

Reconophalt

Downer takes a lead role in repurposing post-consumer soft plastics, glass and toner into higher value products to construct roads. A kilometre of road (two lanes) paved with Reconophalt can contain:

- 500,000 plastic bag and packaging equivalents
- 165,000 glass bottle equivalents
- Toner from 12,000 used printer cartridges.

Overview

Reconophalt is Australia's first asphalt product that contains high recycled content from materials such as soft plastics, glass, toner and reclaimed road. Downer is proud to take a lead role in repurposing recycled materials in asphalt for road construction to create a sustainable, cost effective solution that performs as well or better than conventional asphalt.

This innovative asphalt product demonstrates the economic, social and environmental value for products that would likely end up in landfill, stockpiled or as a pollutant in our natural environments.

More importantly, Reconophalt proves that with thought leadership in sustainability and partnerships with progressive and environmentally conscious governments, suppliers and customers, we can continue to set new benchmarks in recycling and repurposing waste materials into new streams of use.

Sustainable and longer-lasting roads



Recycled content breakdown

Reconophalt contains high recycled content from materials, such as:

- Soft plastics from plastic bags and packaging
- Waste glass destined for landfill
- Waste toner from used printer cartridges
- Reclaimed asphalt pavement (RAP) from end-of-life roads
- Crumb rubber from end-of-life tyres
- Coarse aggregate and sand from street sweepings processed at Downer's detritus processing facility.



Sustainability credentials

- Reconophalt creates new avenues to recycle and repurpose waste materials into new streams of use, diverting waste from landfill and reducing the reliance upon increasingly scarce virgin materials.
- Downer has the capability to perpetually recycle Reconophalt pavements into the future, providing a truly sustainable solution.
- We are focussed on the delivery of best practice solutions that maximise the value of our customers' road assets and support the sustainability of their communities.



Technology

- Downer's extensive range of asphalt plants in Australia, includes the latest High Recycled Technology (HRT) Series mixing plants, designed in partnership with Ammann. These plants are the most advanced facilities of their kind in Australia. We have produced 100% recycled asphalt from these facilities.



World's best practice

- In 2015, Downer partnered with the City of Boroondara in Victoria to demonstrate the world's first 99% recycled asphalt made from post-consumer materials such as tyres and glass, demonstrating the technology and capability to produce high quality recycled asphalt.
- In 2019, Downer partnered with the City of Adelaide to construct a local road with Australia's first 100% recycled asphalt made from reclaimed asphalt pavement and recycled vegetable oil. Production results have shown CO₂e emission savings of up to 65% achieved from 100% recycled materials and a lower mixing temperature (warm mixed asphalt).



Improved performance

- Recycled materials use coupled with innovative product mix design increases the fatigue life of the asphalt, improving durability and resistance to cracking.
- Performance testing of some Reconophalt products have shown up to 65% improvement in fatigue life and superior deformation resistance for withstanding heavy vehicular traffic.



Innovative partnerships

- Downer worked closely with Close the Loop, a resource recovery and recycling company, to innovatively tailor the soft plastic and toner solution to suit a road construction application.

Australia's first road built with soft plastics, glass and toner

In an Australian-first, soft plastics from approximately 200,000 plastic bags and packaging, and glass from approximately 63,000 glass bottle equivalents were diverted from landfill to construct a local road in Craigieburn, Victoria. With more than 25% total recycled content, the road also contains toner from approximately 4,500 used printer cartridges and 50 tonnes of reclaimed road (asphalt).

The recycled materials used in this road were sourced locally, not only saving transportation costs but also delivering an avenue for councils to recycle and repurpose waste materials into their road assets. This is driving the circular economy through practical application for communities, while reducing the reliance upon increasingly scarce virgin materials.

PROVEN TECHNOLOGY IN THE USE OF RECYCLED MATERIALS

Downer leads the industry in the application of recycling technology and use of recycled materials. We develop new products that divert waste from landfill, extracting the value from each material's intrinsic characteristics by turning waste into high quality, high performing products.

