Category 3: Excellence in Sustainability

Northbourne Avenue, Canberra

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Transport Canberra and City Services

ACT Government | Transport Canberra

2021 AustStab Awards of Excellence

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Overview

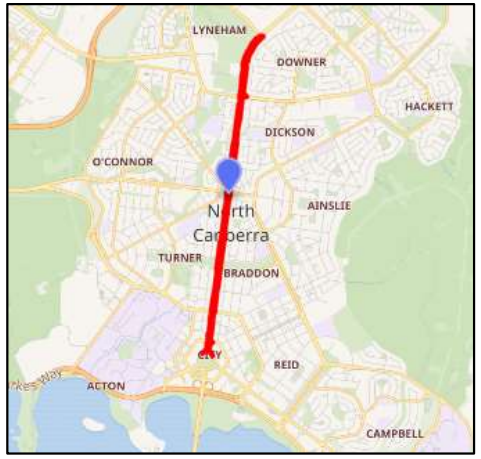
- This initiative showcases the successful implementation of a new and innovative method of pavement rehabilitation – Foamed Asphalt Pavement Recycling – for the upgrading of Northbourne Avenue (Stage 1), located in the ACT
- As part of overall major infrastructure renewal occurring in Canberra and driven by a commitment to sustainable strategies, Transport Canberra and City Services (TCCS) administered the successful delivery of the first Foamed Asphalt Pavement Recycling project in the ACT for the rehabilitation of a section of Northbourne Avenue northbound carriageway
- The Northbourne Avenue (Stage 1) pavement rehabilitation project was administered by TCCS and delivered by local Canberra contractors, Wodens Contractors, and specialist pavement recycling contractors, Pavement Recyclers (a subsidiary division of Stabilised Pavements of Australia)

Objectives

1. Rehabilitate Northbourne Avenue (Stage 1) to improve the road pavement asset with restored structural integrity designed for a 20 year service life
2. Deliver sustainable transport infrastructure in keeping with the aims of the ACT Transport Strategy 2020
3. Provide quantitative evidence to demonstrate the vast sustainability advantages of the initiative in comparison with traditional pavement rehabilitation construction using removal and replacement methods
4. Pave the way for future projects

Background

- Northbourne Avenue is a major arterial road providing critical access from the centre of Canberra, adjacent to the recently installed light rail, and a link to the Federal Highway
- Despite a routine resurfacing program to reseal the road surface and enhanced waterproofing to slow the rate of deterioration, some parts of the existing road pavement were assessed as being in ‘very poor’ condition, exhibiting significant rutting, potholes and cracking in many locations with depressions
- There were clear indications that major rehabilitation was urgently needed and implementing a long-term solution was imminent
- Northbourne Avenue (Stage 1) – the northbound road pavement of Northbourne Avenue between Macarthur Avenue and Mouat Street was chosen by the ACT Government as the first stage for pavement rehabilitation



