A National Approach to Waste Tyres

Prepared for
Environment Australia

by
Atech Group

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Executive Summary

Introduction
Issues associated with waste tyres have exercised the minds of both government policy makers and sections of the tyre industry around the world for many years. Yet there remains a strong perception that waste tyres are not being managed as well as they might. A majority of waste tyres are disposed to landfill, and there are reportedly significant numbers that are dumped illegally or managed in other inappropriate ways. Whatever the environmental risks, such practices fail to extract any value from waste tyres.

The issues are:
• the environmental impacts from waste tyres;
• resource security for potential investors in recycling facilities; and
• the lack of markets to absorb large quantities of waste tyres.

Waste tyres have certain characteristics that should facilitate the introduction of higher value management practices. Waste tyres are ‘generated’ at a number of easily identified (though numerous) points, are relatively homogenous and are uncontaminated at collection point. At the end of its life, a tyre still has much of its structural, physical and chemical integrity. While this places certain difficulties in the way of subsequent processing, it also opens up a number of opportunities.

This study was commissioned by Environment Australia to document what is happening at the moment in terms of waste tyres, what is the potential for improvement, and how we might move to take advantage of the possibilities through action by government and industry at a national level. The structure of the study follows these objectives. A preliminary report was prepared (now Part I of this report) as the basis for discussion at a national workshop held on 14 December 2000. The aim of the workshop was to provide guidance for developing and evaluating possible policy options and responses (written up in Part II of the report).

Part I: Background to the Tyre and Rubber Industry

The preparation of Part I involved assembling information on the current situation and projected developments. The material is arranged under the following headings.

The tyre industry
The structure of the tyre industry can be expected to have an impact on which waste tyre management options may be viable. The industry consists of a number of segments: manufacturers, importers and dealers in the case of new tyres; collectors, transporters, retreaders, reprocessors and recyclers (including waste to energy) in the case of waste tyres.

Although only two companies manufacture new tyres in Australia, it would seem that the availability of imported tyres introduces a high level of competition in the new tyre market. However, in developing options for waste tyres, it is necessary to recognise the position of importance enjoyed by the tyre manufacturers.
In the waste tyre sectors there is also dominance in collection/transport in most States and Territories. At the same time, there are a large number of small waste tyre collectors; controls at the point of collection and the subsequent fate of tyres are reported to be poor.

**Market considerations**

One avenue for reducing the number of tyres being disposed is to reduce the rate of generation of waste tyres (waste avoidance). It is concluded that decisions in regard to tyres are dominated by purchase price in the case of private use vehicles, though fleet operators may pay considerably more attention to total costs taken over the life of tyres.

The report has assembled the limited available data on fees charged for managing waste tyres.

**Regulatory and policy frameworks**

Each State and Territory has imposed statutory and non-statutory controls on activities associated with waste tyres. These controls include licensing or registration requirements on industry players, limits on the number of tyres in certain situations, and restrictions on tyres going to landfill (whether whole or shredded). Management of tyres is subject also to broad-based environmental protection and waste management regulatory provisions.

While there are significant differences across jurisdictions, the common threads are concerns with illegal dumping and policies to promote more valuable uses of waste tyres.

Some of the substantive differences between jurisdictions will become less marked in the future as certain legislative proposals are progressively adopted, continuing the process of recent reform in the waste management area generally.

**Environmental aspects of the tyre and rubber industries**

Although the emphasis in the study is on waste tyres, it is important that environmental impacts from other parts of the life of a tyre are not forgotten. The environmental impacts of manufacture (mainly noise and air emissions) are not excessively greater than the general run of manufacturing industry. However, the manufacture of tyres consumes substantial quantities of energy, both in the manufacturing process but also ‘captured’ in the end product.

During their life, an average passenger tyre loses some 30% to 50% of its rubber content through wear and this has a range of environmental impacts. This is equivalent to a loss of approximately 0.03 g per km for a passenger tyre. Measures to improve tyre life would be expected to reduce these impacts. Poor tyre maintenance has been identified as a major contributor to the generation of waste tyres and increased fuel consumption.

Waste tyres contain a number of organic toxic materials as well as metals, but these are bound (at least in the medium term) in a stable matrix. In the absence of results from very long-term testing, the broad view is that waste tyres pose little direct threat to the environment. Certain past applications have been implicated in several problems such as accelerated stream bank erosion, disturbance of marine ecology (artificial reefs) and visual impacts.

However, by far the greatest environmental threats come from uncontrolled burning of tyres which liberates large volumes of toxic and unsightly emissions. The runoff from fighting tyre fires pollutes local waterways and soil. Waste tyres can also provide breeding grounds for mosquitoes and vermin.
A National Approach to Waste Tyres

The environmental impacts from non-tyre rubber products are similar to that for tyres except for the loss of tyre tread and the non-consumable nature of some non-tyre products.

Material flows in the tyre and rubber industries

Approximately 170,000 tonnes of waste tyres are generated in Australia each year, commonly expressed as 18 million equivalent passenger units (EPU). Overall, the dominant fate of waste tyres is disposal to landfill (approximately 57%) with a further 13% inappropriate disposal. The greatest proportion of waste tyres used beneficially is as tyre derived fuel in cement kilns (22%). Rubber crumb currently accounts for approximately 5%. It is expected all these figures will change significantly in the medium term. Of the States, only Victoria and Queensland have a large number of tyres diverted from landfill (due to use of waste tyres for energy), and the number in Queensland is expected to rise in the future.

The generation rate for waste tyres is forecast to grow in line with vehicle kilometres travelled and is projected to increase to in excess of 20 million EPU by the year 2010. Tyres account for approximately half of the rubber consumed each year.

Practices for managing waste tyres

A wide range of possibilities have been considered (and put in practice) for managing a tyre once it becomes ‘waste’. The simplest, and still by far the most popular, method is to consign it to landfill (or dispose of the tyre illegally). For operational reasons, and to conserve landfill space, tyres are often shredded before disposal.

The tyre casing can be reused by adding a new tread. Retreading is not so widespread now as it was for passenger tyres (for a range of reasons), but the truck and bus industries use retreads extensively, as do certain fleet owners such as taxis.

Whole waste tyres have a range of applications, though some of these are no longer encouraged due to poor practices and the suspicion that in many cases they were disguised disposal. However, recent developments for use of waste tyres in properly engineered structures show considerable promise for using a large proportion of waste tyres in a very beneficial way.

Rubber crumb from waste tyres has been used in a wide range of applications, from rubber mats to playing surfaces to road making. The low strength of rubber crumb restricts its use to non-critical applications (such as the ones given above) where it faces stiff competition. There are conflicting views on the future expansion of markets for rubber crumb products, but recent and planned investment in plant suggests a high level of confidence.

There have been and continue to be research efforts directed at changing the chemistry of rubber crumb to increase its strength, so that is can be used in a wider range of applications, including retreads and new tyres. It is believed that there are no commercial facilities using these processes in Australia at the moment, though CSIRO has made announcements of recent developments that it is actively working to commercialise. Pyrolysis is another technique but considerable research has failed to find a process that is commercially robust.

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1 One EPU represents the quantity of rubber in an ‘average’ passenger tyre. In this report one EPU is equivalent to 9.5 kg.
More waste tyres are used in cement kilns than any other beneficial use. Tyres are used to replace fossil fuels as the source of energy, and the steel wire in tyres provides iron needed in making cement. Currently, two cement kilns burn some 30,000 tonnes of waste tyres per year, and other facilities are also considering using waste tyres for energy.

Finally, trials have been undertaken on the use of shredded tyres for stemming explosives in mine blasting (stemming is the material that is placed on top of explosives in drilled blast holes to contain and direct the explosion). This application has the potential to consume a large proportion of waste tyres generated in Australia each year, but the costs remain above landfill charges.

Part II: Analysis of Policy Options

Waste avoidance
Waste avoidance is reducing the number of tyres that are disposed by reducing the number of tyres generated. The possible approaches that are amenable to waste tyre policy consist of encouraging the purchase of tyres with extended tread life, increased use of retreaded tyres and better maintenance of tyres by vehicle owners.

The hurdles to be overcome in the case of passenger tyres are the relatively low contribution by tyres to the total costs of running a vehicle and the lack of knowledge on the part of the consumer. The most appropriate responses seem to be found in various types of programs to raise public awareness of the financial costs and environmental impacts and to provide information on better practices.

Reducing inappropriate tyre disposal
The greatest concerns for environmental damage from waste tyres is if they are disposed directly in the environment. Any overall program to manage waste tyres must, at the least, be able to address inappropriate disposal.

This is an area where performance is likely to depend to some extent on direct regulation. The weakest link in the waste tyre chain is at the point of ‘generation’ which, in the great majority of cases, is the dealer who retains waste tyres when new tyres are sold. The most direct approach is to impose specific requirements on the key players, including licensing or registration, and strong enforcement to back up the requirements. A nationally uniform scheme, for both the form of regulation and the rigour of enforcement, could be considered, but experience in other fields suggests that the details would still be left to individual jurisdictions. Based on past experience, it appears that a regulatory approach would be too resource-intensive for the outcomes that could be reasonably expected.

To close any ‘gaps’, either here or elsewhere in the tyre chain, a logical approach is to require that the movements of all waste tyres be tracked. In a tracking scheme, the tyre dealer (or other waste generator), the collector/transporter and the receival facility are each required to record the number of tyres that they handle and the previous and next step for the tyre in order to establish links. This is done conveniently by means of a multi-docket system. Experience with such a scheme in South Australia suggests that it can be quite effective. Simpler schemes based on inventory controls, while not offering the same assurance, may nevertheless be adequate, at least in the interim. The key to the effectiveness of such a scheme is effective audits.
Moving away from direct regulation, a more market-oriented approach is to guarantee a minimum payment for waste tyres at approved receival facilities. This would provide direct financial incentives for waste tyre collectors to manage tyres in a responsible way. The level at which the payment is set will determine how attractive this option is, and from how wide a catchment area waste tyres could be attracted.

Finally, there is the option of a tyre dealer environment rating scheme. Under such a scheme, dealers would be rated for the care they took to ensure that waste tyres were managed appropriately, as well as provision of information on tyre life and the value of good tyre maintenance. Although there are a number of design features to be resolved, such a scheme provides environmentally concerned consumers with a basis for selecting tyre dealers, and offers a commercial reward for tyre dealers who do the right thing.

**Improved value from tyres – managing the resource**

Options in this and the following section deal with opportunities to extract greater value from tyres, and expressly view waste tyres as a resource rather than as waste. The material is arranged so that this section is concerned with supply-side considerations while the next section is concerned with end-markets.

While the ‘problem’ with waste tyres is commonly viewed as a question of getting rid of them, in reality the supply of waste tyres is limited and will increase in the future at rates no greater than vehicle use. Moreover, there will always remain a number of waste tyres that are not available for beneficial use due, for example, to remoteness. On the other hand, many beneficial uses for waste tyres are capital intensive, and for these investments to be attractive guaranteed access to the waste tyre resource is required.

The highest level of security that can be provided is if the access is supported by statutory provisions. While this certainly meets the requirements for resource security, such arrangements would be very inflexible in the face of technological developments and changing market expectations. It would also be difficult to argue that the public benefit outweighed the anti-competitive nature of the legislation, or that other means of achieving the end could not be found.

A more flexible approach is to establish infrastructure to facilitate transactions between waste tyre generators and users of waste tyres. The physical infrastructure would consist of centralised regional facilities that would hold stocks of waste tyres to buffer the short-term fluctuations in supply and demand. The tyres would be suitably sorted and held under conditions which could be readily controlled to ensure they met environmental and fire safety requirements.

Associated with the physical infrastructure would be administrative arrangements that would be directed at establishing an orderly market in waste tyres. A number of suboptions could be considered varying with the degree of control over trades that is exercised by the scheme manager. At one end of the scale would be a free market situation where the manager was responsible only for the facilitation and integrity of the trades. At the other end of the scale is a scheme where the manager would specify, or at least approve, all transactions. In between these extremes are suboptions such as where the manager sets up a pool of waste tyres which are then sold to the highest bidder.

In principle, such a centralised administration scheme would provide benefits from a more orderly market in waste tyres. The design of the scheme that is eventually adopted would need to balance the benefits of market forces with some level of external control to avoid one or a small number of agents cornering the market, or to avoid price instability.
A National Approach to Waste Tyres

Special arrangements may be needed for waste tyres to be retreaded, where currently it is claimed by the retread industry that a major constraint on their operations is a shortage of supply of suitable casings in the sizes demanded by the retread market.

Improved value from tyres – industry assistance

Notwithstanding problems with access to the waste tyre resource, for many beneficial applications the limiting factor is the availability of markets for end products. Products made from waste tyres face barriers in terms of buyer acceptance (the image of recycled products has both positive and negative aspects) or the price-quality relationship makes it difficult to compete with other products.

Industry assistance programs are seen to have value in the case of an ‘infant industry’ situation, but because of the inevitable distortions they create should not be viewed as a long-term panacea for waste tyres. Notwithstanding concerns that have been identified with programs in the past, industry assistance is basically a market-driven device and, in general, is less distortionary and more flexible than direct regulation.

Direct financial assistance aims to alter the effective costs to recyclers so that their products can compete more readily and the demand for waste tyres is increased. One example is to provide unit benefits: a recycler receives a fixed payment for each waste tyre or kilogram of waste tyre material, the unit benefit varying across different end uses. A model for such a scheme is furnished by the Product Stewardship Arrangements (PSA) for Oil introduced at the beginning of 2001. One difficulty is to establish a basis for setting the unit benefit for each beneficial use.

Other direct assistance schemes could be targeted at specific proposed developments or sectors within the waste tyre industry, though such assistance suffers from the drawbacks common to the process of trying to ‘pick winners’.

In addition to direct financial assistance, there exist opportunities for broader industry programs; for instance, by looking at competing ‘markets’. The most significant competition in the case of waste tyres comes from landfills. Landfill gate fees should reflect the full costs of disposal for tyres, but consideration could be given to setting the fee so that it would be attractive for collectors to take waste tyres to other receival facilities. Alternatively the gate fee could be set so high that in effect waste tyres would be banned from landfills. The major drawback from such a scheme is that, in isolation, it encourages greater inappropriate disposal. In addition, this is a fairly blunt instrument and may result in transfers of money which do not greatly contribute to solving the waste tyre problem.

Other forms of legitimate industry assistance programs include market development and promotion, and support for research and development. The design and implementation of such programs face the problem of developing generic programs that provide broad benefits. More tightly targeted programs may benefit one sector of the tyre industry at the cost of the remainder of the industry.

Also possible are programs to encourage government purchasing policies to favour products made from waste tyres. Such schemes (which have been mandated in some states in the US for waste tyres in road making) may have merit in view of the implicit subsidies to certain competing products where prices do not reflect the true costs of manufacture.

The various options in this section are not mutually exclusive and a selection could be adopted simultaneously or at different times.
Waste tyres that need special consideration

Much of the discussion above has been implicitly dominated by the opportunities and impediments for tyres generated in urban areas, and mainly passenger tyres at that. Waste tyres generated in small or remote communities give rise to particular problems. The number of tyres in these locations are not sufficient to justify investment in conventional waste tyre management facilities that typically have high fixed costs and are capital intensive. And long distances and high transport costs preclude movement of the waste tyres to larger settlements.

The solution would be to develop new technologies that are viable for relatively small quantities of tyres or to collect the waste tyres for subsequent bulk transport under special pricing arrangements. However, policy responses are difficult to develop at the national level.

Specific questions need to be addressed in the case of waste tyres at mines and quarries. Large off-the-road tyres weighing up to 8 tonnes need special and expensive equipment to reduce their size for subsequent processing, but the large quantity of rubber may also offer opportunities, though further technological development is needed if these opportunities are to be realised. However, recent work in this area has failed to identify clearly attractive solutions.

Funding

Funding is needed for administration of the schemes to establish and manage the orderly movement of tyres, as well as to resource any industry assistance programs.

It is expected that the tyre industry will be required to fund these activities though, regardless of the type of scheme that is put in place, it can be expected that the costs will ultimately be borne in large part by consumers. A probable choice for funding is by means of a tyre levy, which could be managed either by industry or government. In view of international trade agreements, tyres manufactured in Australia will need to be treated identically to imported tyres. Since there are two manufacturers and less than 100 importers, applying a levy at the manufacture/import stage is administratively most straightforward (by comparison, a levy at point of sale would involve over 3,000 dealers across Australia).

Such a levy would constitute an excise and be administered by the Australian Tax Office and Customs Service. Once again, the experience of the PSA for Oil can be used as a basis for a waste tyre levy. Certain design details would need to be resolved, notably whether to apply the levy on a per tyre or per unit weight basis, and whether retreads are to be levied.

The PSA for Oil is to investigate and possibly trial a certificate based scheme, where manufacturers and importers need to purchase sufficient certificates from recyclers (in effect, though contractually from the Government who will operate the scheme) to cover the quantity of oil to be manufactured or imported. A similar scheme, suitably modified, could be considered for waste tyres. Certificate based schemes need careful planning to ensure that the benefits can be achieved without the potential downsides arising from higher levels of complexity and unfamiliarity.
Extended producer responsibility (EPR)

EPR is a strategy that transfers the cost of waste management from the community at large to those economic agents (producers) who are in the best position to influence the factors which are most problematic at the post-consumer stage. EPR can provide strong incentives for producers to develop products that impose lower costs to manage the waste. Since the costs of eventual waste management are embedded in the prices paid for goods, consumers will respond by making product choices that reflect the true (life-cycle) costs of products.

One form of EPR is the levy scheme discussed earlier. Another form, which provides more control and incentives for tyre manufacturers and importers, is a take-back scheme. Overseas experience suggests that arrangements for individual producers to take back post-consumer products may in some cases be cumbersome and unworkable. In the case, for example, of packaging waste, governments in other countries have provided exemptions from EPR obligations if firms join a producer responsibility organisation (PRO) which operates at an industry level. The PRO shares many features and issues with the centralised administration schemes discussed above, though the distinction is that the PRO is a truly industry body.
Acknowledgments

In preparing this report, a wide-ranging consultation program was undertaken. The authors would like to thank all people contacted for generously making available the time to provide their valuable information and insights.
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
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<tr>
<td>ANZECC</td>
<td>Australia and New Zealand Environment and Conservation Council</td>
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<td>ASTMC</td>
<td>Australian Scrap Tyre Management Council</td>
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<td>ATMA</td>
<td>Australian Tyre Manufacturers Association</td>
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<tr>
<td>ATO</td>
<td>Australian Tax Office</td>
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<tr>
<td>CBA</td>
<td>cost benefit analysis</td>
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<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
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<tr>
<td>DLWC</td>
<td>Department of Land and Water Conservation (NSW)</td>
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<tr>
<td>EPAQ</td>
<td>Environmental Protection Agency of Queensland</td>
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<tr>
<td>EPR</td>
<td>extended producer responsibility</td>
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<td>EPU</td>
<td>equivalent passenger units</td>
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<tr>
<td>ERA</td>
<td>Extended regulated area (in NSW)</td>
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<tr>
<td>GATT</td>
<td>General Agreement on Trade and Tariffs</td>
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<tr>
<td>GST</td>
<td>Goods and Services Tax</td>
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<tr>
<td>IGEA</td>
<td>Inter Government Agreement on the Environment</td>
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<tr>
<td>IRRDB</td>
<td>International Rubber Research and Development Board</td>
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<tr>
<td>IWRP</td>
<td>(Tyre) Industry Waste Reduction Plan (NSW)</td>
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<tr>
<td>MTA</td>
<td>Motor Traders Association</td>
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<tr>
<td>NEPC</td>
<td>National Environment Protection Council</td>
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<tr>
<td>NEPM</td>
<td>National Environment Protection Measure</td>
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<tr>
<td>NHTSA</td>
<td>National Highway Traffic Safety Administration (US)</td>
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<tr>
<td>NRMA</td>
<td>National Roads and Motorists Association</td>
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<tr>
<td>NSW EPA</td>
<td>NSW Environment Protection Authority</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>ORR</td>
<td>Office of Regulation Review</td>
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<tr>
<td>OTR</td>
<td>off-the-road (applied to tyres on earthmoving equipment, particularly at mine sites and quarries)</td>
</tr>
<tr>
<td>PAH</td>
<td>polycyclic aromatic hydrocarbon</td>
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<tr>
<td>PM_{10}</td>
<td>fine particulates below 10 µm in size</td>
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<tr>
<td>PRO</td>
<td>producer responsibility organisation</td>
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<tr>
<td>PSA</td>
<td>product stewardship arrangements</td>
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<tr>
<td>R&amp;D</td>
<td>research and development</td>
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<tr>
<td>SA EPA</td>
<td>South Australian Environment Protection Agency</td>
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<tr>
<td>SBR</td>
<td>styrene-butadiene rubber</td>
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<tr>
<td>SMA</td>
<td>Sydney metropolitan area</td>
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<tr>
<td>TCLP</td>
<td>Toxicity Characterisation Leaching Procedure (US EPA)</td>
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</table>
The term *receival facility* is used in this report to refer to all premises that are legally entitled to accept waste tyres and includes landfills and monofills, reprocessing facilities, energy recovery facilities and premises for intermediate processing.

For the purpose of this report, the term *inappropriate disposal* will be taken to mean any waste tyre practice that fails to provide adequate controls on the risk of environmental damage, the loss of local amenity or the risk to public health. The definition excludes disposal of waste tyres to a properly engineered landfill or other licensed premises. The definition includes legal practices such as certain uses where waste tyres are left in the environment without a proper assessment of the likely impacts, proper design of the application, or proper attention to safeguards (for the risk of fire, mosquitoes, etc).

The term *tyre producers* refers to both tyre manufacturers (domestic) and tyre importers unless the context indicates otherwise.

### Spelling

This report follows Australian spelling convention and uses the word ‘tyre’. The same word in the US is spelled ‘tire’. The US spelling is retained for organisations, reports or references from the US.

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2 A monofill is a landfill (or part of a landfill) which accepts only one type of waste (in this case waste tyres). In terms of managing waste tyres, the specific feature that distinguishes monofills is that they may facilitate recovery of the tyres at a later date for processing using technologies not available at the present time or by exploiting new market opportunities.
Part I.
Background to the Tyre and Rubber Industry

1 Introduction

1.1 Background to study

The Atech Group has been commissioned by Environment Australia to investigate and analyse the scope and nature of the tyre waste problem in Australia and to make recommendations on and assess options to address the problem.

The consultancy has been undertaken in three stages:

Stage 1: understanding the problem and the current state of play, exploring and analysing the various existing and emerging re-use/recycle/disposal options (this is in Part I Background of this report).

Stage 2: a National Workshop of major jurisdictions and other major stakeholders to assist in directing the focus of Stage 3.

Stage 3: investigating and analysing options for a national approach (this is in Part II Analysis of this report).

2 Overview of the Waste Tyre Problem

This section provides an overview only of some issues associated with managing waste tyres. A more detailed treatment is provided in subsequent parts of this report.

The ‘problem’ of waste tyres can be viewed as a number of problems or, since the problems are linked, as different facets of one problem.

The size of the problem can be measured by the number of tyres as a component of the waste stream. On best estimates, 170,000 tonnes of waste tyres are generated each year in Australia. It is common practice to use the concept of equivalent passenger unit (EPU) as a standardised measure for the quantity of waste tyres. One EPU is defined to contain as much rubber and other materials as a ‘typical’ passenger tyre, and for this study the assumed weight of one EPU is taken to be 9.5 kg. Using this terminology, the magnitude of the waste tyre management task is estimated to be approximately 18 million EPU per year.
While this represents a relatively small percentage (a little over 1%) of the total wastes generated in Australia, waste tyres often are a visible kind of waste. The high profile of waste tyres and the associated public perceptions are due in large part to poor practices that have been employed in the past to manage waste tyres. Even some so-called beneficial uses of waste tyres (such as for marine buffers or barriers on motor raceways) often give the appearance of being poorly planned and executed, as well as being untidy.

But the bad image of waste tyres has been mainly carried by images of piles of tyres left in the environment, and particularly the large dumps containing up to half a million tyres or more. Fires in these dumps (which have been quite common in the past) are very damaging to the environment, emitting large amounts of thick ugly smoke and noxious gases including carcinogens. Attempts to extinguish these fires are difficult due to the geometry of tyres, are dangerous to fire fighters and the resultant runoff can carry hazardous pollutants into groundwater, waterways and wetlands. Finally, tyres offer attractive breeding grounds for pests such as mosquitoes which, in the more tropical parts of Australia, can be the vectors for the transmission of life-threatening diseases to humans.

Legal disposal to landfills with appropriate controls can avoid most of the more extreme impacts outlined in the previous paragraph. Tyres are constructed to withstand the ravages of the elements, and the consensus of research to date is that in most environments waste tyres behave in a relatively inert way. However, no studies have been conducted into the long-term (say in excess of 50 years) behaviour of waste tyres. Moreover, waste tyres occupy landfill space which in the more densely settled regions of Australia is of considerable value due to its scarcity. Shredding of tyres to conserve landfill space and avoid certain operational problems associated with whole tyres is expensive and energy consuming.

As the true costs and risks associated with disposal have become better defined, there has been added impetus for significant changes in the way that wastes in general, and waste tyres in particular, are viewed. These changes have resulted in waste tyres being viewed as a resource to be exploited for its value rather than a waste to be disposed of. And the focus on the value of ‘waste’ tyres has been sharpened as decision-makers have become more aware of the real costs (both financial and environmental) of products that compete with products made from reprocessed tyres. Distortions in these markets arise from hidden subsidies to virgin materials where producers are not charged the full environmental and economic costs of resources.

This change in perspective has introduced its own ‘problems’ and these relate to how best to maximise the value from waste tyres. The current transition phase is very dynamic. There is a wide range of existing and emerging technologies for using waste tyres, and a number of these are operating in the market place. But it seems fair to conclude that none of these technologies (or practices as they will be referred to in this report) has been able to compete entirely successfully with, and divert the greater part of waste tyres from, the cheapest legal option of sending waste tyres to landfill.

Governments in each of the States and Territories have implemented programs and policies supported by statutory frameworks to address the problems that have been identified with waste tyres. These actions have been successful in achieving substantial improvements in the management of waste tyres. However, while it is the States and Territories who have the direct responsibilities in relation to environmental matters, there has been a growing realisation that limits may exist to what individual jurisdictions can achieve. To go beyond these limits requires a national approach. It is this realisation that has been the trigger for this study being undertaken.
3 The Tyre Industry

This section provides an overview of the tyre industry in Australia. The emphasis is on those sectors of the industry that deal directly with waste tyres but, in order to obtain the full picture for the purposes of this study, it is necessary also to consider connections to other parts of the industry.

A key consideration in evaluating opportunities for improvements in the way that waste tyres are managed is the effectiveness of market factors to bring about desired outcomes. This involves an understanding of the nature of the tyre industry and, through this, how the various markets and sub-markets operate. Such an assessment forms the starting point for certain options for government action.

The characteristics of the tyre industry that are considered to be of importance for this study relate to the distribution in size of the entities within each sector (or sub-sector) of the industry and the types of linkages between entities both within a sector and across sectors.

Table 3.1 contains a summary of the number of business entities within each sector by State and Territory.

3.1 Tyre industry associations

The consultancy team is aware of the following tyre industry associations:

- Australian Scrap Tyre Management Council (ASTMC);
- Australian Tyre Manufacturers Association (ATMA);
- Motor Traders Association (MTA);
- NSW Division of the Australian Tyre Dealers and Retreaders Association;
- Independent Retreaders Division, Australian Tyre Dealers and Retreaders Association;
- NSW Tyre Recyclers Association; and
- Tyre Dealers and Retreaders Association of NSW (a division of the Motor Traders Association of NSW).

There is a wide range in the resources available to individual associations and a consequent variation in the level of activities that they undertake in regard to waste tyres.

3.2 Relationship with other industry sectors

The most direct links between the tyre industry and the rest of the economy are with the automotive industry, and in particular vehicle manufacturers. It is the vehicle manufacturers who specify the sizes of tyres fitted to new vehicles. Tyre manufacturers, as well as tyre importers, are forced to gear their production to meet the demand for tyres fitted to new vehicles (estimated at 4.5 million tyres per year, approximately 25% of the total number of new tyres). The new vehicle market also determines the dimensions of tyres subsequently fitted as replacements.

Thus it is the vehicle manufacturers and importers who hold the dominant power in determining the broad characteristics of tyres in use, and the tyre industry has limited say in these decisions. Decisions by vehicle manufacturers here and overseas on tyre design are likely to be driven by vehicle design considerations, rather than life cycle matters.
## Table 3.1  Summary of the tyre industry (estimate)\(^a\)

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<th>ACT</th>
<th>NSW</th>
<th>NT</th>
<th>Qld</th>
<th>SA</th>
<th>Tas</th>
<th>Vic</th>
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<td>Retailers</td>
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<td>Other</td>
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<td>-</td>
<td>2</td>
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</tbody>
</table>

Notes:  
(a) Blank cells indicate no information; '-' indicates zero facilities  
(b) of the 70 or more importers, 13 importers account for in excess of 90% of all tyres  
(c) Also approximately an additional 200 who are licensed to transport hazardous materials and tyres.

Source: Consultation with Government agencies and industry representatives
3.3 Tyre manufacturers

Of all the sectors or sub-sectors in the tyre industry, only in regard to manufacturers in Australia is it possible to be confident as to the precise number of firms. Southern Pacific Tyres (SPT) has plants in Victoria and Bridgestone Australia Limited has a plant in South Australia.

3.4 Tyre importers

In total there are estimated to be 70 tyre importers. The thirteen largest tyre importers command in aggregate an estimated 90% of the tyre import market. The largest importers are the two local tyre manufacturers.

As with the manufacturers, the activities of the major importers are national in scope.

3.5 Tyre dealers and retailers

For the great majority of passenger vehicle tyres, and for many truck tyres as well, the tyre dealer is the point in the tyre chain where a tyre becomes ‘waste’. Most of the time, the tyre dealer arranges for the collection of the tyres that have been replaced. The dealer therefore occupies a critical point in the flow of waste tyres, and controls on the arrangements between dealers and collectors can have a major influence on the level of illegal dumping.

There is a large number of tyre distribution outlets in Australia. In 1993, just under half of the outlets were independently owned and a further quarter were members of tyre manufacturer retail chains. The remainder were distributed over a variety of ownership types including manufacturer supported stores, franchised outlets, buying groups and independent retail chains.

3.6 Collectors/transporters

The tyre collection sector is dominated by a small number of large players, notably Tyrecycle which operates in four States. At the other end of the size distribution, there is a considerable number of small collection and transport operations, particularly in NSW.

Collection of waste tyres is an activity which commercially has low barriers to entry. There is consistent anecdotal evidence that many of the smaller collectors operate on very slim margins, and their continued commercial viability is vulnerable to even relatively minor events. The resulting uncertainty in service provision (and high turnover in business entities) introduces considerable volatility into the waste tyre collection business. When their usual collector is not operating, dealers need to make, as a matter of some urgency, alternative arrangements for getting rid of waste tyres. This can lead to an increase in the use of unsuitable collectors.

Members of an industry with little cohesion and slender margins are also more likely to be tempted by the possibility of increasing profits by illegal practices. For example, ‘fly by night’ operators are reported to collect tyres for opportune purposes such as back loading without proper options for disposal. There have also been a number of well-publicised incidents involving operators who were not able to realise their stated objectives of finding suitable uses or disposal paths for the tyres that they collect. The subsequent business failure leaves the general community with the problems and costs associated with managing warehouses full of tyres or large external stockpiles.

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3 Stanton and Blyth (1995).
At the other end of the initial transport leg for waste tyres is the receiving facility. In the case of certain reprocessing applications and tyre-derived fuel, the receiving facility is likely to have invested substantial funds. Such facilities need a reliable supply of tyres to meet their operational needs and for their continued commercial viability as well as making an adequate return on the owner’s investment. The basic requirements for an orderly market are problematic under current arrangements. To ensure supplies of the energy feedstock, Queensland Cement Limited, through its wholly owned subsidiary Geocycle, administers the collection and delivery of tyres to its Gladstone cement kilns, subcontracting the physical collection to local operators. In the north Queensland region, Geocycle has entered agreements with local councils, who operate landfills, to set the landfill gate fee for waste tyres at a level that allows Geocycle to charge a fee for accepting tyres high enough to make the waste to energy process commercially viable.

3.7 Retreaders

The retreading sector should in fact be regarded as two separate sub-sectors: retreading of passenger vehicle tyres (including tyres from light trucks) and retreading of heavy vehicle tyres. For reasons that are discussed in more detail elsewhere in this report, truck tyres are a much more attractive proposition to retread than are passenger vehicle tyres.

It is known that retreading is common in the aviation industry but this study has not been able to collect any information for Australia.

The Independent Retreaders Association reports that they represent 30 independent retreaders with coverage of a reported 90% of all passenger vehicle retreads and 10% of all truck retreads. The large multinationals, and in particular the two Australian tyre manufacturers, account for a substantial proportion of the retreading of large truck tyres. In some of the States and Territories with smaller populations there is no retreading of passenger vehicle tyres, though casings suitable for retreading are transported to larger centres in other States.

Closely linked to retreaders are the casings dealers. Casings dealers operate in the collection/transport sub-sector. While the number of casings dealers is unknown, it is understood that in both NSW and Queensland the market is dominated by one enterprise by means of agreements with major tyre retail chains. However, tyre casings are also separated from other waste tyres by collectors (or in some cases by the waste generator), and supplied directly to retreaders.

3.8 Reprocessors

Within the definition of waste tyre reprocessors one could include shredders. While shredding is as much a materials handling activity as it is ‘reprocessing’, in terms of the industry groupings it fits more easily with reprocessors who operate dedicated equipment, than with the collection and transport phase (where many operators own only a truck).

The next stage is the production of rubber crumb. Since this is a capital intensive activity there is only a small number of plants, and these are located in the more populous States where large numbers of waste tyres are generated as feedstock. The rubber crumb is then made into other products such as mats or used in basketball courts. It has not been possible to ascertain how many such downstream manufacturing operations exist in Australia.

Rubber crumb is also mixed with bitumen and sprayed onto roads. NSW and Victoria are making substantial use of this technology, and it is also under consideration in other States. Waste tyres also have application in civil engineering structures such as retaining walls.
3.9 Tyre derived fuel

The two Australian operations for burning tyres as fuel are both in the cement industry. In Victoria, Blue Circle Southern Cement has used waste tyres as fuel for their cement kilns near Geelong since 1993. Queensland Cement has commenced operations in Gladstone, Queensland and is expected, according to the Queensland Waste Tyre Strategy, to dramatically increase their use of waste tyres in the near future. It is understood that the cement industry in other States (notably NSW and South Australia) is keen to investigate further the use of waste tyres for fuel.

3.10 Discussion

In industry analysis and the evaluation of the effectiveness of markets, the factor of prime importance is the level of competition. There is broad-based agreement on the benefits that effective competition can generate for consumers and the economy in general, and major national reforms have been undertaken in this area.

There is no evidence that the tyre industry as a whole suffers from low levels of competition and the indications in fact suggest the opposite. While there are only two tyre manufacturers operating in Australia, strong competition from tyre imports prevents the formation of a duopoly in relation to the market for new tyres. Also, while the tyre industry has both horizontal integration (for example, dealer chains) and vertical integration (manufacturers are also importers, dealers and retreaders), it is not clear how these factors might affect the management of waste tyres.

A characteristic of the collection/transport sector is the existence of a relatively small number of business entities that control a significant volume of activity in this sector, offset by a large number of small operators. While it is true that the small operators ensure a certain level of competition, this structure may be considered to be far from ideal in view of the pivotal role of the collection function. The small operators in the past have been able to escape controls and accordingly face reduced incentives to observe good practice. At the delivery end there are further downside effects of untrammeled competition in relation to reliability of supply to meet the needs of recycling facilities.

Special note should be made of the arrangements made by the cement manufacturers to provide security of supply for tyres to be burnt in the cement kilns. In Victoria, Blue Circle Southern Cement has contracted Tyrecycle to deliver a minimum number of tyres each year. In Queensland, the cement manufacturer directly controls the supply of tyres for fuel as recent increases in gate fees at landfills now allow the cement kiln to be competitive. The consequence of these arrangements is that a significant proportion (currently over 50% in the case of Victoria) of the waste tyres generated in each of these two States are now reserved for use in one application. Since the supply of waste tyres generated in Australia is largely fixed, this means that emerging uses needing large numbers of waste tyres may face restrictions on access to the resource.

There are also close links between major industry players, such as in the case of Tyrecycle, the largest waste tyre collector in Australia sharing common ownership with Encore Rubber, which produce rubber crumb. Such vertical integration at the collection end of the waste tyre chain may be of little importance at the moment, but leaves the industry vulnerable to anti-competitive activities if the demand for waste tyres approaches the level of supply.

Finally, the end-users of waste tyres (including processors, retreaders and tyre derived fuel facilities) are currently in a most dynamic situation and it can be expected that there will be significant developments in regard to individual firms and the overall structure of this sector in the short to medium term. Ideally, these developments will result in a strong and diverse market for waste tyres representing a sufficiently large number of entities selling their products into a variety of end-markets so that fluctuations would be evened out.
4 Market Considerations

Market considerations come into play with regard to the management of waste tyres at two points: at the point of sale (or purchase) of the tyre and at the point of disposal.

4.1 Purchase of tyres

4.1.1 General considerations

Decisions on the purchase of tyres are relevant for a discussion on the management of waste tyres in regard to the operating life of tyres and the choice of retreads.

The operation of reasonably free markets is driven by consumer behaviour as is observed in the choices made relating to, in this instance, the purchase of tyres. Consumer choices are determined by a combination of product characteristics and the characteristics of the acquisition process (such as convenience).

Tyres are a necessary part of operating a motor vehicle. Within the broad function of providing contact with the road surface, individual tyre models deliver a bundle of characteristics in terms of driving safety and performance under different driving conditions, noise levels, comfort and tyre life. Since it is not possible in general to improve one of these bundled characteristics except at the expense of one or more of the others, the consumer’s choice must be based on a trade-off which reflects the relative importance attached to each characteristic by the consumer. Superimposed on this trade-off in the purchase decision is the all-important factor of price. High priced tyres can be expected to be of superior quality either by having say roadholding performance above most of the competing brands, or where the trade-offs occur at a higher level in terms, for example, of treadwear and roadholding performance.

Of course, reaching an appropriate balance in the bundle of tyre characteristics in the purchase decision presupposes a certain level of knowledge on the part of the consumer. The perception of the authors is that little emphasis is placed on tyre life in the marketing of tyres, and very little useful or objective information is provided to consumers. Tyre brochures may describe certain tyres as ‘long life’ without providing any indication for the basis of this claim.

If tyre manufacturers and dealers find little value in emphasising tyre life in their promotional material, it can be assumed that this is because there is little overt demand for this information on the part of the general buying public. To an extent this may reflect a perception on the part of many tyre buyers that reliable advice and information on tyre life is not available.

In regard to buying tyres, owners of private passenger vehicles are relatively uninformed. Tyres represent a relatively small proportion of total vehicle operating costs (of the order of 4% for passenger vehicles). At the time of purchase of tyres, with an outlay of over $300 for a set of tyres fitted to the ‘family’ car, it would seem that for many vehicle owners the overriding consideration is to minimise costs of purchase, not the cost of the tyre over its operational life.

However, there are exceptions. For some vehicle owners, performance is an overriding consideration. Other vehicle owners will have some degree of brand loyalty and replace worn tyres with the same brand and model of tyre. Taxi, rental and other fleet owners are more likely to enter ongoing arrangements with tyre retailers (or even wholesalers) and tyre life can be expected to be a major consideration in such arrangements. It is worthwhile for fleet owners to spend resources on researching the relationship between tyre performance and price, and detailed records on past experience can be a valuable guide to inform tyre purchase decisions.
Finally, there is a perception in the case of many vehicle owners (based generally on little or no objective information) that retreads and, perhaps to a lesser extent, low price tyres offer poor value for money. This perception is based on a combination of safety considerations and low expected tyre life.

The quality of retreads has improved over time and all retreads fitted to vehicles must now meet the Australian Standard AS 1973-1993. The Standard expressly requires the name of the retreader to be placed on the retreaded tyre. Nevertheless, in practice purchasers of retreads face considerable uncertainty in regard to the purchase of a specific retread in view of the variability in retread quality. As a result, the market for passenger retreads is derived mainly from two segments of the vehicle owning population: those who can afford only retreads, and ‘knowledgeable’ consumers (such as fleet owners) who are in a position to evaluate product quality.

Section 4.1.2 below reviews indicative prices for new tyres and retreads both for heavy trucks (including buses) and for passenger vehicles.

**Uniform Tire Quality Grading System (UTQGS)**

The Uniform Tire Quality Grading System (UTQGS) is a tyre information system operated by the US Department of Transport designed to help buyers make relative comparisons among tyres. The UTQGS is not a safety rating and is not a guarantee that a tyre will last for a prescribed distance or perform in a certain way. It simply gives tyre buyers additional information to combine with other considerations, such as price, brand loyalty and dealer recommendations. Under UTQGS, tyres are graded in three areas: treadwear, traction and temperature resistance.

The UTQGS information is located in two places on the tyre:

- there is a paper label affixed to the tread; and
- the grades are also moulded into the sidewalls.

The treadwear grade is a comparative rating based on the wear rate of the tyre when tested under carefully controlled conditions. For example, a tyre graded 200 should have its useful tread last twice as long as a tyre graded 100. However, real world tyre tread life, in kilometres, depends on the actual conditions of their use. Tyre life is affected by variations in driving habits, service practices such as tyre rotation, wheel alignment and maintaining proper inflation pressure, as well as differences in road characteristics and climate.

Advice from the tyre manufacturers suggests that treadwear indicators are of less use in Australia where driving conditions vary much more than in the US and other OECD countries. Notwithstanding the validity of the claim in regard to driving conditions, for the majority of vehicles in Australia the greater part of kilometres driven are on urban streets or good quality highways. Some tyres imported into Australia exhibit the UTQGS ratings if they are also sold in the US.

### 4.1.2 Retail prices and decisions

#### Truck tyres

High quality tyres for heavy trucks and buses retail for around $550 to $600 per tyre. Prices for cheaper versions start in the range $350 to $400.

A retread on a casing supplied by the customer costs $200 to $250. The price for a good quality casing is currently $50 to $70, which is a substantial reduction from recent prices which were in the range $120 to $130. Clearly, at the previous price levels, retreads would be uncompetitive with new tyres at the low end of the price range.
Advice from industry is that there is little difference in the expected life of new truck tyres at different prices. The life of the tread is approximately 150,000 to 200,000 km for tyres fitted to the drive wheels, and perhaps double this figure for tyres on the trailer wheels.

However, low quality tyres are not so suitable for retreading. The life of the casing for high quality tyres is of the order of 600,000 to 700,000 km. Clearly, unless the vehicle owner derives some value from the fact that the casing can be retreaded, there is little incentive to purchase the more expensive tyres. The relatively high value of casings reflects the high proportion of truck tyres that are retreaded; many truck tyres are retreaded multiple times.

**Passenger tyres**

The cost of tyres accounts for 3% to 4% of the total cost of operating a passenger vehicle.

