Fulton Hogan

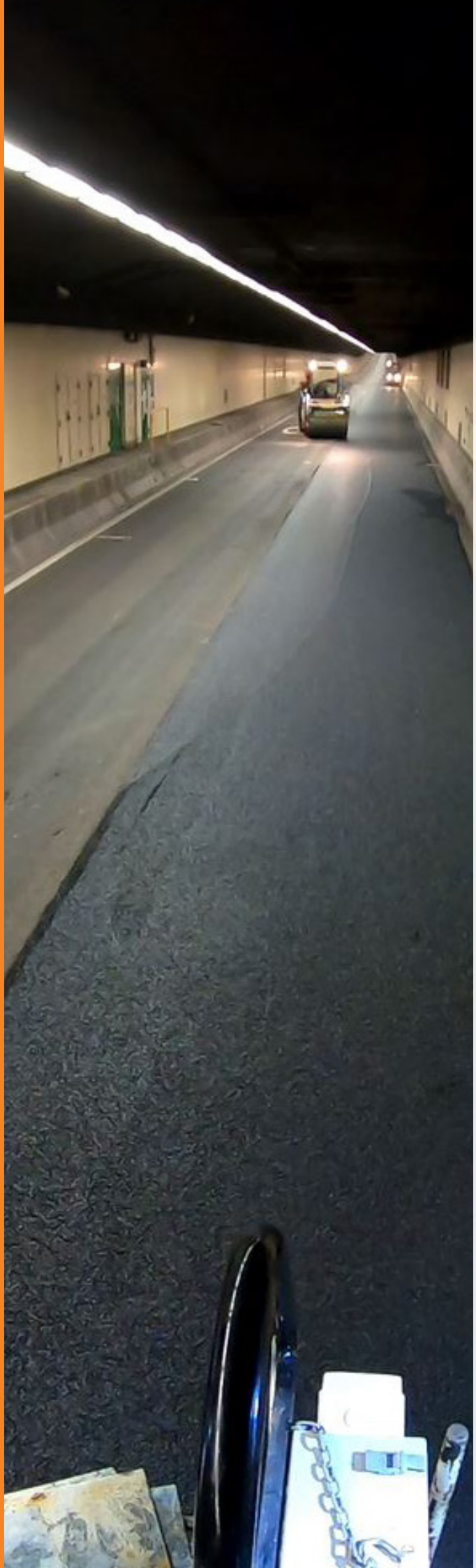
Fulton Hogan Asphalt (NSW)

Environmental Product Declaration
In accordance with ISO 14025 and EN 15804

EPD Registration no. S-P-04649 | Version 1.0
Issued 24 February 2022 | Valid until 24 February 2027
Geographical Scope: New South Wales, Australia

AUSTRALASIA EPD®
ENVIRONMENTAL PRODUCT DECLARATION

ECO PLATFORM
EPD
VERIFIED



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Program Information and Verification

An Environmental Product Declaration (EPD) is a standardised way of quantifying the potential environmental impacts of a product or system. EPDs are produced according to a consistent set of rules – Product Category Rules (PCR) – that define the requirements within a given product category. These rules are a key part of ISO 14025 as they enable transparency and comparability between EPDs. This EPD provides environmental indicators for Fulton Hogan asphalt products manufactured in NSW, Australia. This EPD is a "cradle-to-gate" declaration covering production of asphalt including its supply chain.

This EPD is verified to be compliant with EN 15804. EPD of construction products may not be comparable if they do not comply with EN15804. EPDs within the same product category but from different programs or utilising different PCRs may not be comparable. Fulton Hogan, as the EPD owner, has the sole ownership, liability and responsibility for the EPD.

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PCR review was conducted by:	The Technical Committee of the International EPD® System. Chair: Claudia A. Peña. Contact via info@environdec.com
Independent verification of the declaration and data, according to ISO 14025:	☐ EPD process certification (Internal) ☑ EPD verification (External)
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Introduction

Fulton Hogan

Fulton Hogan is a family-owned business, committed to ensuring the work we do today will make a real difference to the lives of our people and customers, the communities they call home, and the world we live in, tomorrow.

In 1933, Jules Fulton and Bob Hogan teamed up to form Fulton Hogan. From there, we've grown to over 7000 people. A family of real people dedicated to doing good work that connects and cares for communities across New Zealand, Australia and the South Pacific.

From concrete, asphalt and aggregates through to biodiesel, signs and graphics, we've been supplying top quality construction products to the industry for over 50 years.

Fulton Hogan started on roads. In the last 88 years we've gained vast experience across a range of sectors, including roads and transport infrastructure through to utilities and resources.

We're all about keeping it REAL (Respect, Energy & effort, Attitude and Leadership). These are the values at the core of everything we do.

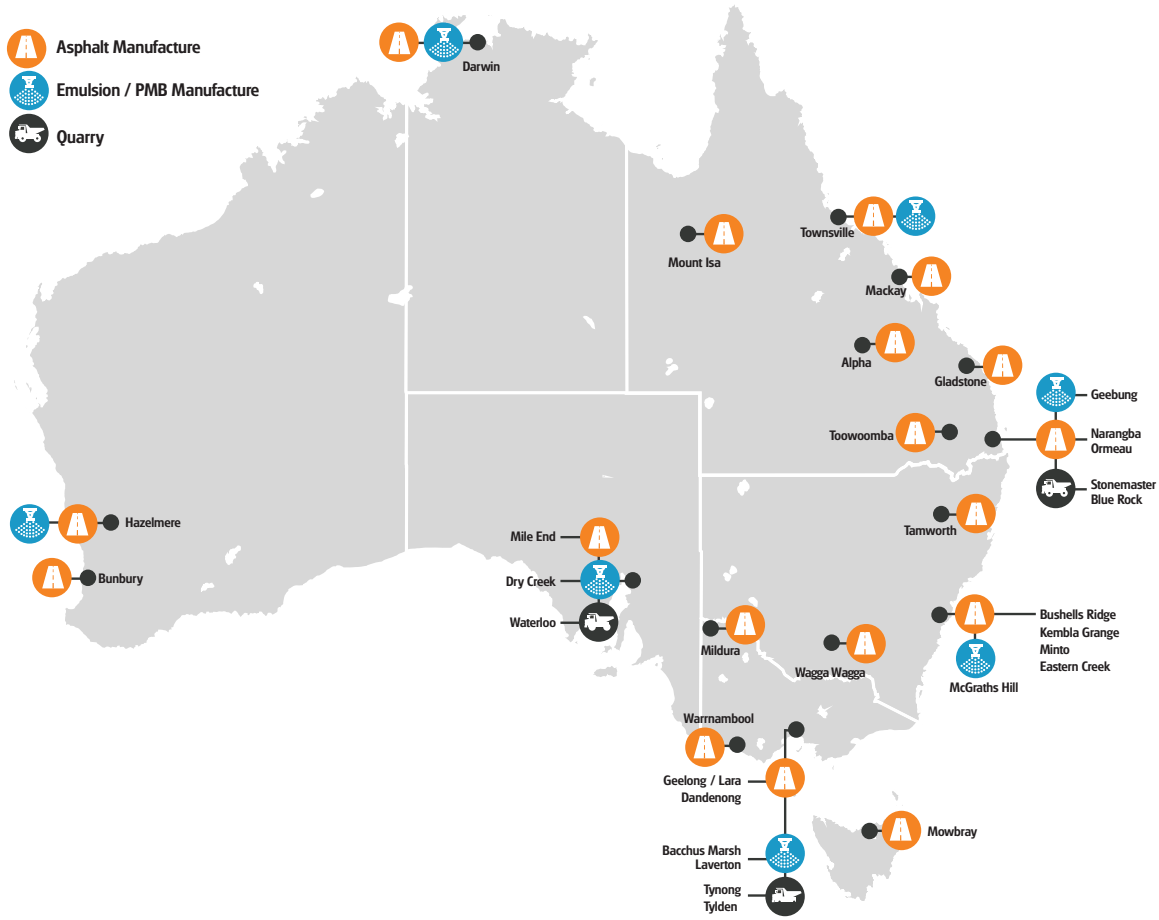
We see sustainability as the only way to do business. That's why we invest in the communities we work in, bridging gaps and creating economic value. It's our way of improving the world we'll live in tomorrow.

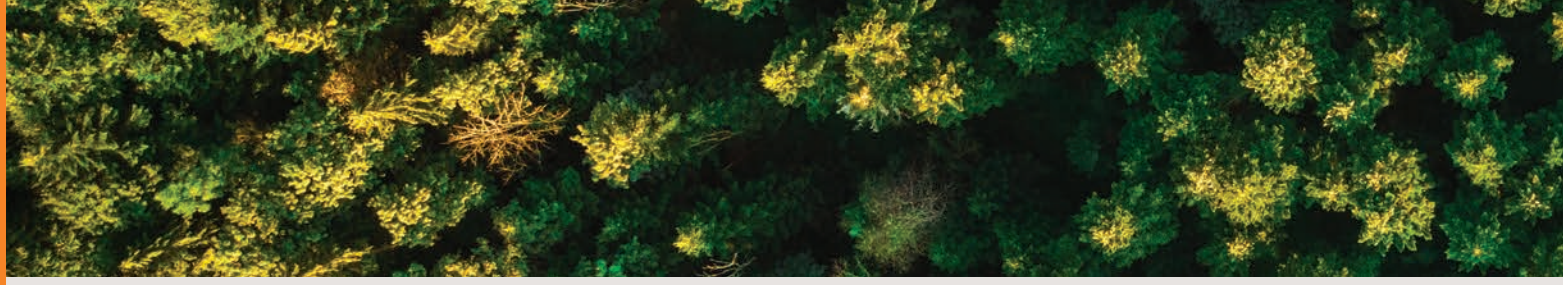
We care for the communities we operate in. Fulton Hogan and our people donate time, money and services to strengthen our communities. Through our partnerships we support wellbeing, diversity, environment, education and innovation.

