INDUSTRY
COMMISSION

Recycling

Volume II: Recycling of Products

REPORT No. 6
22 FEBRUARY 1991

Australian Government Publishing Service

Canberra

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ISBN 0 644 14007 0

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Printed in Australia for the Australian Government Publishing Service by P. J. GRILLS, Commonwealth Government Printer, Canberra

22 February 1991

The Honourable P J Keating, M.P.
The Treasurer
Parliament House
CANBERRA ACT 2600

Dear Treasurer

In accordance with Section 7 of the Industry Commission Act 1989, we submit to you the report on Recycling.

Yours sincerely

M L Parker Presiding Commissioner	R G Mauldon Commissioner	T Hundloe Commissioner	D R Chapman Associate Commissioner

Acknowledgement

The Commissioners wish to thank those staff members who assisted them preparing this report. The staff team was led by Dr Geraldine Gentle.

TERMS OF REFERENCE

I PAUL JOHN KEATING, in pursuance of Section 23 of the Industries Assistance Commission Act 1973 hereby:

1. refer the question of recycling of products for inquiry and report by 28 February 1991

2. specify that the Commission report on

   (a) the current level and possible costs and benefits of recycling, both in terms of economic and environmental considerations

   (b) any institutional, regulatory or other arrangements subject to the influence of governments in Australia which effect the incentives to recycle or re-use products, and advise on their effects and on any appropriate changes to these arrangements

3. specify that the Commission is free to hold public hearings in advance of releasing a draft report and to take evidence and make recommendations on any matters relevant to its inquiry under this reference.

P.J. Keating

18 October 1989

THE INQUIRY AND REPORT

The Commission is to report to the Commonwealth Government on:

a) the current level and possible costs and benefits of recycling, both in terms of economic and environmental considerations

b) any institutional, regulatory or other arrangements which affect the incentives to recycle or re-use products.

The terms of reference are shown on page xiv.

The Commission received 374 submissions. Details of participants, submissions received and organisations consulted are provided in Appendices B and C.

This is Volume II of a two part report. The two volumes are:

Volume I: Recycling in Australia - an analysis of the incentives to recycle and the prospects for further recycling. The Commission's findings and conclusions are in that volume.

Volume II: Recycling of products - information on the recycling of particular products, and some of the costs and benefits.

Recycling has many links with waste management. The Commission has therefore issued a separate information report which examines waste management practices and draws upon a survey of local government authorities in Australia.

In a separate reference (see Appendix A) the Commission was asked to prepare an interim report on the recycling of paper products. That Interim Report on Paper Recycling was completed on 21 May 1990. Public hearings to receive comment on the Interim Report and on the Draft Report for this inquiry were held during November and December 1990.

In this report, measures related to recycling include the *recovery rate,* the *quantity reprocessed* and the *utilisation rate*.

The *recovery rate* is the proportion of consumption of a product recovered in Australia in a particular year. Used goods which are recovered may be exported as scrap for reprocessing or reuse overseas; used goods and scrap may also be imported for recycling or reuse in Australia.

The *quantity reprocessed* is the quantity of a product recovered in Australia, plus imports or minus exports of scrap, reprocessed or remanufactured. The influence of changes in stocks of scrap or used goods, data for which are not available, is not accounted for.

The *utilisation rate* is the proportion of new production which is from recovered materials.

The information on recycling in Australia is far from complete. However the Commission has included even fragmentary information in the belief that it is important to begin the task of building a data base on recycling. In many cases the Commission has had to approach industry and trade organisations to fill in gaps and provide updated information. Because of the different sources and collection methods, some of the estimates are indicative and are intended only as a guide.

Where official consumption figures were not available the Commission derived estimates based on production plus imports less exports. The apparent consumption assessed in this way makes no provision for movements of stocks.

Where goods are consumed and recovered for reprocessing within a year, the recovery rate can be estimated with some confidence. However, many metals are used for long-term applications such as in building and construction, and there can be long delays before they become available for reprocessing. Varying delays mean that there is no simple relationship between the annual consumption of these metals and the quantity which becomes available for reprocessing in that year.

With growth in the economy, the current consumption of a product is likely to be higher than at the time the materials were first used. Technological change also affects consumption. For instance, aluminium is now used to a much greater extent in the building and construction industry than it was in the past. On the other hand, copper is used much less in applications such as plumbing and electrical wiring.

Calculating the recovery rate as a proportion of current consumption will lead to an underestimate if the materials were originally consumed years ago when consumption was much lower. Changing consumption patterns can result in either over or underestimated recovery rates. For all these reasons, a recovery rate expressed as a proportion of consumption in any one year should be taken as a guide only.

Little information is available to compare Australian recovery or utilisation rates with those overseas. Even where methodologies are compatible, comparisons can be meaningless because each country is unique in the conditions which determine its imports and exports and the extent of recovery and reprocessing.

Contents

1 METALS

This chapter discusses recycling in Australia of the following metals: aluminium, lead, copper, steel, iron and tin.

1.1 ALUMINIUM

Aluminium is a component of household and other wastes in the form of beer and soft drink cans, used building materials, consumer durables and car parts. It comprises only 1.5 per cent (by weight, more by volume) of household waste.[1] Two thirds of this, or 1 per cent of household waste, consists of used beverage cans (UBC).

Aluminium produced from melting down waste and scrap is known as secondary aluminium. Comalco Ltd (Comalco), Simsmetal Ltd (Simsmetal) and Nonferral Pty Ltd (Nonferral) are the main producers of secondary aluminium in Australia. Simsmetal acts as agent for Alcoa of Australia Limited (Alcoa) in collecting and reprocessing UBC. Nonferral produces mainly specification secondary aluminium alloys but also acts as agent for Comalco in collecting and reprocessing UBC. A number of smaller organisations also produce a range of secondary aluminium products by combining remelted metal with other alloying metals. This metal is mainly used by the diecasting industry.

Australia produces about 8 per cent of world primary aluminium production. There are still strong incentives to recover used aluminium in Australia, and elsewhere, because of its value as a metal and the saving in energy costs in smelting secondary as opposed to primary aluminium.

[1] Based on figures for Melbourne and Sydney only.

The extent of recycling

Many aluminium products, such as building materials and vehicle components, have an indeterminate life span which may extend over many years. This means that there is no simple relationship between the annual consumption of the metal and the quantity which becomes available for reprocessing in any one year. However, as a broad estimate, around a third of aluminium consumed in Australia is recovered for reprocessing in Australia or overseas (refer Table 1.1).

Table 1.1: Aluminium: Recovery, utilisation, production, exports and consumption, Australia 1986-87 to 1989-90

	1986-87	*1987-88*	*1988-89*	*1989-90*
		per cent		
Recovery rate[a]	31	27	30	31
Utilisation rate	5	4	4	4
		'000 tonnes		
Production				
Primary	921	1074	1226	1235
secondary	47	43	47	48
Exports	623	747	915	922
Imports	<1	2	4	2
Est. consumption[b]	303	336	322	324
Scrap exports	44	44	50	51

na = not available

a) The recovery rate is calculated on the basis of secondary aluminium production together with aluminium scrap exports as a proportion of consumption. The estimate is intended as a guide only. b) Production, exports and consumption do not reconcile due to movements in stocks.

Source: ABARE (1990), Commodity Statistical Bulletin, December, 1990, AGPS, Canberra. ABS (various years), Foreign Trade Statistics, Table MX04C, AGPS, Canberra. BMR (various years), Australian Mineral Industry Quarterly, AGPS, Canberra.

In 1989-90, 48 000 tonnes of secondary aluminium were produced and 51 000 tonnes of aluminium scrap were exported. The two together give an estimate of the total recovered (99 000 tonnes). Taking this as a proportion of consumption gives a recovery rate of 31 per cent for 1989-90. The average world aluminium recovery rate is about a quarter.

The utilisation rate for secondary or recycled aluminium has been about 4 per cent in Australia in recent years. Secondary aluminium has accounted for some 13 to 16 per cent of total aluminium consumed in Australia.

Australia exports significant quantities of aluminium: 75 per cent of primary aluminium produced in 1989-90 was exported. Scrap exports are small relative to exports of aluminium (refer Table 1.1). Imports of both refined metal and scrap are negligible.

Recovery of used beverage cans

Aluminium cans usually become available for recycling within three months of manufacture. Other sources of recyclable aluminium include off-cut aluminium generated by the major aluminium users, discarded manufactures such as car parts, and appliances. Scrap collectors prize goods made predominantly of aluminium. However, the Litter Research Association (LRA) estimates that, after recycling by households, Victorian household waste still contains 1.5 kilograms of aluminium per person annually. One kilogram of this consists of UBC. Many collection firms have contracts with local Councils for the removal of aluminium scrap from local tips. Collection systems are discussed in Chapter 4 of Volume I.

Comalco began its UBC recycling scheme in 1973. Alcoa launched its scheme in 1977. About 28 000 tonnes of UBC were collected during 1989, equivalent to 1570 million cans. The recovery rate was 62 per cent (refer Table 1.2). The majority was processed in Australia. A small quantity was exported, mainly to Japan. UBC contribute about one third of metal recovered for reprocessing.

Australia's 1989 UBC recovery rate of 62 per cent was as high as any in the Western world from voluntary or non-deposit legislated schemes. In the United States the UBC recovery rate rose from 26 per cent in 1979 to 62 per cent in 1989. According to Comalco the current UBC recovery rate in the United States is 60.8 per cent. About 50 billion cans with a total weight of 1.7 million pounds are expected to be collected there in 1990 (Powell 1990, p. 34).

Table 1.2: Recovery of used beverage cans, Australia 1978 to 1989

Year	*Cans*		*Recovery rate*	*Payout*	
	sold	*returned*			
	million	*million*	*per cent*	*$ million*	*$ per '000 cans*
1978	917	165	18	a	a
1979	1290	297	23	a	a
1980	1196	550	46	a	a
1981	1360	680	50	6.4	9.41
1982	1466	733	50	9.2	12.55
1983	1393	752	54	10.0	13.29
1984	1596	816	51	11.0	13.48
1985	1577	820	52	13.0	15.85
1986	1827	950	52	15.0	15.79
1987	2037	1100	54	20.0	18.18
1988	2321	1300	56	25.0	19.23
1989	2523	1566	62	30.0	19.15

a) National data not collated prior to 1981

Source: Comalco, Submission No. 146, p. 8.

Factors affecting the level of recycling

The level of recovery and reprocessing of aluminium in Australia is influenced by the world price of primary aluminium, the price of secondary aluminium relative to collection, transport and processing costs, and by government policies. Industrial disruptions at primary aluminium production facilities can also influence the demand for aluminium scrap.

The principal users of aluminium in Australia are the semi-fabricating and fabricating plants operated by Comalco, Alcan and Alcoa. A number of other independent firms use semi-fabricated products, or primary or secondary ingot to produce finished aluminium goods. Principal users are the packaging, building and automotive industries. Some 41 per cent of all packaged beer and 31 per cent of all packaged soft drinks are sold in Australia in aluminium cans.

The demand for secondary aluminium

Secondary aluminium is a close substitute for primary aluminium in many applications. In general, the cost and availability will determine the degree of interchangeability. Some critical applications in the automotive and electrical fields demand primary metal. Primary alloy is used mainly in gravity and low-pressure diecasting. Secondary alloy is particularly suited to high-pressure diecasting. Automotive diecasters predominantly use secondary alloys, although the balance is changing towards primary alloy (BIE 1988).

The other major application for secondary aluminium is in the manufacture of beverage cans. In the early years of UBC recycling, reprocessed UBC were not used for new can manufacture, mainly because of contamination from steel cans. Improved segregation procedures, consumer education and the virtual disappearance of steel cans as beverage containers, have made it possible to use UBC for the manufacture of new cans.

Comalco said it practises `absolute recycling', in that uncontaminated scrap from recovered cans is remelted and cast into slabs for further can sheet manufacture. Because UBC can be recycled for the same purpose, it is impossible to determine the number of times the metal is re-used. However, a significant proportion of new cans is manufactured from primary metal, firstly because not all cans are recovered, and secondly because of increased demand. Each time a batch of UBC is recycled, it contains a significant proportion of metal being reprocessed for the first time.

Prices

Aluminium scrap prices are volatile. They depend on the export scrap market which in turn is dependent on the world price of aluminium and world production activity, relative to the supply of scrap aluminium. Scrap prices vary with quality but appear on average to be about three quarters of the price of recycled metal (BIE 1988, p. 41).

The industry has endeavoured to smooth out the public buyback prices offered for UBC. This is done partly to maintain a flow of returns and to obviate hoarding. However, Comalco said it was forced to reduce the price in 1983-84 and there was also a reduction in 1989. Collection firms, which deliver in bulk to secondary smelting facilities, receive a margin of about 30 cents per kilogram over the buyback price for deliveries. However, the industry claims that it has no control over prices offered by collectors, and that these can vary from area to area.

Both Comalco and Alcoa support promotional activities, including school can collection programs, media advertising, participation in special events, sponsorships and door-to-door municipal collection schemes. The can manufacturers also provide funds for the LRA.

Both Comalco and Simsmetal control a network of UBC collection and processing centres around Australia (refer Table 1.3). Of the 1161 centres currently operating, about 50 per cent are run by charitable and community service organisations.

Table 1.3: Buyback centres for used beverage cans

	NSW	*Vic*	*Qld*	*WA*	*Tas*	*NT*	*Australia*
				number of centres			
Comalco	326	150	122	155	13	7	773
Alcoa	140	100	40	6	3	1	290
Independent	44	40	11	4	-	4	103
Total	510	290	173	165	16	12	1161

Note: Centres for the return of used beverage containers also exist in South Australia. However, these facilities have been established solely to redeem compulsory deposits and for this reason are not included in data on voluntary recycling.*Source*: Comalco

Some kerbside schemes also collect UBC. The comparatively low collection rates are not surprising since householders gain a monetary return for UBC taken to a buyback centre.

Effect of changes in prices on UBC returns

Because so many factors influence the return of UBC, it is difficult to separate the effects of price changes. The price reduction in 1983-84 was accompanied by a slight reduction in the recovery rate. However, other factors such as the introduction of the very large garbage bin in the Sydney metropolitan area and the simultaneous flattening out of sales growth also had an influence, and it is not reasonable to attribute all of the drop in the recovery rate to the price fall.

Comalco said the most recent fall in buyback price, from $1 per kilogram in October 1989 to 50 cents in January 1990 had not significantly affected returns of UBC. Increased awareness of environmental issues appears to have maintained incentives to recycle.

Energy costs

Aluminium produced directly from bauxite requires substantial inputs of energy, mainly in the form of electricity. Electricity comprises about 24 per cent of total production costs (92 per cent of total energy costs).

The smelting of secondary aluminium requires only 5 per cent of the energy needed to produce an equivalent quantity of primary aluminium, not taking into account energy used in collection and transport. However, in terms of expenditure, the outcome depends on the relative charges negotiated between smelters and electricity suppliers.

Electricity used in the production of primary aluminium is usually at prices negotiated with State Governments and below normal industrial tariffs. This is not unique to Australia. Because of their very large demand and continuous bulk load on generating stations, aluminium smelters worldwide are able to obtain energy on long term contracts at prices below general industrial tariffs.

Location of reprocessing facilities

The production of secondary aluminium requires different processing facilities and is not integrated with the production of primary aluminium.

Both Comalco and Simsmetal operate reprocessing facilities in New South Wales where the aluminium beverage can has become particularly well established. Comalco's dedicated UBC reprocessing facility is located in Yennora (near Parramatta, New South Wales) and is reported to be the largest in the southern hemisphere. It receives cans from buyback centres throughout Australia (except South Australia). Simsmetal also operates reprocessing plants in Victoria and South Australia. All Simsmetal's plants reprocess UBC as well as general aluminium scrap.

Aluminium scrap in general, as opposed to specifically UBC, is also reprocessed at small foundries located on the urban fringes of the major cities. The major smelters reprocess in-house scrap.

Government interventions

The introduction of Container Deposit Legislation (CDL) in South Australia, and past discriminatory deposits on different containers, have contributed to a high rate of reuse of glass beverage containers in that State, and less use of aluminium beverage cans compared with other States. As indicated in Chapter 7 of this Volume, before 5 April 1990 there was a deposit of 15 cents payable on aluminium beer cans, equivalent to about 12 per cent of the retail price of the beverage filled can, compared with a deposit of 5 cents on a 375 ml beer bottle, equivalent to about 4 per cent of the retail price (refer Table 7.1). The return of the deposits involves administrative costs for collection depots and costs and inconvenience for consumers. Partly in response to fears that CDL and similar arrangements could be extended to other States, the aluminium industry has moved to extend post-consumer recycling schemes and to institute new schemes. The industry has also invested resources in promotional and educational campaigns.

The Victorian Environment Protection Authority (EPA) is in the process of implementing `voluntary' recycling targets for a range of products (refer Chapter 7 of Volume I). The recovery rate for aluminium cans in Victoria for the year ending 30 June 1990 was 61 per cent, and exceeded the target of 60 per cent set by the EPA.

Costs and benefits of aluminium recovery and reprocessing

The bauxite used to produce virgin aluminium is a non-renewable resource. However, because most bauxite mined in Australia is exported, domestic aluminium recycling has little effect on the extent of mining or associated land degradation. Recovery and reprocessing leads to net savings in energy. As well as reducing the private costs of the aluminium producer, any energy savings can be of social benefit, for example in reducing air pollution. Recycling can also lead to savings from reduced waste disposal and can reduce the aesthetic costs resulting from litter.

Few attempts appear to have been made to examine the costs and benefits of aluminium recycling. One participant, the LRA, conducted a study into the costs and benefits of increasing the recovery rate for aluminium UBC from the 1988 level of 56 per cent (refer Table 1.4). Some of the results are presented in Table 1.5. The LRA considered two scenarios. One (Scenario A) assumed that voluntary schemes could achieve a return rate of 65 per cent within five years or so, leading to an additional net benefit of $1 million. The other (Scenario B) required intensive commitment by industry, state and local authorities to achieve a return rate of 70 per cent. This was estimated to involve substantial additional costs. The additional benefits in moving from the 1989 level of 56 per cent to the return rate of 70 per cent were estimated at $2.3 million and additional costs at $3.7 million, leading to net losses of $400 000. Each 1 per cent increase in the recovery rate from 65 to 70 per cent brought an 11 per cent increase in benefits, but a 24 per cent increase in costs in recovering an additional 420 tonnes of metal.

Costs taken into account by the LRA analysis include only those for collection and transport. Benefits considered include the value of the aluminium recovered, savings on waste disposal costs, and litter reduction. The scenarios for the two schemes, in terms of assumed extra tonnages collected and methods and costs of collection, are given in Table 1.4. Benefits arising from the recovered aluminium are estimated at $1100 per tonne paid to collectors and buyback centres at the end of 1989. This is a relatively high price compared with current estimates of around $900 per tonne quoted to the Commission by some collectors, and means that the estimated benefits may be overstated.

The LRA estimated avoided waste disposal costs at $50 per tonne. This may be too high as the Commission found average waste disposal costs to be about $32 per tonne in Melbourne and Sydney. The high estimate of savings on waste disposal costs will have further inflated the LRA's assessment of the benefits from increased recycling. This casts some doubt on the conclusion

Table 1.4: Comparison of scenarios in LRA submission

Scenario A	*Scenario B*
65 per cent recovery	70 per cent recovery
3 700 tonnes extra collected	5 800 tonnes extra collected
collection half from households, half from buyback depot with an average collection cost to the recycler of $850 per tonne	extra cans collected wholly from households at an average cost of $1 180 per tonne

Source: LRA, Submission no. 256, pp. 47-52.

reached by the LRA that a voluntary increase in recovery rates to 65 per cent (Scenario A) will bring net benefits of $1 million. It also means that the net costs for Scenario B are likely to be larger than estimated.

The LRA study anticipates that the marginal costs of recovery increase with the switch to a totally household based collection scheme (refer Table 1.5). This is because collections from buyback centres are less costly than kerbside collections. Increasing the level of recycling of aluminium cans is considered to raise the average recovery cost. The cost of increasing the recovery rate from 56 to 65 per cent on a voluntary basis is estimated by the LRA to be 1.4 cents per additional can recovered; the cost of increasing the recovery rate from 65 to 70 per cent is estimated to be 2 cents per additional can.

The study does not consider whether an increase in the recovery rate over 65 per cent could be achieved at lower cost through, for instance, higher buyback prices and/or the operation of more buyback centres. Given favourable market conditions and no adverse regulatory influences, Comalco stated that it is confident it can achieve a 70 per cent return rate without mandatory schemes.

Table 1.6 lists the Commission's estimates of the costs and benefits of recycling to the aluminium reprocessor and to society.

The costs of the reprocessor

The costs to the smelter of post-consumer aluminium cans include collection, transport and processing costs. Figures given in Table 1.6 are those current at the time of writing this report.

Table 1.5: LRA estimates of costs and benefits of increasing the aluminium UBC recovery rate from 56 per cent

	Scenario A return rate 65%		*Scenario B return rate 70%*	
	tonnes	*$ million*	*tonnes*	*$ million*
Additional quantity recovered	3700		5800	
Additional costs		3.1		6.8
Additional value		4.1		6.4
Net benefits		1.0		-0.4

Source: LRA, Submission No. 256 pp.47-52.

The amount of 60 cents per kilogram is paid to the user of aluminium cans on bulk return. The costs incurred by dealers in collecting the cans and transporting them to the recycling or smelting company, including any profit margin or return on capital, are about 30 cents per kilogram. The aluminium smelting and can producing company is hence able to purchase UBC for 90 cents per kilogram. The costs of the aluminium smelter consist of the 90 cents per kilogram for UBC, plus processing costs.

The benefits to the reprocessor

The energy required for resmelting is only some 5 to 10 per cent of that required for primary aluminium production. However, as the energy cost for smelting primary aluminium is 30 cents per kilogram of aluminium smelted ($300 per tonne), the saving is reasonable compared with the scrap aluminium supply cost of 90 cents per kilogram.

The major benefit to the recycler is the aluminium value at $2 to $3 per kilogram.

Costs and benefits to householders and community groups

The additional costs and benefits of the recycling process are those which accrue to society, or parties other than those directly smelting aluminium or producing beverage cans.

People who collect UBC and deliver them in bulk to commercial collectors currently receive some 60 cents per kilogram. Some individuals or groups collect cans for sale at buyback centres because the cost to them in time, inconvenience, transport etc is less than the revenue received. For others, the time, effort and fuel cost involved in sorting and delivering the cans may exceed 60 cents per kilogram, but they may still participate because they derive a benefit from participating in a worthwhile community activity.

The smelting of secondary aluminium is associated with considerably less air and water pollution than the smelting of primary aluminium (refer Chapter 5 of Volume I). However, the extent to which benefits accrue to the community as a result of recycling aluminium depends on the measures which primary smelters take to reduce air and water pollution.

Waste disposal benefits and costs

Recycling of aluminium saves waste disposal costs and tip space. This saving is not part of the returns of the reprocessor, but represents a benefit to local governments and other waste disposal authorities, and hence to society. The Commission's Waste Management Survey found that the average saving is about $32 per tonne for avoided waste disposal charges in Sydney and inner New South Wales and Melbourne and inner Victoria.

Energy used in collection and transport of UBC and other scrap aluminium from remote areas may well exceed that involved in the collection and transport of UBC and scrap aluminium as part of the domestic waste stream. This means that recycling could bring a net addition to vehicle exhaust emissions, unless backfreight is used. This is also true of the collection and transport of many other recyclables.

Table 1.6: Costs and benefits of aluminium reprocessing

Costs to the aluminium reprocessor	*Comment*	*Benefits to the aluminium reprocessor*	*Comment*
Price paid for UBC on return to depot	60 cents per kg for UBC	Value of metal	$2 to 3 per kg
Cost of collection and transport of UBC by dealer	30 cents per kg dealer's margin	Reduced energy use	5% of energy required for primary aluminium which is 30 cents per kg[a]
Cost of UBC to aluminium smelter	90 cents per kg (uncrushed) paid to dealer		

Additional costs to society	*Comment*	*Additional benefits to society*	*Comment*
60 cents per kg paid for UBC may be less than the full cost to the consumer, including fuel and inconvenience costs etc. as indicated by a recovery rate of less than 100 per cent, ie 62 per cent	Consumers may regard any excess as a worthwhile cost of being able to recycle	Savings in waste disposal costs and tip space	$32 plus per tonne in Sydney and Melbourne
		Reduction in underpriced energy use if applicable	
		Resource conservation	
		Reduced land degradation	
Energy used in collection and transport may exceed that for waste disposal		Reduced litter	Each tonne al aluminium recycled saves about 5 tonnes of bauxite

a) Based on information provided by Comalco- approximate only.

Source: Data from NSW Recyclers' Association, Comalco, Financial Review metal price index, ABS/IC Waste Management Survey, IC estimates.

1.2 Lead

Lead accounts for less than 1 per cent of the waste stream but the associated disposal problems are disproportionately large. It is present in a variety of waste products, and can present contamination problems in tips due to its toxic nature. Lead-acid batteries of the type used in vehicles account for the largest proportion of lead in the waste stream.

The extent of lead recycling

The recovery rate of lead in Australia can be estimated from production data for secondary refined (ie recovered and reprocessed) lead and the estimated lead content of waste and scrap exports.

Table 1.7 shows lead recovery and utilisation rates, and production, consumption and exports of refined lead. Production of secondary refined lead amounted to 16 000 tonnes in 1989-90. Exports of lead waste and scrap were 28 000 tonnes (refer Table 1.8). According to Australian Refined Alloys Pty Ltd (ARA), the lead content of lead-acid batteries is 65 to 70 per cent. The lead content of other waste and scrap exported is assumed to be 95 per cent. On this basis, the estimated lead content of lead waste and scrap exports in 1989-90 was 20 000 tonnes. Total lead recovery is estimated as the sum of secondary lead production and the lead content of exports (36 000 tonnes in 1989-90). Taken as a proportion of consumption, the recovery rate obtained in this way is 60 per cent.

The utilisation rate of recovered and reprocessed lead as a proportion of total refined lead production has varied little over the past few years, exhibiting minor fluctuations around 9 per cent. The difference between Australia's recovery and utilisation rates can be attributed to the large quantities of refined lead which are exported.

Pasminco Metals BHAS Pty Ltd (Pasminco), formerly Broken Hill Associated Smelters Pty Ltd, is the sole producer of primary refined lead. Its plant is located at Port Pirie in South Australia. The bulk of secondary refined lead is processed by ARA from used batteries into refined lead alloys at plants in Sydney and Melbourne. In 1989-90 ARA converted 22 500 tonnes of lead-bearing scrap to 16 300 tonnes of lead in various forms.

Around 100 000 tonnes of lead are contained in more than 11 million vehicle batteries on Australia's roads. ARA estimates that of the 4 million batteries scrapped in Australia each year, 85 to 90 per cent are recovered. This leaves 400 000 to 600 000 batteries scrapped annually which are unaccounted for. Some of these are Pulsar batteries (produced by GNB Battery Group), which until recently could not be recycled because of their sealed construction. The technology to reprocess Pulsar batteries has now been developed, but production of these batteries in Australia was recently discontinued. Industry sources stated that they do not expect many to be imported. Any problems associated with the disposal of Pulsar batteries should diminish as those in use wear out. The fate of the remaining lead-acid batteries disposed of is not known but at least some of them end up in landfill, creating potential environmental and health problems.

Table 1.7: Lead: Recovery, utilisation, production, exports and consumption, Australia 1986-87 to 1989-90

	1986-87	*1987-88*	*1988-89*	*1989-90*
		per cent		
Recovery rate[a]	67	80	61	60
Utilisation rate	10	9	8	8
		'000 tonnes		
Production				
primary refined	147	183	184	197
secondary refined	16	18	17	16
Exports				
refined	121	133	162	149
Est. consumption				
refined[b]	57	55	62	61

na = not available

a) The recovery rate is calculated on the basis of secondary refined lead production and the estimated lead content of lead waste and scrap exported. The estimate is intended as a guide only.   B) Production, exports and consumption do not reconcile due to movements in stocks.

Source: ABARE (1990), *Commodity Statistical Bulletin, December, 1990,* AGPS, Canberra.