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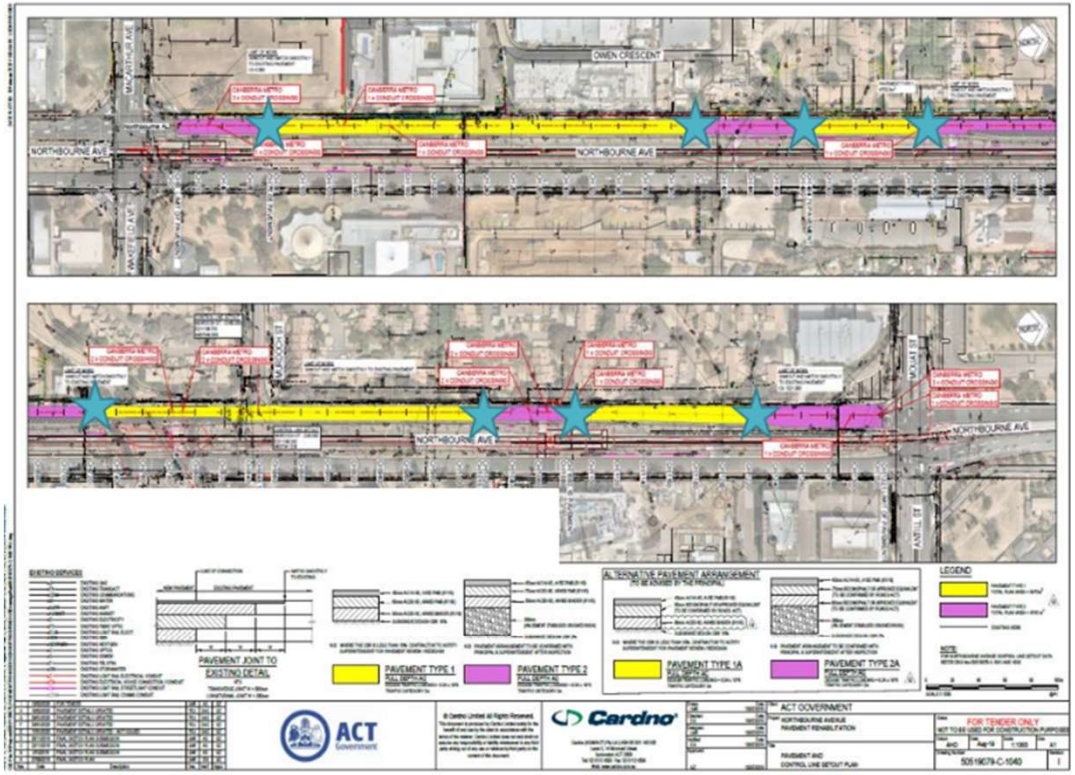
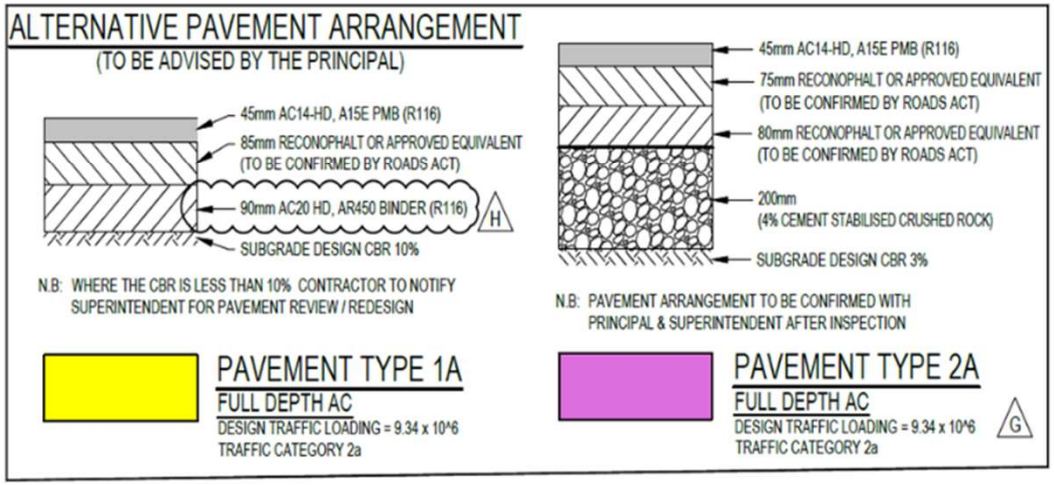
Conforming Conventional Design

- A design engineering company was appointed to carry out all pavement investigations and prepare the rehabilitation designs
- Northbourne Avenue was originally designed for a traditional method of construction – this involved two pavement types, which are shown as the yellow as pink pavement types in the following slide
- The two pavement types involved removing the existing pavement and replacing with layers of new asphalt
- The pink zones represent areas that were to have the subgrade firstly removed and replaced before the new asphalt
- The design required changing between pavement types at eight points along the project as marked out with stars!
- The extensive excavation required meant that only one lane at a time could be rehabilitated
- The lack of construction practicality resulted in an estimated construction period of 26 weeks

Conforming Conventional Design



- Northbourne Avenue was originally designed for a traditional method of construction
- Complete excavation of all existing pavement and replace with layers of new asphalt
- Extra subgrade replacement in pink zones
- Alternating between pavement types at 8 points along the project ★
- Construction occurring one lane at a time and in multiple layers
- 26 week construction program
- No recycling of existing pavement materials for the critical structural pavement layer



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Innovative Pavement Recycling Initiative – Foamed Asphalt

