Practitioners Guideline: Sustainable road construction practices for Local Government roads in WA

Author: Christine Howland, Danny Feigen, Doug Bartlett and Dr James Grenfell

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1.0

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1	16/08/2023	Christine Howland	Final practitioners guideline for publication.

About LG TRRIP

The Local Government Transport and Roads Research and Innovation Program (LG TRRIP) is administered by the Western Australian Road Research Innovation Program (WARRIP) which is an initiative between Main Roads Western Australia and the Australian Road Research Board.

LG TRRIP has a strategic commitment to the delivery of collaborative research and development that positively contributes to the design, construction and maintenance of safe, sustainable transport infrastructure in Western Australia.

Summary

The National Waste Policy Action Plan 2019 was prepared by the Australian, State and Territory governments, and Australian Local Government Association. It sets a target of 80% resource recovery by 2030. Actions include the development of national standards and specifications for the use of recycled content in construction, prioritising road construction. WA's Waste Avoidance and Resource Recovery Strategy 2030 sets targets of increasing material recovery to 70% by 2025 and to 75% by 2030.

The State Road Funds to Local Government Agreement (STRFLGA) 2023 onwards will likely include a commitment for Local Governments to increase usage of recycled materials in road construction. During the term of the Agreement Main Roads WA, WALGA and Regional Road Groups (RRGs) will develop system/s and process/s for supporting, monitoring and reporting the use of recycled materials.

The viability and range of recycled materials and sustainable activities suitable for adoption on local roads in WA is not well understood and to achieve the SRFLGA commitments, Local Governments will require support and guidance to be able to make decisions for the adoption of sustainable practices.

This practitioners guideline has been developed to assist Local Governments in Western Australia to make informed decisions for the use of recycled materials and sustainable practices in road preservation and upgrade activities.

Acknowledgements

The ARRB/NTRO authors would like to acknowledge the collaborative input of the Western Australia Local Government Association (WALGA) and the local government practitioners and suppliers who provided valuable input during the stakeholder engagement process. In particular, the authors would like to thank the LG TRRIP Program Manager, Mark Bondietti from WALGA.

ARRB/NTRO – YOUR NATIONAL TRANSPORT RESEARCH ORGANISATION

ABN 68 004 620 651
National Transport Research Centre and Head Office: 80a Turner St, Port Melbourne, 3207 VIC, Australia
With offices in Perth, Brisbane, Sydney, Adelaide, and Canberra.
arrb.com.au

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1 Introduction

1.1 Background

This guideline has been developed by the National Transport Research Organisation (NTRO) for the Western Australian Local Government Association (WALGA) with the support of Main Roads Western Australia (MRWA) under the Local Government Transport and Roads Research and Innovation Program (LG TRRIP).

In 2022, MRWA and WALGA established a research and innovation program dedicated to the needs of the local government road network in WA, branded as LG TRRIP.

The objective of the program is to achieve better implementation of innovative practices by improving the specialist capability of local government through a collaborative program of projects which deliver advanced technology and cost-effective solutions to roads and transport issues for the people of Western Australia (WA).

1.2 Purpose

The viability and range of recycled materials and sustainable activities suitable for adoption on local roads in WA is not well understood. Local governments require support and guidance to be able to make decisions for the selection of suitable materials and practices. The remoteness and resource capacity of many local governments presents significant challenges.

This *Practitioners Guideline: Sustainable road construction practices for Local Government roads in WA* (the Guideline) has been prepared to enable and support local government implementation of sustainable road construction initiatives within WA.

The Guideline is designed to assist local governments to make informed decisions for the use of recycled materials and sustainable practices in road construction and preservation works. The objective of the Guideline is to present a decision methodology that local governments can use to inform the availability and applicability of suitable recycled materials and sustainable construction practices based on the type of project and its locality.

1.3 Structure

The following documents have been prepared:

- **Practitioners Guideline** (this document)
- Technical Report.

The content and relationship between these 2 documents are summarised in Table 1.1.

Table 1.1: Structure of the documents

Document	Content
Practitioners Guideline	A practitioners guideline in a user-friendly format. The key content is included in tables and graphical formats to provide practical solutions interpretable by non-technical practitioners.
Technical Report	The technical report containing all of the background research and supporting technical information required for the development of the practitioners guideline.

1.4 How to use this Guideline

The following items have been included within the guideline:

- sustainability and waste management context
- road construction in WA
  - funding context
  - road construction scenarios (locality and project type)
- selecting appropriate recycled materials and sustainable road construction practices
  - from the perspective of the overall project
  - the selection process
  - a feasibility check
  - the way forward
- recommended applications
- appendices:
  - factsheets for each recycled material and sustainable road construction practice
  - example scenarios.

2 Sustainability and Waste Management

2.1 Sustainability Context and Waste Targets

International momentum in the sustainable development space has both enabled and supported the development and implementation of policy and action within Australia. In support of the sustainable development goals and the principles of sustainability, Australia has developed the 2018 *National Waste Policy* (Department of Climate Change, Energy, the Environment and Water 2018) and the 2019 *National Waste Policy: Action Plan* (Department of Climate Change, Energy, the Environment and Water 2019). The 2018 *National Waste Policy* drives the integration of recycled materials in infrastructure and introduces the concept of the circular economy. This involves shifting social practice from 'take, make, use and dispose' to an approach where the useful value of resources is maintained for as long as feasibly possible.

The 2019 *National Waste Policy: Action Plan* includes quantifiable targets to measure the success of implementation. These targets are supported through the WA *Waste Avoidance and Resource Recovery Strategy 2030* (Waste Authority 2019). The applicable objectives and targets set out in this strategy are detailed in Figure 2.1.

Figure 2.1: WA Waste Avoidance and Resource Recovery targets

Avoid	Recover	Protect
Western Australians generate less waste.	*Western Australians recover more value and resources from waste.*	***Western Australians protect the environment by managing waste responsibly.***
2025 – 10% reduction in waste generation per capita **2030** – 20% reduction in waste generation per capita	**2025** – Increase material recovery to 70% **2030** – Increase material recovery to 75% **From 2020** – Recover energy only from residual waste	**2030** – No more than 15% of waste generated in Perth and Peel regions is landfilled **2030** – All waste is managed and/or disposed to better practice facilities

Source: Waste Authority (2019).

The WA *Waste Avoidance and Resource Recovery Strategy 2030* (Waste Authority 2019) supports a sustainable, low waste, circular economy in which human health and the environment are protected from the impacts of waste. To achieve this, it is recognised much of the waste that is generated in the state must be valued as a resource that can be re-used or recycled for the benefit of the economy.

2.2 Legislative Framework

The Guideline has been prepared in general accordance with the processes and requirements outlined in current legislation, industry standards and best practice guidelines as set out in:

- Commonwealth:
  - 2018 *National Waste Policy* (Department of Climate Change, Energy, the Environment and Water 2018)
  - 2019 *National Waste Policy: Action Plan* (Department of Climate Change, Energy, the Environment and Water 2019)
- WA:
  - *Environmental Protection Act 1986* (EP Act)
    - Environmental Protection Regulations 1987 (EP Regulations)
  - *Environmental Protection (Landfill) Levy Act 1998*
  - *Health (Miscellaneous Provisions) Act 1911* (Health Act)

- *Land Administration Act 1997*
- *Local Government Act 1995*
  - Local Government (Uniform Local Provisions) Regulations 1996
- *Main Roads Act 1930*
- *Public Works Act 1902*
- *Waste Avoidance and Resource Recovery Act 2007* (WARR Act)
- *Waste Avoidance and Resource Recovery Levy Act 2007* (WARR Levy Act)
  - Waste Avoidance and Resource Recovery Levy Regulations 2008
- *Work Health and Safety Act 2020 (WHS Act)*
  - Work Health and Safety (General) Regulations 2022 (WHS Regulations)

This legislation outlines the current requirements with respect to:

- waste management
- environmental protection and licensing
- work health and safety
- legislation for the management of local roads.

Please refer to the WA legislation web site for copies of the relevant legislation, available for free via https://www.legislation.wa.gov.au/. Additional guidance on the requirements of the applicable legislation and other requirements is detailed in the technical report.

2.3 Health, Safety and Environmental Impacts

Upon sourcing a recycled material for use in road construction, a Safety Data Sheet (SDS) should be obtained from the supplier (refer Section 4.3). Where local government is processing waste materials for use in road construction, an SDS may need to be generated. The SDS should provide specific information with respect to health, safety and environmental hazards, material properties and other relevant information.

Further information on the potential environmental and human health impacts associated with each recycled material is detailed in the technical report and summarised in the factsheets in Appendix A.

2.4 Sustainable Road Construction Principles

In support of the use of recycled materials in road construction, or the implementation of sustainable road construction practices, it is essential that the following pillars of sustainability are considered (refer Figure 2.2).

Figure 2.2: Pillars of road construction sustainability

3 Road Construction in Western Australia

3.1 Funding Context

Through the *State Road Funds to Local Government Agreement 2023/24 to 2027/28* (MRWA 2023), local government is allocated a portion of funding from motor vehicle licence fee collections for works on local government roads. This includes:

- direct grants for local roads (untied funding for routine maintenance)
- road project grants (specific preservation and improvement high-priority projects)
- the State Black Spot Program (for improving road safety in high-risk crash zones).

The Agreement states:

> As part of this Agreement, Local and State Governments commit to:
>
> Increasing sustainable road construction practices through the greater use recycled materials.

and;

> Within the first two years of this Agreement Main Roads Western Australia, WALGA and RRGs will collaborate to establish a system(s) / process(s) for monitoring, reporting and advancing the use of recycled materials focusing, but not limited to, LGA works funded within this Agreement.

This Guideline responds to this commitment.

Funds provided through the *State Road Funds to Local Government Agreement* can cover 100% of funding (via direct grants and Australian Black Spot Program grants), or up to two-thirds (66%) of funding via the other funding sources. Whilst this Guideline is supported by and targeted to projects funded through the Agreement, it is envisaged that it will be suitable for use for all local government road construction works.

3.2 Road Construction Scenarios

This Guideline is designed to support road managers to make decisions at the project level. The decision process in this Guideline, therefore, covers the range of project scenarios likely to be encountered across the state. The scenarios are defined in terms of the type of work and the locality, which are the most likely drivers defining the availability and applicability of recycled materials and sustainable practices.

The road construction scenarios have been prepared to support the effective implementation of this Guideline. These scenarios have been based on 2 key factors:

- localities
- project types.

3.2.1 Localities

WA is the largest state by area in Australia. The majority of the population in WA lives in and around the greater Perth Region, with 80% of the population residing in 0.25% of the total available land area (approximately 253 billion hectares) (Australian Bureau of Statistics 2021). As such, different areas within WA require different types of road construction. To facilitate the implementation of this Guideline, despite the vast locality differences, the following localities have been established:

- Metropolitan
- Regional (includes outer Metropolitan)

- Remote/Very Remote.

These localities are shown in Figure 3.1 and have been further detailed in Table 3.1.

Figure 3.1: Localities in WA

Table 3.1: Locality challenges and opportunities

Locality	Description	Challenges	Opportunities
Metropolitan	Metropolitan WA is positioned to the southwest and primarily includes the greater Perth Region.	• High volume of road users to manage during construction. • Higher engineering performance requirements. • Low cost of transport waste to landfill, countered by high landfill charges.	• High availability of suppliers within close proximity. • Reduced cost of transport for recycled materials.
Regional	Regional WA is positioned to the southwest in an inner regional area and an outer regional area surrounding the greater Perth Region.	• Longer distance for transport of supplies (primarily outer regional areas). • Higher cost of transport for recycled materials. • Lower waste levy for landfill in regional areas. • Environmentally sensitive ecosystems. • Some local governments have limited resources and expertise.	• Apart from the newer urban areas, lower volume of road users than in metropolitan areas. • Greater opportunity for own waste sourcing and separation. • Greater opportunity for partnerships with large private operators e.g. mines.

Locality	Description	Challenges	Opportunities
Remote	A large portion of regional WA is positioned to the southwest surrounding the regional areas, with small isolated regional zones along the northwest coastline.	• Limited suppliers within close proximity. • Long distances for transport of supplies. • Lower waste levy for landfill in regional areas. • Environmentally sensitive ecosystems. • Local governments have limited resources and expertise.	• Low volume of road users. • Potential for equipment and machinery to be available in (relatively) close proximity due to the prevalence of the mining industry in WA. • Greater opportunity for own waste sourcing and separation. • Greater opportunity for partnerships with large private operators e.g. mines.
Very remote	The majority of Western Australia (by area) is considered very remote. It generally includes all areas outside of the state's southwest.	• Limited suppliers within close proximity. • Long distances for transport of supplies. • Environmentally sensitive ecosystems. • Local governments have limited resources and expertise.	• Low volume of road users. • Potential for equipment and machinery to be available in (relatively) close proximity due to the prevalence of the mining industry in WA. • Greater opportunity for own waste sourcing and separation. • Greater opportunity for partnerships with large private operators e.g. mines.

3.2.2 Project Types

Whilst it is envisaged that this Guideline will support improvements to sustainability in all road construction projects, several key project types have been identified as ideal for implementation. It is noted that these types of projects are typically funded through the state roads agreement.

Key project types, to which this Guideline would apply, include:

- granular resheets/stabilisation (rural/regional)
- seal/reseal (regional/rural)
- rehabilitation base and seal (rural/regional)
- upgrade widening (all)
- asphalt overlay (metro)
- metro rehabilitation (mill and re-mill) – base rehabilitation
- improvement projects (all) – e.g., new carriageway, turning lanes, traffic circles etc.

The applicability of sustainable road construction options for each project is detailed further in Section 4.

4 Process for Selecting Appropriate Recycled Materials and Sustainable Road Construction Practices

4.1 The Overall Process

The selection of recycled materials and sustainable road construction practices for integration in road construction is one element of a greater road construction project. For each project type, the steps outlined in Figure 4.1 and detailed in Table 4.1 would generally be undertaken to improve sustainability outcomes.