The Victorian Government stated that the level of recovery of vehicle batteries in Victoria had deteriorated with the introduction of Pulsar batteries. It estimated that the current `recycling rate' for Victoria is 56 per cent, but was not able to confirm whether this is a recovery rate, and whether it includes batteries which are recovered and exported. ARA said the recovery rate in Victoria is possibly in excess of 90 per cent. Exports could account for the difference between the recovery rate estimated by ARA and the 'recycling rate' estimated by the Victorian Government.

Other sources of lead scrap are stationary batteries, lead drosses and sludges, and pipe and sheet offcuts from manufacturing processes and the building industry. The Victorian Government estimates that about 32 per cent of lead used for applications other than batteries is recycled in Victoria. ARA said that, while an accurate recycling rate is hard to measure, it is probably higher than 32 per cent.

About 50 per cent of battery scrap collected is estimated to be exported annually. Table 1.8 shows lead waste and scrap exports and estimated lead content. Exports are mainly to Taiwan, South Korea and the Philippines.

Table 1.8: Lead: Exports of waste and scrap, Australia 1986-87 to 1989-90

	1986-87	*1987-88*	*1988-89*	*1989-90*
		'000 tonnes		
Battery scrap	30	35	31	25
Other waste and scrap	1	2	<1	3
Total	31	37	31	28
Estimated lead content[a]	21	26	21	20

a) According to ARA battery scrap consists of 65 to 70 per cent lead. Other waste and scrap exports are mainly scrap metal and alloy, and 95 per cent lead content is assumed.

Source: ABS (various years), *Foreign Trade Statistics, Table MX04C*, AGPS, Canberra

Most used vehicle batteries are collected from service stations and battery and tyre retail outlets by small collectors and sold to scrap metal merchants. There are some hundreds of 1 or 2 person collection firms, and 20 to 30 larger scrap merchants Australia-wide. Scrap merchants either sell the used batteries to ARA or export them. It is desirable that batteries for export are drained of acid before being packed in sealed containers to prevent the risk of explosion.

Factors affecting the level of recycling

The level of recycling of lead is influenced by a number of factors including the demand for refined lead, the costs of processing recovered lead, and government regulations concerning the transport, processing and disposal of lead.

Demand for lead

Secondary lead if appropriately refined is a perfect substitute for new metal and can be used in all applications where primary lead is used.

By far the largest end-use of lead in Australia is in lead-acid batteries. About 54 per cent of the refined lead sold by Pasminco from its Port Pirie smelter is used for batteries.

The 15 per cent of lead consumed which is used as an additive for petrol, cannot be recovered for reprocessing. The decline in consumption of refined lead since 1986 is associated with the compulsory use of unleaded petrol in new vehicles. Another use for lead is in radiation shields used by X-ray technicians.

Australia is more than self-sufficient in refined lead. The bulk of refined lead produced is exported.

Recycling facilities and structure of the industry

ARA is the major lead reprocessor in Australia. It has plants with a combined capacity of nearly 17 000 tonnes in Sydney and Melbourne. There are other small smelters in each of the mainland States, with a combined capacity of less than 5000 tonnes.

ARA is a joint venture between Simsmetal and Pasminco. In March 1984 the Trade Practices Commission ruled that the joint venture could go ahead but imposed a number of conditions. These were:

- a guaranteed quantity of raw material to be purchased from certain lead scrap suppliers, and
- the output of refined lead to be split between Pasminco and Simsmetal and each to market its share independently.

These conditions were set to avoid a situation of monopoly in scrap supply as well as refined lead production. ARA claims that these conditions constrain its ability to earn an acceptable return and are unnecessary because both the price of scrap and of refined lead are set in world markets.

The price of primary and secondary refined lead and lead scrap

Lead prices are determined by world supply and demand conditions but do not appear to be as volatile as those of some other metals. However, during 1986-87 the price of primary refined lead nearly doubled. The level of lead recovery and reprocessing increased only slightly, being limited by the ability of collection systems to rapidly increase supplies. In contrast, falling lead prices have the potential to quickly reduce the recovery of lead-acid batteries. For instance, in the United States in 1989, a decline in lead prices is said to have directly contributed to a decline in the recovery rate from 90 per cent to 80 per cent; however, more onerous regulations governing transport and storage of batteries may also have contributed to this decline.

Payments of $2 per battery are reported to be made to contractors for batteries picked up in bulk from a municipal landfill. The current downturn in the demand for lead for motor vehicle batteries has put downward pressure on the price of lead battery scrap. In countries with severe temperature variations there can be an element of seasonality in lead scrap prices. This is due to increased demand for lead by battery producers in preparation for increased production before winter. According to ARA the seasonal impact on lead scrap prices in Australia is very small.

Government intervention

There is significant government legislation and regulation governing the transport, storage, processing, disposal, purchasing and marketing of lead. Much of this arises from the toxic nature of lead.

Transport and storage regulations

The States impose strict controls on the transport and storage of lead-bearing materials such as scrap batteries, drosses and sludges, and other scrap lead. To facilitate transport, lead-acid batteries are exempt from some of the regulations in some States. The regulations are subject to periodic review and, following overseas trends, stricter regulations and tighter controls are expected to be imposed. ARA said that the costs involved in implementing these increased safety regulations would reduce its gross annual earnings by at least 5 per cent.

ARA said that in the United States onerous regulations governing transport and storage of scrap batteries were introduced too quickly, resulting in lead reprocessing plants becoming unviable. This led to greater illegal dumping of batteries.

Occupational health legislation

The regulations imposed to protect workers dealing with lead are not consistent between States. For instance, blood lead levels considered unsafe differ between Victoria and New South Wales. It is expected that the national guidelines to be introduced will prescribe lower blood lead levels than either the current Victorian or New South Wales regulations. ARA anticipates that the cost to it of lowering allowable blood lead levels will be $0.5 to $1 million over the next 5 years.

ARA commented that it cannot currently meet the low blood lead levels for females of child bearing age recommended in the draft Worksafe Australia Lead Code of Practice. It therefore does not accept women of child bearing capacity on the factory floor in areas of potential exposure. This possibly creates a conflict with equal opportunity and anti sex discrimination legislation.

Emission controls

This is also an area under State control. ARA said that judging by overseas trends, a tightening of controls is likely in the medium term, causing significant increases in costs. Current legislation prohibiting the use of leaded petrol in new motor vehicles is already reducing the demand for lead as a petrol additive.

Slag disposal

The disposal of slag from secondary lead processing is a world-wide problem for which no satisfactory solution has yet been found. The slag waste cannot be disposed of in the general industrial and domestic waste stream because of its potentially toxic nature. Both in Victoria and New South Wales the material is a registered waste product, subject to control. Pollution of the environment from disposing of harmful substances by landfill and the setting of disposal charges to cover environmental damage costs are discussed in Chapters 5 and 3 of Volume I, respectively.

Deposit refund systems

No deposit refund systems for batteries operate in Australia. Deposit refund systems operate in several countries, including Denmark and in just under half the States of the United States. The Netherlands and Sweden are considering the introduction of similar legislation. The legislation passed in Maine (United States) in 1989 imposes a $US10 deposit on lead-acid batteries. Deposit legislation as a means of preventing harmful materials being discharged into the environment is discussed in Chapter 7 of Volume I.

The costs and benefits of lead reprocessing

Table 1.9 illustrates some of the costs and benefits to the lead reprocessor, and the additional costs and benefits to society from the reprocessing of lead.

The potential damage to health and the environment from dumping lead-acid batteries and other materials containing lead is significant. These are costs

Table 1.9 Costs and benefits of lead reprocessing

Costs to the lead reprocessor	*Comment*	*Benefits to the lead reprocessor*	*Comment*
Payment on collection from tip	$2 per battery, equivalent to about $140 per tonne of battery scrap. Each tonne of battery scrap contains about two thirds of a tonne of lead.	Value of metal as refined lead	$890 per tonne ex Port Pirie in January 1991
Collection and transport costs and margin of scrap metal merchant.		Energy use and energy cost in smelting is less than for new lead	
Cost of scrap to refiner	Including insurance cover for health risk to employees		
Processing costs			
Cost of disposing of lead slag	Lead slag is a registered material and cannot be included in the normal industrial and household waste stream		

Additional costs to society	*Comment*	*Additional benefits to society*	*Comment*
Pollution from processing scrap	Less than for virgin materials	Savings of waste disposal costs and landfill space and associated pollution	Lead cannot be disposed of in landfill because of harmful effects of contamination of landfill sites
Health risk costs for employees not covered in private costs	Less than for virgin materials	Savings in pollution output from smelting and energy production for virgin materials	
		Resource conservation, reduced land degradation from reduced ore mining and scrap dumps	

Source: Industry data

which the market at present does not recognize in signalling the benefits of recycling.

The toxic nature of lead means that unregulated or illegal disposal can lead to social costs from the contamination of land, water and domestic and industrial waste tips. Lead contamination can leave an area permanently unfit for human habitation. The results of a study conducted at Port Pirie suggested that there may be no clear level of direct environmental exposure to lead below which adverse effect on the mental development of young children does not occur (McMichael et al, 1988).

The production of primary lead is associated with the production of considerable quantities of sulphur dioxide. While much of this sulphur dioxide can be, and is, recovered and converted into sulphuric acid, recovery is not 100 per cent and measures need to be taken to protect workers and the environment from its harmful effects. However, no significant sulphur dioxide production is associated with the smelting of secondary lead.

Recycling of lead therefore leads to some conservation of resources, reduced lead contamination of landfill areas and, because of reduced primary lead production, less pollution from that source.

Offset against these benefits should be the risks to health inherent in lead reprocessing. It involves the handling of lead and processes which can, if not adequately controlled, expose individuals to hazardous materials. However, the production of secondary lead does not require the high temperatures necessary for the production of primary lead. This leads to smaller quantities of airborne lead per tonne of refined lead produced and potentially reduced exposure for employees.

1.3 Copper

Copper is a relatively valuable metal, which provides an incentive to recycle it. The majority of used copper consists of commercial waste. A large proportion comes from old telephone wiring and is provided under contracts with Telecom. Little copper is used in consumer goods and it is not a significant part of the household waste stream. Some scrap copper comes from households in the form of old pipes, boilers etc.

Copper waste and scrap is used as feedstock in the production of refined copper. Pre-sorted scrap can enter the refining process at various stages, depending on the quality of the scrap.

The extent of recycling

About 19 per cent of the copper consumed in Australia in 1988 was recovered for recycling (refer Table 1.10). A further 2529 tonnes of copper scrap was imported (refer Table 1.11).

The recovery rate is estimated by taking secondary refined copper production of 27 000 tonnes in 1988 and deducting estimated imports of some 2500 tonnes. The figure of 24 500 tonnes obtained in this way is then expressed as a proportion of estimated consumption of 129 000 tonnes. The recovery rate of 19 per cent is low in world terms.

The utilisation rate for secondary refined copper as a proportion of total refined copper production in Australia was about 6 per cent in 1989 (refer Table 1.10). About half of total world refined copper consumption is accounted for by secondary copper (ABARE 1989).

Australia's relatively low copper recovery and utilisation rates, and the differential between them, come about largely because of Australia's substantial copper mining and smelting industry, the relative costs of producing primary and secondary refined copper, and the reduced incentives available to copper scrap collectors in the face of the past constraint on the export of copper scrap. The copper scrap export embargo, and its associated export quotas applying to secondary copper ingots and other basic shapes made from scrap material, was abolished in January 1990.

About 45 000 tonnes of scrap containing copper mixed with other materials (including alloys) is used for reprocessing and extraction of copper in Australia annually. This scrap is not a homogenous commodity: the amount of refined copper which can be recovered from one tonne depends on the grade of scrap used. For instance, scrap arising from copper fabricators, the electrical, telecommunications, building and demolition industries, and from households can have a copper content of between 75 and 99 per cent.

Scrap generated by manufacturers of brass and gunmetal, or recovered from used machinery, motor vehicles or plumbing fixtures may yield from as little as 20 per cent to as much as 80 per cent copper.

Electrolytic Refining & Smelting Co of Australia Pty Ltd (ER&S) is the largest recycler and has the only plant capable of reprocessing low grade copper-bearing scrap. About half its current feedstock is scrap sourced within Australia. In 1989 ER&S handled almost 22 000 tonnes of scrap of various quality at a value of over $40 million. ER&S relies on scrap merchants for the bulk of its scrap.

Table 1.10: Copper: Recovery, utilisation, production, consumption, exports and imports of refined copper, Australia 1986 to 1989

	1986	*1987*	*1988*	*1989*[a]
		per cent		
Recovery rate[b]	16	22	19	na
Utilisation rate	11	14	12	6
		'000 tonnes		
Production				
Primary refined	164	179	196	230
Secondary refined	20	29	27	15
Exports	140	128	153	177
Imports	73	44	59	61
Estimated consumption	117	124	129	129

a) ABARE estimates. B) The recovery rate is estimated on the basis of secondary refined production less imports of scrap from Table 1.11, and the resulting figure taken as a proportion of consumption.

Source: ABARE (1989), *Commodity Statistical Bulletin*, December, AGPS, Canberra.

The location of recycling

Simsmetal operates a copper base alloy ingotting plant at Milperra in New South Wales. Consolidated Extrusions at Ingleburn in New South Wales relies entirely upon scrap for its raw material. Other major users of copper scrap include the G.E. Crane Group of companies located in Penrith, New South Wales, Mount Isa Mines Ltd (MIM) in Townsville, Queensland, and Extruded Metals in Milperra, New South Wales.

The two major producers of refined copper in Australia are ER&S which has operated at Port Kembla since 1908, and Copper Refineries Pty Ltd which operates a smelter at Townsville. Both also process scrap copper.

There is a large Australia-wide network of scrap collectors and dealers. Some of these melt and extrude the scrap and some sell the scrap to extruders.[2] Simsmetal, which is a major scrap merchant, also operates its own scrap copper melting plant.

Some scrap is imported (refer Table 1.11).

Table 1.11: Imports and exports of copper scrap, Australia 1985 to 1988a

	1985	*1985*	*1987*	*1988*[a]
		tonnes		
Imports				
Scrap	561	518	1003	2748[b]
Copper base alloys	600	729	1292	c
Exports				
Scrap	-	20	176	44
Copper base alloys	318	155	263	176
Net imports	843	1072	1856	2529

a) During the period the coper scrap export embargo was operative, exports were permitted under an import/export scheme whereby participants could import copper and copper alloy scrap, upgrade it and re-export an equivalent copper content of the scrap. B) Includes copper-base alloy scrap. C) Not separately available.

Source: BMR (1989), *Australian Mineral Industry Quarterly* (various issues), AGPS, Canberra

Factors influencing the extent of recycling The level of recycling of copper is influenced by the demand for copper, substitutability of recycled copper for primary source copper, processing costs,

2 Extrusion is the process of pulling semi-molten copper into the required shapes.

costs such as collection and transport which determine the copper scrap recovery rate, and government interventions which affect relative prices. Since the lifting of the embargo on the export of copper scrap, the level of domestic recycling also depends on the extent to which copper scrap is exported.

Demand for copper

Copper products are used as inputs in a variety of industries, including electrical and telecommunications (wiring etc), and building (plumbing fixtures etc). Copper is also used to make a variety of alloys, including bronze and brass used in the manufacture of machinery, motor vehicles and household goods.

Consumption of copper has increased slightly despite competition from materials such as optic fibres in communications, plastics in water tubing, and aluminium in automobile radiators.

About 70 per cent of Australian production of refined copper is exported.

Prices

Australian copper prices follow the world market price. Increased demand and some supply disruptions, particularly in Canada, led to copper prices doubling during 1987. The Australian price began that year at $2060 per tonne and closed at $4280 per tonne. In mid-1990 production problems in Mexico, Peru, Bougainville and Arizona kept virgin copper prices high. Prices currently (January 1991) vary from $3100 to $3600 per tonne depending on type.

Since the lifting of the copper scrap export embargo in 1990, Australian scrap prices have tended to increase. Prices also depend on the quality of the scrap and the processing required. A period of rising copper prices stimulates scrap collection. Good quality copper scrap is in high demand world wide and it is possible for scrap prices to exceed the price of primary copper where it possesses specifications not incorporated in primary refined copper.

Technical limitations to recycling

Some copper products are difficult to recycle. For example, some multi-core telephone cables are moisture proofed by the inclusion of petroleum jelly, generating excessive smoke in smelting. The polyethylene on plastic-coated copper wire is difficult to dispose of as waste. Some copper products are difficult to cut up and are too large to charge to the furnace. While the technology for recycling these products exists, it can be costly and constrains the extent of further recycling of copper scrap.

Substitutability and product characteristics

When copper scrap is added in the primary smelting process the refined product is indistinguishable from primary refined copper. However, where copper scrap alone is reprocessed, the quality of the scrap determines the characteristics of the final product.

Copper scrap comes in a variety of qualities. Brass (an alloy of copper and zinc) or bronze (an alloy of copper and tin) may be added when zinc or tin contamination in the final product is not a problem. If a higher quality product is desired, primary copper ingot may be added to the smelt to dilute the contaminants present in the scrap.

The proportion of scrap to virgin materials used by extruders also depends on the relative prices of scrap and virgin copper. When scrap is relatively highly priced, a higher proportion of primary ingot may be used.

Government intervention

Until January 1990 controls were in place on the exports of copper scrap. The embargo on the exports of copper scrap was introduced in November 1964 to alleviate a domestic shortage of copper caused, in part, by the temporary closure of the Mt. Isa smelter. These controls were lifted in August 1965 and, partly because of a differential between the Australian domestic price and the world price, supplies of copper and alloy scrap began to be exported from Australia. Consequent shortages of scrap and refined copper led to the reimposition in December 1965 of the export embargo on scrap and export controls on primary copper (not including ores, concentrate and blister).

While the copper scrap export embargo was in place, ER&S acted as the buyer of last resort for economically priced copper scrap. With the lifting of the embargo it has to compete with the export market for copper scrap. With the expansion and redevelopment of its smelter capacity requiring a higher proportion of concentrate feedstock, ER&S expects to significantly reduce its reliance on copper scrap. However MIM is increasing its copper recycling activities.

Given the concentrated market structure, the extent of copper recycling undertaken in Australia is likely to have been adversely affected by the embargo as copper scrap collectors could have been offered less than international market prices. Secondary copper ingots were subject to an export quota of 3000 tonnes, but the quota has only been about half utilised in the past decade.

Some smaller extruders argued that the lifting of the embargo has led to reduced access to scrap. Japanese buyers are currently offering to buy high grade Australian scrap at no discount from the London Metal Exchange price. Local extruders say they cannot compete at this level. The outcome will not be known for some time, but it is likely that there will be a higher level of recovery rate of copper scrap as collectors are offered higher prices. There will inevitably be losses to some firms processing copper scrap and gains to collectors of copper scrap. However, the community should gain from a more efficient allocation of resources.

Costs and benefits of reprocessing of copper

Table 1.12 illustrates some of the costs and benefits to the copper reprocessor, and additional costs and benefits to society from the reprocessing of copper.

Table 1.12: Costs and benefits of copper reprocessing

Costs to the copper reprocessor	*Comment*	*Benefits to the copper reprocessor*	*Comment*
Price paid to owner of scrap		Value of new metal	$3100 to $3600 per tonne in January 1991
Costs of collection to scrap merchants			
Costs of sorting, cleaning and preparing for processing			
Processing costs, including energy and labour			
Additional costs to society	*Comment*	*Additional benefits to society*	*Comment*
Pollution from processing scrap	Less than for virgin materials	Savings of waste disposal costs and landfill space use	$32 plus per tonne in Sydney and Melbourne
		Resource conservation from reduced ore mining	
		Reduced land degradation from ore mining and scrap dumps	

Source: Waste disposal costs – IC waste management survey estimates.

1.4 Steel

Steel is believed to account for between 1 and 5 per cent of household waste in Australia. Steel scrap in household waste consists mainly of used food containers and domestic appliances.

There is significant recycling of steel recovered from ships, building demolition (including structural steel), domestic appliances, cars, etc. There is also significant in-house recovery.

Two technologies are used in Australia to make molten steel, both of which can use scrap. They are the basic oxygen furnace and the electric arc furnace. The basic oxygen furnace requires molten iron (from a blast furnace), scrap (no more than 15 per cent of the total charge weight), and dolomite as material inputs. The electric arc furnace can use 100 per cent scrap.

In-house scrap is created when molten steel is cast into ingots for later primary rolling into basic shapes, or when continuous casting technology is used with the molten steel flowing directly into a water cooled continuous mould which forms the desired shape (slabs, blooms or billets). The amount of in-house scrap generated can be considerably reduced where continuous casting technology is employed.

The extent of recycling

The recovery rate in terms of steel scrap collected was around 26 per cent of steel consumption in 1988. This rate is calculated on the basis of steel scrap collected (refer Table 1.13) as a proportion of the consumption of raw steel (refer Table 1.14). The figures for consumption in Table 1.14 do not take into account the steel content of imports and exports of transport equipment, consumer durables and other fabricated steel products. However, BHP Steel (BHP) estimates indicate that when they are taken into account, the figures for consumption are similar to those in Table 1.14. Imports and exports of steel products, therefore, will not significantly affect the recovery rate estimated from Table 1.14.

There is significant further in-house recovery and reprocessing of steel scrap; if this is included the recovery rate increases to around 40 per cent.

Exports account for around half the scrap collected (refer Table 1.13). Minor amounts of steel scrap are imported. In 1988-89 imports accounted for 0.1 per cent of supplies and represented a mixture of various types of high quality steel scrap, with an average value of more than $400 per tonne.

Recovery of scrap

Post industrial and post consumer scrap

Collections and use of post industrial/consumer steel scrap over the period 1978 to 1988 are shown in Table 1.13. Smorgon Steel (Smorgon) is the largest reprocessor of this form of scrap, followed by BHP. Together they processed about 32 per cent of steel scrap recovered in 1988.

Table 1.13: Collection and use of steel scrap, Australia 1978-1988

Year	*BHP*	*Comsteel*	*Smorgon*	*Other*	*Export*	*Total*
			'000			
1978	499	65	-	215	544	1323
1979	596	74	-	215	534	1419
1980	439	74	-	420	633	1386
1981	358	60	-	259	604	1281
1982	269	41	40	215	492	1057
1983	211	55	90	207	424	987
1984	322	63	120	192	386	1083
1985	262	56	185	203	458	1164
1986	367	51	200	221	581	1420
1987	171	65	230	223	859	1548
1988	184	71	340	230	791	1616

Source: BHP, Submission No. 162, p. 20.

The bulk of scrap is generated in the capital cities of the eastern mainland States, reflecting greater potential supplies, and lower collection and transport costs due to higher densities of population and industries. However, there are some remote mining and industrial centres which support a collection and export operation, eg Karratha which serves Western Australia's Pilbara region. Table 1.15 shows scrap industry estimates of collections by State for 1989.

Scrap is largely exported from Queensland, South Australia and Western Australia where local demand is low, rather than transported to the south eastern States.

In 1988 BHP conducted a study to determine potential sources of scrap in Australia. It found an overall potential recovery rate of steel (excluding steel cans) in Australia of 77 per cent (refer Table 1.16). BHP predicts a 'recycle rate'[3] for 1992 of 29 per cent.

Table 1.14: Steel: Production, exports and consumption of crude steel, Australia 1986 to 1989

	1986	*1987*	*1988*	*1989*
		'000 tonnes		
Production[a]	6 703	6 125	6 399	6 735
Imports	25	123	133	185
Exports[b]	496	523	330	375
Apparent consumption	6 232	5 725	6 202	6 552

a) Includes recovery from scrap. b) Blooms, billets and slabs only; does not include semi-fabricated steel products.

Source: ABARE (1990), *Commodity Statistical Bulletin, December 1990*, AGPS, Canberra. ABARE (1990), *Quarterly Mineral Statistics, June Quarter, 1990*, Canberra. BMR (1988), *Australian Mineral Industry Quarterly, 40(4)*, AGPS, Canberra.

3 BHP defines its recycle rate as all steel collected domestically excluding that generated in-house as a proportion of the domestic steel market (local manufacturers) plus foundry make. This definition differs from that used by the Commission.

In-house scrap

Two types of in-house steel scrap are generated by the steel industry. One is that generated within the steelmaking operation and represents about 180 000 tonnes per annum from BHP's three plants.

The other includes the steel off-cuts and off-grade shapes from steel rolling operations. Collections of scrap from these operations have declined significantly due to the introduction of continuous casting. The level of recirculating steel scrap returning from BHP's rolling mills varies from 5 per cent at Port Kembla to 18 per cent at Whyalla. BHP expects the level of internal scrap generation at Whyalla to be reduced to about 6 per cent with the introduction of continuous casting in the early 1990s, cutting the quantity of in-house scrap from the current 500 000 tonnes per annum to 350 000 tonnes per annum. This anticipated reduction reflects the adoption of more efficient casting processes.

Table 1.15: Steel scrap collections by State, 1989

	Quantity	*Proportion*
	'000 tonnes	*per cent*
New South Wales[a]	600	38
Victoria	500	31
Queensland	150	9
Western Australia	150	9
South Australia	140	9
Tasmania	40	3
Northern Territory	20	1
Total collections	1600	100

a) Includes the Australian Capital Territory

Source: BHP, Submission No. 162, p. 20.

Factors influencing recycling of steel

The factors which determine the extent to which steel is recycled include the demand for the final product, the substitutability of the recycled product, the costs of collection and smelting, which include energy, labour and capital costs and technical limitations.

Demand for steel

BHP estimates that about 60 per cent of its sales are to the building and construction industry. Sales to vehicle manufacturers comprise about 9 per cent and to makers of consumer durables about 8 per cent. Sales to tinplaters represent about 5 per cent.

Table 1.16: Potential recovery of contained steel by product category

Product	*Recovery rate*
	per cent
Prompt industrial[a]	96
Vehicles of all types	70
Consumer durables	80
Rails	95
Heavy industrial machinery	80
Light industrial machinery	80
Major industrial plant	81
Building demolition	69
Municipal scrap[b]	0
External to steelplants	72
Internal to steelplants	94
Overall potential recovery rate (including steelplants)	77

a) Offcuts from manufacture using prime steel recycled immediately. b) Small steel and tin cans. The amount recovered is considered to be insignificant.

Source: BHP, Submission No. 162, p. 21.

Substitutability of reprocessed steel

Smelted scrap steel has essentially the same characteristics as new steel of the same type. However, 100 per cent reprocessed steel is generally not used for very demanding applications in flat products steel.

Some of the steel recovered in demolition is in the form of undamaged structural shapes. These steel shapes compete with newly made steel, and sell for about one third of the price. No information is available about the quantities involved.

Industry structure - iron and steel

The Australian primary ferrous metal industry is dominated by BHP, which produces 95 per cent of crude steel. It produces crude steel at Port Kembla and Newcastle in New South Wales, and Whyalla in South Australia. BHP recycles in-house scrap but uses only limited quantities of post industrial scrap. The Commonwealth Steel Company Limited (Comsteel) and Smorgon, which account for the remaining 5 per cent of crude steel produced, are totally dependent on scrap for their inputs. Comsteel operates a mill at Newcastle and Smorgon's mini-mill is in Melbourne. BHP is the only crude steel producer with interests in the minerals necessary for the production of primary ferrous metals, viz, iron ore, black coal, and dolomite. It plans to commission its own mini-mill at Rooty Hill, Sydney in late 1991. When operational, this mill is expected to process nearly 300 000 tonnes of scrap steel per annum.

There are a number of other steel foundries which are totally dependent on merchants' and collectors' scrap. These are not included in the production statistics for primary ferrous metals because the crude steel produced by those foundries is further processed in-house. Included in this category are General Motors' engine foundry and Ford's engine foundry in Victoria, Tubemakers' Yennora foundry in New South Wales and Bradken's foundry in Queensland. Foundries located between Adelaide and Brisbane have a combined capacity of about 270 000 tonnes of scrap per annum.

Industry structure - scrap steel

The Australian steel scrap collection industry is dominated by Simsmetal. The company controls about 70 per cent of the market and in some States is the only processor and exporter of scrap. Other significant scrap merchants are Metal Recyclers and Balcombs in New South Wales, Norstar Steel Recyclers (Norstar) and AB Metals in South Australia and Victoria, and Wanless in Queensland. Throughout Australia there is a network of small local collectors who sell to the major merchants. Small manufacturers sell their steel offcuts mainly to the local collectors but larger manufacturers tend to deal directly with the major merchants.