Prices for casings for passenger tyres vary substantially depending on the demand for a particular tyre size from time to time and within different regions. Generally, prices are in the range $5 to $10 for a good casing. A retread for a standard passenger vehicle costs between $40 and $50. In general the margin between the prices of retreads and new tyres at the low end of the scale is of the order of $10. Prices for new tyres for family cars start at $55 to $70.

**Tax effects**

The retread industry has been adversely affected by the goods and services tax (GST). Prior to the introduction of the GST, new tyres attracted sales tax of 22% on the wholesale price while retreads were tax-free. GST is payable now on both retreads and new tyres. The result has been that the tax payable on new tyres has dropped while the tax payable on retreads has risen by 10%.

Of course, in a competitive situation where substitution is possible between new tyres and retreads, manufacturers/importers and new tyre outlets may have chosen not to pass on to the customer through lower prices the full reduction in tax payable. Nor may all retreaders have passed on the full impact of GST in the price of retreads. But certainly, the end result has been increased pressure on the margins for retreaders.

On the other hand, in the period of time since the GST was introduced, the Australian dollar has depreciated sharply in value against the US dollar and some other currencies. This would tend to raise the prices of imported tyres from these countries, making retreads comparatively more attractive. Once again, importers may choose not to raise their prices by the full amount due to the change in relative value of the currencies, and there may be lags while stocks already in Australia are exhausted.

### 4.2 Charges associated with waste tyres

The overwhelming impression from discussions with industry representatives and others is that most parts of the waste tyre industry are very competitive and that profit margins are slim. The level at which landfill gate charges are set can play a critical role in providing appropriate incentives for different options in the management of waste tyres.

Operators in the waste tyre industry cannot be expected to make decisions that promote optimal community outcomes if they are not faced with paying landfill gate fees which reflect the real costs of the provision of the service. The costs, in the case of landfill, include the direct financial costs of operation, as well as the costs of environmental damage and loss of local amenity, and a component for the value of the landfill space consumed by the waste tyres.
Landfill gate fees that are set too low provide the wrong signals to promote non-disposal options for waste tyres. As the landfill gate fee rises, the effective cost of waste tyres to recyclers is reduced (as waste tyre generators switch to avoid the higher landfill fees) and this improves the economies of the recycling operation (for example, the price of the finished product can be reduced). Unfortunately, higher landfill disposal charges also encourage inappropriate practices such as illegal dumping, and this may need to be addressed by increased regulatory effort, which in turn carries a cost.

In recent years, landfill gate fees in the more closely settled areas have risen to more closely cover operating costs. Payment for the external costs of landfill disposal can be covered through a waste levy (such as exists in SA and the urbanised areas of NSW).

**Table 4.1  Summary of landfill gate fees – passenger tyres**

<table>
<thead>
<tr>
<th></th>
<th>Shredded ($/tonne)</th>
<th>Whole ($/tonne)</th>
<th>Shredded ($/tyre)</th>
<th>Whole ($/tyre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT</td>
<td>$33</td>
<td>$110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSW</td>
<td>$62</td>
<td>$160</td>
<td>$0-$3.50</td>
<td></td>
</tr>
<tr>
<td>NT</td>
<td>$28</td>
<td>$40</td>
<td>$0.25</td>
<td>$0.36</td>
</tr>
<tr>
<td>Queensland</td>
<td>$28-$32</td>
<td>n/a</td>
<td>$1.50-$3.00</td>
<td>$2.00</td>
</tr>
<tr>
<td>SA</td>
<td>$77/10m³</td>
<td>n/a</td>
<td>$1.10-$7.70</td>
<td>n/a</td>
</tr>
<tr>
<td>Victoria</td>
<td></td>
<td></td>
<td></td>
<td>$0.50</td>
</tr>
<tr>
<td>WA</td>
<td>$25-$150</td>
<td>$50 per tonne</td>
<td>more than for</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>shredded tyres</td>
<td></td>
</tr>
</tbody>
</table>

Note:  
(a) Blank cells indicate no information
(b) Charges are for Sydney metropolitan area (SMA) but will increase from 1 July 2001. Whole tyres may not be disposed to landfill in the SMA or extended regulated area (ERA). Whole tyres must be shredded or have their tyre walls removed prior to disposal.
(c) $1.10 for passenger tyres, $7.70 for truck tyres

It is useful, though not straightforward to compare the landfill gate fees for the disposal of tyres with the amount charged by collectors. In some areas the charge (in cases where the tyres are disposed legally) approximates the landfill gate fee plus a component to cover the costs of collection and transport, as well as profit for the operator. Estimates of the amount charged to the waste generator in the case of illegal disposal are about half this level. The issue is confounded when casings for retreads are managed as an integral part of the collection function; that is, the collector retains the not insignificant value of the casings which offsets, to some extent at least, the cost of managing the remainder of the waste tyres.

In the scheme operated by Queensland Cement, collection charges in the north of Queensland are of the order of $2.50 per tyre. This charge can be supported since local councils have agreed to increase their landfill gate fee for waste tyres to this level or above. In the more densely settled areas in South East Queensland, where there is significant competition for the collection of waste tyres, charges are reported to be considerably lower at approximately $1.80 per tyre, which is within the range reported in other parts of Australia.
5 Regulatory and Policy Frameworks

This section reviews the actions that governments have taken and the systems put in place in relation to the management of waste tyres.

5.1 Regulation for environmental protection

Table 5.1 provides a summary of government regulatory frameworks and some related matters in each of the States and Territories.

There is substantial variation across the jurisdictions in relation to the content and form of the individual regulatory and policy frameworks. Nevertheless, in terms of broad goals there is a certain degree of convergence even if the detail of the implementation is quite different. Moreover, during the consultation program it became apparent that some of the States and Territories have conducted substantial reviews of the way that waste tyres are managed, and that further changes are foreshadowed.

Ultimately, the vigour of direct government regulatory actions in each jurisdiction reflects the priority placed on the seriousness of the risk of environmental damage associated with waste tyres. Where sufficiently strong commercial incentives exist to take waste tyres to an appropriate receival facility, the need for direct regulation is much reduced. The incentives arise in cases where the demand for waste tyres results in higher market prices. This is seen in Victoria where, on one estimate, over half the tyres are used beneficially for fuel. The cement kilns at Gladstone are also expected to take an increasing number of tyres, and this has given the Queensland Government the confidence to consider seriously a ban on the disposal of waste tyres to landfill by 2003, although there would be some exemptions for remote landfills.

The greater part of the entries in Table 5.1 relate to controls on those activities in relation to waste tyres that have a clear environmental impact or that aim to reduce the volume of landfill taken up by tyres. Many jurisdictions have provided for statutory measures or guidance which reduce the chance of fires on premises specifically where tyres are stored by prescribing, for example, how tyres are to be placed within a landfill. In some jurisdictions, a flexible approach has been adopted with certain activities allowed subject to approval being granted on a case by case basis where it can be demonstrated that the risks to the environment are not excessive.

Considerable efforts have been made by governments to reduce the rate of illegal dumping. As a broad statement, general environmental regulation and licensing are largely focused on controls on premises. It is notable that nearly all of the States and Territories have regulatory requirements in regard to the collection and transport of waste tyres. This is an activity that, in itself, is not likely to have significant adverse environmental impacts beyond the normal range of environmental damage from road transport. However, the collector/transporter, in conjunction with tyre dealers, is the key to addressing problems of illegal dumping.

One of the difficulties for regulators in the past has been to differentiate between dumping and legitimate applications involving waste tyres. Some jurisdictions continue to allow applications where tyres finish up in the environment. However, clear trends can be seen over the last decade (and apparently continuing into the future) of a tightening of the requirements for these sorts of activities. In some jurisdictions, this has been achieved through removing ambiguities in the definition of waste as applied to tyres. In other cases, approval is now needed or limits have been placed on the numbers of tyres that may be used (the limits may be absolute or they may be expressed as a threshold for triggering the requirement for a formal licence).
Cross-border movements of tyres were identified as a potential issue in the case of the ACT surrounded by NSW and, it may be assumed, also in other places where populations are concentrated near State/Territory borders, such as the coastal region near the NSW/Queensland border. Waste tyres will flow from a jurisdiction with high disposal costs (or tight controls on illegal dumping) to one with low disposal costs (or lax controls). With a number of States proposing to follow the lead of SA in setting up schemes to track waste tyres, significant cross-border movements of tyres will impose some difficulties. The authors have been unable to estimate current cross-border flows of waste tyres, notwithstanding the provisions in regard to record keeping contained in the NEPM on the Movement of Controlled Wastes Between States and Territories.

Table 5.1  Summary of regulatory frameworks

<table>
<thead>
<tr>
<th>Item</th>
<th>Jurisdiction</th>
<th>Regulatory Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill disposal</td>
<td>ACT</td>
<td>Allowed</td>
</tr>
<tr>
<td></td>
<td>NSW</td>
<td>Allowed outside SMA/ERA, Whole tyres may not be disposed within the SMA/ERA</td>
</tr>
<tr>
<td></td>
<td>NT</td>
<td>Allowed</td>
</tr>
<tr>
<td></td>
<td>Queensland</td>
<td>Ban on whole tyres in 2001; complete ban proposed for 2003</td>
</tr>
<tr>
<td></td>
<td>SA</td>
<td>Shredded only</td>
</tr>
<tr>
<td></td>
<td>Tasmania</td>
<td>Shredded only to approved sites (if fire fighting systems are available)</td>
</tr>
<tr>
<td></td>
<td>Victoria</td>
<td>Shredded only</td>
</tr>
<tr>
<td></td>
<td>WA</td>
<td>In TLEZ: shredded only and need approval</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other conditions on separation of piles of waste tyres</td>
</tr>
<tr>
<td>Reuse options*</td>
<td>ACT</td>
<td>Approval required</td>
</tr>
<tr>
<td></td>
<td>NSW</td>
<td>Allowed on case by case basis in consultation with local council and EPA</td>
</tr>
<tr>
<td></td>
<td>NT</td>
<td>Allowed</td>
</tr>
<tr>
<td></td>
<td>Queensland</td>
<td>Allowed but needs licence if &gt;500 tyres</td>
</tr>
<tr>
<td></td>
<td>SA</td>
<td>Approval required if &gt;5 tonnes/year</td>
</tr>
<tr>
<td></td>
<td>Tasmania</td>
<td>Allowed at present; approval may be required for large or atypical projects</td>
</tr>
<tr>
<td></td>
<td>Victoria</td>
<td>Approved on case by case basis</td>
</tr>
<tr>
<td></td>
<td>WA</td>
<td>Permitted if &lt;100 tyres, else needs approval</td>
</tr>
<tr>
<td>Mine sites</td>
<td>ACT</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>NSW</td>
<td>No disposal on site</td>
</tr>
<tr>
<td></td>
<td>NT</td>
<td>Allowed to be buried on site in an environmentally suitable manner – eg within wasterock piles</td>
</tr>
<tr>
<td></td>
<td>Queensland</td>
<td>May be buried on site subject to guidelines and becomes notifiable activity</td>
</tr>
<tr>
<td></td>
<td>SA</td>
<td>Subject to general conditions</td>
</tr>
<tr>
<td></td>
<td>Tasmania</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Victoria</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>WA</td>
<td>On site disposal allowed outside TLEZ subject to approval</td>
</tr>
<tr>
<td>Transport</td>
<td>ACT</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>NSW</td>
<td>Licensed for loads &gt; 2 tonnes</td>
</tr>
<tr>
<td></td>
<td>NT</td>
<td>Must meet NEPM provisions for interstate transport – will license in future under the Waste Management and Pollution Control Act</td>
</tr>
<tr>
<td></td>
<td>Queensland</td>
<td>Licensed if &gt;500 tyres/year</td>
</tr>
<tr>
<td></td>
<td>SA</td>
<td>Licensed</td>
</tr>
<tr>
<td>Item</td>
<td>Jurisdiction</td>
<td>Regulatory Requirement</td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td>Tasmania</td>
<td>Only by approved transporter if tyres are to be disposed</td>
</tr>
<tr>
<td></td>
<td>Victoria</td>
<td>Tyres may only be transported to licensed storage site or approved disposal site</td>
</tr>
<tr>
<td></td>
<td>WA</td>
<td>-</td>
</tr>
<tr>
<td>Storage</td>
<td>ACT</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>NSW</td>
<td>Licensed if &gt;50 tonnes but must comply with NSW Fire Brigades Storage Guidelines and (upcoming) EPA Environmental Guidelines for Used Tyre Storage.</td>
</tr>
<tr>
<td></td>
<td>NT</td>
<td>Will license in future under the Waste Management and Pollution Control Act</td>
</tr>
<tr>
<td></td>
<td>Queensland</td>
<td>Licensed if &gt;500 tyres/year</td>
</tr>
<tr>
<td></td>
<td>SA</td>
<td>If more than 500 waste tyres per annum need to be licensed by EPA and comply with Metropolitan Fire Service Guidelines</td>
</tr>
<tr>
<td></td>
<td>Tasmania</td>
<td>Requires an environmental assessment if &gt;100 tonnes/year. Governed by waste mgt regulations</td>
</tr>
<tr>
<td></td>
<td>Victoria</td>
<td>Draft guidelines on stacks: &lt;5,000 tyres each</td>
</tr>
<tr>
<td></td>
<td>WA</td>
<td>Licensed if &gt;100 tyres/year, or &gt;500 for a tyre fitting business</td>
</tr>
<tr>
<td>Receiveal Facility</td>
<td>ACT</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>NSW</td>
<td>Licensed if processing &gt;5000 tonnes/year</td>
</tr>
<tr>
<td></td>
<td>NT</td>
<td>Will license in future under the Waste Management and Pollution Control Act</td>
</tr>
<tr>
<td></td>
<td>Queensland</td>
<td>Licensed if &gt;500 tyres/year</td>
</tr>
<tr>
<td></td>
<td>SA</td>
<td>Licensed</td>
</tr>
<tr>
<td></td>
<td>Tasmania</td>
<td>Require an environmental assessment if &gt;100 tonnes/year</td>
</tr>
<tr>
<td></td>
<td>Victoria</td>
<td>Covered by general environmental protection regulation</td>
</tr>
<tr>
<td></td>
<td>WA</td>
<td>-</td>
</tr>
<tr>
<td>Reporting</td>
<td>ACT</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>NSW</td>
<td>Reporting under licence conditions. Tracking scheme under IWRP</td>
</tr>
<tr>
<td></td>
<td>NT</td>
<td>Will be required under licences issued under the Waste Management and Pollution Control Act</td>
</tr>
<tr>
<td></td>
<td>Queensland</td>
<td>Tracking scheme proposed for 2001</td>
</tr>
<tr>
<td></td>
<td>SA</td>
<td>Tracking scheme for whole tyres using docket system</td>
</tr>
<tr>
<td></td>
<td>Tasmania</td>
<td>Tracking scheme proposed for mid 2001 using docket system</td>
</tr>
<tr>
<td></td>
<td>Victoria</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>WA</td>
<td>-</td>
</tr>
<tr>
<td>Tyre Industry Plans</td>
<td>ACT</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>NSW</td>
<td>Tyre Industry Waste Reduction Plan (IWRP)</td>
</tr>
<tr>
<td></td>
<td>NT</td>
<td>None at present</td>
</tr>
<tr>
<td></td>
<td>Queensland</td>
<td>Waste Tyre Strategy</td>
</tr>
<tr>
<td></td>
<td>SA</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Tasmania</td>
<td>Scrap Tyre Management System – voluntary levy by retailer</td>
</tr>
<tr>
<td></td>
<td>Victoria</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>WA</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: (a) Options might include use as on-farm silage, barriers on racetracks, landscaping, etc
5.2 Government actions to promote the waste hierarchy

5.2.1 General

Among government initiatives to improve the management of waste tyres, considerable effort in developing policy has been targeted at extracting increased value from a resource as well as to protect against externalities associated with disposal of a waste. As with direct regulation for environmental impacts, government intervention in this area aims to address market failure, but market failure arising from such matters as the difficulty in raising capital or imperfect knowledge due to preconceptions on the part of consumers about reprocessed products. In this case, direct regulation (even performance based regulation) is unlikely to be effective and the best outcomes can be expected to flow from the use of market forces, though supported by appropriate legislative or regulatory provisions.

While it is convenient to separate the two broad types of government action (direct regulation and forms of ‘industry assistance’), it is important not to lose sight of the important connections between the two. The major environmental impacts arise from poor practice of tyre disposal and incentives for illegal dumping arise because of the low (or negative in cases where there is a ‘gate fee’) value of a large proportion of waste tyres at present. If government action results in waste tyres being put to higher valued uses, then the consequent increase in the market price may result in waste tyres being a sought after resource rather than a waste to be disposed of at the lowest possible cost. However, in the short to medium term, it is not anticipated that the price of waste tyres will rise to a level which would obviate the need for more regulatory based controls on collection and disposal.

A range of broad schemes has been developed by a number of governments. In NSW, a Tyre Industry Waste Reduction Plan has been developed and implementation of the Plan is underway. The provisions in the Plan are legally binding on members of the tyre industry and also on the Tyre Industry Waste Management Council established to manage the Plan. Tasmania has introduced a Scrap Tyre Management System, which is voluntary. The Queensland Government in consultation with the tyre industry and other stakeholders has developed a Waste Tyre Strategy which contains a coordinated action plan.

On a more specific matter, the Western Australian Government has introduced a regulation that makes it an offence to damage a tyre casing that is suitable for retreading.

5.2.2 Region specific issues

Governments in a number of jurisdictions have recognised that it is not efficient to apply the same level of regulation across the entire State or Territory. Conditions in the more closely settled areas differ from those in the more remote areas. The environmental and related impacts of similar activities differ across regions, and the costs of environmental protection measures on a per capita basis may be unsupportable for smaller communities. Nowhere is this more apparent than in the case of waste management where, for example, remote areas enjoy abundant and low cost landfill space but economies of scale, which would promote high value uses, are largely absent.

Some States have defined geographic boundaries that differentiate the regulatory requirements. The conditions regulating the disposal of tyres are different within the tyre landfill exclusion zone (TLEZ) and the remainder of WA, and the SMA/ERA and the remainder of NSW. In other States and Territories, variations in the application of the regulatory approach are not based on defined geographic regions, but rather on the size of the community and the distance to major centres.
Representatives from a number of States and Territories have raised the problems associated with economies of scale and the need to reach some threshold in the annual number of waste tyres before investment in processing facilities can become commercially feasible.

There is anecdotal evidence that, notwithstanding the low value of waste tyres per unit volume or weight, waste tyres are transported significant distances to locations where they can be used commercially, or even exported out of Australia after some preliminary processing.

In addition, efforts are being made within some of the less densely populated regions to investigate opportunities for aggregating tyres at collection points for later transport to larger centres where further processing could be undertaken. The success of such schemes is heavily dependent on the level of transport charges, including the possibility of entering agreements for reduced rates for backloading trucks.

There are specific considerations in regard to waste tyres at mining sites. For certain earthmoving equipment, the tyres are huge (of the order of 1 tonne or more) and there is limited capability for shredding them. Moreover, the remoteness of many of the sites means that transport of the tyres to a processing location is not economically feasible.\footnote{Corbett (1999) estimates a transport cost of 24 cents/km per tyre.} In Queensland, NT, Tasmania and WA, waste tyres at mine sites are allowed to be used in civil engineering structures or disposed on site provided that it can be demonstrated that such practices do not pose threats to the environment or in relation to fires.
6 Environmental Aspects of the Tyre and Rubber Industry

The debate on the environmental impact of tyres and other rubber products is generally dominated by the risks and impacts associated with above ground tyre stockpiles. These stockpiles are often visually prominent and the potential impacts from fires and the creation of breeding sites for mosquitoes and other vermin are well documented. However, the environmental impacts of rubber products extend well beyond these and appear through all of the stages in the life of the product. It is important to consider all of these impacts to ensure that waste management approaches do not simply result in the transfer of impacts to a different stage in the life cycle, or to a different environmental medium, and result in greater overall impacts.

For the purpose of this discussion the life cycle of rubber products is as illustrated in Figure 6.1. This illustration has been prepared for tyres but is also broadly applicable to other rubber products.

![Figure 6.1 The life cycle of a tyre](image-url)
When describing the environmental impacts of tyres and other rubber products it is generally only practical to discuss the impact in terms of potential. This is because local factors are critical to the realisation and significance of the potential. For example, tyres contain a range of toxic materials, but these materials are tightly bound in a stable matrix (vulcanised rubber). The rate at which these toxic substances are released to the environment is in most circumstances very low. The rate depends on local environmental factors and the magnitude of any impact is dependent on the sensitivity of the receiving environment and the presence of plants, animals or humans that may be affected. All of these factors vary from location to location, and therefore the impacts also vary.

The potential impacts at each stage of the life cycle are summarised in Table 6.1 and discussed in more detail in the following sections.

<table>
<thead>
<tr>
<th>Life stage</th>
<th>Processes included</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material</td>
<td>Natural rubber production</td>
<td>Resource depletion</td>
</tr>
<tr>
<td></td>
<td>Synthetic rubber production</td>
<td>Agriculture (for natural rubber)</td>
</tr>
<tr>
<td></td>
<td>Steel and fabric production</td>
<td>Energy use</td>
</tr>
<tr>
<td></td>
<td>Production of various other additives incorporated in tyres</td>
<td>Greenhouse and other emissions</td>
</tr>
<tr>
<td></td>
<td>Transportation</td>
<td>Solid and liquid wastes</td>
</tr>
<tr>
<td>Manufacture</td>
<td>Production of the basic components (sheet extrusions, etc) from which the products are made</td>
<td>Energy use</td>
</tr>
<tr>
<td></td>
<td>‘Building’ of the tyre or other rubber product</td>
<td>Greenhouse and other emissions</td>
</tr>
<tr>
<td></td>
<td>Vulcanising and finishing</td>
<td>Solid and liquid wastes</td>
</tr>
<tr>
<td>Use</td>
<td>Use of the product for its design application</td>
<td>Tyres have a significant impact on the operation energy of vehicles resulting in energy use and emissions, dust from wear and tear</td>
</tr>
<tr>
<td>Recycling/Reuse</td>
<td>Shredding</td>
<td>Energy use</td>
</tr>
<tr>
<td></td>
<td>Crumbing</td>
<td>Greenhouse and other emissions</td>
</tr>
<tr>
<td></td>
<td>Energy/material recovery</td>
<td>Solid and liquid wastes</td>
</tr>
<tr>
<td></td>
<td>Whole split or punched tyres</td>
<td></td>
</tr>
<tr>
<td>Disposal</td>
<td>Disposal to land</td>
<td>Leachate to receiving environment</td>
</tr>
<tr>
<td></td>
<td>Uncontrolled stockpiling</td>
<td>Fires</td>
</tr>
<tr>
<td></td>
<td>Disposal in landfill</td>
<td>Free flow of landfill gas and leached compounds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mosquitoes and other vermin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Visual impact</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Erosion</td>
</tr>
<tr>
<td>Transportation</td>
<td>Transport of raw materials</td>
<td>Energy use, greenhouse and other emissions</td>
</tr>
<tr>
<td></td>
<td>Transport of new tyres</td>
<td>Noise</td>
</tr>
<tr>
<td></td>
<td>Transport of used tyres to disposal or retreading</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transport of waste tyres</td>
<td></td>
</tr>
</tbody>
</table>

6.1 Raw materials

Tyres and other rubber products, including materials used for retreading, are made from a wide range of materials in various combinations. The range of materials, their source, applications and potential impacts is listed in Table 6.2.
The major raw material for a tyre is rubber. Rubber is produced either from natural sources or from petroleum and natural gas. Generally products are made from ‘compounds’ which are a blend of natural and various synthetic rubbers, fillers and other chemicals that impart desired characteristics such as wear resistance or resistance to oxidation. There are literally thousands of different compound recipes customised to meet the requirements of different products and manufacturing processes. Some authors have described rubber compounding as much an art as it is a science.

The two major rubber types, natural and synthetic rubber, are discussed below.

### 6.1.1 Natural rubber

The chemical form of natural rubber is a polymer of isoprene (2-methyl-1,3-butadiene). Natural rubber is predominantly sourced from the sap of the *Hevea brasiliensis* tree though, there are a number of other trees that also produce rubber such as the *Ficus elastica*, which is a native of the Congo, and Guayule, a desert scrub from Mexico and Arizona. *Hevea* is a native of the Amazon basin and until about 1910 the majority of natural rubber was derived from trees growing wild in this region. Since then, plantations have been established around the world in suitable, generally tropical, climates.

Rubber trees start yielding at about 5 years and reach peak production at around 15 years after which production gradually decreases until, at about 30 years, the tree is replaced. Yields from plantations are generally above 2,000 kg/ha per year. The wood from *Hevea* has a variety of uses such as in furniture, for construction, and charcoal.

The bulk of natural rubber production is by small landholders with plot sizes of only a few hectares. Large plantations or estates have declined in importance as a result of a range of historical, technological and economic factors. Both the first and second world wars were a stimulus for the development of synthetic rubbers to supplement supplies of natural rubber, which were disrupted by military action. Wild price variations during and after the war, and also concerns in Europe and America about the dependence on rubber supplies from foreign sources, provided further impetus for the development of alternatives. Low prices and difficulties in competing in price, quality and consistency keep natural rubber prices low, making the viability of large plantations marginal.

Though natural rubber plantations are a cause of habitat loss, plantations provide environmental benefits particularly in relation to their ability to lock up carbon dioxide (CO₂), the major greenhouse gas. Nevertheless, low prices for natural rubber place considerable financial stress on rubber producers, which can result in poor environmental practices being followed. Notwithstanding concerns about habitat loss, according to IRRDB, rubber plantations compare well in terms of biomass, fertility and fauna and flora, though the values used in the analysis for biomass in native jungle seem very low.

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5 Others include *Castilla spp* and *Manihot spp* in Tropical America, *Funtumia elastica* and *Landolphia spp* in Africa, *Ficus elastica* in Asia. There are also some rubber-bearing species of *Compositae*, *Taraxacum* (USSR), *Solidago spp* (USA). In all there are over 200 species of rubber bearing plants.

6 International Rubber Research and Development Board, web address www.irrdb.org

7 ibid
6.1.2 Synthetic rubber

There are a number of types of synthetic rubber with various physical and chemical characteristics. Among the most widely used are styrene-butadiene rubbers, ethylene-propylene rubbers, butyl rubbers, acrylic elastomer, and silicone rubbers. Like natural rubber all are polymers, synthetic rubbers are sourced from various hydrocarbons, which are blended and reacted under controlled conditions to form the polymers.

More than half of the world's synthetic rubber is styrene-butadiene rubber (SBR) made from styrene and butadiene monomers which are abundant in petroleum. Three quarters of all the SBR made goes into tyres. The rest goes into products such as footwear, sponge and foamed products, waterproofed materials, and adhesives.

Ethylene-propylene rubbers are used in rubber membranes for roofing, agriculture, and water distribution. With modification, they can be used in radiator and heater hoses, brake components, pond and ditch liners, agriculture silos, tank linings, wire and cable, gaskets, and washers.

Butyl rubbers are used in tyre inner tubes and other products that require a good barrier against gases. The thermal stability of these rubbers makes them suitable for use in automotive radiator hoses. Their ozone resistance makes them appropriate for electrical insulation and for weather resistance. Their ability to absorb shock is earning them wide application in automotive suspension bumpers. These rubbers also have a few disadvantages: they are incompatible with many natural and synthetic rubbers, they tend to pick up foreign matter and impurities, and they lose elasticity at low temperatures.

Acrylic elastomers are used in applications such as spark plug boots, ignition wire jacketing, and hoses where oil resistance is crucial. They are not suited for normal tyre use, however, because they have little resistance to abrasion at low temperatures.

Silicone rubbers perform exceptionally well in O-ring and sealing applications. Many types of wire and cable are insulated with these rubbers, which will burn to an ash yet still function as an insulator. Their resistance to moisture makes them good for outdoor applications. Because they are odourless, tasteless, and non-toxic, they are used for gas masks, food and medical-grade tubing, and some surgical implants. Their use is limited by the high cost of manufacture.

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8 Comptons Encyclopaedia, web address
<table>
<thead>
<tr>
<th>Material</th>
<th>Source</th>
<th>Application</th>
<th>Potential impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural rubber</td>
<td>Natural rubber is predominantly obtained from the sap of the <em>Hevea brasiensis</em> tree.</td>
<td>The proportion of natural rubber to total rubber has been declining steadily over the past several decades and currently makes up about 30% to 40% of the total rubber used.</td>
<td>Loss of habitat in tropical forests - there are approximately 9.5 million ha of rubber plantation. Impacts of agricultural practices on local environments. Impacts from transportation to markets. Impacts from processing including odour.</td>
</tr>
<tr>
<td>Synthetic rubber</td>
<td>All of the synthetic rubbers are made from petrochemicals.</td>
<td>This makes up approximately 60 to 70% of the total rubber used.</td>
<td>Resource depletion of petroleum. Energy consumption, emissions and waste during manufacture.</td>
</tr>
<tr>
<td>Steel cord and beading including the coating materials and activators, copper/tin/zinc/chromium</td>
<td>The steel is premium grade and is only manufactured in a limited number of plants around the world due to the high quality requirements.</td>
<td>Steel is used to provide rigidity and strength to the tyres. In a passenger tyre steel cord makes up about 15% by weight.</td>
<td>Impacts during production and transportation. Leaching of metals during disposal. Issues with difficulty in recycling.</td>
</tr>
<tr>
<td>Other reinforcing fabrics</td>
<td>Predominantly sourced from petrochemicals.</td>
<td>Used for structural strength and rigidity. Makes up about 5% of a radial tyre.</td>
<td>Impacts during production and transport.</td>
</tr>
<tr>
<td>Carbon black</td>
<td>Generally sourced from petroleum stock.</td>
<td>Imparts durability and wear resistance and resistance to degradation. Makes up about 28% of a passenger tyre. The % is higher in the rubber that make up the wearing surfaces.</td>
<td>Impacts during production and transport.</td>
</tr>
</tbody>
</table>
### Table: Materials, Sources, Applications, and Potential Impacts

<table>
<thead>
<tr>
<th>Material</th>
<th>Source</th>
<th>Application</th>
<th>Potential impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc oxide</td>
<td></td>
<td>Zinc is added to provide resistance to UV degradation, control vulcanisation and enhance blending. Zinc oxide makes up about 1.2% of a passenger tyre.</td>
<td>Impacts during manufacture and disposal. Impacts due to leach/emission from waste tyres.</td>
</tr>
<tr>
<td>Sulphur (including compounds)</td>
<td>Sulphur is used to vulcanise the rubber.</td>
<td>Makes up about 1% of a passenger tyre.</td>
<td>Impacts during production. Impacts during combustion for energy recovery.</td>
</tr>
<tr>
<td>Other additives and solvents 9</td>
<td>The other additives are used in the various rubber compounds to modify handling manufacturing and end-product properties.</td>
<td>The additives make up about 8% by weight of a passenger tyre.</td>
<td>Impact associated with manufacture and transportation. Emissions during manufacture. Impacts associated with use and disposal of the solvents. Emissions from tyres in use, during recycling and in final disposal.</td>
</tr>
<tr>
<td>Recycled rubber</td>
<td>Recovered from used tyres or other rubber products.</td>
<td>Used in some rubber compounds in the manufacture of ‘new’ rubber products and retread materials.</td>
<td>Impacts from energy use in production.</td>
</tr>
</tbody>
</table>

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(Source: UK Environment Agency (undated), Tyres in the environment)
6.1.3 Resource depletion

One of the major drivers in attempts to reduce the volume of tyres or other rubber products disposed to landfill or burned for energy appears to be to reduce the loss of the resources contained in the waste rubber products. In addition to the material resources in the products, disposal takes up landfill space, which is also a resource and is limited in many areas.

The major resources consumed in the manufacture of a tyre are:

- petroleum and other fossil fuels for the production of synthetic rubber, fibres, carbon black and to provide energy for the operation of manufacturing equipment and transport;
- land and habitat for production of natural rubber;
- iron ore for the production of steel for tyre cord;
- zinc; and
- other minerals and organic substances for protecting and alloying the steel and processing the rubber.

When reviewing the resource issues it is instructive to consider the relative proportion of resources used in tyres against those used in other parts of a car. For example:

- the steel in a tyre is less than 1% of the total steel in a car\(^\text{10}\), and
- the total oil equivalent in 15 passenger tyres is equal to about 2% of the energy a car will use in its life\(^\text{11}\); the energy a car tyre consumes during its life to overcome rolling resistance is 50 times the energy embodied in the tyres used.

From this it can be seen that tyres contribute only a small component of the material and energy flows associated with transport, and even complete recovery of the resources in tyres would have little impact on the overall resource flows associated with transport. Conversely, any change in the transport system such as reduction in the distance travelled would reduce factors such as fuel consumption as well as result in a proportional reduction in waste tyre generation.

Because of the intermixing of materials in the construction of a tyre and because of the chemical changes (vulcanisation), in practice none of the component materials can be utilised or recovered in its raw form.

Steel from tyres is not generally recycled because it is difficult to handle and is contaminated by rubber and other coating agents, and this reduces its value. As far as could be determined, little if any steel is recovered from the tyres that are currently recycled, though the steel in waste tyres burned in cement kilns contributes to the requirements for iron in cement.

In order for rubber to be recycled to displace new rubber it must be devulcanised, which is difficult to achieve at a competitive price and has potentially high environmental impacts. The rubber in tyres is a mix of natural and various synthetic rubbers, which cannot be practically separated even if they are devulcanised. This decreases the value of the rubber for subsequent uses.

Rubber in ‘crumb’ form is inert and difficult to bond to other materials generally resulting in a deterioration of the properties of any product into which it is incorporated.

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\(^{10}\) Assume a car has 1 tonne of steel and tyres contain 15% steel or approximately 7.5kg for five tyres.

\(^{11}\) Assume that over its life a car uses 3 sets of tyres each consuming 32 L of oil equivalent for a car that travels 150,000km at 10L/100km.
From this it can be seen that the recovery of rubber and associated materials in tyres has technical limitations and involves processes that may result in greater environmental impacts than those associated with disposal to landfill.

In respect of energy, the content of the 18 million EPU of waste tyres generated in Australia each year is equivalent to the fuel consumed in about 2 weeks of a typical large coal fired power station. Overall, the energy in waste tyres is less than 0.5% of the total energy consumed to generate electricity or the energy used in transport in Australia.

In respect of landfill volume, the mass of waste tyres generated each year is less than 1% of the total solid waste generated. In considering landfill capacity, it is volume rather than mass that is the critical factor. On a worst case ‘whole tyre’ basis, the volume of waste tyres is estimated to be approximately 8% of the volume of solid waste. In practice a large proportion of tyres are processed to reduce their volume before being landfilled, so the actual proportion of landfill capacity taken up by waste tyres is several times smaller than 8%.

6.2 Manufacture

As a sector, the rubber industry is a relatively small component of the overall economy and the total contribution to environmental impacts is proportionally small. Over 50% of passenger and truck and bus tyres are imported as well as all larger and specialty tyres. A significant proportion of other rubber products is also imported. Consequently the local manufacturing impacts are lower in proportion to population than in countries that export a significant quantity such as the US.

In Australia there are limited aggregated data on the environmental impacts from the manufacture of rubber products or from retreading and recycling. Available energy and greenhouse statistics indicate that greenhouse gas emissions from the rubber industry are likely to be less than 0.1% of the national total. When compared to the nearly 30% contribution attributable to road transport it can be seen that the impact from the manufacture of rubber products is small at a national scale.

The potential impacts occur at each stage of the rubber manufacturing process. The main potential impacts from manufacture are noise and air pollution. Air pollutants include odours from heating rubber and volatile organic compounds (VOC) from solvent use in rubber manufacture. Liquid wastes, primarily contaminated water, are also a potential source of impact. There is also a range of solid wastes but the overall quantities are small and have low potential impact. Advice from State environmental regulators is that the tyre plants in Australia are not a significant source of complaints.

The overall conclusion, based on available evidence, is that the environmental impacts of the tyre manufacturing industry are only a small proportion of national totals and are far exceeded by the energy consumption due to tyres in use, predominantly in road transport.

6.3 Use

Environmental impacts of rubber products are likely to be dominated by tyres due to the significant proportion of rubber used in tyres, as well as the direct bearing of tyres in use on the energy consumption of transportation due to rolling resistance.

The environmental impacts of tyres in use are summarised in Table 6.3.

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12 Based on the tyre shipping volume (worst case) average of 0.1m³/EPU and an average compacted municipal solid waste density of 0.8 t/m³ and a waste generation rate of 2.5 kg/person/day.
Table 6.3  Impact of tyres in use

<table>
<thead>
<tr>
<th>Impact</th>
<th>Discussion</th>
</tr>
</thead>
</table>
| Noise                | Tyres produce noise via a range of mechanisms. Tyre noise makes up a large percentage of the noise from cars and other vehicles and traffic noise in general has a significant impact on communities. Noise barriers/mitigation is a significant factor in road design.  
Tyre noise can be reduced by design of the tyre and road design.                                                                                                                                                                                                                   |
| Dust                 | The contact surface of a tyre wears off in use and is emitted as dust.  
Approximately 0.03g of tyre dust is generated per km.  
In Australia it is estimated that over 20,000 t of tyre dust is emitted per year which may be associated with air and water pollution as discussed in Section I.6.3.2.                                                                                                     |
| Fuel consumption     | Energy is needed to turn a tyre and this is called rolling resistance. Rolling resistance accounts for about 15% of the energy that is used in moving a car. Rolling resistance is increased by higher vehicle loads and by under-inflation of tyres. It is estimated that for every 20 kPa reduction in pressure rolling resistance increases by 2%. In Australia it is estimated that approximately 1% of the total greenhouse emissions from transport result from incorrect inflation of passenger vehicle tyres. |

6.3.1  Noise from tyres

Noise generated by tyres makes up a significant proportion of the noise generated by traffic. Tyre noise is generated by a range of mechanisms and is affected by both road condition and the design and compounding of the tyres. Some tread patterns are reported to reduce noise generation and pitch while others, such as the lugs on off-road tyres, are relatively noisy.

Traffic noise exposure in capital cities in Australia is shown in Figure 6.2. According to the Motor Vehicle Environmental Committee:

“In 1989-90, an Australian Environment Council (now ANZECC) study of the exposure of the Australian population to road traffic noise indicated that, on the basis of OECD criteria, over 9 per cent of the Australian population is exposed to ‘excessively high’ levels of noise (68 dB(A) Leq 24hr or above) and 39 per cent to ‘undesirable’ levels (58 dB(A) Leq 24hr or above). For Sydney, these figures increased to 10 per cent and 42 per cent respectively.”

(ANZECC (1992) Motor Vehicle Environmental Committee Strategic Plan Part 2)
Rubber is worn off tyres during use particularly during high stress operation such as cornering, braking and acceleration. During its life a tyre loses a significant proportion of its tread accounting for about 10% of the mass of a tyre and 30 to 50% of the rubber. A new 10 kg passenger tyre can be expected to lose about 1.5 kg of rubber as ‘dust’ during use or approximately 0.03 g per km. Aggregate losses of dust from tyres for all road traffic across Australia are of the order of 20,000 tonnes per annum.

The impact that this dust has on the environment is not known but studies in the UK have suggested that a significant source of polycyclic aromatic hydrocarbons (PAH) in waterways is due to tyre dust. Studies in Germany also attribute zinc and other metals in the runoff from roadways to tyre dust.

A recent study reported in New Scientist suggests that levels of PAH and fine particulates (referred to as PM$_{10}$ when below 10 µm in size) attributable to tyre wear exceed the emissions from vehicle exhaust and is responsible for significant health impacts across Europe.

**6.3.3 Fuel Consumption**

Tyres contribute to the fuel consumption of vehicles by virtue of the energy needed to flex the tyre as it deforms during rolling. This ‘rolling resistance’ accounts for about 15% of the energy used to drive a car on level ground at 100 km per hour. During the life of each tyre, approximately 200 litres of fuel is estimated to be consumed in overcoming rolling resistance, and this represents about 3% of the fuel used by a car. Rolling resistance is dependent on the properties of the tyre, the load and inflation pressure, but is not greatly affected by speed (unlike, for example, wind resistance).

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13 New Scientist 10 April 1999.
14 To a certain extent an increase in load is equivalent to a decrease in pressure.
It is estimated that a 20% under-inflated tyre will increase fuel consumption by around 5%\(^{15}\). A limited study by the NRMA\(^{16}\) noted that tyre maintenance and attention to correct tyre pressure was very poor in Australia. The survey found that 25% of cars in the sample had tyres under inflated by more than 10%. If this statistic is extrapolated across the country it is estimated that the fuel consumption and emissions due to passenger vehicles is approximately 1% higher due to tyre under inflation. A 1% increase in fuel consumption in passenger cars is equivalent to about 4 Mt of CO\(_2\). Obviously, these estimates should be considered as order of magnitude accuracy only but they indicate the scale of potential impact. It should also be noted that under inflation also decreases the life of a tyre as discussed in Section I. 8.3.

### 6.4 Recycling and reuse

#### 6.4.1 Impacts of retreading tyres

There are in the order of 100 retreaders in Australia. Many retreading operations are small scale and do not require an environmental protection licence to be held indicating the lower level of controls that are required and/or necessary.

The impacts from retreading are in some ways similar to those from tyre manufacture as they involve many of the same basic materials and processes. Retreading is, however, a more simple process and involves only the tread and outer surface of the tyre, and not the casing which includes the steel and fabrics. New treads or rubber compound used to form a tread are sourced and processed in the same way as in the manufacture of new tyres.

Sources of environmental impact from retreading are given in Table 6.4.

<table>
<thead>
<tr>
<th>Energy and material use</th>
<th>As retreading extends the life of a tyre and utilises much of the original materials and structure, the net result is a decrease in materials and energy used in comparison with new tyres.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air emissions</td>
<td>The primary areas of concern appear to be VOCs (volatile organic compounds) from solvents, bonding agents and rubber compounds. Odour may also be an issue in some areas.</td>
</tr>
<tr>
<td>Solid wastes</td>
<td>Some waste is produced from retreading facilities due to reject tyres, rubber, retreads and compounding material. The rubber removed from used tyres before retreading is generally sold as rubber crumb, so does not constitute a waste.</td>
</tr>
</tbody>
</table>

The impacts from retreading should be contrasted with the benefits of retreads against providing new tyres. Retreading a tyre consumes considerably less material and energy than that required for a new tyre, with a proportional decrease in other impacts. This point is discussed further in Section I. 6.7.2.

#### 6.4.2 Impacts of tyres used in marine environments

Tyres have been widely used in breakwaters, artificial reefs and riverbank erosion control. The assessment of the impacts of tyres in marine environments is divided. On one hand, tyres are stable and resist degradation and leaching of the components.

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\(^{15}\) UK Environment Agency (undated), Tyres in the environment.

\(^{16}\) NRMA (1993), *Are your tyres letting you down?*, November.
On the other hand, tyres do leach both organic and inorganic substances. Abernethy\textsuperscript{17} reports that tyres in water are lethal to rainbow trout in certain circumstances. There are lingering concerns on the impacts artificial reefs have on local ecosystems. Though artificial reefs made from tyres are reported to be rapidly colonised by some marine organisms they are not equally colonised by fish. The stability of tyre artificial reefs has also been questioned with reports of reefs breaking up in bad weather. This is, however, more a matter of defective construction rather than related directly to environmental impacts of tyres.