Figure 4.1: Sustainable road construction overall project flow

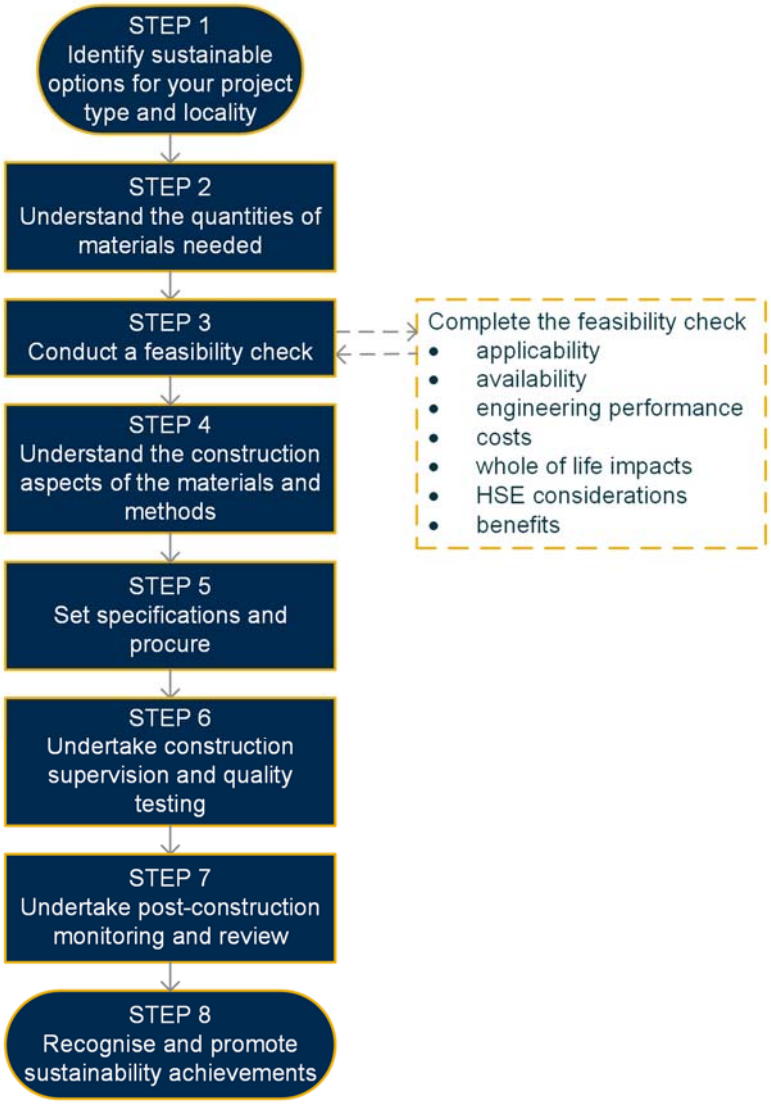


Table 4.1: Sustainable road construction overall project flow

Step	Purpose
1. Identify sustainable options (refer Section 4.2)	For the specific project type completed within the locality of the local government, identify possible recycled materials or sustainable road construction practices that could be included for each road infrastructure component. Each road infrastructure component (e.g. seals, asphalt, embankments, etc.) within the road construction project may have several different types of recycled materials that could be incorporated.

Step	Purpose
	The factsheets included within Appendix A provide guidance for identifying possible recycled materials and sustainable road construction practices.
2. Understand the quantities of materials needed	To increase the portion of recycled materials that are used in road construction, the local government needs to have an understanding of the material's quantities that are going to be needed from its capital and maintenance works programs. This will guideline the quantity of materials that may potentially be exchanged for recycled materials.
3. Conduct a feasibility check (refer Section 4.2 and Appendix A)	Conduct a feasibility check to identify the most appropriate sustainable options. The feasibility check will include, but not be limited to, a review of the following key aspects: • applicability • availability • engineering performance • cost implications • whole-of-life factors • health, safety and environmental considerations • environmental benefits. Where a significant concern is identified, undertake a risk assessment and include it in the feasibility check. Information on these key aspects has been summarised within the factsheets in Appendix A and is detailed within the technical report.
4. Understand construction aspects of using the materials and methods	As the local governments plan for construction, they may need to consider: • Are there any handling or use characteristics of the material that are different to 'standard' or unmodified materials? • Who in the supply chain and construction project needs to know about the products, for site safety, safe working practices, quality and efficiency? • Will the public, as people passing the work site, need any different standard of care? • Will the ultimate users need information about using the constructed products that is different to standard materials? • What type of information should be provided to the public, and should this be presented as an opportunity (saving the environment), cautious (mind the hazards), or both?
5. Set specifications for the material and works and procure	The specifications for the selected recycled materials and sustainable road construction practices are included within the factsheets in Appendix A. The details of the specifications should be considered and distributed during the procurement process.
6. Undertake construction supervision and quality testing	The next actions for the local government are to: • Review safe work method statements, job safety analyses and similar work procedures as required so that they include the recycled materials. • Supervise the works and arrange quality control tests. • Maintain appropriate diary and job records on the aspects of working with the recycled material products, in anticipation of future project reviews. At this stage it is important to keep good records to monitor the life of the assets over the long term. • Arrange project practical completion and handover of records to the asset management teams, ensuring that the recycled material's information is clearly identified.

Step	Purpose
7. Undertake post-construction monitoring and review	As part of the material's life cycle plan that was developed earlier, the local government should arrange post-construction inspections, testing and assessment. This may include: • periodic inspections of the constructed product during the defects liability period, and post construction at 12 and 24 months • enhanced inspections as part of routine asset condition inspection cycles, to specifically identify the effect of the recycled materials on condition • further quality control testing at 12 and 24 months, suited to the usual testing regime of the product type, and then assessment of the test results • user surveys and feedback. The local government also needs to include recycled materials as an agenda item in project review meetings. The project review meetings should include experiences related to the recycled material products such as: • the procurement of the products • supplier capability • transport and delivery • quality control by inspection and testing • site works productivity • site and public safety • communications and engagement results • planning of additional communications if considered appropriate • cost.
8. Recognise and promote sustainability achievements	Having successfully incorporated recycled materials into the construction project, those materials have been prevented from ending up in landfill (or unusable stockpiles), and this has contributed to WA sustainability and its environment. Celebrate and let the community know the great work that has been done!

4.2 Selection Process for Improved Sustainability

This Guideline has been structured to align with the requirements associated with the WA-specific locality constraints and project types. Recycled materials and sustainable road construction practices have been highlighted where applicable for the infrastructure components associated with each project type (e.g. seals). The availability of those materials in each locality is then discussed.

Additional key aspects for consideration (e.g. engineering performance, health, safety and environmental impacts) for recycled materials and sustainable road construction practices are described in individual factsheets in Appendix A. The following factsheets are available:

Recycled materials

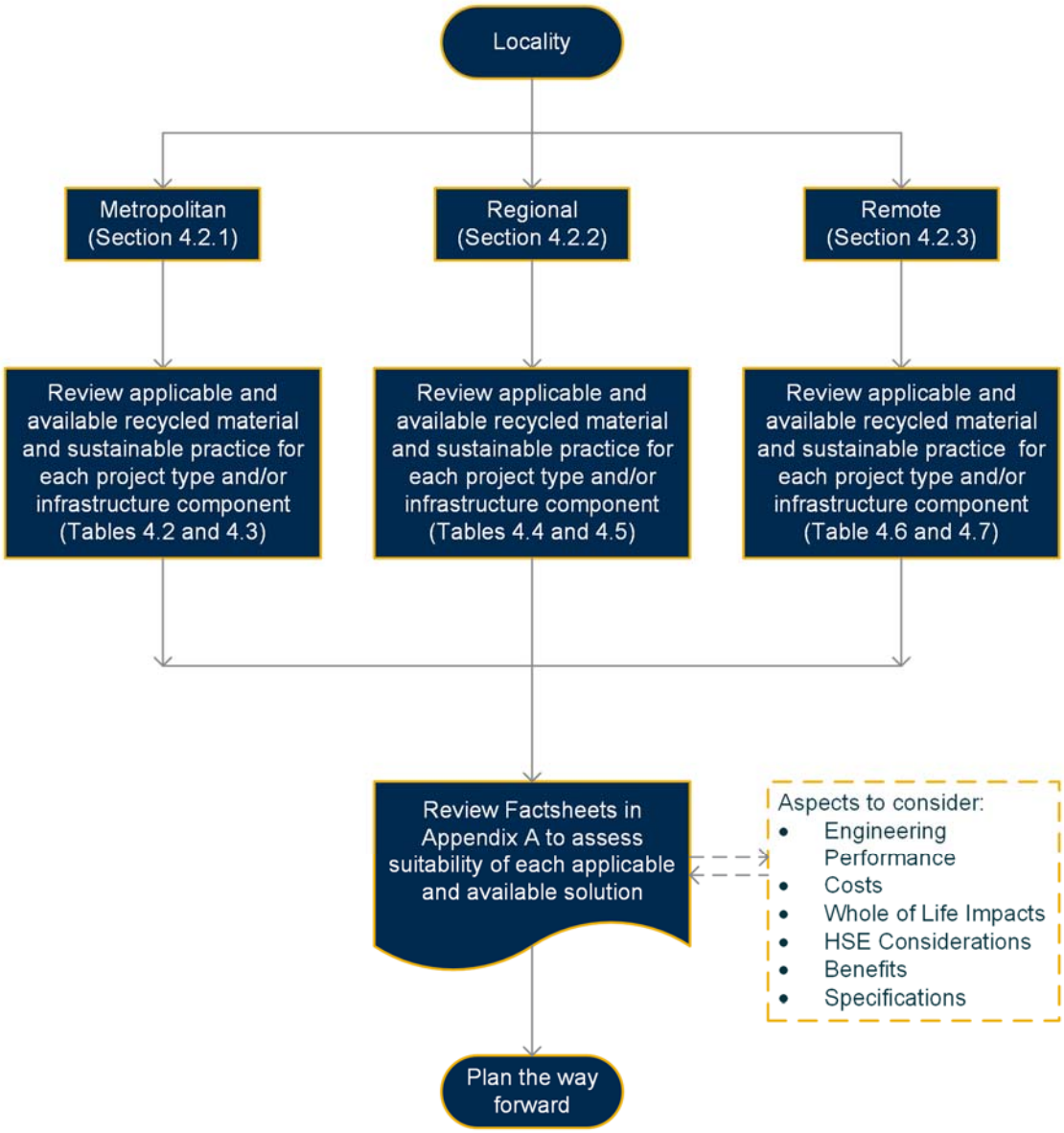
- Reclaimed asphalt pavement (RAP)
- Crushed recycled concrete and crushed brick
- Recycled crushed glass
- Crumb rubber
- Fly ash
- Bottom ash
- Blast furnace slag
- Food and garden organics
- Recycled plastics
- Recycled materials in road furniture.

Sustainable road construction practices

- Foamed bitumen stabilisation
- Bitumen emulsion stabilisation
- Cementitious stabilisation
- Soil/Subgrade stabilisation
- Warm mix asphalt
- Hot in place asphalt recycling
- Insitu recycling of concrete pavements
- Marginal and non-standard materials.

A flow chart outlining the implementation process has been included in Figure 4.2.

Figure 4.2: Implementation flow chart



In addition, there is an opportunity for local governments to conduct their own waste sourcing and separation. This may be of particular relevance for recycled materials including:

- Crushed recycled concrete and crushed brick
- Recycled crushed glass
- Food and Garden Organics (FOGO)

- Recycled plastics.

To understand the viability the requirements for this process, please refer to the technical report, Section 8.

4.2.1 Metropolitan

Metropolitan WA is positioned to the southwest and primarily includes the greater Perth Region. As the majority of WA's population resides in and around the metropolitan area, the majority of local government areas are also metropolitan based.

There are specific challenges and opportunities with respect to road construction in metropolitan areas. For example, the high volume of road users may present a significant challenge during construction and may influence higher engineering performance requirements. However, the higher availability of recycled material suppliers within close proximity presents a valuable opportunity. Further details on the challenges and opportunities for road construction within metropolitan areas is detailed in Table 3.1.

Limited or no new road construction works typically occur in metropolitan areas as these areas are generally significantly developed. As such, the following key project types have been identified as being relevant for road construction works within metropolitan areas:

- upgrade widening
- asphalt overlay
- metro rehabilitation (mill and re-mill) – base rehabilitation
- improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.

Each project type has nominated infrastructure components which may be redeveloped during construction. Recycled materials applicable to each project and infrastructure component is shown in Table 4.2. The potential availability of the materials, based on the desktop study and supplier engagement process (described in the technical report) is also shown.

Table 4.2: Recycled materials in metropolitan areas

Project type	Infrastructure component	Recycled materials[1]								
		RAP	Crushed recycled concrete and crushed brick	Recycled crushed glass	Crumb rubber	Fly ash	Bottom ash	Blast furnace slag	Food and garden organics (FOGO)	Recycled plastics
Upgrade widening	Seals				✓					R
	Asphalt	✓		✓	✓	✓		✓		R
	Unbound pavements	✓	✓	✓		✓	IS	✓		R
	Concrete		✓	✓		✓	R	✓		R
	Earthworks/Embankments	✓	✓	✓		✓	R	✓		
	Ancillaries	✓	✓	✓	✓	✓	R	✓	✓	✓
Asphalt overlay	Asphalt	✓		✓	✓	✓		✓		R
Metro rehabilitation (mill and re-mill) – base rehabilitation	Seals				✓					R
	Asphalt	✓		✓	✓	✓		✓		R
	Unbound pavements	✓	✓	✓		✓	IS	✓		R
	Concrete		✓	✓		✓	R	✓		R

Project type	Infrastructure component	Recycled materials[1]								
		RAP	Crushed recycled concrete and crushed brick	Recycled crushed glass	Crumb rubber	Fly ash	Bottom ash	Blast furnace slag	Food and garden organics (FOGO)	Recycled plastics
Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.	Seals				✓					R
	Asphalt	✓		✓	✓	✓		✓		R
	Unbound pavements	✓	✓	✓		✓	IS	✓		R
	Concrete		✓	✓		✓	R	✓		R
	Earthworks/Embankments	✓	✓	✓		✓	R	✓		
	Ancillaries	✓	✓	✓	✓	✓	R	✓	✓	✓

1. Recycled materials are linked to the product factsheets in Appendix A.

Applicability Key:

✓ = Application in specifications in WA.
IS = Specifications available in other states.
R = Research underway.

Availability Key:

= Readily available from most suppliers.
= Some availability from some suppliers.
= Limited availability in quantity or by number of suppliers.

Sustainable construction practices applicable to each project and infrastructure component are shown in Table 4.3.

Table 4.3: Sustainable practices in metropolitan areas

Project type	Sustainable road construction practices[1]							
	Foamed bitumen stabilisation	Bitumen emulsion stabilisation	Cementitious stabilisation	Soil/Subgrade stabilisation	Warm mix asphalt	Hot in place asphalt recycling	Insitu recycling of concrete pavements	Marginal and non-standard materials
Upgrade widening	✓	✓	✓	✓	✓			✓
Asphalt overlay					✓	✓		
Metro rehabilitation (mill and re-mill) – base rehabilitation	✓	✓			✓	✓		
Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.	✓	✓	✓	✓	✓	✓	✓	✓

1. Recycled materials are linked to the product factsheets in Appendix A.

Applicability Key:

✓ = Application in specifications in WA.
IS = Specifications available in other states.
R = Research underway.

Availability Key:

To be determined by local practitioners.

4.2.2 Regional

Regional WA is positioned to the southwest surrounding the greater Perth Metropolitan Region. These areas are not directly within metropolitan areas and hence, recycled material suppliers are not present to the same extent; however, the distances from regional areas to these suppliers are not likely to hinder their usage.

There are specific challenges and opportunities with respect to road construction in regional areas. For example, the higher cost for transport of recycled materials and sustainable construction equipment may present a challenge. Further details on the challenges and opportunities for road construction within regional areas is detailed in Table 3.1.