- ✓ New process using fundamental geotechnical engineering to improve the existing road pavement resources
- ✓ Streamlined construction
- ✓ Value for money
- ✓ Superior performance
- ✓ Environmental benefits
  - ✓ Lower greenhouse gas emissions
  - ✓ Recycle the existing road materials insitu
  - ✓ Prevent displacing and disposing valuable and reusable construction material to waste
  - ✓ Reduced heavy truck movements

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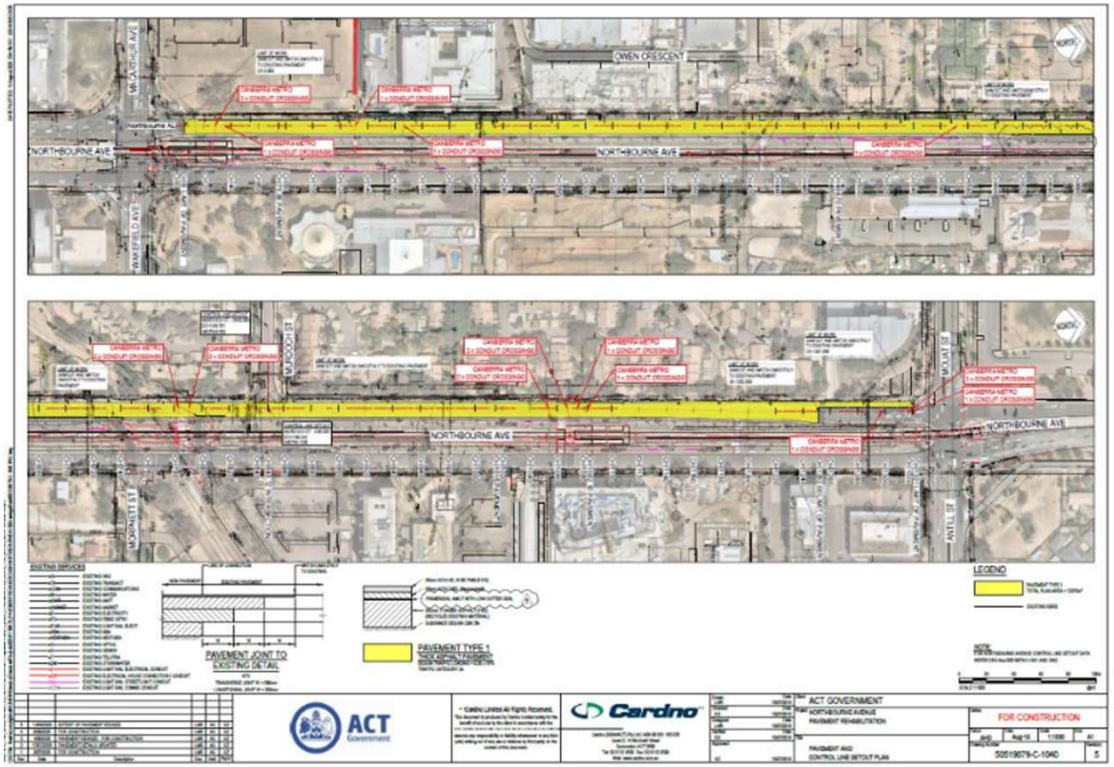
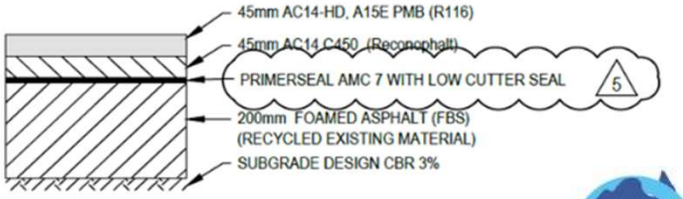
Alternative Foamed Asphalt Design