Downer's National Research and Development (R&D) Laboratory based in Somerton, Victoria continues exploring new methods of incorporating repurposed materials into asphalt, spray seal and other construction applications to:

- Minimise reliance on natural resources and virgin materials
- Reduce carbon emissions
- Minimise the amount of waste material being dumped in landfill.

REPURPOSED MATERIALS

Downer uses the following streams of repurposed materials to develop sustainable, high-quality products.

RECLAIMED ASPHALT PAVEMENT (RAP)

Reclaimed asphalt is an extremely valuable resource as the reclaimed product contains aggregate, dust, sand and bitumen. By reusing milled and excavated asphalt, Downer can reduce the reliance on natural aggregate and sand resources, as well as minimising cartage of raw materials from quarries which are located more than 100kms away from the network.

This product also minimises the use of imported bitumen and avoids purchase and transportation costs. Significant carbon emission savings are achieved by eliminating the need of expensive international shipping. In addition, the oxidation of the aged bitumen improves stiffness of manufactured mixes, thereby improving rutting resistance.

Recycled asphalt is crushed and screened at the Downer site in Camelia near the Rosehill asphalt plant. The material is then sorted and screened again to deliver the highest of quality conformance. Once screened into relevant fractions, the Reclaimed Asphalt Pavement (RAP) is fed through calibrated feeders into the asphalt plant, and heated within the outer collar of the dryer drum to avoid direct contact with the flame. Downer is Level 3 RAP certified with Road Maritime Services NSW.

The Rosehill plant can incorporate up to 40% RAP into asphalt mixes but normally runs at 25 to 30%.



WASTE TYRE RUBBER

Disposal of used and worn tyres is a major environmental problem in Australia. However, the contained rubber is a valuable resource that can improve the characteristics of asphalt through tensile resistance, fatigue mitigation, as well as binder enhancement in spray seal applications.

Downer has conducted extensive research and developed several asphalt mixes that use this crumbed rubber. These asphalt products deliver greater crack resistance, tensile improvements and reduced traffic noise as a result of higher rubber content mixes.

Spray seal binder with crumbed rubber enables more binder to hold the aggregate without associated bleeding or flushing under traffic.

Crumbed rubber is currently sourced from tyre processors but Downer is investigating the option of investing in our own processing facilities to achieve greater productivity.



WASTE GLASS

In a circular economy, repurposed glass is recycled back into glass. However, fractions and colours of waste glass cannot be repurposed back into glass due to differing size and colour. Downer typically targets this source of glass for use in asphalt as sand replacement. The glass is sourced from the domestic recycling process through a material reprocessing facility.

Using recycled crushed glass in asphalt reduces reliance on natural resources and saves on heating fuel due to lower moisture contents. This also offers CO₂ savings in comparison with drying natural sand.

Downer purchases waste glass, which is crushed to a 5mm and washed to remove any impurities such as wine, beer and soft drinks. The processed crushed glass is then added at 2.5% of the total mix; one tonne of asphalt with 10% repurposed glass contains 562 glass bottles that would otherwise end up in landfill.

The Rosehill Surfacing team currently have RMS approved designs, incorporating glass in R116.8.5 specifications of up to 10% in intermediate layers. We have already laid mixes containing 2.5% glass within the Sydney Metropolitan area.



WASTE SOFT PLASTIC

Soft plastics are sourced from Coles and Woolworths supermarket collection boxes all across Australia, through the Red Group, and the Plastic Police who collaborate with local schools and councils in NSW. These waste sources are clean and free of impurities, with the exception of soft plastics. Records of collection quantities are recorded by postcode so we can measure the amount collected within all municipalities.

Use of soft plastics in asphalt repurposes the polymers within the product and enhances the asphalt mix characteristics. Before Downer developed asphalt containing recycled soft plastics, this waste material was sent to landfill, taking generations to decompose.

Downer also partners with a zero-to-waste company called Close the Loop, which collects the plastic and melts it down along with toner from waste printer cartridges. The combined melted product is cooled and shredded to form the asphalt additive, TonerPlas.