The following key project types have been identified as being relevant for road construction works within regional areas:

- granular resheets/stabilisation
- seal/reseal
- rehabilitation base and seal
- upgrade widening
- improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.

Each project type has nominated infrastructure components which may be redeveloped during construction. Recycled materials applicable to each project and infrastructure component is shown in Table 4.4. The potential availability of the materials, based on the desktop study and supplier engagement process is also shown.

Table 4.4: Recycled materials in regional areas

Project type	Infrastructure component	Recycled materials[1]								
		RAP	Crushed recycled concrete and crushed Brick	Recycled crushed glass	Crumb rubber	Fly ash	Bottom ash	Blast furnace slag	Food and garden organics (FOGO)	Recycled plastics
Granular resheets/ stabilisation	Unbound pavements	✓	✓	✓		✓	IS	✓		R
	Concrete		✓	✓		✓	R	✓		R
	Earthworks/Embankments	✓	✓	✓		✓	R	✓		
Seal/reseal	Seals				✓					R
	Asphalt	✓		✓	✓	✓		✓		R
Rehabilitation base and seal	Seals				✓					R
	Asphalt	✓		✓	✓	✓		✓		R
	Unbound pavements	✓	✓	✓		✓	IS	✓		R
	Concrete		✓	✓		✓	R	✓		R
Upgrade widening	Seals				✓					R
	Asphalt	✓		✓	✓	✓		✓		R
	Unbound pavements	✓	✓	✓		✓	IS	✓		R
	Concrete		✓	✓		✓	R	✓		R
	Earthworks/Embankments	✓	✓	✓		✓	R	✓		
	Ancillaries	✓	✓	✓	✓	✓	R	✓	✓	✓

Project type	Infrastructure component	Recycled materials[1]								
		RAP	Crushed recycled concrete and crushed Brick	Recycled crushed glass	Crumb rubber	Fly ash	Bottom ash	Blast furnace slag	Food and garden organics (FOGO)	Recycled plastics
Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.	Seals				✓					R
	Asphalt	✓		✓	✓	✓		✓		R
	Unbound pavements	✓	✓	✓		✓	IS	✓		R
	Concrete		✓	✓		✓	R	✓		R
	Earthworks/Embankments	✓	✓	✓		✓	R	✓		
	Ancillaries	✓	✓	✓	✓	✓	R	✓	✓	✓

1. Recycled materials are linked to the product factsheets in Appendix A.

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R = Research underway.

Availability Key:

= Readily available from most suppliers.
= Some availability from some suppliers.
= Limited availability in quantity or by number of suppliers.

Sustainable construction practices applicable to each project and infrastructure component are shown in Table 4.5.

Table 4.5: Sustainable practices in regional areas

Project type	Sustainable road construction practices[1]							
	Foamed bitumen stabilisation	Bitumen emulsion stabilisation	Cementitious stabilisation	Soil/Subgrade stabilisation	Warm mix asphalt	Hot in place asphalt recycling	Insitu recycling of concrete pavements	Marginal and non-standard materials
Granular resheets/stabilisation	✓	✓	✓					✓
Seal/reseal					✓	✓		
Rehabilitation base and seal	✓	✓		✓	✓	✓		✓
Upgrade widening	✓	✓	✓	✓	✓			✓
Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.	✓	✓	✓	✓	✓	✓	✓	✓

1. Recycled materials are linked to the product factsheets in Appendix A.

Applicability Key:

✓ = Application in specifications in WA.
IS = Specifications available in other states.
R = Research underway.

Availability Key:

To be determined by local practitioners.

4.2.3 Remote/Very Remote

Remote WA is positioned to the southwest surrounding the greater WA regional area, with a small isolated regional zone along the northwest coastline. Very remote WA includes the remaining areas within WA not included in the sections above. The majority of WA (by area) is considered very remote.

There are specific challenges and opportunities with respect to road construction in remote and very remote areas. For example, the limited suppliers within close proximity and long distances for transporting supplies may present a challenge. Further details on the challenges and opportunities for road construction within remote and very remote areas are detailed in Table 3.1.

The following key project types have been identified as being relevant for road construction works within remote and very remote areas:

- granular resheets/stabilisation
- seal/reseal
- rehabilitation base and seal
- upgrade widening.
- improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.

Each project type has nominated infrastructure components which may be redeveloped during construction. Recycled materials applicable to each project and infrastructure component is shown in Table 4.6. The potential availability of the materials, based on the desktop study and supplier engagement process is also shown.

Table 4.6: Recycled materials in remote areas

Project type	Infrastructure component	Recycled materials(1)								
		RAP	Crushed recycled concrete and crushed brick	Recycled crushed glass	Crumb rubber	Fly ash	Bottom ash	Blast furnace slag	Food and garden organics (FOGO)	Recycled plastics
Granular resheets/ stabilisation	Unbound pavements	✓	✓	✓		✓	IS	✓		R
	Concrete		✓	✓		✓	R	✓		R
	Earthworks/Embankments	✓	✓	✓		✓	R	✓		
	Ancillaries	✓	✓	✓	✓	✓	R	✓	✓	✓
Seal/reseal	Seals				✓					R
	Asphalt	✓		✓	✓	✓		✓		R
Rehabilitation base and seal	Seals				✓					R
	Asphalt	✓		✓	✓	✓		✓		R
	Unbound pavements	✓	✓	✓		✓	IS	✓		R
	Concrete		✓	✓		✓	R	✓		R
Upgrade widening	Seals				✓					R
	Asphalt	✓		✓	✓	✓		✓		R
	Unbound pavements	✓	✓	✓		✓	IS	✓		R
	Concrete		✓	✓		✓	R	✓		R
	Earthworks/Embankments	✓	✓	✓		✓	R	✓		

Project type	Infrastructure component	Recycled materials(1)								
		RAP	Crushed recycled concrete and crushed brick	Recycled crushed glass	Crumb rubber	Fly ash	Bottom ash	Blast furnace slag	Food and garden organics (FOGO)	Recycled plastics
	Ancillaries	✓	✓	✓	✓	✓	R	✓	✓	✓
Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.	Seals				✓					R
	Asphalt	✓		✓	✓	✓		✓		R
	Unbound pavements	✓	✓	✓		✓	IS	✓		R
	Concrete		✓	✓		✓	R	✓		R
	Earthworks/Embankments	✓	✓	✓		✓	R	✓		
	Ancillaries	✓	✓	✓	✓	✓	R	✓	✓	✓

1. Recycled materials are linked to the product factsheets in Appendix A.

Applicability Key:

✓ = Application in specifications in WA.
IS = Specifications available in other states.
R = Research underway.

Availability Key:

= Readily available from most suppliers.
= Some availability from some suppliers.
= Limited availability in quantity or by number of suppliers.

Sustainable construction practices applicable to each project and infrastructure component are shown in Table 4.7.

Table 4.7: Sustainable practices in remote areas

Project type	Sustainable road construction practices(1)							
	Foamed bitumen stabilisation	Bitumen emulsion stabilisation	Cementitious stabilisation	Soil/Subgrade stabilisation	Warm mix asphalt	Hot in place asphalt recycling	Insitu recycling of concrete pavements	Marginal and non-standard materials
Granular resheets/stabilisation	✓	✓	✓					✓
Seal/reseal					✓	✓		
Rehabilitation base and seal	✓	✓		✓	✓	✓		✓
Upgrade widening			✓	✓	✓			✓
Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.	✓	✓	✓	✓	✓	✓	✓	✓

1. Recycled materials are linked to the product factsheets in Appendix A.

Applicability Key:

✓ = Application in specifications in WA.
IS = Specifications available in other states.
R = Research underway.

Availability Key:

To be determined by local practitioners.

4.3 Feasibility Check

From the perspective of project and program management, a feasibility check is needed to determine the costs, factors and risks of introducing recycled materials or methods into road construction.

The feasibility check will be conducted to identify the most appropriate sustainable options, if any are appropriate. The feasibility check will include, but not be limited to, a review of the key criteria outlined in Table 4.8. It is expected that the practitioner will consider these criteria as part of their normal project planning processes.

This feasibility check and processes is presented from the perspective of the works, project or construction manager. To understand financial viability from the perspective of the waste manager please refer to the technical report, Section 8.

Table 4.8: Aspects to consider during the feasibility check

Item	Summary
Applicability	• Refer Step 1. • Identify any project constraints such as time and quality that may prevent a recycled material's product from being utilised.
Availability	• Refer Step 1. • Seek advice from the local government's waste operations, and contact product suppliers and recycled material suppliers, to determine the availability of alternative materials for inclusion in the project(s).
Engineering performance	• Consider the durability requirements for the project (e.g. is the road highly trafficked, an unsealed road, etc).
Cost implications	• Undertake a cost analysis of the impact of using the different recycled materials in the projects and programs. • Elements to consider may include a comparison of virgin materials vs recycled materials, transportation costs, etc.
Whole-of-life factors	• At the end of the pavement life, can the road be recycled?
Health, safety and environmental considerations	• Is the road being constructed in a particularly sensitive location? • Are there any potential contamination, workplace exposure, cultural or community considerations that need to be taken into account? • Identify project risks that may be increased or reduced as a result of using the recycled material's products
Environmental benefits	• Identify the local benefits of using each recycled material, which may include tangible savings from reductions of waste-to-landfill, and intangible benefits such as life of products, local employment, and sustainability objectives.

4.4 Way Forward

When considering the potential to use recycled materials and sustainable road construction practices, the recommendation is for local governments to adopt the Process for Selecting Appropriate Recycled Materials and Sustainable Road Construction Practices in this section. While the process identifies many steps and aspects to consider, by taking a methodical approach, the local government practitioner should be able to reach suitable solutions for their projects and programs of work. It is expected that the adoption of the process will also guide local governments towards improving their overall decision-making practices for projects and programs.

As noted in the process and through this Guideline, the lack of comprehensive information on suppliers of suitable materials and methods will require that local governments develop their own lists. Local governments can liaise within their regions to develop these lists which in turn could see greater focus and support for recycled materials and methods through the industry.

As practitioners become familiar with the many specifications for recycled materials and sustainable construction practices, there will be a need for the specifications to be reviewed and updated. Practitioners can liaise with their regional road groups, industry associations, WALGA and MRWA as needed.

To achieve the greatest benefit from the use of this Guideline, the local government will need effective cross-organisational communications. This could include:

- The finance team, to understand how the saving in cost of landfill could offset an increased cost of materials, or in understanding how to justify intangible savings.
- Environmental management and environmental health teams, to understand how their functions can support recycled materials and sustainable methods, and the process in this Guideline.
- Asset management team, to ensure the types of materials are correctly recorded in asset registers, valued, and monitored for performance.
- Statutory and strategic planning teams, so they can understand how to manage proposals as developers seek to also introduce recycled materials and methods.
- Infrastructure maintenance teams, for ongoing maintenance of the assets and the use of compatible materials.
- Building maintenance and project management teams, as they may identify C&D waste opportunities during their works.

Regional and remote local governments will likely have resource and expertise constraints and will not have access to the resources listed above. Decisions will likely be made at the Works Manager level with initial advice from a consulting engineer.

As always, the local government will need to be aware of community expectations towards safety, heritage and the environment, including the presence of native vegetation. The local government can guide expectations through effective communication plans associated with the recycled materials and methods. By adopting a structured process as provided in this Guideline, the local government can also manage, and perhaps allay, community concerns.

5 Recommended Applications

This Guideline has been prepared with the intent of providing local governments the support and guidance required to make informed decisions about integrating sustainable solutions in road construction. The challenges for local governments in improving sustainability outcomes are compounded by the geographical constraints of WA. This Guideline has been tailored to focus on solutions associated with both locality (i.e. metropolitan, regional, remote/very remote) and the project types typically undertaken in those areas.

Improving the sustainability of a road construction project can take many forms. For the purposes of this Guideline, the focus has been on waste and energy reduction and the circular economy. This focus aligns with current local, national and international policies and strategic plans. The use of recycled materials in road construction will aid in transforming the circular economy within WA. This can be supplemented by sustainable road construction practices which primarily focus on improving insitu materials or the technologies currently used. Twelve recycled materials and 8 sustainable practices have been reviewed and presented within this Guideline. Many of these recycled materials and sustainable practices can be utilised now under current MRWA and WALGA specifications.

A review of availability identified that, as expected, many types of recycled materials for use in road construction are predominantly situated or accessible within metropolitan and surrounding regional areas. However, increasing the uptake of recycled materials and sustainable practices in road construction is anticipated to aid in improving availability. Local governments also have opportunities to take control of waste management within their jurisdictions by improving facilities and processes to transform waste (e.g. construction and demolition waste) into valuable construction materials.

The key outcomes of this project are demonstrated through a selection and implementation process for the integration of sustainable practices in road construction. The Guideline includes a methodology for selecting potential sustainable options and identifying which option will best suit the project. A practitioner can use the Guideline by identifying their project type and locality from tables that will provide a range of applicable recycled materials and methods for consideration. Each of the recycled materials and method options are supported by a detailed factsheet providing comprehensive advice including availability, engineering performance and technical specifications, from which a practitioner can decide whether to adopt the option. These parameters provide the information required to enable a feasibility check specific to individual project works. Example scenarios are provided to guide the user through the process to aid in achieving best practice outcomes.

Sustainability innovation within the road construction space is constantly evolving to address the requirements of international goals, government policy and strategic plans and societal expectations. This Guideline provides information on the current status (known at the time this document was prepared) of the use of recycled materials and sustainable road construction practices. Future reviews and revisions of this Guideline may be required to align with emerging technologies and emerging recycled materials.

This Guideline has been prepared in a user-friendly format. The key required content is included in tables and graphical formats to provide practical solutions interpretable by non-technical practitioners. For additional information, please refer to the Technical Report for all of the background research and supporting technical information.

To support the implementation of this Guideline, it is recommended that local government practitioners undertake a review of the recycled materials and equipment available in their local area. The process to undertake this activity has been included within the Guideline. It is recommended that local governments establish a Recycled Materials and Methods Availability Matrix. It is anticipated that this would be a live document/database that would increase in value as more recycled materials and methods are adopted in local projects.

This process would also be suitable for the conversion of waste into resources at local government-owned waste facilities. As each of the main processes are tested and used, the local government can incorporate these into their Waste Plan or Maintenance/Asset Management Plans to:

- increase the conversion of waste into usable road construction materials
- increase the use of road construction materials in works programs.

As practitioners become familiar with the many specifications for recycled materials and sustainable construction practices, there will be a need for the specifications to be reviewed and updated. Practitioners can liaise with their regional road groups, industry associations, WALGA and MRWA as needed.

References

Australian Bureau of Statistics 2021, *Data by region - region summary: rest of WA*, ABS website, Canberra, ACT, accessed 23 February 2023, <https://dbr.abs.gov.au/region.html?lyr=gccsa&rgn=5RWAU>.

Department of Climate Change, Energy, the Environment and Water 2018, *National waste policy: less waste, more resources*, DCCEEW, Canberra, ACT, accessed 22 January 2023, <https://www.dcceew.gov.au/sites/default/files/documents/national-waste-policy-2018.pdf>.