Our decades of experience, combined with our wealth of plant and resources, give us the technical knowledge and skills to provide a wide range of construction services (including construction, surfacing, asset management, laboratories, transport and traffic management).

Fulton Hogan are industry leaders in the research and development of high-performance asphaltic concrete, emulsions, spray seal, and polymer modified binders. Our technical staff are some of the best in the business, developing innovative road building materials, to ensure better long term performance of our client's pavements. Senior members of our technical team work closely with clients in the civil construction and government sectors, to ensure that the products we develop, are not only relevant to their needs, but meet or exceed their stated technical, performance and environmental requirements. Our extensive experience in the structural design of pavements, has led to the development of a number of proprietary asphalt mix designs for motor racing circuits, airport runways, shipping container stacking yards, horse racing tracks, footpaths and residential roads.

Figure 1 - Fulton Hogan manufacturing and quarrying capabilities





Sustainability at Fulton Hogan

Sustainability in our industry means building and maintaining the critical infrastructure on which our nation depends. We do this in a manner that is cognisant of both the positive and negative impacts we may have on the community and the environment in the short and long term. In carrying out our duties, it is essential that we act with integrity and respect for the environment and communities in which we operate.

As a business our approach to sustainability focuses on the principles of **PEOPLE, PLANET, PROSPERITY** and **PARTNERSHIPS** that are aligned to the United Nation's Sustainable Development Goals. Using this framework, our locally empowered business operations are tasked with delivering positive contributions to the environment with solar installations that power our facilities or power purchase agreements to reduce carbon emissions, as well as the community with traineeships, local sponsorships and partnerships.

Our product portfolio centres on developing and delivering quality, innovative products and services for our clients with the circular economy principles of waste utilisation, reuse, recycling and repurposing. These are front of mind when undertaking research and development which has led us to build an array of sustainable products. These include: high percentage recycled asphalt pavement using slag, glass and plastics, as well as crumb rubber asphalt and spray-seals.

We also commit to leaving a positive social impact for our people and communities by partnering with local business, increasing awareness of mental health, wellbeing and indigenous participation. Fulton Hogan's Infrastructure Services team, along with our clients and partners, are committed to taking tangible steps towards sustainability and making positive contributions to the communities in which we work, live and play now, so that future generations can benefit.

PEOPLE

Our People are at the heart of everything in Fulton Hogan. We understand the importance of hiring, developing and retaining great people who bring our REAL values to life every day. It is through maintaining a culture of safety, performance and growth that our people continue to do good work.

PROSPERITY

No company can succeed in a market where revenue doesn't equate to reasonable profits. Fulton Hogan has been in operation for over 85 years and has always taken the long term view of the business and its shareholders in to account. We re-invest heavily in research and development, plant, equipment and our people as we see this as the only way to remain truly sustainable.

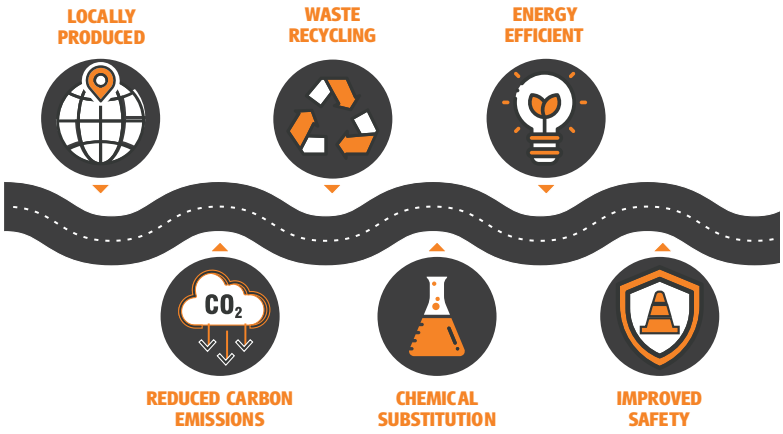
PLANET

Our operations can have an impact on the environment and communities in which we operate, we understand that. We also understand that it doesn't have to be a negative impact, that with intelligent planning and forethought we can contribute positively to the environment in which we operate and leave our world in a better place than when we started.

PARTNERSHIPS

We see and understand that a sustainable business is a stable business and is a key risk management strategy to our ongoing future performance. We cannot maintain our longevity nor succeed in our endeavours without the help and support of others along the way. Our good work philosophy rests with our people, their relationships, our clients and our partners as we strive to achieve shared value in the work that we do.

Figure 2 - Fulton Hogan sustainable product development roadmap



Fulton Hogan is committed to continuing the transition of construction and maintenance in the road sector from a linear to a circular economy by reusing, recycling, creating and circulating. This evolution is well advanced in with Reclaimed Asphalt Pavement (RAP), warm mix, crumb rubber, pavement recycling and glass sand being introduced and used by the sector over the last 30 years.

We understand that our roads are not linear rubbish tips; they are highly complex engineering structures and a key to economic development. Any sustainable product or process used in pavements must maintain the performance of the pavement, have a consistent quality and supply and must be cost competitive to current processes.

Most importantly, the product or process must not affect the sustainability of the world's most recycled product, asphalt.

Fulton Hogan offers the experience and expertise of its pavement engineers supported by our dedicated Research and Development team. The intellectual property they have created over the years has consistently benefited pavement owners.

As a technical leader in its field, Fulton Hogan takes pride in developing innovative solutions that provide environmental, financial and functional benefits to our customers. As our customers are seeking evermore sustainable cost effective and functional solutions, Fulton Hogan is continually looking at new products and processes to increase sustainability.

Over the past 30 years, Fulton Hogan has used a high content of recycled pavements in their products, led the introduction of glass sand and wet blend crumb rubber asphalt, and has undertaken production and placement trials of asphalts produced with waste polymers, such as milk bottles, oil containers, plastic bags and drink bottles.

Our in-house design support benefits our clients by optimising both pavement, structural and material design ensuring material solutions meet both operational and sustainability goals.

Many consider Fulton Hogan's greatest strength to be our ability to work in a collaborative manner with our customers and communities. We focus on creating long-term trust-based partnerships that develop innovative sustainable solutions that can work in with operational considerations that often exceed the environmental, quality and performance expectations.

Fulton Hogan offers a number of sustainable solutions for our customers, which can both improve performance and reduce cost, helping our customer's transition to the circular economy. At Fulton Hogan, we can work with our customers to optimise sustainable solutions based on available materials, economic and functional needs.


JLG LIFT

Our Approach to this EPD

Fulton Hogan put people at the heart of everything. Development of this EPD has been a careful and considered process with the customer and community in mind. The EPD covers a comprehensive range of our asphalt products in key locations to provide our customers with the information they need without limiting choice. Taking a holistic approach to this the process has also provided Fulton Hogan with verified data on our products that will enable us to better understand our impacts on the environment and most importantly take effective action to reduce these impacts.

Fulton Hogan's Asphalt Products

Asphalt is one of the most used, reused and recycled pavement materials. This versatile material is used in several applications including to build roads, highways, airport runways, paths, parking lots and other projects where a smooth flat surface is required. Asphalt is a mix mainly composed of aggregates (crushed rock and sand) and bitumen (the black viscous sticky material) but sometimes special additives are also included to meet specific requirements.

Hot-mix asphalt is manufactured in a purpose-built plant where controlled amounts of aggregates of various size, previously blended and graded to meet a required specification, are dried and heated before being mixed with a measured quantity of hot bitumen in either a drum (large-output/continuous mixing plant) or in a pugmill (smaller-output/batch plant). Heat is used to remove moisture from the aggregate and to obtain sufficient fluidity of the bitumen to enhance mixing and workability.

Once the mixing is complete, the asphalt mix is then transported to the construction site and spread in a partially compacted layer to an even and uniform surface with a paving machine. While still hot, the paving mixture is further compacted by heavy rolling machines to produce a smooth pavement surface.

As part of Fulton Hogan's commitment towards a circular economy in the road construction sector, sustainable materials and practices are implemented during the asphalt manufacturing and laying process.

Fulton Hogan asphalt products incorporate a variety of sustainable materials including Reclaimed Asphalt Pavement (RAP), recycled glass, crumb rubber, and recycled plastics. RAP is a material generated from old, damaged pavement materials containing aggregates and bitumen; it is incorporated in asphalt mixes reducing the need to use virgin materials. Similarly, recycled materials and industry by-products such as recycled glass and slag aggregate (by-product of the steel making process) are used as replacement of natural quarry materials. Other recovered materials such as crumb rubber (from end-of-life tyres) and recycled plastics can be used as bitumen modifiers. These are blended through a wet process, achieving a high-quality binder with improved performance.

Sustainable practices such as the use of warm-mix asphalt and foam bitumen stabilisation are also implemented by Fulton Hogan. Warm-mix asphalt is produced at a reduced temperature allowing a significant reduction of emissions and energy used for production while maintaining the asphalt performance.

GripPhalt® is one of our proprietary sustainable products and is declared in this EPD.

GripPhalt®

GripPhalt® is ideal for any pavement surface where improvements in skid resistance will improve safety, including high braking and problem traffic areas. GripPhalt® utilises a high percentage of steel slag, which is a co-product of the steelmaking process. The artificial aggregate made from slag, is used as a direct replacement of the coarse aggregate component of the asphalt mix.

When combined with the addition of Recycled Asphalt Product (RAP), the total recycled content of the mix can be 60% – 80% for dense graded asphalts, and 80% – 90% for stone mastic and open grade asphalt mixes. GripPhalt® mixes can also be manufactured using 'warm asphalt technology' to reduce the amount of CO2 emissions produced in the manufacturing process.

