.01E-01	1.80E+00	4.11E+00	0.00E+00	0.00E+00
Particulate matter	PM	disease incidence	1.31E-07	1.63E-07	3.54E-07	1.48E-07	1.76E-07	7.52E-08	0.00E+00	0.00E+00
Ionising radiation - human health	IRP	kBq U-235 eq	2.73E-02	4.70E-05	7.37E-02	3.07E-02	4.30E-05	2.29E-03	0.00E+00	0.00E+00
Ecotoxicity - freshwater	ETP - fw	CTUe	2.13E+00	7.78E+00	5.59E+00	2.33E+00	7.15E+00	1.47E+01	0.00E+00	0.00E+00
Human toxicity potential - cancer effects	HTP - c	CTUh	3.24E-11	5.59E-11	7.27E-11	3.03E-11	6.10E-11	6.82E-10	0.00E+00	0.00E+00
Human toxicity potential - non cancer effects	HTP - nc	CTUh	3.93E-09	4.06E-09	5.83E-09	2.44E-09	4.35E-09	2.14E-08	0.00E+00	0.00E+00
Soil quality	SQP	Pt	1.29E-01	1.21E-01	5.25E-02	2.17E-02	1.10E-01	1.11E+04	0.00E+00	0.00E+00

Main Environmental Performance Results - recycling at the end-of-life

Table 14 | Environmental impacts per tonne of recycled densely graded base or recycled densely graded subbase / recycling at the end-of-life (results are in accordance with EN15804+A1:2013)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Global warming potential (GWP100)	GWP	kg CO_2 eq	4.85E-01	1.96E+00	1.20E+00	5.01E-01	1.80E+00	4.10E+00	0.00E+00	0.00E+00
Ozone layer depletion	ODP	kg CFC-11 eq	7.91E-08	2.44E-07	2.14E-07	8.87E-08	2.24E-07	4.09E-07	0.00E+00	0.00E+00
Acidification potential	AP	kg SO_2 eq	3.47E-03	7.40E-03	9.25E-03	3.87E-03	5.88E-03	7.14E-03	0.00E+00	0.00E+00
Eutrophication potential	EP	kg PO_4^{3-} eq	7.50E-04	1.45E-03	1.99E-03	8.33E-04	1.09E-03	1.08E-03	0.00E+00	0.00E+00
Photochemical ozone creation potential	POCP	kg C_2H_4 eq	1.02E-04	4.76E-04	1.82E-04	7.59E-05	3.77E-04	4.02E-04	0.00E+00	0.00E+00
Abiotic depletion potential for non-fossil resources	ADPE	kg Sb eq	2.38E-08	2.30E-09	6.25E-08	2.60E-08	2.11E-09	1.02E-06	0.00E+00	0.00E+00
Abiotic depletion potential for fossil resources	ADPF	MJ	6.47E+00	2.62E+01	1.63E+01	6.79E+00	2.40E+01	5.73E+01	0.00E+00	0.00E+00

Table 15 | Environmental impacts per tonne of recycled densely graded base or recycled densely graded subbase / recycling at the end-of-life (results are in accordance with Green Star v1.3)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Human Toxicity cancer	HTc	CTUh	5.50E-12	1.16E-11	7.25E-12	2.94E-12	1.18E-11	6.63E-11	0.00E+00	0.00E+00
Human Toxicity non-cancer	HTnc	CTUh	2.47E-12	3.72E-12	5.20E-13	2.31E-13	3.69E-12	2.67E-11	0.00E+00	0.00E+00
Land use	LU	kg C deficit eq.	6.90E-03	1.81E-03	1.57E-02	6.64E-03	1.65E-03	1.18E+03	0.00E+00	0.00E+00
Ionising radiation	IR	kBq U235 eq	2.73E-02	4.70E-05	7.37E-02	3.07E-02	4.30E-05	2.30E-03	0.00E+00	0.00E+00
Particulate Matter	PM	kg PM2,5-Equiv.	1.27E-03	1.89E-03	3.39E-03	1.42E-03	1.61E-03	1.23E-03	0.00E+00	0.00E+00
Resource depletion - water	WSI	m^3	3.54E-04	2.20E-03	1.35E-04	7.93E-05	2.01E-03	4.82E-02	0.00E+00	0.00E+00