- To move the alternative Foamed Asphalt Pavement Recycling forward, the new solution was proposed through a consultative approach with stakeholders involved, which was necessary to find a suitable way to have the process implemented at this stage – this included having the design engineer check and certify the structural and mix designs.
- The Foamed Asphalt option was designed for the equivalent design life period (20 years) and performance outcomes as the original design
- The new option was conservatively designed on a natural subgrade with CBR value of 3%, despite geotechnical investigations showing the average of the site to have foundation conditions exceeding CBR 10% – this was one of the contributors to allowing a single pavement treatment across the site
- Most importantly, the rehabilitated Foamed Asphalt pavement would be made by recycling 100% of the existing pavement materials on site – this was possible through the state-of-the-art foamed bitumen technology, which draws upon geotechnical engineering principles to alter pavement materials and produce a material that behaves like an asphalt
- Without the extensive excavation slowing down the works, the program was reduced to only 6 weeks – this included weather delays and a week break between stages

Alternative Foamed Asphalt Design



- ✓ Solution proposed through consultative approach between Pavement Recyclers and Wodens (construction contractors), Cardno (design consultant) and TCCS (Principal)
- ✓ Structural and mix designs tested and certified by designers
- ✓ Same design life (20 years) and performance outcomes
- ✓ Single pavement treatment
- ✓ Existing road materials recycled and improved through geotechnical engineering principles
- ✓ No extensive excavation
- ✓ 6 week program with one week intermission



PAVEMENT TYPE 1
THICK ASPHALT PAVEMENT
DESIGN TRAFFIC LOADING = 9.36 x 10^6
TRAFFIC CATEGORY 2a

PAVEMENT RECYCLERS
DIVISION OF STABILISED PAVEMENTS OF AUSTRALIA PTY LTD

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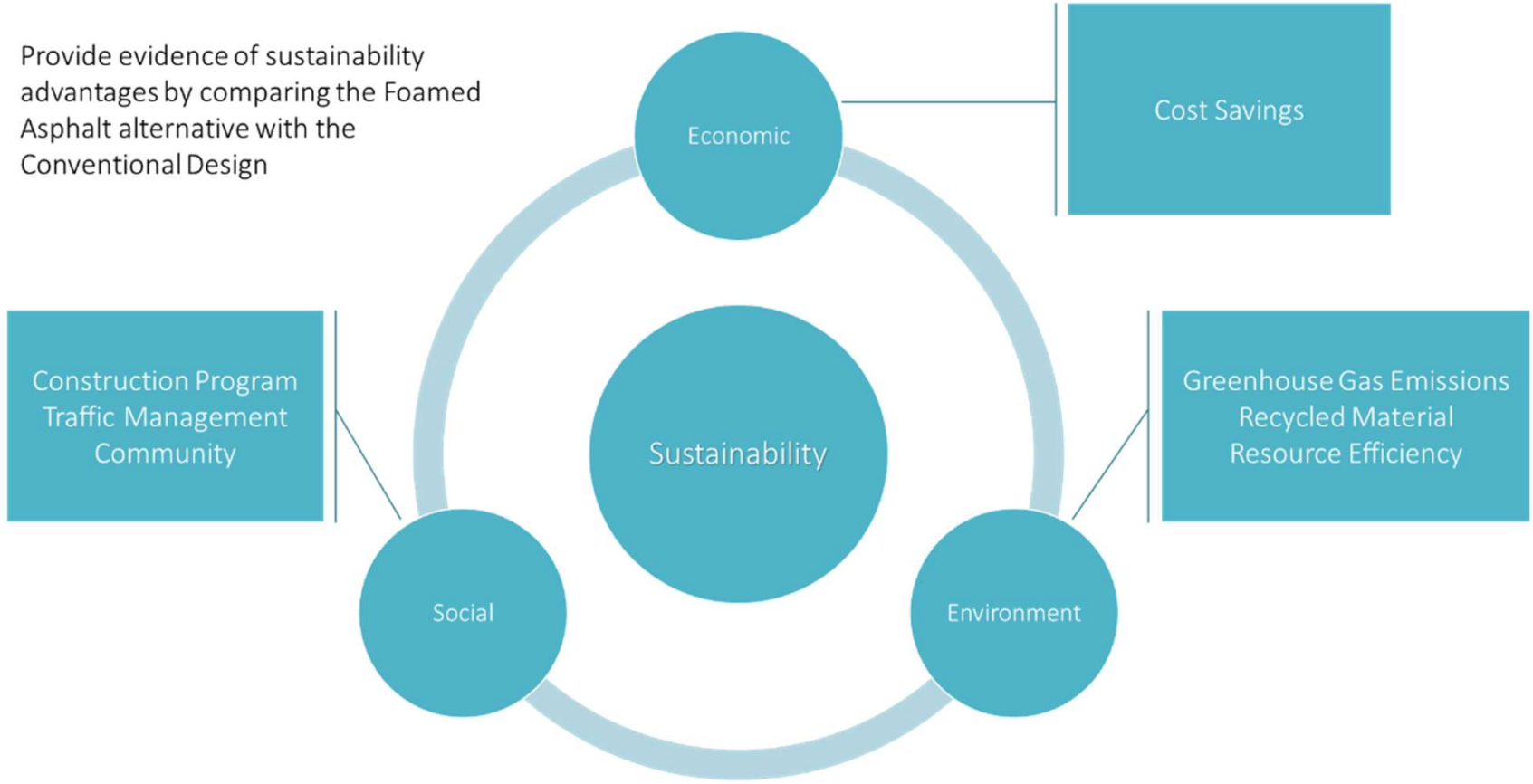
Alternative Foamed Asphalt Design