With 15% – 20% improvement in skid resistance over standard asphalt mixes, GripPhalt® is a safer alternative for high braking and high surface stress traffic areas. More importantly, the product's skid resistance does not diminish over time like most natural aggregates do.

Benefits:

- Superior Skid Resistance (shorter braking distances)
- Texture does not diminish over time
- Minimise sheer failures and surface rutting
- Improved workability and quality finish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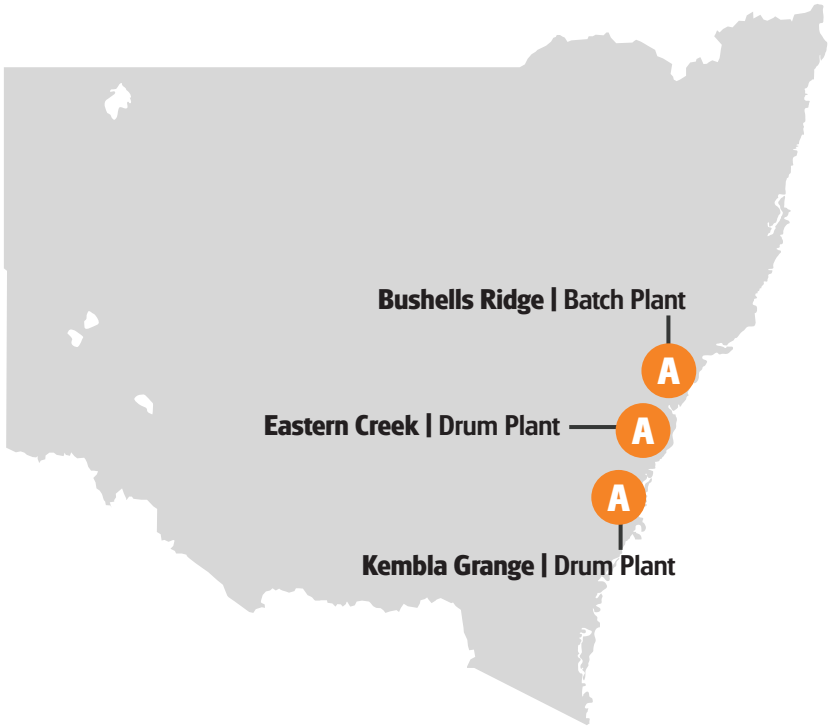
Declared Asphalt Products

This EPD covers key asphalt products manufactured at our three largest NSW asphalt facilities at Bushells Ridge on the Central Coast, Eastern Creek in Sydney, and Kembla Grange near Wollongong, as seen in Figure 3

Figure 3 - Location of Fulton Hogan's asphalt production facilities as included in the EPD



Product Composition

The product composition across the products included in this EPD is shown in Table 1.

A list of all the products that are covered by the EPD at each location is presented in Table 2.

Table 1: Product composition

Raw material	Asphalt mix composition (Weight %)
Bitumen, virgin	3 - 7
Bitumen modifiers (SBS, EVA)	0 - 2
Reclaimed Asphalt Pavement (RAP)**	0 - 30
Recovered Glass Sand*	0 - 10
Crumb Rubber*	0 - 2
Steel Furnace Slag aggregates (coarse and fine)	0 - 40
Fine aggregates (natural / manufactured sand)	5 - 30
Coarse aggregates (crushed rock)	30 - 90
Mineral fillers	0 - 9.5
Anti-strip agents	0 - 2
Fibre	0 - 0.5

* post-consumer recycled material; ** 95% post-consumer recycled material & 5% production waste

The products included in this EPD do not contain any substances of very high concern as defined by European REACH regulation in concentrations >0.1% (m/m).

Table 2: List of asphalt products declared in this EPD

Specification / Standard	Bushells Ridge	Eastern Creek	Kembla Grange
AS2150/Aus-Spec/R117	CM10 AR450 AS2150 DG07 AR450 AS2150 DG10 AR450 FINE AUSPEC DG10 AR450 AS2150 R10% DG14 AR450 AS2150 R15% DG20 AR450 AS2150 R20% GG10 AR450 AS2150 R10%	DG07 AR450 AS2150 DG10 AR450 AS2150 R20% DG10 AR450 AS2150 R20% G2.5% DG10 AR450 AUSPEC R20% DG10 AR450 R117 R20% DG10 AR450 R117 R20% G2.5% DG14 A15E AS2150 R15% DG14 AR450 AS2150 R25% DG14 AR450 AS2150 R25% G2.5% DG14 AR450 AS2150 R25% G10% DG14 AR450 AUSPEC R25% DG14 AR450 R117 R25% DG20 AR450 AS2150 R25% DG20 AR450 AS2150 R25% G10% DG28 AR450 AS2150 R25% G10% GG10 AR450 AS2150 R10%	DG07 AR450 AS2150 DG10 AR450 AS2150 R15% DG10 AR450 AS2150 R30% G2.5% DG10 AR450 AS2150 R30% SLAG DUST DG10 AR450 FINE AUSPEC R10% DG14 AR450 AS2150 R20% DG20 AR450 AS2150 R30% DG28 AR450 AS2150 R25% GG10 AR450 AS2510 R10%
R116	DG07 AR450 R116 DG10 A15E R116 DG10 AR450 R116 R10% DG14 A15E R116 R10% DG14 A15E R116 SLAG (GripPhalt®) DG14 AR450 R116 G2.5% DG14 AR450 R116 R15% DG14 AR450 R116 SLAG (GripPhalt®) DG20 AR450 R116 R20% DG28 AR450 R116 R15%	DG10 A15E R116 R10% DG10 AR450 R116 R15% DG10 AR450 R116 R15% G2.5% DG14 A15E R116 R10% DG14 A15E R116 R10% G2.5% DG14 A15E R116 SLAG (GripPhalt®) DG14 AR450 R116 R20% DG14 AR450 R116 R20% G2.5% DG20 AR450 R116 R25% DG20 AR450 R116 R25% G10% DG28 AR450 R116 R30% DG28 AR450 R116 R30% G10%	DG10 AR450 R116 R15% DG14 A15E R116 R10% DG14 A15E R116 SLAG (GripPhalt®) DG14 AR450 R116 R15% DG14 AR450 R116 R15% G2.5% DG14 AR450 R116 R15% G10% DG14 AR450 R116 SLAG (GripPhalt®) DG20 AR450 R116 R20% DG20 AR450 R116 R20% G10% DG28 AR450 R116 R25%
R116	DG14 AR450 R118 CR		DG14 AR450 R118 CR
R119	OG10 A15E R119	OG10 A15E R119	OG10 A15E R119 OG10 A15E SLAG R119 (GripPhalt®)
R121		SMA10 A15E R121	SMA10 A15E R121 EVO
RPB125			THTAS10
R126	EME2	EME2	EME2
Proprietary and Other	BC14 A10E AIRPORT DG14 PORTPHALT DR DG20 PORTPHALT DR	SMA07 A15E BC14 A10E AIRPORT DG14 PORTPHALT DG20 PORTPHALT	

R %: Reclaimed Asphalt Pavement content
G %: Recovered Glass Sand content

Technical Compliance

Fulton Hogan asphalt mixes are designed in accordance with the following Australian standards and state road authority-based specifications:

- AS 2150 Asphalt - A guide to good practice
- Aus-Spec 1144 Asphalt (Roadways)
- Transport for NSW (TfNSW) QA Specification R116 Heavy Duty Dense Graded Asphalt
- Transport for NSW (TfNSW) QA Specification R117 Light Duty Dense Graded Asphalt
- Transport for NSW (TfNSW) QA Specification R118 Crumb Rubber Asphalt
- Transport for NSW (TfNSW) QA Specification R119 Open Graded Asphalt
- Transport for NSW (TfNSW) QA Specification R121 Stone Mastic Asphalt
- Transport for NSW (TfNSW) QA Specification R126 High Modulus Asphalt (EME2)
- Transport for NSW (TfNSW) QA Specification RPB125 Thin High Textured Asphalt Surfacing (Draft)

Product Identification

The product code for asphalt is UN CPC 1533 (Bitumen and asphalt, natural; asphaltites and asphaltic rock) & 3794 (Bituminous mixtures based on natural and artificial stone materials and bitumen, natural asphalt or related substances as a binder) and ANZSIC Class 1709 (Other Petroleum and Coal Product Manufacturing).