Department of Climate Change, Energy, the Environment and Water 2019, *National waste policy: action plan*, DCCEEW, Canberra, ACT, accessed 23 January 2023, <https://www.dcceew.gov.au/sites/default/files/documents/national-waste-policy-action-plan-2019.pdf>.

Main Roads Western Australia 2023 *State road funds to Local Government Agreement: 2023/24 to 2027/28*, MRWA, Perth, WA.

Waste Authority 2019, *Waste avoidance and resource recovery strategy 2030*: *Western Australia's waste strategy*, Waste Authority, Joondalup, WA, accessed 13 June 2023, <https://www.wasteauthority.wa.gov.au/images/resources/files/Strategic_Direction_Waste_Avoidance_and_Resource_Recovery_Strategy_2030.pdf>.

Appendix A Factsheets

RECYCLED MATERIALS

- Reclaimed asphalt pavement (RAP)
- Crushed recycled concrete and crushed brick
- Recycled crushed glass
- Crumb rubber
- Fly ash
- Bottom ash
- Blast furnace slag
- Food and garden organics
- Recycled plastics
- Recycled materials in road furniture.

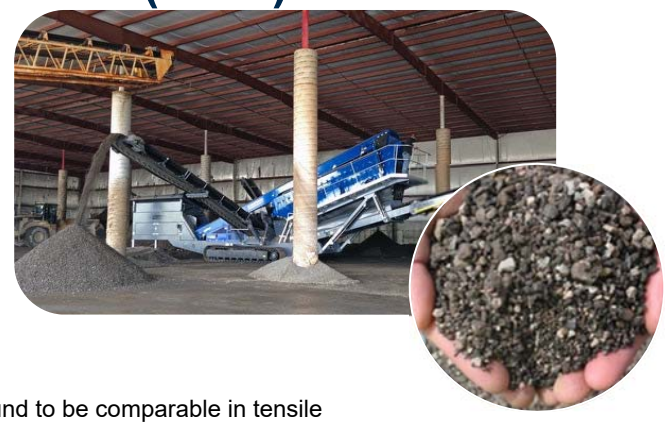
SUSTAINABLE ROAD CONSTRUCTION PRACTICES

- Foamed bitumen stabilisation
- Bitumen emulsion stabilisation
- Cementitious stabilisation
- Soil/Subgrade stabilisation
- Warm mix asphalt
- Hot in place asphalt recycling
- Insitu recycling of concrete pavements
- Marginal and non-standard materials.

The information contained within these factsheets has been sourced from the Technical Report.

RECLAIMED ASPHALT PAVEMENT (RAP)

Reclaimed asphalt pavement (RAP) is former pavement material from an asphalt wearing or intermediate course which has been milled and re-processed for reuse in new roads.



POTENTIAL APPLICATIONS

- Asphalt
- Unbound pavements
- Earthworks/embankments
- Ancillaries (refer to Recycled materials in road furniture)

AVAILABILITY

Supplier	Distribution range	Capacity
Corps Environmental Pty Ltd	Pilbara, Kimberley and Gascoyne	2,000 tonnes
WA Recycled Asphalt	Confirm with supplier	Low – small projects only
Asphalt Recyclers Australia	Confirm with supplier	Low – small projects only
Downer - Road Services Regional Office Perth	WA	High – confirm with supplier
Red Sand Supplies	100 km of Perth	15,000–20,000 tonnes/annum
Boral Asphalt	Confirm with supplier	Confirm with supplier
Peel Resource Recovery	Pinjarra, Bunbury & Vasse	5,000 tonnes/annum

ENGINEERING PERFORMANCE

The quantity of RAP used within the asphalt mix can have an impact on overall engineering performance. Quantities of up to 20% (above currently accepted limits in WA) are reported to be comparable to a virgin asphalt mix, with little impact noted on properties such as ravelling, fatigue cracking, rutting and weathering. Asphalt mixes containing RAP have been found to be comparable in tensile strength, however, may show an increase in stiffness compared to virgin asphalt.

WHOLE-OF-LIFE FACTORS

With the integration of recycled materials within road infrastructure, additional research may be required into the suitability of reusing atypical RAP (e.g. RAP containing crumb rubber, plastics, crushed recycled glass, etc.). Additional considerations may be required for the management of RAP stockpiles.

HSE CONSIDERATIONS

HSE hazards are likely to be comparable to the processing and laying of new asphalt (e.g. fumes, heat, etc.). Additional hazards to consider may come from:

- the site where the RAP was collected (e.g. contaminated sites; fuel, oil, heavy metals, PFAS, etc)
- atypical RAP (e.g. RAP from asphalt that contains recycled materials; plastics, crumb rubber, etc).

BENEFITS

Using RAP presents the opportunity to recover valuable resources and reduce the volume of material being sent to landfill. It also has the potential to minimise or reduce the demand for virgin materials, in turn reducing the potential environmental impacts associated with extractive industry.

WA SPECIFICATIONS

Specification	Application
IPWEA/WALGA Specification for the Supply of Recycled Road Base	• Base < 50 mm asphalt or spray seal, Base ≥ 50 mm asphalt and subbase • Class 1: Maximum 10% by weight • Class 2: Maximum 15% by weight
IPWEA/AfPA Tender Specification, Tender Form and Schedule for Supply and Laying of Asphalt Road Surfacing	• Requirements for materials and a RAP management plan.
Roads to Reuse Recycled Road Base and Recycled Drainage Rock	• Base and drainage
MRWA Specification 501 Pavements	• Up to 15% (by mass of the material larger than 4.75 mm) of pavement materials can be RAP
MRWA Specification 504 Asphalt Wearing Course	• The use of RAP for surface layers is not allowed
MRWA Specification 510 Asphalt Intermediate Course	• The use up to 10% RAP in asphalt intermediate course layers is allowed
MRWA Specification 515 Insitu Stabilisation of Pavement Materials	• The use up to 10% (by volume) RAP in stabilised base and subbase layers is allowed

CRUSHED RECYCLED CONCRETE AND CRUSHED BRICK

Crushed recycled concrete and crushed brick for use in road construction are typically generated from construction and demolition waste. The materials primarily comprise aggregates and cementitious adhesion medium.

POTENTIAL APPLICATIONS

- Unbound pavements
- Concrete
- Earthworks/embankments
- Ancillaries (refer to Recycled materials in road furniture)

AVAILABILITY

Supplier	Distribution range	Capacity
Product Recovery Industries	Postans, Bayswater & Neerabup	Confirm with supplier
Broome Waste Management Facility	Broome area	Low – small projects only
Corps Environmental Pty Ltd	Pilbara, Kimberley and Gascoyne	10,000 tonnes
WA Recycling	300 km of Hazelmere	High – confirm with supplier
Red Sand Supplies	100 km of Perth	15,000–20,000 tonnes/annum
Stoneridge Quarries WA	WA	Confirm with supplier
Encore Recycling & Resource Recovery	Within 50 km Perth GPO	100 tonnes per day
Wylie Bay MRF	Esperance	Low – small projects only
Everything Earth	Port Hedland area	Confirm with supplier
Peel Resource Recovery	Pinjarra Bunbury Vasse	100,000 tonnes/annum

ENGINEERING PERFORMANCE

Crushed recycled concrete is known to increase in strength and stiffness over time. Some key risks include cracking, popping, hazardous contaminants and pH. There is also a risk of recementing if used in pavement base or subbase, which may lead to cracking. Management options are available to reduce this risk. Research indicates that crushed recycled concrete performs satisfactorily when compared to virgin aggregates, and they typically have higher moisture absorption, lower impact resistance, lower density and lower abrasion resistance.

WHOLE-OF-LIFE FACTORS

The potential future application with respect to crushed recycled concrete and brick primarily relate to improved capture and recycling of construction and demolition waste and also increased uptake in road infrastructure projects. Some of the key barriers to this uptake relate to a perceived high contamination rate, a lack of awareness of the benefits of recycling over landfilling and haulage distances.

HSE CONSIDERATIONS

Potential contaminants will likely depend on the previous use of the product. Hazards may vary (e.g. asbestos, fuels and oils, etc.). This material can have high pH, so consideration should be given to the end use location. The crushing required during waste processing may introduce WHS hazards relating to asbestos and respirable crystalline silica.

BENEFITS

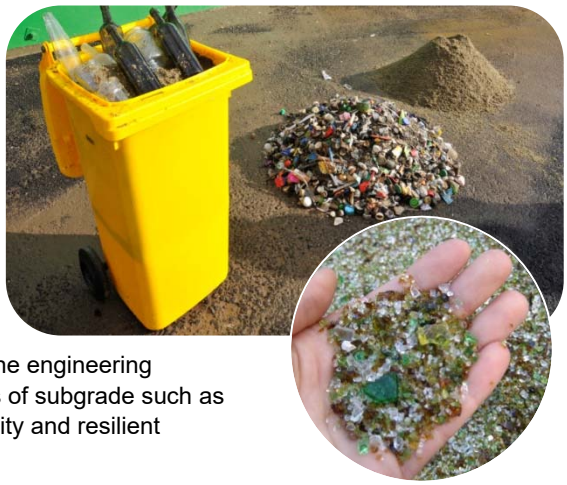
Utilising recycled crushed concrete and brick presents the opportunity to recover valuable resources and reduce the volume of material being sent to landfill. As an aggregate replacement for use in road construction, it also has the potential to minimise or reduce the demand for virgin materials, in turn reducing the potential environmental impacts associated with extractive industry.

WA SPECIFICATIONS

Specification	Application
IPWEA/WALGA Specification for the Supply of Recycled Road Base	Crushed recycled concrete (base and subbase): Class 1: Maximum 95% by weight, Class 2: Maximum 95% by weight as base, 100% by weight as subbase. Crushed bricks: Class 1: Maximum 10% by weight, Class 2: Maximum 15% by weight
Roads to Reuse Recycled Road Base and Recycled Drainage Rock	Base (predominantly concrete) and drainage (mixture of coarse grained aggregate, including bricks) (waste processing specification)
MRWA Specification 501 Pavements	Crushed recycled concrete: may be used as subbase material under full depth asphalt pavements, subject to limitations. Crushed bricks: Up to a maximum limit of 15% by mass retained on a 4.75 mm sieve.

RECYCLED CRUSHED GLASS

Recycled crushed glass (RCG) originates as waste materials from both domestic and commercial/industrial sources. It is converted to materials suitable for use in road infrastructure via crushing, cleaning, screening and an even blending process.



POTENTIAL APPLICATIONS

- Asphalt
- Unbound pavements
- Concrete
- Earthworks/embankments
- Ancillaries (refer to Recycled materials in road furniture)

AVAILABILITY

Supplier	Distribution range	Capacity
Product Recovery Industries	Postans, Bayswater & Neerabup	Confirm with supplier
Corps Environmental Pty Ltd	South West region	1,000 tonnes
Downer Hope Valley Asphalt Plant	Confirm with supplier	Confirm with supplier
Boral Asphalt	Confirm with supplier	Confirm with supplier
Capital Recycling - Postans	Confirm with supplier	Confirm with supplier
Wylie Bay MRF	Esperance	Low – minor projects only
Cleanaway	Confirm with supplier	23,000 tonnes/annum

It is noted that in WA there is an excess of sand sized aggregate and the need to use RCG may be limited.

ENGINEERING PERFORMANCE

In road construction applications, RCG is typically used as a replacement for granular material. It is generally processed to pass the 4.75 mm sieve and for a comparative particle size, it is noted to have similar properties to natural sand. The particle size of RCG is a critical factor in achieving positive results in road construction. Within embankment and non-structural fill applications, incorporating RCG has been shown to improve the engineering properties of subgrade such as permeability and resilient modulus.

WHOLE-OF-LIFE FACTORS

Similar to recycled crushed concrete and bricks, the potential future applications of RCG primarily relate to improved capture and recycling of glass waste and also increased uptake in road infrastructure projects. In support of improving reuse of RCG, research is underway within WA to economically optimise the production of recycled crushed glass material.

HSE CONSIDERATIONS

The potential presence of foreign materials in RCG presents an environmental risk from an increase in chemical and physical contaminants, including metals, total organic carbon and an elevated electrical conductivity.

Although glass dust and glass particle handling may be a hazard, the risk of exposure for both is considered low or negligible. However, the use of PPE and dust suppression/ extraction are recommended.

BENEFITS

Utilising RCG presents the opportunity to reduce the volume of material being sent to landfill, particularly in rural areas where no facilities are locally available to recycle glass into higher value items and haulage distances are significant. As glass does not degrade over time, waste glass materials are ideally reused where possible or recycled into higher value items than embankment fill material.

WA SPECIFICATIONS

Specification	Application
WALGA Earthworks and Pavement Construction – Road Building Model Specification	General fill in non-structural applications
MRWA Specification 302 Earthworks	Imported fill for embankment construction. Maximum allowable limit: 20% of mass

CRUMB RUBBER

Crumb rubber is sourced from end-of-life tyres that are processed via shredding and crumbing. Crumb rubber is approved for use in WA as a crumb rubber modified (CMB) binder in asphalt and sprayed seal applications.

POTENTIAL APPLICATIONS

- Seals
- Asphalt
- Ancillaries (refer to Recycled materials in road furniture)

AVAILABILITY

Supplier	Distribution range	Capacity
CTS tyre recycling	WA	11,000 tonnes/annum.
Wylie Bay MRF	Esperance	Low – minor projects only
Boral Asphalt	Confirm with supplier	Confirm with supplier
Downer Hope Valley Asphalt Plant	Confirm with supplier	Confirm with supplier
Malatesta Group	South West region	Confirm with supplier

Although TSA facilities are recommended for local governments to use, not all rubber recyclers are TSA accredited. If engaging with a non-accredited TSA recycler, local governments should investigate the reason for their lack of accreditation and ensure their recycling and waste process aligns with TSA standards.

ENGINEERING PERFORMANCE

In asphalt, crumbed rubber can improve rutting resistance and fatigue due to its high viscosity and elasticity. Higher percentages of crumb rubber (> 18% by mass of total binder) has been demonstrated to effectively mitigate reflective cracking of failed pavements. In sprayed seal applications, crumb rubber can improve crack resistance, productivity, oxidation resistance and aggregate retention on heavily trafficked roads.

WHOLE-OF-LIFE FACTORS

Recent research undertaken in WA has enabled the integration of crumb rubber into asphalt, in addition to the well-established sprayed seals application. Research is currently underway to investigate further increasing the percentage of crumb rubber in road construction.

HAS CONSIDERATIONS

The primary potential impacts associated with waste tyres relate to the potential discharges and emissions from tyre fires. Heavy metals, hydrocarbons, VOCs are also reported as key potential contaminants of concern. Air emissions and fumes may present a WHS risk to workers during heating and application. Using crumb rubber with warm mix asphalt technology may mitigate fuming risks.

