

# LOCAL SOLUTIONS USING RECYCLED PRODUCTS IN PUBLIC WORKS

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## Abstract

This paper discusses the current status of the Victorian reprocessing industry and outlines work completed in the construction and demolition sector to conserve natural resources. Two projects are discussed i) the use of recycled glass in asphalt and, ii) the performance of recycled concrete, brick and rubble in pavement, sub-base and as bedding material. Both projects outline the application of recycled products as a substitute for the use of virgin materials in public works activities. The roles of the landfill levy and complementary measures play and the role local government plays in the use of recycled products and promotion of local solutions to global problems are outlined.

**Key Words: Reprocessing, construction and demolition, recycled products, public works, local government, local solutions**

## Introduction

The Victorian Government's Towards Zero Waste Strategy (TZW) was launched in 2005. The strategy seeks to generate less waste and maximise opportunities for material recovery. TZW strategy has four state wide targets to reduce waste, recover resources, reduce littering, and sets specific targets for Victoria's municipal and business sectors to deliver more sustainable use of resources by 2014 (Sustainability Victoria, 2009). Table 1 shows details of the targets.

**Table 1: The Victorian Towards Zero Waste Strategy targets**

2014 Targets
1.5 million tonne reduction in solid waste generated
75% by weight of solid waste recovered for reuse, recycling and/or energy generation
Sectoral recovery rates achieved <ul style="list-style-type: none"> <li>• municipal waste (65%)</li> <li>• commercial and industrial waste (80%)</li> <li>• construction and demolition waste (80%)</li> </ul>
A 25% improvement in littering behaviour from 2003 levels

Victoria's current reprocessing capacity is predominantly local as 85% of materials

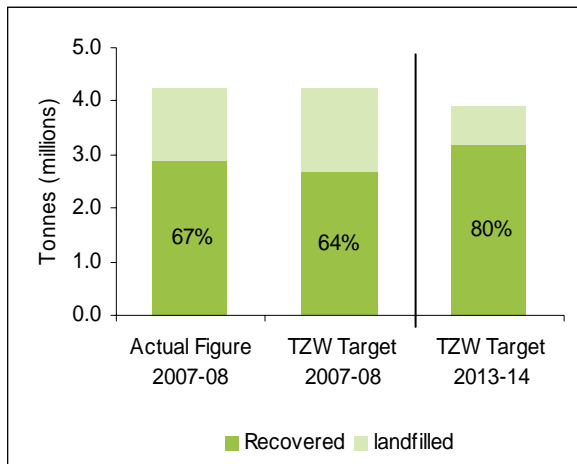
collected from the reprocessing industry in 2005/2006 were converted into new products. The remaining 15% was transported

interstate or exported overseas for reprocessing.

During the same period the reprocessing industry has contributed more than \$68 million to the Victorian economy through capital investment and expenditure on research and development. More than three-quarters of the material collected and reprocessed was sourced from the commercial and industrial (C&I) and construction and demolition (C&D) sectors (Sustainability Victoria, 2007).

The Victorian C&D sector, has worked hard to increase the recovery of recyclable materials and produce quality recyclable products to reduce the use of virgin materials. This is a problem seen across the globe that requires innovation and acceptance of quality recycled products and their use in public works activities. The Victorian C&D sector has developed sustainable local solutions to conserve our natural resources and contribute significantly to meeting the states TZW strategy targets. Figure 1 shows that in 2007/2008, the actual recovery rate for the C&D sector was 67% against the projected target of 64% and the 2014 target of 80%.

**Figure 1:** 2007/2008 C&D resource recovery rate against the projected TZW targets.



In 2001 the Victorian C&D sector identified the need to focus and drive the C&D reprocessing industry to find local solutions for the use of quality recycled products in many different public works activities. The industry determined the most effective way to do this was to work together and the Victorian C&D Recyclers Group was formed. The consists of five of the major C&D businesses in metropolitan Melbourne who combined in 2007/2008 contributed to over two million tonnes of the total 2.86 million tonnes recovered. This gives some context around the reprocessing capability and impact this group has on the C&D reprocessing industry (Sustainability Victoria, 2009).

In the United States, recycled glass has been used successfully over a long period of time but widespread usage has been generally constrained by poor economics. However, this is now changing as there are increased incentives for reuse and recycling of materials (Camilleri, B, 2008).

In order to promote the use of recycled glass in Victoria, Sustainability Victoria contributed funding to trial the use of glass as a replacement for natural sand in asphalt. The project was funded from the TZW Commercial and Industrial Resource Recovery Infrastructure Grants Program that is funded through the Victorian landfill levy. The project was initiated by Alex Fraser Asphalt, part of the Alex Fraser Group the largest C&D recycling company in Australia. Tonnages available for this project ranged from 80,000 to 100,000 tonnes that had been stockpiled. As a result of the project the Victorian roads authority, VicRoads, provided conditional registration for acceptance of recycled glass as an alternative to raw materials in three asphalt mixes.