Scope of Environmental Product Declaration

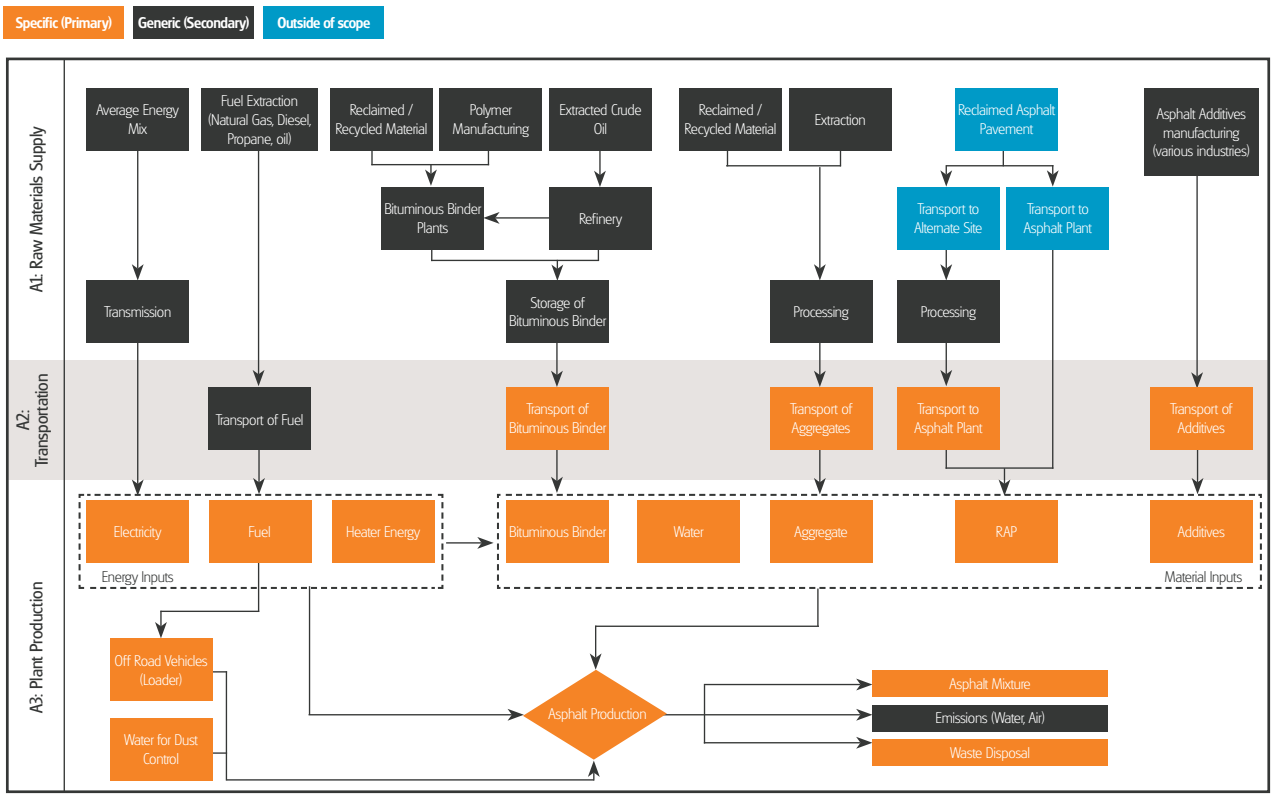
This EPD covers the cradle-to-gate life cycle stages A1-A3. Downstream stages have not been included.

Table 3: Scope of EPD

Product Stage			Construction Stage		Use Stage							End-of-life Stage				Benefits beyond system boundary
Raw Materials	Transport	Production	Transport	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/Demolition	Transport	Waste Processing	Disposal	Reuse, recovery, recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
			Scenario		Scenario							Scenario				
✓	✓	✓	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

✓= module is included in this study
MND = module is not declared

Figure 4: Cradle-to-gate life cycle of asphalt products (AEPDP 2019)



Cradle-to-gate Life Cycle Stages

Raw Material Stage A1

Typically, asphalt is manufactured by blending a selection of the materials shown in Table 1 in proportions determined during the design process.

Bitumen

Bitumen acts as the binder or glue that holds the other materials together. It is a product of the crude oil refining process, which typically takes place overseas before being imported to Australia. Bitumen needs to be stored at temperatures around 165°C in order to make it possible to use in asphalt. Bitumen is available in different classes or grades and typically needs to conform to Transport for NSW (TfNSW) QA Specification 3253 Bitumen for Pavements or 3252 Polymer Modified Binder for Pavements, AS2008 Bitumen for Pavements or ATS3110 Supply of Polymer Modified Binders.

Bitumen Modifiers

Bitumen may be modified by blending it with a synthetic polymer creating what is commonly known as a Polymer Modified Binder or PMB. The polymer is typically either a Styrene-Butadiene-Styrene (SBS) which provides improved resilience and makes the binder less susceptible to temperature or an Ethylene-Vinyl Acetate (EVA) to provide increased stiffness. Synthetic polymers are typically manufactured overseas in countries such as Germany and South Korea prior to being imported to Australia. PMBs are blended at Fulton Hogan's facility in McGraths Hill in Sydney before being transported to the asphalt plant.

Coarse and Fine Aggregates (including sand)

Coarse and fine aggregates generally make up the bulk of the asphalt mixture and provide the finished asphalt pavement with structure and strength. Aggregates are natural materials extracted from quarries before going through processes such as crushing, screening and washing for use in asphalt. The source for asphalt aggregates is typically as close to the asphalt plant as possible provided the finished aggregate product complies with Transport for NSW (TfNSW) QA Specification 3152 Aggregates for Asphalt Specifications or AS2758.5 Aggregates and Rock for Engineering Purposes, Part 5 Coarse Asphalt Aggregates.

Recycled Materials

Fulton Hogan is embracing and accelerating the circularity of materials for incorporating into asphalt without compromising on quality.

Reclaimed Asphalt Pavement (RAP) consists of existing asphalt pavements that have been removed by milling (profiling) before being processed according to strict internal management standards. Incorporating RAP in asphalt replaces a proportion of the aggregates as well as allowing for a reduction in bitumen content.

Recovered Glass Sand is generated by the crushing and washing of used glass containers to a consistency that is similar to that of natural sand. The number of facilities that are able to produce glass sand that complies with QA Specification 3154 Granulated Glass Aggregate and current EPA Resource Recovery Orders is increasing within NSW and providing local access to this material. Recovered Glass Sand is used to replace a proportion of natural sand.

Crumb Rubber is generated from shredding and grinding end-of life tyres at dedicated recycling facilities located across Australia. The crumb rubber used in asphalt is produced to a specified mesh size compliant with QA Specification 3256 Crumb Rubber. Adding crumb rubber improves fatigue performance and asphalt containing this product is produced under QA Specification R118 Crumb Rubber Asphalt.

Steel Furnace Slag aggregates are a co-product of the steel manufacturing process and can be used as a substitute for coarse and fine aggregates in asphalt. Slag is used under conditions of the EPA NSW Resource Recovery Order and Exemption and is required to meet the same QA Specification 3152 Aggregates for Asphalt.

Mineral fillers

Mineral fillers used in asphalt include hydrated lime, flyash and agricultural lime. Filler performs various roles in asphalt from stiffening the bitumen to providing enhanced adhesion properties. The properties of fillers are required to meet TfNSW QA Specification 3211 Cements, binders and fillers.

Additives

Common additives used in asphalt include warm mix additives, adhesion agents, oxides and cellulose fibres. Additives enhance asphalt's structural and/or functional properties such as workability, stiffness, colour, binder retention and adhesion.

Transportation Stage A2

Delivery of raw materials to Fulton Hogan asphalt plants is via road transport in varying truck and trailer combinations including semi-trailers, and tankers in the case of hydrated lime and bitumen. Whilst all efforts are made to source raw materials close to the asphalt plant to minimise transportation impacts, not all materials are locally available. Materials such as bitumen, polymer modifiers and other additives need to be imported and include additional shipping and road transportation prior to delivery to site. The impact of each mode of transportation is determined taking into account the specific supply source for each plant and its location.

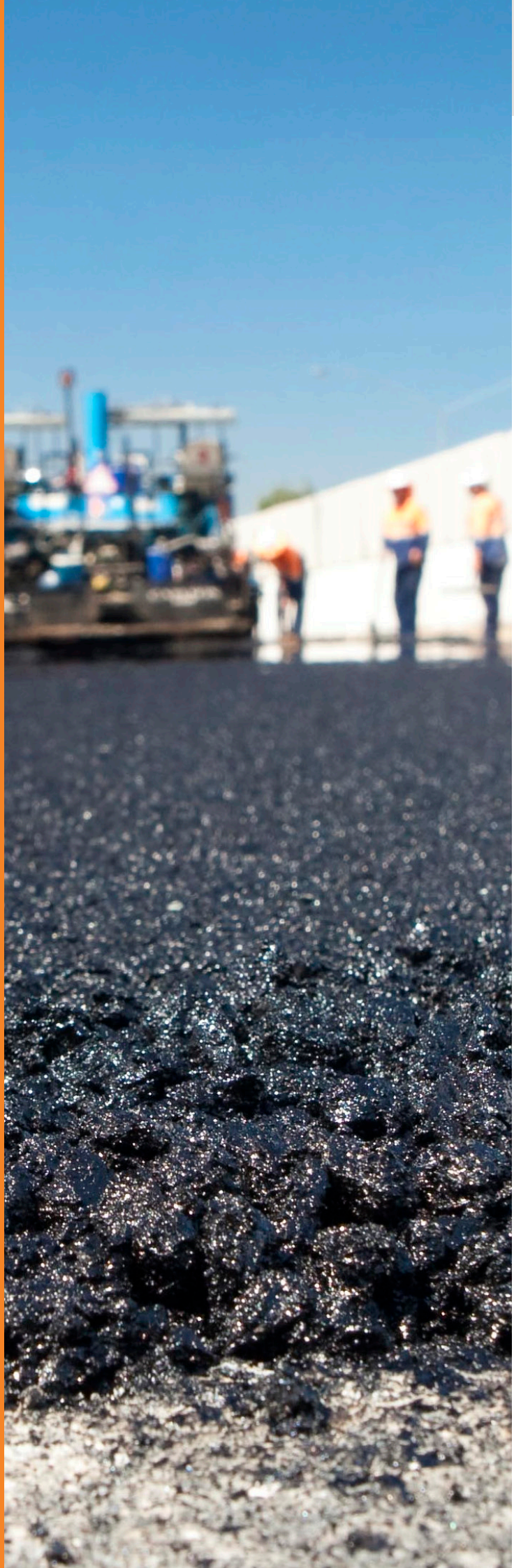
Manufacturing Stage A3

The asphalt manufacturing process as described in the section "Fulton Hogan's Asphalt Products" (p. 9) requires energy inputs in the form of electricity and fuels.

Electricity is typically from the grid and provides mechanical, light and heat energy required to operate the asphalt plant and store raw materials.

Fuels are used to heat and dry the sand and aggregates and are typically diesel, natural gas or Liquefied Petroleum Gas (LPG). Fuel is also required for mobile plant on site, such as front-end loaders used to feed aggregates into the asphalt plant.