TonerPlas is added to asphalt to form part of the binder and in doing so improves the fatigue and rut resistance of the asphalt. In each tonne of the Reconophalt asphalt, 800 plastic bags are consumed. Further, the polymer within plastic adds significant value to the asphalt by extending its life.

This product is now installed on several local authority streets within the Sydney Metropolitan area.



TONER FROM USED PRINTER CARTRIDGES

Used Toner cartridges are collected in boxes in most offices and schools around Australia through the Cartridges for the Planet Ark program. Used cartridges contain remnants of toner which is also extracted by the zero-to-waste company Close the Loop. Other components of the cartridges are broken down and recycled into various products such as outdoor furniture, pens etc.

Repurposed toner performs as a high-grade polymer which melts at 70°C – ideal for use as a bitumen enhancer because toner is so fine, it easily binds with recycled oil to form workable pellets. When added to hot bitumen at 160°C, repurposed toner melts instantly, enabling the polymer to digest into the binder which then performs as a Polymer Modified Binder (PMB).

WASTE OIL

Waste oil is collected from several sources and added to repurposed toner or TonerPlas to form an asphalt additive. Waste oil is also used in several ways to alter viscosity of bituminous products. Downer uses anything from used fish-and-chip oil to waste oil from trucks and cars. Waste oil is also used in some burners or heaters on asphalt plants.

DETRITUS FROM SUCTION SWEEPERS AND GULLY WASTE

Waste materials from suction sweepers is unloaded in Downer's Detritus plant in Rosehill and converted into raw components through a washing and sieving process. Following the washing and separation treatment, the suction sweeper waste is converted back to sand and aggregates, which can be used in asphalt, base course materials, concrete, organics, plastics and metal.

Downer recovers up to 90% of materials that would otherwise be sent to landfill.

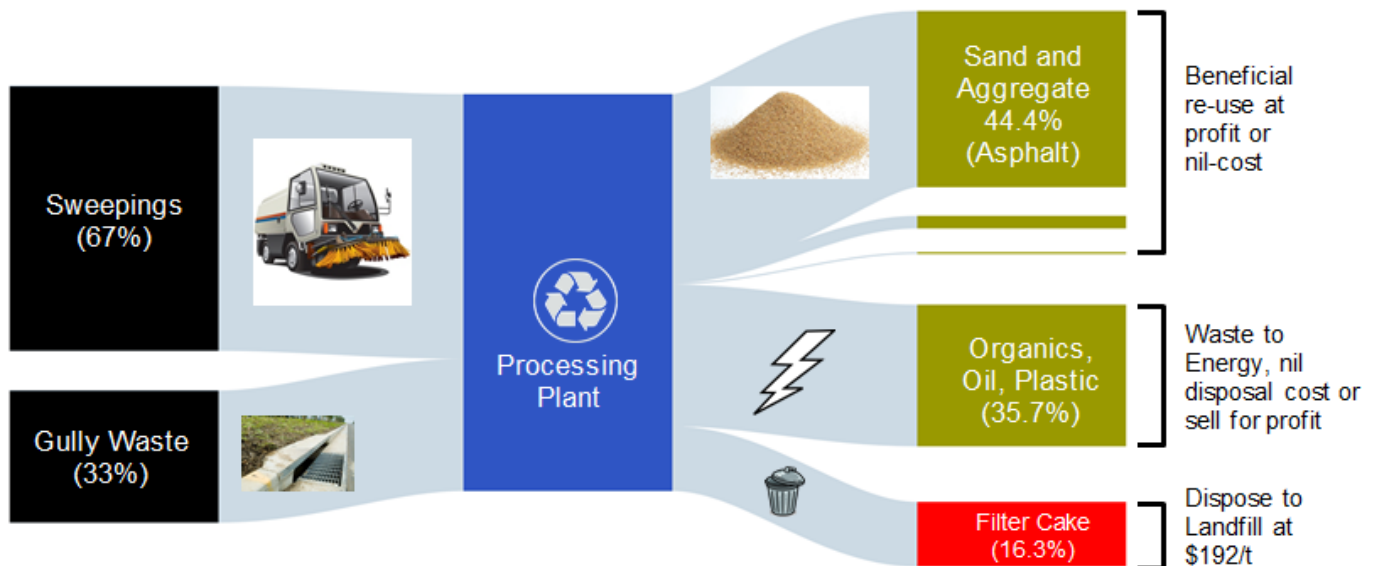


Figure 1. Downer's Detritus plant in Rosehill processes street sweepings and gully waste into high-quality ingredients that are repurposed into a range of asphalt products.