Layer	Thickness (mm)	Material
Wearing Course	45	AC14
Intermediate Course	45	Reconophalt (asphalt product with high quantities of recycled material from various waste streams)
Spray Seal	10	C170 bitumen single coat (reduced bitumen spread rate by 10%, reduced cutter)
Foamed Asphalt	200	100% recycled existing pavement material using insitu Foamed Asphalt technology – geotechnical engineering
Total Rehabilitated Pavement Thickness	300	
Existing Subbase/Subgrade Foundation Layer		Natural subgrade with design subgrade CBR 3%

- Here is another representation of the Foamed Asphalt pavement layers – it is important to highlight that the design was based on achieving the same performance outcomes as the original design, including a service life of up to and over 20 years.
- The wearing course and intermediate courses remained the same as the original design, i.e. 45mm of size 14 asphalt at the surface over a 45mm intermediate asphalt layer.
- The intermediate asphalt layer was advised to be retained and specifically a product called Reconophalt – this product contains higher amounts of RAP than conventional asphalt and therefore was restricted to the intermediate course and not the surface course. This product also replaces some aggregate with glass and some bitumen with approximately 1% soft plastics.
- It is important to note that the existing road material had to be removed to allow for these overlying layers. Their inclusion varies between projects, but is mainly to protect the critical structural pavement layer below, and also depends on the Client's preferences!
- The Foamed Asphalt Pavement – this is the critical structural layer – is made entirely of 100% existing road pavement materials, which have been geotechnically engineered into an improved material. This is the most fundamental form of recycling and occurs all on site.
- The application of a single coat sprayed seal over the Foamed Asphalt pavement helps with cohesion of the overlying asphalt courses. Although it is important to note that the pavement could be immediately trafficked without a seal, it does help protect the pavement in heavy traffic situations before the protective asphalt layers are applied.
- As a side note - the spray seal has a unique design, requiring less bitumen spray rate and reduced cutter, since the Foamed Asphalt pavement already has bitumen in it.



- The new Foamed Asphalt process was justified by the extraordinary benefits gained. To demonstrate these in a measurable way, a quantified report was undertaken covering the three pillars of sustainability: environment, social and economic.
- Sustainability can be challenging to measure and therefore compare due to the intangible nature of mainly environmental factors. In this sustainability report, all benefits were quantified and we are excited to share the results. It is easy to broadly discuss the benefits of recycling, but to see quantified data helps make evidence-based decisions.
- The results include the cost savings, accelerated construction program, minimised impact to the community, and environmental benefits.

Greenhouse Gas Emissions Measured in Carbon Dioxide Equivalents

- Most processes related to road construction or rehabilitation, such as quarrying, manufacturing materials, transportation, excavation and so forth, are energy consuming processes that require the burning of fossil fuels and contribute emissions to the atmosphere
- Greenhouse gas emissions are overall a good metric to just generally quantify the amount of effort required

Estimated CO_2-e Emissions

Option	Total	Manufacturing of Materials	Construction Activities	Transport
Foamed Asphalt Pavement Recycling	716	666	16	34
Conventional Pavement Types	1815	1686	68	61
Savings/Difference by using Foamed Asphalt	1099	1020	52	26
	61%	61%	76%	44%