Technical limitations

Because of the high value of steel scrap the recovery rates for almost all categories are relatively high. However, while the technology exists for recycling virtually all steel scrap generated, the costs may be greater than the benefits obtained for certain types of scrap.

Manufacturers of steel products, and of motor vehicles in particular, are increasingly applying plastic coatings to extend the life of their products. These coatings must be removed before the steel can be reprocessed. With some of the types of plastic currently used this process can be very labour intensive and costly. Some steel scrap reprocessors first crush vehicle bodies and subsequently remove ferrous metals using electromagnets.

The metallic content of motor vehicles, which was about 82 per cent in the early 1970s, is now about 70 per cent. To reduce weight and improve fuel efficiency even lower steel contents are planned. The decline in the metallic yield per recycled vehicle may result in the recycling of car bodies becoming less viable. However, car manufacturers may have an incentive to design vehicle bodies which are economical to reprocess. Some manufacturers are making moves in that direction. For instance, some are coding the plastic parts in vehicles to make them identifiable. In Germany, BMW and Volkswagen are developing disassembly lines where vehicle bodies are drained of oil and fluid and stripped of glass and plastic parts as well as metals, in order to further recycling technology.

BHP said that steel coated with organic substances is not a problem to Australian steelmakers at present and that it does not experience any problems with plastic coated scrap. Problems are, however, encountered with zinc coated steel and studies are currently being conducted in this area.

Municipal waste - steel cans

Steel in municipal scrap (as defined in Table 1.16) consists of small steel and tinplated cans discarded by householders through the regular refuse collection system. As shown in Table 1.16, virtually no small steel scrap is recovered from municipal waste. The Waste Management Authority of New South Wales (WMA) estimates that an average of 13.8 kilograms of small steel and cans are disposed of each year per person in the major cities. This means that a city with a population of 100 000 generates about 1380 tonnes of small scrap annually. BHP said that this quantity is too small to be of economic interest, mainly because of the shredding, upgrading and transport costs.

Currently, scrap food tins are valued at $90 per tonne cleaned and crushed delivered to the detinner. There are around 14 000 cans per tonne. MRI Pty Limited (MRI) estimates that about 220 000 tonnes of tinplate scrap (discarded by households as used food tins) are buried in landfill annually. According to BHP, tinplated steel cans represent about 13 per cent of total steel scrap generated.

Contamination of used food cans is a major deterrent to their recycling in Australia. Trial used food can collection schemes conducted in Adelaide, Wollongong, Sydney and Geelong have met with mixed success. Household participation rates have been at most 20 per cent and quantities collected small due to the time and effort involved in washing cans and the related problems of contamination for collectors and reprocessors.

Overseas experience has been similar. For instance, in North and South Carolina (United States), where Coinbak machines pay five cents for each container inserted, the steel can recovery rate in 1989 was 17.9 per cent. A notable exception is Seattle (Ontario) where the recovery rate for steel cans is nearly 60 per cent. This includes the recovery of steel beverage cans which are relatively uncommon in Australia.

Product characteristics

Scrap is a partial substitute for pig iron and flat iron in the production of steel. BHP is the only manufacturer of pig iron and flat iron in Australia and consumes most of its own production. The availability of sufficient scrap is therefore of critical importance to foundries.

Steel scrap is not a uniform commodity and scrap users have their own specialised requirements dictated by the nature of their plant and the characteristics of the product made. BHP, in consultation with industry, has developed specifications which all major users have agreed to adopt and which are in keeping with international scrap grading codes.

Steel scrap as collected needs to undergo a certain amount of processing, depending on the use to which the resultant steel is to be put. Certain contaminants cause steel to be of inferior quality, or cause difficulties in casting, and can be hazardous. For instance aluminium reacts explosively with caustic soda used in de-tinning and must be eliminated. Cleanliness, analysis for the presence of other metals, size, density and the absence of closed containers are also important.

Scrap prices

The prices of steel scrap on world markets are determined principally by the level of demand of mills in the United States, Japan, Korea and Taiwan, and the level of supply of scrap from the United States. Scrap prices in Australia are set by the export parity price.

Government intervention

Tariffs

Crude steel is subject to Customs duties between Free and 5 per cent. The 17 per cent duty applying to steel castings will be reduced to 15 per cent by 1 July 1991. Waste and scrap enter duty free. Average effective rates of protection in 1988-89 were estimated by the IAC for iron and steel basic products as 9 per cent and for steel castings as 28 per cent.

Deposit refund systems

There are no deposit refund arrangements applying to steel products in Australia. However such schemes operate in Sweden and Finland. In Finland, new car buyers pay a deposit of ECU 130. When the used car is returned to an official recovery site an amount in excess of the deposit is refunded. This has resulted in 90 to 99 per cent of cars being returned. Part of the revenue is used as financial assistance for collection, transportation and scrapping facilities. A similar system operating in Sweden is reported to have been less effective because of its low charges and some scrapping firms charging a higher price for scrapping than the money refunded.

Steel scrap supply and demand: empirical analysis

The Commission has undertaken an analysis of the factors affecting steel scrap collections (IC, forthcoming). The analysis made use of an econometric model of scrap supply and demand which was validated using empirical information on scrap collection (shown in Table 1.13), scrap prices, construction activity and steel production. The main findings are summarized below.

Scrap supply

Steel scrap supply is influenced by two main factors: the price of scrap (current and lagged) and the activity level of the construction sector. Those two factors alone can explain about 95 per cent of the variations in scrap supplies observed during the 1978 to 1988 period. Other things being equal, supply increases by 0.44 and 0.29 per cent if the same period price increases or if the previous period price decreased by 1 per cent, respectively. Scrap supply also expands with increased construction activity because construction usually involves demolition which can release significant amounts of obsolete steel products. The sensitivity of scrap supply to changes in the level of construction activity is high, a 1 per cent increase in construction activity resulting in a 2.3 per cent increment in scrap supply (see Boxes 4.1 and 4.3 in Volume I for further details on scrap supply and demand).

Scrap demand

Scrap demand is a function of three main variables: the scrap price, the activity level of the steel industry and scrap exports. These three variables together with Smorgon's entry in the scrap market and BHP's discontinuance of the open hearth technology can explain about 97 per cent of the variations in scrap demand during the 1978 to 1988 period.

The analysis showed that during the 1982 to 1988 period, a 1 per cent change in scrap prices resulted in a 0.46 change (in the opposite direction) in the amount of scrap demanded. A negative but much lower sensitivity was estimated for the 1978 to 1981 period. The demand for scrap proved to be sensitive to changes in the amounts of steel produced, a 1 per cent change in steel production resulting in an almost identical per cent change in scrap demand during 1978 to 1981. Smorgon's 1983 entry in the scrap market and the discontinuance of the open hearth technology in the early 1980s increased the sensitivity of scrap demand to changes in the amounts of steel produced to 1.4 per cent for the 1982 to 1988 period.

Price and supply-demand interactions

The observed quantities of steel scrap collected (shown in Table 1.13) are the net result of the interactions between three main factors: supply, domestic demand and prices. (In turn, these factors are determined by the variables mentioned in the previous paragraphs.)

Examples of price and supply-demand interactions are provided by the changes in observed scrap collections and exports shown in Table 1.13. During the 1978 to 1981 period scrap collections and exports were relatively high. This combination resulted mostly from an increase in scrap prices . High prices more than offset other changes during this period (such as an expanded domestic demand due to a boom in steel production or a contraction in supply due to low construction activity) that may have led to reduced exports. Prices again had a strong influence in the combination of low collections and exports observed during the 1982 to 1984 period. This combination resulted from the low prices experienced during that period and occurred despite the export boosting effects of a depressed domestic demand (resulting from the collapse of steel production during that period).

The findings suggest that steel recycling has not, in the main, resulted from environmental or resource scarcity concerns nor from government requirements. It has arisen mostly from the technical requirements of steel production and commercial considerations of scrap merchants, steel producers and steel users (who eventually become potential scrap sources). The market seems to have provided an effective mechanism to adjust steel scrap collections to price movements or other changes affecting scrap supply (such as construction activity) or domestic scrap demand (such as steel production).

Costs and benefits of reprocessing steel

Table 1.17 illustrates the costs and benefits to the steel reprocessor, and additional costs and benefits to society from steel reprocessing.

Resource use and environmental impact

Smelting of steel scrap results in less air and water pollutants than from the production of new steel. However, environmental regulations and the installation of gas scrubbers in new steel furnaces limit the release of air pollutants and hence limit the gains in this respect from recycling steel. BHP said that the greatest environmental cost it faces in the construction of the Rooty Hill mini-mill is not in controlling land, water or air pollution but in keeping noise within the limits set by the State Pollution Control Commission.

The smelting of steel scrap uses about 20 per cent of the energy required to produce liquid steel from iron ore. However, energy is used in collection and transport, and is also used for sorting, shredding and compressing some forms of scrap. Less water is also used in the smelting of steel scrap.

Table 1.17: Costs and benefits of steel reprocessing

Costs to the steel reprocessor	*Comment*	*Benefits to the steel reprocessor*	*Comment*
Cost of scrap to steelmaker, comprising:	$130 per tonne	Value of metal as finished steel	$600 per tonne
Cost of scrap to scrap merchant	$10 to $70 per tonne	Energy saving in smelting scrap	Energy cost is 20% of that of smelting virgin materials
Collection and transport costs, and margin of scrap metal merchant	$60 per tonne		

Additional costs to society	*Comment*	*Additional benefits to society*	*Comment*
Pollution caused by processing scrap	Less than for virgin materials	Savings of waste disposal costs and landfill space	$32 plus per tonne in Sydney and Melbourne
		Savings in pollution output from smelting virgin materials	
		Reduction in underpriced energy use if applicable	
		Resource conservation	From reduced ore mining
		Reduced litter	From fewer car bodies dumped etc

Source: Industry submissions; waste disposal costs: IC waste management survey estimates.

1.5 Iron

The vast majority of iron scrap is generated in production processes and is reprocessed in-house without entering the waste stream.

There are six companies involved in the mining of iron ore in Australia. Of these, BHP is the only domestic user and producer of pig iron. Pig iron, which is an input into raw steel production, is produced from the processing of iron ore and coke in a blast furnace, or recovered from scrap.

Table 1.18: Iron: Production, exports and consumption, Australia 1986 to 1989

	1986	*1987*	*1988*	*1989*
		'000 tonnes		
Production[a]	5889	5569	5730	6094
Exports	26	165	25	24
Apparent consumption	5863	5404	5705	6070

a) Includes recovery from scrap.
Source: ABARE (1990), *Commodity Statistical Bulletin, December 1990,* AGPS, Canberra.

1.6 Sand

Diecasters use silica sand and heavy sands such as zircon and chromite sand for casting moulds. One participant, Bradken, uses in excess of 140 000 tonnes of silica sand and some 3000 tonnes of heavy sands annually for its casting operations. Bradken said that with existing machinery and equipment it is economical to recycle only about 56 per cent, or around 80 000 tonnes each year. Additional amounts therefore have to be purchased and some disposed of.

When a steel casting firm recycles its casting sand, it considers only the private costs of this process. The benefits or costs to the wider community are not likely to be taken into account. Any increased recycling would generate costs which the firm could not recoup.

Benefits to the community from increased recycling of casting sand would include reduced sandmining, and reduced dumping of used sand. These may well outweigh the cost of the increased recycling.

1.7 Tin

Tin is a valuable anti-corrosive metal. It is used extensively for the tinplating of sheet steel used to make food cans, but accounts for less than a half of 1 per cent of tinplate by weight. Secondary refined tin is recovered mainly from tinplate scrap, but also from tin-bearing chemical residues. Tin represents only a very small proportion of the waste stream, but its high value provides an incentive to reprocess tinplate scrap.

The extent of recycling

About half of the tin consumed in Australia is used for tinplate manufacture and hence potentially available for recycling. The other half is used in tin chemicals, solder and alloys and is generally not recoverable. The overall recovery rate in 1989 was around 37 per cent of total consumption of 674 tonnes, equivalent to some 250 tonnes of tin.

MRI is the main producer of reprocessed tin in Australia. It processes approximately 40 000 tonnes of tinplate scrap annually, recovering some 250 tonnes of tin. It also produces tin chemicals.

MRI works in association with BHP. Its plant was originally strategically sited to service BHP's Port Kembla Tin Plate Mills. BHP is the only tinplate producer in Australia, and the Port Kembla plant produces some 350 000 tonnes of tinplate annually. Scrap and waste materials generated by the BHP tinplating mills are the largest single source of feedstock to MRI.

MRI said that its principal client, BHP Slab & Plate Products Division, has invited expressions of interest for long term detinning contracts. If foreign detinners win detinning contracts the reprocessing of tin in Australia could be reduced, but the recovery of tinplate scrap and tin could increase.

Table 1.19 shows tin recovery and utilisation rates, production and consumption. Over the past few years, the utilisation and recovery rates have increased. This can be attributed to reduced production and consumption of refined tin in Australia rather than to increased quantities collected and recycled.

Table 1.19: Tin: Recovery, utilisation, production and consumption, Australia 1986 to 1989

	1986	*1987*	*1988*	*1989*
		per cent		
Recovery rate	10	10	22	37
Utilisation rate	15	31	31	37
		tonnes		
Production				
primary refined	1 399	563	439	424
secondary refined[a]	250	250	250	250
Consumption[b]				
refined	2700	2600	1162	674

a) Estimates based on information provided by MRI. b) Consumption figures do not reconcile with production, exports and imports due to movements in stocks.
Source: ABARE (1990), *Commodity Statistical Bulletin, December 1990*, AGPS, Canberra. ABARE (1989), *Quarterly Mineral Statistics, September Quarter 1989*, Canberra. BMR (1987), *Australian Mineral Industry Annual Review for 1987*, AGPS, Canberra. BMR (1988), *Australian Mineral Industry Quarterly 41(2) 1988*, AGPS, Canberra. Industry estimates.

Post industrial scrap The processing of tinplate into cans results in the production of substantial quantities of tinplate scrap. Of the 40 000 tonnes of tinplate feedstock detinned by MRI annually, BHP tinplate mills supply about 15 000 tonnes or over one third. BHP is attempting to reduce the amount of this tinplate steel scrap, including off-cuts, which currently represent about 4.5 per cent of its total tinplated steel production.

A further 25 000 tonnes of industrial scrap is collected from numerous can manufacturers (between 10 and 15 per cent of tinplate steel used by can-makers becomes scrap), tinplate making facilities, and other tinplate processing operations (such as in the manufacture of closures) on the eastern mainland seaboard. A large proportion of this scrap is purchased from collectors by BHP and processed by MRI on its behalf.

Material was formerly also received from Western Australia and Tasmania but transport costs mean it is no longer delivered to MRI's plant. Much of the scrap generated in Western Australia is exported. Smaller quantities generated in Tasmania are collected by Simsmetal. About 100 tonnes is dumped annually in South Australia.

MRI said that the tin it recovers is an electrolytic grade of a higher quality than is produced by smelters of virgin ore. It is either returned to BHP for more tinplating, or sold to alloyers for the manufacture of solders, white metals and bronzes, or to other plating industries including platers of copper wire, or used by MRI to make a tin chemical (stannous chloride).

Post-consumer scrap

MRI estimated that about 220 000 tonnes of post-consumer tinplate waste is generated annually. Most of this waste, consisting largely of used food cans (including pet food cans) is disposed of in landfills.

Factors influencing the extent of recycling

The major factors affecting the level of tin recycling include the value of the de-tinned steel scrap, the availability of tinplate for processing, the value of the tin recovered, the costs of recovery, the substitutability of reprocessed tin for primary tin, and government policies which affect the recovery and utilisation of tin.

Domestic demand for tin

Domestic consumption of tin is about 2600 tonnes, much of which is imported from Malaysia in the form of tin concentrate, largely by BHP's tinplate mills.

The major use of tin is in tinplate for steel cans. Consumption of primary and secondary tin in tinplate manufacture in Australia amounted to about 1380 tonnes in 1987. This was about 23 per cent less than in 1986, due to thinner applications of tin as a consequence of technological change. Other significant uses of tin are as a component of solder, chemicals and alloys.

Cost of recovery of post consumer tinplate scrap

Little or no post consumer tinplate scrap is recovered for reprocessing. MRI and other participants stated that it is currently uneconomic for private de-tinners to collect and prepare domestic tinplate scrap for de-tinning. There are a number of reasons for this:

- the processes used in de-tinning do not cope well with dirt and extraneous materials. Contaminated tinplated products can be hazardous to work with as ignition or explosions can occur. Contamination from aluminium, paper, fats, plastics, galvanized iron, foodscraps all present problems in the de-tinning process;

- the great majority of post-consumer scrap consists of very low density opened food containers. Although the technology to treat the scrap is available, the high costs of collection, transport, separation and cleaning make de-tinning uneconomic to private operators;

- tinplate scrap from can-makers yields an average of about 4 kilograms tin per tonne of scrap, or 0.4 per cent, so only very small quantities of tin would be produced.

A number of collection centres, including all Simsmetal depots throughout Australia, will accept cleaned food cans for recycling on a no payment basis, and trial collection schemes have been introduced in a number of areas. However, participation rates have remained low (refer section on Steel).

Prices

The price of recovered tin is closely related to world tin prices. The price of tin on world markets is volatile; substantial variations occur daily. During 1990 so far relatively low prices have prevailed, the August price being about $9.50 per kilogram. Australia is a substantial importer of tin, hence the Australian price is higher than the world price to take account of shipping and import costs.

The reprocessing of tinplated steel scrap results in the production of essentially two products, tin and detinned steel. The price of detinned steel scrap is therefore also a determinant of the extent to which tinplated steel is reprocessed MRI said that its detinned tinplate scrap is considered a superior grade of steel scrap and can command a premium price.

Current domestic demand for steel scrap is low and variable but could pick up when the new BHP mini-mill at Rooty Hill is commissioned in the near future, and if there is any expansion of the Smorgon mini-mill capacity in Victoria.

Domestic production

Refined tin production in Australia fell substantially in 1987 and 1988 as nearly 90 per cent of Australia's mine output was exported as concentrate for smelting. Tin mines were placed on care-and-maintenance, or closed down during 1987 when world tin prices fell significantly. The refined tin produced in Australia in 1988 represented less than 25 per cent of the refining capacity. Local miners (including the biggest tin miner, Renison) sent their concentrates to Malaysia for smelting and refining to take advantage of lower processing costs.

There are two producers of refined tin in Australia. One (Greenbushes Ltd) produces primary refined tin.[4] The other (MRI) produces refined secondary tin from tinplate scrap, tin-bearing sludge, and chemicals generated from tinplate and other processes. It is a subsidiary of Fine Metals Corporation Ltd.

4 Another refiner of primary tin, Tolltreck Metal Products (it bought the associated Tin Smelters Pty Ltd smelter in 1986) is now closed.

Costs and benefits of reprocessing

Table 1.20 illustrates some of the costs and benefits to the tin reprocessor, and additional costs and benefits to society which the tin reprocessor does not face.

Value of detinned steel scrap

MRI stated that in February 1990 the likely total value of the metals recovered from a tonne of steel tinplate scrap was $152.40, made up of $120.00 for the detinned steel scrap and $32.40 for the tin recovered.

Set against these private benefits of reprocessing tinplate are the costs of purchase and collection of tinplate scrap, detinning and tin recovery (refer Table 1.20).

Some costs of reprocessing tin

The costs of reprocessing tinplate to the de-tinner include the cost of purchase of the tinplate delivered to the factory by collectors, the cost of de-tinning and tin recovery (including materials losses).

When tinplate is collected from domestic garbage, the collectors incur costs in separating the tinplate scrap from the garbage, cleaning it from contaminants such as food and labels, compacting it and transporting it to the de-tinner. These costs tend to outweigh the returns from reprocessing. MRI estimated the cost of preparing post-consumer tinplate scrap for delivery to the de-tinning plant at about $45 per tonne of scrap. This does not include payment for the scrap, or transport costs.

Private returns from de-tinning tinplate scrap appear to exceed the private costs incurred when the tinplate is drawn from industrial scrap.

Environmental effects of tin recovery

MRI said that the detinning process creates no adverse impact on the environment because the plant operates as a closed system with all spillages internally reprocessed. Other than the two principal products, only two

Table 1.20: Costs and benefits of tin reprocessing

Costs to the steel reprocessor	*Comment*	*Benefits to the steel reprocessor*	*Comment*
Any payment to collectors and/or for collection, separation, cleaning and transport		Value of tin recovered	$9000 to $10 000 per tonne
		Value of steel scrap recovered	$120 per tonne
Cost of separating and preparing tin-plate scrap from domestic waste stream	$45 per tonne of tin-plate scrap		
Processing costs	Including energy and labour, and material loss in processing		

Additional costs to society	*Comment*	*Additional benefits to society*	*Comment*
		Negligible landfill savings for tin, but substantial for steel scrap	Each 4 kg of tin recovered from tinplate produces 1000kg of steel scrap which can be processed

Source: Value of metal – Financial Review metal prices; Waste disposal costs – IC waste management survey estimates.

1.8 dry-cell batteries

The Commission found no evidence of reprocessing of household-type dry-cell batteries in Australia or of any used batteries exported. Most household batteries appear to end up in landfill when their useful life is finished. Surveys undertaken by the Victorian EPA suggest that there has been an increase in the numbers of household batteries disposed of, in the case of AA batteries from 3 units per person per year in 1984-85 to 4.3 units currently.

A number of participants expressed concern about the health hazard presented by heavy metal contamination of landfill sites due to the disposal of dry-cell batteries. The Victorian EPA is considering measures to prevent household batteries going to landfill and is investigating overseas initiatives to this end.

The metals causing the greatest concern are mercury and cadmium. However, industry has recently developed a high-performance, mercury-free battery. Cadmium is used mainly in the production of rechargeable batteries which have gained some popularity over the past ten years. Rechargeability will delay disposal as well as reduce the number of batteries going to landfill.

The EPA was unable to say how many of the batteries found in its garbage analysis were of the type containing mercury or cadmium. In view of the relatively small quantities of heavy metals involved, the Commission considers that dry-cell batteries are unlikely to present a significant problem in landfill in the foreseeable future. They could present a contamination problem if schemes to compost all domestic waste, rather than house and garden wastes, were introduced in Australia.

Issues relating to wet-cell batteries are discussed in section 1.2 (Lead).

2 GLASS

Glass has long been recycled by melting down broken glass (cullet) to make new glass. Glass has also been widely reused in the form of bottles which can be washed and refilled. While both are usually deemed 'recycling', the distinction is important because of the different economic forces bearing on refilling and remaking.

National figures are not available on the extent of glass in the waste stream. It is likely that it accounts for about 10 per cent by weight of the household waste stream. [1]The bulk of this is used glass containers.

2.1 The extent of glass recycling

About 25 per cent of all glass containers sold (they account for the bulk of glass produced) are recovered for reprocessing into new glass, and a further 11 per cent are recovered for reuse at least once. The term 'reprocessing' in this context means fabrication of a new product from the packaging material. Reuse or refilling refers to the reuse of the package itself.

For the glass industry as a whole, the proportion of used glass included in the production of new glass products is about a quarter.

Location of glass production and recycling

Glass producing and glass reprocessing activities are located mainly in the capital cities, particularly Sydney and Melbourne. Production is highly concentrated in a small number of establishments. Cullet is used together with other batch materials such as sand, limestone and soda ash.

1 A Victorian EPA study in 1984-85 found that glass comprised about 16 per cent of total domestic garbage by weight, compared with about 21 for paper and about 10 per cent for plastics. This study also found that glass containers were the major component of the packaging content of domestic garbage, comprising about 46 per cent by weight. The NSW Waste Management Authority (1990), *Sydney Solid Waste Management Strategy*, stated that in 1986 about 9 per cent of Sydney household waste by weight was glass.

- The main producers of glass containers are Australian Glass Manufacturers (AGM) [2] and Smorgon. A small amount of vials, which are generally included in the definition of containers, are produced by ACI Crown Glassware (Crown). AGM plants are located in Sydney, Melbourne, Brisbane, Hobart, Perth and Adelaide. Smorgon has only one plant, in Sydney. Glass is recycled at all these plants.
- The sole producer of basic flat glass is Pilkington (Australia) Limited (Pilkington). The main plants are in Melbourne and Sydney. Most used flat glass which is not sourced from within the manufacturing plant is sourced from glass merchants or glass processors such as tougheners or laminators. On average about 25 per cent of the material inputs consist of cullet at the plant in Melbourne, which only makes float glass.[3] More broken glass, from flat glass, can be used to make patterned glass. One of the Sydney plants, which makes patterned glass, uses up to 90 per cent cullet.
- Architectural, automotive and appliance safety glass plants located in Geelong, Sydney, Adelaide, and elsewhere use cullet from similar products, together with other materials, to make the finished products.
- Glass fibre production is dominated by ACI Fibreglass (Melbourne), CSR Bradford Insulation (Auburn NSW) and Boral Insulwool (Nunawading, Victoria). According to ACT Recycling Campaign (ARC), most glass, other than car and building window glass which contains lead, is readily reprocessed into glass containers or other glass products including fibreglass insulation..

Glass drinkware is made by Crown in Sydney.

ACI is the largest producer of glass containers. It supplies about 675 000 tonnes of the glass used in manufacturing containers, just over 80 per cent of local production. Smorgon supplies the balance.

[2] AGM is owned by ACI. ACI is owned by BTR Nylex.

[3] Pilkington (Australia) Limited. Float glass is flat glass made by floating hot molten glass from a melting furnace onto a bath of molten tin

Recycling of glass containers

The rate of recovery of glass containers for reprocessing has increased from a fairly steady 17 per cent in the 1970s to about 25 per cent in 1990 (refer Table 2.1).

The recovery rate for glass is the amount of glass collected as cullet each year, divided by the amount of glass consumed.[4] Recovery rates have been increasing over the last few years reflecting the establishment of and improving participation in kerbside collection schemes. Table 2.2 includes data on the rates of recovery and reuse of glass, by State.

ACI said that the 191 000 tonnes of cullet recovered by it in 1990 represented about 27 per cent of its total glass container sales.[5] Smorgon also recovers cullet equivalent to about 25 per cent of its glass production.

Table 2.1: Production and recovery of glass containers,
Australia 1972 to 1990

Year	*Total production*	*Post consumer recovery* [a]	*Recovery rate for reprocessing* [b]
	tonnes	*tonnes*	*per cent*
1971-72	440 000	73 000	17
1981-82	750 000	130 000	17
1989	850 000	189 000	22
1990 [c]	840 000	209 000	25

a Single-fill containers only.

b Not including glass bottles recovered and refilled, although refillable bottles are included in the total production figures.

c 1990 figures are estimates by ACI.

Source: Maunsell & Partners Pty. Ltd., ***The Nature, Extent and Potential for Materials Recovery, Reuse and Recycling in Australia, July, 1985, p. 17*** and information from industry sources.

4 It is assumed that any imports of cullet will roughly equal exports (data on imports and exports of cullet are not available).

5 A portion of the glass containers sold are also reused.

In NSW, AGM and Smorgon produce glass containers and melt around 400 000 tonnes of glass per year. Of this, approximately 100 000 tonnes is sold interstate.

Table 2.2: Recovery and reuse rates for glass, by State, 1989 and 1990[a]

State	*Refillable bottles reuse rate*	*Single-fill bottles recovery rate*	*Recovery rate for all glass bottles*
	per cent	*per cent*	*per cent*
New South Wales	0 (0) [b]	27 (30)	27 (35)
Victoria	63 (63)	35 (41)	54 (57)
Queensland	68 (68)	23 (28)	31 (33)
Western Australia	69 (69)	41 (46)	55 (57)
South Australia	73 (73)	23 (23)	40 (40)
Tasmania	54 (54)	42 (50)	na (52)
Australia	65 (65) [c]	29 (33)	35 (37) [d]

a) 1990 figures are indicative estimates by ACI and are shown in brackets. They do not take into account imports/exports between states which can have significant impact on smaller markets such as South Australia, Western Australia and Tasmania. b) There is no production and reuse of refillable bottles in NSW. c) This is a national average estimated by industry. For the High Court challenge to CDL in South Australia it was agreed that the national average was 56 per cent. Source: South Australian Waste Management Commission,
Submission No. 67. d) Includes bottles recovered for reuse and reprocessing.

Source: ACI and Smorgon.