COLLECTIONS FROM NON-DESTRUCTIVE EXCAVATION TRUCKS

Downer is certified to treat Non-Destructive Digging (NDD) waste material through the Rosehill Detritus plant. NDD waste is generated through the hydro excavation process and is rich in reusable products.

Sand and aggregates are extracted from what would otherwise be a waste material and reused by Downer in asphalt, road base and concrete. Alternate disposal methods are extremely costly and waste valuable resources that can be repurposed for more efficient use.



RESEARCH AND DEVELOPMENT

Downer's dedicated Research and Development (R&D) laboratory is based in Somerton, Victoria. We employ 15 technical specialists, supported by Downer's Research and Development Board. Our R&D Department perform the following designs and tests:

- Asphalt mix design (Marshall and gyratory compaction methods)
- Materials testing to supplement pavement assessment
- New product development and innovation
- Binder testing, analysis and design
- Microsurfacing design
- Stabilisation testing and design for local conditions
- Statistical data analysis/process control advice
- Recycled pavement design and analysis
- Warm Asphalt Mix design and analysis.

Over the duration of this contract, Downer will continue to develop high quality, innovative asphalt products with a focus on recycling and high performing products.

RECYCLED ASPHALT PRODUCTS

Downer collects reclaimed asphalt pavement, waste tyre rubber, glass, soft plastic, used toner cartridges and other recycled products, repurposing them into a range of asphalt products including:

1. RECONOPHALT

Product Composition and Performance

Reconophalt is an asphalt product containing 20% to 30% Reclaimed Asphalt Pavement, 2.5 to 10% Crushed Recycled Glass and TonerPlas – an asphalt additive containing used soft plastics and printer toner.

Glass and Reclaimed Asphalt Pavement (RAP) is heated and mixed with the virgin materials. TonerPlas is then added to the mix at the same time as the bitumen, forming part of the binder; this creates Reconophalt.

Reconophalt has superior fatigue and rut resistant properties as demonstrated in the following table, showing test results from the first Reconophalt trial conducted in Sydney on the Old Princess Highway, Engadine in September 2018.

The first column of the data represents a plant-mixed sample of Reconophalt, the second shows a laboratory mixed sample. The third column demonstrates the results from a controlled sample, and the last two columns show standards expected for a conventional asphalt mix based on Road Maritime Services and VicRoads specifications.

EACH KILOMETRE OF ROAD PAVED WITH RECONOPHALT REPURPOSES 670,000 PLASTIC BAGS, 105,000 GLASS BOTTLES AND 15,100 EXPIRED PRINTER TONER CARTRIDGES

Parameter	"Reconophalt" Plant mix (30% RAP, 5% Glass, 5.9% Binder, 0.75% Additive)	"Reconophalt" Lab mix (30% RAP, 5% Glass, 5.9% Binder, 0.75% Additive)	NSW (Control) - (30% RAP, 5% Glass, 5.9% Binder)	RMS AC10H Specification	VicRoads AC10H Specification
Resilient Modulus @ 25°C (MPa)	Tested	4780	3606	N/A	2500 – 5500
Wheel Tracking Depth @ 60°C (mm)	2.0	1.3	Not tested	N/A	<11
Fatigue Life @ 20°C (Kcycles)	567 (preliminary result)	552	Not tested	N/A	>140
Moisture Sensitivity – Tensile Strength Ratio (%)	Not tested	84	Not tested	≥ 80	>80
Moisture Sensitivity – Wet Tensile Strength (KPa)	Not tested	1084	Not tested	>600	>850
Particle Loss, Unconditioned (%)	10	Not tested	Not tested	N/A	N/A
Particle Loss, Moisture Conditioned (%)	11	Not tested	Not tested	N/A	N/A
Air Voids @ 80 / 120 Cycles (%)	N/A	4.7 / 4.5	5.5 / N/A	3.0 - 6.0	N/A

Row 2 of the table above shows the wheel tracking depth and rut resistance. Reconophalt significantly outperforms at 2mm, compared with a standard mix expectation of 11mm.