- The quantity of greenhouse gas emissions for each option was estimated using an Environmental Calculator. The Environmental Calculator was first developed by Stabilised Pavements Ltd, which is a UK based company belonging to the Stabilised Pavements group of companies. The calculator has been progressively modified accordingly to suit Australian conditions and expanded upon over the course of seven years. The Environmental Calculator is suitable not only for this case, but for other road rehabilitation options beyond the scope of this paper.
- The Environmental Calculator measures the carbon dioxide equivalents (CO_2-e), which is a metric measurement used to encompass different greenhouse gases with different global warming potentials under a single and distinct unit. The CO_2-e for a gas is derived by multiplying the tonnes of the gas by the associated global warming potential. Global warming potential is the heat absorbed by any greenhouse gas in the atmosphere, as a multiple of the heat that would be absorbed by the same mass of CO_2. Such as, the global warming potential for CO_2 is 1, and for other gases it depends on the gas and the time frame assessed (20, 50, or 100 years for example).
- For each option, the Environmental Calculator quantified CO_2-e emitted for:
  - Manufacturing of materials (cradle-to-gate analysis)
  - Transportation of materials and plant
  - On-site construction processes

Recycled Material

- In essence, road rehabilitation is all about the management of road pavement materials
- In fact, the most valuable asset is the existing road pavement
- It may not be pretty and is often overlooked, but has all that is required for a new road if handled correctly!
- In addition to including a Reconophalt product in the wearing course, the entire critical structural pavement layer was recycled using 100% of the existing road pavement resources – all treated in situ.

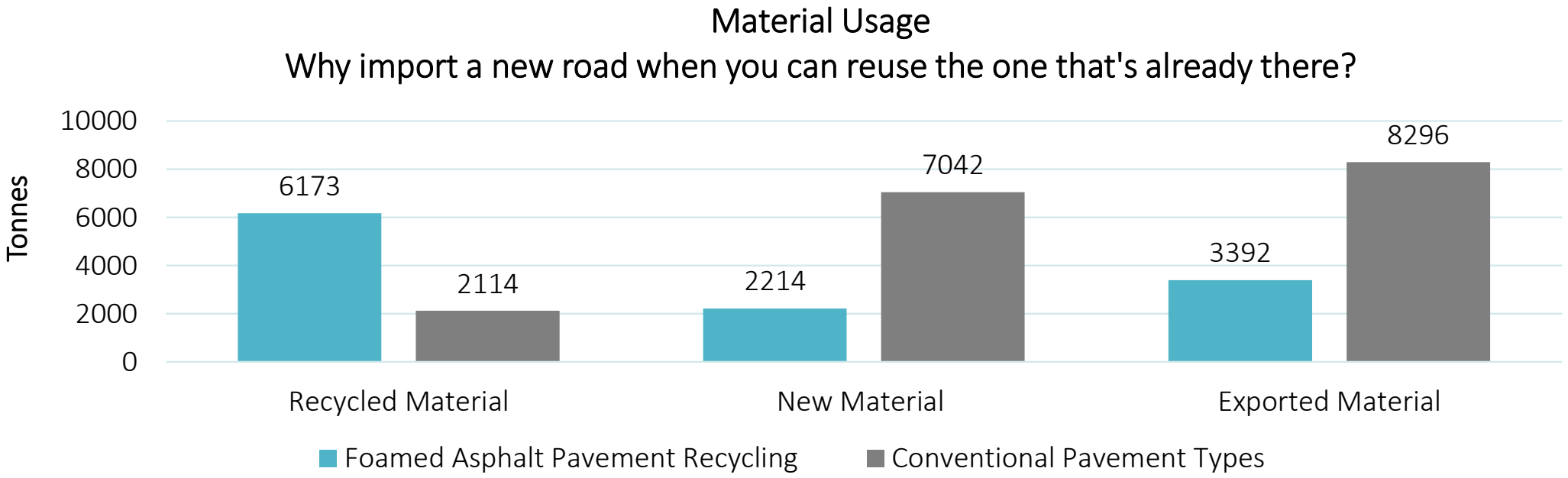
Material Management for Road Rehabilitation Options