This manufacturing stage covers the blending of materials at the asphalt plant and does not capture delivery or placement of asphalt in the construction stage.



Life Cycle Assessment (LCA) Methodology

Background Data

Fulton Hogan has collected and supplied the primary data for the LCA. In NSW, the primary data covers the operation of the three asphalt production sites. Background data (e.g. for energy and transport processes, bitumen and other raw materials) have predominantly been sourced from AusLCI and the AusLCI shadow database (v1.36), in line with the Australian PCR Appendix for asphalt mixtures (AEPDP 2019).

The prescribed Life Cycle Inventory (LCI) data for bitumen and rubber crumb have a significant effect on the results of the LCA. When comparing asphalt EPDs, it is therefore important to understand which background LCI data are used.

The asphalt production data has been collected for FY20 (1 July 2019 – 30 June 2020). Environmental profiles of our products are based on life cycle data that are less than five years old. Background data used are less than 10 years old or have been reviewed within this period.

Methodological choices has been applied in line with PCR 2018:04 Asphalt Mixtures (Environdec 2019) and the Australian Appendix to the Product Category Rules for Asphalt (AEPDP 2019), which also aligns with EN 15804; deviations have been recorded.

The AusLCI electricity data for NSW have been used, which have a greenhouse gas intensity of 0.88 kg CO_2e/kWh.

Allocation

The key processes that require allocation are:

- **Asphalt production:** Fulton Hogan manufactures a range of asphalt products at its sites. Products can be produced at different temperatures (e.g. hot mix, warm mix or cold mix) and the composition of the asphalt mix also affects the amount of energy required to drive off moisture and heat up the raw materials to the required temperature. To determine the energy requirements for each mix design, start2see has applied Method A (AEPDP 2019; section 2.5): Determine the energy use for each mix design based on the composition, specific heat capacity of components, moisture content of raw materials and the plant's overall efficiency.
- **RAP:** Reclaimed Asphalt Pavement (RAP) reaches the end-of-waste state when the reclaimed, milled material has been collected in a truck and transported to a storage pile, ready to be processed for further use. Fulton Hogan typically receives and processes RAP at its asphalt plants. Any energy use for RAP processing is covered by the energy data for the asphalt plant. The main asphalt PCR (Environdec 2019) and ISO 14021 state that recycled content of products should only cover recycled materials from pre-consumer (post-industrial) and post-consumer scraps, but not recycled material made from internal scrap. Fulton Hogan has indicated that around 5% of RAP used in NSW originates from production waste. Therefore, each 1.0 kg of RAP used in Fulton Hogan's asphalt amounts to 0.95 kg of Secondary Material (parameter: SM).
- **Aggregates:** aggregates are produced through crushing of rock, which is graded in different sizes. The energy required for the crushing and screening does not differentiate between products. Therefore, aggregate production (including manufactured sand) has been allocated based on the mass of product.
- **Slag aggregates:** Steel furnace slag is a co-product from steel production. Economic allocation is used to attribute a portion of the steel furnace process to the slag as per AusLCI data.
- **Crumb rubber:** End-of-life tyres reach the end-of-waste state after they have been collected and shredded into tyre-derived-fuel (TDF). Further processing of this rubber can involve grinding the material into crumb rubber, a fine powder. The energy required for the grinding process is attributed to the crumb rubber.

Cut-off Criteria

The cut-off criteria applied are 1% of renewable and non-renewable primary energy usage and 1% of the total mass input of a process

- The contribution of capital goods (production equipment and infrastructure) and personnel is outside the scope of the LCA, in line with the PCR (Environdec 2019).
- Crumb rubber (reusable bulk-bags) and additives used in minor quantities are supplied in packaged format. As the packaging used for these products is well below the materiality cut-off and is often recyclable or reusable, the packaging materials have been omitted from the analysis. The impact on the footprint of asphalt products is negligible.
- Greases, lubricants and other minor ancillary materials used during asphalt production have been excluded. The impact on the footprint of asphalt products is negligible.

Key Assumptions

The key assumptions in the LCA are:

- **Asphalt composition:** The asphalt composition of each product is taken from Fulton Hogan's systems. These data are considered to be of high accuracy.
- **Site energy data:** When calculating the environmental performance of individual asphalt products, the burner energy used for heating raw materials to the asphalt's production temperature is calculated for each individual product. The PCR Appendix (AEPDP 2019) refers to this as Method A.
- **Other site-related impacts** (site electricity use, fuel use for equipment and water use) have been attributed to asphalt products based on their respective production volumes (in tonnes). This approach assumes that the impacts are similar per tonne of asphalt product. Mass allocation is considered the most reasonable approach to attributing generic site environmental impacts across different products.
- **Biodiesel:** We use biodiesel in our cold mix asphalt (CMA) product manufactured in Bushells Ridge. The LCA model uses canola oil as a proxy for biodiesel, in line with AEPDP 2019 requirements for vegetable-based oil. The choice for type of oil can have a significant impact on the environmental profile of the CMA.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Life Cycle Assessment (LCA) Results

The background LCA serves as the foundation for this EPD. An LCA analyses the environmental processes in the value chain of a product. It provides a comprehensive evaluation of all upstream (and sometimes downstream) material and energy inputs and outputs. The results are provided for a range of environmental impact categories, in line with EN 15804.

Declared Unit

The declared unit applied to all of the products is:

1 metric tonne (t) of manufactured asphalt mixture (as ordered by client) with identifying characteristics.

This declared unit has been selected in line with the Australian PCR Appendix (AEPDP 2019).

Explanation of Averages

Some products with minor variations in mix designs have been grouped for presentation in this EPD. No products have been grouped across plants.

Where a characteristic product (a typical or business as usual product) could be selected, that product has been used as the representative product for its group (see table below). Where no clear characteristic product could be nominated, an unweighted average across the products is used as the representative product.

Table 4: Overview of characteristic products for groups

Group name	Characteristic product representing the group
Eastern Creek	
DG10 AR450 AS2150/AUSPEC/R117 R20% G≤2.5%	DG10 AR450 AS2150 R20% G2.5%
DG14, DG20 and DG28 AR450 AS2150/AUSPEC/R117 R25% G≤10%	DG20 AR450 AS2150 R25% G10%
DG10 AR450 R116 R15% G≤2.5%	DG10 AR450 R116 R15% G2.5%
DG14 A15E R116 R10% G≤2.5%	DG14 A15E R116 R10% G2.5%
DG14 AR450 R116 R20% G≤2.5%	DG14 AR450 R116 R20% G2.5%
DG20 AR450 R116 R25% G≤10%	DG20 AR450 R116 R25% G10%
DG28 AR450 R116 R30% G≤10%	DG28 AR450 R116 R30% G10%
Kembla Grange	
DG14 AR450 R116 R15% G≤10%	DG14 AR450 R116 R15% G2.5%
DG20 AR450 R116 R20% G≤10%	DG20 AR450 R116 R20% G10%

In the table headers in the result section (Environmental Profiles), the products presented as a group are marked with an asterisk. For example, Table 16 shows the results for "DG14 AR450 R116 R15% G≤10%*". Table 2 shows which individual products in Kembla Grange meet these criteria ("DG14 AR450 R116 R15%", "DG14 AR450 R116 R15% G2.5%" and "DG14 AR450 R116 R15% G10%"). Table 4 indicates that we used a characteristic product (DG14 AR450 R116 R15% G2.5%) to represent this group.

The environmental profiles of the products that are grouped together have been checked to ensure they stay within ±10% of the representative product.

Environmental Indicators

The environmental indicators presented in this EPD are in line with EN 15804:2012+A1:2013.

Table 5: Environmental indicators

Environmental Indicator	Acronym	Unit	Description
Global Warming Potential	GWP	kg CO_2 eq	Global warming impact of greenhouse gases such as carbon dioxide (CO_2), measured in kg CO_2 equivalents using a global warming potential over a 100-year time horizon. As per PCR 2018:04, a breakdown into fossil, biogenic, and land use and land use change GWP results is provided.
Ozone Depletion Potential	ODP	kg CFC-11 eq	Relative impact that the product can cause to the stratospheric ozone layer, measured in kg trichlorofluoromethane (CFC-11) equivalents.
Acidification Potential	AP	kg SO_2 eq	Increase of soil and water acidity that the product can cause, measured in kg sulphur dioxide (SO_2) equivalents.
Eutrophication Potential	EP	kg PO_4^{3-} eq	Potential impact of nutrification by nitrogen and phosphorus to aquatic and terrestrial ecosystems, for example through algal blooms, measured in kg phosphate (PO_4^{3-}) equivalents.
Photochemical Ozone Creation Potential	POCP	kg C_2H_4 eq	Also known as summer smog, the potential impact from oxidising of volatile compounds in the presence of nitrogen oxides (NOx) which frees ozone in the low atmosphere, measured in kg ethene (C_2H_4) equivalents.
Abiotic Depletion Potential (elements)	ADPE	kg Sb eq	Economic impact from the depletion of scarce non-renewable resources such as metals, measured in kg antimony equivalents.
Abiotic Depletion Potential (Fossil Fuels)	ADPF	MJ	Economic impact from depletion of fossil fuel resources such as oil or natural gas, expressed using their net calorific value.