Smorgon said that substantial work is planned for 1990 and 1991 by Smorgon Glass, ACI and local governments to lift the recovery rate. ACI stated that a much purer cullet is required where cullet accounts for more than 50 per cent of the materials used to make glass. To deal with the increased proportion of cullet recovered and recycled a beneficiation plant that refines and purifies the cullet collected has been established by Recyclers of Australia (with technical assistance from ACI) in Melbourne. ACI said that a similar plant has been established in Brisbane by Recyclers of Queensland and is expected to be operational by the end of January 1991. Although energy costs in glass manufacture are lower with a high component of cullet, there are offsetting costs such as the extra investment in beneficiation and additional costs in collecting cullet over longer distances.

2.2 Recycling in other countries

Glass reprocessing in the United States increased in the 1980s in response to public and governmental pressures. The recovery rate for glass in 1987 was about 15 per cent (Congress of the United States, 1989, p. 136).

Most glass bottles in Europe and Japan are refillable. In the Netherlands, for example, over 90 per cent of retail soft drink and beer sales are in reusable bottles, as required by law. In Japan, 66 per cent of all bottles are collected and reused an average of three times; beer and some sake bottles are reused an average of 20 times. A United States Congressional Committee found:

> The data on international glass recycling are conflicting. One study indicated that glass recycling rates for Europe, Japan, and the US ranged from 10 to 53 per cent, with Japan having a rate of only 17 per cent . However, a 1983 survey in Japan indicated that about 54 per cent of empty bottles and 52 per cent of cullet were recovered. In Switzerland, enough glass was recycled in 1986 to satisfy 75 per cent of raw material needs of the glass packaging industry. About 30 per cent of West Germany's waste is collected, mostly in outdoor collection centres. In Sweden, glass recovery is only about 15 per cent, even though more than 200 municipalities provide facilities for glass recycling. (Congress of the United States, 1989, p. 136).

In Britain only about 20 per cent of glass is reprocessed or reused. This may have to be increased if a directive being drafted by the European Economic Community requiring that 70 per cent of all soft drink containers (including glass) must be recycled by 1997, is passed (Newell 1990, p. 27).

Singapore has found that, as it does not now have a glass container factory and no domestic market for cullet,. it is economic to refill and reuse 85 per cent of all beverage bottles (Watson 1990, p. 104).

2.3 Factors affecting the extent of glass reprocessing and reuse

Major factors affecting the reprocessing of glass in the form of cullet in Australia include the demand for the final glass products and the costs of collecting, transporting, sorting and processing used glass into new glass, compared with the cost of using virgin raw materials (sand, soda ash and limestone).

Glass can be reprocessed into non-refillable containers or reused as refillable containers. The reuse of glass involves the collection of empty refillable bottles, cleaning and refilling them. Cleaning costs include energy, labour and water costs, and are an important determinant of the economics of reuse. The main factors affecting the reuse of refillable bottles include the costs of handling and transporting the empty bottles, levels of returns of bottles, cleaning costs and the costs of disposal of processing waste. Public liability for foreign matter in refilled bottles, the substitutability of refillables for recycled new glass, and government policies such as container deposit legislation (CDL) and reuse requirements are also important determinants of reuse. The effects of CDL are discussed in Chapter 7 of Volume I and Chapter 7 of Volume II.

The extent to which the community (eg through households and councils) carries some of the costs of glass collection, separation and transport, influences the costs of glass reprocessors and reusers and the incentives faced by them.

The proposed purchase of the Smorgon glass containers division by BTR Nylex Ltd (it owns ACI) [6]may affect recycling insofar as:

- it gives ACI greater market power over the supply and price of cullet;
- it allows ACI to benefit from economies of scale in the collection of cullet and production of glass containers. These economies may offset any additional costs of collecting cullet from greater distances from the glass plants; and

6 The Trade Practices Commission won a temporary injunction in late December 1990 restraining BTR Nylex Ltd from proceeding with the takeover of the Smorgon glass container division pending determination of the matter by the Federal Court.

- it gives ACI greater market power in the glass container market, subject to competition from imports [7] and other containers such as cans and PET bottles.

Higher levels of glass recycling are possible, although the costs to cullet suppliers and/or beverage consumers could rise.

The demand for glass products

The demand for cullet arises from the demand for glass as a final product and as an input into other products such as reflective paint. The price paid for cullet is determined by the price of the new glass produced and the cost of processing cullet relative to new raw materials.

Total sales of locally produced glass products in 1985-86 were of the order of $1020 million. ABS does not publish production, import and export data for the major product categories. However, industry sources indicate that 850 000 tonnes of glass containers were produced in 1989.

Glass is highly substitutable for other products in some uses, but only to a limited extent in others, for example windows for cars and houses. In the main application for which there is substantial reuse and reprocessing, as a beverage container, glass competes with plastic, aluminium, steel, paperboard, and even ceramic containers. The extent to which glass is used depends on the relative costs of different containers, their characteristics, and the existence of CDL or other regulations which affect the use of different types of containers.

About $340 million, or over 10 per cent of the total value of packaging in Australia in 1985-86, was packaging with or in glass.

About 79 per cent of glass used in beverage containers in Australia in 1986 (by volume of contents) was in beer and soft drink containers (refer Table 2.3).

The reuse of refillable glass containers has declined to some extent due to the growing popularity of convenient single-serve containers such as small bottles

[7] Imports of such relatively low value, high volume products such as glass containers have to face relatively high freight costs, given Australia's isolated geographical position.

or cans. There is a significant move toward the single-serve beer bottle or can. ACI said that there is a similar move towards single-serve soft-drink containers in smaller sizes. In larger sizes the PET bottle has replaced glass. The proportion of packaged beer sold in large bottles declined from 21 per cent in 1987 to 17 per cent in 1989 Australia-wide.

A significant reduction in the weight of non-refillable bottles is attributable to improvements in design and in the properties of the materials used. The mass of an ACI ‘stubby’ bottle decreased from around 260 grams in 1985 to 170 grams in 1989, and is expected to fall further to 130 grams in 1991. The reduction in weight decreases the raw materials and energy required in the manufacture of glass containers. It also reduces transport costs and gives consumers a lighter and more convenient bottle.

Substitutability of recycled glass in production

Glass made partly or entirely from cullet (ie recycled glass) is produced in the same way as glass from initial batch materials of sand, soda ash, limestone. The initial stage involves the mixing and cooking of the materials at very high temperatures to produce molten glass. To make containers the molten glass is then conveyed to a mould where it is blown into its final form. The product is then annealed by heating to obtain its final strength. From the user's perspective, glass made wholly or partly from cullet is the same as other glass.

Batch materials used to produce glass containers account for about 42 per cent of total costs. Labour accounts for a further 34, per cent.

Container glass is readily recycled to make fresh containers. Container glass manufacturers use only a small percentage of plate glass cullet as it generally contains traces of lead and contaminants such as plastic laminates. Smorgon, for example, accepts a maximum of about 5 per cent of relatively clean clear flat glass in cullet.

Flat glass cullet is used to make float glass and reflective paint, as well as patterned and wired glass. Pilkington estimated that, including in-house acquired cullet, over 80 000 tonnes of flat glass cullet is used to make float glass and over 15 000 tonnes to make patterned glass.

Table 2.3: The use of glass in beverage containers, Australia 1986

Product	*Proportion of all glass used (by volume of contents)*
	per cent
Beer	50
Soft drinks	29
Other uses	21
Total	100

Source: Litter Research Association

2.4 Reuse of glass containers

Refillable glass containers can be washed, refilled and reused a number of times. ACI said that refillable bottles are required by industry to withstand at least 20 trips. They are much sturdier and heavier-than non-refillable bottles and use more materials. Non-refillable bottles can be 30 to 40 per cent lighter than refillable bottles.

In 1989, refillable bottles represented less than 10 per cent of all glass containers produced in Australia. There are no reliable estimates of the rate of return of refillable bottles Australia-wide, but industry sources indicate that it might average 65 per cent. ACI stated that rates of return have been decreasing over the last few years.

Since the 1970s the use of refillable bottles in the packaged beer and soft drinks markets has markedly declined. Currently, about 16 per cent (by volume) of beer sales packaged in glass are in refillable glass and 84 per cent non-refillable (refer Table 2.4).[8] About 30 per cent of the refillable 750 ml

8 Of the volume sold in refillable glass, 64 per cent is in large (750 ml) bottles and 36 per cent in small bottles.

beer bottles are returned for reuse.[9] No refillable glass beer bottles are manufactured for sale in Sydney.

Victoria

In Victoria, the share of the glass soft drink market (in terms of bottles sold) attributable to refillable bottles fell from around 24 per cent in 1982-83 to 13 per cent in 1988-89.

South Australia

In South Australia, the Beverage Container Act has meant that approximately 96 per cent of packaged beer in glass and 98 per cent of soft drinks packaged in glass are sold in refillable bottles. Deposits of 10 cents and 20 cents imposed on these containers have been accompanied by a 85 per cent bottle return rate. A 1 litre bottle is refilled approximately 15 times. These deposit rates were reduced on 5 April 1990 to 5 cents on most containers required to carry deposits while voluntary deposits remain at 10 to 20 cents on certain soft drink bottles (refer Chapter 7 for details).

Queensland

In Brisbane, Bond Brewing collects and reuses 750 ml beer bottles. About 25 per cent of milk is also sold in reusable bottles. The reuse of milk bottles is increasing despite the general decline in the use of returnable bottles for alcoholic beverages and soft drinks in Brisbane. In Townsville, Coca Cola repurchases its refillable one litre bottles at 20 cents per bottle at the factory site at Bohle for rewashing and reuse.

9 The Victorian Recyclers Association stated that glass merchants pay about 20 to 40 cents per dozen for these bottles to suppliers such as scouts. The breweries pay about $1 per dozen delivered to them.

Table 2.4: Beer and soft drinks sales by type of container, 1989

Volume of Contents	Australia		South Australia		Victoria	
	beer packaged in glass	*soft drinks packaged in glass* [a]	*beer packaged in glass*	*soft drinks packaged in glass*	*beer packaged in glass*	*soft drinks packaged in glass*
			per cent			
Refillable bottles and containers	16	19	96	98	20	13
Non-refillable bottles and containers	84	81	4	2	80	87
Total	*100*	*100*	*100*	*100*	*100*	*100*

a) Data from ASDA.

Source: GPIA, 1990

ACT

In the ACT, returnable glass bottles account for 22 per cent of milk sold compared with 35 per cent in plastic bottles and 43 per cent in plastic-coated cardboard cartons.

2.5 Glass reprocessing and reuse by State

ABS data indicate that in April 1986, 34 per cent of households were actively involved in the recycling of glass and bottles (refer Table 2.5). South Australia with its CDL legislation in operation had the highest rate of participation with 51 per cent of households involved. Participation rates are higher in most States now due to increased community concerns about environmental matters. Glass comprises about 9 per *cent of the domestic garbage in South Australia.

Glass was estimated to make up about 16 per cent of domestic garbage by weight in Melbourne in 1984-85. A survey of household garbage in Geelong in November 1986 showed that glass made up 11 per cent of domestic garbage by weight. Glass containers and cullet were 43.6 per cent of the packaging content of domestic garbage by weight. Of this, beer bottles comprised 18,3 per cent, soft drinks bottles 12.7 per cent, wine bottles 2.5 per cent with food containers and cullet making up the other 10.1 per cent.

Glass comprises about 9 per cent of the domestic garbage in Sydney and about 16 per cent in the ACT. The ACT Recycling Campaign (ARC) said that glass recovery rates *in* the ACT are below the Australian average primarily because there is no household collection service for glass.

Table 2.5: Household participation rates in glass recovery, 1986

	NSW	*Vic*	*Qld*	*WA*	*SA*	*Tas*	*Act*	*Aust*
Taken to special areas	8	15	16	21	34	27	32	16
Collected from home	21	28	4	15	17	8	2	18
Total	29	43	20	36	51	36	34	34

Source: ABS Cat. No. 4115.0, 1 December 1986 (rounded to nearest whole number).

Victoria

Victoria recovered about 137 200 tonnes of glass for reprocessing or reuse in 1987-88. An increase in the door-to-door collection service in Victoria since 1985 has brought an increase in the rate of glass recovery. ACI estimated that over 1.15 million households now have a kerbside door-to-door weekly glass collection service in Melbourne. By the end of 1989 almost 90 per cent of tenements (household, business and other premises) in the Melbourne metropolitan area and 50 per cent in the country were covered by door-to-door schemes.

ACI stated that household participation in glass collection is now about 50 per cent in Melbourne.

Table 2.6 shows a decline in the proportion of glass being reprocessed and reused in Victoria from 63 per cent in 1985-86 to 54 per cent in 1988-89, corresponding closely with a drop in the use of refillable bottles, especially those used by Carlton and United Breweries. Non-refillable stubbies (bottles) were introduced in November 1988. The Victorian Recycling and Litter Advisory Committee (RALAC) believes the latter trend also reflects changing practices in small wineries and soft drink companies, which are refilling fewer bottles. A similar decline in reprocessing rates occurred in the non-refillable (but recyclable) containers sector. LRA suggested that the general decline in reprocessing and reuse rates in 1987-88 was associated with the decline in the use of large glass containers for domestic consumption. In turn, this was linked to the increased use of plastic containers and to the growth in small single serve containers. The smaller containers are less frequently used at home and are likely to end up as litter or in litter bins. Data for 1988-89 indicate that this trend seems to have been reversed to some extent (refer Table 2.6).

Tasmania

The recovery rate of glass in Tasmania is generally lower than in Victoria. In Tasmania 60 per cent of refillable and 24 per cent of non-refillable bottles were recovered, compared to 66 per cent refillable and 40 per cent of non-refillable bottles respectively in Victoria in 1988-89.

Queensland

ACI stated that 35 000 tonnes of glass were collected in Queensland for reprocessing in 1989-90 of which over 10 000 tonnes were collected in Brisbane. About 43 200 tonnes were disposed of in the Brisbane municipal waste stream in 1988.

Table 2.6: Beverage .container reprocessing and reuse rates in Victoria, 1985-86 to 1988-89

Activity	*1985-86*	*1986-87*	*1987-88*	*1988-89*
			per cent	
Glass reprocessing (non refillable)	48	43	40 [a]	40 b
Glass reuse (refillable)	69	65	63 [a]	66 [b]
Average (weighted)	63	56	51 [c]	54 [c]

a) Industry estimates. b) Government of Tasmania, Submission No. 49. c) ACT estimates this to be about 55 per cent in 1990.
Source: Second Report of the Victorian Recycling and Litter Advisory Committee, June 1988, p. 8.

Western Australia

In Western Australia AGM recycled over 12 000 tonnes of cullet into new glass containers, representing 31 per cent of all glass used in 1989. About 90 per cent of the glass collected is non-reusable bottles. Payment for glass is around $45 per tonne.

New South Wales

ACI and Smorgon estimated that New South Wales reprocesses about 61 000 tonnes out of the 242 000 tonnes of total container glass sales per year. About 4000 tonnes of additional recovered glass is delivered to Queensland and 2000 tonnes to Victoria. Contractors collect glass throughout the Sydney

region for reprocessing. An average of 1 to 4 kilograms of glass per household per month was collected through weekly collections (on the same day as the normal waste collection service) in 1987 to 1989 in Doonside. A monthly recycling service for residential premises in the City of Campbelltown, which commenced on 1 January 1990, led to the collection of about half a kilogram of glass per household per month up to the end of June 1990 (Webster 1990, p. 40).

South Australia

South Australia reprocesses or refills 40 to 45 per cent of the 75 000 tonnes of all glass beverage containers estimated to be consumed annually in that State. South Australia which has CDL has a higher rate of reuse of glass than any other State.

AGM uses around 25 per cent cullet (about 27 500 tonnes) in the manufacture of bottles at its Kilkenny plant. A further 2500 tonnes of sheet glass is collected and transported interstate for recycling.

2.6 Collection systems

Recovery of glass is concentrated in the areas of highest population densities (ie the main cities) where about 80 per cent of the glass reprocessing or reuse takes place. Recovery of glass is facilitated through drop-off centres, buyback centres and kerbside collection programs (discussed in Chapter 3 in Volume I).

The largest glass producer, ACI, is also the largest user of cullet. In most States glass is collected by contractors, many of whom operate house-to-house collection schemes. Households also participate by depositing glass bottles in collection bins or bags at shopping centres or other depots/tips. The collection of glass from commercial and industrial outlets is fairly well developed.

In Victoria, ACI collects most of its cullet from bottle merchants and councils who recover the glass from hotels, restaurants, schools, scouts, guides, community groups, landfill sites, and, in more recent times, household kerbside collections. About 40 per cent of glass collected in Victoria (by volume) is through the kerbside collection service, about 30 per cent from

commercial premises such as hotels, restaurants and hotels, about 20 per cent by service groups (eg scouts). The balance is collected by making individual visits to specific sources.

Various trials have been undertaken to estimate the costs and benefits of collecting glass for recycling. One such trial was undertaken at Mooloolaba by the Shire of Maroochy in Queensland in late 1989/early. 1990. Kerbside collection was arranged for 850 residential premises and 240 litre containers provided to facilitate collection. Glass when collected was sold to a Brisbane glass merchant for $60 per tonne. Some 6.2 tonnes of glass per month were collected from the 500 participating households, over 12 kilograms per household. The average collection cost was $0.61 per service (the service collected glass and paper) equivalent to about 5 cents per kilogram of glass collected.

The Maroochy Shire Council estimated that the net all-in cost of reprocessing glass was about 4 cents per kilogram. This took into account the collection/transport/container costs of about 10. cents per kilogram of glass and a return of 6 cents per kilogram from the sale of the glass. When all costs were taken into account, including the cost of the 240 litre bin, the credit to the project of the avoided cost of disposal of $70 per collection of glass (including the basic landfill use charges), the net cost was $1.25 per collection service. The Council concluded that this cost had to be reduced before the service could be considered acceptable.

The NSW Recycling Committee believes that there is scope for increased glass collection through improved participation in house-to-house collection schemes. The amount of glass collected is higher when collected on a house-to-house basis rather than delivered to a community recycling centre, as would be expected in view of the relative costs involved to the consumer. This can be seen when the recovery rates for various collection schemes are compared. The Glenquarie Community Recycling Centre collected 19 kilograms of glass per head per year in 1985-86 compared with the house-to-house collection of about 38 to 56 kilograms per head per year in North Sydney in 1986-87. When suitable containers are provided to households the collection of glass also increases. The Doncaster and Templestowe Councils in Victoria recorded an increase of 250 per cent in bottle collection when woven plastic containers were issued to residents. The higher the frequency of glass collection the more the amount collected. In NSW the recovery rates range on average from 4.7 kilograms per person per year to 12.9 kilograms per person per year depending on the frequency of collection.

Smorgon stated that the price paid for cullet varies according to the price of the virgin raw materials, the quality and cleanliness and colour of the cullet, whether or not transport subsidies are paid and the incentives/bonus payment systems used.

A major cost of reprocessing glass is transporting from the source to the glass manufacturing plant. Smorgon stated that road transport is the most economic means of transporting Gullet to its plant. Used glass collected on a door-to-door basis in Sydney costs private contractors about $150 per tonne compared with $75 per tonne when picked up from drop-off depots and tips/transfer stations. In other words, householders 'subsidise' the operation by providing unpaid collection and transport services at a value equivalent to $75 per tonne. The cost of door-to-door collection of glass also varies with the form in which the glass is collected. Refillable glass beer bottles for example cost $150 per tonne compared with the cost of collection of cullet at $90 per tonne in Melbourne in 1988-89.

Some local government councils subsidise collection systems (discussed in Chapter 3, Volume I). In Metropolitan Melbourne, Councils subsidise kerbside collection systems by paying collectors at the rate of about 5 to 6 cents per household per week. In Queensland the major glass manufacturer and user of cullet has negotiated concessional freight with the Railways Department allowing it to make higher payments to collectors in out-back areas. This has allowed it to use more cullet than would otherwise be economic.

2.7 Costs and benefits of glass recycling

The costs and benefits of recycling glass differ depending on whether the glass is reprocessed into new glass or reused. Table 2.7 illustrates the costs and benefits to the glass reprocessor, and the additional costs and benefits to society from the recovery and reuse of glass.

The costs and benefits of reprocessing or reuse also differ between locations (eg urban/rural) and schemes of collection, sorting and transportation used. Costs and prices vary depending on population densities, distances traveled, used glass and raw materials availability, and other factors. It follows that the net economic benefits and viability of recycling schemes vary for each location.

The return to glass manufacturers for collecting cullet decreases with increasing distance from the glass recycling plants.. ACI stated that it pays freight rebates for country collections to partly offset this cost to the collectors.

Table 2.7: Costs and benefits of glass recovery and reprocessing or reuse (a) Into new glass

Costs to reprocessor	*Comment*	*Benefits to reprocessor*	*Comment*
Collection from households	Cost 5 – 10 cents per kg	Price of new glass	
Purchase price reflects purchase, collection and transport costs	Cullet: $40 to $140 per tonne (4 to 14 cents per kg). Weighted average price $65 per tonne	Savings in energy use and increased furnace life	Energy in processing up to 50 per cent lower than that used in producing glass from raw materials

Additional costs to society	*Comment*	*Additional Benefits to society*	*Comment*
Household effort required in cleaning, sorting, delivery (valued up to $75 per tonne) in excess of any cash return and personal satisfaction	The extent to which this is a social cost depends on the level of personal satisfaction, if any	Savings in waste disposal costs and tip space	$32 plus per tonne in Sydney and Melbourne
		Benefits from resource and energy conservation. Less mining and possibly less environmental degradation	
		Lower costs and aesthetic benefits from less litter	Possible savings from fewer injuries and bush fires especially if illegal dumping reduced

(b) Reuse

Costs to reuser	*Comment*	*Benefits to reuser*	*Comment*
Costs of collection and transport, costs of cleaning	Refillable beer bottles cost $150 per tonne in Melbourne at end 1989 [a]	Savings of cost of new glass containers	
Additional costs to society	***Comment***	***Additional Benefits to society***	***Comment***
The cost of return (inconvenience etc) may be more than the deposit refunded	The extent to which this is a social cost depends on the levels of personal satisfaction, if any	Savings in waste disposal cost and tip space	$32 plus in Sydney and Melbourne
Pollution from effluent from washing bottles		Benefits from resource and energy conservation. Less mining and possibly less environmental degradation	
		Lower costs, aesthetic benefits from less litter	Possible savings from fewer injuries and bush fires especially if illegal dumping reduced

a) LRA, Submission No. 256, p. 39.

Source: Industry

The prices reported for cullet which is not collected door-to-door vary from $45 (in Perth) and $60 (in Brisbane and Adelaide), to $90 (in Melbourne and Sydney). Prices as high as $140 per tonne for cullet are reported to have been paid. The LRA stated that in Sydney the current costs of collection exceed the value of non-refillable glass soft drink containers by about 1.35 cents per large bottle and 0.5 cents per small bottle (based on a collection cost for used glass for recycling of $113 per tonne and the value of cullet of $90 per tonne).

Savings from reduced waste disposal

The savings of waste disposal and landfill costs when reprocessing or re-using refillable bottles is a net gain to society. Current waste disposal charges in Sydney and Melbourne are between $30 and $50 per tonne. They may not reflect the true cost to society of the resources used (refer to discussion in Volume I). Reduced waste in the form of litter is one of the benefits of recycling. Estimates of the benefits involved are given in the discussion on CDL in Chapter 7.

Savings in energy use

By including cullet in the glass making process the other batch materials are more easily melted. Smorgon said that without 15 per cent cullet the melting process is very inefficient. The use of cullet reduces the amount of energy required in the melting process. Smorgon said that 100 per cent cullet consumes only 50 per cent of the energy required to melt the batch ingredients. ACI and Smorgon stated that energy requirements decrease by 0.4 to 0.6 per cent for each 1 per cent increase in cullet used.[10] However as the proportion of cullet increases the quality control becomes critical and processing and recovery costs increase.

The reprocessing of glass containers saves energy compared with making new glass from raw materials. The energy used in collecting and transporting cullet may be equivalent to that required to transport used bottles to landfill. The reuse rather than reprocessing of glass saves the energy needed to make

10 According to ACI, based on current usage patterns, increasing cullet content of glass from 0 to 35 per cent has saved an estimated 1.7 picojoules of energy. Increasing cullet recycling to 50 per cent would give an estimated additional saving of 0.7 picojoules.

new glass, but requires energy to collect and transport refillable bottles to the bottler. The energy cost that can be attributed to glass reuse is therefore any additional energy required to transport a refillable bottle to a bottler rather than to a landfill and any additional energy required to wash and sterilise a refillable bottle compared with a new one. However refillable bottles require 50 per cent or more energy to make than the equivalent non-refillable, because they are heavier. The marginal energy cost for reuse [11] however is low. Non-refillable bottles require transport to a glass plant or landfill and new bottles require washing.

ACI said that using refillable systems will not generate energy savings unless more than 50 per cent of bottles are returned for refilling. It claimed that with light-weighting of non-refillable containers, increased conservation of energy in manufacturing and larger distribution distances, refillable containers may not result in savings in energy use. The South Australian Department of Environment and Planning (SADEP) estimated that the energy consumed in using a non-refillable 375 ml bottle was 7.2 megajoules per bottle compared with 5.5 and 5 megajoules for the same capacity bottle reused 4 and 10 rimes respectively (the energy figures used include the energy costs required to produce fuel, fuel/energy used to acquire new materials through to waste disposal). SADEP estimated that for a South Australian market of 12 million dozen 375 ml bottle sales per year the increased energy consumption for a non-refillable bottle compared with a 4 and 10 trip refillable bottle would be 0.24 picojoules and 0.31 picojoules per year respectively.

On balance it would appear that a refillable system can save more energy than non-refillable systems provided high rates of return of refillable bottles are achieved.

According to a study by the University of Melbourne’s School of Environmental Planning, single-fill glass bottles use about six times more energy to produce, distribute and dispose of than plastic ones (Evans and Egerton. 1988). The Evans study and studies in the United States indicate that plastic and multi-trip glass bottles consume the least energy (Gaines and Wolsky 1983).

11 The marginal per trip energy cost of a refillable glass bottle equals the production energy cost divided by the number of uses

ACI disputed the energy consumption figures quoted by SADEP, stating that the energy required during the manufacture of a 375 ml single-fill bottle is about 1.83 megajoules (this figure does not include pre and post manufacturing energy usage for which no reliable Australian data were available at this stage). It stated that most energy studies quoted rely on the 1981 UK study by Boustead and Hancock which for a number of reasons result in far higher energy figures than are currently incurred in Australia. These reasons were said to include the use of oil in the UK and natural gas in Australia, the design of the glass plants and the subsequent lightweighting of glass containers. ACI stated that since 1981 it had reduced its energy consumption in its glass plants by 25 per cent.

Energy use is paid for as a private cost. If energy is efficiently priced to reflect its true cost to society the greater or lesser use of energy by one system or product compared with another will not adversely affect efficiency and resource allocation.

Carbon dioxide emission

Brickwood and Commercial Polymers, two manufacturers of high density polyethylene (HDPE) plastic quote research findings which show that to package a litre of milk a 2-litre HDPE bottle results in the emission of 156 grams of carbon dioxide compared to more than 1400 grams of carbon dioxide from the recycling of a once-used only 600 ml glass bottle. ACI disputed these figures. It stated that they were based on 1981 UK data which yielded over-estimates of energy used (the amount of carbon dioxide produced is directly related to the amount of energy used). It stated that to package 1 litre of milk in a non-returnable glass bottle produces-only 286 grams of carbon dioxide. The discharge of carbon dioxide also decreases as the percentage of cullet used to make new glass is increased. Output of carbon dioxide as an issue in the context of the greenhouse effect is discussed in Chapter 5.

Conservation of natural resources

It takes 1.1 tonnes of sand, limestone and soda ash to make a tonne of glass, as well as a great deal of energy. Used glass can effectively be recycled forever. The greater the use of cullet in the manufacture of glass, the lower the quantity of all these materials (refer Table 2.8). Less mining for these materials would be required and possibly less environmental degradation.

However, the use of these resources may be distorted if they are not priced to reflect their full value to society (refer Volume I).