Results for Additional Scenario - landfilling at the end-of-life

Table 16 | Environmental impacts per tonne of recycled densely graded base or recycled densely graded subbase / landfilling at the end-of-life (results are in accordance with EN15804+A2:2019)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Global warming potential - fossil	GWP - Fossil	kg CO_2 eq.	4.92E-01	1.99E+00	1.21E+00	5.05E-01	1.82E+00	0.00E+00	2.52E+00	4.75E+00
Global warming potential - biogenic	GWP - Biogenic	kg CO_2 eq.	3.00E-04	1.61E-04	3.57E-04	1.43E-04	1.48E-04	0.00E+00	1.45E-03	1.24E-02
Global warming potential - land use/ land transformation	GWP - Luluc	kg CO_2 eq.	1.16E-05	9.27E-07	2.98E-05	1.35E-05	8.48E-07	0.00E+00	8.59E-05	1.02E-06
Global warming potential - total	**GWP - Total**	kg CO_2 eq.	4.92E-01	1.99E+00	1.21E+00	5.05E-01	1.82E+00	0.00E+00	2.53E+00	4.76E+00
Ozone depletion potential	ODP	kg CFC 11 eq.	1.00E-07	3.09E-07	2.71E-07	1.12E-07	2.83E-07	0.00E+00	5.24E-07	2.63E-07
Acidification potential	AP	mol H^+ eq.	5.06E-03	1.41E-02	1.30E-02	5.45E-03	1.16E-02	0.00E+00	2.60E-02	1.63E-02
Eutrophication – freshwater	EP - F	kg P eq.	2.77E-06	2.02E-07	7.25E-06	2.93E-06	1.85E-07	0.00E+00	7.49E-05	1.05E-05
Eutrophication – marine	EP - M	kg N eq.	2.20E-03	3.71E-03	5.84E-03	2.45E-03	2.69E-03	0.00E+00	1.13E-02	2.76E-03
Eutrophication – terrestrial	EP - T	mol N eq.	2.41E-02	4.11E-02	6.41E-02	2.69E-02	3.01E-02	0.00E+00	1.24E-01	3.00E-02
Photochemical ozone creation potential	POCP	kg NMVOC eq.	6.65E-03	1.01E-02	1.75E-02	7.34E-03	7.41E-03	0.00E+00	3.45E-02	7.85E-03
Abiotic depletion potential - minerals and metals	ADP	kg Sb eq.	2.37E-08	2.27E-09	6.24E-08	2.60E-08	2.08E-09	0.00E+00	1.22E-07	5.86E-07
Abiotic depletion potential - fossil fuels	ADPF	MJ	6.63E+00	2.68E+01	1.67E+01	6.98E+00	2.46E+01	0.00E+00	3.36E+01	5.83E+01
Water Depletion Potential	WDP	m^3	7.99E-03	1.73E-01	4.31E-03	2.17E-03	1.58E-01	0.00E+00	1.36E-02	6.02E+01