Table 6: Parameters describing resource use, waste and output flows

Parameter	Acronym	Unit
Parameters describing resource use		
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	PERE	MJ_{NCV}
Use of renewable primary energy resources used as raw materials	PERM	MJ_{NCV}
Total use of renewable primary energy resources	PERT	MJ_{NCV}
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	MJ_{NCV}
Use of non-renewable primary energy resources used as raw materials	PENRM	MJ_{NCV}
Total use of non-renewable primary energy resources	PENRT	MJ_{NCV}
Use of secondary material	SM	kg
Use of renewable secondary fuels	RSF	MJ_{NCV}
Use of non-renewable secondary fuels	NRSF	MJ_{NCV}
Use of net fresh water	FW	m^3
Waste categories		
Hazardous waste disposed	HWD	kg
Non-hazardous waste disposed	NHWD	kg
Radioactive waste disposed	RWD	kg
Output flows		
Components for re-use	CRU	kg
Materials for recycling	MFR	kg
Materials for energy recovery	MER	kg
Exported energy	EE	MJ

Environmental Profiles for Asphalt Products at Bushells Ridge

The cradle-to-gate (module A1-A3) environmental profiles and environmental parameters of each product (group) are expressed per tonne of asphalt (volume as ordered by the client).

Table 7: Environmental profiles and parameters of asphalt products manufactured at Bushells Ridge, stages A1-A3, per tonne

	Product	CM10 AR450 AS2150	DG07 AR450 AS2150	DG10 AR450 FINE AUSPEC	DG10 AR450 AS2150 R10%	DG14 AR450 AS2150 R15%	DG20 AR450 AS2150 R20%	GG10 AR450 AS2150 R10%
	Standard	AS2150/AusSpec/R117						
Indicator	Unit							
Global warming (total)	kg CO_2 eq	9.03	71.9	71.7	69.0	65.6	63.3	82.2
GWP-fossil	kg CO_2 eq	61.0	71.9	71.7	69.0	65.6	63.3	82.1
GWP-biogenic	kg CO_2 eq	-52.0	0.0378	0.0370	0.0341	0.0308	0.0287	0.0359
GWP-land use	kg CO_2 eq	3.48E-03	1.25E-04	1.21E-04	1.14E-04	9.76E-05	8.77E-05	1.23E-04
Ozone layer depletion	kg CFC11 eq	2.48E-05	3.27E-05	3.15E-05	2.97E-05	2.54E-05	2.29E-05	3.22E-05
Acidification, soil and water	kg SO_2 eq	0.592	0.444	0.432	0.411	0.364	0.335	0.443
Eutrophication	kg PO_4^{3-}eq	0.242	0.0225	0.0222	0.0210	0.0194	0.0184	0.0234
Photochemical ozone creation	kg C_2H_4 eq	0.0734	0.0645	0.0626	0.0595	0.0525	0.0482	0.0665
Abiotic depletion - elements	kg Sb eq	8.46E-05	1.38E-06	1.36E-06	1.23E-06	1.15E-06	1.10E-06	1.19E-06
Abiotic depletion - fossil	MJ_{NCV}	2620	3580	3450	3250	2790	2510	3500
Parameter	Unit							
PERE	MJ_{NCV}	1.14E+01	9.91E+00	9.69E+00	8.91E+00	8.10E+00	7.58E+00	1.17E+01
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	1.14E+01	9.91E+00	9.69E+00	8.91E+00	8.10E+00	7.58E+00	1.17E+01
PENRE	MJ_{NCV}	6.14E+02	7.52E+02	7.58E+02	7.33E+02	7.16E+02	7.03E+02	8.11E+02
PENRM	MJ_{NCV}	2.22E+03	3.13E+03	2.99E+03	2.80E+03	2.31E+03	2.03E+03	2.99E+03
PENRT	MJ_{NCV}	2.83E+03	3.89E+03	3.75E+03	3.53E+03	3.03E+03	2.73E+03	3.80E+03
SM	kg	0.00E+00	0.00E+00	0.00E+00	9.50E+01	1.43E+02	1.90E+02	9.50E+01
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.80E+00	1.82E+00	1.81E+00	1.65E+00	1.52E+00	1.42E+00	1.66E+00
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	8.01E-02	7.37E-02	7.21E-02	6.62E-02	6.02E-02	5.63E-02	6.97E-02
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 8: Environmental profiles and parameters of asphalt products manufactured at Bushells Ridge, stages A1-A3, per tonne

	Product	DG07 AR450 R116	DG10 A15E R116	DG10 AR450 R116 R10%	DG14 A15E R116 R10%	DG14 A15E R116 SLAG
	Standard	R116				
Indicator	Unit					
Global warming (total)	kg CO_2 eq	87.7	103	79.3	95.1	95.0
GWP-fossil	kg CO_2 eq	87.6	103	79.2	95.0	94.9
GWP-biogenic	kg CO_2 eq	0.0400	0.112	0.0347	0.0898	0.0844
GWP-land use	kg CO_2 eq	1.28E-04	2.19E-04	1.09E-04	1.80E-04	1.81E-04
Ozone layer depletion	kg CFC11 eq	3.38E-05	2.92E-05	2.88E-05	2.62E-05	2.64E-05
Acidification, soil and water	kg SO_2 eq	0.461	0.511	0.404	0.452	0.454
Eutrophication	kg PO_4^{3-}eq	0.0249	0.0292	0.0222	0.0263	0.0269
Photochemical ozone creation	kg C_2H_4 eq	0.0700	0.0786	0.0607	0.0692	0.0696
Abiotic depletion - elements	kg Sb eq	1.37E-06	1.90E-06	1.22E-06	1.64E-06	1.32E-06
Abiotic depletion - fossil	MJ_{NCV}	3670	3620	3130	3180	3180
Parameter	Unit					
PERE	MJ_{NCV}	1.36E+01	1.46E+01	1.14E+01	1.31E+01	1.16E+01
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	1.36E+01	1.46E+01	1.14E+01	1.31E+01	1.16E+01
PENRE	MJ_{NCV}	8.45E+02	1.31E+03	7.95E+02	1.17E+03	1.18E+03
PENRM	MJ_{NCV}	3.13E+03	2.60E+03	2.60E+03	2.27E+03	2.27E+03
PENRT	MJ_{NCV}	3.98E+03	3.92E+03	3.40E+03	3.44E+03	3.45E+03
SM	kg	0.00E+00	0.00E+00	9.50E+01	9.50E+01	0.00E+00
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.81E+00	2.88E+00	1.62E+00	2.42E+00	2.08E+00
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	7.84E-02	7.43E-02	6.80E-02	6.73E-02	5.58E-02
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 9: Environmental profiles and parameters of asphalt products manufactured at Bushells Ridge, stages A1-A3, per tonne

	Product	DG14 AR450 R116 G2.5%	DG14 AR450 R116 R15%	DG14 AR450 R116 SLAG	DG20 AR450 R116 R20%	DG28 AR450 R116 R15%
	Standard	R116				
Indicator	Unit					
Global warming (total)	kg CO_2 eq	80.4	77.7	77.9	74.8	72.7
GWP-fossil	kg CO_2 eq	80.1	77.7	77.9	74.8	72.7
GWP-biogenic	kg CO_2 eq	0.258	0.0329	0.0286	0.0301	0.0296
GWP-land use	kg CO_2 eq	1.10E-04	1.03E-04	1.04E-04	8.96E-05	7.81E-05
Ozone layer depletion	kg CFC11 eq	2.88E-05	2.71E-05	2.73E-05	2.37E-05	2.06E-05
Acidification, soil and water	kg SO_2 eq	0.406	0.385	0.387	0.347	0.314
Eutrophication	kg PO_4^{3-}eq	0.0229	0.0215	0.0223	0.0201	0.0191
Photochemical ozone creation	kg C_2H_4 eq	0.0614	0.0579	0.0583	0.0522	0.0472
Abiotic depletion - elements	kg Sb eq	1.31E-06	1.16E-06	8.94E-07	1.08E-06	1.13E-06
Abiotic depletion - fossil	MJ_{NCV}	3140	2950	2960	2580	2260
Parameter	Unit					
PERE	MJ_{NCV}	1.20E+01	1.10E+01	1.03E+01	1.03E+01	1.02E+01
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	1.20E+01	1.10E+01	1.03E+01	1.03E+01	1.02E+01
PENRE	MJ_{NCV}	8.07E+02	7.86E+02	7.69E+02	7.69E+02	7.61E+02
PENRM	MJ_{NCV}	2.60E+03	2.41E+03	2.03E+03	2.03E+03	1.69E+03
PENRT	MJ_{NCV}	3.41E+03	3.20E+03	2.79E+03	2.79E+03	2.45E+03
SM	kg	2.50E+01	1.43E+02	1.90E+02	1.90E+02	1.43E+02
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.73E+00	1.53E+00	1.41E+00	1.41E+00	1.44E+00
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	7.21E-02	6.46E-02	5.94E-02	5.94E-02	5.90E-02
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 10: Environmental profiles and parameters of asphalt products manufactured at Bushells Ridge, stages A1-A3, per tonne

	Product	DG14 AR450 R118 CR	OG10 A15E R119	EME2	BC14 A10E AIRPORT	PortPhalt®*
	Standard	R118	R119	R126	Other	Other
Indicator	Unit					
Global warming (total)	kg CO_2 eq	97.3	92.1	78.6	99.2	82.2
GWP-fossil	kg CO_2 eq	97.2	92.0	78.6	99.1	82.2
GWP-biogenic	kg CO_2 eq	0.0627	0.0912	0.0384	0.112	0.0254
GWP-land use	kg CO_2 eq	1.47E-04	1.76E-04	1.14E-04	2.18E-04	9.10E-05
Ozone layer depletion	kg CFC11 eq	3.85E-05	2.51E-05	2.99E-05	2.89E-05	2.39E-05
Acidification, soil and water	kg SO_2 eq	0.530	0.440	0.418	0.506	0.367
Eutrophication	kg PO_4^{3-}eq	0.0312	0.0261	0.0227	0.0286	0.0232
Photochemical ozone creation	kg C_2H_4 eq	0.0790	0.0667	0.0619	0.0770	0.0549
Abiotic depletion - elements	kg Sb eq	1.41E-06	1.78E-06	1.44E-06	1.95E-06	1.43E-06
Abiotic depletion - fossil	MJ_{NCV}	4270	3080	3270	3590	2860
Parameter	Unit					
PERE	MJ_{NCV}	1.94E+01	1.29E+01	1.18E+01	1.39E+01	1.22E+01
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	1.94E+01	1.29E+01	1.18E+01	1.39E+01	1.22E+01
PENRE	MJ_{NCV}	9.63E+02	1.16E+03	8.00E+02	1.29E+03	1.06E+03
PENRM	MJ_{NCV}	3.66E+03	2.17E+03	2.75E+03	2.60E+03	2.03E+03
PENRT	MJ_{NCV}	4.63E+03	3.33E+03	3.55E+03	3.89E+03	3.09E+03
SM	kg	2.89E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.87E+00	2.55E+00	1.77E+00	2.88E+00	1.88E+00
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	1.27E-01	7.06E-02	7.60E-02	7.45E-02	7.81E-02
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* Grouping of products for presentation.