Table 2.8: Raw materials typically used to produce one tonne of beverage container glass

Raw Materials	*When 25 % of raw materials is cullet*	*When 50% of raw material is cullet*
	kilograms	
Cullet	300	575
Sand	550	365
Limestone	160	90
Soda Ash	160	90
Other	50	30
Total	1220	1150

Source: LRA, Submission No 256, p. A1

Water use and pollution

Refillable glass bottles must be washed between trips. , Tetra Pak said that the washing process uses drinking quality water and chemicals and leads to water pollution. The bottles are washed using a very hot mixture of clean water and caustic soda, under pressure. The bottles are then rinsed with chlorinated water. About 1.15 litres of water are used per bottle washed. This used water is discharged into the sewer system together with its contained caustic soda, chlorine and some product residue.

2.8 Government initiatives

Mandatory deposits on certain beverage containers have been in force in South Australia since September 1977. The objectives of CDL were to reduce litter and solid waste and conserve resources. In trying to achieve these objectives costs are imposed on users, beverage producers, container manufacturers and distributors (refer Chapter 7). These costs are high. Estimates by LRA, the Business Regulation Review Unit (BRRU 1989)) and the IAC range from around $136 million to $500 million per annum should CDL be extended to the rest of Australia. A recent study by the Centre for South Australian Economic Studies (CSAES)(Hatch 1990) suggested that the BRRU figures, which estimated the costs at more than $500 million in 198788 dollars terms, were excessive. The study said that smaller cost-price impacts of CDL can lead to very significantly lower estimates of welfare losses. For example, the CSAES stated that an impact of 4 per cent on beer prices and 6 per cent on soft drink prices would lead to estimated losses of $215 million, less than half that estimated by the BRRU and comparable at current prices with the estimates of the IAC in its 1987 Glass report.

CDL as implemented in South Australia (up to the date of the High Court decision on 7 February 1990) discriminated in favour of refillable containers and encouraged their use over non-refillables. However deposits are still not required to be imposed on all containers (fruit juice containers are exempt). This discriminates against containers requiring deposits and influences consumption choices. The recent High Court decision could however reduce the adverse effects of any extension of CDL to other States as the change in the market shares held by different containers may not be as much as analysed by the earlier IAC and BRRU reports when non-refillables and refillables faced significantly different deposit rates.

The costs of CDL have to be set against the benefits. Proponents of CDL argue that resource conservation, litter and waste control benefits in particular have been underestimated. However, the question remains whether it would be more efficient to address these objectives directly by other policy instruments (refer Chapter 7 in Volume I).

3 PLASTICS

Plastics make up about 5 to 15 per cent of the waste stream by weight. According to the Plastics Industry Association, around 1 million tonnes of plastic resins are consumed annually in Australia. About 450 000 tonnes of plastic products are currently discarded annually (ANZEC 1990b, p. 7). This quantity may be expected to increase as longer life plastic products reach the end of their usefulness. Although some biodegradable plastic products are marketed most plastics are not biodegradable, and do not break down in landfills.

A high proportion of the plastic scrap generated in industry is recycled. It is mostly clean, homogeneous and in sufficient volumes to make this financially worthwhile. Little household plastic waste is recycled in Australia or overseas. It is generally only collected in small volumes, is contaminated, and mixed with a variety of other products.

The main focus of attention in recycling plastic waste from households is plastic packaging. The recycling of household plastic waste is inhibited by collection and segregation costs and the lack of markets for the recycled product. However technology for plastic recycling is rapidly developing and is likely to eventually overcome many of the current difficulties.

3.1 The extent of recycling

Around 15 per cent of plastic waste is reprocessed in Australia. The vast majority of the recycled material is commercial and industrial scrap. The greater part of plastic waste is generated by households, but very little of this is recycled (refer Table 3.1.). As Table 3.2 illustrates, of 140 000 tonnes of high and low density polyethylene disposed of in the domestic waste stream only 750 tonnes or half of 1 per cent was recovered in 1989. PET (polyethylene terephthalate) had the highest recovery rate, 3 per cent of the 20 000 tonnes consumed, and this is expected by PET, producers to increase to about 15 per cent by 1992.

Table 3.1: Recovery. of plastics by source, Australia 1989

Plastics source	*For disposal*	*Reprocessed*	*Recovery rate* [a]
	tonnes	*tonnes*	*per cent*
Industrial and commercial waste (excluding waste reused in-house)	130000 [b]	65 000	50
Household waste	320 000	1 350	0.4

a) This recovery rate of plastic as a proportion of the waste stream should not be confused with the recovery rate used elsewhere in the report that refers to waste recovered as a proportion of total consumption. When dealing with specific products such as PET or HDPE bottles that have short life spans the distinction is less important because the vast bulk of consumption ends up immediately as waste. b) Breakdown of estimated 20 000 tonnes of industrial scrap (not recycled in-house) and 110 000 tonnes industrial post consumer waste. The industrial scrap estimate assumes 10 per cent of thermoplastic production is waste, of which 90 per cent is recycled and 5 per cent of thermoset production is scrapped.

Source: Australian and New Zealand Environment Council, Plastics Recycling and the Economic Potential for Recycling, September 1990.

Table 3.2: Recycling of major plastics from household waste, 1989

	Polyethylene		*PET*		*Total*	
	tonnes	*per cent*	*tonnes*	*per cent*	*tonnes*	*per cent*
Quantity in household waste stream	160 000 [a]	50	20 000	6	320 000	100
Recovered & reprocessed	750	<1	600	3	1 350	<1

a) Commission estimate assuming 50 per cent of household plastic waste is polyethylene.

Source: Environmental Protection Authority, Recycling-Cost Analysis, and Energy Balance, Perth Western Australia, Bulletin 409, October 1989, p. 12. Australian and New Zealand Environment Council, Plastics Recycling and the Economic Potential for Recycling, September 1990. In the latter it is estimated that 250 tonnes of HDPE and 500 tonnes of LDPE and LLDPE are recycled nationally.

The major plastics reprocessed at present are low density polyethylene (LDPE), polypropylene, polyurethane, polystyrene, polyvinyl chloride (PVC) and high density polyethylene (HDPE). Taken together, about 50 per cent of industry scrap and commercial waste is believed to be reprocessed (ANZEC 1990b, p. 7). This does not take into account reuse of in-house waste by plastic producers and converters. Recycling of in-house waste by plastic processors is regarded as a normal part of the efficient management of plastics processing operations.

The recovery and reprocessing rate for household plastic waste is low worldwide. The same emphasis on PET and HDPE recycling, rather than other plastics, exists in the United States. According to the Plastic . Industry Association, in the United States in 1989 about 1 per cent of the PVC discarded by consumers was recovered and reprocessed, 10 per cent of PET and 14 per cent of polyethylene. The overall recovery and reprocessing rate of all plastics consumed by households in the United States has variously been estimated to be 1 per cent (Economist Survey 1990, p. 18) and 2 to 3 per cent (Economist 1990a, p. 72). In Western Europe it is less than 1 per cent (Economist 1990a, p. 72).

Factors influencing the level of. plastics recycling

Major factors influencing the level of plastics recovery and reprocessing include the costs of collecting, transporting and segregating plastics into the various resins, the costs of processing, the costs of new resins, the degree of substitution of reprocessed resins and new resins, and technical and specification limits to the end use of products made from reprocessed materials and the demand for the product made from reprocessed resins. The opportunity to recycle certain plastics is limited by their chemical. structure. Government interventions such as CDL also affect the level of use, re-use and recycling.

Plastics consumption

Table 3.3 shows the growth in turnover and quantities of plastic resins consumed in Australia. Plastics are increasingly used. in the vehicle and building and construction industries where they have tended to replace materials such as metals.

Table 3.3: Turnover and consumption of plastics, 1983 to 1989

Type of plastics	*1982-83*	*1983-84*	*1984-85*	*1985-86*	*1986-87*	*1987-88*	*1988-89*
				$million			
Plastic & related products turnover [a]	2298	2566	2927	n.a.	3637	4400	n.a.
				'000 tonnes			
Resin consumption [b]	675	749	834	874	925	981	1005

n.a. not available.

Sources: ABS Cat No. 8203.0, Manufacturing Industry Details of Operations Australia, various years. Plastic News International, May 1990, p.18. Consumption figures are estimated as the quantity of resin consumed in the conversion process. Resins made in Australia and imported are included. Reinforcements, additives and fillers which are used with various resins in certain processes are not included. Imports of finished or semi-finished products are not included.

About 75 per cent of the plastics consumed in 1989 were polyethylene's, polypropylene, PVC and polystyrene, alkyd resins and amino resins, and polyurethanes. HDPE, polypropylene and PET consumption grew the

fastest between 1985 and 1989. Table 3.4 shows the growth of the major domestic and imported resins consumed in Australia.

As shown in Table 3.5, packaging is the largest and fastest growing market for plastics.

Table 3.4: Plastics consumption by material, 1981, 1985, 1989

Material	*Quantity 1981*	*Quantity 1985*	*Quantity 1989*	*Proportion of consumption 1989*
	'000 tonnes	*'000 tonnes*	*'000 tonnes*	*per cent*
ABS [a]	13	12	16	2
Acetal	2	1	2	<1
Acrylic	16	15	15	2
Alkyd	39	48	51	5
Aminos	47	45	45	5
Nylon	6	7	7	<1
Phenolic	21	19	17	2
Polyester	21	22	23	2
Polycarbonate	2	4	5	<1
Polyethylene HD [b]	59	94	133	13
Polypropylene LD [c]	119	142	164	16
Polypropylene	59	83	120	12
Polystyrene	34	38	45	5
Polyurethane	37	40	50	5
PVA	15	16	16	2
PVC	139	165	193	19
PET	na	13	20	2
Other	85	69	82	8
Total	715	834	1005	100

a) acrylonitrile-butadiene-styrene. b) High density polyethylene. c) Low density polyethylene.

Note: These figures represent the estimated quantity of resin consumed in the conversion process. Resins made in Australia and imported are included. Reinforcements, additives and fillers which are used with various resins in certain processes are not included. Imports of finished or semi-finished products are not included.

Source: Mitek Pty Ltd, Plastics News International, May 1989, pp. 15 &18.

Available plastic waste

There are no precise estimates of the amount of plastic disposed of each year in Australia. Estimates vary from 225 000 tonnes to 500 000 tonnes. A study commissioned by ANZEC estimated that. 450 000 tonnes of plastic waste accumulates per year (ANZEC 1990b, p. 7). Of this 130 000 tonnes is industrial and commercial waste and 320 000 tonnes household waste. The latter figure is consistent with State estimates indicating that plastic accounts for 7 to 10 per cent by weight of a total domestic waste stream of 3.5 million tonnes. The share of household waste accounted for by plastic increased from 3 to 10 per cent between 1974-75 and 1984-85 in Victoria, and from 1.8 to 7 per cent between 1979 and 1989 in Sydney.

Table 3.5: The consumption of plastic resins by major market

Market	*Consumption by weight 1989*	*Quantity [a] 1980*	*Quantity [a] 1989*	*Change 1980 to 1989*
	per cent	*'000 tonnes*	*'000 tonnes*	*per cent*
Packaging	25	125	257	106
Building	11	90	112	24
Plumbing	12	70	117	67
Furniture & bedding	8	56	80	43
Material Handling	6	50	65	30
Transportation	6	34	56	65
Electric	5	48	52	8
Houseware	4	41	38	-7
Agriculture	4	24	36	50
Appliances	3	22	25	13
Footwear & clothing	1	10	10	0
Marine	1	12	9	-25
Other	15	117	149	27
Total	100	699	1005	44

a) The estimated quantity of resin consumed in the conversion process includes resins made in Australia and imported. Imports of finished or semi-finished products are not included. Due to rounding totals do not add.

Source: Mitek Pty Ltd, cited in K. Fahey, An Island of Plastics: Recycling in Australia, Plastic News International, July 1989, Appendix II, Table 10, and Plastic News International May 1990, p. 18

Plastics are estimated to account for 5 per cent by weight of household garbage disposed of each year. They may be 10 to 15 per cent by volume. The proportion is similar in the United States, where according to one source landfill excavations indicate that plastics make up less than 5 per cent by weight and 12 per cent by volume of the waste in the landfill

(Dourado 1990, p. 26), and according to another, 7 per cent by weight and 12 to 13 per cent by volume (Congress of the United States 1989, p. 83). These data do not indicate all plastic waste generated, as recycled or incinerated plastic is excluded.

COMPOL was of the opinion that the practice of . assessing the costs of landfilling in terms of weight rather than volume understates these costs in the case of bulky articles such as plastic beverage containers. Plastic has around twice the volume relative to weight of aluminium cans, and four times that of glass. This can result in municipalities underestimating the savings in landfill if plastic containers are recycled.

Sources of recovered plastic

Plastic can be recovered and reprocessed at several stages in its life; as industrial scrap either for in-house or by outside reprocessors, as commercial waste or as household waste. In each stage of production, use and disposal, the plastic waste has different characteristics in terms of cleanliness, homogeneity and volume. These characteristics determine whether it is financially viable to recycle.

Many plastic products consist wholly or partly of resins which, using present technology, can technically be reprocessed. The reuse of some other plastics is limited because they cannot be remoulded. Even if part of a product consists of resins that can be remoulded the cost of separating the two can be prohibitive.

Infinite recycling of the same plastic material is technically impossible as reprocessing and contamination generally degrade plastic polymers and adversely affect characteristics such as durability and dimensional stability. Degradation of some properties can be reduced with the use of additives, by incorporating some virgin material, by making the reprocessed product thicker, or by coextrusion which involves making a product with a reprocessed core and a virgin outer layer.

Industrial scrap

Plastic industry waste has higher recovery rates as it is normally freer of contaminants, more homogeneous and available in larger volumes, mostly unmixed with other wastes. Scrap in the form of resin or plastic product makes up 5 to 6 per cent of total raw material use. Fahey (1989, p. 96) estimated that over 80 per cent of establishments processing plastics recycle their in-house waste resin and scrap. The remainder sell their scrap to merchants or dump it.

According to the PIA, industrial scrap sells at 60 to 90 per cent of the price of new material depending on the cleanliness, form, location, type of plastic and quantity available. The high recovery rate for industrial scrap indicates that, aside from technical limitations for some resins, plastics will be reprocessed if the economic incentives exist.

Commercial waste

Commercial waste from shops and factories is also frequently less contaminated than household waste, available in larger quantities and more homogeneous. Commercial waste includes stretch wrap and pallet shrouds from warehouses, empty plastic bags from industrial products, bags from bakeries and broken crates such as bread trays and milk crates and many items from other sources. Collection firms are relatively small, and localised, and generally also collect industrial scrap.

The ANZEC study suggests that in 1989 approximately 65 000 tonnes of industrial and commercial waste were recycled nationally. Table 3.6 indicates the amount and type of plastic scrap recycled in Victoria. The recyclers do not record the source of the plastic waste, that is whether it is factory scrap or trade.

Household waste

Household waste includes a variety of plastics; plastic containers for beverages and cleaning goods, shopping bags and other articles. Individual plastic products are in small quantities relative to the total waste stream and dispersed through it. For example, PET bottles make up less than 2 per cent of domestic waste and plastic milk bottles less than one half of 1 per cent by volume (Hansen 1989, p 17). Household waste is contaminated and expensive to collect and sort. Market incentives to recover and reprocess post-consumer plastic are hence small.

Table 3.6: Industrial and commercial plastic waste reprocessed, Victoria 1989

Plastic	*Quantity reprocessed*	*Proportion of total*
	tonnes	*per cent*
Low density polyethylene's	8 600	35
High density polyethylene	1 100	5
Polypropylene	850	3
Polystyrene	2 000	8
PVC	5 000	20
Polyurethane	4 500	18
Others	2 450	10
Total	24 500	100

Source: Australian and New Zealand Environment Council, Plastics Recycling and the Economic Potential for Recycling, September 1990.

In 1989 approximately 1350 tonnes of post-consumer waste were reprocessed. The major recycling activity is in PET bottles and products made from polyethylene and PVC (polyvinylchloride). According to the PIA 600 tonnes of PET were reprocessed. There were also 500 tonnes of LDPE and 250 tonnes of HDPE (ANZEC 1990, p. 32). The reprocessing rate for PET in 1989 was 3 per cent, and less than 1 per cent for polyethylene (see Table 3.2). Assuming that plastic waste is 320 000 tonnes then the recovery rate for all plastic in household waste was 0.4 per cent.

The low rates reflect the technology used and economic viability, the latter being influenced by collection costs, volume and new resin prices. Post-household plastic collection operations appear to be largely loss-making to date, due to their small scale and lack of market for output. Government health and product regulations limit the products which can be manufactured from reprocessed resins. Plastic utilisation rates are expected to increase as newly announced plants begin operation.

The recycling of household .plastic waste is presently focused on packaging. The reason for this is that many plastic household and commercial consumer products have a relatively long life and there can be a long delay before they are recovered for reprocessing. Packaging generally becomes available for recycling within a year of manufacture [1] and is a consistent part of household garbage. Some material handling articles such as crates and pallets also have a short life. Packaging and material handling articles together make up around 27 per cent of the plastic consumed in Australia. In 1989 virtually all packaging was made from easily recyclable resin. According to the LRA, in 1985-86, the latest year for which statistics are available, plastics packaging accounted for 42 per cent of cosmetic and toiletry, 47 per cent of cleaner and detergent, 22 per cent of food, 18 per cent of beverage and 20 per cent of paint and chemical packaging markets. Plastic is believed to have increased its share of the packaging market since 1986.

The main plastics used in packaging in 1989, were LDPE (31 per cent), HDPE (28 per cent), polypropylene (16 per cent), polystyrene (8 per cent), PET (8 per cent) and PVC (7 per cent) (Mitek Pty Ltd 1990, p. 15).

3.2 Recycling activity

Industrial and commercial scrap is recovered for reprocessing by many small regional operators. The ANZEC survey indicated that at least 44 companies across Australia accept, treat and either reuse that product within their process or resell it (ANZEC 1990b, p. 24). The bulk of plastic recycling occurs in New South Wales and Victoria. Recycling is discussed below by the following plastic types: polyethylene, polyurethane foam, PVC (polyvinylchloride), PET (polyethylene terephthalate) and mixed plastic waste. A more detailed comparison of PVC, PET and HDPE recycling is given in chapter 4 of Volume I.

[1] Packaging is estimated to have an average life of less than -a year compared with the average life of 25 years of building and construction products.

Polyethylene

Polyethylene is used in a range of packaging applications including plastic film, bags, bottles and containers. There are many varieties of polyethylene which have been engineered for different types of moulding processes and applications. Industry estimates indicate that 297 000 tonnes of domestic and imported polyethylene's were used in 1989. According to Commercial Polymers Ltd, an additional 25 000 tonnes of HDPE film, 12 000 tonnes of LDPE film and 13 000 tonnes of HDPE tape and monofilament were imported. Commercial Polymers (Compol) estimated that 180 000 tonnes could be reprocessed assuming a perfect collection system and economic viability. Table 3.7 summarises industry estimates of polyethylene used in short to medium life products that could be recycled given sufficient economic incentive.

There is some reprocessing of polyethylene in the form of milk containers, film, drums, crates and plastic bags including supermarket bags. About .27 000 tonnes of industrial post-consumer LDPE waste is estimated to be reprocessed annually (ANZEC 1990b, p. 29). It appears that, in volume terms, substantially more LDPE is reprocessed than HDPE.

Collected polyethylene is sorted into type and then granulated, washed and reprocessed into pellets. The pellets are converted into agricultural and building film, garbage bags in the case of returned film products, and mouldings such as flower pots and coat hangers for moulding grades.

The reprocessing of household HDPE waste has focused upon plastic milk bottles. In Australia they were first used for milk in 1982 and currently have about 50 per cent of the overall market in milk containers. According to Brickwood Holdings Ltd,. about 15 000 tonnes of HDPE resins are used in their manufacture. Compol expects that the recovery rate for HDPE milk bottles will rise from its current rate of 3.4 per cent to 10 per cent in 1991, and continually increase as collection programs expand. HDPE milk bottles are being recycled into products other than food or drink containers at this stage because of concern about the risk of contamination.

Brickwood Holdings, Australia's largest producer of HDPE milk bottles, has begun to reprocess these and similar containers at Cheltenham, Victoria, and is presently collecting bottles from several States. The

Table 3.7: High volume recyclable polyethylene products, Australia 1988

Polyethylene type	*Products*		*Quantity*
			'000 tonnes
LDPE & LLDPE film	High clarity thin gauge packaging for toys, small articles of clothing and consumer goods		
	Thin gauge film used in cling wraps and dry cleaning applications	}	45
	Medium gauge film for boutique bags and food packaging		
	High slip film for frozen food packaging, ice and dry food		
	Bags for bread and bakery products and food produce		
	Pallet stretch wrapping and newspaper/toilet roll over-wrap		14
	Bundle shrink applications		6
	Heavy duty industrial film such as liners, protective sheeting and agricultural film		15
HDPE film	Supermarket and produce bags		35
HDPE blow moulding	Milk and cream bottles, fruit juice containers		18
	Bottles for household and industrial chemicals and oils		15
	Large containers for chemicals and oils		6
LDPE injection moulding	Ironing baskets, rubbish bins, re-sealable lids and small buckets		6
LLDPE & HDPE injection moulding	Bucket, pails, flower pots, house-wares, tote boxes, crates		20
Total			180

Source: Compol: internal survey from the three polyethylene suppliers, Compol, ICI and Hoechst.

reprocessing plant has cost $1.75. million and has a capacity of 4500 tonnes per year. Brickwood Holdings said that. the operation will be viable if sufficient bottles are processed; however the plant is budgeted to lose

$300 000 per year in the first year of operation because of initially low volumes of available HDPE bottles.

The plant produces plastic for a variety of high value uses, for example plastic pallets which the firm can use in its own operations. Pallets, returnable crates and compost bins were said to be of an acceptable standard when about half of the plastic used in their production is reprocessed resin.

Environmental Plastics in Queensland recycles HDPE from milk bottles and also from ice-cream and oil containers. The company produces about 20 tonnes per week of granulated material for supply to converters. Three to four tonnes go into pipe manufacture, 2 tonnes into flower pot manufacture and 5-6 tonnes into ‘bar chairs’ used to hold weld mesh in place during the laying of concrete foundations.

Plastic Technology in Victoria produces over 300 tonnes per annum of resin from HDPE milk bottles. Final use includes irrigation pipes.

K Mart sells recycled lubricating oil in containers made entirely from recycled HDPE milk containers as supplied by Morton Plastics of Queensland. Priority Plastics in Victoria is purchasing blow moulders to produce laminated motor oil bottles composed of an inner and outer shell of virgin HDPE and a central layer of recycled plastic.

Brickwood expressed the view that existing collection methods preclude economies of scale and that unnecessarily high costs of collection restrict the amount of recycling that could be economically achieved. The company plans to establish its own drop-off points for HDPE milk bottles.

Polyurethane foam

Polyurethanes are used for insulation, mattresses, car and furniture seating, shoe soles and vehicle bumper bars. In 1989 around 49 600 tonnes of polyurethanes were consumed with over 80 per cent used in flexible foams (Mitek Pty Ltd 1990, p. 22). The largest single polymer reprocessing operation in Australia is that of Joubert & Joubert Pty Ltd, a subsidiary of Pacific Dunlop Ltd. The firm operates crumb urethane bonding facilities in Melbourne and Sydney, enabling it to reprocess polyurethane foam into carpet underlay and industrial paddings. Operations commenced in

Melbourne during the early 1970s, and the company now reprocesses around 5 000 tonnes of polyurethane foam per year. Consumer demand was slow at first, but the product presently has a major market share in Australian dwelling underlay applications.

Most of the used polyurethane foam is sourced from industry, where 10 to 15 per cent of the material used becomes scrap. Some post-consumer carpet underlay is also used, but is not sourced from the domestic waste stream. As the supply of clean used foam is insufficient some used foam is imported.

PVC (Polyvinylchloride)

ICI, Australia's largest plastic resin and PVC manufacturer, announced in July 1990 that it would manufacture a product consisting of 30 per cent reprocessed PVC and 70 per cent new PVC. The reprocessed PVC will be sourced only from households and curbside collection. With other recyclables it is being trialed in six Victorian municipalities. ICI is concentrating on collecting fruit and cordial bottles as they are easy to identify. The vinyl bottles are washed, shredded, dried and ground to form a fine vinyl powder. The powder is recompounded to stabilise, strengthen and colour the vinyl as required by the bottle manufacturers. The compound will be used for sunscreen, detergent and household cleaner bottles. A small quantity of vinyl bottles will be reprocessed at first but this will increase if the operation is successful (ICI Plastics 1989). The reprocessed PVC resin is expected to be commercially viable due to its marketing advantages.

Several companies, for example Nylex SRM in Victoria, reprocess PVC from electrical cable. The PVC is compounded and sold as resin for a wide range of applications, eg garden hose and shoe soles.

PET (Polyethylene terephthalate)

PET resin is mainly used in the production of 1.25 litre, 1.75 litre and 2 litre soft drink bottles; a small amount is used to produce methylated spirit bottles. Due to its light weight, consumer safety and elimination of breakage in filling and shipping, PET created and captured the entire 2 litre bottle soft drink. According to the LRA, in 1989 40 per cent (by liquid volume) of softdrink sold in Australia was in PET containers.[2] PET resin is not produced in Australia and presently around 20 000 tonnes of PET resin is imported annually. ACI Petalite, a subsidiary of BTR Nylex, and Smorgon have held 55 per cent and 45 per cent of PET sales respectively in recent years.

PET bottles are reprocessed in Australia by ACI and Smorgon Plastics. ACI said it undertakes around 95 per cent of the reprocessing of PET. ACI recovers PET bottles from Sydney and Melbourne at its Blacktown, Sydney plant. The company reprocessed around 600 tonnes of PET in 1989. The PET is granulated, washed, dried and bagged. . To date the major application for reprocessed PET has been the use of its terephthalic acid in the manufacture of fibreglass products.

The operation is presently not financially viable due to the small scale. Processing costs are around $1000 per tonne whereas the reprocessed resin has a value around $800 per tonne. ACI said the ‘net cost of the program to ACI has been increasing as intake volumes have risen’. Despite financial support from beverage bottlers, ACI estimates it will lose $1.8 million in 1990 from its recycling operations. This is in addition to the $400 000 it will spend in 1990 to promote PET as a recyclable container.

A $5 million PET reprocessing plant in Wodonga, which ACI is to open in late 1990, is expected to reach full production by mid-1991. The plant will accept granulated bottles from cities around Australia. Between the Blacktown and Wodonga plants, up to 4000 tonnes out of the 22 000 tonnes of PET bottles expected to be used in 1992 will be reprocessed, a rate of about 18 per cent. The Wodonga plant will have lower processing costs and produce a cleaner, higher quality resin which will attract a substantially higher price. ACI plans to utilise the reprocessed PET in other ACI and BTR Nylex plastics plants to produce sheet film for thermoformed products replacing imported PVC film. PET bottles collected in South Australia have been landfilled, but may in the future be transported to Wodonga (Vic.) for reprocessing.

ACI and Smorgon levy softdrink producers $3 per thousand PET bottles which is paid into a trust fund administered by Price Waterhouse. The fund

2 PET is unsuitable technically for small drink containers.

is used to pay commercial bottle collectors $700 per tonne (equivalent to the levy on 21000 PET bottles) for used PET bottles delivered to premises in Sydney and Melbourne. ACI said this is an artificially high price paid to attract collectors' interest, rather than a viable unsubsidised price for collection. The importance of PET for collectors' returns is discussed in Chapter 4 of Volume I.

Smorgon incorporates a small amount of PET in its production of ‘Syntal’ (refer to next section).

Mixed plastic waste

Recovering and reprocessing mixed plastic waste avoids the cost of segregating plastics. However, it limits the ;range of uses of the resulting product. This is because the different plastics in the mixture are not bonded at a molecular level. Consequently the resulting product has unpredictable properties and low structural strength. New technologies enabling intra-molecular bonding, however, ! may in the future widen the range of uses (Newell *1.990, p. 24). ACI* Plastics Packaging stated that:

One of the differences between ‘single product’, and ‘co-mingled’ plastic recycling is that with the former we know what the markets are (we just have to get the recycled material up to required specification). With co-mingled recycling the material specification is more tolerant but the end-use markets have to be developed.