Results for Additional Scenario - landfilling at the end-of-life

Table 17 | Resource use per tonne of recycled densely graded base or recycled densely graded subbase / landfilling at the end-of-life (results are in accordance with EN15804+A2:2019)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	PERE	MJ	5.55E-02	3.86E-02	2.71E-02	1.08E-02	3.54E-02	0.00E+00	0.00E+00	0.00E+00
Use of renewable primary energy resources used as raw materials	PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Primary renewable energy - total	**PERT**	MJ	5.55E-02	3.86E-02	2.71E-02	1.08E-02	3.54E-02	0.00E+00	1.41E-01	3.24E+00
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	MJ	6.63E+00	2.68E+01	1.67E+01	6.98E+00	2.46E+01	0.00E+00	0.00E+00	0.00E+00
Use of non- renewable primary energy resources used as raw materials	PENRM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Primary non-renewable energy - total	**PENRT**	MJ	6.63E+00	2.68E+01	1.67E+01	6.98E+00	2.46E+01	0.00E+00	3.36E+01	5.83E+01
Use of secondary material	SM	kg	1.00E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels	RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels	NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water	FW	m^3	2.04E-04	3.90E-03	2.68E-04	1.27E-04	3.57E-03	0.00E+00	6.67E-04	1.39E+00

Table 18 | Waste generated per tonne of recycled densely graded base or recycled densely graded subbase / landfilling at the end-of-life (results are in accordance with EN15804+A2:2019)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Hazardous waste disposed	HWD	kg	1.65E-05	6.37E-06	4.38E-05	1.83E-05	5.83E-06	0.00E+00	8.48E-05	7.59E-06
Non-hazardous waste disposed	NHWD	kg	3.77E-03	1.22E-03	1.25E-03	5.29E-04	1.11E-03	0.00E+00	9.99E+02	9.95E-02
Radioactive waste disposed/stored	RWD	kg	4.44E-05	1.66E-09	1.20E-04	5.00E-05	1.51E-09	0.00E+00	2.32E-04	1.33E-07

Results for Additional Scenario - landfilling at the end-of-life

Table 19 | Output flows per tonne of recycled densely graded base or recycled densely graded subbase / landfilling at the end-of-life (results are in accordance with EN15804+A2:2019)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Components for reuse	CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	MFR	kg	5.47E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	MFRE	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy - electricity	EE - e	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy - thermal	EE - t	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 20 | Additional environmental impacts per tonne of recycled densely graded base or recycled densely graded subbase / landfilling at the end-of-life (results are in accordance with EN15804+A2:2019)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Global warming potential, excluding biogenic uptake, emissions and storage	GWP-GHG	kg CO_2 eq	4.92E-01	1.99E+00	1.21E+00	5.05E-01	1.82E+00	0.00E+00	2.52E+00	4.76E+00
Global warming potential, IPCC 2013 AR5	GWP-GHG (IPCC AR5)	kg CO_2 eq	4.85E-01	1.96E+00	1.20E+00	5.01E-01	1.80E+00	0.00E+00	2.48E+00	4.72E+00
Particulate matter	PM	disease incidence	1.31E-07	1.63E-07	3.54E-07	1.48E-07	1.76E-07	0.00E+00	6.96E-07	1.33E-07
Ionising radiation - human health	IRP	kBq U-235 eq	2.73E-02	4.70E-05	7.37E-02	3.07E-02	4.30E-05	0.00E+00	1.44E-01	9.52E-04
Ecotoxicity - freshwater	ETP - fw	CTUe	2.13E+00	7.78E+00	5.59E+00	2.33E+00	7.15E+00	0.00E+00	1.70E+01	8.45E+00
Human toxicity potential - cancer effects	HTP - c	CTUh	3.24E-11	5.59E-11	7.27E-11	3.03E-11	6.10E-11	0.00E+00	2.08E-10	4.74E-10
Human toxicity potential - non cancer effects	HTP - nc	CTUh	3.93E-09	4.06E-09	5.83E-09	2.44E-09	4.35E-09	0.00E+00	2.53E-08	1.50E-08
Soil quality	SQP	Pt	1.29E-01	1.21E-01	5.25E-02	2.17E-02	1.10E-01	0.00E+00	4.13E+01	1.43E+02