Fatigue life results show a vast improvement to standard mix at 552K cycles compared to 140K cycles. When entered into pavement modelling analysis, we predict that Reconophalt will:

- Last 15% longer than the standard asphalt
- Be capable of withstanding 20% increased traffic loading.

Reconophalt Health, Safety and Environmental Testing

Downer has undertaken extensive health and environmental testing on Reconophalt in conjunction with the Environmental Protection Authority in NSW. Health testing results have shown no ill affect from fumes at normal operating temperatures of 160°C to 170°C.

Environmental testing has shown no emissions through leaching that differ to standard Polymer Modified Binder (PMB) asphalt. Similar to commonly-used PMB mixes, Reconophalt will still be able to perform like Reclaimed Asphalt Pavement (RAP) at the end of its extended pavement life. This means Downer has created an asphalt product that can be recycled again and again.

Landfill and Carbon Emission Reduction

Downer has produced more than 15,000 tonnes of Reconophalt, which has been successfully placed on roads in New South Wales, Tasmania, Victoria, the ACT and South Australia.

For every 1km of road (two lanes) paved with Reconophalt as a wearing course, the equivalent of the following quantities of products are diverted from landfill:

- 530,000 plastic bag equivalents
- 168,000 glass bottle equivalents
- 12,500 waste toner from printer cartridges.

In addition, for the same 1km of wearing course, the following reductions in CO₂e emissions will be achieved:

- 30% reduction of CO₂e
- 481 tonne of CO₂e saved.

These savings are equivalent to:

- 1,104 trees over a 12-month period
- Travelling 3.2 times around the world in a small car.

In addition, a total of 357.5 tonnes of recycled material will be used in the same 1km road.

Downer can issue a Statement of Carbon Emission Reductions achieved on a six-monthly basis to track progress throughout a contract. The certificate will be similar to the example shown to the right.

**DOWNER'S
RECONOPHALT IS
RUT RESISTANT
AND LASTS
15%
LONGER THAN
STANDARD
ASPHALT**

Downer
Relationships creating success

Statement of Carbon Emission Reduction

Downer is proud to have partnered with
City of Marion
on the **COSOL-002-RI Bituminous Works**
1 July 2018 to 30 June 2019
for the adoption of sustainable asphalt, reducing impacts on the environment.

331 tonnes CO₂-e was saved
through the use of **Sustainable Asphalt including RAP** in lieu of traditional hot asphalt.

Equivalent to
134 cars off the road

This report provides results from a 12-month Carbon Life Cycle Assessment (CLCA) conducted for Downer, based on the City of Marion's project. The CLCA is based on the International Standards for Life Cycle Assessment (ISO 14040 and ISO 14044) and is the first of its kind to be conducted using the Greenhouse Gas Protocol (GHG) as a measure of impact.

2. TONERPAVE

TonerPave is a high-grade asphalt product that uses toner from expired printer cartridges, redirecting tonnes of waste product into an enhanced surfacing material that takes advantage of the polymer from the toner. The toner is a high-grade polymer that melts at 70°C, and therefore incorporates easily into the 160°C binder.

TonerPave is a mild Polymer Modified Asphalt which can be produced at a similar price to standard asphalt. It also incorporates Recovered Asphalt Pavement and can contain crushed glass giving a total recycled content of up to 33%.

3. CRUMB RUBBER ASPHALT SURFACING

Crumb Rubber Asphalt Surfacing uses end-of-life vehicle tyres that would otherwise be buried in landfill, and uses these to make a high-grade polymer surface that lasts longer and is more resistant to cracking.