Tests conducted in accordance with the standard US EPA Toxicity Characterisation Leaching Procedure (TCLP) found that contaminants from tyres were below the TCLP thresholds. However, it has been observed that the TCLP may not be sensitive to the chemicals found in tyres.

### 6.4.3 Impacts of tyres in energy recovery

The four main options for energy recovery are:

- cement kilns;
- other co-firing applications (paper mills, power plants);
- direct combustion (for electricity or steam); and
- pyrolysis\textsuperscript{18}.

Waste tyres have a higher energy content than coal and a lower overall greenhouse coefficient due to the natural rubber content as shown in Table 6.5. This makes tyres an excellent energy source.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Energy GJ/t</th>
<th>Greenhouse gas emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>kgCO₂/t</td>
</tr>
<tr>
<td>Tyres shredded with majority of steel removed\textsuperscript{19}</td>
<td>32</td>
<td>2,391</td>
</tr>
<tr>
<td>Whole tyres</td>
<td>27</td>
<td>2,080</td>
</tr>
<tr>
<td>Thermal coal</td>
<td>27</td>
<td>2,430</td>
</tr>
<tr>
<td>Brown coal</td>
<td>10</td>
<td>922</td>
</tr>
<tr>
<td>Oil</td>
<td>46</td>
<td>3,220</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>39</td>
<td>1,989</td>
</tr>
</tbody>
</table>

\textsuperscript{17} Abernethy S (1994), \textit{The Acute Lethality to Rainbow Trout of Water Contaminated by an Automobile Tire}.

\textsuperscript{18} Pyrolysis can also be classified as material recovery of components such as oil, carbon black and metals.

\textsuperscript{19} The rubber in a tyre is approximately 30% natural rubber, which is assumed to have no net greenhouse impact due to the sequestering of carbon dioxide by rubber trees. It is noted that these values are approximations for comparison only and do not take into account the full life cycle impacts of the fuels.

\textsuperscript{20} Estimate only, based on carbon content of the constituents of tyres.

\textsuperscript{21} ibid
The non-combustible components of tyres contain a range of potentially toxic materials that can be released to the atmosphere if tyres are burned in an uncontrolled fashion (as is the case for fires in illegal dumps). Emissions can include dioxins and furans, which are carcinogenic, as well as oxides of nitrogen and sulphur.

Studies on the use of tyres in cement kilns have generally concluded that the impacts are either positive or neutral compared to the combustion of other fuels. However this needs to be considered on a case by case basis as it is dependent on good operating practice as well as the particular characteristics of the tyres used and the kiln. The combustion characteristics of tyres are such that only processes that have relatively high temperatures and long residence times can be used.

6.5 Disposal

6.5.1 Impacts of tyres in landfill and mines

As with their behaviour in marine environments, the impacts of disposal of tyres on land are determined by the possibility of the escape of the toxic components from a stable matrix. The authors are not aware of any reports of major environmental impacts as a result of appropriate disposal of tyres to controlled landfill or in mines notwithstanding the fact that millions of tyres have been disposed of in this way. However, it must be acknowledged that there is limited experience with long-term impacts (50 years or more).

The objections to landfills appear to be driven mainly by materials handling and operational issues, the exhaustion of landfill space and resource issues as discussed below, rather than environmental impacts themselves.

Tyres in landfills are also associated with fire risks. For example, the WA Used Tyre Regulations provide that tyres are buried in batches of volume not exceeding 40 m$^3$ or less than 1,000 whole tyres, separated by at least 100 mm of soil.

Operational problems

Whole tyres are reported to float if buried. Corbett has challenged the validity of this and the mechanisms which cause it to occur.

Whole tyres are not easy to manage with equipment generally available in a landfill.

These are not issues in the case of shredded tyres which are routinely disposed to landfill.

Landfill space

Whole tyres have large ‘voids’ which consume available space (approximately 75% of the volume of a whole tyre is void).

Waste tyres are generated at greater rates in areas where population is highest and these are the areas where landfill space is limited.

Resource issues

This issue is discussed in Section 6.1.

Future use

Tyres reportedly destabilise a landfill and may impact on the useability of the landfill area for future use.

6.5.2 Impacts of tyres on land - uncontrolled

Impacts due to the uncontrolled disposal of tyres to land are similar to those for stockpiles as discussed in Section 6.5.3. In addition, waste tyres can have a visual impact and form breeding locations for pests and vermin. Gullies and watercourses, which are favoured disposal sites for tyres, can become increasingly eroded due to the changed water flow patterns.
6.5.3 **Impacts and risks of waste tyre stockpiles**

When the tyre waste issue is discussed the impacts of stockpiles of tyres above ground are generally the dominant factor. The issues with tyre stockpiles are listed in Table 6.6.

<table>
<thead>
<tr>
<th><strong>Table 6.6</strong> Environmental impacts of tyre stockpiles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fire</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Mosquitoes</strong></td>
</tr>
<tr>
<td><strong>Weeds</strong></td>
</tr>
<tr>
<td><strong>Vermin</strong></td>
</tr>
<tr>
<td><strong>Visual impact</strong></td>
</tr>
</tbody>
</table>

6.6 **Transportation**

Each stage in the life cycle of a tyre involves transportation. The materials that are used to make tyres and other rubber products are made and distributed around the world. Rubber products are also transported locally and internationally. At the end of its life a tyre is transported once more, and during recycling further transport of recycled rubber occurs. This section analyses the significance of the impact of transport in the life cycle of a tyre.

Australia manufactures its own tyres as well as importing a significant proportion. Australia also manufactures some proportion of the raw materials used to make tyres as well as importing raw or semi-processed materials. The distance travelled and the modes of transport involved in the life cycle of a tyre are varied and a full analysis is complicated. However, by making reasonable simplifications and assumptions, it is possible to arrive at useable estimates of the relative impacts of the transport requirements at different points through the life cycle. Further comment on the life cycle of a tyre is made in Section 5.7.
Ignoring the in-use contribution, transport accounts for approximately 4% of the total energy and greenhouse emissions associated with a tyre, suggesting that transport impacts are not a major contributor to tyre energy usage. This ‘whole system’ perspective does not, however, take into consideration other transport emissions and impacts, or the locations where they occur. For example, relatively small emissions of nitrogen oxides from trucks in major cities may be far more significant than, say, emissions associated with sea transport between countries.

The overall estimate of 4% given above is based on assumptions about the mode of transport and average distances travelled. Table 6.7 contains estimates of energy use and greenhouse emissions for different modes of transport. It can be seen that emissions from light commercial vehicles are several times greater than those for articulated trucks or rail. It is noted that waste tyres are often transported with smaller vehicles (particularly from the initial collection point) and this increases the emissions significantly.

The values in the table are subject to considerable uncertainty because of variations in the load carrying capacity and fuel consumption of vehicles that fall into each of the general classifications. A review of several published sources and calculations based on published load and fuel consumption data suggest that the values used for rigid trucks in particular may be too high by 2 or 3 MJ/tonne km. However, for the purpose of this report, the figures in the table are sufficiently robust to provide a valid comparison of the efficiency of transporting tyres by different modes of transport. For more accuracy actual tyre transport data would be required. In particular, the effect of the mass versus volume constraints of bulk transportation of tyres and part loading during collection and distribution would also need to be taken into consideration.

Table 6.7  Energy used in transport task

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>MJ/tonne km</th>
<th>kg CO₂/tonne km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Commercial</td>
<td>5</td>
<td>0.35</td>
</tr>
<tr>
<td>Rigid truck</td>
<td>3.5</td>
<td>0.24</td>
</tr>
<tr>
<td>Articulated truck</td>
<td>1.4</td>
<td>0.095</td>
</tr>
<tr>
<td>Rail</td>
<td>0.5</td>
<td>0.035</td>
</tr>
<tr>
<td>Sea</td>
<td>0.3</td>
<td>0.022</td>
</tr>
</tbody>
</table>

Figure 6.3 illustrates the relationship between greenhouse gas emissions and the magnitude of the transport task for different modes of transport.

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22 Lenzen (1999). The values taken from the source are for direct energy consumption only.
Figure 6.3  Relationship of greenhouse gas emissions to transport task for different modes of transport

Figure 6.4 provides an estimate of the aggregate greenhouse emissions of transporting the entire 18 million EPU generated annually (approximately 170,000 tonnes) by different transport modes. The diagram can be used to provide a quick estimate of the order of magnitude of greenhouse gas emissions for transporting tyres (whether new or waste tyres). For example, on a national basis the annual greenhouse gas emissions if waste tyres are transported on average 100 km by light trucks are equivalent to approximately 6,000 tonnes of CO₂. The corresponding figure for articulated trucks would be approximately 4,000 tonnes CO₂ less.

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23 The transport task is a function of both weight (in most cases) and distance, and is conventionally measured in units such as tonne kilometres (tonne km). Energy efficiency for transport is the quantity of energy needed to accomplish one unit of the transport task and this is the basis used for comparison across modes.
Another parameter that can be considered in relation to transport is the distance that a waste tyre can be carried before the impacts from transport exceed the benefits derived from recycling or other application for which the tyre is transported. The simplest way to make this comparison is on the basis of energy consumed. It must be emphasised that the use of energy as a basis of comparison ignores other issues associated with both transport and energy recovery or recycling operations.

The energy content of a tyre is approximately 27 GJ/t for whole tyres and 32 GJ/t for shredded tyres with most of the steel removed. Estimates for the distance that a tyre could be transported before more energy is consumed in transport than is recovered from the tyre are given in Table 6.8. It can be seen from the entries in the table that there is a positive energy recovery even when using light commercial vehicles over distances of several thousand km. The values in Table 6.8 are only approximate, being based on a simple analysis with an uncertainty of at least ±20%. The comments made above in relation to the uncertainty in the energy intensity of different modes of transport remain valid.

### Table 6.8 Transport distance before the energy from transport exceeds the energy recoverable from the tyre

<table>
<thead>
<tr>
<th>Mode</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light commercial vehicle</td>
<td>5,400 km</td>
</tr>
<tr>
<td>Rigid truck</td>
<td>7,714 km</td>
</tr>
<tr>
<td>Articulated truck</td>
<td>19,286 km</td>
</tr>
<tr>
<td>Rail</td>
<td>54,000 km</td>
</tr>
<tr>
<td>Sea</td>
<td>90,000 km</td>
</tr>
</tbody>
</table>
6.7 Preliminary life cycle assessment of tyres and selected waste tyre management options

The following section includes a preliminary life cycle assessment of some aspects of tyre production, use and recycling. The values quoted are preliminary only and have not been fully validated. They are based on data from a variety of sources of varying reliability. In some instances we have been forced to make our own best estimate for energy and greenhouse emissions.

6.7.1 Manufacture

The breakdown of energy and greenhouse emissions for the production of the raw materials used to manufacture rubber products is shown in Table 6.9. The total energy and greenhouse emissions computed from the raw material estimates to manufacture a range of tyres are shown in Table 6.10.

![Table 6.9 Energy and greenhouse emissions associated with the raw materials used in tyres and other rubber products](image)

<table>
<thead>
<tr>
<th>Material</th>
<th>Energy MJ/kg</th>
<th>Greenhouse kgCO₂/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural rubber</td>
<td>8</td>
<td>0.4</td>
</tr>
<tr>
<td>Synthetic rubber</td>
<td>110</td>
<td>5.0</td>
</tr>
<tr>
<td>Carbon black</td>
<td>125</td>
<td>5.7</td>
</tr>
<tr>
<td>All other additives</td>
<td>100</td>
<td>8.2</td>
</tr>
<tr>
<td>Fabric</td>
<td>45</td>
<td>2.1</td>
</tr>
<tr>
<td>Steel tyre cord</td>
<td>36</td>
<td>3.2</td>
</tr>
<tr>
<td>Manufacture (per kg tyre)</td>
<td>11.7</td>
<td>1.86</td>
</tr>
</tbody>
</table>

![Table 6.10 Energy and greenhouse emissions to produce tyres](image)

<table>
<thead>
<tr>
<th></th>
<th>Passenger (9.5kg)</th>
<th>Truck and bus (45kg)</th>
<th>Earthmoving (3,500kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MJ</td>
<td>kgCO₂</td>
<td>MJ</td>
</tr>
<tr>
<td>Natural rubber</td>
<td>11</td>
<td>0.5</td>
<td>51</td>
</tr>
<tr>
<td>Synthetic rubber</td>
<td>361</td>
<td>16.5</td>
<td>1,637</td>
</tr>
<tr>
<td>Carbon black</td>
<td>268</td>
<td>12.3</td>
<td>1,299</td>
</tr>
<tr>
<td>All other additives</td>
<td>95</td>
<td>7.8</td>
<td>425</td>
</tr>
<tr>
<td>Fabric</td>
<td>25</td>
<td>1.1</td>
<td>43</td>
</tr>
<tr>
<td>Steel tyre cord</td>
<td>59</td>
<td>5.3</td>
<td>391</td>
</tr>
<tr>
<td>Manufacture</td>
<td>117</td>
<td>18.5</td>
<td>553</td>
</tr>
<tr>
<td>Transport of materials</td>
<td>38</td>
<td>2.8</td>
<td>191</td>
</tr>
<tr>
<td>Total</td>
<td>974</td>
<td>65</td>
<td>4,591</td>
</tr>
<tr>
<td>Total per kg</td>
<td>103</td>
<td>6.8</td>
<td>102</td>
</tr>
</tbody>
</table>

As may be deduced from the table entries, the values for large earthmoving tyres have been extrapolated from those for truck tyres and the proportion of steel and other materials in earthmoving tyres may be different from that indicated.
6.7.2 Recycling

Analysis of various recycling technologies is difficult because there are limited data available on the energy, greenhouse gas emissions and other impacts of various recycling technologies. Based on available information a number of scenarios can be investigated as discussed in the following sections.

Retreading

A number of authors have published data in broad terms about the energy and material savings from retreading. Retreading utilises a significant proportion of the rubber and all the fabric and steel in a tyre. The processing energy is reported to be lower than for a new tyre though the actual reduction varies depending on the type of retreading (whether hot or cold or remoulding). Even using rough estimates it is evident that retreading has significant potential to reduce overall energy and greenhouse emissions, as well as reduce the quantity of waste tyres that are produced. The energy to retread a passenger tyre is approximately 400 MJ (compared with 900 MJ for a new tyre) of which 75% (300 MJ) is estimated to be contained in the retread materials and the remainder is energy used in the process.

Using these figures and assuming one retreading cycle for passenger tyres and five retreading cycles for truck and bus tyres and that the expected life of retreads is comparable with that of new tyres, the benefits due to different rates of recycling can be predicted as shown in Figure 6.5.

![Figure 6.5 Estimated overall energy saving from retreading tyres](image-url)
6.7.3 **Crumbling and shredding**

The energy and greenhouse effects of crumbing and shredding are largely determined by the final size of the rubber particles. Figure 6.6 shows the estimated energy to process rubber to various final sizes based on data from IRRDB\(^{25}\). The diagram shows that as the particle size decreases the energy increases substantially, rising to 100 MJ/kg for cryogenically ground rubber. This approaches the quantity of energy to produce new synthetic rubber. As crumb rubber without further treatment is only used as filler this suggests that the use of finely ground rubber may not be justified from a resource and energy perspective. However, as the data upon which the figure is based is both limited and dated, more detailed investigations would be necessary to confirm this observation. Further, the value of crumb rubber when used (in small proportions) as a direct substitute for new rubber is much higher than as dead filler. Also as a significant source of crumb rubber in Australia is a by-product from retreading, the environmental costs and benefits of crumbing may, at least in this instance, be better than indicated in Figure 6.6.

![Figure 6.6 Energy to process waste rubber to different final particle sizes](image)

### 6.7.4 Material reclaim

Material reclaiming is the process whereby the waste rubber product is devulcanised by chemical and or thermal processes. This produces a raw rubber polymer that can be substituted for new rubber. Though reclaiming was once common practice, as far as we are aware India is the only country that is currently reclaiming any significant quantity - approximately 70,000 tonnes of waste rubber each year. The conditions that make this possible (low labour costs and demand for rubber that exceeds supply) may also be present in other developing nations.

\(^{25}\) IRRDB web site at www.irrdb.org
No data were found on the energy and other environmental costs for reclaiming rubber. What can be said is that, as the process involves initial granulation followed by the use of various solvents, rubber reclamation can be expected to result in impacts beyond those associated with crumbing. The key benefit of reclaiming is that it results in a product that approaches the properties of new natural or synthetic rubber and therefore has a far greater substitution value, which needs to be balanced against the added financial costs and environmental impacts.

6.7.5 Surface modification

Waste vulcanised rubber is, by design, very chemically stable. This makes it difficult to combine and bond to other substances. Surface modification includes a range of processes that change the surface chemistry of the rubber particles so that they can combine more readily with other substances.

No data have been found on the energy and material costs of surface modification. In comparison to rubber crumb (the starting point for surface modification), there will be increased energy costs and the use of certain chemicals in the process poses additional risks to the environment.

In return for the additional costs and environmental impacts of the surface modification process, the resulting product has much improved properties (particularly strength) and can be used in significantly more critical applications. Thus, surface modified waste rubber can be expected to displace an increased quantity of rubber made from virgin materials. The avoided energy and environmental impacts of the virgin rubber is an offset in determining the net financial costs and other impacts of surface modification.

6.7.6 Energy recovery

However, when comparing energy recovery with retreading, the valid comparison is the energy to produce a tyre. The energy that can be recovered from a tyre in, say, a cement kiln is approximately 25% to 35% of the total energy to produce a tyre. To this should be added the additional benefits of displacing iron feed to cement, which is estimated to add at most 1%, and displacement of other fuels, which would add further benefits for coal and slight negative impacts for gas. From this it can be seen that while energy recovery in a cement kiln represents complete waste elimination with reduced environmental impacts it represents only about 30% recovery of the ‘value’ in the tyre that is available for, and can be beneficially used in, retreading.
7 Material Flows in the Tyre and Rubber Industries

The following sections describe sources and fate of tyres and other rubber products, both in Australia and internationally. There is considerable uncertainty in the data for Australia due to a range of factors which are discussed below. Consequently, the information should be used with caution.

7.1 Sources and quality of data

In respect of tyres, there are no reliable and comprehensive statistics available in Australia on the quantity of tyres produced, sold and retreaded, or the fate of tyres including the numbers that go to various alternative uses. A number of studies by government agencies and consultants ranging back to the early 1970’s have compiled figures as part of waste management investigations and policy development. These, however, have often been restricted in their coverage (often to a single State) and appear to have faced the same difficulties as the current study. Industry representatives in certain sectors hold statistics and estimates on their activities, but are reluctant to provide detailed data in view of the competitive nature of the business and uncertainty about the use of the data by government or other industry players. In regard to other entities in the tyre industry there are many small operators that do not keep any records, and the resources needed to contact a representative sample are prohibitive. None of the tyre industry associations collect or maintain industry-wide statistics. The Australian Bureau of Statistics (ABS) collects import and export statistics but the classification of tyre and other rubber products and the use of financial values rather than physical values makes the ABS information difficult to reconcile with other data. Compounding the data collection problems for individual States and Territories are the significant interstate transfers of waste tyres. Finally, and of great concern for the current study, there is a high level of inappropriate activity. In NSW and Queensland there are suggestions that illegal practices may account for as much as 25% of all waste tyres but, by definition, there is no way to obtain reliable estimates and there is even debate about what should be classified as illegal or inappropriate disposal.

The comments for tyres are even more relevant to other rubber products. Information has only been found at the aggregate level reflecting the relatively small size of the remaining segments of the rubber industry in comparison with the tyre industry. With the exception of conveyor belts there does not appear to be significant waste or environmental issues in the other rubber product sectors.

The consequence is that material flows in regard to tyres and other rubber products can only be estimated from a collection of fragmented data points, which individually have low levels of confidence. There is considerable difficulty in reconciling the various sources of information and presenting a comprehensive picture of new, used, recycled and reprocessed tyres and other rubber products in Australia.

7.2 Units of measure and classification

Various units of measure and classification have been used or are used by different segments of the rubber market and for different products. The discussion on classifications is dominated by a focus on tyres, which are the largest and most obvious source of rubber waste.

Depending on the perspective taken, tyres can be measured by number, mass or volume. Tyres can also be classified by application and market segment such as passenger tyres or off-the-road (OTR) tyres which are tyres used on earth moving and mining equipment. A unit of measure that has been introduced is the equivalent
passenger unit (EPU) which relates tyres of various sizes to an equivalent passenger tyre as shown in Table 7.1.

<table>
<thead>
<tr>
<th>Type of tyre</th>
<th>EPU</th>
<th>Assumed mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger</td>
<td>1</td>
<td>9.5 (basis)</td>
</tr>
<tr>
<td>Light truck</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>Truck and bus</td>
<td>5</td>
<td>47.5</td>
</tr>
<tr>
<td>Tractor and grader</td>
<td>10</td>
<td>950</td>
</tr>
</tbody>
</table>

Though there is no absolute requirement to establish rigid definitions for units of measure for tyres, the current disparity can lead to difficulties in collecting and interpreting data. It is noted that considerable errors may arise in using the EPU basis as defined above, particularly when converting back to the number of tyres and volumes. Observed inconsistencies in the application of EPU include:

- 9.5 kg is the approximate weight of a larger passenger tyre while tyres for smaller cars may weigh 7kg or less;
- a passenger tyre will lose approximately 10% of its mass due to wear during its life, and a new 9.5kg tyre may weigh only 8.5 kg at the post-consumer stage; using the weight of new tyres for waste tyres will result in a 10% over estimate;
- large earthmoving tyres can weigh 3.5 tonnes (370 EPU) or more but some reports appear to include them within the category of tractor or grader tyres at a much lower number of EPUs; and
- it is not always clear if 4WD tyres which are approximately equivalent to light commercial tyres are included as passenger or light commercial.

7.3 Are more accurate data required?

There are considerable shortfalls in available data on all aspects of tyre production, recycling and waste generation. However our view is that the general ‘state of play’ is known with sufficient accuracy for the purposes of this study. Uncertainties about the data should not therefore be a barrier to further assessment and developments of national, local or industry approaches.

Nevertheless, this should not be taken to imply that efforts to improve data availability, quality, classification and units of measure would not be of considerable value for planning, policy development and implementation.

7.4 Summary of world rubber market

Rubber use is dominated by the tyre industry which consumes over 50% of the mass of all rubber produced. A significant proportion of the non-tyre rubber production is also associated with the automotive industry so that about 80% of all rubber is consumed in this sector. There is a vast range of non-tyre rubber products ranging from medical products through to earthquake mounts for high rise buildings and the list includes; belting, hose, moulded and extruded products, seals, roll coverings, mats, carpet underlay, footwear, clothing and foamed products such as mattresses.

On a global basis between 700 million and 1 billion new tyres are manufactured each year and this figure is rising with increased population, vehicle ownership and usage.

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26 Based on NSW EPA Tyre Industry Waste Reduction Plan.
Australia produces approximately 6 million tyres and overall consumes approximately 18 million tyres. It can be seen that on a world scale Australia’s tyre consumption is small though a rough estimate suggests that waste tyre production per person is relatively high by world standards.

Worldwide tyre production is dominated by a small number of multinational companies with the top 6 companies producing more than 80% of the tyres. There are many smaller companies that produce tyres and other rubber products and many of the major tyre producing companies are also significant players in the non-tyre rubber industry. In addition to rubber there is significant industry associated with supplying the fabrics, steel and various additives that make up finished rubber products. The rubber industry is one of the largest secondary industries in Australia with an annual output worth about $1.5 billion and employing about 12,000 people.

Rubber, as a raw material, can be divided into two main types: natural rubber and synthetic rubber. The ratio of consumption in Australia is about 60:40. Annual synthetic rubber production in the world is approximately 10 million tonnes and total natural rubber production is 7 million tonnes. Australian total rubber consumption is estimated to be of the order of 120,000 tonnes per annum. Australia imports all its natural rubber requirements but manufactures about 70% of synthetic rubber used locally. A breakdown of the applications for rubber is given in Table 7.2.

<table>
<thead>
<tr>
<th>Application</th>
<th>Natural rubber</th>
<th>Synthetic rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tyres (including tubes etc)</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Other automotive</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>Other</td>
<td>20%</td>
<td>20%</td>
</tr>
</tbody>
</table>

7.5 Sources of waste in the rubber industry

The perceived waste ‘problem’ in the rubber industry is dominated by waste tyres. Conveyor belts are the only other rubber product that appear to raise significant waste management issues though the quantities of waste are much smaller than for tyres. No specific information or discussion of issues have been found on the effects of non-tyre waste rubber other than for conveyor belts. A significant proportion of rubber products is used in the automotive industry but mainly not in consumable components, and consequently it is likely that much of the waste ends up in scrapped cars. In Australia the non-metallic components of cars are disposed to landfills. Other rubber products are likely to be disposed to landfills via domestic or commercial waste management processes and account for less than 1% of the total waste mass.

7.6 Summary and trends in international waste tyre use

Waste tyre management is a significant issue in most developed countries and major waste tyre management projects have been put in place. Information on waste tyres as well as trends in uses in various countries is shown in the following figures and tables.

Figure 7.1 shows statistics for the number of waste tyres utilised in the US. The significant increase in waste tyres between 1990 and 1996 is interpreted as referring to the number that are used beneficially, not the total number of waste tyres generated. The trend shows a steady increase in the use of waste tyres for fuel and also an expansion of recycling and other uses. It is interesting to note that a paper on rubber
modified asphalt published in 1992 predicted much higher rates of use in roads and rubber products than appears to have been realised.

Table 7.3 shows recent figures for the US. It can be seen that the percentage of waste tyres utilised is approaching the rate of generation. The author of the data predicts that within a few years the US will be utilising all of the waste tyres as well as drawing down on the huge waste tyre stockpiles. The percentage of tyres going to energy is 75% with the remaining tyres going to a variety of whole tyre and crumbed tyre uses.

Figure 7.2 shows the trends in the use of waste tyres in the UK. Here it is noted that the quantity of tyres going to material reuse (such as crumbing) has increased significantly between 1996 and 1999. Contrary to the US trend, energy recovery has declined and the disposal of tyres (both landfill and illegal) has increased.

Table 7.4 contains data for a number of countries, and indicates that energy recovery and landfill disposal account for the greatest destinations for waste tyres in most countries. Recycling is generally only 10% to 20% of the total.

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28 The exception to this is the US for which the estimate is 28%; this figure is considerably higher than other sources and so has been discounted.
Figure 7.2 Trends in waste tyre generation and use in the UK

---

Table 7.3  Estimated utilisation of waste tyres in the US market\(^{30}\) (millions of tyres\(^{31}\))

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement kilns</td>
<td>53</td>
<td>58</td>
</tr>
<tr>
<td>Pulp and paper</td>
<td>37</td>
<td>39</td>
</tr>
<tr>
<td>Utility boilers</td>
<td>32</td>
<td>36</td>
</tr>
<tr>
<td>Dedicated tyres to energy</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Industrial boilers</td>
<td>23</td>
<td>25</td>
</tr>
<tr>
<td>Resource recovery facilities</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Lime kilns</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Copper smelters</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Iron cupola foundries</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td>172</td>
<td>192</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Products</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Size reduced</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>C/S/P products</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Agricultural</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Export</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Miscellaneous uses</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td>56</td>
<td>63</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>228</td>
<td>255</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual Generation</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste as a % of market</td>
<td>84%</td>
<td>93%</td>
</tr>
<tr>
<td>Products as a % of waste</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>Energy as a % of waste</td>
<td>75%</td>
<td>75%</td>
</tr>
</tbody>
</table>

Table 7.4  Fate of waste tyres in selected countries\(^{32}\)

<table>
<thead>
<tr>
<th></th>
<th>France</th>
<th>Germany</th>
<th>Italy</th>
<th>UK</th>
<th>Belgium</th>
<th>Netherlands</th>
<th>Sweden</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retreading</td>
<td>20</td>
<td>17.5</td>
<td>22</td>
<td>31</td>
<td>20</td>
<td>60</td>
<td>5</td>
<td>–</td>
</tr>
<tr>
<td>Recycled</td>
<td>16</td>
<td>11.5</td>
<td>12</td>
<td>16</td>
<td>10</td>
<td>12</td>
<td>12.5</td>
<td>28</td>
</tr>
<tr>
<td>Energy</td>
<td>15</td>
<td>46.5</td>
<td>23</td>
<td>27</td>
<td>30</td>
<td>28</td>
<td>64</td>
<td>72</td>
</tr>
<tr>
<td>Landfill</td>
<td>45</td>
<td>4</td>
<td>40</td>
<td>23</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>–</td>
</tr>
<tr>
<td>Export</td>
<td>4</td>
<td>16</td>
<td>2</td>
<td>2.5</td>
<td>25</td>
<td>NA</td>
<td>7</td>
<td>–</td>
</tr>
</tbody>
</table>

\(^{30}\) Taken from Table 14-1 Snyder (1998).

\(^{31}\) It is not specified in the source if the number of tyres is reported on an EPU basis. As EPU is an Australian concept, the reported values are assumed to be number of tyres without differentiation by type.

\(^{32}\) Taken from Adhikari et al (2000).
Table 7.5  Fate of waste tyres in various countries

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>Japan</th>
<th>Germany</th>
<th>UK</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill/stockpile (%)</td>
<td>74</td>
<td>11</td>
<td>30</td>
<td>53</td>
<td>66</td>
</tr>
<tr>
<td>Energy recovery</td>
<td>7</td>
<td>35</td>
<td>37</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Retreading</td>
<td>12</td>
<td>12</td>
<td>19</td>
<td>19</td>
<td>27</td>
</tr>
<tr>
<td>Crumbed</td>
<td>2</td>
<td>22</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Export</td>
<td>4</td>
<td>22</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other uses</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Estimated annual volume (millions of tyres)</td>
<td>300</td>
<td>70</td>
<td>40</td>
<td>30</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: ANZECC Taskforce report on ‘Water Lubricating Oil, Used Motor Vehicle Tyres, Recycling and Re-Use” 1990. Practices and volumes may have since changed.

As has been found with Australia, the data on waste tyres in other countries contain many inconsistencies and it is difficult to draw conclusions on what is actually occurring and what are the drivers for change. Based on available information, it appears that in both Europe and the US uses for waste tyre derived products have expanded rapidly following the recognition of the problems associated with waste tyres and the introduction of a coordinated approach to dealing with the problems. While use of crumb rubber has expanded, the greatest growth appears to have occurred in energy recovery. It is of interest to note that most countries do not explicitly differentiate between the ‘value’ derived from energy recovery, material reuse (such as crumbing) and retreading as appropriate solutions to dealing with waste tyres.

In respect of other rubber products there is little published information from other countries and the programs focused on tyre waste do not appear to extend to other rubber products.

India provides a contrast to the state of play in the US and Europe. India has a large tyre market both for internal use (in the original equipment and replacement markets) and for export. In respect of waste tyre utilisation, all tyres are recovered and India is the only country that has appreciable rubber reclaiming operations. The structure and performance of the tyre industry in India is based on low labour costs and a high demand for rubber, well above local supply, to support both local and export industries.

7.7 Flows of tyres and other rubber products in Australia

The total consumption of rubber in Australia is estimated to be in the range of 150,000 to 200,000 tonnes per year. As discussed above, tyres make up 50% of the total consumption of rubber, and account for the greater part of the waste rubber ‘problem’.

The only other rubber-based products with an identified waste management issue are conveyor belts. Despite the obvious differences in physical characteristics and applications, conveyor belts are in many ways similar in structure and composition to tyres, consisting of a rubber matrix surrounding fabric and/or steel reinforcing. The use of conveyor belts is almost exclusively at mines or in industrial processes. Discussions with industry representatives suggest that waste conveyor belts are either used in applications such as, for example, protecting truck bodies or strips in cattle

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33 As reported in ACIL (2000).
yards, or are disposed on site. The management of waste conveyor belts is reported to be a problem for some companies and sites but the overall quantity is considerably less than the quantity of tyres. There appear to be opportunities to incorporate conveyor belts in waste tyre management programs. However, as with OTR tyres, the opportunities are limited in view of engineering or economic considerations due to the physical nature of the product and the typically remote source of the waste.

Estimates of the flow of tyres for each of the major tyre segments are shown in Figure 7.3 to Figure 7.6.

For each of the tyre flow diagrams the inputs to the tyre market in Australia are shown on the left, including imported new (and used) tyres, locally manufactured tyres and tyres on locally produced or imported vehicles. The centre of the diagram shows the flows within Australia. In practice, the flows are much more complex than shown here so the diagram is only an approximation. The right hand side of the diagram shows the tyres that are exported from Australia, including those on locally produced vehicles. The bottom of the diagram shows the final fate of waste tyres. Note that all values in the figures are number of tyres not EPU. The exception is the diagram for OTR, which is expressed in tonnes.

Estimates for the number of tyres used in agriculture are not included due to the lack of reliable statistics. The situation with on-farm tyres may, in many respects, mirror that of mine sites in that farmers are likely to find the costs associated with collection and return of tyres excessive, and the waste tyres may be put to use around the farm. While the number of tyres in use in agriculture at any time is expected to be substantial, the rate at which these become waste will be relatively low, in view of the lower overall usage rates and less punishing conditions under which they operate compared with mines. In view of the diverse nature of the problem due to the large number of agricultural properties, effective policy initiatives will be difficult to design. This report has largely ignored tyres used in agricultural.

In addition, tyres for motorcycles and bicycles and other minor types, such as solid tyres and tyres for wheelbarrows and similar, have not been covered but this has little significance on the analysis as the annual waste quantity of these tyres is expected to be relatively low.
Figure 7.3  Estimated number of passenger tyres in Australia  
- year 2000 (numbers of tyres)
Figure 7.4  Estimated number of light commercial tyres - year 2000 (numbers of tyres)
Figure 7.5  Estimated number of truck and bus tyres - year 2000 (numbers of tyres)
Figure 7.6  Estimated mass of off-the-road (OTR) and agricultural tyres - year 2000 (tonnes)
7.8 Australian waste tyre quantities and fate

The estimated number of waste tyres generated annually (excluding those retreaded) in Australia is 18 million EPU. The breakdowns by use and by fate of tyres are shown in Figure 7.7 and Figure 7.8 respectively.

![Figure 7.7 Estimated breakdown of the number of waste tyres](image)

![Figure 7.8 Estimated breakdown of the fate of waste tyres](image)
In the above figures inappropriate disposal includes illegal dumping of tyres and tyre disposal or storage which, while not technically illegal, is not considered appropriate due to the expected environmental or related impacts and/or loss of resource. For the purposes of this report all interstate transfers are assumed to go to landfill. In addition to these transfers there are interstate transfers of tyre casings, which are not shown in the previous figures.

### 7.9 State and Territory waste tyre quantities and fate

Estimates for the breakdown of the types of waste tyres generated and of the fate of the tyres for each State and Territory are presented in Table 7.6. The estimates are based on a wide range of sources and the uncertainty in the figures is considered to be at least ±20%. The values in the table are presented graphically in Figure 7.9.

#### Table 7.6 Quantity of tyres generated by state and estimated fate for the year 2000

<table>
<thead>
<tr>
<th>Number of waste tyres (millions of EPU)</th>
<th>Keya</th>
<th>NSW</th>
<th>VIC</th>
<th>QLD</th>
<th>WA</th>
<th>SA</th>
<th>TAS</th>
<th>NT</th>
<th>ACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger</td>
<td>P</td>
<td>3.27</td>
<td>2.41</td>
<td>1.79</td>
<td>0.95</td>
<td>0.76</td>
<td>0.24</td>
<td>0.10</td>
<td>0.16</td>
</tr>
<tr>
<td>Light commercial</td>
<td>LC</td>
<td>1.48</td>
<td>1.08</td>
<td>0.81</td>
<td>0.43</td>
<td>0.34</td>
<td>0.11</td>
<td>0.04</td>
<td>0.07</td>
</tr>
<tr>
<td>Truck and bus</td>
<td>TB</td>
<td>0.94</td>
<td>0.69</td>
<td>0.52</td>
<td>0.22</td>
<td>0.22</td>
<td>0.07</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td>OTR and other</td>
<td>OTR&amp;O</td>
<td>0.5</td>
<td>0.3</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.03</td>
<td>0.01</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>18.12</td>
<td>6.15</td>
<td>4.52</td>
<td>3.37</td>
<td>1.73</td>
<td>1.43</td>
<td>0.45</td>
<td>0.30</td>
</tr>
</tbody>
</table>

#### Fate of waste tyres - excluding retreads

<table>
<thead>
<tr>
<th>Fate of waste tyres</th>
<th>Keya</th>
<th>NSW</th>
<th>VIC</th>
<th>QLD</th>
<th>WA</th>
<th>SA</th>
<th>TAS</th>
<th>NT</th>
<th>ACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy recovery</td>
<td>ER</td>
<td>-</td>
<td>75%</td>
<td>20%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Inappropriate disposal</td>
<td>ID</td>
<td>25%</td>
<td>-</td>
<td>15%</td>
<td>15%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Landfill</td>
<td>L</td>
<td>68%</td>
<td>13%</td>
<td>55%</td>
<td>80%</td>
<td>91%</td>
<td>100%</td>
<td>100%</td>
<td>33%</td>
</tr>
<tr>
<td>Other uses</td>
<td>OU</td>
<td>2%</td>
<td>5%</td>
<td>5%</td>
<td>3%</td>
<td>2%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Recycled</td>
<td>R</td>
<td>5%</td>
<td>7%</td>
<td>5%</td>
<td>2%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Interstate transfers</td>
<td>ST</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7%</td>
<td>-</td>
<td>-</td>
<td>67%</td>
</tr>
</tbody>
</table>

#### Notes:

- Rounding accounts for totals not appearing to add up. The number of decimal places quoted is a measure of our confidence in the estimate.

(a) The key for fate of tyres is used in the graphs below.

(b) In the absence of relevant information, we have not included estimates of inappropriate disposal for SA, Tasmania, NT and the ACT.

(c) Interstate transfers refer to the State or Territory of origin. Some interstate transfers are tracked but many are not, such as exports from the ACT. It is suspected that there are significant numbers of untracked interstate movements of tyres but in the absence of information these cells in the table have been left blank.
The entries in Table 7.6 do not include rubber products other than tyres, but some non-quantitative observations are made later.

It should be noted that the mining industry generates less than 1% of the waste tyres in Australia but because of the large size of many of the tyres this constitutes 15% of the total waste rubber from tyres. While some reuse is reported to occur for these tyres (such as in the goldfields of WA), it is believed that the great majority are disposed on site due to the costs and difficulty of alternative disposal options.

The salient features from the reported statistics include:

- Estimates for the quantity of waste tyres generated in each State and Territory are closely aligned to the population and vehicle ownership levels.

- The data do not fully reflect interstate transfers of waste tyres. Several sources have suggested that these transfers are quite significant and this distorts the magnitude of the waste tyre management task in some States. Examples include tyres sent from South Australia for energy recovery in Victoria, interstate transport of tyre casings for retreading (for example from Tasmania to the mainland), and situations where there are substantial concentrations of population near a border.

- With the exception of Victoria, landfill is by far the largest ultimate fate of waste tyres in all States and Territories. Energy recovery is dominant in Victoria and to a lesser extent Queensland. Illegal/inappropriate disposal is reported to be significant in most of the States.

- Recycling of tyres accounts for only a small proportion of the total waste tyres generated.

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34 Corbett (1999).
A National Approach to Waste Tyres

Part 1 Background

Figure 7.9  The estimated number of waste tyres generated and their fate in the States and Territories of Australia
7.10 Trends and future issues for tyres

The data on the rate of generation of waste tyres in Australia are incomplete and gaps are detailed above. The availability of time series information, in particular, is limited and the analysis of trends presented below has relied on indirect methods using parameters for which data and projections are available.

For tyres the most straightforward approach is to base predictions of waste generation on tyre usage, as measured by the number and type of vehicles and the distance travelled. Using these primary factors it is possible to predict the number of waste tyres generated using a model that takes into account:

- vehicle type (which determines type of tyre and number of tyres);
- average distance travelled;
- usage factors such as maintenance, tyre pressure and in service use;
- design life of the tyre in km; and
- the proportion of tyres that are retreaded and the number of times that a tyre can be retreaded.

Forecasts for the number of waste tyres generated in the future, based on our best understanding of these factors, are presented in Figure 7.10.

![Figure 7.10](image-url)

**Figure 7.10** Preliminary estimates of the trend over time in the number of waste tyres generated in Australia

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Note that the graph shows passenger, light commercial and truck and bus tyres only. Total estimated EPU in the figure are therefore lower than 18 million EPU due primarily to the exclusion of OTR and agricultural tyres.
The net increase in the generation rate of waste tyres is forecast to be approximately 2% per year, driven by increases in population, vehicle ownership and distance travelled, assuming constant retreading rates and tyre design life. By the year 2010, the number of waste tyres is forecast to be in excess of 20 million, from the current level of 18 million.

The rate of retreading has a significant impact on waste tyre generation. In the forecasts above it has been assumed that the current rate of retreading for passenger tyres is 20% and that this remains constant over the prediction period. It has been indicated by a number of parties that retreading is declining. Every 1% decrease in the rate of passenger tyre retreading results in an increase of approximately 1% in the rate that waste passenger tyres are produced. For truck tyres the impact is more significant because they are retreaded more than once so that a 1% decrease in the rate of retreading results in a 2% increase in the rate that waste truck tyre are generated.

One factor that influences waste tyre generation rates that is not taken into consideration is the lag between when a tyre is fitted to a vehicle and when it is scrapped. A passenger tyre is assumed to have an average design life of 50,000 to 60,000 km. This is reduced by 10% to account for usage and maintenance factors which, in combination with the retreading rate, results in an apparent life of the average passenger tyre of about 56,000 km. At an average distance travelled of 15,000 km per year the life of a tyre is estimated to be between 4 and 5 years. For truck and bus tyres the average life is 6 to 7 years due to longer design life and multiple retreadings. Accordingly, the estimate for the generation rate for waste tyres (as calculated above) is actually a prediction for the number of waste tyres that will be produced several years in the future. This factor introduces an error of between 5% and 14% in the predicted waste tyre generation rate. However, as the overall accuracy of the estimates from the model is probably of the order of ±10 to 20%, due to uncertainties in the values of the modelling parameters, this simplification is considered to have only a relatively minor effect on the interpretation of the results.

Applying the per person generation rates derived from the above model to the relevant population statistics, it is possible to estimate the number of waste tyres that are produced in urban and country regions in the various States and Territories for the major vehicle/tyre types, as listed in Table 7.7. The figures computed from this process are acceptably close to the estimates provided by the various State agencies and other sources as listed in Table 7.6, confirming the validity of the model.

Urban includes both capital cities and major regional cities. It is estimated that over 65% of tyres are generated in major urban centres. ABS vehicle usage statistics estimate that 54% of the total kilometres travelled in Australia occurs in capital cities, which can be related directly to the generation rates for waste tyres.