From the same grants program Sustainability Victoria contributed funding to a project initiated by the Victorian C&D working group in partnership with VicRoads and the centre for sustainable infrastructure at Swinburne University of technology. The project investigated the engineering properties and suitability of recycled crushed brick combined with other reclaimed materials like concrete and crushed rock, as an alternative to virgin materials in pavement and sub base material. Two of the largest C&D companies in Victoria participated including Alex Fraser and Delta Recycling.

This piece of work is critical for the C&D reprocessing industry with over 100,000 tonnes of brick and rubble produced annually and a stockpile of over 300,000 tonnes waiting to be used.

The results of both projects are discussed in the body of this paper.

The use of recycled products like glass, brick, rubble and concrete have been proven to perform to the same standards as virgin materials and are suitable for public works activities. The limitations for using recycled products include finalising required changes to VicRoads specifications, followed by the acceptance and use of these valuable products in local government public work activities for the sustainable development of these local solutions to global problems.

### Recycled glass in asphalt

Glass has most of the properties of high quality natural silica sand and is free of clay and other contaminants. Being almost totally inert, it is extremely durable. It also has extremely low absorption hence provides a greater effective binder content in the mixing of asphalt.

Glass Asphalt (Glassphalt) was developed as an alternative to landfill disposal of mixed coloured waste glass. Mixed coloured glass is generally unsuitable for traditional recycling processes due to small sizes and the requirement to separate glass colours for reprocessing. Because of this, mixed coloured glass is available in large volumes and is created by most recycling and collection practises. Unavoidable glass breakage occurs during disposal in to

recycling bins, collection in to recycling trucks and reprocessing practices. The coloured glass that breaks into small particles and fines is called cullet and can be seen in Figure 2. This can be separated from the collected glass stream that is used to make products like glass containers and is then either stockpiled or sent to landfill.

Alternative uses for mixed coloured glass is critical. Currently one Victorian reprocessor has a stockpile of over 100,000 tonnes of glass cullet and more is available through others. Over recent years the number of Victorian landfills has reduced and a reduction in the use of raw materials is required if we are to preserve our natural resources. For example sand close to the city on the Eastern Seaboard is a rare commodity, often requiring truck trips in excess of 100km to transport the material. The use of alternate materials like glass means that virgin resources like sand will last longer and there will be less distance travelled in transport requirements.

Glassphalt provides one alternative local market using processed glass as a substitute for natural aggregate in asphalt. This process has the potential to avoid glass cullet being disposed of to landfill altogether and reduce the need for stockpiling. The Glassphalt product also contributes significantly to Victorians meet the states TZW strategy targets by 2014.

**Figure 2:** Mixed coloured glass called cullet, Alex Fraser Asphalt, Laverton



The aim of the project was not only to develop an asphalt product using glass cullet but to have this approved by the Victorian roads authority, VicRoads. In turn this would lead to acceptance and use of the product by local governments.

The designs of asphalt mixes using glass are required to meet the appropriate VicRoads specifications. Once the mixes were designed field trials were conducted at Alex Fraser Group's Recycle yard. The location at the site selected was at the entry point to the recycle yard and the approach to the weighbridge. The section of access road was chosen because it is subject to heavy traffic conditions including truck movements both loaded and unloaded. The site also allowed the trial to be closely monitored and frequency of truck movements to be observed as the trial progressed.

Testing of the field trial area where two different types of Glassphalt products were placed involved compaction testing where the removal of core samples was taken and density tested. Skid resistance testing was completed on the pavements in the field trial and glass cullet had no effect on skid resistance. Grading and bitumen content of the trial mixes was also tested to determine if the right mix of ingredients in the Glassphalt products were present. Visual inspections were also completed. Testing and mixes were measured against VicRoads specifications and standards.

The main problem encountered during the field trials was in producing the glass cullet to the right grading (size), which took some time. The right grading size is critical to ensure that the glass cullet is crushed to a grading suitable to be used as a replacement for natural sand in the asphalt production.

**Figure 3:** Processed glass, Alex Fraser Asphalt, Laverton



All tests completed for grading, bitumen content, skid resistance and density passed the required VicRoads specifications. The next step was to submit the asphalt design

mixes using glass cullet to VicRoads for approval. A number of mixes were designed of the following types:

- a fatigue resistant structural base course asphalt for heavy duty asphalt pavements
- a multi purpose structural asphalt for intermediate course in heavy duty pavements or base course in medium duty pavements
- a light to medium duty wearing course or regulating course for use in light to moderately trafficked pavements (VicRoads, 2008).