Downer is the first supplier to trial crumb rubber open graded asphalt surfacing on the Emu Mountain Road project in Brisbane, reusing 3,325 end-of-life car tyres for every two kilometres of road surface.

This trial crumb rubber asphalt delivers a longer-lasting product that provides whole-of-life cost savings. Since then, Downer has conducted extensive research and development into a range of asphalt products that contain recycled rubber and Reclaimed Asphalt Pavement (RAP).

Our most recent trials of mixes have been in Western Australia containing Crumbed Rubber, Soft Plastics, Waste Toner, RAP and crushed glass.

4. HIGH RECYCLED CONTENT ASPHALT

Downer has the capacity to produce up to 40% Reclaimed Asphalt Pavement (RAP) mixes from the Rosehill plant.

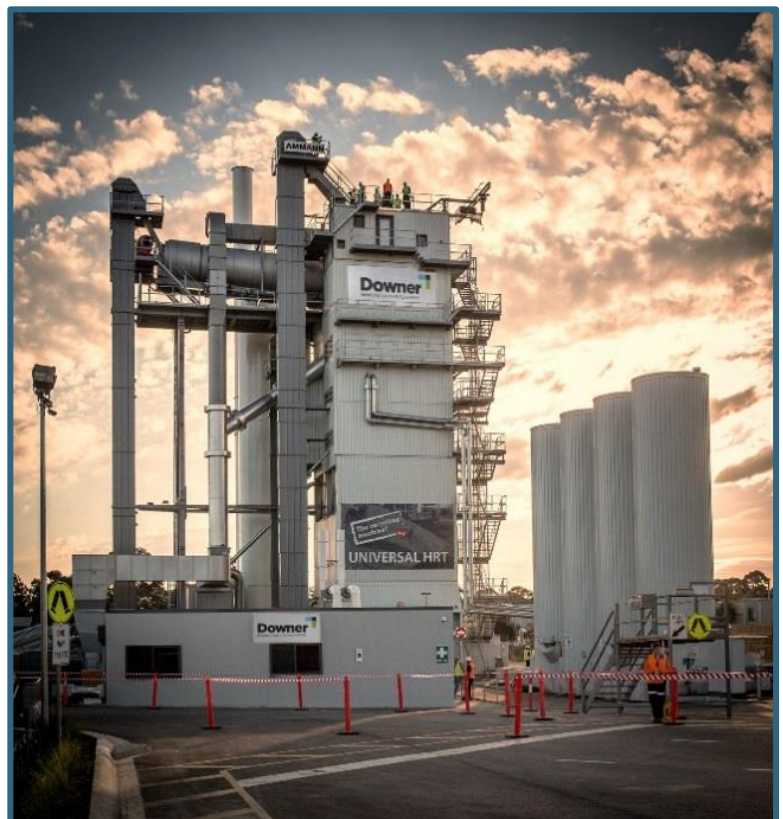
We look to bring a High Recycle Technology (HRT) plant to the Sydney Metro in the future.

This new technology has been used in Adelaide and Bayswater, Melbourne where we have operated two Amman HRT plants over the past five years. The HRT plants heat the RAP in a second dryer which feeds directly into the pugmill.

RAP cannot be heated in a standard dryer and normally relies on heat transferred from the heated aggregate. In the HRT plants however, the RAP is elevated cold to the upper drum and then heated indirectly by a flame which is enclosed within a collar. This happens while the RAP moves in the outer collar and not through the flame.

The HRT plants can produce a high-quality asphalt with 60 to 70% Reclaimed Asphalt Pavement (RAP). This was confirmed during a recent trial in Adelaide where we produced a 100% recycled mix containing RAP, and 2% recycled fish-and-chip oil to enhance the oxidised binder.

Although we do not advocate using 100% Reclaimed Asphalt Pavement (RAP), Downer believes high contents of RAP can be adapted to achieve CO2 savings and further reduce reliance on virgin materials.