Smorgon Plastics has established Australia's only mixed polymer reprocessing plant. It was commissioned in May *1989* at a cost of $1.5 million. It has an annual capacity of 2000 tonnes. The waste plastic is shredded, mixed and melted as it is extruded into a moulded material called . ‘Syntal’. Smorgon claims that for many applications ‘Syntal’ can replace steel and concrete as well as timber. All varieties of plastics are processed together, with at least a 50 per cent polyethylene/polypropylene content. The removal of bottle caps, labels and other contaminants is not required but the product deteriorates after non-plastic contamination reaches 15 per cent. Around half of the plant's input is industrial waste, which provides some. control. over the technical quality of the plastic being reprocessed. ‘Syntal’ is a new product which has so far not achieved its producers' hoped for market penetration. As a result the plant has incurred substantial losses.

Table 3.8 provides examples of products that can be made from reprocessed resins.

Table 3.8: Products made from reprocessed resins

Plastic type	*Products*
PET	In Australia, the terephthalic acid is used to produce fibreglass products such as boats, skis, baths and paint. ACI plans to make sheet film. PET is incorporated with other plastics in plastic lumber. Overseas it is used for carpet backing, fibre fill for ski jackets, pillows, sleeping bags, audio cassettes, non-food containers and the terephthalic acid is extracted for use in paints.
Polyethylene	
- film	agricultural and building film, garbage bags
- moulding grades	flower pots, coat hangers, drainage pipe, crate cases, pallets, drums and pails, non-food bottles
Polyurethane foam	carpet underlay
Polystyrene foam cushioning	In North America and Europe reprocessed polystyrene is used for shapes, cassette casings, rigid sheets and foam insulation board.
Mixed plastic	plastic lumber used for landscape timbers, stadium seating, fencing, farm pens and roadside posts

Source: Plastic Industry Association, Commercial Polymers Pty Ltd, ACI Plastics Packaging.

3.3 Factors influencing the level of plastics recycling

Characteristics of plastics

Plastics encompass a range of synthetic, organic compounds that greatly differ in physical and chemical characteristics which determine their ability to be reprocessed. There are two main types of plastics: thermoplastics,. which can readily be reprocessed, and thermosets, which cannot. Thermoplastics can be repeatedly softened and hardened without seriously damaging the property of the resin. Thermosets cannot be heated and reformed into new products as their structure prevents the movement of their molecular chains beyond a certain point. However thermosets can be ground to a very fine powder which is then mixed with new resin in a typical moulding process.

Thermoplastics include polyethylene, polypropylene, acrylonitrile-butadiene-styrene (ABS), nylons, thermoplastic polyesters such as PET, polystyrene, polyvinyl acetate. (PVA), polyvinyl chloride (PVC) and styrene-acrylonitrile (SAN). Thermoset plastics include epoxy, melamine's, unsaturated polyesters, urea-formaldehyde resins and phenolics. Polyurethane foams are usually considered to be thermosets, but have some characteristics similar to thermoplastics. Industry estimates indicate that of the plastic materials consumed in Australia in 1989, including imports, 82 per cent were thermoplastics, 13 per cent thermosets and 5 per cent polyurethanes (Mitek Pty Ltd 1990, p. 18).

Additives are used to meet specific applications and improve processing. The major ones are anti-oxidants, plasticisers, lubricants, colorants, ultra violet light stabilizers and antistatic agents.

Plastic resin prices

Depending on the product and process, virgin resins account for between 28 and 54 per cent of the costs of manufacturing plastic packaging. Reprocessed resins compete with domestically produced and imported virgin resins. Reprocessed post consumer resins are classified as substandard or off-specification material and their price is influenced by the price of new but off-specification resin. According to PIA, there is a perception amongst purchasers that new off-specification resins are of better quality than the reprocessed product. Reprocessed resins presently also command a lower price because they are available on an intermittent basis and are of a less certain. quality. Industry sources said that post-household reprocessed resins currently receive between one third and two thirds of the price of new resins depending on the resin and its quality.

The price of virgin resin has a major influence on the financial viability of reprocessing operations. In South Australia some companies collecting post-consumer plastic products, for example plastic bags and ice-cream containers, collapsed when the price of new plastic fell in 1989.[3] Based on discussion with 20 medium-sized plastics processors in June 1988, Fahey (1989, p. 87) concluded that" Australian processors pay 20 to 35 per cent more per, tonne for resins than their North American counterparts. The differential stems from Australian customs duties on imported resins and transportation costs which provide protection for resin producers in Australia.

In September 1990 ICI Australia Operations Pty Ltd lodged a dumping complaint against imports of LDPE resin from 16 countries. In January 1991 the Australian Customs Service reached a positive finding in the case of 10 of these countries. The matter has now been referred to the Anti-Dumping Authority.

With virgin plastics selling for some US 40 cents per pound (equivalent to $A1100 per tonne), reprocessed plastics in the United States were reported to sell for US 30 cents per pound ($A825 per tonne), three-quarters of the price of new resins (The Economist 1990a, p. 72). Given the higher prices paid for resins in Australia, the incentive to recover may be greater than in the United States. However, high collection and transport costs and fewer opportunities for economies of scale may reduce this incentive.

There are two domestic producers of high and low density polyethylene and polypropylene, the major plastic resins used in packaging. Commercial Polymers is Australia's largest polyethylene producer and competes in the Australian polyethylene market with ICI for LDPE and with Hoechst Australia for HDPE. Some polyethylene is imported but much of it is special grades not produced in Australia. Commercial Polymers competes with imports on the LLDPE market. ICI is planning to open a new plant at Botany, Sydney, in early 1992 which will produce 90 000 tonnes of LLDPE each year. Polypropylene is produced by ICI Australia and Shell Chemical. Domestic capacity in 1989 accounted for 89 per cent of local demand.

The price of the finished product is sensitive to resin prices as these form a large component of costs. Increases in prices of both virgin and recycled resins may result in substitution into other products, some of which may not be recyclable, eg. a switch from HDPE containers to imported cartons. On.

3 Discussion with South Australian Department of Environment and Planning in February 1990

the other hand the Plastics Industry Association drew on United States experience to suggest that products made from, or packaged in, reprocessed plastics and labeled as ‘environmentally friendly’, could command a higher price than the same product when labeled otherwise. If this is the case the use of the higher priced reprocessed resins in some markets may be financially acceptable, and a marketing advantage, to producers.

Collection

Collection arrangements are discussed in Chapters 3 and 4 of Volume I of the report. Presently PET bottles, HDPE milk bottles, PVC bottles in a few areas and plastic film products such as supermarket bags are the main plastic items collected from the household waste stream.

The low intrinsic value and higher volume per unit weight of plastic makes it less economical to collect from households than some other waste material. According to industry sources in July 1990, collectors in Sydney are paid about $100 per tonne for mixed plastics, for example, milk and detergent bottles and $89 per tonne for glass. PET and PVC bottles attract $700 per tonne. The NSW Recyclers Association stated that $700 per tonne for collecting plastic bottles door-to-door was too low to support collection. The Recyclers Association of Victoria said that the collection of plastic containers was not financially viable unless subsidised by higher value material such as glass.

Information provided by industry indicated that collection costs account for between 30 and 40 per cent of the total cost of reprocessing resins at the present level of technology and scale of operation in collection and processing. The price reprocessors can afford to pay to collectors for plastic waste, given other costs and the price reprocessed resins receive, may be insufficient to ensure enough plastic waste for the reprocessing operations to be profitable. The size and regularity of the quantity collected also depends on community participation in collection schemes. One conclusion of the ANZEC study was that uncertainty as to long term supplies of plastics of known quality and, contamination level from the domestic waste stream had inhibited the size and scale of the investment in equipment (ANZEC 1990b, p. 31).

Segregation

The recovery and reprocessing of plastics is hampered by the difficulty of distinguishing different varieties. For single polymer reprocessing it is necessary to sort the plastics to maintain the quality of reprocessed resins. According to the Victorian Government, a trial recycling scheme in Geelong, between May 1987 and April 1988 conducted by the Environment Protection Authority (EPA) and the Recycling and Litter Advisory Committee (RALAC) found that while large quantities of plastic beverage containers were collected on a house to house basis, they 'were not well separated from other plastic containers and the variety of container types detracted from efforts to achieve economic collection of plastics'. Currently PET and HDPE milk bottles, which are readily identifiable, are sorted by hand which is a costly process. Smorgon's reprocessing process avoids this by using mixed plastic waste, but the number of applications for which the product can be used is limited.

The PIA has introduced a voluntary code to make it easier for plastic recyclers to identify the different types of plastics when sorting, hence reducing the cost of segregation. The code is based on the United States standard and consists of an easily identifiable symbol. One concern in the United States has been the difficulty of reading symbols after bottles have been flattened to facilitate collection.

The PIA said that standardising the ingredients used to make various plastic products would greatly simplify the segregation of plastics, thereby reducing recovery and reprocessing costs. It recommended that standardisation be left to the marketplace, and governments should not ban particular plastics, for example the use of polystyrene in containers.

Industry structure

There is concern within the plastics packaging sector that its products will be the subject of government legislation and some community backlash if they are not recycled. To date, much of the post-household recycling has been by companies with substantial market shares in the plastic products concerned. ACI and Smorgon supply the PET softdrink market while Brickwood Holdings is Australia's largest producer of HDPE bottles.

However, many plastic packaging operators are small and not in a position to undertake their own recycling of household plastic waste.

Technological change

Research has been occurring in areas of compaction, segregation, processing and product design. ACI recently introduced the one-piece PET bottle which avoids the cost of removing the HDPE base prior to processing, In the United States research is underway to identify resin types based on bar codes using photoelectric beams, machine vision and near infrared technology.

Research and development initiatives overseas are expected to lead to greater use of biodegradable plastics. These will not solve all the problems associated with disposal of plastics, but could achieve a reduction in the landfill space required. Several companies have announced developments in biodegradable plastics partially made of starch which are decomposed by bacteria. Bunge Australia Ltd has recently obtained the licence to manufacture and market a plastics additive which renders plastics biodegradable. The product is 40 per cent starch, and is typically used at 15 per cent content with virgin materials. It is presently available for LDPE, polypropylene and polystyrene.

There is industry concern that the use of bio-degradable plastics will adversely affect plastics recycling by threatening the physical integrity of products made from reprocessed plastics. Bunge Australia said it was targeting products which it viewed as financially difficult to recycle such as six pack rings, disposable nappies and garbage bags. Another concern is that use of degradable products might encourage people to litter.

The environmental effect of the decomposed plastic on soil, water and fauna is uncertain. Moisture needs to be present in the landfill for bacteria to break down the plastic, but landfill management aims to prevent water entering to minimise leachate problems. Furthermore, even under the best conditions, biodegradable plastic may still take years to decompose. Photodegradable plastics, which break down in sunlight, are available. However they do not readily break down in landfill due to the absence of sunlight.

Government initiatives

Commonwealth Government

The reprocessing of plastics may bemarginally influenced by Commonwealth Government customs duties on imported (usually virgin) plastics. Since January 1990, the duty on most plastics has been 15 per cent on imports from general sources (developing countries and Canada 10 per cent). There are exceptions such as PET (which is wholly imported),. polytetrafluoroethylene and polycarbonate, for which Customs duties are 10 per cent (developing countries and Canada 5 per cent). As with other industries, government research and development tax incentive programs are available.

State Government

Several state governments are developing formal procurement policies favouring recycled goods and most have promotional material and information to encourage recycling.

Governments in Victoria, South Australia and Western Australia have announced intentions to make available grants for businesses recycling materials, including plastics. In South Australia assistance is to be available *to* industry to encourage the development of products which incorporate secondary materials.

State government grants have also been made available to local councils for pilot schemes to investigate ways of collecting plastics. For example in Victoria a grant was made to the City of Brunswick for a pilot scheme to look at different compaction and shredding systems to achieve volume reduction of waste plastics.

In South Australia a 5 cent deposit is imposed on PET bottles under container deposit legislation (CDL). The collected PET is currently disposed of in landfill, but ACI plans to transport it to its Wodonga plant in 1991. The effects of CDL requirements are discussed in Chapter 7 of Volumes I and II. The South Australian Recycling Advisory Committee has suggested that the refundable deposit system could be applied to a variety of household items including food and non-food plastic containers.

The Victorian RALAC has recommended that plastic beverage containers be subject to a 10 per cent recycling target by 1991.

Health and product legislation

Recycled resins from packaging are not used where they would be in direct contact with food or beverages owing *to* risks of contamination. The NSW *Pure Food Act 1908, Section 11* and the Victorian Food Act 1984, Section 2, both address contamination. However, lamination and washing techniques are being developed which may overcome this problem. Recycled resins may not yet be suitable for products made to Australian Standards or to comply with Dangerous Goods codes. The virgin material in these products is formulated to specific performance requirements.

It is reported that the two largest firms producing for the United States cola market plan to use bottles incorporating 25 per cent recycled PET, subject to approval of the United States Food and Drug Administration.

Industry initiatives

The Plastics Industry Association (PIA) has expressed concern about plastic's poor environmental image. In February 1990 the Association' launched a three year strategy to ‘establish a public credibility and acceptance that the plastics industry is environmentally conscious and concerned for the wellbeing of future generations’ (Plastics News International 1990, p. 6).

Sponsored by various companies in the plastics industry, the program has an annual budget of $750 000. It has established a data base on plastics and the environment, and has funded research into the collection, separation and recycling of plastic. The PIA is implementing a voluntary coding system for plastic containers..

Concern to avoid the introduction `of container deposit legislation has prompted industry in NSW, Victoria and Tasmania to provide funds to government for recycling and anti-litter activities.

Overseas government initiatives

In the United States at least five states have banned the use of plastic can connector rings that are not biodegradable. Oregon requires that all can connector packs be made of substances that will decompose within 120 days of disposal. Maine has banned the use of plastic connectors for packs of beer and softdrink, while non-biodegradable plastic-coated paper and polystyrene containers are banned in Florida. In 1989 Missouri and North Carolina joined Florida, Illinois, California and Michigan with bills requiring the coding of plastic containers by resin types. The Federal Plastic Pollution Control Act of 1988 requires that by 1992 all plastic items deemed recyclable must be recycled and all remaining plastic items have to be biodegradable. Miller suggests that about 43 per cent of the plastic wastes produced in the United States could be recycled by the year 2000 (Miller 1990, p. 475).

In 1989 Italy imposed a tax on non-biodegradable manufactured and imported plastic bags used as containers in the retail trade. The tax is expected to provide a strong incentive as the tax rate is 100 liras per bag compared to the manufacturing cost of 20 liras. In Taiwan, the softdrink bottling industry is helping fund a PET recycling operation, Taiwan Recycling Company, by a surcharge on each bottle produced equivalent to US 4 cents.

3.4 Costs and benefits of recycling

Tables 3.9 and 3.10 list some of the costs and benefits to reprocessors of PET soft drink containers and HDPE milk bottles, and additional costs and benefits to society which plastic reprocessors do not face.

Environmental protection

Savings from reduced waste disposal

Every tonne of plastic reprocessed represents one tonne less waste to be disposed at charges which currently average around $32 per tonne in

Table 3.9: Costs and benefits of reprocessing PET

Costs to PET reprocessor	*Comment*	*Benefits to PET reprocessor*	*Comment*
Payments to collectors	&700 per tonne, According to ACI not a commercial price	Value (selling price) of reprocessed PET	Presently $800 per tonne. With improved technology the value of recycled PET from the Wodonga plant will be substantially greater
Processing costs	$1000 per tonne, average cost at Blacktown plant, due to small scale of operation. Processing costs at Wodonga plant will be lower		

Additional costs to society	*Comment*	*Additional Benefits to society*	*Comment*
Costs of consumer inconvenience in sorting and putting out plastic for curbside collection		Avoided waste disposal charges	$32 plus per tonne in Sydney and Melbourne
Energy used in collection and transport may exceed that for waste disposal			

Source: Industry submissions, including PIA (Plastics Industry Association).

Table 3.10: Costs and benefits of reprocessing HDPE

Costs to HDPE reprocessor	*Comment*	*Benefits to HDPE reprocessor*	*Comment*
Payments to collectors	Milk bottles, curbside $700 per tonne, collection from point of sale $250 per tonne	Value (selling price) of recycled HDPE	$900 to $1200 per tonne
Processing costs	Milk bottles $400 to $600 per tonne		

Additional costs to society	*Comment*	*Additional Benefits to society*	*Comment*
Costs of consumer inconvenience in sorting and putting out plastic for curbside collection in excess of personal satisfaction		Avoided waste disposal charges	$32 plus per tonne in Sydney and Melbourne
Energy used in collection and transport may exceed that for waste disposal		Saving in energy use of reprocessed resin for alternative uses, eg toys	

Source: Industry submissions, including PIA (Plastics Industry Association).

Sydney. Plastic, however, is only about 8 to 10 per cent by weight of domestic garbage in Sydney, and a little higher in Melbourne (10 per cent) and Brisbane (11 per cent), much less than other components such as biodegradable organic waste (about 45 per cent) and paper (about 21 per cent).

Several participants said that as, most plastics are inert and do not readily decompose, disposing of them in landfill imposes higher costs on the community than many other types of waste. The biodegradable forms of plastic which have been developed to date simply degrade into small pieces.

Other participants said plastic provides structural support to landfill due to its non-biodegradable characteristics. However, if the proportion of plastics is too high or if plastics are not distributed well the landfill will develop spongy areas. Structural support is desirable where tips are to be covered or grassed over for recreational use. It is less desirable in terms of the compaction of waste and extending the life of landfill facilities.

Energy Use

The reprocessing of plastics can save energy. It avoids the energy required to produce new resins and in the collection and disposal of plastic waste. However, offsetting these savings is the energy used in the collection and segregation of waste plastics for reprocessing. Estimates of energy used in producing new and reprocessed resins vary, but there appears to be quite substantial energy savings in using recycled resins. However, recycled resins from food and beverage containers cannot generally be used to make the same products because of hygiene and contamination considerations.

Energy use in plastics recycling is discussed in Chapter 5 of Volume I.

Conservation of natural resources

Oil and gas are the non-renewable resources used to produce plastics. Less than 2 per cent of Australian crude oil consumption is used for production of primary petrochemicals, and about half of this is used to manufacture plastics (IAC 1986, p. 42). The amount of resin used to produce beverage containers has been declining. According to the Packaging Council of

Australia (PCA), typical weight reductions are 38 per cent for the PET bottle since its introduction in the late 1970s, and 37 per cent for the polyethylene milk bottle since it was introduced in 1983.

Litter

According to Keep South Australia Beautiful (KESAB) plastic accounts for 13 to 22 per cent of litter depending on the State (BRRU 1989, p. 67). Discarded plastic is sometimes more obvious than other types of litter as it floats and is easily airborne. Plastics accounted for 42 per cent of the waste collected from and around Sydney Harbour during Clean Up the. Harbour Day in January 1989 (Elkington and Hailes 1989, p. 93).

Plastic litter creates environmental costs through aesthetic damage, the blocking of drains and watercourses, and damage to wildlife. There is no financial incentive to collect plastic litter equivalent to that for aluminium cans. However, there are regulatory and legal disincentives to littering, and the success of drives to clean up certain areas or facilities indicates some public willingness to deal with the problem without payment for the time and effort involved. Waste plastic is also widespread in the marine environment. It imposes substantial costs on marine life through ingestion and recovery presents major technical difficulties and costs. Plastic marine litter includes lost plastic driftnets, plastic six-pack container rings, fishing bait ties, bags, bottles and other litter left by commercial and recreational fishing, sea transport and tourism, or washed into the sea from land.`

4 PAPER

Australia recycles about one third of its paper. The vast majority is used to produce packaging papers. Some is used in printing and writing papers and minor amounts in the production of tissues. At present wastepaper is not used in Australia to produce newsprint.

The main opportunity to increase paper recycling is to make newsprint using old newspapers and magazines. If plans of Australian paper companies to produce recycled newsprint go ahead, Australia's recovery rate will rise to about one half.

In an *Interim Report on Paper Recycling* released in July 1990, the Commission found that paper recycling can be cost effective and can help the environment. But paper recycling is not costless.

The sections below summarise parts of the *Interim Report* dealing with Australia's paper recycling performance.

4.1 The extent of paper recycling

Nearly 2.8 million tonnes of paper products are consumed annually in Australia. Of this, about 15 per cent does not become available for reprocessing. This includes much of the printing and writing papers used for long term applications such as books and for filing and archiving, most tissue papers and some packaging papers.

About 2.4 million tonnes of paper products are potentially available for recycling of which 850 000 to 900 000 tonnes are recycled. Australia's overall recovery rate therefore exceeds 30 per cent. About 69 per cent of the wastepaper recovered consists of packaging materials, about 16 per cent is printing and writing papers and the remaining 15 per cent is used newsprint.

Recovery rates vary from one area to another. Estimates by Pratt suggest a recovery rate of 50 per cent for Victoria and about 28 per cent for New South Wales. The Commission's survey of recycling by local governments indicates that paper collection is heavily concentrated in capital cities. The areas with higher recovery rates tend to have lower unit recovery costs because of higher population densities and closer proximity to mills that recycle wastepaper.

The utilisation rate is the amount of secondary fibre (recovered fibre) used in the manufacture of paper, expressed as a percentage of the total fibre used. In 1987-88, Australia's utilisation rate was 36 per cent. This was lower than the rate for Japan, the Netherlands and West Germany, but above the United States. Australia's utilisation rates for wastepaper used in packaging and in printing and writing papers are high by world standards. The contrary is true in newsprint and in tissue production (refer Table 4.1).

Table 4.1: Wastepaper utilisation rates for major paper product groups

Product group	*Australia* [a]	*West Germany* [b]	*Western Europe* [c]	*USA* [c]	*Japan* [c]
			per cent		
Newsprint	0	50	25-30	20-25	45-50
Printing/writing	6	4	3	6	14-15 [d]
Tissue paper	1	25	40	30	na
Packaging/industrial	68	90	65-70	30	65-70

a) APM b) APPM, 1987-88 data. c) ANM, 1985-87 data. d) McEntee, ‘The current and future paper recycling market’, *Resource Recycling*, November 1990, p. 88.

Location of paper recycling

About 90 per cent of the wastepaper collected in Australia in 1988-89 was used in the pulp and paper industry. Most of the remainder was exported (refer Table 4.2).

Paper mills which incorporate wastepaper in the production of packaging and industrial paper are located in New South Wales, Victoria, Queensland and Western Australia. They account `for the bulk (about 750 000 tonnes) of all wastepaper recovered in Australia.

Recycled papers are substitutable for most virgin pulp in the manufacture of liner boards, cartons and other packaging materials. The process makes use of comparatively low quality wastepaper (magazines and old newspapers) together with used packaging papers. There is keen demand among these traditional paper recyclers for supplies of clean, high quality wastepaper and board, most of which comes from industry rather than households.

About 35 000 tonnes of wastepaper are used annually in the production of printing and writing papers in mills located in New South Wales and Victoria. High quality wastepaper of the type recovered from offices is used to produce a range of printing and writing papers, including some 100 per cent recycled paper.

Table 4.2: Wastepaper use in Australia, 1985-86 to 1990-91

Papermaker	*1985-86*	*1986-87*	*1987-88*	*1988-89*	*1989-90 Est.*	*1990-91 Est.*
			'000 tonnes			
APM	342	342	398	400	480	500
Smorgon [a]	165	155	155	165	45	-
Pratt (Visy Board)	55	110	130	160	220	260
APPM	17	18	20	22	22	22
Others [b]	0	0	0	3	6	6
Total paper industry use	579	625	703	750	773	782
Other Uses [c]	4	7	13	20	20	20
Export	5	28	25	65	95	95
TOTAL	588	660	741	835	888	897

a) Smorgon withdrew from paper manufacture in September 1989, but continues to use some wastepaper for pulp moulding. b) Bowater and Austissue. c) Insulation, shredded packaging, animal bedding, pulp mouldings, energy generation etc.

Source: APM, Submission No. 144, p. 19; and other industry sources.

Minor amounts of wastepaper are used in the production of tissue paper in mills located in Victoria, Queensland and Western Australia. The expansions now proposed could. lead to over 16 000 tonnes of high quality wastepaper being used in the production of tissues within a year or two. Austissue in Perth and the Paper Converting Group in Brisbane both produce a tissue made entirely from wastepaper.

There is no recycled content yet in Australian newsprint but there are a number of proposals to recycle significant quantities of old newspapers and magazines into newsprint. These are discussed below in the section on newsprint. Of the 598 000 tonnes of newsprint used in Australia in 1990, about 194 000 tonnes, or 30 per cent, was either recycled or exported.

About 20 000 tonnes of wastepaper annually are also used to produce products such as insulation, egg cartons and animal bedding, and for energy generation. Cellulose Industries Pty Ltd has a plant at Dandenong in Victoria, which produces insulation material from wastepaper for the building industry. Westpaper in Perth is involved in a project due to be commissioned in 1991 that will recycle 1000 tonnes of old newsprint into 16 million egg cartons a year for the Western Australian Egg Marketing Board. The operation is expected to extend to fruit trays, disposable hospital trays and seedling pots.

Making pulp from wastepaper

The suitability of wastepaper for re-use by paper manufacturers is affected by the quality and characteristics of the original pulp and the paper made from it. These, may limit the extent to which existing processes and machinery can be adapted to use recycled fibre.

The pulping process for wastepaper is different from that using pulpwood. No grinding or heavy chemical or heat treatment is required. After sorting and the removal of contaminants, the wastepaper is delivered to a blender where it is slurried in the presence of a variety of chemicals dissolved in hot water. Various washing, cleaning, bleaching and screening actions may then be applied. De-inking may also be involved.

Paper fibres weaken and shorten each time they are recycled. This limits the scope for paper recycling in some uses. In the production of packaging papers, the consensus is that Australia is close to the economic limit for recycling given technical considerations. Recycling is inevitably a downgrading process unless virgin pulp or higher quality wastepaper is added. However, European experience indicates that with an appropriate mix of wastepaper fibres, recycling to a higher quality can be achieved. Steinbeis, a West German company produces office paper from a pulp made out of a combination of de-inked newsprint and magazines.

Reliable access to large quantities of clean, graded wastepaper is essential for the production of quality recycled paper. This is one reason why paper manufacturers prefer clean industrial wastepaper such as printers' offcuts, publishers' returns or cartons from retailers. The small quantities of mixed papers coming from offices and homes can be costly to collect and sort.

4.2 Costs and benefits of more paper recycling

Private costs and benefits are at the heart of commercial decisions to recycle wastepaper. Assuming that the capital costs of producing paper from waste and from virgin pulp are the same, the main costs which affect a decision to use recycled material are those of fibre, electricity, chemicals and labour.

In Australia, wastepaper has long been recycled into packaging and industrial papers, and some high quality wastepaper has long been used in the manufacture of printing and writing papers. In these uses, the cost of recycled fibre is significantly less than the price of virgin chemical pulps. The present estimated cost of recycled fibre for newsprint manufacture in Australia is roughly equivalent to the cost of securing additional wood pulp supplies at the proposed used newsprint pulping location. However, it is two to three times higher than the present average costs of virgin mechanical pulp in Australia. Labour costs within mills are probably higher for recycling too. ANM, said that the cost of producing de-inked pulp in Australia will be about the same as the cost of mechanical pulp. Lower electricity and chemical costs are major offsetting factors.

The major private costs of collecting, sorting and transporting wastepaper to the recycling plant are labour costs and the petroleum and capital costs involved in transport. These costs are high because of Australia's low population density and the location of most paper mills away from capital cities. Collection and sorting costs alone are about $50 to $70 per tonne for newsprint. Transport costs can be $20 to $42 per tonne, depending on the grade of wastepaper.

The major private benefits of paper recycling are the savings in waste disposal costs by waste generators and waste management authorities. In Australia, charges for wastepaper disposal in landfill are low - from $0 to $45 per tonne depending on location.

To the extent that waste disposal charges are too low there is a bias against paper recycling. Any underpricing of pulpwood would also discourage the use of wastepaper (and other non-wood feedstocks) in the production of paper. These are complex issues discussed in Volume I.

4.3 Improving Australia's recycling performance

Wastepaper is a raw material for which new and innovative uses are being developed. There are sound commercial reasons for some firms to undertake the investment. For others, the commercial justification is strengthened by the perception that their existing markets for . paper products could be in jeopardy unless they are seen to respond to the community's growing concern for recycling. Such projects are likely to proceed without government assistance.