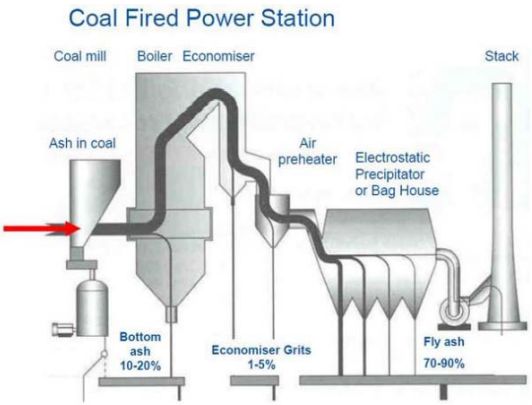
BENEFITS

In addition to the noted improved performance benefits, utilising waste tyres presents the opportunity to recover valuable resources and reduce the volume of material being sent to landfill. It also has the potential to minimise or reduce the demand for virgin materials, in turn reducing the potential environmental impacts associated with the production of polymers and petroleum derived bitumen products. It is also reported that crumb rubber modified roads can also aid in reducing traffic noise.

WA SPECIFICATIONS

Specification	Application
WALGA Sprayed Bituminous Surfacing: Road Building Model Specification	Crumb rubber modified binder (CMB) shall be manufactured using Class 170 bitumen and recycled rubber from end-of-life vehicle tyres or other suitable sources.
IPWEA/AfPA Tender Specification, Tender Form and Schedule for Supply and Laying of Asphalt Road Surfacing	Requirements for materials.
MRWA Specification 503 Bituminous Surfacing	5% by mass rubber can be utilised in geotextile reinforced seals in Class 170 bitumen. Rubber binder to be supplied from a bulk mixing facility capable of mixing the rubber blend to ensure the rubber is thoroughly mixed prior to transport.
MRWA Specification 511 Materials for Bituminous Treatments	A minimum quantity of 18% crumb rubber by mass of total binder shall be used in the crumb rubber modified asphalt binder. Crumb rubber shall be sourced from an accredited supplier.
MRWA Specification 516 Crumb Rubber Open Graded Asphalt	A minimum quantity of 18% crumb rubber by mass of total binder shall be used in the crumb rubber modified asphalt binder. The crumb rubber shall be designed to meet the requirements of Table 516.1, without the inclusion of a warm mix additive.

FLY ASH



Fly ash is a by-product of the coal combustion process. It can be blended with and used as a partial replacement for general purpose cement in concrete and pavements.

POTENTIAL APPLICATIONS

- Asphalt
- Unbound pavements
- Concrete
- Earthworks/embankments
- Ancillaries (refer to Recycled materials in road furniture)

AVAILABILITY

Supplier	Distribution Range	Capacity
Stabilised Pavements Australia	WA	Confirm with supplier
Worsley Alumina Power Station	Confirm with supplier	100,000 tonnes/annum

There is limited availability of fly ash in WA. Fly ash and bottom ash are locally sourced only in areas around a coal-fired power plant. In WA, there are four coal power plants, all located in the Shire of Collie. Adopting the use of these products may increase the demand and supply in areas, but general shortages of supply will continue to limit greater use of fly and bottom ash.

ENGINEERING PERFORMANCE

The engineering performance benefits associated with the use of fly ash in concrete includes increased durability, increased strength and improved workability. As a mineral filler in asphalt, fly ash offers improved rutting resistance, improved stability and improved moisture resistance. It also has the potential to reduce stripping and reduce workability.

WHOLE-OF-LIFE FACTORS

It is noted that some jurisdictions are working on shifting from coal-fired power generation in response to addressing sources of climate change pollutants. This shift may lead to a future reduction in fly ash supplies. However, there is a potential for the generation of different sources of fly ash (e.g. Waste2Energy). It is noted that different sources would result in different fly ash properties and less yield (approx. 10% of by products).

HSE CONSIDERATIONS

In a coal combustion process, fly ash is a powdery residue material captured within the stack. It has the potential to contain contaminants of concern (e.g. heavy metals) which may leach from the material. It is noted that when bound, the potential for leaching is greatly reduced.

Fly ash may create a respiratory hazard when dry which can lead to flu-like symptoms. This is primarily due to dust generation caused by the low density and particle size of the material, however dust suppression, compaction and suitable storage techniques may aid in reducing that risk.

BENEFITS

The following benefits are noted as being associated with the reuse of fly ash and coal ash products generally:

- Environmental benefits: reduced greenhouse gas emissions associated with extractive industry, reduced landfill disposal.
- Economic benefits: reduced disposal costs, increased revenue from the sale of coal ash, savings from the reduced use of other natural materials.
- Product benefits: improved strength, durability and workability of materials.

WA SPECIFICATIONS

Specification	Application
MRWA Specification 302 Earthworks	Cement stabilisation of subgrade
MRWA Specification 404 Culverts	Concrete for culvert
MRWA Specification 410 Low strength infill	Low strength infill for the backfilling of redundant or abandoned pipes, culverts and other buried structures
MRWA Specification 515 Insitu Stabilisation of Pavement Materials	Insitu stabilisation of granular pavement layers
MRWA Specification 820 Concrete for structures	High performance concrete for structures
MRWA Specification 507 Microsurfacing	Microsurfacing

BOTTOM ASH

Bottom ash is a by-product of black coal combustion and waste to energy processes. This variability in source materials and processing methods can result in a product that has variable physical properties and chemical composition.

POTENTIAL APPLICATIONS

Research is being conducted for use of bottom ash in the following applications:

- Unbound pavements
- Concrete
- Earthworks/embankments
- Ancillaries (refer to Recycled materials in road furniture)

AVAILABILITY

Supplier	Distribution range	Capacity
Worsley Alumina Power Station	Confirm with supplier	10,000 tonnes/annum
Eclipse Soils	Perth Metro	100,000 m^3 per annum

Fly ash and bottom ash are locally sourced only in areas around a coal-fired power plant and Waste2Energy Plants. In WA, there are four coal power plants, all located in the Shire of Collie. A bottom ash facility is under development in Kwinana.

ENGINEERING PERFORMANCE

Bottom ash is a well graded material with a particle size generally ranging from 75 µm to 40 mm. It has a lower density and higher porosity than virgin aggregates, making it potentially suitable for drainage applications, embankment fill or unbound granular material.

A study of bottom ash in hot mix asphalt (HMA) applications concluded that 20% replacement of fine aggregate resulted in increased strength, stiffness and moisture resistance properties.

WHOLE-OF-LIFE FACTORS

Additional research is required for the practical application of bottom ash in road infrastructure, particularly in asphalt. Prior to the use of bottom ash in any road construction, it is essential that the physical and chemical properties be analysed and assessed as suitable for the proposed application.

HSE CONSIDERATIONS

In a coal combustion process, bottom ash is a coarse material captured at the bottom of a coal furnace. It has the potential to contain contaminants of concern such a cresol, semi-volatile organic compounds and polycyclic aromatic hydrocarbons. Bottom ash associated with end-of waste facilities has the potential to contain PFAS due to the processing of biosolids.

Similar to the potential environmental impacts, the WHS risks are likely to vary due to the feedstock or process. Additional WHS risks associated with the contaminants are likely to be either reduced during processing or managed via appropriate personal protective equipment (PPE) and effective work hygiene controls.

BENEFITS

The environmental benefits of reusing bottom ash include the opportunity to recover valuable resources and reduce the volume of material being sent to landfill. It also has the potential to minimise or reduce the demand for virgin materials.

WA SPECIFICATIONS

There are limited specifications in Australia for the use of bottom ash in road infrastructure, with further research required to optimise its use and to determine and manage any associated health, safety and environmental impacts. The only road agency to have a specification for the use of bottom ash is Transport for NSW (TfNSW) which allows 10% by mass to be used in base and subbase as granular material.

BLAST FURNACE SLAG

Blast furnace slag is a by-product of the steel and iron manufacturing process. It can be blended with and used as a partial replacement for general purpose cement in concrete and pavements.

POTENTIAL APPLICATIONS

- Asphalt
- Unbound pavements
- Concrete
- Earthworks/embankments
- Ancillaries (refer to Recycled materials in road furniture)

AVAILABILITY

BFS is produced as a by-product of steel manufacturing, such plants are located in and nearby to the Perth metropolitan area. However, as with fly ash and bottom ash, local availability of blast furnace slag will depend more on the imported supply of BFS than the proximity to a steel manufacturing plant, and demand may well change the supply in a given area. Local governments can collaborate with local steel manufacturing plants to better supply an area with blast furnace slag.

ENGINEERING PERFORMANCE

The nominated concrete utilised by MRWA (S50M) utilises 60% ground granulated blast furnace slag and 8% silica fume to aid in the reduction of thermal expansion and resultant cracking. It is also resistant to chloride and sulfate attack, proving useful in a marine or other aggressive environments (e.g. certain types of soils and/or groundwater). When used in subgrade/soil stabilisation works as a cementitious or geopolymer binder, a higher strength and durability is reported over standard Portland Cement, with additional benefits noted when combined with fly ash.

WHOLE-OF-LIFE FACTORS

Blast furnace slag is well established and the most widely used SCM in Australia.

HSE CONSIDERATIONS

Due to the nature and origins (i.e. steel production) of the product, blast furnace slag is likely to contain high levels of heavy metals and a high pH. The potential environmental risks associated with these contaminants are primarily associated with leaching.

Potential WHS hazards associated with blast furnace slag relate to skin, eye and respiratory irritation. Each of these risks will require assessment and management prior to and during use of the material.

BENEFITS

Utilising blast furnace slag presents the opportunity to recover valuable resources and reduce the volume of material being sent to landfill. It also has the potential to minimise or reduce the demand for virgin materials (i.e. Portland cement), in turn reducing the potential environmental impacts associated with extractive industry.

WA SPECIFICATIONS

Specification	Application
MRWA Specification 302 Earthworks	Stabilisation of subgrade
MRWA Specification 410 Low strength infill	Low strength infill for the backfilling of redundant or abandoned pipes, culverts and other buried structures
MRWA Specification 515 Insitu Stabilisation of Pavement Materials	Insitu stabilisation of granular pavement layers
MRWA Specification 820 Concrete for structures	High performance concrete for structures
MRWA Specification 901 Concrete general works	Concrete for general non-structural works

FOOD AND GARDEN ORGANICS (FOGO)

Food organics and garden organics (FOGO) are biodegradable organic waste from either a plant or animal. FOGO is typically used in topsoil, soil conditioner and mulch.

POTENTIAL APPLICATIONS

- Ancillaries (refer to Recycled materials in road furniture)

AVAILABILITY

Supplier	Distribution range	Capacity
Wylie Bay MRF	Esperance	Low – minor projects only
Abbotts Liquid Salvage	Great southern WA	7,500 tonnes/annum
Richgro Composting Facility	70 km of Perth	High – confirm with supplier
Hastie Waste Pty Ltd	WA	High – confirm with supplier
Eclipse Soils	Esperance to Pilbara	50,000 m^3/annum
Aussie Organics Garden Supplies	WA	5,000 m^3/annum
Peel Resource Recovery	Pinjarra Bunbury Vasse	10,000 tonnes/annum
Product Recovery Industries	Postans, Bayswater & Neerabup	Confirm with supplier

ENGINEERING PERFORMANCE

FOGO are considered soil amendment products. The objective of these products is to increase microbial activity within the soil, increase organic matter content, improve erosion and sedimentation resistance, promote water permeability and increase the nutrient content in the soils.

The engineering performance associated with the use of FOGO relates to the physical, chemical and biological properties of the material scheduled for reuse and how that material aligns with the requirements of the receiving site.

WHOLE-OF-LIFE FACTORS

The potential future application with respect to recycled organics (FOGO) primarily relate to increased uptake in FOGO derived soil conditioners, mulches and topsoil products. Some of the key barriers to this uptake relate to a perceived high contamination rate.

HSE CONSIDERATIONS

Similar to RAP, recycled concrete and bricks and recycled glass, there is a risk of introducing contaminants from the FOGO waste stream into the end product receiving site. It is noted that one of the primary exposure pathways is via the leachability of the contaminants.

Potential WHS risks, in addition to those that would be encountered during standard landscaping works, primarily relate to the potential contaminants introduced via the waste stream.

BENEFITS

Utilising FOGO presents the opportunity to recover valuable resources and reduce the volume of material being sent to landfill. Further, composting FOGO via aerobic processes reduces the amount of greenhouse gases and leachates created under anerobic landfill conditions.

WA SPECIFICATIONS

Specification	Application
SWA Food and Garden Organics (FOGO) derived soil conditioner, mulch and topsoil	Landscaping and rehabilitation elements of transport infrastructure projects.

RECYCLED PLASTICS

Recycled plastics for use in road infrastructure projects can be sourced as a waste product from commercial, industrial, and municipal sources.

POTENTIAL APPLICATIONS

- Ancillaries (refer to Recycled materials in road furniture)

Research is also being conducted for the use of recycled plastics in asphalt and concrete.

AVAILABILITY

Supplier	Distribution range	Capacity
Wylie Bay MRF	Esperance	Low – minor projects only
Downer Hope Valley Asphalt Plant	Confirm with suppler	Confirm with suppler
Poly Pipe Recycling	WA	High – confirm with supplier
Boral Asphalt	Confirm with suppler	Confirm with suppler

ENGINEERING PERFORMANCE

Recycled plastics can be integrated into asphalt applications via three methods: dry, wet and hybrid. As recycled plastics are not as strong as natural aggregates, only a small quantity can be substituted into asphalt via the dry method without affecting the performance of the pavement. The resultant pavement will not be as stiff or durable as conventional asphalt. When combined via the wet or hybrid methods, preliminary research suggests the resultant pavement may end up being overly stiff and brittle. As a result, this may be at the detriment to fatigue properties.

Recycled plastics can be used in non-structural and low risk concrete applications as a partial aggregate replacement or a fibre reinforcement.

WHOLE-OF-LIFE FACTORS

Consideration needs to be given to the end-of-life prospects for the plastic modified pavement and its ability to be reused or recycled. Current research suggests that plastics in RAP can be reused, however additional considerations may be required for stockpile management.

HSE CONSIDERATIONS

The key areas for potential environmental impact from the integration of recycled plastics includes:

- leaching of potential contaminants of concern
- generation and release of microplastics.

Similar to the integration of crumb rubber in asphalt and sprayed seals, the hybrid and wet methods include a heating process which has the potential to emit fumes and airborne particles as a result of contaminants of concern present. Further research may be required to verify the extent of impacts to human health. Using crumb rubber with warm mix asphalt technology may mitigate fuming risks.

BENEFITS

Utilising recycled plastics presents the opportunity to recover valuable resources and reduce the volume of material being sent to landfill. Research is underway nationally to better understand the engineering performance and potential environmental, health and safety impacts of incorporating recycled plastics in road infrastructure. These studies include research and trials into utilising both hard and soft plastics in asphalt applications.

WA SPECIFICATIONS

There are no specifications in Australia for the use of recycled plastics in asphalt and concrete. The majority of specifications that enable the use of recycled materials are performance based, in that a recycled material may be included on the condition the performance requirements can be met. with further research required to optimise its use and to determine and manage any associated health, safety and environmental impacts.