Downer HRT Asphalt Plant: Bayswater, Victoria

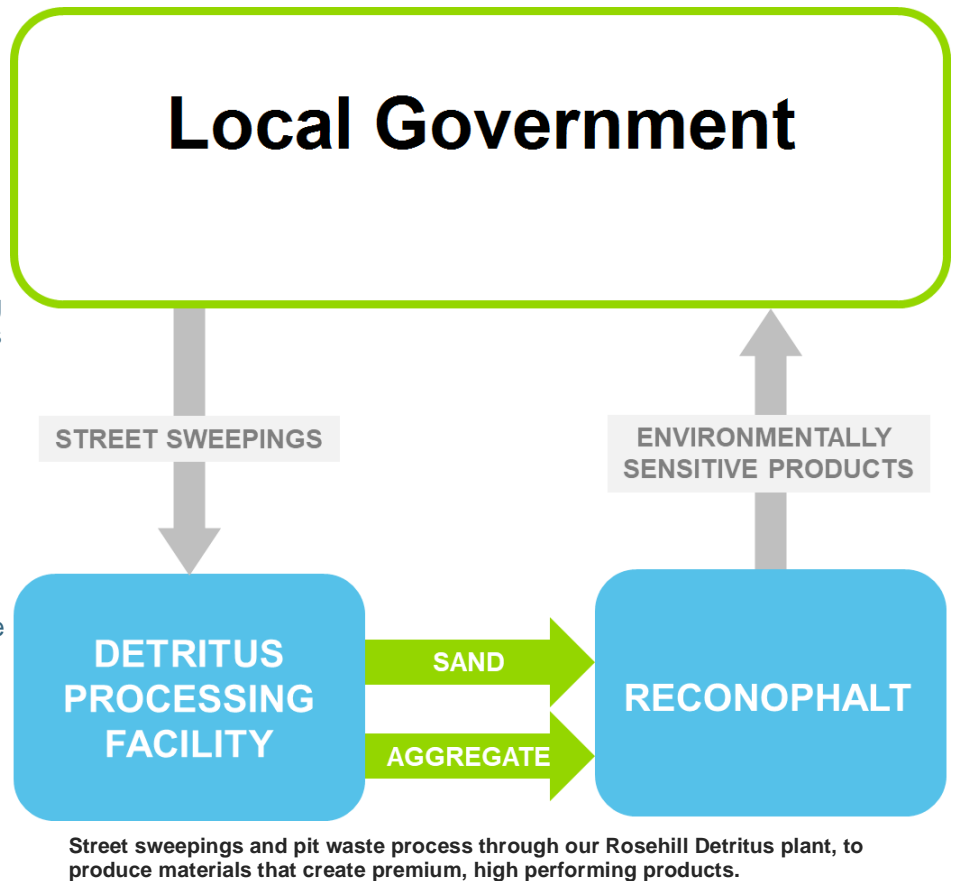
RECONOMY

Downer's commitment to using recycled materials has been demonstrated with the launch of Reconomy, our recently established circular-economy business that repurposes end-of-life materials to make environmentally sustainable products.

Based at Rosehill, NSW and in Epping in Victoria, the Reconomy and Detritus plants collect street sweepings, gully waste material and non-destructive digging generated materials otherwise sent to landfill, and recycles these materials to manufacture asphalt sand, aggregates and other useful materials.

Local Government, Transurban and private sweepers bring materials to the plant and discharge these contents.

The Detritus Plant then screens, washes, tumbles, flocculates, screens again and sorts the material back to raw constituents of aggregates, sand, garden mulch, organics, metals and oils. These materials are repurposed back into asphalt and basecourse production.



Street sweepings and pit waste process through our Rosehill Detritus plant, to produce materials that create premium, high performing products.



Figure 2. Downer's Detritus plant takes street sweepings and landfill, and turns this into materials used for manufacturing quality asphalt and building materials

Over the past 12 months, for the period from 5 June 2018 to 5 June 2019 (World Environment Day 2018 to 2019), Downer has collected and repurposed the following sweepings from the Detritus plant based in Rosehill:

- 10,114t of street sweepings and drain cleaning material
- 8,850t (87.5%) of material has been diverted from landfill and repurposed.