36 ABS (2000), Document No 9208 Survey of Motor Vehicle Use in Australia
Table 7.7 Model estimates for number of waste tyres for Australian States and Territories disaggregated by urban and country regions nominally for the year 2000\(^{37}\)

<table>
<thead>
<tr>
<th>Number of tyres</th>
<th>ACT</th>
<th>NSW</th>
<th>NT</th>
<th>QLD</th>
<th>SA</th>
<th>TAS</th>
<th>VIC</th>
<th>WA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urban</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger</td>
<td>158,431</td>
<td>1,853,086</td>
<td>35,651</td>
<td>1,189,043</td>
<td>556,763</td>
<td>125,509</td>
<td>1,838,234</td>
<td>611,095</td>
</tr>
<tr>
<td>Light commercial</td>
<td>35,708</td>
<td>417,657</td>
<td>8,035</td>
<td>267,992</td>
<td>125,486</td>
<td>28,288</td>
<td>414,310</td>
<td>137,731</td>
</tr>
<tr>
<td>Truck and bus</td>
<td>9,103</td>
<td>106,472</td>
<td>2,048</td>
<td>68,319</td>
<td>31,990</td>
<td>7,211</td>
<td>105,619</td>
<td>35,112</td>
</tr>
<tr>
<td>Total (EPU)</td>
<td>275,362</td>
<td>3,220,761</td>
<td>61,963</td>
<td>2,066,620</td>
<td>967,684</td>
<td>218,141</td>
<td>3,194,948</td>
<td>1,062,115</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger</td>
<td>0</td>
<td>1,421,898</td>
<td>62,870</td>
<td>605,012</td>
<td>205,875</td>
<td>114,693</td>
<td>568,669</td>
<td>339,482</td>
</tr>
<tr>
<td>Light commercial</td>
<td>0</td>
<td>320,474</td>
<td>14,170</td>
<td>136,360</td>
<td>46,401</td>
<td>25,850</td>
<td>128,169</td>
<td>76,514</td>
</tr>
<tr>
<td>Truck and bus</td>
<td>0</td>
<td>81,698</td>
<td>3,612</td>
<td>34,762</td>
<td>11,829</td>
<td>6,590</td>
<td>32,674</td>
<td>19,506</td>
</tr>
<tr>
<td>Total (EPU)</td>
<td>0</td>
<td>2,471,334</td>
<td>109,272</td>
<td>1,051,544</td>
<td>357,822</td>
<td>199,342</td>
<td>988,376</td>
<td>590,038</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EPU based % of total</th>
<th>ACT</th>
<th>NSW</th>
<th>NT</th>
<th>QLD</th>
<th>SA</th>
<th>TAS</th>
<th>VIC</th>
<th>WA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urban</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger</td>
<td>0.9%</td>
<td>11.0%</td>
<td>0.2%</td>
<td>7.1%</td>
<td>3.3%</td>
<td>0.7%</td>
<td>10.9%</td>
<td>3.6%</td>
</tr>
<tr>
<td>Light commercial</td>
<td>0.4%</td>
<td>5.0%</td>
<td>0.1%</td>
<td>3.2%</td>
<td>1.5%</td>
<td>0.3%</td>
<td>4.9%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Truck and bus</td>
<td>0.3%</td>
<td>3.2%</td>
<td>0.1%</td>
<td>2.0%</td>
<td>1.0%</td>
<td>0.2%</td>
<td>3.1%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Sub total</td>
<td>1.6%</td>
<td>19.1%</td>
<td>0.4%</td>
<td>12.3%</td>
<td>5.7%</td>
<td>1.3%</td>
<td>19.0%</td>
<td>6.3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger</td>
<td>0.0%</td>
<td>8.4%</td>
<td>0.4%</td>
<td>3.6%</td>
<td>1.2%</td>
<td>0.7%</td>
<td>3.4%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Light commercial</td>
<td>0.0%</td>
<td>3.8%</td>
<td>0.2%</td>
<td>1.6%</td>
<td>0.6%</td>
<td>0.3%</td>
<td>1.5%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Truck and bus</td>
<td>0.0%</td>
<td>2.4%</td>
<td>0.1%</td>
<td>1.0%</td>
<td>0.4%</td>
<td>0.2%</td>
<td>1.0%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Sub total</td>
<td>0.0%</td>
<td>14.7%</td>
<td>0.6%</td>
<td>6.2%</td>
<td>2.1%</td>
<td>1.2%</td>
<td>5.9%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Total</td>
<td>1.6%</td>
<td>33.8%</td>
<td>1.0%</td>
<td>18.5%</td>
<td>7.9%</td>
<td>2.5%</td>
<td>24.8%</td>
<td>9.8%</td>
</tr>
</tbody>
</table>

Using road transport statistics it is also possible to make estimates of the contribution that each individual travel purpose makes towards generating waste tyres. For passenger tyres the distance travelled for each activity can be assumed to be directly proportional to the number of waste tyres generated. According to ABS statistics, 51% of total passenger car distance travelled is for private use, 24% is for travel to and from work and 25% is work/business related.

\(^{37}\) Columns do not sum directly as the values for the tyres are number are number of tyres and the total is in EPU (Equivalent Passenger Units). To calculate the total multiply the number of tyres by the EPU for each tyre type.
Similar breakdowns are not possible for trucks, but it is of interest to make a comparison of the transport task (freight carried) with the estimated number of waste tyres generated for different truck types, as listed in Table 7.8.

Table 7.8  Relationship between the number of tyres generated and transport task for different truck types

<table>
<thead>
<tr>
<th>Truck Type</th>
<th>Million tonne km</th>
<th>Total waste tyres generated</th>
<th>% of total waste tyres</th>
<th>Tyres/ million tonne km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articulated</td>
<td>99,303</td>
<td>385,619</td>
<td>19%</td>
<td>4</td>
</tr>
<tr>
<td>Rigid truck</td>
<td>22,916</td>
<td>184,013</td>
<td>9%</td>
<td>8</td>
</tr>
<tr>
<td>Light commercials</td>
<td>5092</td>
<td>1,480,657</td>
<td>72%</td>
<td>291</td>
</tr>
</tbody>
</table>

The high value for light commercials vehicles in Table 7.8 is, in part, due to the fact that a significant proportion of the light commercial fleet do not carry freight. Nevertheless, the ‘tyre efficiency’ is related strongly to the higher general efficiency of executing the transport task by larger vehicles.

Of the total distance travelled, 54% was in the capital city of the State/Territory in which the vehicle was registered and again this can be assumed to relate directly to the percentage of tyres generated.

Based on this analysis it is possible to derive an overall breakdown of the total number of tyres generated in different areas as a proportion of the total number, as summarised below. This analysis is restricted to the tyre types listed in Table 7.7, such that:

- 37% of all tyres are passenger tyres in major urban centres and a further 20% are passenger tyres in country areas;
- nearly 30% of all tyres are truck, bus and light commercial tyres in major urban centres and a further 15% within these categories are in country areas; and
- nearly 70% of all waste tyres are generated in major urban areas.

7.11 Effect on trends in waste tyres due to changes in the types of vehicles

Over the past several years there has been an increasing number of smaller vehicles. This does not affect the number of waste tyres generated but does affect the characteristics of the waste tyres. Smaller vehicles have smaller tyres that weigh less and contain less rubber and other materials (a small passenger tyre may weigh 2 or 3 kg less than a standard 9.5 kg tyre). Smaller (whole) tyres do not occupy a proportionally smaller volume and still require a comparable level of handling as a larger tyre. The significance of the trend to smaller vehicles to tyre recyclers is not clear, except that they will essentially face a reduced material return for a similar effort. In extreme cases it could result in price differentials for waste tyres within the passenger tyre category, or possibly selective exclusion of small tyres from recycling.
8 Practices for Managing Waste Tyres

This section provides an overview of the methods that are available to manage waste tyres. The term *practices* in the heading refers to the actual (physical or engineering) processes that waste tyres undergo (including disposal to landfill); that is, the term relates to the technology employed. The term *option* in this report is reserved for activities under the general umbrella of policies, strategies and frameworks that might be considered by governments or industry to promote a greater uptake of certain practices.

8.1 The waste management hierarchy

A concept that has been adopted widely to assist in assessing and prioritising practices for dealing with waste is the *waste management hierarchy*. The waste management hierarchy provides a framework within which different practices for managing waste are listed in order of preference. A commonly used form of the waste management hierarchy is given below:

```
Eliminate
Reduce
Reuse
Recycle
Dispose
```

For the purpose of the discussion in this report, the waste management hierarchy has been adapted as follows in accordance with other authors in this area:

```
Avoid
Reuse
Recycle
Waste to energy
Dispose
```

The concept of the waste management hierarchy should be considered as providing broad guidance only and the ordering above is not intended to convey a preference for individual waste tyre management practices. This study takes the position that decisions need to be made on the results of soundly based assessments of individual practices on a case by case basis taking into consideration option-specific factors. Some of the issues that may need to be considered have been discussed in Section 6.

Currently, by far the most widely used practice is disposal to landfill (as well as illegal dumping), followed by retreading (which can be considered a form of reuse) and waste to energy. Aside from disposal, waste to energy is the only option that provides an immediate large-scale solution.

8.2 General operational requirements

Before discussing individual practices for the end-point or fate of a waste tyre, it is worthwhile to review the major activities that are an integral part of the management chain for a waste tyre to arrive at whatever end-point.

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8.2.1 **Collection, transport and storage**

Collection, transport and (where appropriate) intermediate storage are very significant components in the management of waste tyres. Regardless of the ultimate fate of a waste tyre, arrangements have to be put in place for its collection and transport. The costs, difficulties and other factors associated with this part of the waste tyre chain have a direct bearing on the opportunities and viability for the various use, processing and disposal practices that may be considered. It is also noted that this stage of the waste management chain is perhaps the most critical in terms of the level of illegal or inappropriate disposal.

It is worth observing at this point that not all waste tyres are ‘generated’ at tyre retail outlets. Operators of large fleets may obtain their tyres through wholesalers and make their own arrangements for the disposal of waste tyres generated by their operations. A fleet owner who contracts for the disposal of waste tyres directly with a tyre collector assumes much the same role as the tyre dealer in the more common situation. Conversely, a fleet owner who manages waste tyres directly become in effect the tyre collector (in the case of disposal to a remote site) or receival facility (in the case of on-site management). In either case, it would appear that there are no special issues from a regulatory or policy point of view. However, the economies of scale and other considerations may open up opportunities for innovative management solutions. In any case, advice from the trucking industry is that the aggregate number of waste tyres managed directly by the tyre owner is likely to be small in relation to the totals for a State or Territory.

Pick-up costs are largely independent of the ultimate fate of waste tyres, so are not likely to influence decisions as to which management practices to adopt. Transport costs, on the other hand, effectively define a catchment region for a particular waste tyre receival facility. The magnitude of transport costs for tyres generated outside the catchment preclude transport to the facility on a commercial basis, depending on the gate fee/payment at the receival facility. On the other hand, pickup and transport costs are usually quoted as one price, and market considerations may result in some cross subsidisation in cases where a contractor offers a discount to secure business.

8.2.2 **Shredding**

For this report, the term *shredding* is defined as the processing of the tyre into more useable shapes or sizes but does not generally involve separation of the material components (rubber, steel, fabric). Shredding is also taken to include cutting of large (typically OTR) tyres into manageable sections using hydraulic ‘jaws’ (similar to those used for scrap steel cutting) and guillotines. The distinction between shredding and crumbing (discussed below) is somewhat blurred particularly, for larger crumb particle sizes.

A wide variety of different types of shredding equipment is available including locally manufactured and overseas equipment. Mobile units have been developed but the extent of their use in Australia is uncertain, although apparently limited. The primary application of shredding in Australia appears to be for volume reduction prior to landfill. Some shredded rubber is used in products such as ‘soft fall’ in playgrounds.

The technology and experience in operation of shredding equipment is well established and there continues to be further development to produce equipment with improved operational and economic characteristics. Capital costs for a shredder capable of processing around 250,000 tyres per year are reported to be of the order of $0.5 to $1 million. Reported costs for shredding tyres vary, perhaps due to differences in the specification for the end product, but appear to fall in the range $0.40 to $0.60 per passenger tyre (although anecdotal evidence suggests that it may be as high as $2.00 in some cases). Shredding equipment, because of steel in the tyres, is subject to breakdowns and high maintenance costs. Energy costs are quite high and the process generates noise and dust. The physical nature of tyres also results in the need for considerable manual handling to feed tyres into the machine.
It is estimated that approximately 100,000 tonnes of tyres are shredded in Australia each year, with the majority of this being prior to landfilling.

There is no commercial competition for shredding since it is generally an intermediate step in processing rather than a final product.

8.3 Waste avoidance

In the case of tyres, avoidance means reducing the rate at which waste tyres are generated. The means by which this can be achieved are to either reduce the distance travelled or extend the life of the tyre by decreasing the rate of wear. These issues are discussed in the following sections.

8.3.1 Reducing the distance travelled

Other things being equal, the generation rate for waste tyres is determined by the distance travelled. There is considerable pressure to reduce the level of road traffic for reasons not primarily associated with the generation of waste tyres, such as the costs of infrastructure to provide capacity to meet peak demand and environmental impacts including the greenhouse effect.

To a minor extent, changes to the type of vehicles can reduce the volume of waste associated with tyres or even the number of tyres.

8.3.2 Reducing the rate of wear

The design wear life of a good quality passenger tyre is currently in the order of 50,000 to 65,000 km while the wear life of a truck tyre is considerably longer, in the order of 150,000 km for a drive wheel and linger for a trailer wheel. The expected life of tyres has increased considerably over recent decades with the introduction of radial belted tyres and improvements in tyre manufacturing technology.

The life of road tyres should be considered in two separate parts:

*The tread.* When this reaches the wear limit – 1.6mm for a passenger tyre – the tyre reaches the end of its ‘first’ life.

*The casing.* A good casing can remain serviceable for a number of new treads. A good car tyre casing has a life of between 100,000 to 200,000 km while a good truck casing has a life of 650,000 to 750,000 km. Generally, a car tyre can only be retreaded once, but truck tyres are routinely retreaded up to five times.

Different tyres have different wear rates and tyres can be designed and manufactured so as to maximise life. However, the longer life may be at the expense of tyre performance in other areas such as ride/comfort, wet handling, dry handling, aquaplaning, noise and rolling resistance. For truck tyres, characteristics such as ride comfort may be deemed to be of lesser importance and are sacrificed in the interests of extended tyre life to a greater extent than is the case for passenger tyres.

Several sources have claimed that tyre life will continue to increase due to advances in tyre technology and also to improved road conditions. A counter to these claims is the introduction to the tyre market of so called ‘cheap’ imports that have a lower life expectancy. Overall, recent increases in the life expectancy of tyres do not appear to have matched earlier gains, and predictions that tyres will last for the life of the vehicle remain remote.

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39 For example small car tyres weigh less than a large car tyre and a B-double truck has 34 tyres and carries nearly twice the weight/volume of a standard semi-trailer which has 18 to 22 tyres.
The expected or design life of a tyre does not appear to be a factor in marketing of tyres in Australia. It is argued that availability of information on tyre life and other factors such as rolling resistance would help inform purchasing decisions that would favour longer life tyres over ‘cheap’ alternatives and perhaps promote the development and introduction of longer life tyres. The US has a tyre rating scheme in place to these ends, which is discussed above in Section 4.1.1.

Differences in expected tyre life across individual tyre models are in many cases dwarfed by the in-use variation due to factors such as driving behaviour (particularly speed and the severity of acceleration, braking and cornering), loads carried and abuse/damage, tyre maintenance, and the road conditions.

The effect of tyre maintenance or, as appears to be more often the case, lack of maintenance provides perhaps the best opportunity for reducing the quantity of waste tyres generated. Tyre maintenance includes maintaining appropriate pressure, tyre rotation and maintaining correct wheel alignment. Tyre pressure in particular is an area that could be significantly improved. The effect of incorrect tyre pressure (typically low pressure) is shown in Figure 8.1.

![Figure 8.1 Effect of low pressure on tyre life](image.png)

By applying the relationship in Figure 8.1 to the entire passenger vehicle fleet using the NRMA survey of tyres in Part II Table 3.1, the generation rate for waste tyres is estimated to be approximately 6% higher than if correct tyre pressures were maintained.

Despite clear instructions in owner’s manuals, tyre pressure guide stickers in the driver’s door jamb, and offers of free servicing and maintenance plans by tyre retailers, tyre maintenance appears to remain a low priority for many vehicle owners. A number of factors, such as the increase in self-serve petrol stations with limited access to tyre pressure hoses and the exceptional durability of tyres that seem to be able to absorb almost any amount of neglect and abuse, all contribute to poor maintenance.

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Based on OECD (1980)
The benefits of improved tyre maintenance are not restricted to extended tyre life but also include reduced fuel consumption and improved safety. These factors are potentially more beneficial to the environment and economy than longer tyre life and reductions in waste tyre generation and are worthwhile regardless of the waste tyre issue.

Increased public awareness of the issue and of the benefits of improved tyre maintenance is obviously an important approach to ‘avoiding’ the waste tyre management problem. Access to resources, such as accurate tyre pressure gauges and pumps and use of tyre valves that can indicate when the tyre pressure is low, are some of the other potential options. Finally, incorporating tyre maintenance and rotation in the periodic mechanical servicing of cars would also improve the tyre life.

8.4 Reuse

8.4.1 Used tyres

Used (partly worn) tyres can and are reused without further treatment. Sources of used tyres include:

- tyres fitted to second-hand vehicles that are sold and from vehicles that are scrapped;
- old (out of date) tyres that are used for less demanding applications such as on trailers; and
- tyres that are exchanged for reasons other than that the tyres have reached the end of their life, such as fitting a set of high performance tyres or different wheels.

It could be argued that these used tyres do not fit within the definition of waste since they will continue to be used for their original purpose (as a tyre) even though they are no longer on the original vehicle. The continued ability to meet their design function is determined by safety considerations and personal taste rather than waste reduction objectives. A major sink for worn tyres is used car saleyards. The aggregate number of tyres involved is relatively small and the current informal arrangements deal with these tyres in a satisfactory way. It is considered that they do not warrant special waste policy attention.

In addition, used tyres are imported into Australia at the rate of 500,000 per year, and Australia exports approximately 350,000 used tyres annually, based on ABS figures. It has not been possible to obtain estimates of the breakdown of used tyre imports. Further, it would appear that imports of used tyres are misreported to a significant extent and even the aggregate estimates may understate the actual numbers. It is known that there is a legitimate trade in truck and bus casing imports for retreading. However, frequent comments have been received from industry and government representatives that a significant number of imported used passenger tyres have little (or no) useable tread left, do not meet Australian safety requirements or are unsuitable for retreading. Some tyres are in such poor condition that they are disposed of immediately on arrival in Australia, and anecdotal evidence suggests that the numbers are significant.

The implications for this study are that tyres with little or no residual useful life are entering the country and adding to the waste tyre management problem, but there is no robust estimate of the significance of the consequent impacts.

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41 The shelf life of tyres is in fact limited and tyres suffer degradation and embrittlement with age even if not in use, so that after several years they are no longer suitable for ‘new’ tyre applications.
Overall, the reuse of tyres is a small but valuable means of ensuring that the maximum possible life is derived from the majority of tyres. Poor practices in relation to imports of tyres may be giving this aspect of the industry an undeservedly poor reputation.

8.4.2 Retreading

Of rather more importance than the direct reuse of partly worn tyres is retreading. Retreading is a general term that includes a range of technologies to replace the wearing surface of the tyre. The types of retreading are discussed in Table 8.1.

Of all the beneficial uses of waste tyres, retreading has the potential to extract the greatest value. The process of retreading involves the removal of the residual tread (which has no further value in relation to the tyre function) while retaining the full value of the casing. Casings do not wear out due to friction, as with the tread, but are subject to fatigue, which ultimately renders the casing unserviceable, and also suffer from traumatic damage due to impacts. It is of interest to note that due to the smaller diameter a passenger tyre is subject to more deflections per unit of distance and will therefore suffer fatigue failure/damage at a greater rate than does a truck or bus casing. This is one of the reasons that truck tyres tend to be able to be retreaded more often than passenger tyres.

About 450,000 truck tyres are retreaded each year and about 50 to 70% of all new truck tyres are suitable for retreading when their tread is worn to below legal limits. Prices for retreaded tyres are about 20% less than those for the cheapest new tyres though the price differential varies considerably. Many truck operators utilise a lower cost option by retreading their own casings, and this saves about 30% of the retreading cost.

About 1 million passenger tyres are retreaded each year and one of the major users is reported to be taxis.

<table>
<thead>
<tr>
<th>Table 8.1</th>
<th>Methods used in retreading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold capping</td>
<td>A pre-formed new ‘tread’ is bonded to a prepared casing. The tread can be either a strip, which is joined to the tyre, or a ‘ring’, which is stretched over the casing.</td>
</tr>
<tr>
<td>Hot capping</td>
<td>A new ‘tread’ is remoulded by placing a prepared casing in a mould with new rubber compound. This is then heated under pressure causing the new tread to vulcanise and bond to the casing.</td>
</tr>
<tr>
<td>Remoulding</td>
<td>Similar to hot capping but involves resurfacing the tyre from ‘bead to bead’ including a veneer on the sidewalls</td>
</tr>
</tbody>
</table>

All retreads fitted to vehicles are required to comply with the provisions in the Australian Standard AS 1973-1993: Pneumatic tyres – passenger car, light truck and truck/bus – Retreading and repair processes. However, anecdotal evidence suggests that the quality of retreads varies significantly, ranging from retreads which are to all intents and purposes of equal serviceability as a new tyre in relation to safety and life performance, through to inferior retreads perhaps on poor quality casings which do not meet AS 1973-1993.
While market acceptance is a major barrier (at least in the case of passenger tyres) to an enhanced rate of retreading, consultation with industry representatives suggest that the greatest constraint is the availability of suitable casings. Currently approximately 70% of truck tyres are suitable for retreading while only 15 to 20% of passenger tyres are suitable for retreading. The significant difference in the rates of retreading is due to differences in design and maintenance – truck tyres constitute a substantial proportion of the costs of operating a truck fleet and tend to be maintained to a much higher level than are passenger tyres.

While developments in tyre manufacturing technology have resulted in improvements in the life of tyres, the life of the casing appears to have followed the opposite trend, with evidence suggesting casing life is decreasing. Industry representatives have suggested that ‘cheap’ imported tyres are not generally suitable for retreading. It should also be noted that, increasingly, some locally produced tyres have also been identified as unsuitable for retreading.

Moreover, a number of older car models are fitted with tyres of dimensions that are no longer widely used on more recently produced vehicles. Casings of a size suitable for retreading on these older models (a major market for retreads) are consequently generated at much lower rates.

The type of retreading varies widely from region to region, as does the price, depending on the type and cost of tyre casings available, the capacity (both volume and type) of existing retreading facilities and the demand for certain tyre types. There seems to be a marked difference between the acceptance of truck retreads and passenger retreads by both customers and the tyre and transport industries. It has been remarked that the truck industry would find it difficult to survive without the availability of retreads - truck tyre casings are imported to meet the demand. Some new tyre dealers actually offer a guaranteed buy back price for the casing at the end of a tyre’s tread life.

On the other hand, passenger tyre retreads have limited acceptance. The uncertainty associated with retread quality suggests that the buyer would need to be ‘knowledgeable’, and this is a major reason why fleet owners have a high representation in the retread market. Tyre manufacturers have expressed concerns about their brand remaining on retreaded tyres in view of the association of their name with a possibly inferior product over which they have no control and the possibility of product liability implications.

8.5 Recycling

For tyres, recycling is the use of the materials in the waste tyres for different purposes, which may be, but are not necessarily, tyres themselves.

It is the very characteristics of rubber that makes it so suitable for use in tyres (strength, flexibility, chemical stability and durability) that is the source of much of the difficulties in recycling waste tyres. Rubber is vulcanised during manufacture and this process is effective in making rubber relatively inert and difficult to bond or combine with other substances.

For the purposes of this report the recycling practices have been structured along the lines of the preliminary process used to break the tyre down into an end or intermediate product. There is no particular objective basis for the approach adopted other than for convenience and other authors have adopted different structures. Figure 8.2 illustrates the range of recycling practices including energy recovery which is discussed in Section 8.6.

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42 Personal communication
8.5.1 **Crumbing**

Crumbing is the production of fine powder, granules or larger particles of rubber mostly associated with careful separation of the rubber from the steel and fabric components. The distinction between shredding and crumbing for larger particles is largely arbitrary. In this study, crumb is defined as rubber that is used as a raw material in subsequent product manufacture. Direct application of shredded rubber was discussed in Part I.8.2.2.

Several means of producing crumb have been developed including wet and dry grinding, high-pressure water sprays and freezing followed by crushing. Review of the literature and discussions with industry representatives point to several other new crumbing processes and it appears that this is quite an active area of research and development as part of continual attempts to improve the economics. In addition to dedicated crumbing processes a significant source of crumb is from retread ‘buffings’ – rubber removed from the tyre cases to prepare them for retreading or during finishing of the tyres after the retreads are applied. There are significant variations in the properties of rubber crumb sourced from each of these processes and, within limits, the properties can be tailored for specific end uses.

The process of making rubber crumb is quite capital intensive. Indicative up-front costs are up to $8 per tyre of annual capacity, and the economies of scale demand an operation processing a substantial number of tyres (no less than say 50,000 to 100,000 per year). The process is also energy and labour intensive and generates noise and dust.
The problems associated with crumbing waste tyres have been summarised as:

- separation of the tyre components into rubber, fibre and steel, if required for certain applications;
- production of components in a form that is suited to a specified market, has a significant market value and can be varied in accordance with market demand; and
- handling, transport and processing costs.

Nevertheless, there are substantial quantities of rubber crumb produced in Australia, and recent investments have resulted in significant increases in capacity. This trend is projected to continue into 2001, with further investments in NSW and Queensland. In addition, a Chinese delegation has shown interest in establishing a plant in Australia to make ultra-fine rubber crumb for which there is reported to be considerable demand world-wide, with a projected capacity of 1.5 million tyres per year.

Rubber crumb is traded internationally and Australia both imports and exports crumb. The current applications of rubber crumb in Australia and potential markets are listed in Table 8.2 and are discussed in more detail below.

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Table 8.2 Application and market potential of rubber crumb in Australia

<table>
<thead>
<tr>
<th>Application</th>
<th>Current market</th>
<th>Potential market</th>
<th>Barriers/issues</th>
</tr>
</thead>
</table>
| Roads               | Australia uses approximately 1,000t of crumb in roads each year. | The potential market for rubber crumb in roads is in the order of several hundred thousand tonnes per year, which significantly exceeds the available waste tyre supply. | As an aggregate, rubber competes with crushed rock that is less costly to produce and transport.  
Rocks that use substantial proportions of rubber are reported to have extended life but cost over twice as much.  
Rubber is reported to increase emissions if existing road materials are reused during resurfacing.  
Despite numerous studies it is likely that significant testing work over several years would be required before rubber would be used for road making in all States and Territories in Australia. |
| Moulded products    | There is a wide range of products made from rubber and synthetics where rubber crumb could be used. | The market potential is significant in the order of several million tonnes.       | Crumb must compete with other readily available fillers.  
Markets demand consistent quality and security of supply.                                                                                                                                                          |
| Paving products     | Use of rubber crumb in paving products, athletic tracks and equestrian arenas is increasing. |                                                                                 | Availability of consistent quality cost competitive crumb.  
Competition from existing products.                                                                                                                                                                              |
<table>
<thead>
<tr>
<th>Application</th>
<th>Current market</th>
<th>Potential market</th>
<th>Barriers/issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>New rubber products</td>
<td>Rubber crumb is added to rubber compound and subsequently into tyres and other rubber products.</td>
<td>At 2% addition to new tyres the potential annual consumption is about 4,000 tonnes. Consumption in other rubber products is of a similar magnitude.</td>
<td>Competition from natural and synthetic rubber, which have superior quality and security of supply.</td>
</tr>
<tr>
<td>Adhesives</td>
<td>Tile adhesive is reputedly one of the biggest users of rubber crumb, which is currently sourced from retread ‘buffings’.</td>
<td>No data have been obtained on this area.</td>
<td>This is an existing market and it is not clear how it would be influenced by the expansion of the crumb industry.</td>
</tr>
<tr>
<td>Loose</td>
<td>Predominantly ‘soft fall’ material in playgrounds.</td>
<td>Mulches, composting aids, aggregate absorption media, explosive stemming and drainage material.</td>
<td>Availability of suitable crumb and knowledge of applications.</td>
</tr>
</tbody>
</table>
The market value of crumb is determined by its size and purity. As a general rule, the costs of production for rubber crumb increase with decreasing particle size and increasing purity (removal of metal and fabric). Subsequent applications have varying requirements for size and purity.

Within each of the markets for rubber crumb products there are existing and potential competing products. Market penetration is limited due to factors such as price and market acceptance of reprocessed products. The ability of the Australian market to use the number of waste tyres generated annually is considered to be limited. In no country, with the exception of the special case of India, has the number of tyres used for rubber crumb yet exceeded 20% of the total waste tyre volume, though this should not be considered an inherent limitation. The current crumb market in Australia is only a few percent but has been described as ‘immature’ and based on international trends and current developments there is significant scope for expansion.

A wide variety of moulded products can be manufactured from rubber crumb including, mats, paving products, athletic tracks, posts and pipes. To make the products the crumb is bonded using a material such as polyurethane. In many applications much of the physical strength of the product comes from the bonding agent and the crumb acts just as filler. As vulcanised rubber is essentially inert, rubber crumb is referred to as ‘dead filler’ and does not contribute directly to the physical properties of the product. As a rule of thumb, the effect of adding an additional 1% of crumb is to weaken the product strength by 1%. The bonds between rubber crumb and other materials or objects (including other rubber crumb particles) are essentially physical rather than chemical in nature and this limits their strength. According to the CSIRO, the inability to bond rubber crumb to other products restricts the range of applications to low value products where strength requirements are not critical.

As a loose material rubber crumb has a number of applications and it is here that the distinction between crumb and shred becomes blurred. Applications include:

- ‘soft fall’ in children’s playgrounds;
- garden mulch;
- soil and aggregate augmentation (resists compaction);
- composting media;
- leachate drainage channels;
- oil and organic capture material; and
- explosives and explosive stemming.

As the requirements for particle size and purity of loose crumb are generally lower than is the case for other applications, this represents a lower cost application for waste rubber. Total use of loose rubber crumb in Australia is unknown though proposals have been put forward in all of the areas listed above.

One of the relatively recent applications in Australia is explosive stemming on mine sites and in quarries. Trials of rubber crumb have been described as very promising, both technically and economically. The potential for rubber crumb consumption is considerable. As an example, one mine quoted that it consumes in the order of 6,500 tonnes of stemming material per year. Savings could be achieved if the rubber is sourced from waste tyres generated on the mine site though the processing equipment

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44 Personal communication with CSIRO.

45 Stemming is the material that is placed on top of explosives in drilled blast holes to contain and direct the explosion. Blasting occurs regularly in many mines and quarries and involves drilling a series of holes into the material to be removed which are subsequently filled with explosives, ‘stemmed’ and then detonated to break up the material before removal by earth-moving equipment.
would then need to be brought to the mine. On the financial side, it is understood that this application would require a ‘gate fee’ of the order of $2.50 per tyre to make it competitive with the use of aggregate as a stemming agent. The down side is that the rubber crumb cannot be reused and essentially ends up being landfill in the mine, albeit in a widely dispersed manner and at very low overall concentrations.

The potential applications of rubber crumb in road construction include:

- as fill material;
- in asphalt (wet or dry);
- as a crack sealant; and
- in repair membranes

As a fill material, rubber has the advantage that it is lightweight which can reduce the costs of some civil structures particularly on slopes. The occurrence of fires in a number of such applications in the US has prompted concern over this application. Investigation of the fires suggests that while the tyres ultimately provided the fuel they were unlikely to be the source of ignition.

The use of rubber asphalt has been shown in tests to result in an increased economic life by a factor of two or more due to a number of reasons such as reduction in the occurrence of cracking, bleeding and ageing. The surface is also apparently more skid resistant and less noisy. The improved performance comes at a cost penalty multiple of two or three due not only to the higher cost of rubber crumb but also to increases in process time and new practices that are less suited to existing road making and repair equipment and outside the current experience of operators. Some of the techniques are patented and attract royalties, at least in the US. There are also concerns with increased emissions of air pollutants at the time when the road is refurbished by recycling the surface.

Crumb can be used in asphalt in, so called, wet or dry methods. It should be noted that these general terms cover a range of similar and proprietary processes, and various terminologies are used by different authors. In the wet method fine crumb is mixed with the asphalt prior to mixing with the aggregate. Here the crumb acts as a binder with the asphalt. In the dry method crumb of large and small sizes is blended with the hot aggregate just before it is blended with the asphalt. Here the crumb acts both as a binder (small particles) and as a flexible aggregate (large particles).

Crack seals and repair membranes utilise the flexibility of rubber to provide improved road maintenance performance.

In the US, some States have mandated minimum levels of waste tyre use in road works though there have been delays in implementing this due to legal challenges from the road construction industry. Despite this, considerable quantities of rubber crumb are used in US roads.

It is considered that there is significant scope for expansion in the use of rubber crumb in roads in Australia. Total usage of rubber crumb in roads is estimated to be in excess of 1,000 tonnes per year. Victoria reports that approximately 15% of new road surfaces use bitumen containing combined rubber (approximately 300 lane kilometres out of a total of 2,000 lane km) representing approximately 600 tonnes of crumbed rubber.

Australia’s sealed road network is over 320,000 km long, all of which needs periodic maintenance and repair and replacement. It is recognised however that the bulk of this network is ‘spray seal’ bitumen, a process not suited to the inclusion of rubber. The rates of application of rubber crumb in different uses are listed in Table 8.3. No direct statistics on the quantity of road works could be found, but a rough estimate of 5% replacement of roads per year (equivalent to a 20 year life) equates to over 700,000 tonnes of rubber, which is several times larger than the available waste tyre rubber supply.
As a further example, the lane widening as part of the proposed national highway project\textsuperscript{46} (ignoring town bypasses) represents approximately 4,500 lane km of new road. At a 3% addition the potential consumption of crumb is 80,000 tonnes or nearly 10 million tyres.

Table 8.3 Quantity of rubber used in different road applications

<table>
<thead>
<tr>
<th>Application</th>
<th>Rate of rubber use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt rubber crack sealant</td>
<td>0.2 kg rubber /kg</td>
</tr>
<tr>
<td>Asphalt rubber seal coat</td>
<td>0.6 kg rubber/m\textsuperscript{2}</td>
</tr>
<tr>
<td>Asphalt rubber stress absorbing membrane interlayers</td>
<td>0.6 kg rubber/m\textsuperscript{2}</td>
</tr>
<tr>
<td>Rubber modified asphalt</td>
<td>3% to 20%</td>
</tr>
</tbody>
</table>

Moving away from road applications, rubber crumb can be added to new rubber compound, which is the starting point for all rubber products. There are a plethora of compound recipes made up of mixes of natural and synthetic rubber and various additives and fillers. Several different compounds may be used in any one product. Rubber crumb replaces some of the natural or synthetic rubber and can both improve handling and some properties, such as wear resistance, while reducing others, such as strength. A few percent is routinely added to many compounds used in new tyres and retreads. In the US, Continental General Tire uses up to 6% of crumb in new passenger tyres\textsuperscript{47} and one US car manufacturer is reported to be making a car with tyres that contain 25% recycled content. With surface modification (as discussed below) it is potentially possible to use even higher proportions in tyres and other rubber products. Given that the market for rubber in Australia is of the order of 150,000 to 200,000 tonnes annually the scope for use of rubber crumb in ‘new’ rubber products is considerable.

8.5.2 Devulcanisation and surface treatment

In view of the limitations on end uses of rubber crumb, because of its low bonding strength, considerable effort has gone into developing chemical processes which reverse (in part at least) the vulcanisation of rubber, which is referred to as reclaiming, or in some way modify the surface of the rubber so that it is more easily bonded to other substances. Some of the major techniques that are available are listed in Table 8.4.

\textsuperscript{46} BTCE (1997).

\textsuperscript{47} Continental General Tire (1999).
Table 8.4  Summary of de-vulcanisation and surface treatment processes

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Devulcanisation</td>
<td>Devulcanisation is reported to be both energy intensive and utilises a range of chemicals that could harm the environment.</td>
</tr>
<tr>
<td>CSIRO process</td>
<td>CSIRO have developed a technique that allows the surface of rubber crumb to be modified so as to make it compatible with virtually any other substance. CSIRO are currently working with a number of companies to complete a demonstration trial and commercialise the process.</td>
</tr>
<tr>
<td>TyreRecycle</td>
<td>The process has been available for a number of years in the US and also in one plant in Australia. The process involves coating the rubber crumb with latex, which improves its adhesion to other materials.</td>
</tr>
<tr>
<td>Gas phase halogenation</td>
<td>US company Composite Particles has developed a gas phase halogenation process to oxidise the rubber surface which makes crumb suitable for a limited number of alternative applications.</td>
</tr>
</tbody>
</table>

Numerous other processes have been reported that use a variety of thermal, chemical and even microwave techniques to devulcanise rubber but few if any are used commercially.

Devulcanisation is not new. Prior to World War II it was widely practised, even by the major tyre companies. However, due to rubber shortages during the war, the subsequent development of synthetic rubber and competition from plastics for traditional markets, the economics of devulcanisation changed drastically such that it is now carried out in appreciable quantities only in India.\(^{48}\)

Since the recent commercial failure of an operation using a US proprietary process for surface treatment, there are currently no commercial examples of the use of this technology in Australia. However, CSIRO has been active in developing new products and processes and report that they have successfully addressed technological questions in regard to strength and other characteristics. They have joined EcoRecycle in developing markets.

The market for devulcanised and surface treated rubber is complementary to the market for rubber crumb, as overviewed above, and has the potential to increase the quantity of crumb that can be incorporated into products without adversely affecting properties.

### 8.5.3 Pyrolysis

Pyrolysis involves heating the tyre (usually shredded) in the absence of oxygen. The resulting thermal decomposition of tyres produces:

- carbon black (22%);
- oil (30%);
- gas (28%);
- steel (10%); and
- a small quantity of inorganic slag or ash (5%).

\(^{48}\) After Snyder (1998) and IRRDB.
The gas from the process is generated in sufficient quantities to meet the heating requirements for pyrolysis and little or no external energy is needed.

Markets exist for all of the products of pyrolysis but product quality limits the potential commercial values, as outlined in Table 8.5. Though there are reports of a number of pyrolysis plants operating around the world (none of which are in Australia), apparently none have been particularly successful and the economics of pyrolysis appear to be marginal. Further development is occurring which may shift the economics in the future to bring down costs and improve quality so as to be competitive with similar products made from virgin materials.

### Table 8.5 Market potential for some of the major products from pyrolysis

<table>
<thead>
<tr>
<th>Product</th>
<th>Market potential</th>
<th>Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Black</td>
<td>Carbon black is used in a wide variety of applications - one of the major users is the rubber industry. Tyres contain approximately 20% carbon black. The tyre industry in Australia consumes approximately 10,000 tonnes of carbon black which could be supplied from processing 40% to 50% of the waste tyres generated.</td>
<td>The value of carbon is determined by the purity and VOC content. Achieving the necessary quality standards at a competitive price is a limiting factor.</td>
</tr>
<tr>
<td>Oil</td>
<td>Pyrolysis oil is similar to diesel and can be used as a fuel. It is reported to be of value to the chemical industry because of its high aromatic content.</td>
<td></td>
</tr>
<tr>
<td>Steel</td>
<td>There is a large market for recyclable steel and the quantity routinely traded in Australia greatly exceeds the amount that could be produced from processing waste tyres.</td>
<td>The steel scrap from tyres contains a number of other metals which affect recycled steel quality. The ‘residuals’ present in tyre steel are likely to limit its value and saleability.</td>
</tr>
</tbody>
</table>

### 8.6 Energy recovery

Tyres have a relatively high specific energy content (slightly higher, when the steel is removed, than coal), which makes them a valuable fuel source. Worldwide, energy recovery makes up one of the largest end uses of waste tyres, particularly in the US. Tests suggest that the use of waste tyres as a substitute for coal results in lower emissions of oxides of nitrogen and sulphur, as well as greenhouse gases. Concerns regarding dioxins and furans need to be addressed by attention to furnace design and operation. In cement kilns (the only significant use of tyres as fuel in Australia), the long residence times and high temperatures are effective in reducing the organic compounds to carbon dioxide and water and any potentially harmful non-volatile residual materials are encapsulated in the cement product. In addition, the steel in tyres displaces the iron that is added as part of the standard cement product.

The energy recovery options and potential levels of use for waste tyres in Australia are listed in Table 8.6.

Currently approximately 14,000 tonnes of tyres are burnt in cement kilns in Victoria and 11,000 tonnes in Queensland, equivalent to a total of over 3 million EPU per year. Cement industry representatives indicate that they see considerable potential for
further applications for fuel from waste tyres. There is potential for three other cement plants to use tyres for energy and mineral recovery, bringing the total potential use of waste tyres by the cement industry to 75,000 tonnes per year or approximately 8 million EPU. The main requirements for further developments to proceed are:

- secure access to a steady and sufficiently large supply of waste tyres;
- support for tyre derived fuels in certain jurisdictions; and
- acceptance by the local community where the facility is located.

The competition for tyre derived fuel (TDF) comes from other fuels: energy requirements in cement kilns are currently met by fossil fuels (coal or natural gas). The burning of 11,000 tonnes of tyres annually as in Gladstone displaces a slightly higher quantity of coal, say 12,000 tonnes. At a price for delivery of coal to the plant of $25 per tonne, the annual avoided cost is $300,000. Operating costs are increased due to labour and maintenance requirements, and vary according to plant - use of tyres decreases productivity of a cement plant by 5-15 per cent. According to the cement industry, a cement plant needs to receive, on average, in the order of $0.80-$1.20 per tyre (EPU) at the gate for a feasible resource recovery operation. This is within the range of landfill gate fees for shredded tyres.

The cost for modifying the Geelong plant was reported to be $2.6 million in 1993 dollars, which at today’s prices would be over $3 million. The cement industry estimate that there is an additional $0.5 million upfront cost for trials and consultation.

A quick analysis suggests that total ‘income’ for an assumed throughput of 1.7 million tyres is $1.7 million (assuming a gate fee of $1 per tyre) plus $300,000 for avoided fuel costs, or a total of $2 million. The income has to cover the cost of capital, provide for depreciation and pay the additional operating and maintenance costs. For a plant with an expected life of ten years, the capital and depreciation charges are estimated to be somewhat less than $1 million per year.

In summary, the use of TDF in cement kilns appears to be an environmentally benign approach to the management of waste tyres (see section 6.4.3 above) and has the advantage of leaving no residue. The cement industry has the capacity to consume a substantial proportion of all the waste tyres generated in Australia. From an economic perspective, TDF appears to be competitive with landfill disposal costs, though Corbett (1999) notes the difference in effective gate fees between Victoria and Queensland.

There seem limited opportunities for costs to be reduced below the estimates given here, since the technology is well established. TDF is unlikely to become more attractive in the future unless there are increases in the real costs of the fuels that it displaces.