RECYCLED MATERIALS IN ROAD FURNITURE

The construction and integration of sustainable road furniture is an essential part of sustainable road construction.

Road furniture includes those components outside of the standard road pavement and may include, but not be limited to:

- Footpaths
- Noise and retaining walls
- Drainage infrastructure
- Electrical and communications infrastructure
- Signage and markers
- Guideposts and bollards
- Geosynthetics (geogrids and geotextiles).

HSE CONSIDERATIONS

The environment, health and safety benefits and impacts noted in for each material apply when using those recycled materials in road structures and furniture. As each item will differ, there is however a potential for the risks to vary throughout a products lifecycle. For example, tyre rubber in footpaths or guideposts may have a higher risk of releasing microplastics to the environment. It is recommended that the potential environment, health and safety impacts be considered and assessed prior to the procurement and/or manufacture of road structures and furniture containing recycled materials.

BENEFITS

Utilising recycled materials presents the opportunity to recover valuable resources and reduce the volume of material being sent to landfill.

POTENTIAL APPLICATIONS

Material	Footpaths	Noise walls	Retaining walls	Underground infrastructure	Guideposts and bollards	Signage and markers	Geosynthetics	Landscaping
Reclaimed asphalt pavement (RAP)	✓							
Crushed concrete and bricks	✓	✓	✓					
Crushed glass/glass fibres	✓	✓	✓			✓	✓	✓
Crumb rubber/tyres	✓		✓		✓			✓
Fly ash	✓	✓	✓	✓				
Bottom ash	✓	✓	✓					
Blast furnace slag	✓	✓	✓	✓				
Food and garden organics (FOGO)								✓
Recycled plastics	✓	✓	✓	✓	✓	✓	✓	

WA SPECIFICATIONS

Specification	Application
MRWA Specification 404 Culverts	Use of fly ash in seawater or saline groundwater environments.
MRWA Specification 602 Guide Posts	Use of rubber and plastic in flexible guide posts.
MRWA Specification 820 Concrete for structures	Use of fly ash in seawater or saline groundwater environments.
MRWA Specification 904 Noise Walls	Use of recycled materials not included within this specification. Primarily dictates use of bricks and concrete.

FOAMED BITUMEN STABILISATION

Foamed bitumen stabilisation is a stabilisation technique used to provide cohesion in granular soils and improve waterproofing properties in clayey soils.

PROJECT TYPES

- Rehabilitation base and seal
- Granular resheets/stabilisation
- Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.

AVAILABILITY

Supplier	Distribution range	Capacity
Stabilised Pavements Australia	WA	1,500,000 m²/ annum

ENGINEERING PERFORMANCE

Foamed bitumen is created via the mixture of foaming agent (application specific), air, water and hot C170 bitumen. This mixture of materials produces an instantaneous expansion of the bitumen of up to 15 times its original volumes. Upon contact with the pavement, very fine droplets of bitumen are dispersed onto the underlying soils and/or pavement. Hydrated lime is also typically used as a secondary binder to stabilise road surfaces and form a cemented finish. This process improves strength during curing. A suitability assessment for the use of foamed bitumen stabilisation may include the following factors:

- cost
- pavement design requirements
- utility depth
- vibration during compaction
- moisture
- plasticity and particle size distribution (PSD) of the granular material
- existing bound pavement.

EQUIPMENT AND MATERIALS

Foamed bitumen stabilisation requires a variety of plant and equipment to ensure the successful application of the product. This includes plant for the supply of the stabilising agent, plant for the spreading of the chemical stabilising agent and plant for stabilisation. The materials for stabilisation works can plant-mixed or carried out in situ.

BENEFITS

Benefits include reduced construction costs compared with full depth asphalt pavements and improved moisture and flood resistance in comparison to granular materials susceptible to moisture. As the process can stabilise the materials insitu (not including plant mixed), reduced cartage of additional materials is also required. Some additional sustainability benefits include:

- reduced energy and emissions usage through reduced grading maintenance compared to unbound granular. Note, a seal would be the next option prior to stabilisation.
- reduced energy and emissions through reduced cartage of raw materials for insitu applications.
- reduced road traffic costs due to improved rideability when compared to unbound granular.
- reduced dust emissions when compared to unbound granular.

WA SPECIFICATIONS

Specification	Application
WALGA Pavement Rehabilitation Road Building Model Specification	Foamed bitumen products and materials, plant and equipment, environmental considerations, quality control.
MRWA Specification 515 Insitu Stabilisation of Pavement Materials	Foamed bitumen products and materials, plant and equipment, construction and acceptance.

BITUMEN EMULSION STABILISATION

Bitumen emulsion stabilisation is the process of incorporating a bitumen emulsion mixture into the upper pavement layer to improve pavement strength.

Bitumen emulsion stabilised basecourse with recycled aggregate

PROJECT TYPES

- Rehabilitation base and seal
- Granular resheets/stabilisation
- Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.

AVAILABILITY

To be determined by the local practitioner.

ENGINEERING PERFORMANCE

A bitumen emulsion mixture is comprised of approximately 60% bitumen and 40% water with a small quantity of emulsifier. The emulsifier is either positively (cationic) or negatively (anionic) charged to ensure the mixture is kept in suspension and adheres to the aggregate. This process is best used for stabilisation of materials that have a low cohesion and plasticity and aids to decrease the permeability and moisture sensitivity of the road surface. Similar to the Foamed Bitumen Stabilisation process, hydrated lime is also typically used as a secondary binder to stabilise road surfaces and form a cemented finish. This process improves strength through curing.

EQUIPMENT AND MATERIALS

Similar to foamed bitumen stabilisation, bitumen emulsion stabilisation materials can be either plant-mixed or mixed insitu. Where insitu stabilisation works are being conducted, The following equipment would be required:

- centrally mounted mixer with suitable power for adequate mixing of materials.
- two separate pumping / injection systems regulated by the ground speed of the reclaimer/stabiliser for metering the bitumen and water.
  - fitted with a control device that calibrates the application rate in litre/m^2 of residual bitumen.

WA SPECIFICATIONS

Specification	Application
WALGA Pavement Rehabilitation Road Building Model Specification	Bitumen emulsion products and materials, plant and equipment, environmental considerations, quality control.
WALGA Sprayed Bituminous Surfacing: Road Building Model Specification	Bitumen emulsion products and materials, plant and equipment, environmental considerations, quality control.
MRWA Specification 511 Materials for Bituminous Treatments	Bitumen emulsion and materials, plant and equipment, construction and acceptance.
MRWA Specification 515 Insitu Stabilisation of Pavement Materials	Bitumen emulsion construction and acceptance.

CEMENTITIOUS STABILISATION

Cementitious stabilisation incorporates cement or supplementary cementitious materials with water and granular materials to produce a bound material.

PROJECT TYPES

- Upgrade widening
- Granular resheets/stabilisation
- Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.

AVAILABILITY

To be determined by the local practitioner.

ENGINEERING PERFORMANCE

Cement stabilisation can be tailored to address the requirements of the specific granular materials. For example, the following binder applications by 28-day unconfined compressive strength (UCS):

- heavily bound or heavily cemented: > 3 MPa
- lightly bound or lightly cemented: 1–2 MPa
- modified 0.7–1 MPa.

The combination of cement with SCMs such as fly ash, blast furnace slag or lime with water into the granular mix will produce a bound material. This process will generally improve the moisture susceptibility of a material and increase stiffness through increased tensile strength.

EQUIPMENT AND MATERIALS

Cementitious stabilisation can be undertaken either insitu or through a fixed-plant mix pugmill operation.

WA SPECIFICATIONS

Specification	Application
WALGA Pavement Rehabilitation Road Building Model Specification	Cement stabilisation works
WALGA Earthworks and Pavement Construction – Road Building Model Specification	Earthworks and pavement construction
WALGA Granular Pavements Materials Road Building Model Specification	Supply of unbound and centrally stabilised (plant-mix) granular pavement materials, including basecourse and subbase.
MRWA Specification 302 Earthworks	Cement stabilisation of subgrade
MRWA Specification 410 Low strength infill	Low strength infill for the backfilling of redundant or abandoned pipes, culverts and other buried structures
MRWA Specification 515 Insitu Stabilisation of Pavement Materials	Insitu stabilisation of granular pavement layers

SOIL/SUBGRADE STABILISATION

Soil/subgrade stabilisation is undertaken to stabilise granular materials with properties considered inadequate for use in pavements.

PROJECT TYPES

- Upgrade widening
- Rehabilitation base and seal
- Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.

AVAILABILITY

To be determined by the local practitioner.

ENGINEERING PERFORMANCE

Stabilisation is typically undertaken to improve properties including strength, permeability, volume stability and durability. Some common soil/subgrade stabilisation methods include:

- granular stabilisation (blending multiple different types of granular materials to improve properties).
- cementitious stabilisation (refer above factsheet).
- lime stabilisation (ideal for use in clayey soils as lime binds to clay particles to make it less susceptible to moisture changes).
- chemical additives (primarily used as a binder for fine soil particles).
- geotextiles and geogrids.

EQUIPMENT AND MATERIALS

Soil/subgrade stabilisation can be undertaken either insitu or, if necessary, through a fixed-plant mix pugmill operation.

WA SPECIFICATIONS

Specification	Application
WALGA Pavement Rehabilitation Road Building Model Specification	Insitu stabilised pavement materials.
WALGA Earthworks and Pavement Construction – Road Building Model Specification	Earthworks and pavement construction
MRWA Specification 302 Earthworks	Lime stabilisation of subgrade

WARM MIX ASPHALT

Warm mix asphalt refers to the preparation of asphalt at a lower temperature than hot mix asphalt.

HMA fuming left vs WMA no fuming right

PROJECT TYPES

- Upgrade widening
- Asphalt overlay
- Rehabilitation (mill and re-mill) – base rehabilitation
- Seal/reseal (sprayed sealing)
- Rehabilitation base and seal
- Improvement projects – e.g. new carriageways, turning lanes, traffic circles etc.

AVAILABILITY

To be determined by the local practitioner.

Benefits such as the increased haulage distance would be advantageous in regional, remote and very remote areas.

ENGINEERING PERFORMANCE

Most warm mix asphalt technologies require some form of licensing, modified asphalt mixing plant or the use of proprietary products as additives. Common processes for achieving a warm mix asphalt includes:

- foamed bitumen.
  - direct injection.
  - two-component binder system.
  - addition of water through a foaming rig or synthetic zeolite.
- addition of workability additives (e.g. workability additives such as Rediset).
- addition of waxy type additives (e.g. Sasobit).
- bitumen emulsions.

EQUIPMENT AND MATERIALS

Standard hot mix asphalt plant and equipment can generally be modified to suit warm mix asphalt requirements, depending on the chosen technology. For example, standard hot mix asphalt equipment can be used for additive based warm mix asphalt technologies, with the simple edition of facilities for handling, dosing and blending of additives. To undertake conventional foaming, a foaming rig would also be required. Further, binder foaming technologies require asphalt mixing modifications.

BENEFITS

Some of the benefits of using warm mix asphalt include:

- improved and extended workability.
- consistent compaction.
- energy savings.
- reduced emissions.
- extended paving season.
- increased haul distance (i.e. the distance to the asphalt plant can be increased).
- reduced issues with crack sealant.
- less oxidised binder at time of construction.
- reduce brittleness of binder.
- improved rideability.

WA SPECIFICATIONS

Specification	Application
IPWEA/AfPA Tender Specification, Tender Form and Schedule for Supply and Laying of Asphalt Road Surfacing	Foamed bitumen products and materials, plant and equipment, environmental considerations, quality control.
MRWA Specification 502 Stone mastic asphalt	Products and materials, mix design, manufacture and transport, placing of asphalt
MRWA Specification 504 Asphalt Wearing Course	Products and materials, mix design, manufacture and transport, placing of asphalt
MRWA Specification 510 Asphalt Intermediate Course	Products and materials, mix design, manufacture and transport, placing of asphalt
MRWA Specification 511 Materials for Bituminous Treatments	Workability additives
MRWA Specification 516 Crumb Rubber Open Graded Asphalt	Products and materials, mix design, manufacture and transport, placing of asphalt

HOT-IN-PLACE ASPHALT RECYCLING (HIPAR)

The HIPAR process is an insitu pavement rehabilitation technique that mills a road and re-lays the recycled mix in one passing.

PROJECT TYPES

- Asphalt overlay
- Rehabilitation (mill and re-mill) – base rehabilitation
- Seal/reseal (sprayed sealing)
- Rehabilitation base and seal (i.e. thin asphalt surfacing, constructability may need to be considered)
- Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.

AVAILABILITY

To be determined by the local practitioner.

ENGINEERING PERFORMANCE

Appropriate uses for HIPAR include:

- rehabilitation of major structurally sound roads.
- restoration of surface shape, texture, and skid resistance.
- rejuvenation of oxidised binders.
- rehabilitation of problem asphalt layers.
- addition of a thin layer of asphalt to a pavement.

Key factors requiring consideration include the significant quantity of gas required for heating and the details of the existing pavement (e.g. properties and thickness of the asphalt and the presence of moisture in the pavement)

EQUIPMENT AND MATERIALS

It is undertaken using a train of equipment which:

- heats and mills the asphalt surface material (to a depth of approximately 50 mm).
- mixes the millings with aggregate, binder and a rejuvenating agent as required.
- places and compacts the new mix onto the pavement in a single pass.

BENEFITS

Some of the key benefits of the HIPAR process are related to the fact that the pavement rehabilitation process can be undertaken in one pass, using existing road materials. These benefits include:

- cost savings
- reduced use of virgin materials
- reduced traffic delays.

WA SPECIFICATIONS

No specific standards – refer General Road Construction Standards as shown below.

Specification	Application
MRWA Specification 502 Stone mastic asphalt	Products and materials, mix design, manufacture and transport, placing of asphalt
MRWA Specification 504 Asphalt Wearing Course	Products and materials, mix design, manufacture and transport, placing of asphalt
MRWA Specification 510 Asphalt Intermediate Course	Products and materials, mix design, manufacture and transport, placing of asphalt

HIPAR train

IN SITU RECYCLING OF CONCRETE PAVEMENTS

Insitu recycling of concrete pavements can be conducted by fracturing the concrete pavement into smaller pieces, prior to constructing the new road on the surface.

PROJECT TYPES

- Infrequent applicable uses in WA due to limited or no concrete pavements. For information only.

AVAILABILITY

To be determined by the local practitioner.

ENGINEERING PERFORMANCE

The 2 main techniques for undertaking these works include ‘crack and seat’ and rubblisation. These techniques fracture the existing concrete pavement into smaller pieces, prior to constructing a new road on the surface.

- Crack and seat: Concrete pavements are cracked into 300 mm to 600 mm square sections. The sections are then rolled and pushed down onto the underlying pavement.
- Rubblisation: The concrete pavement is pulverised until it resembles a coarse granular material. An asphalt overlay is then applied over the fractured and seated slabs to strengthen the pavement.

WHOLE-OF-LIFE FACTORS

As insitu concrete recycling is a relatively costly process, the severity of deterioration and the requirement for extensive repair should be taken into account prior to selecting this option.