Environmental Profiles for Asphalt Products at Eastern Creek

Table 11: Environmental profiles and parameters of asphalt products manufactured at Eastern Creek, stages A1-A3, per tonne

	Product	DG07 AR450 AS2150	DG10 AR450 AS2150/ AUSPEC/ R117 R20% G≤2.5%*	DG14, DG20 and DG28 AR450 AS2150/ AUSPEC/R117 R25% G≤10%*	DG14 A15E AS2150 R15%	GG10 AR450 AS2150 R10%
	Standard	AS2150/AusSpec/R117				
Indicator	Unit					
Global warming (total)	kg CO_2 eq	92.2	71.9	63.6	84.7	89.2
GWP-fossil	kg CO_2 eq	92.2	71.6	62.7	84.6	89.2
GWP-biogenic	kg CO_2 eq	0.0386	0.253	0.913	0.0858	0.0346
GWP-land use	kg CO_2 eq	1.31E-04	1.19E-04	8.74E-05	1.73E-04	1.22E-04
Ozone layer depletion	kg CFC11 eq	3.45E-05	3.09E-05	2.20E-05	2.40E-05	3.22E-05
Acidification, soil and water	kg SO_2 eq	0.480	0.428	0.327	0.429	0.448
Eutrophication	kg PO_4^{3-}eq	0.0258	0.0221	0.0189	0.0245	0.0240
Photochemical ozone creation	kg C_2H_4 eq	0.0704	0.0622	0.0486	0.0630	0.0669
Abiotic depletion - elements	kg Sb eq	1.28E-06	1.03E-06	9.54E-07	1.53E-06	1.08E-06
Abiotic depletion - fossil	MJ_{NCV}	3740	3370	2420	2960	3480
Parameter	Unit					
PERE	MJ_{NCV}	1.25E+01	8.11E+00	7.11E+00	9.69E+00	1.21E+01
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	1.25E+01	8.11E+00	7.11E+00	9.69E+00	1.21E+01
PENRE	MJ_{NCV}	9.31E+02	7.66E+02	7.00E+02	1.13E+03	8.81E+02
PENRM	MJ_{NCV}	3.13E+03	2.89E+03	1.93E+03	2.07E+03	2.89E+03
PENRT	MJ_{NCV}	4.06E+03	3.66E+03	2.63E+03	3.21E+03	3.77E+03
SM	kg	0.00E+00	2.15E+02	3.38E+02	1.43E+02	9.50E+01
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.85E+00	1.50E+00	1.24E+00	2.35E+00	1.66E+00
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	7.47E-02	6.03E-02	5.29E-02	5.88E-02	6.67E-02
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* Grouping of products for presentation.

Table 12: Environmental profiles and parameters of asphalt products manufactured at Eastern Creek, stages A1-A3, per tonne

	Product	DG10 AR450 R116 R15% G≤2.5%*	DG10 A15E R116 R10%	DG14 A15E R116 R10% G≤2.5%*	DG14 AR450 R116 R20% G≤2.5%*	DG20 AR450 R116 R25% G≤10%*	DG28 AR450 R116 R30% G≤10%*	DG14 A15E R116 SLAG
	Standard	R116						
Indicator	Unit							
Global warming (total)	kg CO_2 eq	81.7	101	94.7	74.8	73.5	70.5	95.4
GWP-fossil	kg CO_2 eq	81.4	100	94.4	74.5	72.6	69.6	95.3
GWP-biogenic	kg CO_2 eq	0.255	0.0949	0.311	0.251	0.915	0.912	0.0846
GWP-land use	kg CO_2 eq	1.17E-04	1.97E-04	1.76E-04	9.04E-05	8.87E-05	7.70E-05	1.84E-04
Ozone layer depletion	kg CFC11 eq	3.07E-05	2.85E-05	2.49E-05	2.37E-05	2.27E-05	1.96E-05	2.72E-05
Acidification, soil and water	kg SO_2 eq	0.425	0.488	0.437	0.345	0.334	0.300	0.462
Eutrophication	kg PO_4^{3-}eq	0.0229	0.0275	0.0259	0.0200	0.0197	0.0183	0.0261
Photochemical ozone creation	kg C_2H_4 eq	0.0639	0.0739	0.0670	0.0521	0.0517	0.0466	0.0703
Abiotic depletion - elements	kg Sb eq	1.09E-06	1.58E-06	1.61E-06	1.05E-06	9.36E-07	8.58E-07	1.30E-06
Abiotic depletion - fossil	MJ_{NCV}	3330	3450	3040	2570	2470	2130	3270
Parameter	Unit							
PERE	MJ_{NCV}	1.05E+01	1.30E+01	8.11E+00	8.16E+00	8.22E+00	8.15E+00	1.15E+01
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	1.05E+01	1.30E+01	8.11E+00	8.16E+00	8.22E+00	8.15E+00	1.15E+01
PENRE	MJ_{NCV}	8.08E+02	1.25E+03	7.66E+02	7.65E+02	7.78E+02	7.70E+02	1.18E+03
PENRM	MJ_{NCV}	2.80E+03	2.49E+03	2.89E+03	2.80E+03	2.89E+03	2.80E+03	2.36E+03
PENRT	MJ_{NCV}	3.60E+03	3.74E+03	3.66E+03	3.56E+03	3.67E+03	3.57E+03	3.54E+03
SM	kg	1.43E+02	9.50E+01	2.15E+02	2.15E+02	1.90E+02	1.90E+02	9.50E+01
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.58E+00	2.54E+00	1.50E+00	1.49E+00	1.53E+00	1.52E+00	2.14E+00
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	6.51E-02	6.54E-02	6.03E-02	6.07E-02	6.11E-02	6.06E-02	5.56E-02
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* Grouping of products for presentation.

Table 13: Environmental profiles and parameters of asphalt products manufactured at Eastern Creek, stages A1-A3, per tonne

	Product	OG10 A15E R119	SMA10 A15E R121	EME2	BC14 A10E AIRPORT	DG14 Port-Phalt®	DG20 Port-Phalt®	SMA07 A15E
	Standard	R119	R121	R126	Other	Other	Other	Other
Indicator	Unit							
Global warming (total)	kg CO_2 eq	90.5	108	87.4	110	86.9	82.3	107
GWP-fossil	kg CO_2 eq	90.4	108	87.4	110	86.9	82.3	107
GWP-biogenic	kg CO_2 eq	0.0901	-0.0594	0.0390	0.113	0.0237	0.0276	-0.0589
GWP-land use	kg CO_2 eq	1.76E-04	3.46E-04	1.18E-04	2.18E-04	9.58E-05	8.86E-05	3.51E-04
Ozone layer depletion	kg CFC11 eq	2.50E-05	3.25E-05	3.09E-05	2.91E-05	2.51E-05	2.33E-05	3.37E-05
Acidification, soil and water	kg SO_2 eq	0.434	0.561	0.442	0.518	0.400	0.371	0.573
Eutrophication	kg PO_4^{3-}eq	0.0256	0.0326	0.0251	0.0305	0.0260	0.0240	0.0329
Photochemical ozone creation	kg C_2H_4 eq	0.0659	0.0847	0.0638	0.0782	0.0579	0.0536	0.0864
Abiotic depletion - elements	kg Sb eq	1.71E-06	4.83E-04	1.45E-06	2.00E-06	1.46E-06	1.41E-06	4.83E-04
Abiotic depletion - fossil	MJ_{NCV}	3060	3980	3380	3610	3030	2760	4110
Parameter	Unit							
PERE	MJ_{NCV}	1.25E+01	2.10E+01	1.20E+01	1.53E+01	1.26E+01	1.18E+01	2.09E+01
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	1.25E+01	2.10E+01	1.20E+01	1.53E+01	1.26E+01	1.18E+01	2.09E+01
PENRE	MJ_{NCV}	1.15E+03	1.37E+03	9.21E+02	1.40E+03	1.15E+03	1.05E+03	1.36E+03
PENRM	MJ_{NCV}	2.17E+03	2.94E+03	2.75E+03	2.51E+03	2.12E+03	1.93E+03	3.09E+03
PENRT	MJ_{NCV}	3.32E+03	4.31E+03	3.67E+03	3.91E+03	3.27E+03	2.98E+03	4.45E+03
SM	kg	0.00E+00	0.00E+00	2.85E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	2.55E+00	2.89E+00	1.79E+00	2.88E+00	1.93E+00	1.84E+00	2.91E+00
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	6.80E-02	8.25E-02	7.71E-02	7.80E-02	8.17E-02	7.58E-02	8.33E-02
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Environmental Profiles for Asphalt Products at Kembla Grange

Table 14: Environmental profiles and parameters of asphalt products manufactured at Kembla Grange, stages A1-A3, per tonne