### 8.7 Whole tyres

Whole tyres or tyres that are split or processed in some way have a wide variety of uses ranging from artificial reefs to water tanks. The current uses in Australia and potential markets include:

- artificial reefs and breakwaters;
- erosion control and bank stabilisation;
- on farms as weights on plastic sheet over silage;
- as sound barriers and crash barriers;
- in engineered retaining walls; and
- in concrete slabs.
Increasingly, Australian governments are discouraging some of the more traditional forms of whole tyre applications, or are taking more direct action such as imposing bans or licence and approval requirements. A major reason why such applications have lost favour is that in the past they have often been carried out with little controls. There have been unfortunate experiences with environmental impacts (in relation to mosquitoes and risk of fires), increased erosion or disturbance of stream flows, or the structures have collapsed and loose tyres have become a problem by being washed away.

More recent developments of properly engineered structures using waste tyres offer the prospect for a much more valued use of tyres, which meets engineering standards and environmental requirements at competitive cost levels. An example is the civil engineering applications developed by Ecoflex® that involve removing one wall of the waste tyre, thus creating a container which is then filled with gravel or other material.

The market at the moment is estimated to be of the order of 200,000 tyres per year. There is considerable potential for using waste tyres in applications such as retaining walls, road base, and as void formers and reinforcing in concrete floor slabs for buildings. Based on current levels of construction activity alone, the last-named process could take the major part of all waste tyres generated in Australia.

The system has the advantage that, unlike TDF and rubber crumb applications, capital costs are low. The equipment costs approximately $10,000 and is easily transported. This is an attractive feature for small remote communities without sufficient tyres to justify major investments or which cannot generate economies of scale. The system could be applied to accumulated waste tyre stockpiles in their area by perhaps sharing the equipment with neighbouring councils.

The analysis summarised by Robinson (2000) suggests that the environmental impacts on a whole-of-life basis are much less than for competing materials. The process uses the entire tyre, leaving no residue. On the economics side, products are claimed to be price competitive with more traditional materials and construction methods to the extent that waste tyres have positive value in absolute terms not just relative to landfill gate fees. There remains the issue of flammability of tyres and this may be of concern in some applications.

A major barrier appears to be conservatism and related poor knowledge in respect to new solutions on the part of engineers and purchasing officers. This observation applies more widely to a number of other products made from waste tyres.

8.8 Discussion

At present, there is insufficient demand for products made from waste tyres using existing or emerging technologies to divert the greater part of waste tyres from landfill and inappropriate disposal. The causes are both supply-side and demand-side related or, perhaps more accurately, arise from the interaction between supply and demand.

On the supply side, there are limitations of a mainly technological nature to certain recycling options. Strength and other performance characteristics of rubber crumb restrict the range of products made from crumb. There are many competing products in view of the non-exacting strength requirements, and the costs associated with crumbing tyres (as well as the costs of collection, transport and materials handling) make it difficult to get significant market share. In the retread industry, there are reports that a constraint is the availability of good quality casings in the sizes demanded by the market.

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49 see Robinson (2000).
There is also the ‘cost’ of supply. Most end users are actually paid for accepting waste tyres (or arrange the collection of tyres directly). The price that can be charged is determined in a market situation by the cheapest management option, which is generally disposal to landfill (or even cheaper, in the case of certain operators, for illegal disposal). Accordingly, landfill gate fees set the price structure within which end-users of waste tyres are forced to operate.

Both recycling and energy applications are capital intensive. One of the risks faced by these investors in these facilities is the difficulty in gaining access to a constant supply of waste tyres. If investment in high-value use of waste tyres is to be promoted then this risk must be managed by arrangements that provide an acceptable level of assurance for the supply of tyres.

On the demand side, a major hurdle to increased sales is market conceptions regarding the quality of goods made from waste tyres. Nowhere is this more apparent than with tyre retreads for passenger vehicles where there has been a significant decline in market share. The price of recycled goods is also a major barrier in very competitive markets. Some opportunities are limited due to the relatively small size of the Australian market and, while there is the potential for exports, production generally needs to be established for the home market to provide a solid base before moving to sell offshore.

Of all the end-uses for tyres, only for tyre derived fuel have schemes been set up which utilise a large proportion of the Australia-wide total. Currently these schemes operate within the cement industry in two States, but there are prospects for extension to other areas. But even the cement industry, in Queensland, has apparently needed to induce an increase in landfill gate fees so as to be able to accept waste at charges that make the operation commercially viable.

On the other hand, there are prospects for growth in the case of rubber crumb, particularly in road making applications. More recent developments appear to have an even greater potential to absorb large numbers of tyres, notably civil engineering applications and use in mine blasting. However, cost pressures and highly competitive end markets suggest that further developments will be needed in one or more of the areas of technology, marketing and institutional arrangements.

There is also promise from the more high technology applications, such as pyrolysis and chemical treatment of the rubber from waste tyres to give it better adhesive properties and therefore greater strength. These are areas that are subject to considerable interest and R&D activity, and it is difficult to forecast with any confidence their future place in managing waste tyres. However, the potential is there for them to absorb a large proportion of the waste tyres generated in Australia, if technological and cost barriers can be overcome (or if economic factors such as a rise in the price of crude oil make their competitors more expensive).
Table 8.6  Options for energy recovery from waste tyres in Australia

<table>
<thead>
<tr>
<th>Application</th>
<th>Current market</th>
<th>Potential market</th>
<th>Barriers/issues</th>
</tr>
</thead>
</table>
| Cement kilns                 | Approximately 14,000 tonnes/year are consumed in Victoria in cement kilns. The total consumed in Queensland cement kilns in 1999 was 600 tonnes, currently 11,000 tonnes/year and forecast to rise to 30,000 tonnes/year by 2003. | Tyres are used as a fuel substitute for coal and natural gas. Between 5 and 7 GJ of energy are used in the kiln for each tonne of cement produced depending on the type. Tyres can be substituted for 15% of the fuel used. Australia produces approximately 7 Mt of cement per year meaning that 10 million tyres can be consumed which is 60% of the total. | Resource security.  
Overcoming implementation hurdles and approvals at a State level.  
Capital cost of $3 million to install feeding and handling works. |
| Other co-firing (use of tyres in conjunction with another form of fuel) | A pulp mill in Tasmania has investigated using tyres as fuel in its boilers. | The total annual Tasmanian supply of waste tyres could be consumed in only 2-3 months of operation.  
A number of studies have been conducted around the world on the co-combustion of coal and tyres and the co-gasification of coal and tyres where the tyres apparently have favourable impacts on the process. | The combustion processes that can be used are limited to those that can burn the tyre without resulting in increased pollution and waste.  
Some types of boilers such as coal-fired power stations cannot use tyres because the metal in the tyres causes accretions. |
| Direct firing                 | A number of tyre powered options have been investigated by various proponents but there are no examples in operation. | The energy content of all waste tyres generated each year is equivalent to about 2 weeks of the operation of a typical coal fired power station. | Resource security.  
Other uses preferred.  
Small in comparison to other fuels, that is limited economies of scale. |
| Blast Furnaces                | Not currently used.                                                            | No strong prospects.                                                             | The zinc in the tyres caused significant operational issues. |
9 Findings of Part I

In spite of the deficiencies in the information available, the message from Part I is quite clear. Waste tyres do constitute a ‘problem’ and there is considerable room for improvement in the practices associated with waste tyres and expansion of the markets and uses of products derived from waste tyres. The problem is not directly due to the physical and chemical nature of waste tyres. Rather the problem arises from the failure to recover value from the resource to an adequate extent, as well as the high levels of inappropriate disposal which pose the greatest threats to the environment.

Though it is not a prerequisite or an absolute requirement, improvements in the availability and quality of data and periodic reporting of this data to the general public and the tyre and rubber industry would improve decision-making and policy development.

Part II of the report assesses a range of options that deal with specific aspects of the waste tyre problem identified in Part I, using the information presented there as a basis for evaluation.
Part II.  
Analysis of Policy Options

1 Introduction

1.1 Scope and focus of Part II

The scope of Part II is somewhat more narrow than Part I. This section explains the reasons for omitting certain areas and the focus on others.

1.1.1 Non-tyre rubber waste

Non-tyre rubber waste is suitable for many of the practices that are in operation or have been suggested for waste tyres (with the exception of whole tyre applications and retreading). Nevertheless, this report has not focused on the evaluation of options for managing non-tyre rubber waste in view of the special characteristics of waste tyres and associated activities, which indicate that:

- waste tyres are collected from a relatively small number of waste generators; and
- waste tyres are generally free from contamination and are not mixed with other wastes;

Unlike some rubber products, tyres are a consumable product (tyres need to be replaced at regular intervals).

The consequence is that the collection of waste tyres is relatively straightforward and waste tyres when collected are in a state ready for further applications. These factors have largely determined the existing structure of the waste tyre industry and the way it operates. Collection of other rubber waste is quite different and is unlikely to fit easily into the policy and strategic options for waste tyre management that are assessed in this report.

1.1.2 Differences between tyres

Different classes of tyres have different characteristics and this is reflected in current management activities. They also have different requirements in policy considerations.

In the past, most attention has been paid to waste passenger tyres generated in urban areas, and this is true of this report. Some of the conclusions also apply to truck and bus tyres, and this will be implicit in the discussion. In general, commercial tyres are more valuable due to their larger size and suitability for retreading, and the waste tyre ‘problem’ is correspondingly smaller. Tyres in remote areas and OTR tyres (particularly very large OTR tyres) are dealt with separately in Part II.8.
1.2 Why a national approach?

In addition to the benefits that derive from uniformity and the consequences of the division of regulatory responsibilities between the Commonwealth and the States and Territories, a national approach may provide a range of other benefits. Some examples are given below.

Certain schemes are administratively more straightforward when managed at a national level. A good example is furnished by the NEPM for movement of controlled waste (waste tyres are scheduled as a controlled waste under the NEPM). The introduction of the NEPM obviates the need for States and Territories to develop bilateral arrangements for cross border movements of waste, where the development and transaction costs of such arrangements are likely to be well in excess of the costs of the NEPM.

It can be anticipated that there will be economies of scale if a national approach is adopted compared with efforts by individual jurisdictions. One example is that national advertising programs for products made from recycled tyres or programs that promote better tyre maintenance reach a larger audience, reducing unit costs by defraying the fixed costs associated with development over a larger number of potential ‘customers’.

Similarly, overlaps and duplication of effort in relation to research and development activities may be avoided as a result of a national approach. This will result in superior outcomes at a lower overall cost.

Additional benefits will be generated to the extent that a national approach promotes greater opportunities involving interstate arrangements for managing waste tyres.

There are matters where the Constitution provides that only the Commonwealth has certain powers. Of most relevance to the management of waste tyres are the provisions in respect of customs and excise. In such cases (the main examples include a levy on new tyres at the point of manufacture or import, or restrictions on the import of used tyres), then not only is a national approach required but also the involvement of the Commonwealth Government will need to be explicit.

1.3 Objective and justification

For the purpose of this study, the overall objective of the wider process has been taken to be as follows.

**Objective: To solve the waste tyre problem**

The statement of the objective in this way immediately begs the question “In what ways do waste tyres constitute a problem?”, and in particular, how do the problems associated with waste tyres differ from problems associated with wastes more generally?

In considering wastes, the two major dimensions that have been the focus for government action and reforms are:

- to minimise the impacts on the environment and on local amenity from the waste or from managing the waste; and
- to maximise the net value generated by the waste, viewed as a resource.
Of course, the two dimensions are not independent. Certain practices for processing wastes may entail considerable damage to the environment, or the use of resources, which may outweigh the gains from the more valuable end goods or services that are produced. In this regard, the waste management hierarchy, while providing a useful framework for considering different options, does not obviate the need for careful evaluation of all the costs and benefits associated with specific fates for the waste.

In the case of waste tyres, some of these considerations can be made a little more concrete. The question of environmental and amenity impacts has been covered in Part I. The conclusions from that part of the report are that waste tyres are relatively benign when disposed properly to landfill, but pose significant risks to the environment and public health if disposed inappropriately.

There is also the question of the extent to which waste tyres are disposed inappropriately. Estimates of the extent of inappropriate disposal range from ‘low’ to as high as 50% (some of this variation may be the result of genuine variations across different parts of Australia). If the actual incidence is towards the high end of the range of estimates, then waste tyres would appear to have much higher rates of inappropriate disposal than is common for other kinds of waste.

1.4 Market failure

It is worth reviewing the justification for intervention in the waste ‘industry’. Basically, the grounds for intervention are contained in the definition of the waste tyre problem. There is likely to be little argument regarding government’s role (if not the means) in protecting the environment. However, it is valid to raise the question: if waste tyres are valuable, then why do we not see entrepreneurs exploiting this value? After all, management of waste is an industry and within the constraints of regulatory controls (imposed largely to control environmental impacts) a market operates with buyers and sellers of waste management services, using a price mechanism that reflects supply and demand.

The grounds for government (or industry-based forms of) intervention all come under the umbrella of market failure. The first form of market failure arises as a result of distortions in competing markets. Products made from waste tyres compete with products made from virgin materials.

“If all external costs of extraction and production were included, then the price of many virgin materials would rise relative to reused or recycled materials. This would raise the demand for recycled materials, diverting some waste from landfill. As long as external costs for virgin materials are not internalised, a target for diverting waste from landfill, even an arbitrary one, could lead to a more economically efficient level of recycling, reuse, and waste minimisation than if no target were in place.”

Similar arguments could be raised to justify other forms of government intervention (other than setting landfill disposal diversion targets), even if the extent of distortions due to externalities associated with virgin materials cannot be quantified with any degree of confidence.

Another example of distortion is in the ‘market’ for waste tyre practices that compete with these high value uses, specifically disposal to landfill and, even more so, illegal dumping. As a broad observation, landfill gate fees have moved progressively to recover direct operating costs, and waste levies now imposed by a number of jurisdictions aim to reflect the associated externalities of landfill operation.

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50 IPART (1996).
The second form of market failure is due to imperfect knowledge. A relevant example in the case of waste tyres is where consumers may have a misconception that reprocessed products offer poor value. Frequently, judgements are made on less than rational grounds (sometimes unavoidably so if objective evidence is unavailable) or purchasing decisions are made to maintain the (possibly false) sense of security felt by following past practice.

The third form of market failure can arise from the dynamic nature of markets. A great part of the dramatic gains in material well-being since the time of the industrial revolution has been generated by innovation. But there are high risks in undertaking and implementing research, and individuals and firms will not be encouraged to embark on this route unless the potential rewards are correspondingly high. In some instances it may be problematic whether the developer of a new good or service can capture the benefits from the resource investments needed to bring the idea to the market. Yet such developments may make society better off.

The final form of market failure is where the structure of the industry is such that potential users do not have fair access to the markets. Most instances of such market failure occur in the product market and are often associated with unconscionable practices by competitors who can make use of their market power. But these problems can also arise in regard to inputs that are needed to produce goods and services. In the case of facilities that depend on a constant supply of waste tyres, this can occur due to the fragmented nature of tyre collection and transport and the relatively fixed number of waste tyres generated each year.

The assessment of which type of market failure is the most significant is a key determinant on future policy initiatives. The effects of distortions due to the failure of prices to reflect all costs in markets where waste tyre products compete are almost certainly important. But such distortions are endemic in the economy, and the solution will need instruments with a broader coverage than those considered in this report. Historically, there have been large investments in research and development, and activity is continuing at different levels ranging from work by individual firms to government supported investigations. There is no clear evidence of substantial market failure in this regard.

The message at an industry level (and from some Government agencies) is that the major limitation on improved practices for waste tyres is the difficulties associated with secure access to the resource. On the other hand, individual recyclers emphasise the lack of depth in the markets into which they sell their products, including difficulties with consumer acceptance. It is not possible with any confidence to separate the two forms of market failure as to which is the most important, and separate sections of the report are devoted to options which address each.

1.5 Extended producer responsibility

Extended producer responsibility (EPR) is an important high-level concept that underlies much of the philosophy as well as more practical matters in regard to tyres and other products. In effect, EPR represents a fundamentally different perspective, not just on the management of waste, but on the economic, environmental and social connections between the act of producing goods, their subsequent use and post-consumer management.

For the purpose of the current study, EPR is a strategy that transfers the cost of waste management from the community at large to those economic agents (producers) who are in the best position to influence the factors that are most problematic at the post consumer stage. EPR can provide strong incentives on producers to develop products which impose less costs to manage as waste. Since the costs of eventual waste management are embedded in the prices paid for goods, consumers will respond by making product choices that reflect, to a greater degree, the true (life-cycle) costs of products.
During the 1990s, the Organisation for Economic Co-operation and Development (OECD) conducted the first stage of an EPR project that evaluated design issues in the light of practical experience to date. The OECD made the following definition:\(^{51}\)

‘EPR is defined, for the purposes of the OECD project, as the extension of the responsibilities of producers to the post-consumer stage of the products’ life cycles.’

The OECD has observed:\(^{52}\)

‘The essence of EPR is who pays for, not who physically operates, the waste management system.’

EPR schemes have been implemented in a range of industry sectors, such as electronic and electric consumer products, and consumables used in office equipment. The OECD studies on EPR focus largely on municipal waste and the case studies are in the packaging industries. In the case of municipal waste, the price faced by the waste generator for an additional unit of waste is often very low or even zero (for example in the case of uniform domestic waste collection rates). In other words, the waste generator is not paying the actual costs associated with the management of the waste. Consequently, within a product market, there is an implicit subsidy from products with low post-consumer costs to products with high post-consumer costs. The distortions in consumer decisions in response to price signals affected by such a cross subsidy result in sub-optimal allocation of the community’s resources. Specifically, more waste is generated or the costs of managing the waste are higher than would be the case if the purchase price of products reflected all costs (including those at the post-consumer stage). One objective of EPR is to make producers face these costs explicitly, so that they are integrated in decisions made throughout the life of the product.

EPR can take many forms.

One form (the OECD refers to the use of economic instruments in this regard) has been implemented in Australia for oil through the PSA (product stewardship arrangements) scheme, which commenced operation at the start of 2001. A similar scheme for tyres is discussed in Part II.7.3.1. In this form of EPR, producers (interpreted to be manufacturers and importers) discharge their responsibilities by making a payment that covers the expected costs for post-consumer management of the product. This is essentially a funding mechanism.

Other forms of EPR can provide more control to individual producers, or to the industry as a whole, over the way they meet their producer responsibilities. Within this general group of forms of EPR, the role of the regulator is restricted to ensuring, in the first instance, that waste tyres are not disposed by inappropriate means. The regulator may set further requirements in respect of the proportion of waste tyres used in specified applications. Within the constraints imposed by such requirements, tyre producers are provided the flexibility to manage waste tyres in the way that best suits their operations.

Perhaps the most publicised form of EPR is commonly referred to as a take back scheme. In essence, take back schemes, as the name suggests, require tyre producers to take back tyres once they reach the end of the consumer stage of their life. This is discussed in more detail in Part II.2.

Experience overseas suggests that there are three main design questions for EPR:

- the setting of waste reduction or recycling targets and the timing for these targets to be achieved;

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\(^{51}\) OECD (1996), page 15.

\(^{52}\) OECD (1998a), page 5.
• the conditions under which industry organisations may act on behalf of individual firms in meeting their responsibilities; and

• the relationship to other government policy matters.

While the question of source of funding for waste management is obviously important (certainly on distributional or fairness grounds), there is little incentive to seek and implement improvements in the environmental impacts arising post-production. EPR extends the traditional responsibilities for producers, which have been largely concerned with the production process itself (health and safety of the workforce, impacts on the environment, public health and local amenity) and consumer issues such as product quality and safety. EPR in its wider sense aims to make the producer responsible for longer term in-service impacts as well as, importantly for this study, management of the post-consumer stage in the product’s life. The specific concerns here are:

• waste volume, which can be addressed by developing products with longer life (but in the case of tyres might also relate to the ability of tyres to be retreaded);

• toxicity, which can be addressed by careful choice of inputs used in the manufacture of the product; and

• recyclability, which can be addressed by such measures as avoidance of undue use of composite components, which need to be separated before material-specific reprocessing can commence.

1.6 Options

The choice of options to be considered is based, in part, on the outcomes of the National Workshop held 14 December 2000. However, the structure of the evaluation of the options differs from the discussion at the workshop.

In classical cost benefit analysis, the options to be assessed are evaluated against their ability to meet specified objectives. Commonly there is a single objective. The options to be considered are mutually exclusive. Either it is not possible to implement more than one option or there is nothing to be gained, once one option has been put in place, to also implement any other option.

The situation in regard to waste tyres is rather different. It is true that the options to be evaluated in this study are all directed at solving the waste tyre ‘problem’, but in general they either target different aspects of the problem or they address the same aspect in different ways that can be considered to be complementary. To obtain the best overall outcome requires a ‘toolbox’ approach, selecting the appropriate tool that deals with each aspect of the waste tyre problem.

A second important consideration in regards to the assessment of options is the timeframe for implementation, and the existence of delays before it can be realistically expected that substantial improvements can be obtained. This suggests that it may be worthwhile to work on certain options which are fairly straightforward to implement, even though these may be viewed as of an interim nature, until such time as better options can be introduced.

1.6.1 The base case

In economic assessment, it is necessary to define a base case against which all the options are compared. In this report the base case is taken to be the do nothing option in regard to the options that are discussed below. The term do nothing is somewhat of a misnomer in that there are a large number of important developments and changes in terms of waste tyres that will go ahead regardless of decisions made in the process of which this study is a part. More correctly, the base case should be termed business as usual, and is defined to be the future situation as discussed in regard to various elements in Part I.
1.7 Structure of the report

Part II.2 deals with take back schemes as an option under EPR.

The following sections of the report have been structured on the basis of three major opportunities to move towards the solution of the waste tyre problem that have been identified for evaluation:

- waste avoidance (Part II.3 of the report);
- reducing inappropriate disposal (Part II.4); and
- improving the value extracted from waste tyres (Part II.5 and Part II.6).

The third opportunity has been split into two sections that address impediments due respectively to concerns regarding security of supply and forms of market failure.

Part II.7 deals with options for funding which is discussed separately from the management of the disbursement of the collected funds.

One consequence of this structure is that parts of certain ‘packages’ that have been proposed as options by stakeholders are discussed in different sections (an example is the product stewardship arrangements (PSA)). However, in terms of inputs into decision-making, our view is that the structure adopted in this report is more ‘natural’ in that it separately addresses considerations that are independent for the purpose of decision-making.

Part II.8 discusses the issues associated with waste tyres generated in mine sites and remote areas.
2 Take Back Schemes

A take back scheme represents the furthest point that the concept of EPR can be taken, in that the producer (manufacturer or importer) is required to be responsible in a physical sense for managing the product once it has reached the post-consumer stage.

It is worth noting that a take back scheme can be interpreted by viewing consumers as paying for the ‘services’ provided by a tyre\(^{53}\) rather than buying a tyre as a product; in effect the producer retains ownership of the tyre. The interpretation of tyres as a service rather than a product is implicit in some existing commercial buy-back arrangements for truck tyre casings to be used for retreading. Similar schemes have been introduced within Australia in other markets (carpets is one example) by firms who take an expressly life cycle approach to their products.

2.1 Design considerations

It is possible that producers in such schemes may actually take back the product. In the case of waste tyres, as was pointed out in Part I, technological limitations and financial constraints prevent closing the loop by reprocessing waste tyres into new tyres. Nevertheless, each of the two domestic tyre manufacturers operates retreading facilities for truck and bus tyres. It is reasonable to raise the possibility that the tyre manufacturers would in fact physically take back the tyres they produced, and then process them to generate high-value products.

However, it is more likely that they would enter arrangements for these operations with third parties, perhaps through a producer responsibility organisation (PRO), as discussed below. In the case of importers who do not operate plant in Australia, the incentive to manage their take back obligations externally would be even stronger.

The strongest form of take back schemes is where each producer is required to take back its own products, and this introduces the strongest incentives to develop products that are less costly to manage as waste. However, the reality is (at least in the short term) that tyres are reasonably homogenous. Any gains anticipated from the requirements for take back of a firm’s own product may well be lost in increased costs resulting from the less flexible arrangements for collecting and transporting waste tyres.

It may be better to require that each producer is responsible for a specified number of waste tyres expressed as a percentage of the new tyres produced by the firm. The specified percentage could be increased over time allowing the scheme to be phased in. This provides an opportunity for both industry and the regulator to adapt to the scheme during implementation. Such an approach would facilitate incorporating exemptions for certain types of tyres (say for mining or agricultural tyres) or for variable take back percentage rates.

\(^{53}\) The services provided by a tyre could be defined in some way such as making contact with the road, and providing grip for cornering, acceleration and braking.
An important consideration is the level of government involvement. There are successful examples of voluntary industry schemes (such as the scheme operated by the Xerox company and the scheme to take back spent nickel-cadmium batteries in the US). The OECD reports that the experience in Europe in the case of packaging waste (and to a lesser extent consumer electric and electronic goods) has been that the success of take back schemes has been weakened when firms opt out (the free rider problem). Domestic take back schemes can be undermined by importers who choose not to join the scheme. Thus it is likely that some form of statutory support may be necessary which could be take a prescriptive form or be more outcomes based.

Mandatory take back schemes bring with them the need for monitoring, reporting and enforcement so that the performance of producers can be audited. Monitoring that a firm takes back its own products would be extremely difficult in practice. Monitoring numbers of tyres taken back would by contrast be quite straightforward using a modification of the tracking scheme discussed in Part II.4 below. There would need to be penalties or other sanctions for firms who failed to meet their take back obligations.

2.2 Producer responsibility organisations

The OECD has observed that virtually all take back schemes have spawned a producer responsibility organisation, since arrangements at the level of individual firms for take back and recycling (the core of EPR) have proved to be largely unworkable in practice. This conclusion may not be so clearcut in the case of waste tyres as it is with municipal waste.

The PROs undertake a number of activities including administrative arrangements with enterprises that guarantee the recycling targets, setting prices for individual members, reporting the performance of the scheme as required by the regulator, and undertaking public awareness programs. It is noted that the success of a take back scheme rests largely with the effectiveness of the PRO, and this in turn requires careful attention to design and planning in the establishment phase to ensure smooth operation.

In concept, a PRO has much in common with options associated with a central administration scheme that will be discussed in Part II.5. The important difference is that the schemes discussed later arise from express Government direction (possibly with some industry involvement). On the other hand, the establishment of a PRO within an industry occurs when individual firms seek an exemption from their responsibilities under the take back schemes.

Notwithstanding this important difference, some of the concerns for PROs are similar to those raised later for central administration schemes. The key concern is the power that the PRO exerts on both the product manufacturers and importers, and the recyclers.

If membership of a PRO is mandatory (or the only feasible commercial alternative for small to medium enterprises), then it is important that the fees and other requirements for new membership are not set prohibitively high so as to restrict entry to the product market. Also, the allocation of costs and benefits by the PRO may disadvantage certain companies that make products which have been burdened with higher costs in relation to the recycling process. There is the possibility that large contracts entered into by the PRO may freeze out small waste operators. There is the further possibility for high-level vertical integration to result in a closely inbred system, which would impose additional costs on consumers without achieving important waste management goals.
The attractions of gaining an exemption can be expected to be even stronger for importers who are not domestic manufacturers. Some importers may have minimal facilities available for taking back waste tyres. In some cases, where the importers are not directly involved in retailing, their facilities in Australia might constitute only a warehouse for holding tyres which may not be well suited to accepting waste tyres. As a member of a PRO, an importer may still suffer some disadvantage in view of the reduced flexibility (compared with local manufacturers) to arrange their operations so as to take full benefit of the PRO. Where this is potentially an issue, international trade obligations could need to be considered in the design and operation of the PRO.

Governments in Europe have responded to these concerns by means of different types and levels of controls. In Germany, for example, the government maintains oversight to ensure that the decision-making elements of PROs and waste management firms (including recyclers) are kept at arms length, while The Netherlands relies on a much more voluntary approach. Of particular note are the concerns relating to competition policy, both the impacts on domestic markets and in respect to international trade agreements for markets for reprocessed goods.

A key to success in delivering improved waste management and related outcomes is producer participation in active product redesign. Producers should be confident in expecting returns for their efforts and expenditures. The OECD reports that experience to date suggests that the rewards have not flowed back to the firms who generated the improvements but have been captured by the PRO or shared amongst all members of the PRO. However, this should not be a problem with tyres, since the products of individual firms can be identified and the rewards directed to the producers involved.

2.3 Other matters

Two issues arise in relation to take back schemes: orphan products and grandfathering.

Orphan products are taken to be those waste tyres for which the producer no longer exists to take responsibility for their management. This is obviously not a problem for some EPR schemes (for example, in a levy scheme provided the levy is paid at the point of production). For take back schemes, it is necessary for the responsibility for the tyre to be assumed by some other entity. The choice is between the waste generator (consumer or tyre dealer), the tyre industry as a whole, or the community through the Government. Alternatively, all tyre producers could be required to lodge a financial assurance which would cover the costs of take back in the event that the firm ceased to trade.

Grandfathering refers to tyres that are in existence prior to the introduction of a take back scheme. One possibility, as these tyres reach the end of their consumer life, is that they could be ignored for the purpose of the take back scheme (provided they could be separately identified from the post scheme tyres). This would result in a delay before the benefits of take back were realised. Alternatively, all tyres that reach the end of their consumer life after the commencement of the scheme could be required to be taken back. In this case, the tyre industry might argue with some justification that they had not been able to incorporate additional take back costs in the original sale price of the grandfathered tyres. This argument has less force in the case where tyre producers have responsibility for a specified number of tyres rather than specifically the tyres that they produce.

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54 OECD (1998b), page 38.
2.4 Conclusions

Take back schemes, as one form of EPR, provide the ultimate in levels of control by manufactures and importers over the management of waste tyres, and incentives to integrate actions over the life cycle of the tyre to minimise financial and environmental costs. Experience in other countries suggests that the concept is workable in practice. If the EPR requirements for take back result in the establishment of a PRO, then this may raise a number of concerns that are common to other centralised administration schemes. In addition, although PROs arise from industry decisions, it is likely that they will need Government controls and oversight if they are to deliver benefits without undesirable side effects.

It would appear that any EPR initiative, and in particular take back schemes, would need to be implemented at the national level.
3 Waste Avoidance

3.1 The opportunity

At the top of the waste management hierarchy is waste avoidance. In regard to tyres, waste avoidance means achieving a reduction in the rate at which waste tyres are generated within Australia.

Waste avoidance, in the case of tyres, is the responsibility of both the tyre producer (manufacturer or importer) and the consumer. The role of producers is firstly to develop tyres that have longer lives, and this can be considered to refer to both the life of the tread and the potential for the casing to be used as a retread. It must be pointed out that the Australian market for tyres is small in comparison with the world market, and that tyre producers in Australia are generally offshoots from large international enterprises. Under these circumstances, it is unrealistic to expect major advances in tyre technology to occur in Australia, though certain manufacturers claim their tyres are ‘designed for Australian conditions’.

A more promising area for tyre producers to contribute to waste tyre avoidance is through the provision of information to consumers, and this leads naturally to considerations of decisions made by vehicle owners. The major opportunities to reduce the rate at which waste tyres are generated relate to changes in consumer behaviour. A narrow definition of the term consumer behaviour would be restricted to the purchase of tyres. However, for the purpose of this study the definition of the consumer will be taken to include the role as vehicle owner/operator, and to extend the use of the term behaviour to actions during the life of the tyre, such as tyre maintenance and driving behaviour.

Decisions by consumers that influence the waste tyre generation rate at the point of purchase include:

- the choice of tyre in terms of expected life; and
- the choice between new tyres and retreads.

Decisions by consumers that influence the waste tyre generation rate during the life of the tyre include:

- maintenance of the tyre and associated vehicle components (steering and suspension);
- the distance travelled by the vehicle; and
- driving behaviour in terms of loads carried, road surface, abuse (such as running into gutters), excessive speed, and abrupt acceleration, braking and cornering.

Clearly, not all of the above decisions are subject to influence by programs and policies that aim to reduce the rate of waste tyre generation. In particular, the last two bullet points will not be addressed in this report, since these matters are the subject of other, broader programs (targeted at road congestion, safety and environmental impacts – mainly air emissions) that are likely to be more successful in achieving change in driver behaviour. However, it must be acknowledged that programs to reduce vehicle usage have not been very effective in the past and there do not seem strong prospects for improvements in the future.\(^5\) In fact, vehicle-kilometres has

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\(^5\) The problem that needs to be addressed is that the convenience and comparatively low cost of private motor vehicle use has resulted in private road travel becoming an integral part of the lifestyle of many people, and this role cannot be substituted for by other forms of transport.
outstripped the growth in population. For the purpose of projecting vehicle usage trends into the future, no significant reduction in distance travelled has been assumed in the analysis conducted for this study.

Of the other decisions listed above, information provided by tyre producers (in concert with tyre dealers) can certainly be expected to provide a sounder basis for the choice of tyre purchased in terms of expected life. Producers and dealers could also contribute (possibly in cash but certainly in kind) to programs to promote better tyre maintenance.

Also, increased use of retreads can reduce the rate of generation of waste tyres. The retreading process is much less resource intensive than is the production of new tyres. While retreading does not keep a tyre out of landfill in the long term, by deferring the time of disposal retreading slows the waste generation rate and reduces the need for new tyres to be manufactured.

3.2 Impediments

3.2.1 Purchase decisions

It would be expected that a rational consumer would choose the tyre that offered the best bundle of attributes: roadholding performance, noise and comfort against cost. Cost in this case is the expected cost of the tyre over its life. However, it has been frequently observed that consumers have a high effective discount rate when assessing purchases of long-lived products (such as energy efficient lighting), and commonly demand a ‘payback period’ of the order of one to two years for the additional cost. In the case of tyres, this problem is exacerbated since, if the vehicle is disposed within the life of the tyre, the increase in the residual value from a superior tyre is largely lost. In particular, owners of older vehicles are often loath to fit expensive tyres, regardless of the projected cost per kilometre.

Also, there is little hard factual information provided by tyre manufacturers or tyre dealers to assist consumers. For fleet operators it is worthwhile to spend resources on careful evaluation of available tyres that best suit their needs, because the costs (and resulting benefits) for obtaining the required information are spread over a large number of tyres. Again, fleet owners will have considerable experience (based on detailed records) of past tyre performance. For individuals, who may only buy tyres once every few years, such information is not available, and they have to rely on a mixture of advice from friends and advertising by the tyre industry.

The consequence of this is that purchase decisions by many (perhaps the majority of) private buyers are dominated by the purchase price of tyres and appear to pay little or no attention to the expected tyre life. Yet tyre industry members indicate that choosing better quality tyres generally provides better value notwithstanding the higher purchase price.

The value-for-money problem is reversed for retreads. Tyre retailers tell us that many customers reject retreads as poor value-for-money or as unsafe, even though the price of the retread might be significantly less than the price of the cheapest new tyre and the customer is otherwise keen to buy cheaply. A survey undertaken by the National Roads and Motorists Association found that only 4 per cent of motorists said that they would choose retreads when replacing tyres.

While official data are lacking, the limited evidence suggests that the market for passenger vehicle retreads is in steady and significant decline. The NSW Environment Protection Authority estimated that market share of passenger vehicle retreads was

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56 NRMA (1993), page 34.
57 NSW EPA (1996b), pages 6-7.
about 40 per cent in the 1970s (based on a retreading rate of 65 per cent), 27 per cent in the early 1990s, and around 20 per cent in the mid 1990s. It may now be as low as 10%. The pressure on the retread industry is also reflected in reports of severe competition between suppliers of passenger vehicle retreads at the present time. This contrasts with the increasing market share of truck retreads. Why the difference?

Tyre dealers and retreaders have largely blamed the falling supply of retreadable casings for the loss of business:

- a decline in the quality of tyre maintenance has reduced the proportion of retreadable casings in the waste stream;
- some new tyres that have come on the market cannot be retreaded – the casings are not built to last;
- the range of tyre sizes and designs has increased markedly: compared with the 1970s, this creates mismatches between the flow of worn casings from newer cars and the needs of older cars whose drivers are more likely to be in the market for retreads; and
- retreaders also suspect that some retreadable casings are being withheld from the retread market.

However, if this last-named situation were the case, then the price of retreadable casings would have risen to reflect the scarcity, but there is no strong evidence that this has occurred. A greater problem facing retreaders may be that they produce a largely undifferentiated product. Although the Standard for retreads requires the name of the retreader to be placed on the sidewall there is no ‘brand’ awareness amongst the general public.

3.2.2 Tyre maintenance

Members of the tyre industry have consistently nominated tyre maintenance as the key determinant of the durability of tyres. Further, poor maintenance can damage tyres to the point where they cannot be retreaded.

In the case of tyre maintenance, it is clearly in the interests of the vehicle owner to strive to maximise the life of tyres fitted to the vehicle. The costs, in time and money, of proper tyre maintenance are very modest, involving only regular tyre pressure checks and visual inspection. Maintenance of vehicle components is more expensive but has safety and comfort benefits. Yet there is abundant evidence that tyre maintenance receives inadequate attention on the part of many vehicle owners.

One problem is that tyres constitute only a small component (perhaps 3-4%) of the total cost of a vehicle. Unlike fuel, tyres only need to be purchased at infrequent intervals (on average a tyre has a life of three years). The vehicle owner is not confronted on an ongoing basis with the increased costs resulting from poor tyre maintenance practices. There is no strong feedback loop from changes in behaviour to effects of longer tyre life.

The quality of tyre maintenance is reported to have declined steadily over the last 10 to 15 years and some of the blame has been placed on the growth of self-service petrol stations. Many stations have only one air hose and it is not always handy to the refuelling aisles. The quality of the air hoses is also variable: the gauges may be inaccurate or unreadable; motorists are often frustrated by a leaky seal between tyre valve and air nozzle. One option to consider is for tyre dealers to include pocket air pressure gauges with the purchase of new tyres (or discounts for vehicle owners that have a gauge in their car).

3.2.3 Importation of used tyres

Under the heading of waste avoidance is an additional ‘impediment’ that is not concerned with consumer behaviour, but relates to the importation of used tyres. Truck tyre casings are imported to augment the local supply for retreading. On the
other hand, surveys have found repeatedly that a large proportion of used passenger tyre imports do not meet Australian safety requirements and are unsuitable for retreading. These tyres are disposed immediately on landing in Australia; they add to the waste management burden without providing economic benefits from use.

3.3 Options for waste avoidance

3.3.1 Option 1: Purchase decisions

In respect of tyre purchase decisions, it is true that vehicle owners can only make choices from the range of tyre models available and based on information that they can access. To derive significant waste avoidance from changes in purchase decisions, it is necessary that consumers have the right type of information. But it is likely that the tyre industry will only provide this information if there is a strong demand for it by consumers or the provision of information is mandated by law.

To confront the image problem for retreads requires, in the first place, some program to promote the value for money of retreads. The Tire Retreading Information Bureau (TRIB) funded by members of the retread industry in the US provides a model. TRIB provides point of sale materials - posters, videos, brochures, fact sheets - explaining that retreads are commonly used by transport professionals, such as on taxis, aircraft, racing cars, trucks and school buses. The TRIB also reports on studies on tyre debris alongside highways, which is commonly interpreted as the result of retread failure.\(^{58}\)

The other type of program is to provide for product differentiation for retreads. Concurrent with this program, if there are enterprises that are known to be producing defective or seriously inferior retreads, then pressure should be brought to bear on them to improve quality or leave the industry.

Options to improve the management of the supply of casings for retreading will be dealt with in section [Part II.5.4.3](#).

3.3.2 Option 2: Tyre maintenance

Programs to improve the awareness of vehicle owners in regard to the importance and benefits of proper tyre maintenance can take one of two forms. The first form is direct contact with vehicle owners in car parks or public places. The form of such activities could be modelled on a survey undertaken by the NRMA in 1993 on tyre maintenance or free inspections of emissions equipment under the NRMA’s Clean Air 2000 activities that commenced in 1997. The second form is a more conventional mass media appeal to the public promoting the direct financial, safety and wider community benefits from correct tyre maintenance.

3.3.3 Option 3: Importation of used tyres

Two direct options can be considered to address problems associated with the import of used tyres:

- a total ban on imports; and
- controls on imports, such as requirements in regard to roadworthiness, minimum tread depth or suitability for retreading.

A third option is to impose a levy on imports of used (and new) tyres, as discussed in [Part II.7](#) which by raising the effective landed costs would discourage imports of tyres which are in fact waste tyres with little or no further use as tyres.

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\(^{58}\) See for example Commonwealth of Virginia (2000).
3.4 Assessment

3.4.1 Option 1: Purchase decisions

The discussion will use as a model the Uniform Tire Quality Grading Scheme (UTQGS) developed by the National Highway Traffic Safety Administration (NHTSA) in the US Department of Transport.

Once tyre life information is available to consumers, it can be expected that this will have an influence on the characteristics of tyres that are placed on the market, by giving a competitive advantage to tyres with long life. The expected tread life of tyres will become a selling point.

Tyre manufacturers and importers will react in the short term perhaps by adjusting their price structures in response to any differential in demand across tyres. In the longer term, there will be incentives that encourage the development of tyres with longer tread life (better quality tyres including those with longer tread life are already available in the Australian market). However, realistically, Australia is such a small market in an international industry that local consumer demand cannot be expected to have a major impact on tyre design and manufacture.

The provision of the information could be made mandatory by government passing the appropriate regulations. Alternatively the tyre industry could agree to a code of practice that required this information. In the case of an industry-based scheme, tyres for which tread life information was not provided under a voluntary scheme would be less attractive to aware consumers, and so market forces (along with appropriate public awareness programs) might be effective in generating full compliance. However, experience in the US with the UTQGS is that tyre manufacturers as a group are less than supportive of the tread life rating given to tyres. Thus a tyre industry rating scheme may have difficulty getting off the ground.

Various regulatory schemes could be considered, such as requiring new tyres to have some minimum tread life, or imposing some form of tax on tyres which is inversely proportional to the tread wear rating. However, it seems premature to consider strong interventionist measures that over-ride consumer choice until measures to educate and inform the consumer have been tried and shown to have failed.

Some estimates of costs can be provided for a tyre grading scheme. For the UTQGS, the contract fee to conduct a tread wear test is approximately $37,000 (when converted to year 2000 Australian dollars).

Obviously, each tyre model only needs to be tested once and the test costs can be defrayed over the production run for the tyre. Many tyres for sale now in Australia have already got UTQGS ratings (the UTQGS currently lists 2,265 tyres). Costs for labelling (including moulding the information on the sidewall) for the rating are estimated at $0.20 to $0.30 per tyre. If 10 new tyre models required testing each year the total cost would be around $400,000, a fairly small fraction of turnover in the new tyre industry which is of the order of a billion dollars per year.

It might be argued that there are increased costs to the buyer associated with higher price tyres. But if the buyer has the necessary tread life and price information to make comparisons, he or she will only purchase a more expensive tyre if this is of greater value. Consumers should never be made worse off when they are offered a greater (or more informed) choice.

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59 NHTSA (1995). The UTQGS test for tread wear is an on-road test using 4 vehicles over a standard 6,400 mile course plus 800 miles for pre-test break-in.
How effective might such a scheme be? In the US, 79% of the public have heard of the UTQGS tread wear rating and 29% take it into account in tyre purchase decisions. Tread wear information is reportedly given prominent treatment in tyre advertising.