EQUIPMENT AND MATERIALS

Insitu recycling of concrete pavements is conducted using specialised equipment.

WA SPECIFICATIONS

No specific standards – refer to General Concrete Road Construction Standards.

MARGINAL AND NON-STANDARD MATERIALS

Marginal and non-standard materials are naturally sourced materials that do not necessarily meet the specifications for use in road construction.

PROJECT TYPES

- Upgrade widening
- Granular resheets/stabilisation
- Rehabilitation base and seal
- Improvement projects – e.g. new carriageway, turning lanes, traffic circles etc.

AVAILABILITY

All areas.

ENGINEERING PERFORMANCE

Typically comprising naturally occurring gravels, weathered rocks and occasionally clayey sands, they are known to successfully perform as granular base and subbase materials. These materials are often required for use in regional environments as they are prevalent and readily available. The use of recycled materials (e.g. crushed recycled concrete and bricks, RAP, etc.) and sustainable practices such as insitu recycling should still be encouraged to reduce the dependency on natural resources.

EQUIPMENT AND MATERIALS

Marginal and non-standard materials can be used in road construction using conventional equipment and machinery.

WA SPECIFICATIONS

Specification	Application
WALGA Granular Pavements Materials Road Building Model Specification	Supply of unbound and centrally stabilised (plant-mix) granular pavement materials, including basecourse and subbase.
MRWA Specification 501 Pavements	Guidance notes available for natural laterites and ferricretes for use in selected regions.

Appendix B Example Scenarios

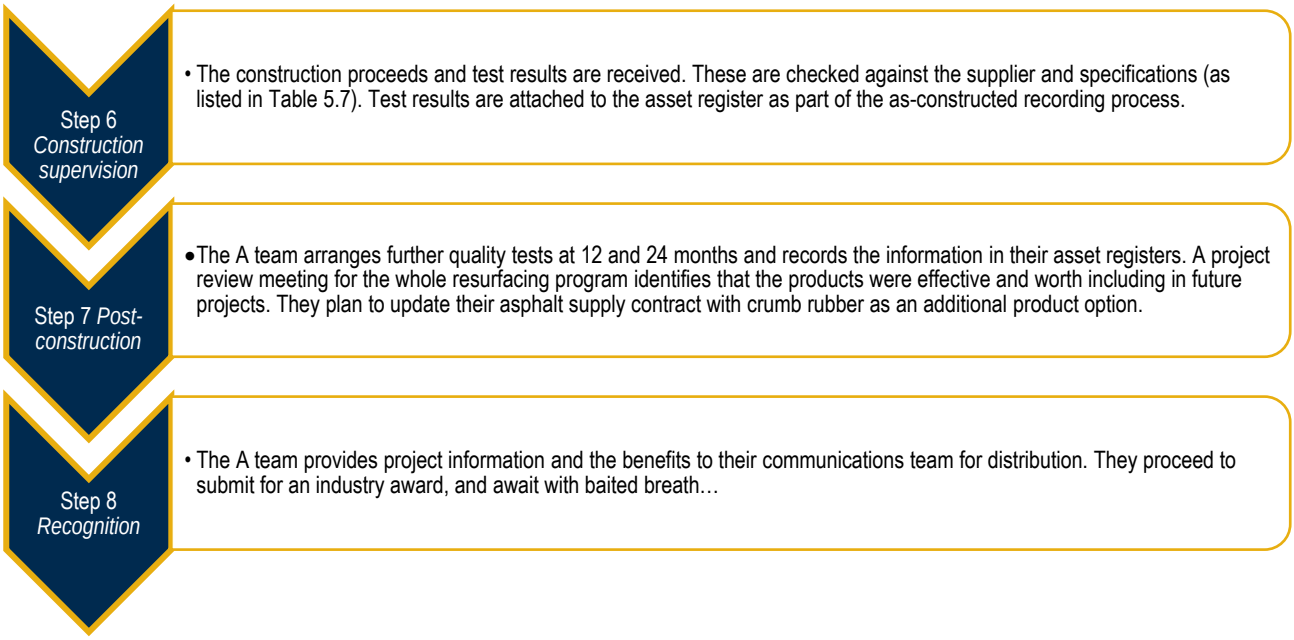
The following example scenarios have been provided to assist practitioners in using the Guideline to identify and implement sustainable options within road construction projects:

- Example scenario 1 – A metropolitan city resurfacing project
- Example scenario 2 – A remote shire spray seal project
- Example scenario 3 – A metropolitan rehabilitation project with insitu foamed bitumen stabilisation
- Example scenario 4 – A remote gravel resheeting program
- Example scenario 5 – A regional city using crushed glass.

B.1 Example Scenario 1 – A Metropolitan City Resurfacing Project

In this example, the asset infrastructure team in a metropolitan city (known as the A team) have a resurfacing program consisting of asphalt overlay of 20 to 30 roads per year. As part of their new Climate Change Action Plan and Waste Management Strategy, they have identified the need to introduce recycled materials into their road construction projects to reduce climate change effects and reduce waste to landfill. It is thought that crumb rubber in asphalt would be a good product to trial.

The A team accesses the *Practitioners Guideline: Sustainable road construction practices for Local Government roads in WA* (this Guideline) and proceeds to follow the implementation process:

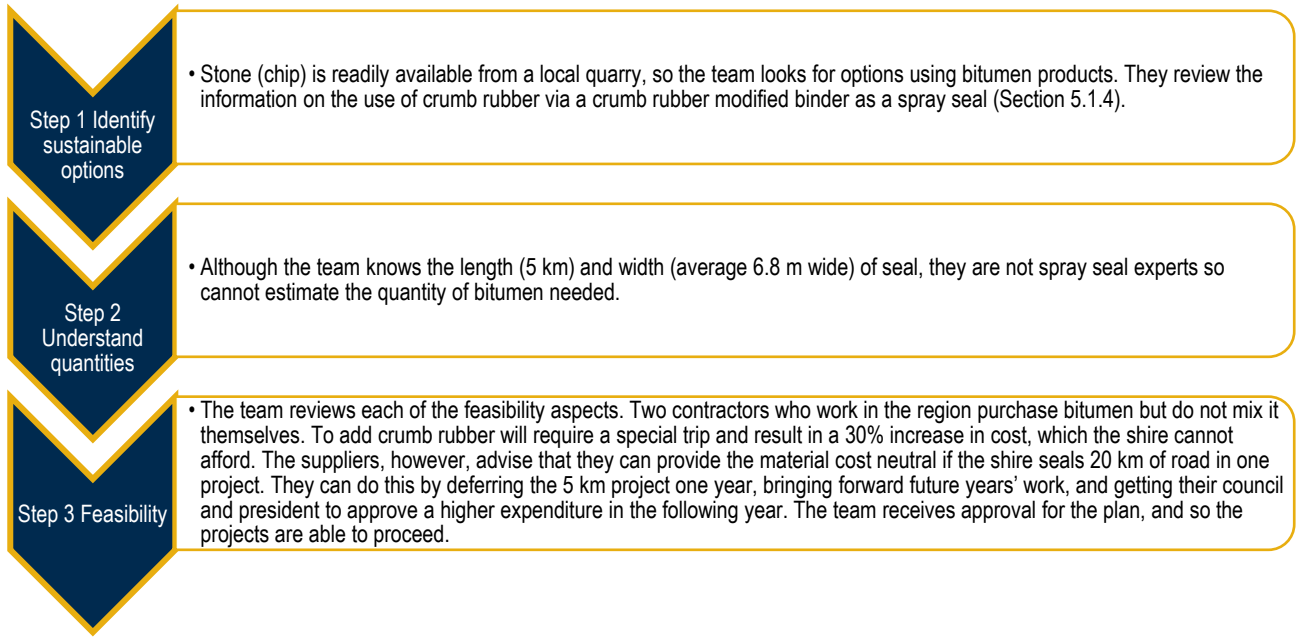


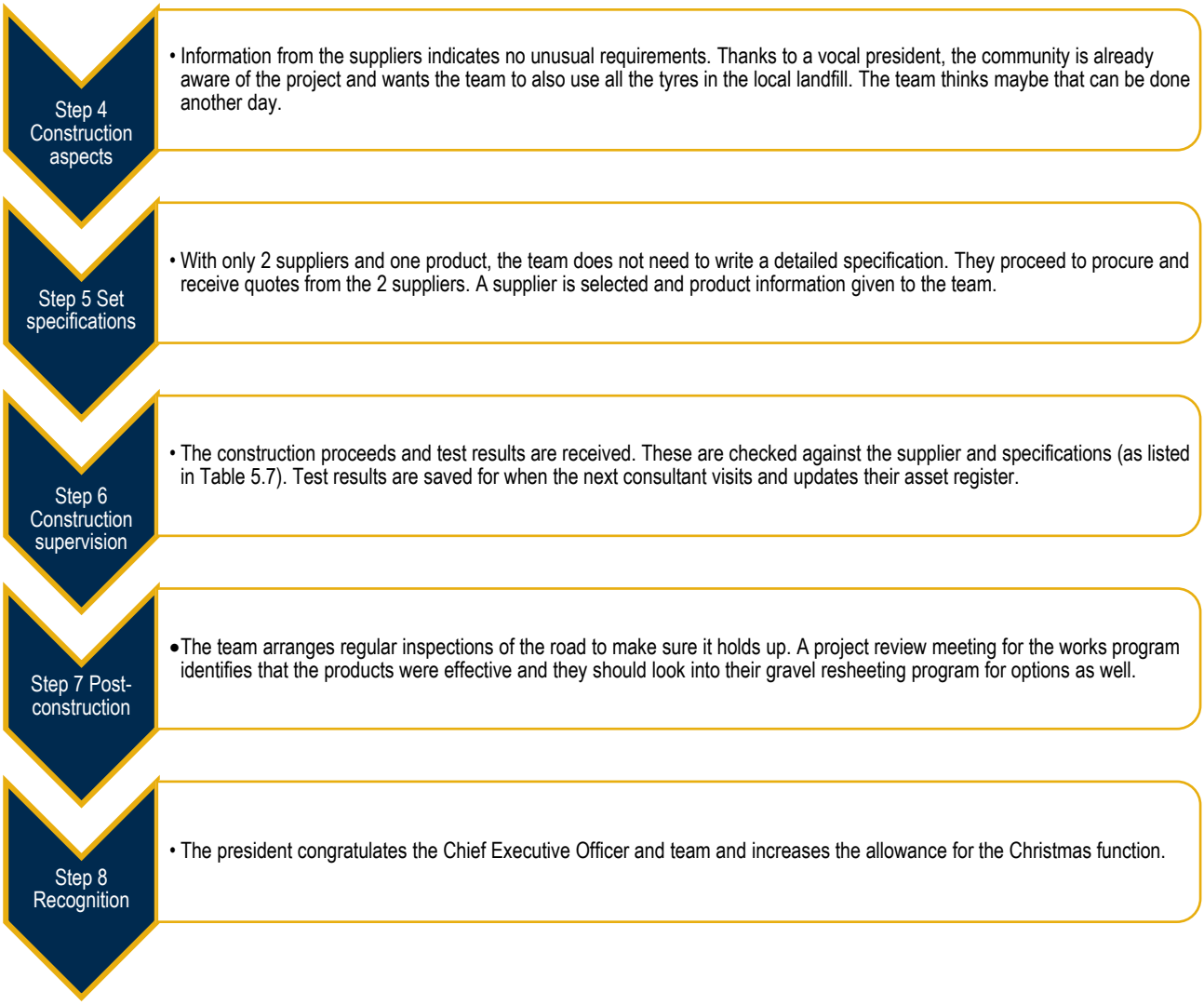
The scenario is presented here as having a positive outcome; however, another local government may have different results. There could be situations where the cost is too high, or risks are identified that cannot be managed, or perhaps the materials do not meet the required specifications. The purpose of the scenario is to show the use of the implementation process to aid the local government in managing risks and ensuring only feasible products and methods are applied.

B.2 Example Scenario 2 – A Remote Shire Spray Seal Project

In this example, a shire's engineering team need to arrange spray sealing of 5 km of one of their roads. The old seal has stood up well to time and weathering but is showing some cracking and ravelling. It carries relatively high volumes of traffic leading to a main road and needs a good quality single coat spray seal.

The shire's president is keen on using recycled materials and saving the environment and has asked for options to be found across the shire's operations. The team refers to this Guideline and follows the implementation process:





The scenario shows an example of resolving a significant constraint (the recycled material product was too expensive) by changing the planning of works, while using the support from community leaders. Such a large-scale adjustment of works programs may not be feasible in many situations and will take time to obtain the relevant approvals.

B.3 Example Scenario 3 – A Metropolitan Rehabilitation Project with Insitu Foamed Bitumen Stabilisation

In this example, a large city (local government organisation) has researched the use of foamed bitumen stabilisation for its road rehabilitation projects. The projects have been scoped following technical pavement investigations, including falling weight deflectometer, and have qualified for funding through the Metropolitan Regional Roads Group's Road Rehabilitation funding program. The use of the stabilisation is expected to save time and cost on the project, in particular to significantly reduce the amount of time that the distributor roads will be closed for works. There was also the added benefit of re-using materials, saving direct costs of work and disposal. The project's delivery team now want to undertake due diligence on the proposed treatment, to make sure the engineering performance and life cycle aspects are suitable.