VicRoads provided conditional registration for these mixes based on a client's acceptance of glass being used as a substitute for natural sand. The limitation with the conditional registration applied to Glassphalt product is that use of the quality product is reliant on acceptance by the clients, for example local government.

Local governments' acceptance of the use of glass is critical to achieve the sustainable development of local markets for the Glassphalt product, local government's acceptance of its use is critical. Councils can ensure the use of recycled products are considered in the design stage of public works and that tender documents and specifications include the requirement to use recycled products where suitable. With out support and promotion by local governments the use of products like Glassphalt will remain stagnant.

### **Recycled brick and rubble in pavement sub base and as a bedding material**

The use of recycled products in road construction is not new. Concrete materials that are recovered from the different phases of C&D activities are crushed and reused in road construction activities. However, in Victoria there is limited application of the reuse of crushed brick material that comes from these C&D activities and is produced at a rate of 100,000 tonnes per year.

To address this issue the Victorian C&D working group initiated an applied research project to characterize the engineering properties and to assess the suitability of recycled crushed brick as an alternative to virgin material in pavement, sub-base and as

a bedding material for stormwater and drainage systems ( Swinburne, 2008).

Currently, section 820 of the VicRoads standards specifications outlines the use of recycled crushed concrete for pavement sub base and light duty base (low grade roads). It allows for a small percentage, use of recycled products, approximately 3 to 5 %, and does not include recycled crushed brick (Swinburne, 2008).

Materials produced from C&D activities are generally homogeneous by nature, being similar in composition. This allows these materials to be easily adapted as alternatives to virgin materials.

The research involved combining crushed brick and rubble material with crushed rock and concrete from two sites in metropolitan Melbourne, Alex Frasers Recycling site in Laverton and Delta Recycling's site in Sunshine. The material from the Laverton site typically consists of 70% crushed brick and 30% of other material including asphalt, concrete and rock. Material from the Sunshine site typically includes 40% crushed brick, 55% crushed concrete and 5% asphalt. The grade of these aggregates was 20mm in size from both sites. The crushed rock sourced from both sites was from surface excavation (basalt) that is mostly disposed of to landfill. VicRoads authority has approved the controlled use of basalt rock material for mixes used in pavement and sub base activities (Swinburne, 2008).

**Figure 4:** Crushed brick (20 mm) stockpile Delta Recycling, Sunshine (Swinburne, 2008)



A number of testing methods were used to determine the engineering characteristics and suitability of different percentages of crushed brick as an alternative to virgin material in pavement, sub base and as a bedding material.

These laboratory tests included:

- particle size distribution
- particle density
- water absorption
- modified compaction
- California bearing ratio (CBR)
- pH
- clay content
- plasticity index
- organic content
- Los Angeles abrasion loss
- flakiness index
- permeability
- wet and dry strength
- repeat load tri-axial.

Mixes were tested using a combination of crushed brick, concrete and rock at 10%, 15%, 20%, 25% and 30% of recycled product applied (Swinburne, 2008).

The result of the research work and tests completed show that the addition of crushed brick combined with basaltic crushed rock or crushed concrete has a “low to minimal affect” on the physical and mechanical properties of the original material. Both of these blends met the current VicRoads specification requirements satisfactorily (Swinburne, 2008).

Specific research and test results show that:

- Up to 15% of crushed brick can be added to class 3 crushed concrete and crushed rock blends. This could be increased but is dependent of on the results of field trials.
- Up to 25% addition of crushed brick can be added to class 4 crushed rock or crushed concrete blends.
- Up to 30% of crushed brick material can be added to blends for bedding and backfill material which met Melbourne Water requirements for grade A and B materials for this type of activity (Swinburne, 2008).

VicRoads have commenced the process to include 15% of crushed brick in to registered

blends. Although conservative, this approach will control the application of recycled materials in pavement, sub base and as a bedding material to companies that comply and register proven mixes against VicRoads requirements. It also provides clients like local government with the confidence that these recycled products are of a high quality and withstand specification requirements.

As with Glassphalt the next step is to gain acceptance and increase the use of these valuable recyclable materials as an alternative to virgin materials by local governments in public works activities. Roads authorities can support this by indicating in specifications that recyclable products that meet these specifications are of high quality and are suitable as a replacement for virgin materials in accordance with the specification requirements.

One example in the use of recycled products is the Eastlink road construction project that used 200,000 tonnes of class 3 cement stabilised to 3% in accordance with VicRoads specification section 821. Class 4 was also used and the material was delivered at up to 5000 tonnes per day.