It is true that durability can often be purchased at the expense of other tyre qualities - like traction, comfort and road noise. If the value-for-money equation is sufficiently complex, it might be difficult and misleading to present simple messages about the relative merits of different tyres. But our view is that there is a lot of information and opinions that are swapped by vehicle owners about some of the other characteristics of tyres (such as road holding performance) but comparatively little on tread wear.

**Retreads**

One possibility is to include retreads in a system of independent advice along the lines outlined above. However, the information provided by the UTQGS - on tread wear, traction and the dissipation of heat - does not directly address concerns about safety. And there is some potential for the characteristics of the retread to be attributed to the original tyre. Not only would that undermine the UTQGS itself; it might also be a real or imagined reason for new tyre manufacturers to resist the introduction of the UTQGS. Retreads are not included in the US version of the UTQGS.

The development and distribution of promotional material extolling the value of retreads is relatively straightforward and need not be overly expensive. However, it would remain of limited value unless implemented in parallel with a scheme that provides consumers with guidance on individual retread products. Otherwise, private buyers would have little confidence in the quality of their purchase.

Governments could play a valuable role by adopting retreads for their fleets, and could specify certain minimum requirements for retreads to be fitted to their vehicles. This could give guidance and added confidence to private vehicle owners to purchase retreads and establish confidence in the market.

**3.4.2 Option 2: Tyre maintenance**

The pay-off from better tyre maintenance is multi-dimensional. As well as more durable tyres, the benefits include better fuel economy, safety, comfort and control, and less damage to shock absorbers.

The extent of the problem is indicated by the NRMA survey of the condition of tyres in Sydney, Newcastle and Wollongong. It comprised:

- examination of 3,012 tyres on 701 vehicles by NRMA staff at eight large car-parks and seven NRMA Vehicle Inspection Centres;
- a survey of the car drivers that achieved a 30 per cent response rate; and
- examination of tyre gauges at 215 service stations.

The key findings are set out in Table 3.1. In summary:

- only 33 per cent of tyres were correctly inflated, that is, within 19 kPa or 2.75 psi of the manufacturer’s recommended pressure;
- about 25 per cent of tyres were under-inflated. This can be a serious safety problem and also damages the tyre, reducing its life and the chances of retreading; and

60 NHTSA (1995).
• tyres are more likely to be over-inflated (37 per cent) than under-inflated: over- 
inflated tyres cause uneven treadwear and give a harder ride that damages 
suspension joints, shock absorbers and bearings.

Table 3.1   Findings from the NRMA survey of tyre conditions

<table>
<thead>
<tr>
<th>Actual minus recommended pressure (%)</th>
<th>Incidence of uneven wear (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than −99 kPa (under)</td>
<td>Left front tyre 35</td>
</tr>
<tr>
<td>−99 to −50 kPa</td>
<td>Right front tyre 31</td>
</tr>
<tr>
<td>−19 to −50 kPa</td>
<td>Left rear tyre 24</td>
</tr>
<tr>
<td>−19 to +19 kPa (correct pressure)</td>
<td>Spare tyre 23</td>
</tr>
<tr>
<td>+20 to 49 kPa</td>
<td>Right rear tyre 22</td>
</tr>
<tr>
<td>+50 to 99 kPa</td>
<td>Cause of uneven wear (%)</td>
</tr>
<tr>
<td>More than +99 kPa (over)</td>
<td>Wheel alignment 64</td>
</tr>
<tr>
<td>Total</td>
<td>Tyre pressure 29</td>
</tr>
<tr>
<td>Average tread depth 3mm or less (%)</td>
<td>Suspension 1</td>
</tr>
<tr>
<td>Right front tyre</td>
<td>Not established 6</td>
</tr>
<tr>
<td>Spare tyre</td>
<td></td>
</tr>
<tr>
<td>Left front tyre</td>
<td></td>
</tr>
<tr>
<td>Right rear tyre</td>
<td></td>
</tr>
<tr>
<td>Left rear tyre</td>
<td></td>
</tr>
</tbody>
</table>


About a quarter of tyres show evidence of uneven wear, a prime cause of reduced 
durability. Misalignment and incorrect pressures are the main contributors.

The potential benefits of programs to improve tyre maintenance are the avoided 
damage to tyres, and the extent of the damage can be gauged from the findings of the 
NRMA survey.

The question is: how effective a package of information and educational initiatives 
might be, and what would be the costs? There are some indications that it might be 
difficult to educate motorists about the importance of tyre maintenance. The market 
for advice on tyre economy is probably much thinner than that for advice on fuel 
economy. Whereas petrol accounts for 20-25 per cent of motoring costs and is 
purchased regularly, tyres account for only 3-4 per cent of costs and are purchased 
irregularly.

The experience of one Sydney company with an innovative product for tyre 
maintenance is instructive. J C Ludowice & Son Ltd. developed its Green Ring Valve 
in 1993. The Green Ring Valve replaces the standard valve, is fitted and adjusted 
when the tyre is fitted, and replaced when the tyre is replaced. The green ring is 
visible whenever the tyre is under-inflated and disappears when the tyre is restored to 
its correct pressure, that is, without further reference to an air gauge. The tyres can be 
checked simply by walking round the car. However, when the valve was offered free 
to the company’s 300 plus employees and members of the board, only 21 per cent 
took up the offer. At a price of $6.00 each from tyre retailers, its impact on the general 
public was quite small.
And even a short session of individual instruction about car maintenance can be expensive. On rough estimates provided informally by the NRMA, its inspection day in Newcastle seems to have cost about $100 per participant, mostly advertising costs. Given that the average passenger vehicle consumes about $100 to $150 of tyres per year, it would be difficult to justify spending anything like $100 per participant in a tyre education campaign.

Notwithstanding these difficulties and costs, efforts in this area have great potential: members of the tyre industry have claimed that poor tyre maintenance can reduce the life of a tyre by up to 50 per cent. Using the results of the NRMA survey on the distribution of under and over inflated tyres in conjunction with the estimates in Section Part I.8.3.2 over the entire passenger fleet, proper maintenance could reduce tyre generation in aggregate by approximately 6%.

Further, the NRMA inspection day might not be a good guide to the costs of such programs. It was staffed by NRMA inspectors and the advertising had to succeed to the point where participants would go to the bother of booking a time at a specific inspection station. An alternative and less expensive approach might be to use non-professionals as ‘inspectors’, give them one or two hours training, and set them to work in the parking lots of supermarkets on weekends. They might do no more than offer to check tyre pressures; tell people where the tyre pressure placard is located; hand out a fact sheet on tyres, safety and the environment; nominate one or two service stations where the air hoses are accessible, easy to use, and accurate; and suggest some polite ways to rebuke service station operators when air hoses and gauges are found in poor condition. The inspectors should quickly learn to identify the better targets, for example, by age or sex. Motorists might be more interested if told that they pay a few cents towards the cost of the inspection day when they buy tyres.

Also, education programs have multiplier effects. That is, information is generally shared or swapped with other family members and friends; it is applied to second and subsequent cars. Hence, if it is possible to design a simple program that costs $5 per direct participant, and each participant shares that information with four others, the real cost is reduced to $1 each.

These types of direct contact programs would appear to offer greater promise of changing behaviour than public awareness programs in the mass media, but the latter would reach a wider audience. Of course, there is no reason why the two types of programs could not be run concurrently.

### 3.4.3 Option 3: Importation of used tyres

The two direct options could be designed to achieve the aim of keeping out unusable waste tyres in an effective manner. All options would need to be supported with well-designed monitoring and enforcement activities, and this would impose additional costs.

A total ban on imported tyres has the drawback that it would stop genuine imports of used tyres and result in foregone economic opportunities. The consequences in the case of passenger tyres would be felt most keenly by those who depend on used tyres, and these may belong to sectors in society who are least able to meet the resulting higher costs.

The more flexible approach of allowing used tyres into Australia subject to conditions is likely to be associated with operational difficulties, not the least of which is the complexities of determining compliance with the conditions.

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62 Taking new and retread tyres together, passenger tyres are consumed at the rate of 1.67 tyres per registered vehicle per year. Assuming an average price of $80 per tyre, the cost is $133 per year.
The Australian Customs Service believes that a ban based on end use would not be feasible as the Customs Tariff and rules of classification focus on the characteristics of the goods at importation rather than end use.

The application of a levy on imports has the advantage that it confronts the importer with price signals that more closely approximate the real costs of eventual management of waste tyres. For used tyres with genuine value, the impact should not be dramatic, since these tyres would compete with used tyres generated within Australia which would also attract the levy (possibly at the point of manufacture). Thus the levy could be seen as functioning like a filter, allowing in used tyres with genuine value, but imposing significant additional costs on tyres that can be regarded as waste. It is not known how effective these costs might be in discouraging imports of used tyres with no beneficial use.

Any actions which apply to imports immediately raise international trade issues. In the framework of international trade, requirements on recycling or reuse are interpreted as product standards. Under GATT rules, product standards:

- must not discriminate between goods manufactured domestically and imported goods;
- must not increase the difficulty of market entry by foreign competitors (in other words, must not be technical barriers to trade); and
- must not impact the cost and competitiveness of foreign goods in relation to domestic goods except in the proportion to the environmental benefit expected from this requirement.

These requirements do not seem to throw up insurmountable hurdles to a levy on used tyres provided the levy is also applied to other tyres that compete with the imported used tyres.

### 3.5 A national approach?

Clearly a tyre rating scheme (whether government or industry) is national (in reality international) in scope.

The rationale for a national approach in market development programs for retreads and public awareness programs in relation to tyre maintenance is more problematic. Certainly a national based program would save costs in the development of promotional or educational materials, but an inspection activity, for example, would need to be tailored to local conditions.

It should also be remarked that programs targeted at product differentiation in the case of retreads will assist only the retreaders within the tyre industry, and it seems only fair that this should be funded by the retreaders. The retreading association represents the larger (and presumably more quality conscious) retreaders who would benefit from the product differentiation. Many retreaders operate locally, and a national scheme would have limited benefits.

Actions in regard to the importation of used tyres would need to be national in scale, and indeed be implemented by the Australian Customs Service with the requirement that the taxation treatment of imported tyres is mirrored in the domestic market. The Australian Taxation Office would need to be part of such an arrangement. Changes to legislation may be required.
4 Reducing Inappropriate Tyre Disposal

This section will be restricted to regulatory approaches to the problem of inappropriate tyre disposal, where the term *regulatory* is to be interpreted in the sense of imposing restrictions on the regulated community. Other approaches provide financial incentives that encourage waste tyre operators to manage waste tyres in ways that meet community expectations. These approaches may also require regulation (and legislation) to underpin the associated market activities, and will be discussed in a later section.

4.1 The opportunity

Although there is considerable debate about the precise numbers of tyres involved, there is broad agreement that inappropriate disposal (including illegal dumping) is a significant problem. As overviewed in Part I, the major known impacts on the environment, public health and local amenity due to waste tyres arise when they are not properly managed. The associated risks can be substantially reduced if the incidence of inappropriate disposal is minimised.

4.2 The impediments

The impediments to improvements in this area would appear to include commonly held perceptions and attitudes in regard to inappropriate waste tyre disposal. As a general observation, where there is widespread activity that is illegal, then it may be surmised that significant sections of the community condone the activity and consider it ‘harmless’. In the eyes of many, waste tyres are viewed as a relatively benign waste, and it is considered no great crime to leave tyres in various locations provided they are not visible and become an eyesore.

At the heart of the problem is the fact that present financial incentives encourage the waste generator to find the least cost way of disposing waste tyres, and the least cost way is to dump the tyres. Dumping of tyres can be done by the waste generator acting singly, or in collusion with a waste tyre collector/transporter who also has no financial incentive to do the right thing. The waste generator/tyre collector interface is the weak link in the waste tyre chain. Moves by landfill operators to set gate fees to recover all costs of operation have increased the temptation for inappropriate practices by raising the resulting benefit - the avoided gate fees.

One of the impediments in the past to effective policing in this area has been a lack of clear definition of the boundary between acceptable and unacceptable practices. Certain practices (such as on-farm applications, erosion control) have been in a regulatory grey area. This problem is now being addressed in most jurisdictions by means of tighter definitions of what constitutes ‘waste’ (thus coming under the waste regulatory umbrella). Options include imposing limits on the numbers of tyres in any application of tyres, or requiring all such activities to be subject to approval on a case-by-case basis.

The existence of waste tyre operators working outside the system takes away market share and puts pressure on profit margins for those operators who comply with the requirements.

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63 There is an incentive generated by the risk of a fine or other penalty if detected committing an offence.

64 See for example Hayes and Simonovski (1996).
4.3 Options for tyre disposal

We consider four options for overcoming these impediments:

- a scheme for tracking waste tyres;
- national uniform legislation (including greater levels of enforcement);
- payment at point of delivery for a tyre received at an approved receival facility; and
- environmental rating for tyre dealers.

4.3.1 Option 1: Tracking scheme

By requiring documentary evidence of all waste tyre movements, as well as introducing audit and enforcement provisions, the opportunities for inappropriate practices are drastically reduced. The purpose of such schemes is to increase the chances of being caught for not complying.

The movement of waste tyres across State and Territory borders currently comes under the NEPM for the movement of Controlled Wastes, where waste tyres are classed as *controlled waste*. This NEPM is relevant for the options discussed here and a brief description follows.

The NEPM requires the jurisdiction of origin (where the waste originates) to ensure that transport of controlled waste is subject to licence (which is recognised for this purpose by other jurisdictions). All movements of controlled waste are subject to authorisation and the NEPM provides that the jurisdictions, both of origin and destination (where the waste finishes), ensure that the movement is appropriate and that the receiving facility is appropriate to receive that type of waste. Tracking requires information to be supplied by the waste generator, the waste transporter and the receiving facility.

NEPC reports annually on activities under the NEPM, but the quantities of waste tyres are not separately reported, and we have not been able to obtain detailed information on interstate movements of waste tyres from individual jurisdictions.

The model for a tracking scheme is a scheme implemented in South Australia as described below.

The SA EPA aims to ensure that all waste tyres find their way from the waste generator (tyre dealer, transport company, farm or mine site) to a licensed waste facility (retreader, recycler or shredder) using a licensed transporter (who may also be the retreader or recycler, or a specialist casings dealer). The key elements of the tracking system are as follows:

- only whole tyres are tracked;
- individual transactions in waste tyres are reported on a Waste Tracking Form (WTF), and signed off by the generator, transporter and waste facility;
- SA EPA engages in limited educational and audit activities to ensure that waste generators contract solely with registered waste transporters for the removal of waste tyres and that the transaction is recorded on a WTF;
- there are special provisions for small or once-off transactions in waste tyres with approvals from EPA; and
- SA EPA has complementary arrangements for tracking inter-state movements under the NEPM.
Whole tyres only

The tracking system deals solely with whole tyres - SA EPA does not track tyres that are destined for landfill beyond the shredder. As part of their licence conditions, shredding operations are required to submit an annual return showing how many tyres were shredded and landfilled or recycled. This suggests a combination of the following:

- the cost of shredding is such a significant part of the cost of legal disposal that, once a tyre is shredded, there is little remaining incentive to avoid proper disposal; and
- shredding companies have large investments in several States, and are unlikely to risk the damage to their reputations that would result from the detection and exposure of illegal dumping of tyres for which they had been paid a disposal fee.

Waste Tracking Form

The WTF is in three sections (denominated A, B and C) and each form comprises four duplicate dockets (green, white, yellow and blue). Note that:

- the WTF originated as a liquid waste tracking system and now serves both liquid waste and waste tyres;
- sections A, B and C are completed by the waste generator, transporter and facility respectively;
- the transporter facilitates the process by collecting the blank forms from the SA EPA, ensuring the waste generator and facility complete their sections, and returning a copy to the SA EPA; the SA EPA records the returns on an electronic database;
- the generator retains the green docket with sections A and B completed, but not section C. All sections are completed on the remaining dockets; the white docket is returned to the SA EPA, and the yellow and blue dockets are retained by the facility and transporter respectively; and
- the transporter and facility do not enter separate counts of the tyres that are transported and delivered - they confirm the count originally made by the generator.

It is often impractical to track specific shipments from generator to waste facility. For example, tyres are typically collected from various sources on a ‘milk run’, classified and grouped on the truck or at some sorting facility, then delivered to various destinations. Tyres that lose their identity in this way are tracked from generator to transporter on one WTF - and then from the transporter to the facility on a second WTF. In the former case the transporter is both transporter and (intermediate) facility and completes sections B and C of the WTF. In the latter case the transporter is both (intermediate) generator and transporter, and completes section A and B.

Audits, education and leadership

The WTF can be circumvented in two ways. First, tyres can be illegally disposed of by the generator or by the generator and transporter acting in concert - without initiating the WTF. Second, the facility can collect the gate fee on deliveries under the WTF but still dispose of the waste illegally - possibly in concert with the transporter to save on transport costs as well. Audits are part of the answer, in that:

- waste generators are obliged to contract with a licensed transporter to dispose of waste tyres and are subject to audit against their sales of new tyres, which should tally with their collection of green dockets;
- waste depots are subject to audit against their production of tyre derivatives, for example, retreaded tyres, shredded tyres, crumb rubber, etc., which should tally with their collection of yellow dockets; and
• waste transporters who nominate themselves as the waste facility should generate equivalent docket where they are nominated as the waste generator - the SA EPA conducts this audit directly on its database.

But the educational effort is also substantial, particularly to advise waste generators that they are responsible for the eventual disposal of waste tyres - they cannot hide behind a fly-by-night or bankrupt transporter. Other important drivers are:

• the enthusiasm of the larger tyre waste transporting operations to regularise the business - it is a competitive device for them; and

• the desire of professional waste operators and retailers to be seen to do the right thing.

Once several large retail chains participate in the system, a large part of the waste tyre business, including transporters and receival facilities, would be induced by commercial considerations to adopt the tracking system in order to retain business.

**Special provisions for small and one-off transactions**

Use of the WTF becomes cumbersome in two situations:

• where new tyres are bought by individuals without returning the worn cases;

• where a land-holder wants a relatively small number of tyres for, say, erosion control or to build a dam.

In the first case, the SA EPA obliges the retailer to record the name, address and licence number of the purchaser. In the second case, land-holders are not obliged to register as a waste facility if less than 5 tonnes of tyres are required, but they must obtain SA EPA approval for the intended work and that paperwork must accompany the WTF as a substitute for the blank section C. In other words, the SA EPA aims to have waste generators account for every single waste tyre. They have not achieved that objective but claim to be working steadily towards it.

**Further development of the tracking system**

SA EPA started to develop its WTF system in February 1996; it is still evolving. For example, discussions have been held for some time regarding the need for a separate waste tracking form solely for tyres. Waste tracking of tyres takes approximately 50%-60% of the resources of the entire tracking system. More movements of waste tyres are tracked than for any other waste commodity. This means that:

• further development of the system in rural areas depends on the viability of mobile shredders that could be used in a round-robin fashion to deal with stockpiles of waste tyres, and reducing transport costs of waste tyres from country areas to stand-alone shredders; and

• SA EPA is open to industry’s suggestions for modifying the WTF and associated procedures to reduce compliance costs, including the use of electronic reporting systems.

SA EPA has initiated a system of annual returns for waste facilities to provide more detail on the actual disposal of waste tyres, for example, numbers shredded, retreaded, etc.

**4.3.2 Option 2: National uniform regulation**

The Australian Constitution is silent in respect to protection of the environment. As a consequence, responsibility for the environments resides with the States (and now with the Territories), except for those matters that can only be dealt with on a national basis or where the relevant powers have been expressly referred to the Commonwealth.
Each of the States and Territories already has in place specific government programs and measures to deal with waste tyres. The management of waste tyres is also required to comply with the broader regulatory framework and government policies, particularly those that relate to the protection of the environment and management of waste. The development of a national approach for waste tyres must take into account the existing instruments at the State and Territory level. However, the possibilities available to the individual jurisdictions and the consequent effectiveness of State-based measures have certain limitations and these are discussed below.

In addition, there already exist a number of broad statutory requirements regarding uniformity across Australia. Section 92 of the Australian Constitution prohibits actions that would restrict trade between States. More recently, the mutual recognition requirements adopted by all jurisdictions state that approvals granted to products in any part of Australia are to be recognised in other jurisdictions.

In the case of the environment, the Inter Government Agreement on the Environment (IGEA) provides that the objectives of the National Environment Protection Council (NEPC) are that (as stated in the NEPC Act 1994):

- a) people enjoy the benefit of equivalent protection from air, water or soil pollution and from noise, wherever they live in Australia; and
- b) decisions of the business community are not distorted, and markets are not fragmented, by variations between participating jurisdictions in relation to the adoption or implementation of major environment protection measures.

It is notable that the details regarding the implementation of each of the NEPMs are to be decided by each State and Territory, and are not uniform. The powers vested in NEPC are restricted to making NEPMs and assessing and reporting on their operation. The NEPM on the movement of controlled waste does not prescribe the details of licensing for waste transporters. From a perspective external to the NEPM development process, it appears there has been a conscious decision to restrict NEPMs in general to specifying outcomes, leaving it to individual governments to prescribe the detail of how the outcomes are to be achieved in their area of responsibility. This perception is echoed in views that have been expressed in regard to the NEPM on air quality.65

The option to be considered here involves a greater level of uniformity, not just in the framing of regulatory provisions but even in the way that the available powers are used to enforce the requirements. Uniform regulation could be applied to:

- licensing/registration requirements for waste tyre operators;
- restrictions on waste tyres going to landfill, including outright bans (see below in Part II.6);
- the definition of beneficial use of tyres; and
- limits on the threshold of number of tyres before licensing or approval is required.

A frequent comment has been the lack of enforcement rigour of powers available to regulators. For a nationally uniform regulatory framework to operate as envisaged there must be a uniform approach to the way that the regulations are enforced.

### 4.3.3 Option 3: Payment at point of delivery

This option involves a guaranteed payment for waste tyres brought to an approved receiveal facility. The most administratively simple approach would be to set up a centralised facility to accept waste tyres (see Part II.5) which would make the payments.

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65 Morgan (2000).
In the absence of a central facility, the delivery payment would remain constant across all types of receipt facility (including landfills), notwithstanding that some end uses may be deemed to be of more value than others. Differences in value could be taken into account in a separate scheme that provides benefits differentiated on the basis of the perceived value of individual waste tyre practices (see Part II.5). Higher levels of benefits could be used to bid for additional tyres.

The delivery payment is meant to provide an incentive to avoid inappropriate disposal only and would be set to cover average costs incurred by the waste tyre collector. The payment would be significantly less than the tyre levy if this option were to be introduced.

### 4.3.4 Option 4: Environmental rating scheme for tyre dealers

Tyre dealers are located at the point in the tyre chain where the tyre becomes waste, and are generally referred to as waste generators in this report. In view of this, as well as the large number of tyre dealers in Australia, dealers and the arrangements they make with collectors are viewed as the most vulnerable point in terms of inappropriate disposal of waste tyres.

This option would provide for a scheme where dealers were rated according to the attention they paid to good practice in managing waste tyres. The scheme would be similar in concept to energy efficiency star rating schemes. Dealers could use the rating as a selling point, and the preference of environmentally aware tyre purchasers would be to buy tyres from a dealer with good environmental credentials. Thus market forces would provide incentives for dealers to behave in an environmentally responsible manner.

The rating awarded could be based on the destination of waste tyres after leaving the dealer, with the rating ranging from a low for dealers who arranged for inappropriate disposal of waste tyres, to a maximum for dealers who ensured their waste tyres were sent to high value management practices. Alternatively, or in parallel to this, the rating could reflect overall good practice including the provision of advice on tyre maintenance or the offer of tyre checks at regular intervals during the life of the tyre.

### 4.4 Assessment

#### 4.4.1 Option 1: Tracking scheme

**Administrative and compliance costs**

The costs for a tracking scheme are estimated first on the experience with the SA scheme and then extrapolated to yield national estimates.

We distinguish between the administrative costs of SA EPA in developing, maintaining, and using the tracking system, and the compliance costs of industry in completing, returning and storing the WTFs. Conservative estimates of these costs are presented and explained in Table 4.1. The total cost of $250,000 is for approximately 1.5 million EPU generated in SA each year, or about 17 cents per tyre.
Table 4.1  Estimated cost of the WTF system in SA  
(development phase)

<table>
<thead>
<tr>
<th>Administrative costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 of an administrative officer @ $75,000 p.a.</td>
<td>$7,500</td>
</tr>
<tr>
<td>0.75 of an administrative officer @ $55,000 p.a.</td>
<td>$41,250</td>
</tr>
<tr>
<td>0.4 of a data entry operator @ $30,000 p.a.</td>
<td>$12,000</td>
</tr>
<tr>
<td>Total salary</td>
<td>$60,750</td>
</tr>
<tr>
<td>Printing and distribution of forms</td>
<td>$15,000</td>
</tr>
<tr>
<td>Multiply by 2.0 for overheads</td>
<td>X 2.0</td>
</tr>
<tr>
<td>Total administrative costs</td>
<td>approx. $120,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Compliance costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per WTF (detailed below)</td>
<td>$1.67</td>
</tr>
<tr>
<td>Multiply by 40,000 WTFs in a full year in SA</td>
<td>X 40,000</td>
</tr>
<tr>
<td>Total compliance costs</td>
<td>approx. $67,000</td>
</tr>
</tbody>
</table>

Derivation of compliance cost per WTF

- There is no extra work in counting tyres for the WTF because tyres are routinely counted in all waste tyre transactions.
- Assume that it takes 4 minutes to complete and handle each WTF – one minute to complete each of the three sections and one minute in storage, handling and dispatch to the EPA. Hence 15 WTFs are completed each hour.
- Makes no allowance for overheads.
- Assuming a gross wage is $25.00 per hour, each WTF incurs compliance costs of $1.67.

Note:

a) Overheads include labour on-costs, office space, materials and equipment, communications and travel costs, and the cost of providing WTFs free of charge to transporters. About 40,000 WTFs will be processed each year when the system is fully developed.

These estimates are likely to overstate the true costs for several reasons. The costs relate to the waste tracking system in its development phase, and the one-off consultative and educational effort has essentially been phased out.

While Table 4.1 represents good estimates of the current administrative costs of the SA EPA (based on discussions with the relevant officers), compliance costs could be much lower than our figure. For example, form-filling is the sort of task that is done while socialising or chatting about business, or while waiting for something else to happen, like the opening of a gate or the arrival of a co-worker. It is not difficult to imagine that WTFs are routinely completed without any impact on the productive capacity of the enterprise.
The paper-based system could be improved, for example, by pre-printing WTFs with the details of routine users. Redesign of the system for greater efficiency is currently in the hands of the industry. There are benefits for industry as well. The WTF is likely, in some cases, to replace other business records, perhaps improving them. And it may save operators time and effort in the event that a tyre dumping incident triggers an investigation of their tyre disposal practices.

On the basis of an estimated all-up average cost of $0.17 per tyre, the aggregate annual cost for Australia (18 million waste tyres per year) is $3.1 million.

The tracking scheme will not be effective unless there is a strong possibility that non-compliance will be detected. Accordingly, the tracking scheme will need to have an effective audit function, as well as educational activities to ensure that waste tyre operators are aware of their responsibilities. In aggregate across all jurisdictions it is assumed that the audit and education activities will require 2 full time equivalent inspectors with a total annual cost of $300,000.

The all-up cost estimate is $3 million per year, or approximately 19 cents per tyre.

**Benefits**

How effective would such a scheme be in practice? The view of the consultancy team is that with a strong audit function, the number of waste tyre operators willing to take the risk of being apprehended will fall to very low levels, and the numbers of illegally dumped tyres would be reduced proportionally. Anecdotal evidence from industry suggests that the level of inappropriate disposal in SA (the only State that has tracked tyres in the past) is lower than in other jurisdictions, though this may not be due only to the tracking scheme.

Importantly, a tracking scheme, modelled on the SA EPA example, focuses on the arrangements between the waste generator (generally the tyre dealer) and the tyre collector/transporter. This is the weakest link in the chain, where waste tyres can ‘disappear’ from the system. Proposals for a tracking scheme should be designed with this weak point very much in mind.

The tracking scheme will provide ongoing data on the numbers of waste tyres and their destination, which would fill major gaps that the present study has encountered. Such information would be invaluable for policy development.

**Suboptions**

It has been argued by some stakeholders that waste tyres do not pose risks of such magnitude as would justify the introduction of a comprehensive tracking scheme in the form sketched out above. Moreover, the existence of a tracking scheme might be seen by some as implying that waste tyres are more hazardous than in fact current knowledge indicates.

It is certainly true that information at a level adequate for much policy analysis could be collected at a much lower cost than the estimates indicated above. One example of a simpler scheme is where waste tyre operators would report inventory levels and flows on a regular basis, perhaps annually. This level of data would be expected to generate reliable estimates of the extent, in aggregate, of inappropriate management practices but would not have sufficient detail to identify those who are not complying with the requirements. Nevertheless, the information made available might allow the development of a much better targeted scheme to detect non-compliance (and determine if, in fact, such a scheme is justified). Thus a two-stage process could be considered, with the first stage defining the problem to be addressed by the final version (for example, if tyres become a ‘valuable’ resource there will be a direct financial incentive not to dispose of tyres inappropriately thus possibly doing away with the need for a tracking system).
Another consideration is that a tracking scheme may turn out to be an interim measure while one or other of the options described in later sections are developed and introduced. In that case, it would be sensible to minimise development costs.

4.4.2 Option 2: National uniform regulation

The question of regulatory federalism has underlain much of the political debate in Australia during the last century (and before), and extends well beyond the management of waste tyres or even purely environmental matters.

At the heart of the debate is the trade-off between the benefits from a uniform approach across the nation and the loss of flexibility for individual jurisdictions to tailor systems to take advantage of the particular characteristics within a State or Territory.

Uniformity provides a range of benefits for those firms whose operations span more than one jurisdiction, since it removes the requirements for different practices within each jurisdiction and the associated complexities this imposes on corporate management. For example, under uniform regulations, equipment meeting the same design standards can be used in each State or Territory, and equipment can be moved across borders without the need for expensive redesign or modifications.

Uniformity also provides a level of control in regard to movements of waste tyres across borders. Where numbers of waste tyre generators are concentrated near a border (as is the case with major centres of population such as Canberra and in south east Queensland), there may be opportunities to escape some of the costs of disposal by transporting tyres to the adjoining State or Territory (without complying with the NEPM). Uniform regulation would certainly remove some of the attractiveness of this type of activity but, as we suspect is the case for waste tyres generated in the ACT and then disposed in NSW, the major driving force may be the greater availability of inconspicuous dumping locations rather than a more relaxed regulatory regime.

The other side of the coin is that a national approach by its very nature may fail to take full advantage of the conditions that are peculiar to individual States and Territories, or to allow for specific difficulties and problems. This drawback is likely to be exacerbated if the national scheme relies heavily on a prescriptive rather than a performance-based approach.

Differences between States and Territories may be due to a number of factors, including:

- differences in physical conditions (climate, topography, soil types) or the presence of sensitive environments that need to be protected: such differences may provide varying motivation for the level of protection against environmental damage;
- differences in economic factors (relative importance of industries such as mining), which may make certain options irrelevant; and
- differences in demographic factors (concentrations of waste tyre generators in urban areas, scarcity of landfill space), which may influence the feasibility of pursuing some options in certain areas.

Part 1.5 provides an overview of some of the differences in regulatory approach and waste tyre policy across Australia. In the case of Victoria and Queensland, the decision to allow energy recovery from waste tyres appears to have resulted in a more light-handed approach to controls in Victoria, and consideration of total bans on waste tyres to landfill in Queensland. The design of the regulatory framework in the less densely populated States and Territories appears to have been relatively light-handed, perhaps reflecting the lower pressures for finding solutions to waste problems. Finally, jurisdictions with a high representation of remote settlements, and particularly mine sites, have addressed these problems more or less explicitly.
For the rest, the variation in how States and Territories have developed their regulations seems little related to the substantive differences across States and Territories.

A uniform approach would almost certainly impose greater costs on the less densely populated States and Territories while possibly reducing the stringency in some other States. Those States and Territories that might face the greatest rises in dollar costs are likely to be the ones least affected by cross-border movements of waste tyres due to the remoteness of their settlements. While exceptions could be provided for in specific cases, this immediately weakens the case for a uniform approach and the consequent benefits. Also the benefits to industry as a result of working under uniform requirements may be relatively modest in the case of waste tyres.

There is also the question of how standardisation might be achieved. The earlier discussion suggests that the NEPM process in its current form is unlikely to be suitable and in any case the time taken to develop and implement a NEPM is typically of the order of two years. The experience with alternatives such as inter-governmental agreements suggests that they are also time-consuming.

At the end, the real question is: do the problems associated with waste tyres justify such an effort? In view of their relatively low level of environmental impact and the availability of alternatives which are expected to be more effective overall (specifically, with the potential to address intrastate issues), the view of the consultancy team is that the answer is no.

Of course, States and Territories with adjoining borders could still elect to enter into agreements to control cross-border traffic in waste tyres. The avoided ‘transaction’ costs of reaching agreement represent one benefit from national uniform regulation.

Finally there is the question of enforcement rigour. All States and Territories have provisions for imposing penalties for non-compliance. Certainly, there have been some high profile prosecutions in relation to large tyre dumps and presumably there is other activity by the regulators which does not reach court. However, there are anecdotal reports of people getting away with illegal activities, though in many cases it is suspected that the activity is legal though it may not be environmentally sound or represent best practice.

It is our view that higher levels of enforcement would be successful in detecting non-compliance, particularly since many jurisdictions now have the benefit of a tighter regulatory framework. But this work is resource intensive and there are often more environmentally urgent matters vying for the time of inspectors. Given a plausible level of resources and willingness to launch some form of action, it is likely that there would still be substantial numbers of tyres that are disposed of in inappropriate ways.

4.4.3 Option 3: Payment at point of delivery

The benefits of this option in terms of the reduction in inappropriate disposal are provided by direct incentives to bring tyres to designated receival points. Provided the payment is set at an appropriate level, the effectiveness of the option should be very high. Since the ‘payment’ for inappropriate disposal is zero, then any positive payment should be sufficient. If this option were implemented as part of a product stewardship scheme, then the payment would logically cover collection and transport costs.

It can be expected that this option would result in tyres being taken from dumps in order to receive the payment. The reduction in tyre dumps is a benefit in itself, though allowance should be made in the funding arrangements for the increased payments for tyres that may suddenly appear. Of more concern is the possibility that some people, knowing of the imminent introduction of the payment scheme, may hoard tyres. It would be difficult to design the scheme to control directly for this possibility. However, environmental regulations that control the number of tyres that may be stockpiled can be expected to limit the number of tyres involved.
In addition, it would be counter-productive to encourage imports of used tyres by offering payments at the receival facility at the same time as measures are imposed to control the import of used tyres.

4.4.4 Option 4: Environmental rating scheme for tyre dealers

The rating scheme could be administered by the government but it would seem based on current experience that there would be substantial resourcing difficulties. An industry run scheme would not be mandatory. Dealers that choose to remain outside the scheme would be at risk of commercial disadvantage, though this may only be a strong force in larger centres where competition is strong. Some form of auditing would be needed to ensure continuing compliance with the awarded rating, including some form of reporting for firms who do not comply. The chances of success of the scheme would be increased if the support of the major tyre chains could be obtained.

The benefits of the scheme would be the number of waste tyres that are no longer inappropriately disposed as a result of dealers behaving more responsibly. What level of effectiveness could be expected from such a scheme? While surveys have demonstrated that many people have genuine concerns about the environment, this does not always translate into changes in behaviour particularly if it means higher costs. Certainly, to be effective, the scheme needs to be promoted by a high profile public awareness program to explain what the ratings are and how they are intended to lead to better outcomes.

In the end, however, it is the expectation that dealers have as to the weight attached by consumers to the ratings that is important since the benefits will be driven by actions on the part of the dealer rather than the purchaser. Some dealers may expect customers to react to the rating scheme as a measure of overall merit for dealers, rather than restricted to environmental performance, and be swayed to participate in the scheme as a result.

In any case, such a scheme would provide rewards to those dealers that behave responsibly in relation to waste tyres.

4.5 A national approach?

There is no intrinsic reason why individual jurisdictions could not develop a tracking scheme restricted to their own State or Territory. Such schemes could be meshed with the requirements for the NEPM in regard to cross-border movements of waste tyres. Nevertheless, it is to be expected that there could be considerable value in a national arrangement that integrates the tracking schemes from the individual jurisdictions. It would only be necessary for the national arrangement to integrate the cross-border flows: the internal operation of the scheme within each State or Territory could remain a ‘black box’ as far as the other participants were concerned. There should be possibilities for modifying the existing arrangements under the NEPM to reduce costs for such a national arrangement.

It is the view of the authors that a truly national scheme integrating all States and Territories is not necessary, and that the costs of integrating individual schemes are unlikely to be justified in terms of the relatively small proportion of interstate movements of waste tyres. Certainly in the short term, until there is a better understanding of the number of tyres that are transported across State borders (both legally and illegally) it would seem unwise to commence the process of designing and implementing a national tracking scheme.

The arguments for national uniform regulation stand or fall on the value of a national approach, and these have already been discussed above.

The payments for waste tyres at the point of receival at an approved facility would have to be a national scheme if it was part of product stewardship arrangements. A uniform nationally based scheme would avoid the problem of waste tyres being sent interstate so as to attract the payment.
A national rating scheme for dealers would have advantages if, for example, the major tyre chains were targeted. Also, overall administration of the scheme by a national body would be more effective, though auditing would perhaps best be conducted at a local level.
5 Improved Value from Waste Tyres - Managing the Resource

5.1 The opportunity

The opportunity in this section and [Part II.6] which follows is to extract the maximum value from the waste tyre resource, after allowing for the associated costs, both financial and non-financial. While the opportunity is much the same in the two sections, the impediments form two quite distinct groups and it is appropriate to discuss them separately.

5.2 Impediments

The impediments to be considered in this section relate in the main to the ‘supply’ side in relation to increasing the beneficial use of waste tyres. Waste tyres considered as a resource differ from many other resources that are used as inputs in the manufacture of other products or as an energy source.

The supply of waste tyres is largely fixed. Tyres are an essential part of a vehicle providing contact with the road surface and transmitting tractive, braking and steering forces. Vehicle owners are forced to buy tyres, but tyres constitute a fairly small proportion (of the order of 3-4%) of total vehicle costs. Thus the generation rate for waste tyres is insensitive to changes in consumer choice.

There are two ways that the supply (generation) of waste tyres may be modified. The purchase of replacement tyres may be deferred but, at most, for a short time. Also, a vehicle owner may choose to switch brands and this could affect average tyre life, but the effects will be essentially second order. The major determinant of the number of waste tyres generated is the aggregate distance travelled.

At the moment, waste tyres are seen as a ‘problem’: how do we manage waste tyres in a sustainable way? But even now there are concerns on resource security. In any commercial activity, investors will not commit substantial sums of money unless they have good market prospects for their products, but in the case of using waste tyres an equally important consideration is an assured access to inputs where the supply is largely fixed. Investment is an inherently risky activity since funds have to be committed upfront, while the returns may not be received until some time later when conditions may have changed from those expected when the investment decision was made.

As new applications are developed, or existing ones made more attractive, the demand for waste tyres will rise. Prices will also rise reflecting the increased value and the higher price will allow more waste tyres to enter the scheme (for example, it will be commercially viable to transport waste tyres a greater distance and this will increase the effective catchment for waste tyres). Also, some demand may be met by increased imports of used tyres, though this is a matter that is considered elsewhere (see [Part I.2]). Finally, tyres may be obtained from waste stockpiles and, to a lesser extent, tyres that have been dumped at different locations.

Not all waste tyres are available for high value uses, for example due to the costs and difficulty of collecting tyres from remote sites (see [Part II.8]).

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66 In supply-side analysis, as the demand for an input rises the price will increase and it is often valid to assume that more of the input will be produced, perhaps at progressively higher price. In the case of inelastic supply, there is no scope to increase the level of production of the input.
Other than these possibilities, there is no way for the supply of waste tyres to adjust to the fluctuations in demand, or to keep up with the increasing demand if this exceeds the natural rate of increase which is largely proportional to aggregate vehicle kilometres. If one user manages to increase their share of waste tyres, this will be at the expense of another user.

In looking at options for managing the resource, it is essential to make an estimate of the ‘real’ value of a waste tyre. If waste tyres are intrinsically valuable, then this would suggest that there is a demand for the products that can be made from them or to use their energy content. Managing the resource is then a matter of putting in place a scheme that facilitates the establishment of effective links between ‘producers’ (waste tyre generators) and users (processors or other applications).

In addition to the long-term trends in demand and supply for waste tyres, there are other more pressing considerations. At present, the constraints arise not so much from a shortage of waste tyres in aggregate, but rather inefficiencies in the delivery to the end-user.

Collection of waste tyres is an activity that is characterised by low barriers to entry. Virtually anyone with a truck with a suitable tray can enter the industry, even if the truck may be used for transporting other items at different times. The only other requirements are access to some waste generators as customers and, for those who concern themselves with such matters, a licence or equivalent from the regulator.

The result has been that a considerable number of waste tyres is collected by small operators, many working for themselves, and in a less than orderly situation. There have been two consequences. The first is that the absence of proper controls has made the waste generator/collector point the most vulnerable link in the waste tyre chain in relation to inappropriate disposal (refer Section II.4).

The second consequence is that this can place at risk the operations at certain receival facilities. Commonly, there is little stockpiling of tyres at these facilities, for both commercial (just-in-time operation) and fire safety reasons. This means that the facility must receive a steady stream of waste tyres to meet the day-by-day demand for its operations, and in turn make the payments on the debt from the initial investment. The situation at the moment is that often the level of assurance of obtaining the required number of tyres places the commercial viability of the operation at risk. The perception of these risks will be an impediment to further investment.

As an indication of the consequences of mismatches between supply and demand, industry representatives have reported that a proposal for a cogeneration plant using waste tyres as fuel did not proceed largely due to concerns regarding the security of supply.

5.3 Options for managing the resource

Options proposed to overcome the impediments are required to be assessed against certain considerations or criteria. These criteria may be mutually contradictory, and include:

- compliance with National Competition Principles and the Trade Practices Act;
- flexibility to take advantage of new technological or market developments; and
- provision of sufficient assurance that individual investors will be confident in committing funds.

5.3.1 Option 1: Legislative support for tied agreements

To meet the concerns regarding resource security, the most direct approach is to guarantee supply explicitly. Under option 1, legislation would be enacted that provided for the conditions of supply of waste tyres to specified end-users. Conditions
covered in the legislation might include the number of tyres, the sizes or quality of the

tyres, and certain delivery requirements such as timeliness.

5.3.2 Option 2: Centralised market scheme

This option would involve two infrastructure components.

**Holding facilities**

Firstly there is a need for a physical facility that would assemble and sort waste tyres,
and make them available for ‘sale’ on some basis.

**Administration scheme**

In addition to the physical infrastructure, it will also be necessary to establish administrative infrastructure. While the two types of infrastructure are not completely independent, they will be dealt with separately. The administrative schemes to be considered are those for managing the flow of tyres in an orderly fashion: a discussion of options for providing assistance to specific high value practices for waste tyres is located in Part II.6 below.