The team undertakes an assessment of foamed bitumen stabilisation by following the implementation process in Section 4.1 of this Guideline:

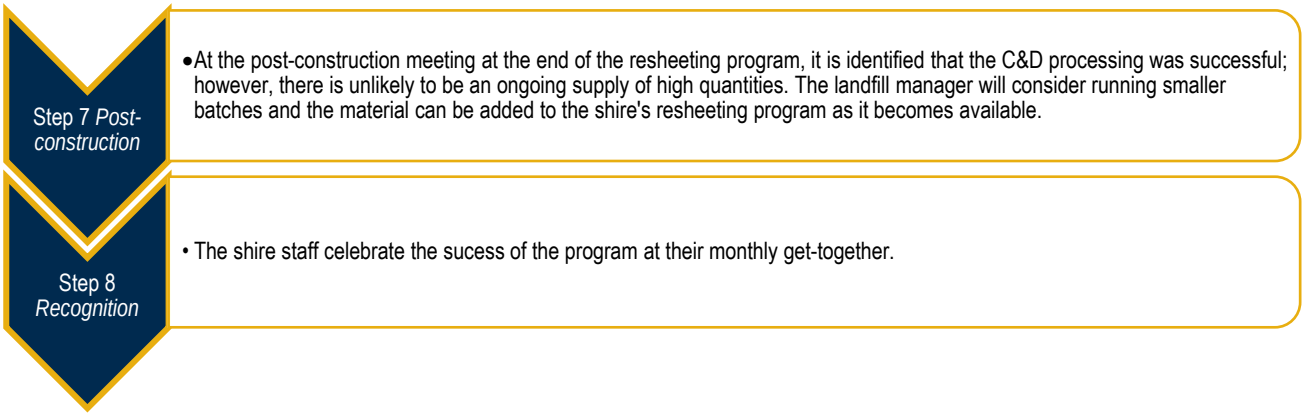
Step 1 *Identify sustainable options*	• The team had identified foamed bitumen stabilisation as a suitable product after checking with a number of other local governments, suppliers and a consultant 'guru' on the method.
Step 2 *Understand quantities*	• The projects had been scoped by area as they involved a number of sections of lanes along a high-volume road. The quantities are known to a high level of accuracy.
Step 3 *Feasibility*	• The time savings is confirmed with suppliers. The project's team then engages with the city's asset management team to ensure the new pavement type is recorded and the performance of the material can be monitored post-construction. In the risk assessment, a high risk is identified relating to the potential vibration of the plant affecting adjacent properties. A dilapidation survey will be arranged to monitor this. There is also an opportunity identified, whereby the pavement materials could be excavated and mixed off site. This is found to not be as effective in reducing time and cost on the project.
Step 4 *Construction aspects*	• The construction management plan is amended to reflect the different types of plant on site, shorter road closure period, and need for tighter scheduling of subcontractors.
Step 5 *Set specifications*	• The supplier is identified as a sole supplier under the city's purchasing procedures. Nevertheless, the team specifies the work fully, referencing the specifications (see Section 5.2.1) and covering the range of site safety and traffic management requirements. They document this to ensure that future projects could use the same information.
Step 6 *Construction supervision*	• Construction supervision proceeds with normal procedures, and the dilapidation surveys do not identify any problems despite some local residents complaining of the noise and vibrations.
Step 7 *Post-construction*	• During a post-construction review meeting, it is identified that a problem with scheduling the asphalt contractor to follow the stabilisation contractor had resulted in the road surface being unsealed and exposed to the weather for longer than desired. Some of the time saving from the change in method had been lost due to this, and the team will develop new processes to schedule the work more effectively next time.
Step 8 *Recognition*	• The project was summarised and presented as part of the city's annual report, emphasising the time and cost savings from introducing new sustainable construction methods.

This scenario shows how even if a project or projects are well advanced in their planning, funding and scoping, there is still an opportunity to apply a decision process. By adopting the project flow presented in this Guideline, the organisation can ensure that their objectives are able to be met, while identifying and managing other risks and opportunities.

B.4 Example Scenario 4 – A Remote Gravel Resheeting Program

In this example, a remote shire (local government organisation) is planning its usual annual gravel resheeting and grading program. An increase in private building construction activity in the region has resulted in larger than usual volumes of construction and demolition waste arriving at the local landfill site, and the shire officer that supervises the landfill has asked if the materials can be used in the resheeting program. The works manager (sitting next to him – it is a small shire) suggests they refer to the *Practitioners Guideline: Sustainable road construction practices for Local Government roads in WA* to work out what they would need to do to use the crushed concrete and brick waste materials.

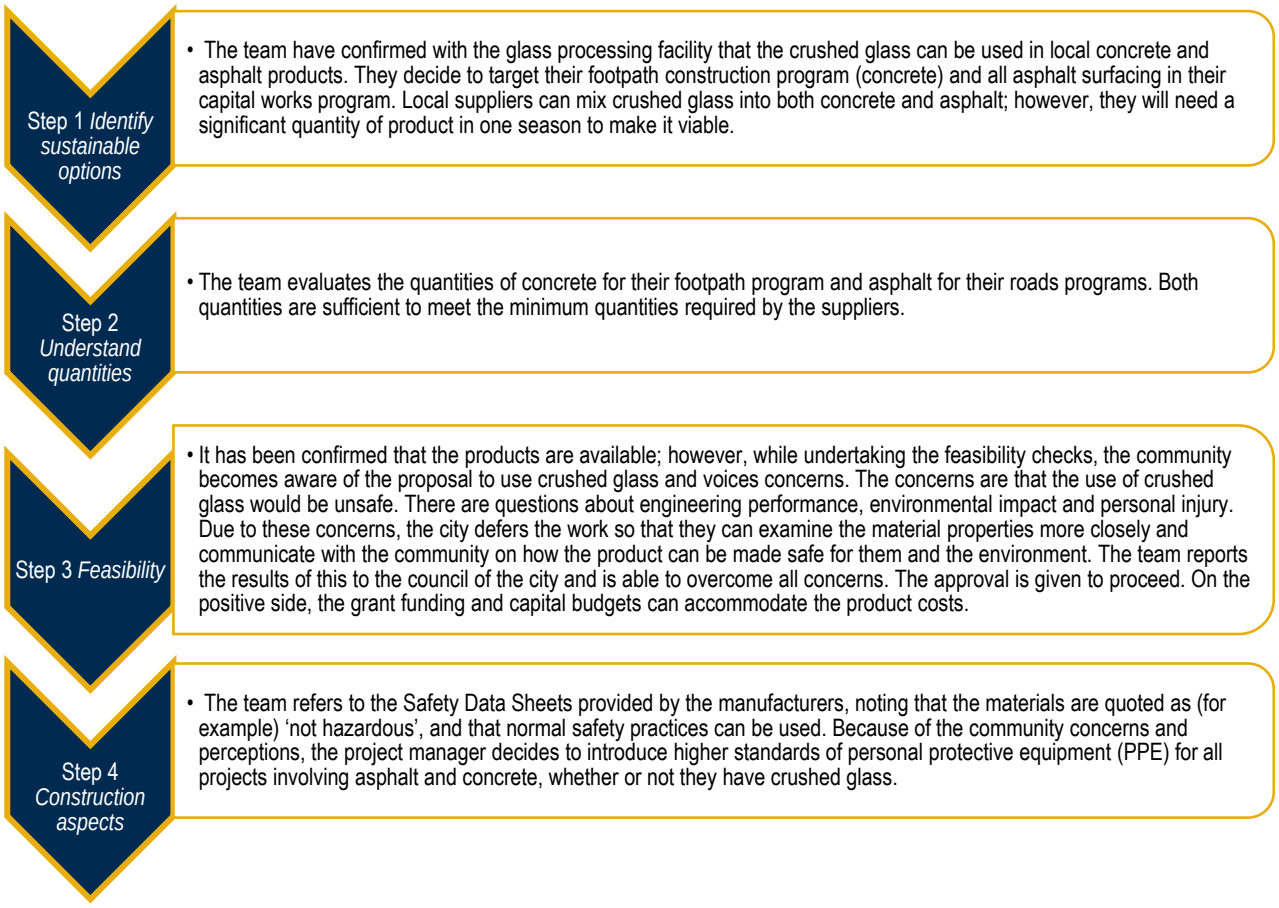
Coincidentally, a local mine site has just asked if the shire needs any of their clean fill material from a haul road expansion project. The works manager follows the implementation process:

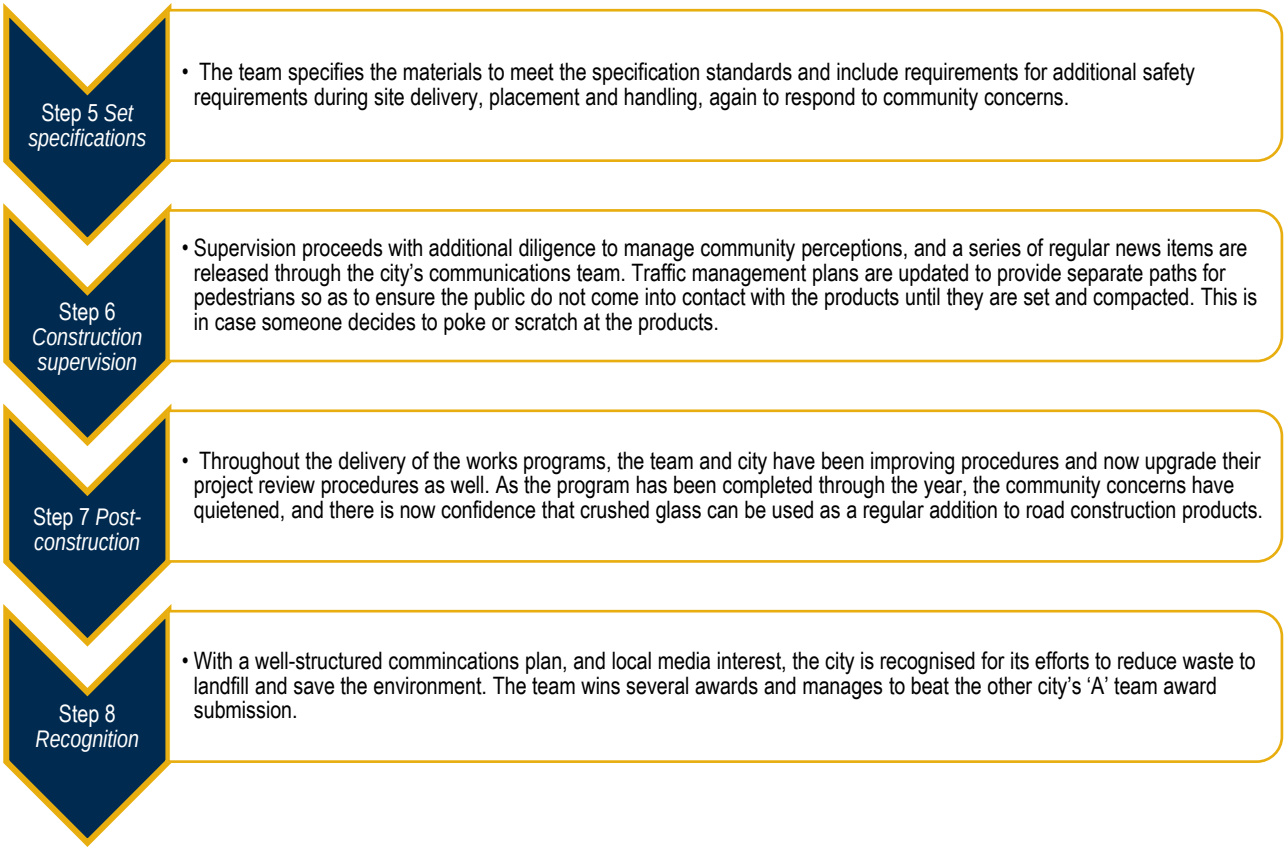


This scenario promotes the re-use of materials even when the cost to the shire of disposal to free landfill space is almost zero. It looks at a way of taking advantage of free materials and following a process to assess and apply the materials into suitable road construction.

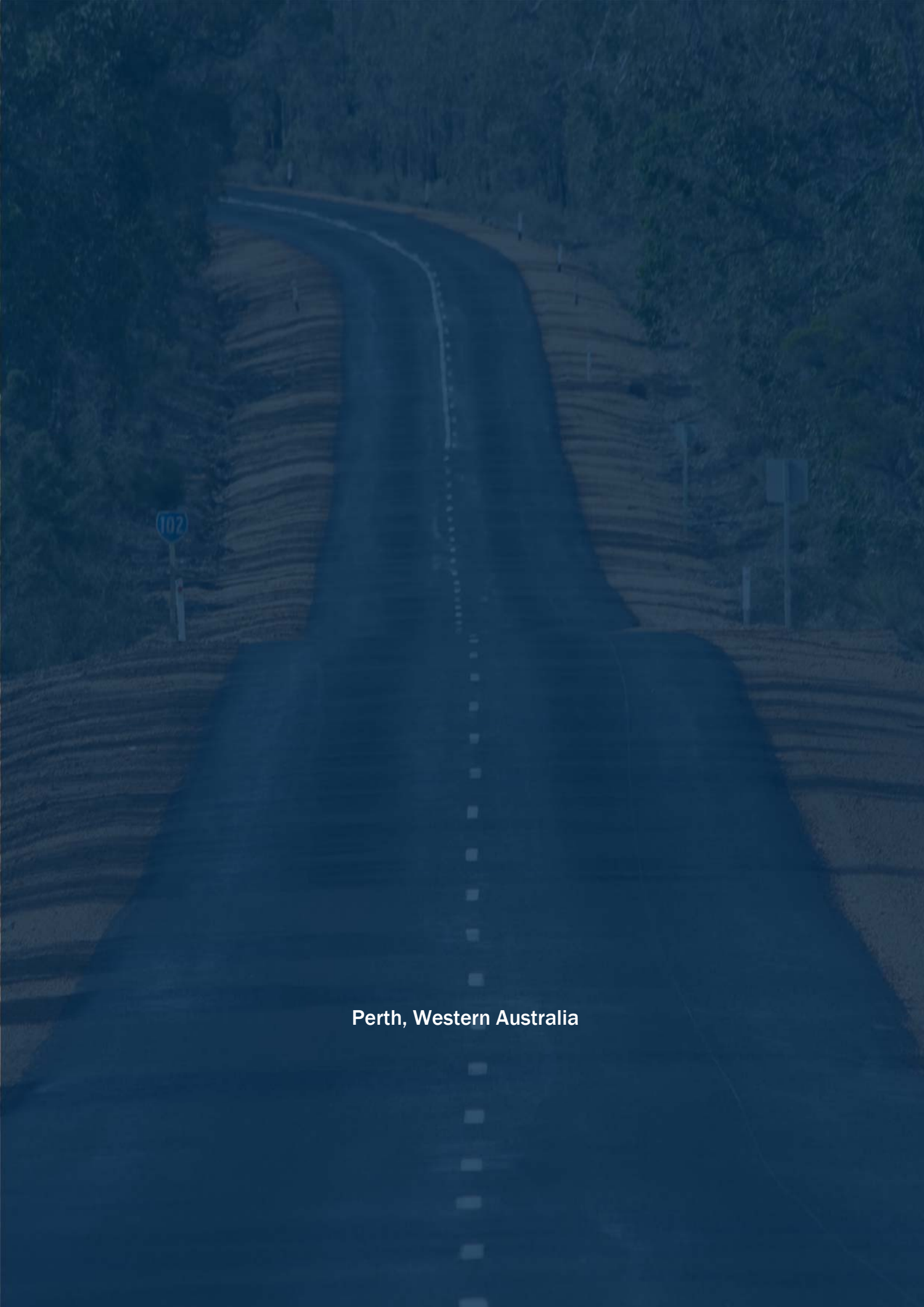
B.5 Example Scenario 5 – A Regional City Using Crushed Glass

In this example, a regional city (local government organisation) wants to take advantage of a large quantity of glass waste that is being collected and processed through a third-party waste facility. There are grants associated with the glass processing that could flow through and reduce the overall cost of capital works, reduce rates in the community, and ultimately improve the city's financial health index. The confidence of the council with the administration is suffering from poor financial performance in recent years. The waste facility operator has confirmed they are able to crush the glass and provide to local asphalt and concrete suppliers. All the city's infrastructure team has to do is specify for those materials in their large construction program.





This scenario presents a story in overcoming a strong community perception of safety risks associated with the recycled material. While it is of course speculative and imaginative, the aim for a local government that experiences this type of situation is to ensure that technical diligence is undertaken and effective communications are made to deliver viable and safe solutions to the community.


Perth, Western Australia