Some of the smaller projects may succeed initially, but have difficulty in competing when prices paid for wastepaper eventually recover. There was evidence that if all the proposed projects were undertaken, the requirements for wastepaper would exceed any realistic assessment of the supplies available in the near future. Government assistance now could add to these problems later. Of special concern would be government assistance to projects which have been planned solely in expectation that governments will (as in the United States) intervene in ways which create a captive market for the firms concerned. Encouraging the establishment of enterprises dependent on government support does not make good economic sense.

From an environmental point of view, the case for government intervention is no better. While the production of virgin wood pulp and paper unavoidably create some pollution, recycling and de-inking of, paper have pollution problems of their own. As pointed out by the Department of the Arts, Sport, the Environment, Tourism and Territories (DASETT) 'it is critical that we learn from our mistakes and do not merely replace one set of environmental problems with another'.

Two of the environmental issues linked with paper recycling - pollution and energy consumption - do not unambiguously favour recycling. The major sources. of pollution from recycling wastepaper are discussed in the Commission's *Interim Report on Paper Recycling. As* production of newsprint from recycled wastepaper is the most significant likely addition to paper recycling in Australia, the *Interim Report* also compares the environmental costs and benefits of producing newsprint from mechanical pulp and from de-inked pulp as proposed by ANM.

In brief, the finding in the *Interim Report is* that recycled newsprint will use less wood and one sixth of the electricity needed for virgin mechanical pulp. It will also save tip space. But other environmental benefits in Australia may not be large. Paper recycling is not by itself a major means of preserving Australian native forests. More recycling will reduce our imports of newsprint and help preserve forests overseas. These are issues discussed in Volume I.

Whether the production of newsprint from recycled waste is less polluting than production from pulpwood can only be assessed on a project by project basis. The de-inking process creates salt which can be an environmental problem for inland locations unless action is taken to remove it. Paper recycling may also result in organochlorines including dioxins in paper and effluent, but if subject to control by State authorities the levels of pollution may not pose any significant risk. The environmental costs and benefits of newsprint recycling are discussed further below.

There are trade-offs involved in any decision to recycle significantly larger quantities of paper. For recycling is not unambiguously environmentally friendly. The difficulties associated with the establishment of de-inking facilities at Albury illustrate the need for governments at all levels to speed up and co-ordinate decision making.

There is a role for industry, and perhaps governments, .in providing better information on performance characteristics of paper, including papers with varying proportions of recycled inputs. Better information could, for example, discourage inappropriate consumption of 100 per cent recycled paper. Beyond this, attempts by governments to coerce manufacturers and consumers to change their behaviour through discriminatory purchasing policies, tax concessions, or mandated or ‘voluntary’ targets would merely compound inefficiencies. Such policies can have the perverse effect of increasing costs to traditional paper recyclers, and increasing imports of recycled paper and perhaps of pulp.

4.4 Newsprint

About a quarter of the newsprint used in Australia is recovered for reuse, but none is currently reprocessed into new newsprint. Most is reprocessed into packaging products, some is exported and small amounts are used in the manufacture of insulation and other cellulose based products. Proposals to extend paper production facilities to include de-inking and reprocessing used newsprint and magazines could substantially change this situation.

The market for waste newsprint

The past two years have seen a major turnaround in the market for waste newsprint. In December 1988 old newspapers were reported to be selling for as much as $100 per tonne in Sydney. By early 1990 these prices were as low as $10 per tonne. Since the publication of the Commission's Interim Report on Paper Recycling the market for old newspapers has declined still further. Many local collectors have gone out of business or have stopped .collecting newspapers. The only optimistic note is in the export market, where there has been some recovery.

This recovery is partly due to an increase in used newsprint being reprocessed in North America, and consequently a reduction in exports. Japanese mills have made increased use of imported used newsprint. With the addition of new de-inking plants in the United States and Canada, the use of old newspapers and magazines for newsprint is expected to increase from 1.56 million metric tonnes in 1989 to more than 3.3 million metric tonnes in 1992, according to the Canadian Pulp and Paper Association.

Green Recycling said that the new de-inking plants will absorb all the old newsprint that is currently being exported by the United States to South-East Asian markets.

The decline in prices of used newsprint has not been uniform across regions or across categories of newsprint. Prices in early 1990 were still $35 per tonne in Perth and one company, Green Recycling, was offering $30 per tonne for set supply arrangements up to two years ahead. During part of 1990 the company operated under a contract whereby all the used newsprint it collected was delivered to APM at $35 to $40 per tonne. The company proposed to resume exports when the contract expired in January 1991.

A distinction must be made between post-industry and post-consumer waste newspaper. Post-industry waste accounts for 10 to 20 per cent of newsprint used, but this proportion is falling as publishers introduce new machines and techniques to minimise waste. There is still a ready market for unprinted and uncontaminated white newsprint waste, which can be sold for $200 per tonne for use as butchers' wrapping paper.

Local government councils responded in various ways to the fall in used newspaper prices. Some discontinued collections from households but maintained collections from commercial premises. Some Councils tried to maintain collections, while operating at a loss, or subsidising collectors, until mills ceased taking deliveries. Since old newspapers cannot be stored without undergoing some deterioration, increasing quantities were disposed of in landfill rather than recycled.

The decline in used newsprint prices has also affected school recycling programs and the activities of special schools, sheltered workshops and similar groups involved in sorting paper and other recyclables.

In 1990 about 181000 tonnes of used newsprint, or 30 per cent of consumption in that year, was estimated to have been recovered. APPM said that the potential recovery rate of used newsprint is 65 per cent, or more than 400 000 tonnes annually, based on actual recovery rates in Japan. However, ANM considered that Sydney, Melbourne, Adelaide and Brisbane, and areas in between, account for 80 per cent of newspaper consumption in Australia and that only 55 per cent of that quantity can be recovered.

Wastepaper exporter Loumbos Pty Ltd said that there is no excess supply of old newsprint. Eight years ago the company established its Melbourne plant at a cost of $2 million, but it has. been unable to obtain adequate supplies of old newsprint.

In order to obtain waste newsprint, Loumbos proposed to add $20 per tonne to council subsidies of $18 per tonne (based on avoided waste disposal costs), with an anticipated further $20 per tonne from the newspaper publishers' environmental fund. Individual collectors would receive $58 per tonne in total. Loumbos said that the costs of collecting sorting and transporting paper for export are $60-$80 per tonne.

Recycling newsprint in Australia

In Australia, old newspapers and magazines form the bulk of household wastepaper which represents about a fifth of domestic garbage. To the extent that old newspapers are collected, they are used mainly in the production of packaging materials. According to News Ltd, of the 188 000 tonnes of old newspapers recovered in 1990, 91000 tonnes, or 50 per cent was used in the manufacture of packaging materials. The demand for this purpose varies cyclically. The greater the level of economic activity, the higher will be the industrial demand for these products, and in turn the demand for used newsprint. However, there is a technical limit to the proportion of fibre in packaging materials that can come from old newsprint.

About 31000 tonnes of scrap newsprint or 16 per cent is used by other industries in a range of products. Old newspapers are used on a small scale for commercial grass seeding, for hand made paper and craft products, and in a shredded state for filling for boxes and bedding for animals and pulp mouldings for egg cartons. Visy Board, a member of the Pratt Group, has developed a disposable sleeping bag. Cellulose Industries Pty Ltd produces insulation and other products from recycled newspapers and old telephone directories.

In 1990 66 000 tonnes of waste newsprint or 35 per cent of the amount collected was exported to South East Asian countries where it is de-inked and used in newsprint production.

As pointed out in Volume I, recycling rates in other countries are of limited use in indicating Australia's options for paper manufacture using wastepaper. Table 4.3 shows that recycling is most developed in countries like Germany and Japan where fibre and energy costs are relatively high and wastepaper costs are low because of high population density and low internal transport costs.

Table 4.3: Wastepaper utilisation rates in newsprint production - selected countries

Country	*Utilisation Rate %*
Australia [a]	0
Federal Republic of Germany [b]	50
USA [c]	20-25
Japan [c]	45-50
UK [d]	26
Sweden [d]	27

a) APM, Submission No. 144, p. 19. b) APPM, Submission No. 193, p. 3. 1987-88 data. c) ANM, 1985-87 data. d) The Pulp and Paper Manufacturers Federation of Australia, submission no. 94 p. 15, quoting a 1988 FAO Survey.

This situation is virtually reversed in Australia. Fibre and energy prices to paper manufacturers are relatively low. Because of the lower concentration of the population, paper collection costs are high. As the two newsprint mills are located in Albury in New South Wales and Boyer in Tasmania, transport costs for old newspapers and magazines collected in the major cities would be relatively high.

Table 4.4 illustrates in index form potential production costs in Australia of making newsprint from recycled pulp compared with virgin wood pulp. While the cost of energy used directly in recycling is lower, fibre and labour costs are estimated to be higher. The high fibre costs for recycling stem from high transport and sorting costs. The estimates are based on the assumption that higher prices than those at present in force would have to be paid to obtain the large supplies of old newsprint required for, a major recycling operation. Collection and transport costs would increase due to the need to collect from more dispersed sources and transport further distances.

The estimates in Table 4.4 cover only the private costs which manufacturers, on average, would have to pay if a major newsprint recycling operation were to be established. They make no allowance for other costs borne by the rest of the community, such as waste disposal or environmental costs. Nor do they reflect relative price changes that might be expected in future. For example, if wood pulp or electricity prices were to rise relative to other prices, or social or environmental costs were to be internalised into newsprint production costs, recycling would be more attractive. Such prospective changes appear to have played a part in encouraging several proposals to recycle old newspapers and magazines into newsprint and similar papers. Conversely, any reduction in the price of virgin fibre would deter recycling.

Table 4.4: Estimated private costs in Australia of newsprint production

	Wood pulp based	*Recycled*	*Ratio of recycled to wood pulp*
Fibre	27 [a]	60 + b	2.2 +
Chemicals	4	2 +	.5 +
Energy	26	5 +	.2 +
Labour	18	18 +	1.0 +
Materials and overheads	14	14	1.0
Depreciation	11	11	1.0
Total private costs	100	110 +	1.1

a) Cost includes felling, transport and any royalties or other payments. Fibre costs vary between locations.

b) Cost includes energy and labour costs of collection, initial sorting and transport to mill.

Note: The location of wood pulp mills can mean higher costs of transporting the final product to markets in some cases.

Sources: HA. Symons Ltd and estimates based on information supplied by participants.

Recycling proposals

As part of a major upgrading and expansion of its Albury newsprint mill, ANM proposes to develop a $100 million recycling and de-inking facility which would use 133 000 tonnes of wastepaper, some 70 per cent of which would be used newspapers and the remainder magazines. Some 100 000 tonnes of recycled pulp would be produced. The inclusion of magazines in recycled pulp is considered to confer technical benefits, since newsprint incorporating them is much brighter and stronger than newsprint made solely from unbleached mechanical pinewood pulp, and the clay content used as a paper coating or filler) has a beneficial effect on the flotation de-inking process. The facility is not expected to be commissioned until early 1993. ANM expects to source most ` of its wastepaper from Sydney, Melbourne, Adelaide, and Brisbane, in that order, and areas in between.

The Albury proposal has some environmental costs as well as benefits. The establishment of a de-inking plant would double the present level of salt discharge from the pulp and paper mill into the Murray River. The issues involved are summarised later in this Chapter. Implementation is subject to approval on environmental grounds.

The level of salt discharged could also be increased from 700 to 1700 tonnes per year by plans to use a bleaching process to brighten the pulp at the Albury mill. ANM said that the paper currently produced there, which supplies 30 per cent of Australia's newsprint needs, is regarded as unsuitable by some national newspaper publishers. The Public Commission of Inquiry for the Environment and Planning (1990) has considered ANM's proposal for a newsprint brighting facility at Albury, and recommended, *inter alia*, that development consent be granted ‘subject to conditions to mitigate and control potential environmental impacts.’

ANM is also investigating establishment of a recycling facility to process 65 000 tonnes per annum of wastepaper at its. Boyer mill in southern Tasmania. It would enable ANM to recycle old telephone directories and Tasmanian mixed wastepaper into new directory paper for Telecom. An option under consideration by ANM is to use recycled fibre at the Boyer mill in conjunction with pinus radiata thermo-chemical pulp. The eucalypt wood at present used to produce pulp for newsprint would then be used for lightweight coated paper. ANM stated that these changes (the use of recycled newsprint and the associated increased production of papers) are likely to lead to more native trees being cut.

The Publishers' National Environment Bureau, comprising News Ltd, the John Fairfax Group, Australian Consolidated Press, Marinya Media Holdings and Regional Dailies of Australia, intends to provide $4 million over two . years to assist recycling and disposal of old newspapers until ANM's de-inking plant, at Albury comes on stream.

Pratt is also considering the establishment of plants to produce newsprint from 100 per cent recycled newspapers and magazines. Feasibility studies are being undertaken and similar plants in the United States have been examined. The company has discussed with ANM a possible joint operation to collect old newspapers and other wastepaper nationally and to segregate the material for use in one or more de-inking plants which could be jointly owned. A pilot plant may be built in Sydney or Melbourne. Subsequent to ANM's announced decision to establish a de-inking plant at Albury, Pratt advised that ‘discussions with ANM about joint venture possibilities are continuing’.

A recycling plant proposed by Pratt would be located adjacent to its existing paper mill at Smithfield in New South Wales and/or at Coolaroo in Victoria. It would have a potential production of up to 150 000' tonnes of newsprint using wastepaper. Pratt said that the plant would only be justified if supported by governments, and if firm commitments were obtained prom Australian newsprint users to take the newsprint.

A proposal to establish a newsprint recycling and de-inking plant in Melbourne was put forward on behalf of the Resources Recycling Group. The proposal is for an integrated system of regional recycling centres which would involve equity participation from local government, the State Government, and waste contractors; and a de-inking plant and paper mill which would involve equity participation from waste contractors, users of de-inked pulp, and the State Government. The Group has subsequently advertised for expressions of interest in this proposal.

Westpaper Pty Ltd, . initiator of the Austissue project, is studying the feasibility of developing a $30 million plant near Perth to produce de-inked pulp from newsprint and other wastepaper. The pulp would be exported to

Asia. If finance is approved the company expects processing to begin in late 1992.

The project would process over 45 000 tonnes per year of mixed, unsorted wastepaper, comprising about 75 per cent newsprint and 25 per cent magazines, telephone books and other waste. With 12 per cent wastage in processing, the project would produce some 40 000 tonnes per year of secondary market pulp. The company expects to take about two fifths of the wastepaper in Perth now going to landfill.

Westpaper is examining processes used in Europe which recycle both the paper and the LDPE in liquid paperboard containers. The company referred to prospects for recycling LDPE into garbage bags.

Newspaper environmental research

The major newspaper publishers informed the Commission of other initiatives to encourage research and public support for recycling. News Ltd, in co-operation with Fairfax and Australian Consolidated Press set up the Publishers National Environment Bureau (PNEB) in May 1990. The Bureau analyses information and advises the companies concerned on resource management and waste collection issues, including the recycling of old newspapers and magazines. It is also funding research into new methods of recycling newsprint. News Ltd has also established an Environmental Secretariat which among other things has created a newspaper recycling database.

Effects of proposals

The ANM proposals alone would radically change the paper recycling scene in Australia. The widely expressed concern that greater quantities of used newsprint should be recycled would be met. Within two to three years the recovery rate for newsprint in major cities on the eastern seaboard could rise from the current relatively low levels to about 55 per cent. The utilisation rate for newsprint could rise to about 25 per cent and the scene would be set for higher rates in years to come.

If any of the other de-inking and recycling projects proposed for Sydney, Melbourne and Western Australia were also developed, used newsprint supplies could become very tight. However, the effects would vary regionally. Very high recovery rates would be required in south eastern Australia. Further afield, in northern Queensland and Western Australia, exports may remain a competitive outlet. In locations which are less accessible to ports or de-inking facilities, landfill may remain the preferred disposal outlet unless attractive back freight or subsidised internal transport (eg for used telephone directories) were available.

Reprocessing of used newsprint also has implications for resource use and pollution.

Electricity use

The production of newsprint by the mechanical pulping process makes heavy use of electricity. Electricity accounts for around 30 per cent of operating costs for a newsprint mill (New South Wales Department of State Development, 1989).

The requirement for electricity does not seem to be substantially different when wastepaper is used as a feedstock for papermaking, except in the case of newsprint. In announcing its intention to build a recycling plant in Albury, ANM said that the use of wastepaper as the feedstock would reduce electricity requirements from 2400 kWh per tonne of pulp, to 400 kWh per tonne.

Pollution

The Commission's *Interim Report on Paper Recycling* examined the environmental issues associated with the reprocessing of used newsprint.

- Salts

The de-inking process uses caustic soda and produces salts, the disposal of which could be a major environmental issue at an inland location. For example, the proposed Albury plant would double the present level of salt discharged into the Murray River by the paper mill. Although the amounts involved (1000 tonnes) are small in terms of the 1.1 million tonnes of salt which the Murray is estimated to carry each year at the point where it crosses the Victoria - South Australia border, it is a significant problem. The salt is in such low concentration that it cannot be effectively removed before discharge. The Murray-Darling Basin Commission's policy is to ensure that existing Murray River water quality is not allowed to deteriorate further.

ANM has sought to contribute to government schemes to remove salt from the river before it reaches South Australia, thereby avoiding any effect which the additional discharge would otherwise have on water quality at Adelaide. The company is seeking a similar facility to that available to States. Each State which reduces the quantity of salt entering the Murray (for example by a drainage or evaporation scheme) is allowed to release salt from other arrangements into the river so long as the overall State limit in terms of electro conductivity units (a measure of salt content) is not exceeded. To date, the arrangement has not been approved for use by a single point user of water such as ANM.

- Organochlorines and dioxins

Newsprint produced at Boyer is within an absorbable organic halides (AOX) level, a measure of organochlorines present, of 1 kg/t and has no detectable dioxins. The pulp produced at Boyer is not bleached with chlorine, although purchased chlorine bleached pulp is used to a level of 8 per cent by weight of newsprint produced. Newsprint produced at Albury is not bleached with chlorine and no chlorine bleached pulp is added. Newsprint paper and pulp imported into Australia are considered to be roughly equivalent to the domestic product in terms of AOX levels and the presence of dioxins. Hence newsprint used for recycling in Australia should contain less than 1 kg/t of AOX and no detectable dioxins.

- Landfill use

De-inking sludges require landfill space unless disposed of as mulch or in effluent. Solid de-inking waste from the Shoalhaven mill not disposed of as mulch is at present dumped as landfill. At the proposed plant at Albury part of the de-inking waste will be burnt to generate heat, but inert wastes such as sand and metal fragments will be dumped in landfill:

As long as pollution from leachate can be prevented, the cost to society of using landfill for de-inking wastes is small compared with the savings in landfill from recycling of paper. The production of 1000 tonnes of recycled paper results in a net saving in post-consumer waste of 300 tonnes.

Environmental costs and benefits of newsprint recycling

Whether the production of newsprint from recycled waste is less polluting than production from pulpwood can only be assessed on a project by project basis. On balance, however, it would appear that there are environmental benefits from producing recycled newsprint in Australia. Table 4.5 lists some of the environmental effects of producing newsprint from wood pulp and recycled pulp respectively.

From a global perspective, there would be environmental gains. As the recycled newsprint is likely to replace imports, any reduction in output of paper could lessen environmental costs in countries presently exporting newsprint and pulp to Australia.

4.5 Disposable nappies

Disposable nappies are made largely from wood pulp. A number of participants expressed concern over potential environmental and health problems associated with their inclusion in the household garbage stream. These problems include bacteriological contamination, the non-biodegradable nature of the plastic exterior cover, and the possible presence of organochlorines or dioxins in the wood pulp component of the nappies.

Disposable nappies are not recycled in Australia. However, in Seattle in the United States a recycling test project is being undertaken by a major manufacturer, involving about 1000 families. The plastic outer layer of the nappy is separated from the wood pulp inner portion, and the absorbent gel removed from the wood pulp. Test markets are reported to have been arranged for the recovered material (Resources Recycling 1990). A motivation behind such trials is the threat of bans on the use of disposable nappies. It is reported that Nebraska intends to apply such a ban from 1993.

Disposable nappies are compostable in most industrial composting plants, as demonstrated by recent experiments in the U.S. and Germany. The plastic component of the nappy (about 10 per cent) can be removed during initial screening.

Some participants suggested that reusable (i.e. cloth) nappies are preferable on environmental grounds. However, the cleaning and sterilisation of cloth nappies involves the use of significant quantities of water and energy, and

Table 4.5: Environmental costs of producing newsprint from wood pulp and recycled pulp for mills in Australia

	Mechanical pulp mill per 1000 tonnes mechanical pulp	*Recycled pulp mill per 1000 tonnes recycled pulp*
Materials -	Approximately 1050 tonnes pulp wood	Approximately 1300 tonnes used newspapers and/or magazines
Fresh water	5 m^3/t	3 m^3/t
Air pollutants	No significant emissions of air pollutants except combustion products from collection and transport of waste	No significant emissions except combustion products from collection, transport, and burning de-inking residue
Suspended solids	May have negative impact on photosynthesis as they lower light penetration of water environment	Depends on whether waste is dried and disposed of in effluent, as landfill or as mulch
-BOD (biological oxygen demand)	10 mg/1 in waste water at Albury, where treatment reduces BOD by 99%. Where mill is on tidal location environmental cost will depend on the strength of tides and currents	BOD 15 kg/t of pulp. Max. allowed level at Albury 20 mg/1 in waste water
NFR (Non-filtrable residues)	15 mg/1 in waste water at Albury	Max. allowed level 30 mg/1 in waste water at Albury

Process solid wastes	Depends on disposal method. Landfill may impose little cost, sea disposal greater costs, inland water disposal very high costs	Ink sludge and waste fibre burnt to generate steam. Inert material requires landfill disposal
Salts	Salts may be produced. Disposal into sea or tidal waters imposes little or no cost. Disposal into inland waters, eg Murray River, has significant cost from degradation of irrigation and drinking water, or taking actions to remove an equivalent quantity of salts	De-inking produces twice the level of salt. With bleaching the level is three times. Disposal into sea or tidal river imposes little or no cost Disposal into Murray River has same effect as for wood pulp mill
AOX (Absorbable Organic Halides) – a measure of the quantity of organochlorines	Approximately 1 kg/t of fibre produced at Boyer, lower at Albury where no chlorine bleached pulp incorporated	Organochlorines present in original paper are retained in the paper produced and liquid and solid wastes, but levels are small. Use of chlorinated urban water in production could add to these
Dioxin	No detectable dioxins. Dioxins naturally present in water, wood etc, used in production would be retained in paper and effluents	Possible dioxin levels
Net post-consumer waste	1000 tonnes (assuming none is exported)	300 tonnes (assuming none is substituted for exports of wastepaper)
Electricity use [a]	2400 k Wh/t of pulp	400 k Wh/t of pulp
Other energy use [a]	Some energy use in wood cutting and transport. High energy use in collection and transport of waste	High energy use in collection and transport

a) Exhaust gas emissions from energy used in collections and transport, and by power stations, have a detrimental effect on the environment.

Source: Information supplied by participants the release of chlorine and other sterilising chemicals into the sewerage system. According to the Australian Conservation Council, the use of chlorine for this purpose is being replaced by sodium perborate which is environmentally more benign.

5 OTHER MATERIALS

5.1 LUBRICATING OIL

The recycling of waste oil avoids the environmental costs of illegal or improper disposal. Waste oil may contain toxic substances such as lead and chlorinated hydrocarbons. In 1990 some 83 000 tonnes or 35 per cent of used lubricating oil generated was recovered for recycling. The major proportion, 94 per cent, was reused as a fuel or process oil. Only 3 per cent was rerefined to a base lubricating oil. The processes of reuse and rerefining are distinguished later in this section.

Lubricating oils account for less than 5 per cent by volume of total petroleum products consumed in Australia. Lubricating oils include petroleum products not classed as fuels, solvents or bitumen’s. Grades of lubricating oils are used for different purposes, including vehicle motor oils, hydraulic oils, gear oils, heat transmission oils, cutting oils, transformer oils, greases, and pharmaceuticals.

All of the crude oil used in Australia as a feedstock in the production of lubricating oil is imported, mostly from the Middle East.

Oil is recovered for recycling in Australia by a few relatively small companies. Companies undertaking rerefining include Oil and Chemical Industries Pty Ltd in Brisbane and Spree International Pty Ltd (Ma-Refine Oils) in Sydney. Trifoleum Pty Ltd is a subsidiary of the Shell Group of Companies operating under the registered names of Lubrico and Independent Oil Refineries. Trifoleum operates in New South Wales, Victoria, Queensland and South Australia. Worth Oil Pty Ltd in New South Wales collects used oil for use as a fuel/process oil. In the south west of Western Australia, Keith Muir (WA) and Independent Waste Oil (in Bunbury) collect used oil for use as a fuel oil.

The extent of recycling

Sales of lubricating oil in Australia in 1990 amounted to 469 000 tonnes, equivalent to about 515 megalitres (Technisearch 1991). Of this, 49 per cent (230 000 tonnes) consisted of products which do not generate waste oil or are lost or otherwise unavailable for recycling, for example car motor oil which is lost in combustion or coats engine parts, and process oil consumed in rubber, ink and other industries (refer Figure 5.1). This left 239 000 tonnes of potentially recoverable used oil.

About 84 000 tonnes was recovered by industry for reuse or rerefining, leaving 155 000 tonnes not recovered. The recovery rate, in this case the quantity of used oil recovered as a proportion of used oil available for collection, was 35 per cent in 1990 (equivalent to 18 per cent of total new oil sold).

Of the used oil not collected, 49 000 tonnes was used on-site in environmentally acceptable ways such as for fuel or lubrication, while 106 000 tonnes was disposed of in environmentally undesirable (and uncontrolled) ways such as for dust control, vegetation control or dumped. If the used oil which is recovered on-site for use as a fuel or lubricant is included, the ‘reuse rate’ (which includes in-house or on-site use) for Australia in 1990 was 55 per cent.

The largest use for used oil is as fuel or process oil. Rerefining accounted for only 3 per cent (2730 tonnes) of all oil recovered by the collection industry in 1990. The Australian Institute of Petroleum (AIP) anticipates that the rerefining industry will increase its intake of used oil to 20 000 tonnes of lubricating oil per year by 1991. However, Spree alone indicated that it plans to increase its capacity to 18 000 tonnes per year.

Recovery of used lubricating oil

Establishing and maintaining a steady and reliable supply of used oil can be a major problem in the industry. Recovery from commercial/industrial generators is generally considered to be high. The small volume generator, or ‘Do-It-Yourself’ market (DIY) is a potentially valuable source of used oil, but high collection costs and contamination problems have meant that various collection schemes have met with little success.

Commercial/industrial generators

Collection of used oil from commercial generators is market driven and believed to be relatively efficient, with very little used oil being dumped in landfill or illegally. Used oil is available in bulk from commercial generators and is hence collected at a relatively low cost (refer Figure 5.2).

Used oil is collected by agents and small companies specialising in collection services. In the past this oil has been given 'free' to the collectors. However more generators are now charging collectors for used oil. The collection points are generally service stations, retail outlets and government and private vehicle fleets. The reprocessors accept used oil for rerefining, or blending into fuel oil. In Sydney, they are charged (by collectors) 5 to 6 cents per litre. In Perth, Keith Muir pays 5 cents per litre for used oil delivered to its depot.