Underlying the success of a centralised administration scheme is a requirement that the ‘manager’ of the scheme be independent of both the waste tyre collection and transport operators, and the waste tyre processors and downstream users. This is naturally the case in those options characterised by a more or less free market, but is also an important consideration for options where the manager has the power to exercise considerable control. Similar considerations regarding independence, accountability and transparency apply in the discussion on industry organisations (PROs) in take back schemes under the extended producer responsibility concept (refer Part II.2).

A range of suboptions (or details of design) could be considered and evaluated in regard to the form that the administration scheme might take. The choices are driven largely by the degree of central control that is seen as optimal for the management of flows of waste tyres.

In addition, there is the question of the degree of involvement of the tyre industry in managing such schemes. Regardless of the answer to this question, it is likely that the Government will have some role as a midwife at the birth of such a scheme. In particular, the establishment of such a scheme would need ‘seed funding’ or at least a loan from the Government. Thereafter, the scheme should be at least partly self-funding, and the question of ongoing funding is discussed separately under each suboption.

Under all suboptions, individual recyclers are assumed to obtain sufficient financial benefit needed to pay for waste tyres at either the market price (suboptions 2.1 and 2.3) or the price set by the manager in option 2.2. The level of the benefit will vary across recyclers to reflect the differing values placed on certain waste tyre practices.

**Suboption 2.1: Free market operation**

At one extreme are schemes that allow free operation of the ‘market’ in waste tyres. In such an approach, the administration scheme would act rather in the way of a stock exchange for waste tyres. It would provide a system whereby bids for buying and selling waste tyres could be lodged, and the means for documenting any contracts that are reached. The only controls would be to ensure the integrity of the buy-sell process in terms of recording details of contracts and dealing with disputes related to market transactions. The responsibilities of the manager of such a scheme would be restricted

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67 The term Government as used here could refer to the Australian Government in the case of a national scheme or the relevant State or Territory Government otherwise.
to administration matters and, for example, there would be no vetting of possible trades.

Other design details concern whether the use of the central exchange facility should be compulsory for all trades in waste tyres. The alternative is to give individual buyers and sellers discretion whether to opt to take advantage of the convenience and security afforded by a central exchange, or to undertake off-market deals.

The costs of operating a central exchange facility could be met on a cost-recovery basis by means of transfer charges on individual trades. The costs of the physical facility could be met by those who make use of the facility. While the physical facility would assist in materials management, it is not an essential feature of suboption 2.1 since there is no need for either a physical or ‘virtual’ pool of tyres.

**Suboption 2.2: Manager retains strict control**

At the other extreme, the manager of the scheme would have the power to ‘approve’ or vet all potential trades in waste tyres. Or, possibly, the powers of the manager could be extended to directing that certain waste tyres as defined by the manager will be sent to a specified destination. In such a scheme, the function of the manager clearly is no longer restricted to administrative and recording activities, but involves questions of policy and the exercise of judgement. Thus, the manager will influence in a very direct way the structure of the waste tyre industry and the applications that will be adopted.

In considering funding for the ongoing costs there seems little to be gained by ‘charging’ one or other player in view of the controlled nature of the scheme if, as is likely, many of the waste tyre applications will need some assistance. The funding will come out of some reserve that has been set aside (perhaps from levy receipts) for the purpose of managing the scheme, and individual recyclers will not ‘see’ the monetary benefits that they enjoy.

**Suboption 2.3: Sale of waste tyres from a managed pool**

An intermediate position would be for the manager to administer the collection of waste tyres, and thus control the supply side by creating a ‘pool’ of waste tyres. The physical collection and transport of waste tyres could be contracted to individual operators by means of commercial arrangements, but the operators would not be linked directly to downstream parts of the waste tyre industry. Such an arrangement should mesh smoothly with proposals for a fee paid at point of receival of a waste tyre that were assessed earlier as a means to reduce inappropriate disposal. Alternatively the collection of tyres could be subject to tender by the manager.

The manager of the scheme could then arrange for the sale of waste tyres from the pool to the highest bidder. This could be done either on a ‘spot’ basis or through bids for longer term contracts. The expected shortfall, when the sale price fails to cover the receival payments, could be met by disbursements from the levy fund. As in suboption 2.1, market forces would determine the destination of waste tyres with the manager having a purely administrative role.

**5.4 Assessment**

Overall, the benefit of these options is that end uses will have access to the resource (waste tyres) in an orderly marketplace, which facilitates access to the resource for high value applications. The resulting increase in confidence in relation to security of supply will encourage investment in new plant that will increase the value from waste tyres.

The central facility scheme would simplify the administration of the point of delivery payment option discussed above in Part II.4 which is assessed as being an effective weapon in reducing the extent of inappropriate disposal.
5.4.1 Option 1: Legislative support for tied agreements

The advantage of option 1 is that it provides the ultimate in assurance for the investor in a facility that waste tyres will be available for the life of the facility. Moreover, no further involvement is required by industry or government in regard to the allocation of tyres to specific applications. The alternative is to have the flexibility of many agreements with room to tender competitively within a legislative framework as discussed under option 2 (centralised market scheme).

On the other hand there are a number of downsides. In practice, an agreement tying the supply of waste tyres to a single industry or firm means that other possibilities are closed out and this raises serious competition issues. The legislation supporting such an agreement may be deemed to be anti-competitive, in which case the relevant jurisdictions would need, under the conditions of the Competition Principles Agreement, to demonstrate that the public benefit criterion applies. The difficulty in such an argument is that waste tyres are not viewed as a major risk to the community on environmental grounds.

Tyre derived fuel

In general, this study is not about detailed evaluation of different practices available for the management of waste tyres. Nevertheless, a special case needs to be made in this instance for consideration of the use of waste tyres for energy. The reason for this is that tyre derived fuel (TDF) currently constitutes the only beneficial application for waste tyres that is taking a significant number of waste tyres (3 million EPU annually), and has the proven potential to absorb more tyres in the future.

The consultancy team agrees that providing guaranteed access to the waste tyre resource for the cement industry can be expected to be the most effective approach in reducing the number of waste tyres going to landfill at least in the short term. However, there are a number of drawbacks:

- the cement industry will be given a monopoly on managing the collection of waste tyres;
- the monopoly will be held by a downstream user rather than an independent waste tyre collector, and this increases the potential for barriers to new entrants to the downstream industry; and
- in the example of arrangements for the supply of tyres for cement making in Queensland, there appears to be an implicit subsidy to Queensland Cement which we estimate may be in the order of $1 per tyre (compared with landfill disposal).

It is the view of the consultancy team that these represent drawbacks to this proposal, and that trade-off between short-term gains and the prospects for long-terms improvements is not favourable.

5.4.2 Option 2: Centralised market scheme

The assessment is at two levels: physical management of waste tyres; and administrative arrangements for distributing the tyres to the end user.

Holding facilities

A centralised location for assembling tyres is seen as necessary in view of the general lack of stockpile capacity at receival facilities. The centralised facility could buffer day-to-day fluctuations in supply and demand. The aim would be to have the capacity to accept additional tyres, while maintaining sufficient tyres in stock to meet the demand from contract agreements or ‘spot’ sales.

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68 Since the technology of TDF is well developed, it is unlikely that innovation will bring this subsidy down, unless the price of the displaced fuel rises in the future.
Past experience indicates that the presence of a large number of tyres in one location runs a significant risk of accidental or purposely lit fires. On the other hand, such a facility could afford to invest in appropriate fire fighting and hazard reduction measures. In fact, since tyres are not overly easy to ignite, the major requirements relate to good access for fire fighting equipment and security measures to protect against wilful starting of fires and other damage. Queensland has developed environmental policy in regard to conditions of storage for tyres and Western Australia has statutory requirements for how waste tyres are to be buried in landfills. Whether these sorts of conditions would be appropriate for larger central facilities is unclear. The development of clear guidelines (perhaps at a national level) regarding best practice would be particularly useful.

In view of fire safety considerations as well as requirements for materials handling and sorting of tyres, a large area of land would be needed. Careful selection of the location and appropriate landscaping or similar measures would minimise the visual impacts. Another requirement is to protect the stored tyres from contamination. Ideally, this would take the form of a bunded and sealed hardstand area, though lower cost alternatives may be adequate. Measures would also be needed to minimise breeding potential for mosquitoes.

Some form of financial assurance could be specified to cover the cost of site remediation in the event of owners not fulfilling their responsibilities. The Queensland waste tyre strategy suggests remediation costs may be of the order of $30 per square metre, though this seems rather high and presumably refers to cases where the ground has become contaminated as a consequence of fire in the stored tyres.

Some waste tyres need not physically come to the central facility, but could be taken directly from waste generator to receival facility.

While the discussion above has been in terms of a single centralised holding facility, in practice there would be a collection of such facilities. The optimum size and location would be determined on the basis of the geographic distribution of the generation of waste tyres and the siting of receival facilities, as well as operational considerations for material handling. Analysis of such schemes is conducted routinely using operations research techniques.

Large concentrations of populations, such as found in the capital cities and surrounding areas, may each be able to support more than one holding facility. On the other hand, such facilities in smaller settlements may take the form of transfer stations. Waste tyres would be accumulated up to the stage where the number of tyres supports movement by large line-haul vehicles, which would then transport the waste tyres to a larger holding facility or directly to the end user. For remote settlements, subsequent transport may not be feasible and the value of holding facilities may need to be evaluated on a case by case basis.

Administration of the scheme

The benefits of having a physical facility (or a number of facilities strategically located) is that it forms the necessary first step in developing an orderly distribution system for waste tyres to bring together buyers and sellers. In particular, it facilitates the operation of a ‘pool’ of waste tyres under suboptions 2.2 and 2.3, some of which would be represented physically by the tyres at the holding facilities. Unlike the physical premises to hold tyres, which may be replicated even within one region, it is not feasible to have more than one administrator within a jurisdiction. The question of whether the jurisdiction is interpreted to be national or at the State/Territory level is taken up in Part II.5.5.

Refer Part I 6.6 for estimates of the financial gains and the reductions in emissions from using large capacity vehicles for the transport of waste tyres.
Suboption 2.1: Free market operation

Suboption 2.1 provides a formal mechanism for buyers and sellers to make deals. The proposals associated with physical infrastructure and the establishment of a waste tyre exchange remove the worst of the existing factors that stand in the way of an orderly market in waste tyres.

Under idealised conditions, free markets are predicted to lead to socially optimal outcomes. In the case of waste tyres, certain market ‘defects’ remain under this suboption. The most important of these arise from the relatively fixed supply of waste tyres, and the potential for one or a small number of agents to corner the market and exclude other (possibly more valuable) practices for dealing with waste tyres.

There may also be other causes for market instability resulting in wildly fluctuating prices and low confidence on the part of potential investors in waste tyre recycling facilities that they will be able to secure access to the required number of tyres.

Suboption 2.2: Manager retains strict control

The outcomes from this suboption would be similar to option 1 where access to the waste tyres stream is guaranteed. The difference is that here the contracts will be specified by the manager of the scheme rather than written into legislation. This reduces the resources needed in the cumbersome process of legislative amendment, but it leaves the problems associated with trying to pick winners.

Decisions made by the manager are going to have major financial consequences, and in some cases would result in firms going out of business. Without the scrutiny of Parliament in enacting legislation, careful attention would need to be paid to the selection of the manager and the decision-making process.

Suboption 2.3: Sale of waste tyres from a managed pool

In comparison with the free market scheme (suboption 2.1), this suboption would involve the establishment of a pool of waste tyres from which sales are made. Greater controls on the supply side (which traditionally has been the source of many of the difficulties) is expected to result in a greater level of stability in prices. However, in the absence of an approval role for the manager, there remains the potential for the market to be dominated by one or two players, at the detriment of the remainder of the industry and the community as a whole.

Discussion on administration

Proposals for a central administration scheme would appear to have considerable worth in view of the expected benefits from a more orderly market in waste tyres. The major difficulty is that reaping the benefits of market forces runs the risks of market domination. The trick in the balancing act is to determine the optimum triggers for, and the form of, intervention by a body that is external to the market.

A key question is whether the manager of the scheme should be Government or an industry body. Government fills the role of ‘fair broker’ but suffers from not having the detailed industry understanding needed to optimise the system. The ATMA\textsuperscript{70} has proposed a scheme where direct industry involvement would be through a secretariat which administers the scheme. Oversight of the secretariat and a monitoring and auditing function would be provided by a statutory body, with a broader representation extending to Government and private sector representatives not connected to the tyre industry. The need for oversight of decisions made by the secretariat is viewed as critical in the light of the issues associated with obtaining

\textsuperscript{70} ATMA (2001)
secure access to an adequate waste tyre supply for certain enterprises, and this is discussed below.

The selection of tyre industry members to be appointed to a secretariat may not be straightforward. The secretariat will make decisions that have significant commercial consequences and it will be necessary to find appointees who have the standing and trust to act in the best interests of the tyre industry as a whole, not to mention the community at large. Given the low level of cohesion observed in the waste tyre industry and the absence of an overall industry body, the consultancy team is of the view that there are substantial practical problems facing an industry based secretariat whose responsibilities extend beyond mere clerical activities.

Refer [Part II.2.2] for an overview of actions in Europe in comparable situations in regard to government control.

Any scheme that is adopted will need to deal with the existing arrangements between waste tyre generators, collectors and recyclers. As an interim measure, it may be necessary to take a light-handed approach in relation to existing arrangements. As a result of vertical integration or legal contracts, significant numbers of waste tyres are currently locked into specific destinations. It is not intended that these arrangements necessarily be overturned. However, as the scheme matures it is expected that more tyres will ‘appear’ and overall the number of tyres in the pool available for further distribution will increase (particularly if financial incentives are made available for tyres to enter the pool). It is our view that the scheme administrator should have considerable say in how to allocate those tyres which are not tied to current agreements.

The exact forms of these controls and powers will depend on how tight the supply of waste tyres becomes in the future. At the moment, there are many tyres going to landfill, but part of the reason for this is inadequate collection infrastructure inhibiting more valued uses. If markets for recycled tyres can be augmented by various forms of assistance, then it seems possible that demand could exceed the increased supply. In that case, the administrator may need to act to ensure that selected end users have access to long term supply guaranteed by legal contract.

It would appear impractical to allocate the entire expected supply of waste tyres to applications that depended on a fixed number of tyres. Either some applications would need to be sufficiently flexible that they could vary their requirement from day to day, or there would need to be some ‘slack’ in the system. Arrangements would be needed to deal with the slack in times of oversupply, such as spot sales, transport to another centre, or disposal to landfill.

5.4.3 Retreads

Retreads require separate consideration. The specifications for casings to be used for retreads are much tighter than for other end uses. The current collection arrangements for retread casings are dominated by single operators in at least two States. At the other end of the scale, it is understood that individual retreaders who collect casings indulge in wasteful practices to ensure a supply of the casings that they need.

The availability of holding facilities will certainly assist the management of casings, providing retreaders with a more efficient means of selecting casings in sizes that they need and avoiding certain wasteful collection practices that occur now. The considerations specific to casings for retreads arise from their positive value without government assistance. Current arrangements exhibit a range of beneficiaries of this market value:

- dealers who separate out the retreadable casings themselves and ‘sell’ the casings;
- waste tyre collectors and casing dealers who separate the retreadable casings which they then on-sell to retreaders; and
- retreaders who collect casings themselves.
If all tyres received at the central holding facility attract the same payment, then those operators who currently get the value of the casings will miss out. There would be no incentive to bring retreadable casings to the central facility and it can be anticipated that some operators would baulk at joining the scheme thereby reducing its effectiveness. The alternative of paying a premium for retreadable casings requires casings to be screened by the facility operator prior to, or at, receival and this is complicated by the uncertainties in assessing casings.

Retreading has distinct features and requirements and tends to be regarded by the other parts of the waste tyre industry as separate. In view of the above difficulties, it may be better, in the initial phases, to exclude retreads from the options considered in this section, until such time as detailed discussions with key stakeholders can resolve the issues that have been identified.

### 5.5 A national approach?

It would appear that legislative support for tied agreements to supply waste tyres would become prohibitively complex if applied at a national level, in view of the requirements for consistency between the amendments needed and other parts of the legal framework in individual States and Territories.

A national approach would almost certainly be required for the central administration scheme, in view of the need for a capability to handle interstate movements of waste tyres. In addition, the preferred option for funding the operation of the scheme as well as payments at point of receival (if this option is adopted) would be nationally based and this would add weight in favour of a national administration of the spending of the funds.
6 Improved Value from Waste Tyres - Industry Assistance

6.1 The opportunity

The previous section dealt with options that are aimed at improvements in the supply side of beneficial use of waste tyres. This section deals with the demand side, assessing options that target market aspects of beneficial uses for waste tyres. The opportunities are the same in each case: to generate greater net value for the community from waste tyres.

6.2 The impediments

By industry assistance, we mean certain activities that could be undertaken at an industry level that would result in community-wide (and even industry-wide) benefits, but which individual enterprises could not justify on a purely commercial basis.

Thus the justification for intervention derives from a different type of market failure from that associated with the generation of *externalities* (such as environmental or public health impacts) which are typically the focus of environmental regulation and are the main motivation for the options discussed in Part II.4. Market failure in this regard refers to situations where the operations of markets fail to deliver outcomes that are socially optimal as a result of the structure or operation of the market itself.

What are examples of this type of market failure? In some cases, firms that would be expected to be viable face great difficulties in attracting adequate finance to fund the investments needed during the starting up phase. Or entrepreneurs may opt not to pursue research and development (R&D) on new products because the R&D may have industry-wide applicability and the entrepreneurs cannot be confident that they will be able to capture a sufficient share of the resulting benefits. Or it may simply be that distortions in the market (or related markets for virgin materials, or landfill fees) suggest that a ‘second best’ outcome may be appropriate. One form of market imperfection arises from imperfect knowledge, perhaps as a result of preconceptions regarding the ability of a given product to meet specifications.

6.3 Options for industry assistance

Where market failure of the kind referred to above occurs, some form of ‘industry assistance’ may be called for and justified, provided that appropriate conditions are met. The experience with industry assistance provided by governments in the past is littered with examples where the initial good intention has resulted in costs being imposed on the community at large without a corresponding contribution by the industry towards the welfare of the community. The costs of such programs are represented not just by the quantum of funding provided by the government, but also the resulting ‘hidden’ costs, such as the possibility that more efficient firms have been crowded out of the market as a result of a subsidised competitor.

There are certain criteria that desirable industry assistance programs should meet:

- there should be a clearly demonstrated need (related to some form of market failure) for the assistance and the expected benefits should be explicitly identified;
- programs should be well targeted to those firms, and those activities conducted by a firm, which have been identified as needing assistance;
- ideally programs should have a sunset clause or, alternatively, ongoing programs should be subject to critical review at specified intervals for their continued appropriateness; and
• programs should be equitable and administratively straightforward with transparent decision-making.

6.3.1 Option 1: Direct regulation in regard to products

We include direct regulation as an option. Examples include relatively modest requirements in relation to producers making key information available, ranging through provisions for minimum standards, to absolute bans on certain products or processes.

6.3.2 Option 2: Direct assistance to recyclers

In effect, these are production subsidies.

Unit benefits

The discussion, here and in the corresponding part under assessment, will use as a model the payment of benefits to recyclers of waste oil under the PSA scheme introduced at the beginning of 2001.

In this scheme recyclers of waste oil who register as a manufacturer under the Excise Act 1921 and who meet relevant eligibility criteria are entitled to receive benefits under Part 2 of the Product Stewardship (Oil) Act 2000. The benefits are paid on the basis of each litre of oil recycled and the unit amount of benefit varies depending on the form of recycling. The amounts are prescribed in the Product Stewardship (Oil) Regulation 2000, and vary from 50 cents per litre in the case of re-refined oil (‘lube-to-lube’) to zero for certain reuse of used oil where there is minimal reprocessing and the activity is likely to be undertaken from purely commercial considerations. All benefits are treated as assessable income for the purposes of income tax.

There are also requirements that the recycling process and the products are to comply with environmental and other statutory requirements in the relevant State or Territory. To be considered for benefits, the recycler must undertake the final processing (recycling) stage prior to end use and the product must be used by that recycler or sold for end use (that is, not just processed and stockpiled).

The PSA for oil maintains a substantial degree of government control on the recycling process. The final requirement ensures that the benefits are not used merely to convert one mountain (or, more appropriately in the case of oil, lake) of waste into another. The payment is linked directly to the volume of oil recycled, and the government has made a judgement as to which recycling activities deserve the greatest level of assistance. The discussion below is based on material that has been prepared to explain the operation of the PSA for oil.

The benefits paid for each use have been determined by weighing up environmental and economic considerations and the likely available revenue. The benefit levels also take account of current prices paid for these products in the marketplace, and attempt to provide an incentive to undertake more recycling, whilst avoiding windfall gains.

Payment for the first category (lube-to-lube) is significantly higher than for others in order to encourage full re-refining of waste oil and thereby more sustainable management of the resource. The higher benefit reflects both the environmental and sustainability benefits that accrue, and the very substantial industrial and marketing investment that is needed to make lube-to-lube viable.

The level of benefits has been set by the Minister for the Environment, but the ongoing administration of the scheme is the responsibility of the Australian Tax Office (ATO), who will make rulings on the interpretation of the definitions of the benefit categories.

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71 Environment Australia (2000b).
A PSA for waste tyres could look rather similar to the newly implemented waste oil scheme. One design issue that would need resolution is whether benefit payments are to be paid on a per tyre or per unit weight basis. We would favour a per weight basis consistent with the discussion on levies in Part II.7.

Other forms of assistance

Other forms of assistance would be on a more or less case by case basis in response to submissions by parties seeking funding. One area where many firms experience difficulty is in raising capital in the start-up phase.

6.3.3 Option 3: Controls on landfills

One means of diverting tyres from landfill to more highly valued uses is to make disposal to landfill more expensive, or to ban tyres from landfill altogether. In this regard, there would presumably be some level of landfill gate fee that would make disposal of waste tyres so prohibitively expensive that it would act effectively as a ban. This option entails setting landfill gate fees at or above true costs (including externalities such as impacts on the environment and local amenity) of waste tyre disposal to landfill. This option can operate in conjunction with other options discussed here.

6.3.4 Option 4: Market promotion

There are a number of different forms that industry assistance could take. The NSW Tyre Industry Waste Reduction Plan provides for a number of activities by the Tyre Industry Waste Management Council (TIWMC) (numbers in the box below refer to paragraphs in the Plan) in regard to promoting markets for waste tyres and their products.

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**NSW Tyre Industry Waste Reduction Plan**

9.5 Demonstration sites

The Tyre Industry Waste Management Council (TIWMC) will develop and construct a series of tyre-derived product demonstration sites with the objective of encouraging architects, engineers, designers and other professional people involved in project specification and construction to use and specify tyre-derived products.

9.6 Market research report

The TIWMC will commission a market research report… The objective of the report will be to determine untapped or under-utilised markets for new and existing tyre-derived materials and products and to assist NSW manufacturers of these materials to capture these products.

9.10 Market development

The TIWMC will develop a market development program to assist tyre recyclers and tyre-derived product manufacturers to expand their markets.

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72 NSW EPA (1998)
The Queensland waste tyre strategy also nominates a number of actions to assist industry:

<table>
<thead>
<tr>
<th>Queensland Waste Tyre Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycling 1.1</td>
</tr>
<tr>
<td>Develop new markets for tyre-derived products through commissioning a market research report to determine under-realised markets for new and existing tyre derived materials.</td>
</tr>
<tr>
<td>Recycling 1.2</td>
</tr>
<tr>
<td>Develop and construct a series of tyre-derived product demonstration sites with the objective of encouraging engineers, designers, and architects to specify tyre-derived products in project specification and construction activities.</td>
</tr>
<tr>
<td>Recycling 1.3</td>
</tr>
<tr>
<td>Encourage the road construction and civil engineering industries to revisit the use of crumb rubber in road and highway applications.</td>
</tr>
<tr>
<td>Recycling 1.4</td>
</tr>
<tr>
<td>Produce a folder containing flyers of all tyre-derived products and materials manufactured in Queensland or from Queensland waste tyre materials, case studies, tyre industry contact directory, and other relevant information.</td>
</tr>
<tr>
<td>Recycling 1.5</td>
</tr>
<tr>
<td>Review the extent to which State and Local Government purchasing policies can be used to specify the use of waste tyre-derived products where these products are available and competitive.</td>
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These are the sorts of activities that could be considered in this option. They are by no means mutually exclusive and in fact could reinforce each other. These actions could also operate in conjunction with other options.

### 6.3.5 Option 5: Government purchasing policies

Most governments have developed acquisition policies whereby they give favourable consideration to certain suppliers or products. Local government associations have also been active in this field in relation to council purchasing. Option 5 would involve development and implementation of specific programs in relation to used tyres, such as requiring Governments to give specific attention to purchasing goods made from recycled tyres or fitting retreads to their vehicle fleets.

### 6.3.6 Option 6: Funding for research and development

By its very nature, research and development is a high risk activity, in terms of timing, technological expectations and market penetration of the product. Consequently, funding for R&D may be very difficult to source through traditional financing channels that tend, at times, to follow inflexible approval guidelines.

The other major justification for assistance in this area is where the R&D will generate benefits for the industry as a whole at a level to make it worthwhile in aggregate, but where no individual player would reap sufficient benefits to pay for the R&D.

Option 6 envisages a role for funding to be provided for R&D in cases where the R&D will result in welfare gains for the community as a whole but where purely commercial considerations acting by themselves will not deliver the required outcomes. Decisions on funding would be made by an appropriately constituted council or board established for this purpose.
The range of R&D activities that might be eligible for funding is quite extensive. At one end of the scale is relatively fundamental research into, for example, material properties that could be of very broad application though possibly requiring further work (perhaps by individual firms) to bring the results into practical use. At the other end of the scale, there could be fine-tuning of relatively well-established processes to improve the ability of the products to compete in terms of price and quality.

6.4 Assessment

A requirement common to a number of these options is a source of funding and, more importantly, a framework for making decisions on assistance. Decisions would be needed on a range of matters including:

- the types of activities and programs for which assistance is to be made available;
- the firms or individuals that would be eligible for assistance;
- limits on the amount of assistance to be given under the various options;
- criteria for allocating assistance; and
- the setting of conditions with which the recipient has to comply, including accountability (monitoring, reporting, assurances etc).

The PSA for oil is administered by the Australian Government, and it could be argued that the Government would also control a similar scheme for waste tyres.

The ATMA has argued that the tyre industry should have a greater role in the operation of the provision of assistance. It is the manufacturers and importers who will be most directly affected by a levy scheme if, as proposed, a levy is exacted at the point of manufacture or import into Australia. Their preferred approach involves a number of elements that go well past what is entailed in the PSA for oil, and includes infrastructure for managing waste tyre flows in a more orderly manner (see Part II.5).

On the administrative side, they envisage a secretariat together with a statutory body providing oversight and audit functions.

The ATMA proposals in regard to administration can be expected to be considerably more costly than the PSA for oil which, once established, is largely restricted to clerical functions and interpretation. However, the ATMA scheme is considerably more flexible in terms of the types of assistance that could be provided, and the associated infrastructure would deliver substantial benefits in other facets of waste tyre management.

6.4.1 Option 1: Direct regulation in regard to products

The advantage of direct regulation is that it delivers relatively high levels of assurance regarding certain activities. This can be valuable, or even essential, where there are major risks to human health, but is of little application when the goals are to do with improving the management of a resource.

The downside to regulation is that it imposes costs. Some costs are direct costs (represented by actual expenditures by the regulated community) while others are the costs of foregone opportunities (where certain prescribed activities, which would otherwise generate value for the community, are not allowed). Regulatory reforms by Australian governments have changed the emphasis in regulation to a focus on outcomes rather than prescribing the means to achieve these outcomes. Even regulation that is outcomes based will in many cases impose additional costs because of difficulties in accurately targeting regulation.

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73 ATMA (2001).
Not only is regulation a blunt instrument, it is also unwieldy and inflexible. What is desirable today may not be so a few years hence, and this is particularly so in the case of the waste tyre industry which is characterised by aggressive development of new and existing technologies and rapid changes in market demand. One effect of regulation is to stifle innovation, a major example of lost opportunities. And once it is recognised that current regulation is no longer desirable, the processes required to make amendments are generally costly and time consuming.

Even in cases of identified market failure, it is still generally preferable to allow market forces the greatest leeway possible. Regulation may be justified if the intervention in the market takes the form of addressing market failure but exploiting the powers of the market. For example, regulation in regard to provision of information may have a place in our toolbox (refer to the discussion in Part II.2 on tread wear information moulded on tyres). Even in the case of information, there needs to be careful evaluation of all the consequences of any proposed regulation. It would appear that stronger product-related regulation would be difficult to justify given the availability of market mechanisms that are likely to be not only much more effective, but also not cause the distortions and associated costs of heavy-handed regulation.

Implementation of product-related regulation would need to take into account the implications of mutual recognition agreements.

### 6.4.2 Option 2: Direct assistance to recyclers

One form of industry assistance is the provision of subsidies to those waste management activities that occupy the higher levels in the waste management hierarchy or activities that are assessed as valuable on some other basis, such as life cycle assessment. The effect of the subsidies is to modify the economics of supply and demand in favour of the activities that are to be encouraged.

Production subsidies of one form or another have been used extensively in Australia and other countries to support certain industries. They have been criticised by certain economists and others on a number of grounds:

- subsidies result in distortions to the operation of markets and interfere with the way that preferences of consumers and commercial decisions by producers are articulated;
- some subsidies are hidden and their effects are not straightforward to gauge;
- many subsidies are poorly targeted or are received by firms that do not use the subsidy in the way intended (in some firms, the subsidy may not change any decisions but merely contribute directly to increased profit levels);
- there is the potential for other sectors of the industry, or other industries, whose commercial interests are threatened by the expected effects of the subsidy to protest on the grounds of unfairness; and
- the provision of a subsidy removes incentives for a firm to look for greater production efficiency or products that are more valued by the market.

To meet these criticisms, subsidies are often targeted at industries that operate in seriously failed markets. Even in many such cases, other antidotes to market failure may be preferable (including the imposition of levies on competing activities). One area where some justification can be found for subsidies is the ‘infant industry’, where the subsidy provides the means to hurdle barriers in the early stages. For example, it takes time for markets, or market acceptance, to develop for certain products.

In view of the preceding discussion, it would appear that if production subsidies are to be considered as a form of industry assistance, then there should be a ‘sunset’ arrangement whereby after, say, five years the subsidy would cease. One effect of this may be to discourage some firms from investing in the industry, but it would avoid the ongoing effects of some of the criticisms indicated above.
On the other hand, a limited duration subsidy could be viewed as assistance to industry in the form of raising capital to start-up or enlarge their business (in effect, overcoming other hurdles in the establishment phase).

**Payment of unit benefits**

This scheme is conceptually straightforward to implement. Much of the necessary legislative changes to support the scheme, as well as the establishment of administrative arrangements, could take advantage of the work done in developing the PSA scheme for waste oil.

Once in operation, costs to industry would be low - at specified intervals a recycler would make a claim for benefits based on the quantity (number or mass) of waste tyres used within the accounting period. The handling of payments on claims by the ATO would be largely automated. Only matters of interpretation and audits would require specific attention. Another advantage is that benefits are received in a timely manner, reducing cash flow problems for recyclers.

The Government has committed $60 million over four years from 1 July 2000 during the transitional phase of the PSA. The funding is for strategic initiatives to increase high value oil recycling and ensure a sustainable oil recycling industry. Transitional assistance is an interim mechanism to engender change that will underpin the long-term viability of the oil recycling industry.

The funds will be used to:

- ensure a sustainable waste oil recycling industry;
- accelerate the uptake of waste oil from urban and rural Australia;
- facilitate the transition of the industry and the community into effective participants in the PSA; and
- as far as possible, address special difficulties that remote Australia has in the recovery and management of waste oil for appropriate recycling.

The transitional assistance will also be used to fund stewardship benefits, in the event that benefit payments exceed levy income (see next section).

The incentives in a scheme for waste tyres would work as follows. In the hands of the recycler, the benefit would make the recycling operation financially less problematic. Recyclers would be able to afford to pay more for waste tyres of a type suitable for their application or they may be able to drop the price of their products and thereby achieve greater market penetration. In many cases it can be anticipated that recyclers will do some combination of both. The outcome will be that the demand for and the price of waste tyres will rise. In response to the higher price, a greater number of tyres will be diverted from landfill and, more particularly, from inappropriate disposal.

The scheme has a number of drawbacks. The Government has to make decisions as to which types of recyclers to register and the unit level of benefits recyclers of different types should receive. This process is unlikely to be based entirely on objective criteria and depends on the Government making judgements as to the real financial value of the products and on the environmental and sustainability considerations, as well as the 'need' for assistance. In effect, it overrides the normal market mechanisms which allow values to be placed on goods by observing the prices of transactions, and where the flow of goods is a consequence of the prices.

To achieve a desired level of activity (either in aggregate or for a specific recycled product), the Government may need to adjust the unit benefit, possibly requiring incremental trial and error changes. The consequent uncertainty for industry would result in difficulties in decision-making.

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74 Refer Environment Australia (2000a).
Also, the existing waste oil scheme is rather inflexible, in that the benefits are defined in regulations. As new technologies appear, or markets develop, the setting of unit benefit levels may need to be reviewed which will involve a somewhat cumbersome process.

In view of these matters, consideration has also been given in the PSA for oil to a certificate based system that is similar in concept to trading schemes for pollutant emissions. Under this scheme, the Minister issues certificates to each recycler based on the number of tyres recycled. Any firm that wishes to manufacture or import tyres would be required to hold certificates covering the required number of new tyres. Tyre producers would make bids for certificates with sufficient merit points in terms of various waste practices.

The major advantage of the scheme is that the level of recycling (the number of tyres to be recycled) is set by the Government, rather than the amount of the payment to recyclers. Within the target level of recycling, market forces would operate to set the value of the certificates, and consequently the amount of assistance received by individual recyclers. The Government would retain some controls, particularly to prevent large firms from cornering the market in certificates which would otherwise be an effective practice to exclude competition from other potential industry entrants.

Notwithstanding the advantages, the certificate scheme is rather more complex than the current PSA scheme with direct payments to recyclers. It is not clear at this stage how a certificate scheme would operate in practice. The Government has foreshadowed a trial of the certificate scheme for waste oil, and it is considered that further consideration of a certificate scheme for waste tyres be deferred until some lessons can be extracted from the experience with the trial.

**Other direct assistance**

More direct assistance in raising investment capital could also be considered through, for example, capital grants or low interest loans. The advantages of such assistance are that it could be closely targeted in response to individual proposals. However, it would raise even greater fairness questions than would a subsidy based on unit benefits because the assistance would be provided on an individual firm basis, rather than to an entire industry sector such as retreading.

In addition, providing assistance for specific firms or products presupposes substantial expertise and understanding in regard to waste tyre technologies and markets. It is also very much a matter of trying to pick winners, with all the issues that that practice would bring into question.

**6.4.3 Option 3: Controls at landfills**

The great attraction of using landfill fees to encourage diversion of waste tyres from landfills is that it is easy and quick to implement once agreement is reached on the level at which the fees are to be set. The problem to be addressed is that waste tyres do not recognise boundaries that define the limits of responsibility for government at either the State or local level. If landfill gate fees are not set consistently, then there will be leakage of tyres to low fee landfills, and this is clearly undesirable in terms of meeting the objective of raising fees in the first place and of the impacts on local communities. The arguments for and against setting common gate fees mirror in part the discussion on uniform national regulation (refer Part II.4).

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75 Similar to some air pollution emission trading schemes in the US, new certificates have to be acquired for each lot of tyres produced in other words, the certificates are not perpetual entitlements.
The major drawback in making landfill disposal of waste tyres more expensive or difficult is that it will provide increased incentives for illegal disposal. The reduction in the number of tyres in landfills will be made up of the sum of the increase in tyres used beneficially and the increase in the number of illegally dumped tyres. There will be positive benefits from the higher value uses (net of any additional costs incurred in realising these higher values) and there will be the avoided costs of the tyres no longer destined for landfills. From this will need to be subtracted the costs of additional illegal disposal.

A number of stakeholders have argued that increased controls or bans on waste tyres to landfill should be introduced only after alternative fates have been developed to the stage that they are viable. This suggests that the best approach, if this option were adopted, would be to progressively raise the landfill gate fee over time. As the gate fee for any particular use or practice is reached, then this would divert sufficient waste tyres that would meet the demand for the products from that technology. This leads us to a more careful evaluation of the financial incentives provided by more expensive disposal to landfill.

It is illuminating for the purpose of this study to couch the problem of management of waste tyres in a marginal cost framework. The marginal cost of a product is defined as the cost of generating the next item of the product. Commonly, the marginal cost curve decreases initially due to the effects of economies of scale. Thereafter, it is assumed that supply is made up initially from the lowest cost producers, and that as these sources are exhausted, the next least cost producer is included. However, as the quantity to be produced increases, more and more expensive sources for the product must be tapped and the marginal cost rises. Thus the curve is U-shaped though commonly only the increasing section is considered, and this is the case for the present study.

In this study, some adjustments need to be made to definitions in the base model. The ‘product’ will be taken to denote management of waste tyres. The ‘price’ in conventional cost curves is interpreted as the gate fee needed to make an individual management practice commercially viable. In other words, it is the costs of the management practice less the return from the produce generated. Thus the marginal cost as defined is a form of subsidy - costs net of returns.

In the case of some practices for waste tyres, the gate fee will be negative (the tyres have a genuine commercial value) or at least they are below the current gate fee for landfill. Allowing for imperfections in supply, the markets for the products from these practices are assumed here to be saturated. This is the point denoted by current level in Figure 6.1. Note that the values in the figure are purely illustrative.

76 In this report, the term gate fee is meant in the sense of payments made to recyclers to take waste tyres so that their operation is commercially viable; in other words the gate fee represents the shortfall of revenues to cover costs. The gate fee for landfill under this definition accords with the conventional interpretation of a landfill gate fee.
The diagram also shows the gate fee and expected market size (in percent of waste tyres) for other practices at the present moment. For gate fees above the disposal charge, the tyres to the right of any given point represent the number of tyres going to landfill or illegally disposed. By increasing the landfill gate fee, progressively more practices will be able to attract waste tyres away from landfills, precisely as the landfill gate fee exceeds the gate fee for the next most expensive practice (application 1, 2, … in the diagram). By setting the gate fee at or above the highest beneficial use gate fee theoretically no more waste tyres could be diverted from landfill. This is similar to the situation under a ban on disposing waste tyres to landfill.

Of course the process is not static. If the price elasticity \( 77 \) in the end-product market is non-zero, then producers can use the higher gate fee to reduce the price of the product (while maintaining profit margins) and so sell more product and consume more tyres. Thus the vertical segments actually slope to the right (dotted line in Figure 6.1). In the case of a total ban, the ability to charge higher and higher gate fees would eventually consume all waste tyres, or new technologies would be introduced.

There is a cost associated with this. The beneficial uses with the highest gate fee will always be crowded out of the market (regardless of where the landfill fee is set) because they can always be outbid by uses with lower gate fees. However, these low cost uses will receive substantial windfall gains (a form of producer surplus). The windfall gain is the difference between the amount they receive for accepting a waste tyre and the amount they would need to receive to make their operation viable (for the currently viable applications, the windfall gain is represented by the shaded area in Figure 6.1).

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\( 77 \) Price elasticity is a measure of the sensitivity of demand for a good to changes in its price. If demand for a good is inelastic (zero or, in the real world, very low price elasticity) then the volume of sales of the good is not affected by the price.
This is a transfer from those who provide the funding to the low cost users. The amount of this transfer is the area between the cost curve and the landfill gate fee. If the cost curve is fairly flat, then this amount is relatively small. However, if the landfill fee is set to exceed the gate fee for a single use at the right side of the graph and this gate fee is substantially above the general run of gate fees then the amount can be substantial.

From a cost benefit analysis (CBA) perspective, this amount represents a transfer between market players rather than a resource cost. From a community viewpoint, there is no loss in welfare. However, the dynamics of the situation are quite different, since the option fails to encourage the very waste tyre management practices (at the high end of the range) to which it was directed.

6.4.4 Option 4: Market promotion

Undoubtedly, well-prepared and targeted marketing programs will assist in selling more products made from reprocessed tyres and thus increase the number of waste tyres diverted from landfill.

The difficulty is how product-specific should the marketing be? The effects of general exhortations to buy recycled products are unlikely to add significantly to the outcomes from programs already in place. At the other end of the spectrum, programs that promote individual products raise questions of unfairness. In the case of such assistance, it might be more effective to make the costs of the program available in cash, thus allowing the recipient to make the decisions on how to spend the money so as to maximise the benefits. At an intermediate or sector level some gains may be available, for example in the case of retreads, to redress conceptions based on incomplete information.

Other activities such as market analysis, demonstration sites and preparation of product lists may have more potential, though questions in regard to scope need to be resolved in these cases.

6.4.5 Option 5: Government purchasing policies

The option of government purchasing policies to favour recycled goods was criticised by the Office of Regulation Review in regard to recommendations made by the ANZECC report. The gist of the criticisms was that it would be more efficient to provide the assistance in the form of direct funding leaving it to the recipient to decide how best to use the money, and on distortions caused by different decision criteria between the public and private sectors.

We agree with much of the arguments put forward in by the Office of Regulation Review. However, their analysis fails in our view to take into account certain dynamics in relation to ‘infant industry’. Purchase of a new product by the government can set a powerful example that the product is suitable and cost-effective for the application, and this can overcome reluctance on the part of buyers due to suspicions regarding the performance of a new product. Furthermore, decisions by Government should take into account distortions in prices due, for example, to externalities associated with the extraction of virgin materials used in the manufacture of competing products.

6.4.6 Option 6: Funding of research and development

Some funding for R&D would come under option 2 (direct financial assistance) regardless of whether the R&D was conducted in-house or contracted out.

The main justification for assistance with R&D is where the expected outcomes are in the nature of a ‘public good’, where the industry as a whole (or a sector within the industry) will enjoy the benefits.

6.5 A national approach?

A national approach would be implicit in the introduction of regulatory controls on products in view of agreements on mutual recognition between States and Territories.

To be effective, controls on landfill disposal of tyres or increased landfill fees, would need to be applied nationally to avoid interstate transfers of tyres searching for the cheapest disposal route.

Administration of direct assistance would need to be on a national basis to be consistent with the preferred funding mechanism. It should be noted though that while the PSA for oil is a national scheme, there do not seem to be overriding reasons for uniformity in the unit benefits paid for waste tyres used in specific practices across States and Territories.

It should be possible to make savings by sharing promotional material. Other activities such as demonstration sites would be organised locally. Similarly, purchasing decisions and acquisition policies would normally be developed by individual governments.

Research and development is effectively a global matter. Conducting R&D nationally avoids duplication, makes best use of available information and maximises the firms that will use the findings.