	Product	DG07 AR450 AS2150	DG10 AR450 FINE AUSPEC R10%	DG10 AR450 AS2150 R15%	DG10 AR450 AS2150 R30% G2.5%	DG10 AR450 AS2150 R30% SLAG DUST
	Standard	AS2150/AusSpec/R117				
Indicator	Unit					
Global warming (total)	kg CO_2 eq	79.3	63.3	61.4	59.6	61.1
GWP-fossil	kg CO_2 eq	79.2	63.3	61.3	59.4	61.1
GWP-biogenic	kg CO_2 eq	0.0496	0.0418	0.0419	0.259	0.0353
GWP-land use	kg CO_2 eq	1.24E-04	1.07E-04	1.01E-04	9.10E-05	9.09E-05
Ozone layer depletion	kg CFC11 eq	3.42E-05	2.94E-05	2.79E-05	2.51E-05	2.53E-05
Acidification, soil and water	kg SO_2 eq	0.398	0.342	0.325	0.294	0.301
Eutrophication	kg PO_4^{3-}eq	0.0229	0.0200	0.0193	0.0183	0.0186
Photochemical ozone creation	kg C_2H_4 eq	0.0711	0.0607	0.0580	0.0539	0.0554
Abiotic depletion - elements	kg Sb eq	1.43E-06	1.19E-06	1.24E-06	1.03E-06	1.00E-06
Abiotic depletion - fossil	MJ_{NCV}	3610	3100	2950	2630	2660
Parameter	Unit					
PERE	MJ_{NCV}	1.54E+01	1.04E+01	1.05E+01	9.30E+00	8.71E+00
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	1.54E+01	1.04E+01	1.05E+01	9.30E+00	8.71E+00
PENRE	MJ_{NCV}	7.80E+02	7.07E+02	6.87E+02	6.83E+02	7.08E+02
PENRM	MJ_{NCV}	3.13E+03	2.65E+03	2.51E+03	2.17E+03	2.17E+03
PENRT	MJ_{NCV}	3.91E+03	3.36E+03	3.19E+03	2.85E+03	2.88E+03
SM	kg	0.00E+00	9.50E+01	1.43E+02	3.10E+02	2.85E+02
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.84E+00	1.64E+00	1.55E+00	1.28E+00	1.17E+00
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	1.16E-01	9.98E-02	1.01E-01	9.16E-02	8.71E-02
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 15: Environmental profiles and parameters of asphalt products manufactured at Kembla Grange, stages A1-A3, per tonne

	Product	DG14 AR450 AS2150 R20%	DG20 AR450 AS2150 R30%	DG28 AR450 AS2150 R25%	GG10 AR450 AS2510 R10%	THTAS10
	Standard	AS2150/AusSpec/R117				RPB125
Indicator	Unit					
Global warming (total)	kg CO_2 eq	58.0	55.7	54.3	80.0	98.5
GWP-fossil	kg CO_2 eq	57.9	55.7	54.3	80.0	98.5
GWP-biogenic	kg CO_2 eq	0.0392	0.0352	0.0355	0.0448	-0.0494
GWP-land use	kg CO_2 eq	8.64E-05	7.38E-05	6.85E-05	1.17E-04	3.41E-04
Ozone layer depletion	kg CFC11 eq	2.40E-05	2.08E-05	1.94E-05	3.25E-05	3.26E-05
Acidification, soil and water	kg SO_2 eq	0.282	0.246	0.230	0.379	0.497
Eutrophication	kg PO_4^{3-}eq	0.0178	0.0166	0.0160	0.0224	0.0301
Photochemical ozone creation	kg C_2H_4 eq	0.0516	0.0463	0.0439	0.0689	0.0861
Abiotic depletion - elements	kg Sb eq	1.18E-06	1.03E-06	1.09E-06	1.18E-06	4.83E-04
Abiotic depletion - fossil	MJ_{NCV}	2530	2170	2030	3400	3890
Parameter	Unit					
PERE	MJ_{NCV}	9.87E+00	8.80E+00	8.95E+00	1.43E+01	2.32E+01
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	9.87E+00	8.80E+00	8.95E+00	1.43E+01	2.32E+01
PENRE	MJ_{NCV}	6.67E+02	6.62E+02	6.50E+02	7.97E+02	1.27E+03
PENRM	MJ_{NCV}	2.07E+03	1.69E+03	1.54E+03	2.89E+03	2.94E+03
PENRT	MJ_{NCV}	2.74E+03	2.35E+03	2.19E+03	3.69E+03	4.21E+03
SM	kg	1.90E+02	2.85E+02	2.38E+02	9.50E+01	0.00E+00
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.43E+00	1.25E+00	1.30E+00	1.65E+00	2.88E+00
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	9.58E-02	8.79E-02	8.90E-02	1.06E-01	1.21E-01
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 16: Environmental profiles and parameters of asphalt products manufactured at Kembla Grange, stages A1-A3, per tonne

	Product	DG10 AR450 R116 R15%	DG14 A15E R116 R10%	DG14 AR450 R116 R15% G≤10%*	DG20 AR450 R116 R20% G≤10%*	DG28 AR450 R116 R25%	DG14 AR450 R116 SLAG	DG14 A15E R116 SLAG
	Standard	R116						
Indicator	Unit							
Global warming (total)	kg CO_2 eq	72.0	76.1	69.5	68.2	64.6	73.7	92.7
GWP-fossil	kg CO_2 eq	71.9	76.0	69.2	67.2	64.5	73.6	92.6
GWP-biogenic	kg CO_2 eq	0.0427	0.0978	0.263	0.909	0.0370	0.0392	0.0922
GWP-land use	kg CO_2 eq	1.01E-04	1.73E-04	9.18E-05	8.70E-05	6.83E-05	1.03E-04	1.81E-04
Ozone layer depletion	kg CFC11 eq	2.82E-05	2.56E-05	2.55E-05	2.37E-05	1.96E-05	2.86E-05	2.79E-05
Acidification, soil and water	kg SO_2 eq	0.330	0.373	0.300	0.280	0.234	0.350	0.423
Eutrophication	kg PO_4^{3-}eq	0.0203	0.0232	0.0192	0.0186	0.0169	0.0211	0.0261
Photochemical ozone creation	kg C_2H_4 eq	0.0608	0.0669	0.0565	0.0544	0.0465	0.0655	0.0795
Abiotic depletion - elements	kg Sb eq	1.20E-06	1.71E-06	1.19E-06	1.10E-06	1.10E-06	1.25E-06	1.61E-06
Abiotic depletion - fossil	MJ_{NCV}	2960	3020	2670	2480	2030	3050	3300
Parameter	Unit							
PERE	MJ_{NCV}	1.30E+01	1.24E+01	1.28E+01	1.24E+01	1.17E+01	1.14E+01	1.24E+01
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	1.30E+01	1.24E+01	1.28E+01	1.24E+01	1.17E+01	1.14E+01	1.24E+01
PENRE	MJ_{NCV}	7.44E+02	1.05E+03	7.22E+02	7.06E+02	7.02E+02	7.90E+02	1.20E+03
PENRM	MJ_{NCV}	2.46E+03	2.22E+03	2.17E+03	1.98E+03	1.49E+03	2.51E+03	2.36E+03
PENRT	MJ_{NCV}	3.20E+03	3.27E+03	2.89E+03	2.68E+03	2.20E+03	3.30E+03	3.57E+03
SM	kg	1.43E+02	9.50E+01	1.68E+02	2.88E+02	2.38E+02	0.00E+00	0.00E+00
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.53E+00	2.41E+00	1.47E+00	1.30E+00	1.28E+00	1.32E+00	1.95E+00
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	1.02E-01	1.02E-01	1.01E-01	9.80E-02	9.24E-02	9.47E-02	8.89E-02
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* Grouping of products for presentation.

Table 17: Environmental profiles and parameters of asphalt products manufactured at Kembla Grange, stages A1-A3, per tonne

	Product	DG14 AR450 R118 CR	OG10 A15E R119	OG10 A15E SLAG R119	SMA10 A15E R121 EVO	EME2
	Standard	R118	R119	R119	R121	R126
Indicator	Unit					
Global warming (total)	kg CO_2 eq	92.8	82.5	97.0	98.4	71.0
GWP-fossil	kg CO_2 eq	92.7	82.4	96.9	98.5	70.9
GWP-biogenic	kg CO_2 eq	0.0732	0.101	0.0890	-0.0494	0.0486
GWP-land use	kg CO_2 eq	1.47E-04	1.72E-04	1.76E-04	3.41E-04	1.10E-04
Ozone layer depletion	kg CFC11 eq	3.99E-05	2.53E-05	2.65E-05	3.26E-05	3.03E-05
Acidification, soil and water	kg SO_2 eq	0.482	0.372	0.416	0.497	0.354
Eutrophication	kg PO_4^{3-}eq	0.0302	0.0236	0.0262	0.0300	0.0210
Photochemical ozone creation	kg C_2H_4 eq	0.0830	0.0679	0.0802	0.0860	0.0636
Abiotic depletion - elements	kg Sb eq	1.47E-06	1.85E-06	1.56E-06	4.83E-04	1.53E-06
Abiotic depletion - fossil	MJ_{NCV}	4310	3000	3160	3890	3210
Parameter	Unit					
PERE	MJ_{NCV}	2.21E+01	1.50E+01	1.24E+01	2.32E+01	1.41E+01
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	2.21E+01	1.50E+01	1.24E+01	2.32E+01	1.41E+01
PENRE	MJ_{NCV}	9.10E+02	1.07E+03	1.24E+03	1.27E+03	7.33E+02
PENRM	MJ_{NCV}	3.76E+03	2.17E+03	2.17E+03	2.94E+03	2.75E+03
PENRT	MJ_{NCV}	4.67E+03	3.24E+03	3.41E+03	4.21E+03	3.48E+03
SM	kg	2.89E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.88E+00	2.55E+00	1.71E+00	2.88E+00	1.77E+00
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	1.67E-01	1.09E-01	8.26E-02	1.21E-01	1.15E-01
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

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