Option	Recycled Material	New Material	Exported Material
Foamed Asphalt Pavement Recycling	Existing pavement materials, RAP and any recyclates used in asphalt products such as Reconophalt	Binders, asphalt materials excluding RAP and recyclates, spray seal	Existing material to allow for asphalt wearing courses and seal, approximately 10% treated material to account for bulking due to binders and material handling
Conventional Pavement Types	RAP and any recyclates used in asphalt products such as Reconophalt	Asphalt materials excluding RAP and recyclates, crushed rock and cement for subgrade replacement	Existing materials to allow for new pavement layers

Three areas regarding material management were assessed:

- Recycled Material – including existing pavement materials recycled in situ and any recycled materials used in asphalt products, such as RAP and recyclates (plastics, toners, etc)
- New Material – including materials required to be manufactured from primary sources
- Exported Material – including any material taken away from site, even if it was later brought back to site as RAP in asphalt products

Recycled, New and Imported, and Exported Materials for Road Rehabilitation Options



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Calculations Example

		Project m^2	Project depth (mm)	Material Dry Density (t/m3)	Project tonnes	Material Type/Process	% of supply	Project tonnes	Manufacturing of Materials (Cradle to Gate Analysis) t CO2-e/t	t CO2-e		Recycled (t)	New (t)	Removed (t)
Manufacturing of Materials	Stabilisation/Recycling	13250	200.00	2.00	5300.0	Hydrated Lime	1.5%	79.5	0.8175	64.99		5300.00	79.50	
	Stabilisation/Recycling	13250	200.00	2.00	5300.0	Bitumen	2.5%	132.5	0.63	83.48			132.50	
	Stabilisation/Recycling				0.0	Bitumen	0.0%	0.0	0.63	0.00			0.00	
	Stabilisation/Recycling				0.0	Bitumen	3.0%	0.0	0.63	0.00			0.00	
	Additional Material				0.0	Aggregate	100.0%	0.0	0	0.00			0.00	
	Additional Material					Aggregate			0.1806	0.00			0.00	
	Spray Seal	13250	Bitumen Spray Rate (L/m2)	1.00	13.3	Bitumen	100.0%	13.3	0.63	8.35			13.25	
		0	0.00	2.00	0.0	Aggregate	100.0%	0.0	0.1806	0.0000000			0.00	
	AC14	13250	45.00	2.40	1431.0	AC 10% RAP	100.0%	1431.0	0.21788	311.79		143.10	1287.9000	
	Reconophalt	13250	45.00	2.40	1431.0	AC 50% RAP	100.0%	1431.0	0.13777	197.15	665.75	729.81	701.19000	
Construction Activities	Mill and Load Material onto Trucks (Untreated/Treated Excess)				530.0	mill and load onto trucks, 100%	100.0%	530.0	0.0007975	0.42				530.00
	Mill and Load Material onto Trucks (AC Exported to Downer EDI in Hume for Reuse)				2862.0	mill and load onto trucks, 100%	100.0%	2862.0	0.0007975	2.28				2862.00
	Stabilisation/Recycling	13250	200.00	2.00	5300.0	foamed asphalt	100.0%	5300.0	0.001630839	8.64				
	Stabilisation/Recycling			2.00	0.0	insitu stabilise, BC or SB	100.0%	0.0	0.001509841	0.00				

- Please note this is an actual screenshot of the calculator, but there is more below and more tabs
- Screenshot is for demonstration purposes only
- Any further Environmental Calculator queries can be addressed separate to this presentation

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Construction Program, Traffic Management & Community

- Northbourne Avenue is essential infrastructure and it was utmost importance to keep it open for business!
- This meant a carefully crafted construction program that finished works as quickly as possible, whilst also allowing as much traffic as possible during roadworks.