Two final points are worth making. Firstly, funds will always be limited and decisions on where funds are to be spent must be based on sound evaluation of options to determine which provides the greatest benefits. Secondly, there is broad support for the position that industry assistance should be viewed as being interim in nature. Society will find unacceptable the provisions of assistance without a sunset clause, and activities that require ongoing support are not viable in the long term.
7 Funding

This section deals with the source of funds needed for the various options considered so far. The question of funding is separate from considerations on how the money is to be spent. For example, in the PSA for oil the funds collected by the excise are not hypothecated in a legal sense to fund the benefits paid to oil recyclers.

7.1 Options for funding

7.1.1 Option 1: Disbursements from Consolidated Fund

One option is for funding to be derived from Consolidated Fund and managed by standard government finance arrangements.

The management costs of such a scheme would be low. On the other hand, the scheme is at odds with various broad policies that have been adopted by Australian governments, such as the user pays principle.

The remainder of this section deals with the main option – different forms of a levy.

7.1.2 Option 2: Levy

A levy could be applied at a number of points in the life of a tyre:

- at the point of manufacture/import;
- at the point of sale; or
- at the point of disposal.

A levy can play a number of roles:

- it can assist in making stakeholders aware of their product stewardship responsibilities in regard to products that they manufacture or import, use, or process;
- it can be used to fund eventual management of the tyre when it is waste;
- it can provide financial incentives for waste tyres to be managed appropriately;
- it can be used to fund industry assistance programs of various types; and
- it can provide pricing signals to consumers that encourage certain choices (such as purchase of retreads).

The first two roles are linked. If the costs of the waste management of a tyre are paid at an earlier stage in its life, then there is no risk that the community at large will be required to fund waste tyres.

Product stewardship argues that the producer (manufacturer or importer) of a good has a responsibility for that good over its entire life from production through use to eventual waste. Having benefited from the initial sale, producers also accept the costs of eventual waste management. There is also the concept that what is being sold is not a product (a tyre) but rather a service (provision of contact with the road and related services) which has an implication that the producer retains ownership of, and responsibility for, the tyre.

79 Funds collected by government are hypothecated if they may only be spent in specified ways and are not available for general government use.

80 Of course, the costs in part at least are likely to be passed onto the consumer as the effective waste generator, which means that the costs remain internalised as far as the life cycle of the tyre is concerned.
In the PSA for oil, this has been translated into a levy applied at the point of production or import of oils. Notwithstanding the product stewardship argument, this arrangement has very real advantages in terms of administrative ease in the case of tyres. It is much more convenient to apply the levy at the point of production since there are only two manufacturers in Australia and an estimated 50 importers. Other parts of the supply chain have considerably more business entities (for example it is estimated that the number of tyre dealers in Australia is 3,200).

7.2 Form of levy

As with some other examples of excise (including the PSA for oil), the amount of excise would be indexed to the cost of living index.

There are a number of questions in regard to the form of the levy.

7.2.1 Ad valorem versus unit/weight based levy

Current import duties are applied on an *ad valorem* basis, so that the duty for each import classification is a fixed percentage of the declared value of the imported item. Import duties commonly act as a tariff protecting Australian industry by raising the landed price of imported goods.

A levy to be imposed on tyres should be designed so as to promote the purpose of the levy. In the present study, the aim of the levy is to support other initiatives for the better management of the tyre once it becomes waste. The impacts of management of waste tyres (both positive and negative) are largely determined by the number of tyres, or possibly the weight of the tyres (see below), and so the levy should be structured on a per tyre (or per weight basis) rather than *ad valorem*.

Under the various international trade agreements to which Australia is a party, a waste tyre levy will need to treat imported tyres identically to tyres manufactured locally. What this means, in effect, is that the existing differential between imports and locally manufactured tyres as a result of the duty on imported tyres will remain unchanged. A levy would be applied after the import duty, so that the import duty will not change (either in percentage or dollar terms). It is understood that GST will be applied on top of both the levy and the import duty (the existing arrangement is that GST is applied to import duty), and in this way the GST will have the same effect in regard to the levy on imported and locally manufactured tyres.

The PSA for oils provides for a rebate of the levy on oil that is subsequently exported. Since exported tyres will not need to be managed as waste tyres in Australia, it seems logical and fair to provide for a similar rebate from the levy for tyre exports. The rebate would also apply to tyres fitted to exported vehicles.

There are also equity issues. An excise imposes the same increment on the price of a tyre (of a particular classification, say passenger tyre) regardless of whether the tyre is cheap or expensive. The proportional increase will be greater for lower price tyres, which are more commonly bought by the less affluent members of society.

7.2.2 Per tyre or per weight

In the case of oils, there is no debate as to what ‘unit’ the levy is to be applied to - the volume of oil (per litre) is the only logical choice. In the case of tyres, there is a choice between applying a levy to each tyre or on a weight basis (per kilogram).

Administratively, the simplest scheme would appear to be based on the number of tyres. Commercial transactions are carried out and recorded in numbers of tyres. From the industry point of view, a tyre-based levy would involve the least change to existing business ordering and accounting systems.
However, the size of the waste management task is related more to the weight of tyres rather than the number of tyres, and so is the value of waste tyres. For example, for shredded tyres the space taken up in landfill is approximately proportional to the weight (ignoring second order effects due to the geometries of different sized tyres).

The question is further complicated when the question of benefit payments is raised. Certain end uses are essentially weight based (production of rubber crumb and tyre derived fuel) while others are based on the number of tyres (civil engineering applications) though commonly certain tyre sizes will be of greater value.

A weight-based scheme could operate with the levy computed strictly on the weight of a tyre (so many dollars per kilogram). Alternatively, each tyre model could be allocated to one of a fixed set of weight grades, with a preset levy for each grade. At its simplest, the grades could correspond to broad tyre classifications – such as passenger vehicle, light commercial and truck. A possible drawback here is that tyre manufacturers might respond by modifying tyre designs to fit in a grade with a lower levy, sacrificing particular performance or safety characteristics or compromising consumer value in other ways.

An average family passenger vehicle tyre weighs some 10 kg whereas tyres for smaller passenger vehicles may weigh only 6 kg. Truck tyres can weigh 50 kg. Large earth moving tyres, such as those used in mines, can weigh 5 tonnes or more. For the purpose of comparison, if a weight-based levy on a passenger tyre was set at $1, the levy would be $5 on a truck tyre and $500 on an earth-moving tyre. On a pro rata basis, the levy on a passenger tyre is less than that on a large earth-moving tyre. In the example given above the passenger tyre attracts a levy of $1 in a retail price of $80 to $100 or approximately 1.0% to 1.2%, compared with a levy of $500 for an earth-moving tyre in a price of $30,000 or approximately 1.7%.

Equity issues also need to be considered. A fixed levy imposed on each tyre will be a larger proportion for low cost tyres than for high cost tyres. This is not only a function of passenger tyres versus truck tyres but also an issue for imports of used tyres.

7.2.3 Should the levy be applied to retreads?

In the case of the PSA for oils, oil that is produced from recycled waste oil attracts the oil levy. The supporting documentation argues that the recycled oil will need to be managed when it becomes waste in the same way as oil produced from virgin sources. If the justification for the oil levy is to address the problems associated with waste oil, then the levy should apply to all oils regardless of how they are made. In the case of oil, there is also a more practical reason that arises from the difficulties due to the widespread practice of blending oils, and the associated complexities of distinguishing between recycled and virgin oil.

This second problem is not an issue with tyres, which are discrete and identifiable. If the tyre levy is interpreted as a levy on the tyre casing, then the levy should not apply to retreads since the casing has already been levied at the point of production or import.

It would be possible to design a scheme where retreads are levied at the point of production and take this levy into account in the benefits paid to retreaders (this is similar to the approach adopted in the PSA for oil). But perhaps, from an administrative point of view, retreading should be kept separate from other practices for managing waste tyres. Retreaders have much stricter and more specialised requirements for waste tyres than do other recyclers, and a broad-based benefits scheme might not provide the outcomes that are optimal for retreads. In such options, exemption from the levy would confer a direct pricing advantage on retreads relative to new tyres equal to the amount of the levy.
Used tyres and tyre casings imported into Australia for the purpose of retreading (or any other purpose) would be subject to the levy, since the casings eventually will become waste. In this regard, products made from tyres (end-products as well as intermediate products such as rubber crumb) would be exempt from a tyre levy. These items would be managed in accordance with the waste management framework for non-tyre rubber products and this subject lies beyond the scope of this report.

Conceptually, the application of a levy (as well as exemptions and rebates) is based on a boundary system. One part of the boundary is the Australian coastline (pay for imports and rebate for exports). The other part is at the point of manufacture (pay). Once a waste tyre arrives at an approved receiveal facility, it drops out of the system, and is no longer treated as a tyre. Australia’s trade obligations will need to be considered in any decision on different treatment of new, used and retreaded tyres.

7.2.4 Tyres fitted to vehicles

A substantial number of tyres enter Australia already fitted to imported vehicles. It would seem inequitable if these tyres were to escape the levy, and the costs associated with these tyres had to be met by the rest of the tyre industry. Attempts to take advantage of the exemption could lead to distortions in the market. Accordingly, it is logical that tyres entering Australia on vehicles be subject to the levy. Mirroring these arrangements, rebates or exemptions could be claimed for tyres fitted to vehicles for export. Special consideration may be needed where international agreements exist (eg diplomatic vehicles, vehicles for the disabled and rally or racing cars).

7.3 Operation of the levy

7.3.1 Product stewardship based scheme

In the base scheme, the levy would be in the form of an excise. The levy would be collected by the ATO and managed under the Australian Government finance and accounting systems. The funds would be deposited in Consolidated Fund and would not be hypothecated. However, as with the PSA for oil, the underlying aim would be to achieve a balance between funds collected under the levy and disbursements towards measures to improve the management of waste tyres.

The legal changes to implement the scheme could be modelled on the PSA for oil. Consequential amendments would be needed in customs and excise legislation.

The Product Stewardship (Oil) Act 2000 also provides for an Oil Stewardship Advisory Council to be established and a similar council could also be considered in the case of a levy on tyres. The PSA for oil is to be reviewed within the first four years of operation.

The Australian Government has made available a sum of $60 million over the next four years to fund transitional arrangements for the PSA on oil.

7.3.2 State operated scheme

A state operated scheme as envisaged here is not possible. Under section 90 of the Constitution, only the Australian Government may impose an excise, although the States could distribute benefits linked to a Commonwealth collected levy.

7.3.3 Industry-operated scheme

There is in-principle support for a levy on tyres from the manufacturers and major importers, who are likely to be the entities that would manage the collection of the levy. Given their role in a levy scheme, the manufacturers and importers consider that they are entitled to a bigger say in how the scheme operates than is the case with the PSA for oil which is operated in practice by the ATO. In fact, industry sources refer to manufacturers and importers paying the levy. While this is correct to the extent that they would be responsible for remitting levy funds to the government under a PSA scheme, it is anticipated that the tyre levy would, in practice, be largely passed onto
the consumers in the way of higher tyre prices. In view of the inelastic nature of
demand for tyres, the actual financial cost to industry may well be minimal.

Nevertheless, industry’s role in a levy scheme will be pivotal. The issues have been
discussed earlier in regard to decisions on the disbursement of funds collected to
promote waste tyre programs (refer Part II.6). At core, for industry to have greater
control on spending probably implies that the levy scheme should be operated by
industry in total, including management of the collected funds.

Thus, a sub-option is for the tyre industry to operate a scheme that collects money and
allocates the collected funds towards waste tyre management. As early as 1994 the
Australian Scrap Tyre Management Council made a number of proposals in a
submission to ANZECC. These proposals involved payments per tyre which would
go into a fund.

The support by industry for a levy is, however, conditional on the levy being applied
to all tyres, so that no firm can escape paying the levy. Otherwise, the scheme would
be vulnerable to ‘free riders’ within the industry who elect not to contribute. In the
case of tyres, there is a relatively large number of small importers (in excess of 50
including importers of used tyres) and it would be difficult to maintain controls or
impose sanctions (such as publicising the details of non-contributors).

Various arrangements for ‘waste tyre levies’ charged to consumers by tyre dealers
have been put in place in Australia in the past. In some examples, the cost of waste
tyre disposal is a separate item in the account given to the consumer for the purchase
of new tyres (and the dealer accepting the waste tyre). In other cases, the cost of
disposal may be passed onto the consumer but not made explicit. In some cases, the
tyre industry working with the support of the government, as in the case of
Queensland and the scheme in Tasmania, has attempted to systematise the practice on
a voluntary basis, though there have been problems with dealers who stay outside the
scheme. One major failing with a number of these schemes is that there has been no
mechanism to ensure that the money paid ostensibly for appropriate management of
the waste tyre has found its way to this end.

The difficulty then is how to make an industry-run scheme mandatory. ATMA are
currently investigating the legal and constitutional implications and possibilities for a
statutory levy scheme operated by industry. Until such time as the position is
clarified, it is difficult to conduct a realistic assessment of such a scheme.

7.4 Costs and benefits

From a resource perspective, the payment of the levy does not constitute a cost since
it is regarded as a transfer payment. The loss to the economic agent paying the levy
(the tyre manufacturer or importer) is offset by the gain to the agent who receives it
(the government in the first instance). However, there are distributional effects and
these are discussed below. Of course, the costs of the activities or assistance funded
by the levy are, in part, the resources paid for by the funds collected under the levy.
This is a separate matter and is discussed in earlier sections.

The direct resource costs of a levy are the administrative costs of the scheme. Costs
will be incurred both by Government and by industry.

The costs to industry are the establishment of the mechanisms for making the levy
payments. If a tyre-based scheme is adopted, then the costs for importers would be
minimal, since they already have to collect the information on tyres for their import
duty payments. Some adjustment would be needed to recording systems in a weight-
based scheme to account for the numbers of tyres in each classification or to compute
the weight of tyres over each accounting period.

81 See ASTMC (1994) in the bibliography.
The tyre manufacturers pay no duty at the moment and would need to establish systems for the payment of the levy. As part of their commercial operations, the manufacturers would already have in place records of tyres sold which would be adequate for a tyre based scheme. As with importers, modifications would be needed for a weight-based scheme.

There would also be ongoing costs incurred by manufacturers and importers (above what is needed for the current import duty payments) for a weight-based scheme. These costs are assumed to be relatively low, since the information on tyre size and model (and hence the weight factor if needed) would already be available electronically, and subsequent processing would be largely automated.

The costs to Government include one-off costs for changes to the legislation and other matters needed to introduce the scheme including the preparation of an impact statement. These changes would be modelled on the oil scheme and this would reduce some of the costs (and time).

In the PSA for oil, the Government has set aside $60 million over 4 years to cover the costs for transitional arrangements. One lesson from the oil scheme is the need for a longer lead time to conduct education and training for those industry participants who are unfamiliar with the payments of excise and customs duties.

7.4.1 Distribution of costs

The tyre manufacturers and importers will incur the administrative costs to industry in the first instance but this will be small in comparison to the levy itself. It is important to evaluate how the industry might react to this increase.

Tyres are an essential part of a vehicle but represent a relatively small component of the cost of running a vehicle (around 3-4% in the case of passenger vehicles). A rise in the price of a tyre due to say a $3 levy will have an almost unnoticeable effect on the aggregate number of tyres sold, after a possible small effect at the time of implementation. Consumer choice may however change between tyre brands or models.

All new tyres that will be made available for sale in Australia would be treated uniformly in terms of the levy. It might be supposed that all tyre importers and manufacturers would pass on the levy in full (as well as transaction costs) to the customer (via the dealer) since their relative market position will remain unchanged. There are two considerations in relation to substitutes for individual new tyre models that may cloud this conclusion.

Firstly, if retreads are exempt from the levy, then an increase in the price of new tyres will make retreads more attractive. It has not been possible to derive quantitative estimates of the elasticity of demand for retreads based on the price differential with new tyres. In view of the consumer groups that are presumed to be the major buyers of retreads (fleet owners and vehicle owners from lower socio-economic groups) it seems reasonable that a levy set at a notional $3 might be sufficient to induce some consumers at the margin to purchase retreads over new tyres.

The second consideration is that for most vehicles there is a considerable variety of tyre models that can be fitted. These tyre models are differentiated in the minds of many consumers by little more than price (particularly where the price difference is less than say $5). Vehicle owners may choose to maintain their current level of spending on tyres by choosing another tyre model at the same price as the pre-levy price of their existing tyre. Where there is such a competing brand available, tyre producers and/or tyre dealers may choose to absorb some, or all, of the levy.

The conclusion is that on the evidence available from the introduction of the GST, it would be reasonable to expect much of the levy to be passed on to consumers though perhaps not immediately. It is only in some parts of the tyre market, determined by the pricing structure and the characteristics of demand, that less than the full levy would be passed on.
8 Waste Tyres That Need Special Consideration

8.1 The opportunity

This is not so much a separate option, but rather a discussion on considerations that underlie all options. Much of the assessment presented above assumes that the costs associated with materials handling (collection and transport of waste tyres) are relatively low, or that sufficient waste tyres are available to defray the fixed costs of certain practices. The consequence is that much of the discussion has been relevant for major urban areas in the capital cities, surrounding areas and large regional centres (which account for approximately 65% of total travel in Australia). Waste tyre management in small remote communities requires specific consideration. The opportunity is to manage tyres better in areas where the main options are not so effective.

8.2 The impediments

For any specific option and in relation to the conditions at any point in time, thresholds can be established for the materials handling costs. If the actual costs exceed these thresholds, then certain options will not be feasible. The options may represent specific waste tyre practices (such as production of rubber crumb) or they may relate to more strategic considerations such as transport to a central holding facility.

The main factors that contribute to the value assumed by the threshold for a given option are the number or rate of waste tyre generation and the distance to a facility of a specified type. The problems associated with these thresholds can occur at different scales. For example, a small community may be only 100 km from a facility, but difficulties are experienced because of the low numbers of tyres generated locally. On the other hand, the number of waste tyres generated annually in Perth is well over 1 million. But if this rate is insufficient to justify investment in specific plants or facilities, then it is likely to be uneconomic, notwithstanding economies of scale, to transport the tyres to a facility in the east.

It may be remarked that over time there will be changes in the thresholds. These changes will be driven by the development of new or improved technologies with lower fixed costs particularly capital costs, cost reductions in materials handling processes, the availability of good infrastructure for managing waste tyre flows and market impacts on prices for end-products. As a result, the choices in relation to management of waste tyres for small and isolated communities will change over time. However, for the foreseeable future it is expected that it will not be viable to manage all waste tyres according to the options considered earlier.

There are special considerations in the case of OTR tyres on mine sites. Giant earthmoving tyres raise specific issues in regard to availability of suitable equipment, but may also provide specific opportunities to overcome the problems associated with long distances.

8.3 Options for waste tyres that need special consideration

The two main options for passenger and truck tyres are:

- to provide a holding facility to assemble waste tyres for later dispatch to a receiveal facility once a critical mass has been reached, or
- to develop attractive technologies with low fixed costs so that the lack of economies of scale are not prohibitive.

Corbett (1999) has evaluated four options for managing waste tyres at mine sites:

- the extended producer responsibility principle (a form of product stewardship);
• shredding of waste tyres for use as TDF;
• on-site burial (shredded); and
• on-site burial (whole).

8.4 Assessment

The benefits of improved management practices for waste passenger and truck tyres are qualitatively similar to those for the options in the more densely settled areas in relation to generating value from the tyre.

In regard to environmental impacts, some differences may be noted. Because of the lower number of waste tyres, the cumulative impacts will be spread over a wider area and will not be so concentrated. Also, a smaller number of people will be affected by any impacts that do occur. In terms of avoided impacts from disposal, controls on inappropriate disposal and the level of monitoring will be lower in small communities, but the pressure on landfill space is also much less. The upshot is that low landfill fees remove some of the incentives for illegal dumping, but environmental management at remote landfills is often minimal, particularly in regard to fire safety and control of breeding grounds for mosquitoes. In comparison with urban areas, many of the effects counteract each other and it is difficult to compare the relative resource costs and risks to the environment.

8.4.1 Option 1: Collection of tyres for subsequent transfer

The requirements for a waste tyre holding facility are similar in small communities as those outlined in Part II.5. The particular considerations here relate to provision of security measures at what presumably would be unstaffed sites, so as to keep the risks of fire at an acceptable level.

The major issue with option 1 is freight rates. Depending on the actual transport distance, line haul transport costs are estimated to be of the order of $10 per tyre in the case of whole tyres. This cost would come down if tyres were shredded on location, but this would need a certain number of waste tyres before it was economic to bring a shredder to the site.

It can be presumed that there is available capacity for the return trip for general goods transport vehicles to most remote areas. There may however be issues in relation to difficulties in handling waste tyres and the risk of despoiling or contamination of vehicles, containers or other goods. Trucking companies are reported to be reluctant to offer concessional rates for backloading waste tyres. It is understood that a number of jurisdictions (Queensland, NT and WA) are assessing joint approaches towards finding opportunities for transfer of waste tyres to larger centres.

It is difficult to suggest positive policies to deal with this issue. The main avenue for progressing this option would appear to involve some form of direct financial support, whether this was funded by the local community or through some form of subsidy. But the question must be raised whether, in fact, it is a valid and sensible objective to extract increasingly remote tyres when faced by a steepening marginal cost curve.

8.4.2 Option 2: Low fixed cost technologies

Many technological practices for waste tyres require large investments regardless of the numbers of tyres processed. The only beneficial uses that do not have high upfront costs are civil engineering applications. For example, the proprietors of the Ecoflex technology have indicated that their equipment costs $10,000 and is easily transportable. However, to derive the benefits, there must be sufficient demand for the end-products to make its use attractive in using locally generated waste tyres.

8.4.3 Waste tyres at mine sites

Table 8.1 shows the cost estimates have been made for the management of large earthmoving tyres.
Table 8.1  Cost estimates for the management of large earth moving tyres

<table>
<thead>
<tr>
<th>Option</th>
<th>Cost/tyre ($)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer responsibility</td>
<td>$100-$1000</td>
<td>Does not include cost for final fate</td>
</tr>
<tr>
<td>Shredding for TDF</td>
<td>$370+</td>
<td>Includes transport</td>
</tr>
<tr>
<td>on-site burial (shredded)</td>
<td>$175</td>
<td></td>
</tr>
<tr>
<td>on-site burial (whole)</td>
<td>$30</td>
<td></td>
</tr>
</tbody>
</table>

Source: Corbett (1999).

8.5 A national approach?

The development of low cost flexible technologies to deal with waste tyres generated in small communities appears to be a worthwhile candidate for funding research and development. As discussed in Part II.6, R&D is rightly considered on a national scale. Current joint initiatives by three jurisdictions to explore low cost transport alternatives point the way for a national perspective on options in this area.

If funding is available in a national scheme, then consideration could be given to direct assistance for managing waste tyres from small remote communities on an interim basis. As with all decisions regarding funding, it will be necessary for the fund manager to carefully evaluate the benefits from competing bids for funding, in view of the relatively low impact that waste tyres have in these areas and the amount of money needed on a per tyre basis.
9 Summary

For convenience, the findings of Part II are summarised in Table 9.1 to Table 9.6.

It should be noted that the options within each table are not mutually exclusive with the exception of those within each of Table 9.3 (managing the resource) and Table 9.5 (funding). Even, where the options within a table are not mutually exclusive, some options may be substantially more cost effective than others. However, it may still be worthwhile to pursue more than one option from any one table (or to select none).

Another point to be noted is that an option in one table may affect the outcomes relative to the objective of another table. Thus controls on landfills (Table 9.4) will encourage greater levels of inappropriate disposal and it may be necessary to tighten measures in Table 9.2 to control the potential increase. The scheme for payments for collection of waste tyres to be made at the point of receival (Table 9.2) could be used to improve the management of tyres more generally (Table 9.3).

Below are some views of the consultancy team, which should be considered as suggestions rather than recommendations.

Firstly, we see value in all three of the options for waste avoidance (Table 9.1), each of which needs to be addressed at the national level (though option 2 could be implemented locally).

In regard to measures to reduce the environmental damage and loss of amenity from inappropriate disposal (Table 9.2), our thoughts are that the scheme for payment at the point of receival holds most promise in the longer term for tyres generated in more densely settled areas. Such a scheme needs to be supported by industry based funding and this may be time consuming to establish. In the interim, a tracking scheme (consistent with the NEPM requirements for interstate movement of controlled wastes) appears to be able to provide adequate levels of environmental protection.

Management of the resource of waste tyres (Table 9.3) has been identified as a key barrier to improved resource recovery practices. The requirement here is to balance the needs of resource security for investors against the potential for gains from a flexible approach while maintaining safeguards in respect of fairness, accountability and transparency. In our view, some form of centralised administration scheme will be necessary to deliver these outcomes.

An alternative approach is to invoke a take back scheme or similar under extended producer responsibility principles (Table 9.6). This has some similarities to the administration scheme outlined in the previous paragraph in the case where industry was to set up an organisation to discharge the responsibilities of individual producers (manufacturers and importers). But in the case of EPR, this organisation is a creation of industry itself in response to regulatory requirements. In either case, we believe that there will need to be strong oversight to manage and control any undesirable side effects. Experience overseas with EPR schemes in relation to products that enter the municipal waste stream, suggests that they can be quite effective once established, but considerable care needs to be taken with design and implementation. An EPR scheme would need to be nationally based.

Industry assistance schemes such as those summarised in Table 9.4 can contribute to the development of a robust recycling industry for waste tyres. However, experience with similar schemes has highlighted certain dangers in delivering community-wide economic gains. Some form of unit benefits payable to recyclers may be needed to support certain resource management options. For the rest, at this time (and at a national level) the aim should be to design a sound decision-making framework for disbursing funds, rather than the detailed selection of which items promise the greatest gains.
Funding will be needed for the range of programs considered earlier. The most attractive option is for a levy on tyres at the point of manufacture or import. The levy scheme would be run by the Australian Government in view of constitutional requirements and could be modelled on the product stewardship arrangements for oil. If the funding scheme is national, then this suggests that the programs to be funded will also need to be managed at a national level.
Table 9.1  Summary of take back options

<table>
<thead>
<tr>
<th></th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take back</td>
<td>Creates new industry culture by emphasising responsibilities of producers for all stages of the life of tyres (an example of extended producer responsibilities – EPR). Provides flexibility for producer to modify tyre at production stage to minimise whole of life impacts. Possibility that producers are granted exemptions by joining producer responsible organisation (PRO) created by industry.</td>
<td>No experience with take back schemes in Australia. Power held by PRO may be used in anti-competitive way. Theoretical gains from take back schemes may be lost if individual firms are not able to earn benefits from their improvements to product waste performance.</td>
</tr>
</tbody>
</table>
Table 9.2  Summary for waste avoidance options

<table>
<thead>
<tr>
<th>Options</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1: Purchase decisions</td>
<td>Provides better consumer information (including on retreads).</td>
<td>Cost of setting up a tyre quality rating scheme. Technical difficulties associated with trade-offs between wear and other tyre characteristics. Differences between tyres likely to be dwarfed by in-service variability.</td>
</tr>
<tr>
<td>Option 2: Tyre maintenance</td>
<td>Potentially large effect (aggregate 6% reduction in waste passenger tyres). Associated benefits from fuel economy and road safety.</td>
<td>Costs of running such a scheme. Uncertain effectiveness in changing people’s behaviour. May be better addressed through programs that emphasise vehicle safety.</td>
</tr>
<tr>
<td>Option 3: Importation of used tyres</td>
<td>Addresses one aspect of the waste tyre problem that is generated outside Australia. Can be designed to keep out tyres that have no value.</td>
<td>Possible international trade implications. Danger of discouraging tyres that have value unless scheme is designed with care.</td>
</tr>
</tbody>
</table>
## Table 9.3 Summary for options to reduce inappropriate disposal

<table>
<thead>
<tr>
<th>Option 1: Tracking scheme</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In conjunction with registration scheme and proper auditing has the potential to deliver high confidence of detecting inappropriate disposal. Availability of sound information on which to base development of strategies and policy decisions.</td>
<td>May be seen as implying that waste tyres are hazardous. Relatively high costs – possible availability of lower cost schemes. Requires waste tyre operators to be registered or licensed.</td>
</tr>
<tr>
<td>Option 2: National uniform regulation</td>
<td>Reduces attractiveness of transporting waste tyres interstate to save money or avoid stringent regulatory controls. Reduces costs for firms that operate in more than one jurisdiction.</td>
<td>Uniformity means loss of benefits from regulatory approach tailored for conditions in individual States and Territories. Inconsistent with existing approach to environmental regulation in terms of roles of each jurisdiction.</td>
</tr>
<tr>
<td>Option 3: Payment for waste tyres at point of receival</td>
<td>Strong financial incentive for waste tyres to be delivered to approved receival facilities. Administrative basis can be shared with options that promote improved value from waste tyres.</td>
<td>Could be cumbersome if no centralised administrative scheme.</td>
</tr>
<tr>
<td>Option 4: Environmental rating scheme for tyre dealers</td>
<td>Makes waste tyre management a part of good business practice. Highlights to tyre purchasers the issues associated with waste tyres.</td>
<td>Need to resolve design issues. Who will run scheme: Government, industry? Need to audit scheme, and associated costs.</td>
</tr>
<tr>
<td>Option 1: Legislative support for tied agreements</td>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Provides very high level of assurance for recyclers in respect of supply of waste tyres.</td>
<td>Extremely rigid scheme: provides no encouragement for improved management practices for waste tyres. Cumbersome: needs decision of parliament to change arrangements. Government has to try and pick winners, difficulties in defining criteria. Competition policy impacts.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option 2: Centralised market scheme</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides orderly basis for waste tyre flows from waste generator to end-user. Physical holding facility to buffer fluctuations in supply and demand for waste tyres. Facilitates payment for waste tyres at point of receival.</td>
<td>Costs of operation. Who is to operate scheme: Government, industry? Almost certainly will need to retain some control or oversight by Government.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Suboption 2.1: Free market operation</th>
<th>Makes maximum use of market forces.</th>
<th>Market could be dominated by one or two operators. Other sources of price instability.</th>
</tr>
</thead>
</table>

| Suboption 2.2: Manager retains strict control | Provides very high level of assurance for recyclers in respect of supply of waste tyres. | Extremely rigid scheme: provides no encouragement for improved management practices for waste tyres. Government has to try and pick winners, difficulties in defining criteria. Competition policy impacts. |

<table>
<thead>
<tr>
<th>Table 9.4 Summary of options for improved value from waste tyres – industry assistance</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1: Legislative support for tied agreements</td>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>Provides very high level of assurance for recyclers in respect of supply of waste tyres.</td>
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</tbody>
</table>

<table>
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<tr>
<th>Suboption 2.1: Free market operation</th>
<th>Makes maximum use of market forces.</th>
<th>Market could be dominated by one or two operators. Other sources of price instability.</th>
</tr>
</thead>
</table>

| Suboption 2.2: Manager retains strict control | Provides very high level of assurance for recyclers in respect of supply of waste tyres. | Extremely rigid scheme: provides no encouragement for improved management practices for waste tyres. Government has to try and pick winners, difficulties in defining criteria. Competition policy impacts. |
### Suboption 2.3: Sale of waste tyres from a managed pool

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makes use of market forces for ‘sales’ to recyclers.</td>
<td>Market could be dominated by one or two operators.</td>
</tr>
<tr>
<td>Maintains controls on weak link (dealer/collector) in waste tyre chain.</td>
<td>Other sources of price instability.</td>
</tr>
<tr>
<td></td>
<td>Administration scheme may be seen as participant in market rather than as tyre exchange – competition policy impacts.</td>
</tr>
<tr>
<td>Option 1: Direct regulation in regard to products</td>
<td>Advantages</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td></td>
<td>Government has direct control over fate of waste tyres in order to advance policy objectives.</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option 2: Direct assistance to recyclers</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Provides recyclers with discretion to spend assistance in the way that adds most value to them.</td>
<td>In unit benefits scheme, Government will make decisions which unavoidably favour some recyclers over others.</td>
</tr>
<tr>
<td></td>
<td>Unit benefits scheme and certificate scheme can be integrated with collection of levy from producers.</td>
<td>Unfairness with programs that support only one sub-sector (or firm).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Difficulty with setting unit benefits – may need to be adjusted to achieve target level of recycling.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complexity of certificate scheme and lack of practical experience.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option 3: Controls on landfills</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Straightforward to implement in practice.</td>
<td>Encourages inappropriate disposal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poorly targeted: some recyclers will receive windfall gains.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Needs agreement from different governments.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimal or no controls at many landfills in small communities.</td>
</tr>
<tr>
<td>Option</td>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Option 4: Market promotion</td>
<td>Used to overcome consumer resistance to recycled products. Can support industry wide programs.</td>
<td>Unfairness with programs that support only one sub-sector (or firm). Doubts about effectiveness of industry wide programs.</td>
</tr>
<tr>
<td>Option 5: Government purchasing policies</td>
<td>Sets example to overcome consumer misconception. Can be used to compensate for other pricing distortions.</td>
<td>Possible extra costs to taxpayers. Leads to distortions in resource costs between Government and private sector.</td>
</tr>
<tr>
<td>Option 6: Funding for research and development</td>
<td>Overcomes certain barriers to R&amp;D by individual firms.</td>
<td>Unfairness with programs that support only one sub-sector (or firm). Doubts on effectiveness of industry wide programs.</td>
</tr>
</tbody>
</table>
Table 9.6  Summary of funding options

<table>
<thead>
<tr>
<th>Option 1: Disbursements from Consolidated Fund</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very simple scheme.</td>
<td>Unlikely to be politically acceptable.</td>
</tr>
<tr>
<td></td>
<td>Low administration costs.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option 2: Levy (Assumed to be at point of manufacture/import)</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reinforces product stewardship role for manufacturers and importers.</td>
<td>Decision on who should operate scheme: Government, industry?</td>
</tr>
<tr>
<td></td>
<td>Provides funding for post-consumer management of tyres.</td>
<td>Need to resolve design features.</td>
</tr>
<tr>
<td></td>
<td>If levy is passed on, sends appropriate price signals to consumers on waste management costs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scheme could be modelled on scheme for PSA for oil.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No free riders – all producers pay levy.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 1 Uncontrolled Tyre Fires

Uncontrolled tyre fires impose a range of costs on the community. The discussion in this section is based on three fires at tyre dumps of different sizes:

- Fire A where the tyre pile was 35 metres by 100 metres by 3-4 tyres deep;
- Fire B where an A-frame building 15 metres by 20 metres by 6-7 metres high (at the peak) was filled with tyres and tyres were also stacked 20 metres in front and 5 metres to side; and
- Fire C which was at a tyre dump 80 metres by 150 metres by 12 metres high.

Firstly, as with any fire, tyre dump fires pose a threat to life (or at least of injury) for the general public and more particularly to fire fighters. In addition, there is the risk of the fire spreading and causing damage to property or natural areas.

In addition, because of their chemical composition, uncontrolled burning of tyres results in the emission of air pollutants. Of special concern are toxics and carcinogens such as polycyclic aromatic hydrocarbons, dioxins and furans, but carbon monoxide, oxides of nitrogen and particulates are also released. Burning of tyres results in loss of amenity through visual impacts as a result of the heavy dark smoke and extremely unpleasant odours. One large fire in Sydney’s fringe caused a pall of acrid black smoke that hung over the city for days. Fire fighters have reported respiratory problems after fighting tyre fires.

There is also the potential for pollutants from tyre fires to enter waterways and contaminate land. The water used to extinguish fires can transport the combustion products (including hydrocarbons and carbon black) from the fire to wetlands or other waters.

Finally there are the actual financial costs of fighting the fire (all cost estimates are reported in year 2001 dollars unless stated otherwise).

Uncontrolled fires in tyre dumps pose specific difficulties for fire fighters to induce water into the inside of the pile of tyres since, due to the geometry of tyres, the outer tyres in the pile form a barrier to penetration of the water. Experience with tyre fires has shown that while water by itself can control the fire, it is not sufficient to extinguish it. A common method to circumvent this problem is to use a powerful wetting agent (to be effective an A grade foam is required), such as the so-called BFFF compound, which allows the water to track into the centre of the pile of tyres. BFFF compound costs about $150 for a 20 litre container. Examples of quantities used are:

- 20 containers ($3,000) at Fire A; and
- 600 containers ($90,000) at Fire B.

The alternative is to pull the pile of tyres apart using an excavator or similar equipment, provided access is possible, and once the fire has died down to an extent. Two excavators were used at Fire C (foam was not used on this fire). This fire burned for over 5 days and at a cost of $120 per hour for each machine working for 12 hours per day, the total cost is estimated at $14,400.

Details for fire appliances and personnel at the three fires are given in the following table:
Table A1.1  Summary of dollar costs of fighting tyre fires

<table>
<thead>
<tr>
<th></th>
<th>Fire A</th>
<th>Fire B</th>
<th>Fire C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of hours</td>
<td>5</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>Number of units</td>
<td>3</td>
<td>24</td>
<td>41</td>
</tr>
<tr>
<td>Cost of units @$120 /hour</td>
<td>$1,800</td>
<td>$57,600</td>
<td>$295,200</td>
</tr>
<tr>
<td>Number of fire fighters</td>
<td>15</td>
<td>120</td>
<td>288</td>
</tr>
<tr>
<td>Cost of fire fighters @$30 per hour</td>
<td>$2,250</td>
<td>$72,000</td>
<td>$518,400</td>
</tr>
<tr>
<td>TOTAL COSTS</td>
<td>$4,050</td>
<td>$129,600</td>
<td>$813,600</td>
</tr>
</tbody>
</table>

There are further costs associated with cleanup after the fire. It is reported that the cleanup of the site at Fire B took 2 people and a bobcat 3 weeks at an estimated cost in excess of $10,000. Costs were also incurred for removal of weeds from a wetland, which had been quite effective in capturing the suspended hydrocarbon products in the runoff from the fire.

Various other costs were incurred. The local council spent $20,000 (in 1997 dollars) to provide food for the fire fighters at Fire C, and $15,000 for fuel. At Fire B the building had to be demolished. One street of residences was evacuated as a precautionary measure.

**Summary**

The major direct costs for fighting tyre fires are incurred on staff and equipment, with a substantial contribution from the purchase of wetting agents or hire of excavators. Based on the costs for the three case studies summarised above an estimate of the direct cost of $300,000 for a ‘typical’ tyre fire would appear reasonable. If one typical fire occurs each year, the annual cost is $300,000. To these financial costs must be added the costs of the likely significant environmental and amenity impacts.
Appendix 2 Clean-up Costs for Tyre Dumps

Options for clean-up of tyre dumps divide along two lines:

- whether tyres are to be disposed on site or transported to an existing waste facility; and
- whether tyres are to be disposed whole or shredded.

For tyres that are shredded prior to disposal at an existing facility, a further distinction is made between tyres that are to be shredded on site, or tyres that are to be transported whole and shredded on arrival at the waste facility.

This section will first consider the costs for the component operations involved in clean-up of a tyre dump.

(a) Shredding

Costs for shredding are reported to be of the order of $1 per tyre if shredding is undertaken at a permanent installation, such as at a landfill. Costs for shredding on-site are some $0.10 per tyre more costly due to the use of a portable shredder and the need for special security arrangements against theft and vandalism of the shredder.

The cost estimates do not include a component for any additional work that might be needed, such as extracting tyres that are partly covered, cleaning the tyres, additional expense in operating the shredder due to earth in the tyres, or clearing foreign material from the shredder. An allowance of $0.15 has been added for these additional costs.

(b) Transport

The following assumptions have been made in regard to the transport of tyres:

- operating cost of a truck is approximately $60 per hour including labour;
- a large truck can carry on average 600 whole tyres;
- average speed of 50 km/hour; and
- loading and unloading time of 30 minutes at each end.

For a distance of 25 km each way, the cost is $120 for 600 tyres or $0.20 per tyre.

A truck should be able to carry three to four times as many shredded tyres as whole tyres, so that the transport cost for shredded tyres is estimated at $0.05 per tyre.

(c) Disposal

A reported cost for on-site disposal of 100,000 whole tyres (20,000 m³) is $50,000 or $0.50 per tyre, including a component of $15,000 for 5,000 m² of geofabric used as liner. Shredded tyres would be considerably less expensive due to their much smaller volume (75% of the volume of whole tyres is void) and it has been assumed that the cost would be approximately 30% of this figure or $0.15 per tyre. Note that on-site disposal may be subject to approval by the environmental regulator in some States and Territories.

Disposal at a waste facility is assumed to occur at an inert waste landfill. The disposal costs are estimated to range from $12 per tonne for a 250,000 tonnes per annum (tpa) landfill to $27 per tonne for a 5,000 tpa landfill. A value of $20 per tonne will be used in this analysis, equivalent to $0.20 per equivalent passenger tyre. While these cost estimates are expressed in terms of tonnes, the resource costs of landfills are dominated by volume considerations. Since whole tyres have so much empty space, it is assumed that a landfill operator would charge three times as much ($0.60 per tyre) for whole tyres as for shredded tyres.
Table A2.1  Clean-up Costs for Tyre Dumps ($/tyre)

<table>
<thead>
<tr>
<th>Shredded/whole</th>
<th>Disposed at</th>
<th>Shredding costs</th>
<th>Transport costs</th>
<th>Disposal costs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole</td>
<td>on-site</td>
<td>-</td>
<td>-</td>
<td>0.40</td>
<td>0.50</td>
</tr>
<tr>
<td>Whole</td>
<td>landfill</td>
<td>-</td>
<td>0.20</td>
<td>0.60</td>
<td>0.80</td>
</tr>
<tr>
<td>Shredded</td>
<td>on-site</td>
<td>1.25</td>
<td>-</td>
<td>0.15</td>
<td>1.40</td>
</tr>
<tr>
<td>Shredded</td>
<td>landfill</td>
<td>1.25</td>
<td>0.05</td>
<td>0.20</td>
<td>1.50</td>
</tr>
<tr>
<td>Shredded at landfill</td>
<td></td>
<td>1.00</td>
<td>0.20</td>
<td>0.20</td>
<td>1.45</td>
</tr>
</tbody>
</table>

Discussion

The cost estimates given above are gross figures for cleaning up illegal dumps of used tyres. However, some of these costs would need to be met even if tyres were properly disposed of in the first place.

The costs to the community as a whole that could be ascribed to illegal dumping of waste tyres are the additional costs of clean-up such as:

- the cost of extracting partly covered tyres from the ground - say $0.10 per tyre;
- if shredding occurs on site, the extra cost of a mobile shredder including security measures compared with a fixed shredder possibly of larger capacity - assumed to be $0.10 per tyre;
- the additional costs of operating the shredder due to earth or other material in the tyre cavity, or of cleaning the tyre - say $0.15 per tyre; and
- any costs due to handling tyres twice or the extra distance the tyres are transported if taken to a landfill - $0.05 shredded or $0.20 whole per tyre depending on distance.

Clearly the total additional cost would depend on the option selected, but would generally be not less than $0.20 per tyre.

Perhaps of greater importance than the level of resource costs (as estimated above) is the fact that, if the person responsible for the dump cannot be identified, the owner of the land or society at large is liable for both the usual costs of disposal as well as the incremental costs referred to above.

The above unit cost estimates were based on quotes to clean up a large dump (over 100,000 tyres). The significant economies of scale in the case of such a dump would not be available in the case of smaller numbers of dumped tyres, such as those typically found on farms, and the unit costs would accordingly be higher than the estimates given above.
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