### **Role of local government**

Local governments (LG) play a very important role in the sustainable development and accepted use of recycled products in public works activities. LG are key promoters of activities that impact on the use of recycled products in municipalities. LG have the ability to reach and enable positive partnerships with community, business and government to gain acceptance of recyclable products.

In some cases LG can enforce the use of recycled products by including this as a requirement in purchasing policies, tender specifications and planning and building approval processes. As with road authorities LG can also include the expectation that all applications for public works approvals show that recycled materials have been considered and if they have not been used acceptable justification should be provided prior to approvals being granted. This would place much needed emphasis on the use of these quality recycled products.

The benefits to LG to promote and build acceptance of recycled products include;

increased revenue for local businesses, more local jobs, increased revenue and reduction in operational costs for local government.

The results presented in this paper provide local government with the knowledge and confidence that recycled products perform to the same standard as virgin materials and will also meet community pressure and expectations that LG lead in the use of recycled products. LG experience not only environmental benefits; there are economic benefits, in that most recycled products are competitive with the equivalent quarry product and there is added social benefits by enhancing public reputation within the community (Griffith, 2009).

This has recently been recognised by ECO-Buy who in April 2009 initiated a round table to discuss the role of local governments in the use of recycled products. The round table involved all key players including Municipal Association of Victoria (MAV) representing local government, industry, VicRoads and State Government representatives. It was acknowledged that while Local governments generally do support the purchase of recycled products through the Eco-buy program, there is confusion about the quality of recycled products like Glassphalt, crushed brick and concrete. This highlights the importance of promoting the results of the research presented and the key role of the state road authority, VicRoads, who demonstrate confidence in the product through specification changes.

One key action from the round table is that MAV will lead an implementation plan to address some of these barriers including policy and strategic plans, education and awareness, case studies, review of VicRoads specifications and surveying the current practice (ECO-Buy, 2009).

### **Market and economic instruments**

Economic, or market-based, instruments can be price-based such as up-front charges or advance disposal fees, user charges, environmental taxes, subsidies and tax concessions, or they can be quantity-based, for example, providing limits to the quantity of waste to landfill. Many of these instruments aim to attach a price, or value, to commonly discarded items in order to encourage people to take more care in their use and disposal.

They are one set of a range of policy implementation tools that encourage behaviour through market signals rather than through prescriptive regulation. They are intended to make those people or businesses responsible for causing environmental damage bear the cost of the impacts of that behaviour, and those who benefit from environmentally damaging behaviour pay according to the proportion of the benefits they receive.

The Victorian Landfill Levy is an example of a market instrument designed to reduce waste to landfill and allocate revenue back into resource recovery and other environmental programs such as the projects mentioned in this paper. Funding has also been used to establish or upgrade facilities, innovation and research and development.

Some countries have used landfill bans to stimulate the sustainable development of alternative uses for valuable recyclable materials which may be supported by regulations and specifications by environmental or other authorities, such as roads. These approaches can play a major role in contributing to the acceptance and use of recyclable products.

Some of the members of the Victorian reprocessing industry are strong advocates for continued increases in the landfill levy to drive further increases in resource recovery rates and reduce disposal of materials to landfill.

Sections of the Victorian reprocessing industry are highly sensitive to commodity prices. When commodity prices are good reprocessing activities are strong, when prices are low activity drops. These sections can be more reliant on market instruments to assist them.

### **Conclusion**

To achieve the Victorian Government's TZW strategy targets by 2014 we, as industry, government, authorities or as community members, all have a key role to play in the use and acceptance of recycled products in public works activities.

Glass in asphalt and crushed brick in registered blends for specific public works activities are successful examples of local solutions to global problems that are evident in Victoria.

It is also evident that one of the largest opportunities to increase diversion of materials from landfill and increase resource recovery rates from the C&D sector to preserve our valuable resources, like quarried rock and sand, is the uptake and use of recycled materials.

Local government can show leadership by accepting and incorporating the use of these proven quality recycled products into all public works activities. Authorities can contribute to the acceptance and sustainable use of recycled products.

In concluding, a holistic approach is required to drive investment in resource recovery and the acceptance and use of recycled products. The research discussed in this paper proves that recycled products are a quality substitute for virgin materials in public works. Road authorities have accepted changes to specifications, therefore, the success and acceptance of recycled product used in public works activities is dependent on local governments commitment to using recycled materials.

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### Biography

Amanda has worked in the waste and environmental management field for 15 years. Her experience stems from roles in both the private and public sectors. Her background includes working within the food manufacturing industry, the mining industry, Local and State Government. Currently Amanda is a Project Manager with Sustainability Victoria working on resource recovery projects within the commercial and industrial and construction and demolition sectors.