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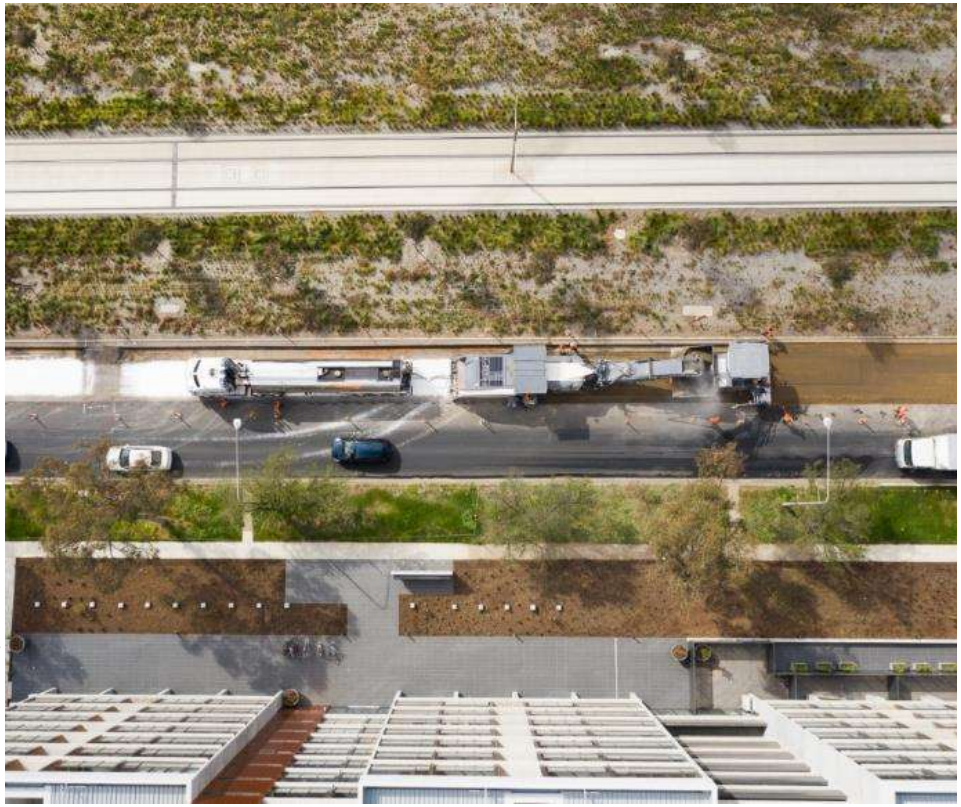
Construction Program

Streamlined Construction Advantages of Foamed Asphalt:



- Continuous, single-pass construction with all recycling occurring in just one pass of the 'train' without reversing
- The ability to recycle multiple road lanes at a time, enabled by the paver screed-board placing material at extensive widths greater than the 3.8m working width of Pavement Recycler
- Treatment and placement of substantial layer thicknesses of up to and over 200mm, which was greater than conventional asphalt and enabled single-layered construction
- The material being treated in situ and mixed separately four times prior to placement, which excluded the need for separate pre-milling to either export material for treatment and effectively achieves uniform blending of pavement layers prior to incorporating treatment additives
- Paver-laid treated material had an initial compaction upon placement and controlled levels, eliminating the need of a grader and requiring only one roller for final compaction

Comparison of Construction Program Metrics

Feature	Preliminary Project	Foamed Asphalt
Construction Program Time	26 weeks total, not accounting for delays.	8 weeks total, with pavement rehabilitation taking only 6 weeks including a week intermission between stages.
Staging	Works undertaken one single lane at a time.	Two stages comprising of two longitudinal segments or 'runs' that covered multiple lanes.
Pavement Types	Two pavement types implemented and requiring alternation eight times along the project.	One pavement design implemented along the project, excluding any isolated areas requiring additional subgrade treatment as identified during works.

26 weeks down to 6 weeks

- Due to these advantages, the following quantified points listed demonstrate the main reasons for the selection of Foamed Asphalt Pavement Recycling as the best option in terms of a streamlined construction whilst minimising disruption to the community
- Most importantly, the in situ recycling resulted in an overall construction program reduction from 26 weeks down to only 6 weeks

Direct Cost Savings of 25%

- There are several basic elements under a life-cycle-analysis model that could be considered as economic costs related to road assets. These are:
  - Initial (or direct) costs
  - Pavement life
  - Maintenance costs
  - Salvage value of pavement [5]
- The scope of this paper assesses the first element only, which is the direct cost of road rehabilitation options. With regard to the second to fourth points, the road rehabilitation options proposed were intended for equivalent design life periods and performance outcomes and therefore these can be considered equal. Also in keeping with the aims of this paper, the complexities of considering these approaches along with the realistic influence of political and financial pressures dictate that the direct cost is the value most significant in the decision-making in determining road pavement rehabilitation options

Paving the way for future projects……

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