Results for Additional Scenario - landfilling at the end-of-life

Table 21 | Environmental impacts per tonne of recycled densely graded base or recycled densely graded subbase / landfilling at the end-of-life (results are in accordance with EN15804+A1:2013)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Global warming potential (GWP100)	GWP	kg CO_2 eq	4.85E-01	1.96E+00	1.20E+00	5.01E-01	1.80E+00	0.00E+00	2.48E+00	4.71E+00
Ozone layer depletion	ODP	kg CFC-11 eq	7.91E-08	2.44E-07	2.14E-07	8.87E-08	2.24E-07	0.00E+00	4.14E-07	2.08E-07
Acidification potential	AP	kg SO_2 eq	3.47E-03	7.40E-03	9.25E-03	3.87E-03	5.88E-03	0.00E+00	1.86E-02	6.08E-03
Eutrophication potential	EP	kg PO_4^{3-} eq	7.50E-04	1.45E-03	1.99E-03	8.33E-04	1.09E-03	0.00E+00	4.04E-03	1.18E-03
Photochemical ozone creation potential	POCP	kg C_2H_4 eq	1.02E-04	4.76E-04	1.82E-04	7.59E-05	3.77E-04	0.00E+00	7.24E-04	4.03E-04
Abiotic depletion potential for non-fossil resources	ADPE	kg Sb eq	2.38E-08	2.30E-09	6.25E-08	2.60E-08	2.11E-09	0.00E+00	1.22E-07	5.88E-07
Abiotic depletion potential for fossil resources	ADPF	MJ	6.47E+00	2.62E+01	1.63E+01	6.79E+00	2.40E+01	0.00E+00	3.34E+01	6.68E+01

Table 22 | Environmental impacts per tonne of recycled densely graded base or recycled densely graded subbase / landfilling at the end-of-life (results are in accordance with Green Star v1.3)

Indicator	ABR	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
Human Toxicity cancer	HTc	CTUh	5.50E-12	1.16E-11	7.25E-12	2.94E-12	1.18E-11	0.00E+00	2.54E-11	1.37E-10
Human Toxicity non-cancer	HTnc	CTUh	2.47E-12	3.72E-12	5.20E-13	2.31E-13	3.69E-12	0.00E+00	1.22E-12	8.34E-11
Land use	LU	kg C deficit eq.	6.90E-03	1.81E-03	1.57E-02	6.64E-03	1.65E-03	0.00E+00	2.95E+00	1.08E+02
Ionising radiation	IR	kBq U235 eq	2.73E-02	4.70E-05	7.37E-02	3.07E-02	4.30E-05	0.00E+00	1.44E-01	9.53E-04
Particulate Matter	PM	kg PM2,5-Equiv.	1.27E-03	1.89E-03	3.39E-03	1.42E-03	1.61E-03	0.00E+00	6.65E-03	1.43E-03
Resource depletion - water	WSI	m^3	3.54E-04	2.20E-03	1.35E-04	7.93E-05	2.01E-03	0.00E+00	4.32E-04	1.96E+00

Interpretation of Results

The following insights were observed from the LCA results for Roadbase and Subbase 20DGB and 40DGS:

- The GWP-Total emission from the product stage (A1-A3) is 5.8% of total lifecycle emissions (modules A-C) for landfilling scenario and 4.8% of total lifecycle emissions for recycling scenario.
- Following the Polluter Pays Principle (PPP), no impact was accounted for raw materials and raw material transport to ECORR site. The largest impact in the product stage (A1-A3) is the onsite movement of materials by front-loader and dump truck accounting 90% of product stage emissions.
- The downstream (module A4) accounts 23.3% of total lifecycle emissions for landfilling scenario and 19.6% of total lifecycle emissions for recycling scenario.
- Installation (module A5) accounts for only 14.2% for the landfill scenario and 11.9% for the recycling scenario.
- Waste transport (C2 module) accounts 21.3% of total lifecycle emissions for landfilling scenario and 17.9% for recycling scenario.
- In the recycling scenario, module C3 contributes 40.7% of the total GWP. In the landfilling scenario, module C4 contribute up to 29.6% of 20DGB/40DGS total GWP.
- Across all modules, 100% of the waste disposed is non-hazardous (NHWD).

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