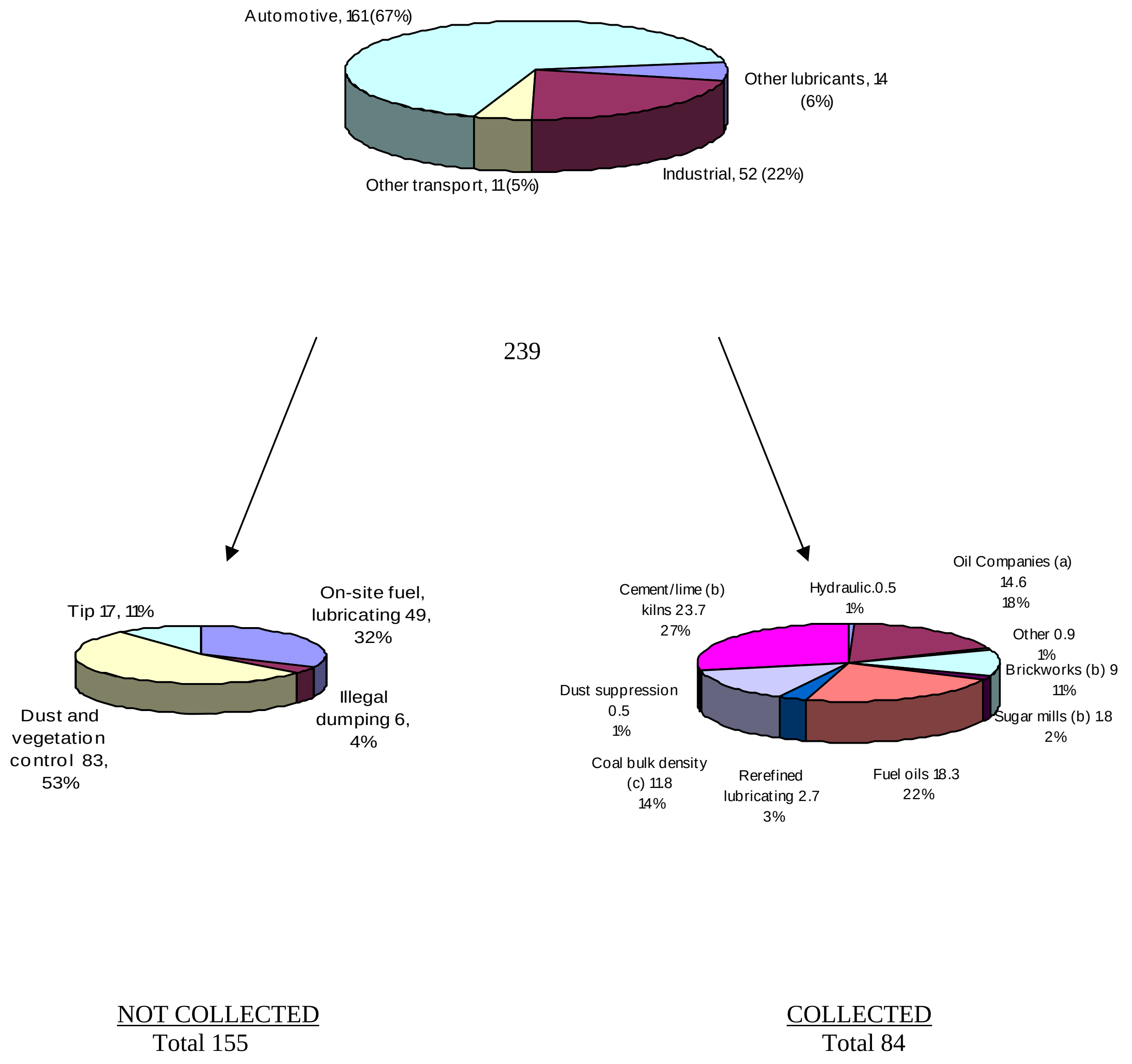
Long haul transportation costs can account for 0.6 cents per litre per 100 kilometres. Oil and Chemical in Brisbane said that it is willing to collect used oil within a 300 kilometre radius of that city. Keith Muir in Western Australia, collects used oil from as far as Port Headland using road trains, with a minimum load requirement of 60 000 litres. Transportation costs can approach the price received for the reprocessed oil (11 cents per litre as fuel oil), but the company is willing to accept some losses in long distance collections to maintain reliable supplies to its customers in Perth.

How far and at what price reprocessors are willing to source used oil depends primarily on the supply situation at the time. To supplement supplies, rerefining companies in Sydney have obtained used oil from Queensland. Companies in Melbourne have drawn supplies from Adelaide.

The small volume generator (DIY)

The recovery rate from the DIY market is low at 17 per cent of used oil potentially available for collection, compared with the 35 per cent overall recovery rate for used oil (refer Table 5.1).

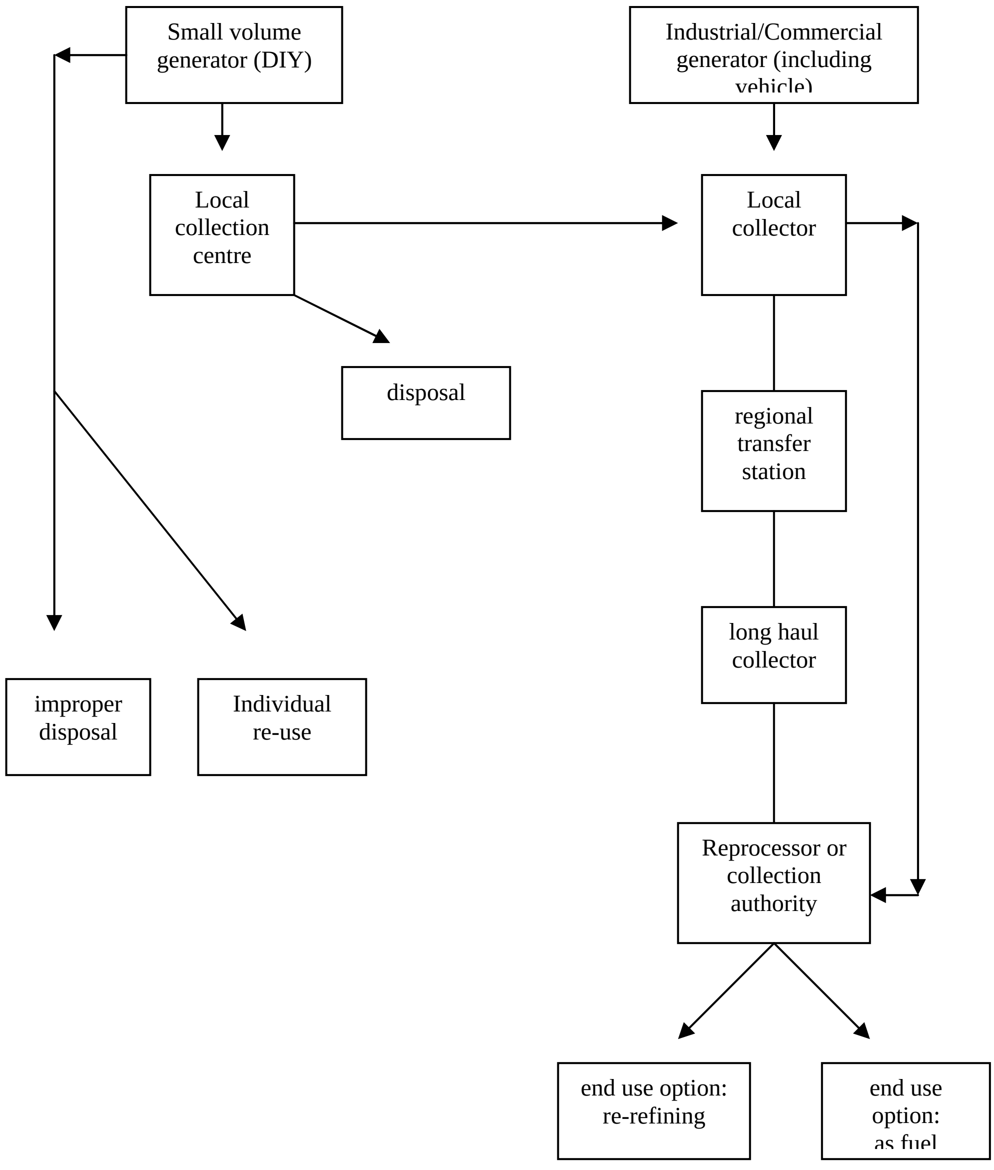
Figure 5.1: Disposal and recycling of used oil, Australia 1989-90 ('000 tonnes)



Source: Technisearch Survey, 1991

a) Blended with virgin oil for use as a fuel oil. B) Used as a fuel or fuel supplement c) Used as a process oil

Figure 5.2: The recovery of used oil



Source: Industry information

There are a number of reasons for the low recovery rates in the DIY market. The Victorian Government indicated that service stations in that State refuse to accept used oil from the DIY market, and the number of drop-off points available to the DIY market is limited. Drop-off points are not always provided at tips and consumers may be unaware of services provided.

Retailers are not required to provide facilities to take back used oil, and many do not. They would incur substantial costs in providing take-back facilities: in the provision of large storage containers; shop space; supervision; clean up services; and disposal of containers in which the used oil is taken to the collection point. Service stations are not paid for waste oil which is collected by agents and sometimes must pay for its proper disposal; therefore they have little incentive to provide take-back services.

K-mart has publicised a take-back scheme aimed at the DIY market. The company has arranged with major oil rerefiners for collection of used oil and the supply of rerefined product back to K-mart (K-mart 1990).

Table 5.1: Quantities recovered from the Do-It-Yourself (DIY) market and the total lubricating oil market, Australia 1990

	DIY	*DIY*	*Total market*	*Total market*
	'000 tonnes	*per cent*	*'000 tonnes*	*per cent*
Products which do no generate waste oil	0	0	71	15
Oil consumed, lost or otherwise unavailable	12	33	159	34
Available for collection:				
- recovered by industry for recycling[a]				
- not recovered by industry				
Total new oil sales	36	100	469	100

a) Recovery rate in terms of used oil available for collection is 17 per cent for the DIY and 35 per cent for the total market

Source: adapted from Roy Morgan (cited by AIP) and Technisearch (1991)

The AIP considered that service stations and retail outlets are not suitable points for collection of used oil, due to health, safety and environmental considerations.

Recovery and recycling overseas

According to Technisearch (1991) the recovery rate in Australia was 35 per cent of recoverable used oil in 1990, compared with 40 per cent in Canada (1986) and 56 per cent in the United States (1988). Higher population densities and therefore lower transport and collection costs, lower labour costs, and a higher level of competition between oil companies and rerefiners all contribute to this outcome. Trifoleum stated that an increase in the recovery rate to 57 per cent, representing some additional 20 000 tonnes of used oil, would involve significantly higher collection costs, making collections unprofitable.

Factors affecting the level of recycling

Major factors affecting oil recycling include the price of virgin oil and the collection, transport and processing costs of used oil. When used oil is highly contaminated, for example bilge oil from ships, reprocessing costs may prevent its use. Reuse of oil as a fuel is mainly limited by restricted supply and collection costs of used oil. Rerefining is limited mainly by demand for the rerefined oil which is affected by the substitutability for virgin oil and perceived quality differences. The price offered for used oil as a fuel oil additive is also important as rerefiners may compete with fuel oil blenders when supplies of used oil are limited.

The demand for rerefined oil

The substitutability of rerefined oil for virgin oil is influenced by quality perceptions held by consumers. Currently rerefined oil is viewed as a product which may not meet standards applied to the lubricating oil industry. The dearth of information regarding the rerefining processes may affect consumer confidence in the product and limit the growth of this market.

The quality of rerefined oil may vary as a result of improper filtration. Silicon accumulates in oil from ingested dirt and its presence in filtered oil is indicative of faulty filtration. Participants said that the quality of rerefined oil depends on the rerefining process used. It was claimed that filtration does not extract soluble organic additives and water impurities.

Participants suggested that there is a role for government to improve consumer confidence in rerefined oil by using it in government vehicle fleets. The Queensland Government has sought to promote the use of rerefined oil in government vehicles. However, it faces the problem that suppliers of passenger vehicles, trucks and heavy earthmoving equipment threaten to void their warranties if rerefined oil is used. The Department of the Premier and Economics Trade and Development intends to use rerefined oil for vehicles and machinery only when their warranties have expired.

Quality standards

The Standards Association of Australia does not have performance standards for rerefined oil but is currently examining the question. The Canadian Environment Protection Service (EPS) has conducted laboratory and field tests to determine the quality differences of rerefined oil and virgin oil with a view to using rerefined oil in government vehicle fleets (Armstrong 1983). These tests led to a recycling program developed and carried out by the EPS in Canada.

The tests indicated that rerefined oils met the physical/chemical property requirements of the United States Department of Defence specifications for lubricating oils used in internal combustion engines. The EPS (Armstrong 1983 p. ix) concluded that the tests:

> ...provided a successful demonstration of the fact that, for the type of operation conditions selected, re-refined lubricating oil can be substituted for virgin lubricating oil of 'comparable' quality and cost, and used over the normal life span of a vehicle without experiencing reduced engine performance or reliability and without incurring significant additional operating costs.

The report recommended that a large number of government fleet vehicles use rerefined oil while monitoring engine oil performance.

The AIP recommended that all lubricants which contain rerefined oil should show the proportion of rerefined oil and quote specifications on the packaging.

Prices

Participants claimed that rerefined lubricating oil may be priced as much as 50 per cent lower than comparable virgin oil. Virgin oil is generally priced in the range $2.75 to $4.00 per litre, but can be cheaper depending on the outlet. The lower prices obtained for rerefined oil stem in part from the perception that it is of lower quality. Oil rerefiners claimed that the low prices mean that they have difficulty competing with the major oil companies for supplies of used oil.

With growing community concern about environmental issues, rerefiners hope to obtain a premium for rerefined oil marketed as a 'green' product.

Government intervention

Rerefining as lubricating oil: Rerefiners are classified as 'recyclers' by the Australian Taxation Office (ATO), and are afforded sales tax exemption on the finished products. However this advantage is offset by the loss of sales tax exemption on the inputs and equipment used in rerefining, which would otherwise be available if rerefiners were classified as 'manufacturers'. The sales tax regulations discourage investment in new plant and equipment which is required to upgrade facilities or take advantage of new technologies. Which classification is most advantageous to the rerefiner is not clear.

Reuse as fuel: Fuel oil refined from crude oil is subject to excise duty. However, where used oil is reused as fuel oil by independent operators outside bonded areas[1], the Australian Customs Service (ACS, personal communication G.N. Steele, 30 August 1990) advised the Commission that:

> It is Government policy that recycling by these independent operators is not to be covered by the requirements of the excise legislation and recycled products should not be subject to excise duty. Legislative amendment is proposed to clarify this intent.

The ACS advised that excise duty is applicable in a situation where waste oil is blended with new oil at a refinery or distribution terminal, these being bonded premises.

[1] A bonded area is one which is approved by the ACS for the manufacture, storage, handling or other treatment of goods prior to the payment of excise duty and the release of the goods into free circulation.

Excise duty would be liable on the total extended quantity as current legislation provides no exemption in this situation.

Trifoleum said that an exemption on the waste oil proportion blended at the refinery or distribution terminal would help to minimize handling costs by blending fuel oils at these points. Present arrangements discourage blending of waste oil into fuel oil because excise duty applies in full to both the waste oil and the new oil with which it is blended, when this is undertaken at bonded premises such as a refinery or distribution terminal.

Since the Commission's Draft Report ACS has agreed to waive excise duty on the used oil portion of blended fuel oil at refineries and terminals. To enable ACS to provide the tax exemption, AIP is working to develop a satisfactory administrative system to account for the waste oil.

Supplies of used oil

The small rerefining companies compete with the major oil companies for available supplies of used oil. Some participants claimed that the major oil companies have in the past bought used oil to convert to fuel oil in order to reduce the competition from rerefined oil in the lubricating oil market. However access to used lubricating oil seems to be primarily determined by the profitability of the two recycling industries.

Fuel oil, used in home heating appliances and small steam generators, is gradually being supplanted by gas and fuels which are able to compete on price or ease and cleanliness of use. If this continues, a lower proportion of waste oil supplies will be converted into fuel oil, hence increasing the availability of waste oil to the rerefining industry.

Recycling processes

The oils which are recycled are typically motor, hydraulic, transformer, compressor and cutting oils. Lubricating oil is a viscous medium containing surfactants, commonly referred to as ‘additives’ which function to reduce friction and wear of engine parts. With use, the oil in an engine collects impurities including metal oxides, lead from petrol, carbon deposits and other compounds of combustion. The impurities in an engine react with the surfactants to make them ineffective, and accumulation of grit further reduces the ability of the oil to protect mechanical parts from undue wear.

Reuse

The *reuse* of used oil implies minimum treatment, as when it is blended into fuel oil.

Fuel oil

Used oil can be used as a fuel oil in boilers, furnaces or ships to recover the energy value of the material. When used in this way only minor purification is required. Used oil is blended with virgin oil in specific quantities ranging from 2 to 7 per cent of used oil to reduce the concentration of contaminants. This reduces the lead content of emissions to levels which meet the pollution control requirements of the States. When used by small firms, emission control measures may not always be applied, resulting in a high level of pollution. The problem is one of policing standards already in place in each State.

Cement kilns

Used oil can be burnt in kilns used to produce cement. The process retains harmful substances, such as lead, in the clinker, and thus avoids the emission problems associated with burning used oil in small to medium sized boilers. A field trial indicated that 99.97 per cent of the lead contained in used oil feedstock was retained in the cement produced (CCME 1989).

Densifying agent for coking coal

BHP at Port Kembla has been using a mixture of virgin fuel oil and diesel oil to improve the burning qualities of the coal used in coke-making. The oil improves the combustion qualities by increasing its bulk density. After several years of trials BHP has found that the high grade oils can be replaced by used lubricating oil. The Port Kembla plant is using 900 tonnes of waste oil to densify 290 000 tonnes of coal per year.

The plant makes use of waste oil collected in Sydney by two oil recycling companies, Worth Oil and Independent Oil Refineries.

Analysis by BHP has found that the lead is not released into the atmosphere during burning but is retained in the coke.

Conversion of coal washery reject into an energy source

Coal washery reject, or coal tailings, is a waste product of coal processing, consisting of coal dust, clay and silica. More than 35 million tonnes of washery reject were produced in Australia in 1986-87, mainly in NSW and Queensland (Gellender 1988). Washery reject typically contains about 30 per cent combustible coal. Having a low energy content, washery reject requires a special fluidized bed combustor. The high cost of equipment and maintenance more than offsets the cost saving of using washery reject and attempts to use it as an energy source have been unprofitable.

Century Herald indicated that technology is available to combine used oil with coal washery reject to produce a coal-based energy product which could be sold on world markets. This product could be used as a fuel for mini power stations or as an auxiliary fuel in larger power stations. If commercially feasible, it could reduce two sources of pollution, namely waste oil and washery reject.

Rerefining

Lubricating oil

Refining is defined as freeing from impurities or defects, purifying or clarifying. Rerefining for use as lubricating oil consists of removal of contaminants to obtain the base oil to which new surfactants can be added.

Acid/clay filtration is the oldest rerefining process. This involves the reaction of used oil with sulphuric acid which dissolves and settles contaminants. An acid sludge is settled from the oil which is drawn off for clay filtration.

The sludge is a hazardous waste and is disposed in a 'secure landfill' to contain any leachate.

Rerefining can also involve distillation under high vacuum. This process has several advantages over acid/clay filtration, including: lower processing costs (it does not require sulphuric acid which is expensive), and avoidance of acid sludge disposal (thereby eliminating or reducing disposal costs).

The base oil obtained from rerefining has a viscosity which is derived from the viscosities of the waste oils used. To achieve the required viscosity or grades, the base oil is then blended with virgin oils or 'additive packages' (or 'viscosity improvers').

Throughput volumes

Oil rerefiners need a substantial investment in plant and equipment to achieve high quality standards in competition with virgin lubricating oil. The Queensland Government submitted that a typical thin film evaporating plant needs to process about 2700 tonnes of oil per month to be viable. Due to the limited quantity of used oil available for rerefining, the Queensland Government considered that rerefining is viable only in Sydney and Melbourne. However, Oil and Chemical submitted that it operated an acid/clay filtration process profitably in Brisbane, with a throughput of 90 tonnes per month and is currently setting up a thin film evaporation plant to process about 450 tonnes per month.

In Western Australia an acid/clay filtration plant has ceased operations. Keith Muir submitted that an oil rerefining plant in Perth is not viable due to the small quantities of used oil available and high collection/transportion costs. The only economic use for used oil in that State was said to be fuel oil, as only simple purification processes, such as filtration and drying, are needed.

A Melbourne company, Oilclean, has developed a mobile refining service, based on the acid/clay filtration process to recycle industrial oils on site.

Hydraulic and transformer oil

Hydraulic and electrical transformer oils are in a special category of petroleum oil. Levels of contamination, usually water and/or solids, are normally low and the oils therefore require only minor processing. The large quantities generated by commercial/industrial users are keenly sought by oil collectors. Generators have a strong price incentive to segregate these oils from contaminated and lower value lubricating oils.

With purification, hydraulic and transformer oils are reused for their original purposes and rarely as fuel oil. Purification is often undertaken on a contract basis and the oil returned to the generator .

Energy use in reprocessing

The energy used for long haul transport of used oil has been estimated by the Commission from data for fuel consumption received from industry. The energy[2] used in long haul transport of used oil is about 0.46 megajoule per litre per 100 kilometres or 0.010 megajoule per litre per megajoule of used oil transported. This is less than 1 per cent of the energy content of the material transported.

The energy used for rerefining of used oil has been estimated from data for electricity consumption in the rerefining process for the various processes obtained from industry. The acid/clay filtration process consumes about 0.09 megajoules[3] per litre of oil reprocessed, however this does not include energy used in production of the major input, sulphuric acid. The distillation process consumes about 0.95 megajoules per litre of oil processed.

In terms of conserving energy, reuse/rerefining of used oil has major benefits as the energy content of each litre of oil saved is about 45 megajoules. However, energy is only one of the resources needed to reprocess used oil. Conclusions reached as to the net social benefits of reprocessing used oil,

2 This value has been adjusted for the fuel production efficiency of petroleum oil to take account of the energy input or that which is otherwise lost in production. For petroleum products this is 83 per cent (Boustead and Hancock 1981).

3 This value has been adjusted for the electricity production efficiency rate, assumed to be 20 per cent in Victoria (Evans and Egerton 1988).

when based on energy criteria alone, are likely to be misleading. Volume I examines some of the environmental and economic implications of energy use.

Costs and benefits of reprocessing used oil

Benefits of reprocessing and reuse

The major benefit from reprocessing of used lubricating oil is the avoided environmental cost of improper disposal, particularly from the DIY market or uncontrolled burning as fuel by commercial/industrial burners (refer Table 5.2). The major benefit to the reprocessor is the value of the rerefined oil or of the used oil as a component of fuel oil.

Costs of reprocessing and reuse

The costs of reprocessing and reuse of used lubricating oil include collection and transport. Collection costs range from 5 to 6 cents per litre in Sydney and Melbourne, and interstate transport can raise costs by 0.6 cents per 100 km. Costs of burning used oil as fuel include blending equipment, storage tanks and emission control equipment. For rerefined oil they include the cost of filtration or distillation or both these processes. Acid/clay filtration is said to have high operating costs as it requires sulphuric acid and disposal of toxic waste residues (refer Table 5.2).

Costs of improper disposal

About 106 000 tonnes of used oil not recovered by the collection industry in 1990 were dumped or used in an uncontrolled manner (refer Figure 5.1). Used oil disposed in stormwater drains and sewers can foul drains and sewers, disrupt sewage treatment processes, and damage aquatic ecosystems.

Dumping used oil on land may pollute surface and/or ground water by runoff or seepage. Technisearch (1991) reported that some bores in Perth (where a third of the water supply is from bores) have been shut down on occasions due to hydrocarbon contamination. Perth's sewerage system is also reported to be affected on occasions by illegal dumping of used lubricating oil. Dumping is also a problem in stormwater drains, used oil being flushed into watercourses after periods of rain. In Melbourne, this problem is said to have lessened significantly over the past 10 years, due to decreased dumping of used lubricating oil.

The disposal of used oil by burning can cause hazardous and illegal emissions of smoke and of toxic materials, including heavy metals and known or suspected carcinogens, if emission control measures are not applied.

Environmental costs of reuse

Where used oil is burnt as fuel oil without being rerefined, there is the danger of emission of lead and other heavy metals. State Acts regulate the emission of lead so that used oil is generally legally blended in a ratio of not more than 3 per cent. An emission problem may also occur with authorised burning if inadequate pollution control measures are used or pollution requirements are not enforced. With the gradual move to unleaded petrol, the lead problem is likely to decline.

The rerefining of oil results in toxic residues, which cannot be discharged into the environment. Residues from the distillation process can be used in road-making although acidic sludge cannot be used. Residue from the acid/clay filtration process is discharged at ‘secure landfills’ for the disposal of hazardous waste. Environmental problems encountered in Kingston, Queensland, and also in Western Australia have been attributed to the improper disposal of residues from acid/clay filtration plants.

The NSW State Pollution Control Commission is of the view that the environmental benefits provided by the recovery, reprocessing and reuse as lubricating oil of used oil far outweigh the environmental problems caused by this activity.

Table 5.5: Costs and benefits of reprocessing chemicals

Cost to reprocessor	*Comment*	*Benefits to reprocessor*	*Comment*
Collection costs	For solvents 20 cents per litre	Market price of reprocessed product	Approximately $1.80 to 50 cents for TCE
Reprocessing costs	No collection cost for in-house solvent recycling	Reduced input costs for in-house recycling	
		Savings in waste charges	$50 per drum. Up to $5000 per tonne in avoided waste disposal charges

Additional costs to society	*Comment*	*Additional benefits to society*	*Comment*
Maintains a market for toxic substances and is a disincentive to replace toxic materials from production processes Health risk to employees		Removal of toxic chemicals from waste stream	
		Reduced environmental risk associated with improper disposal or storage	

Source: Resolv Liquids, Safety Kleen (Worton Services Pty Ltd)

Suggested government initiatives

Sales tax exemption is not granted on equipment and plant used in the rerefining of used oil under the ‘Aids to Manufacture’ provision of sales tax legislation, since recycling is not regarded as a manufacturing industry. The recycling industry is of the opinion that it is disadvantaged by current tax legislation and seeks a review. However, if the recycling industry were to be classified as manufacturing, it may lose current tax advantages in sales tax.

Participants put forward other proposals for government support of the industry. They included:

- quality testing, setting of standards and labelling specifically for rerefined oil;
- the use of rerefined oil for government vehicle fleets;
- promotion of the need to separate waste oil from other wastes; and
- involvement of local governments in the collection of used oil from the ‘Do It Yourself’ market via kerbside and/or transfer station collections.

Some of these issues are examined in Chapter 7 of Volume I.

5.2 CHEMICALS

Production of chemicals is mainly in and around Sydney and Melbourne which account for 41 per cent and 38 per cent of turnover. Only a limited number of these chemicals are recycled, and for many recycling is not technically feasible. Some intractable and toxic wastes are produced, Sydney being the source of about 95 per cent of intractable chlorinated hydrocarbon waste (MWDA 1989). As disposal charges and environmental concerns have been increasing, industry is taking a greater interest in the recycling of liquid wastes.

The extent of recycling

Recycling of chemicals is limited mainly to organic solvents which have a high value and relative ease of recovery and purification. The extent of recycling depends on the industry in question. In some, for example dry cleaning and electronics, virtually all solvents used are recycled. The recovery rate is between 60 to 85 per cent, the rest being lost in evaporation. Recycling rates are shown for individual product sections below where possible.

Several new developments in chemical recycling are cited in ‘Waste Management Technologies’ (DITAC, 1990). Sirius Biotechnology Pty Ltd, converts waste sugar in the waste stream of Bunge Chemicals (Melbourne), using a biological process to produce citric acid. Fujitsu Pty Ltd of Japan plans to process metal oxide wastes from BHP's metal plant in Westernport, Victoria to manufacture magnets and other electronic components.

Factors influencing the level of recycling

The dispersal properties of many chemicals often precludes recovery and recycling. Where the chemical can be recycled, the extent to which this is done depends on the price for the recycled material relative to the costs of collection and processing.

Recycling is carried out by some companies to reduce disposal and input costs. In-house recycling can reduce costs further if the company has sufficient volumes of waste. The size of the company can influence its capacity to acquire technical information and expertise and make the necessary investment in recycling.

Industry participants claimed that the high costs of disposal of solvent distillation residues at municipal tips is a disincentive to recycling operations. Due to the nature of the residue the New South Wales Waste Management Authority (WMA) applies a disposal charge of $200 per tonne or $50 per drum and requires a detailed analysis of the waste contained in each drum before it is landfilled. Resolve indicated that the analysis can cost up to $150 for each test. The Commission understands that a screening test developed by Centec, a company in the United States, indicates the presence of chlorinated hydrocarbon at a cost of US$5 per test (Chemical Week 1983).

Sludges containing chlorinated hydrocarbons cannot be disposed in landfills and must be polymerised before landfilling. Other options are high temperature incineration overseas at a cost of $7000 per tonne, or long-term storage.

In Western Australia, industrial liquid waste disposal charges were increased from $17.30 per kilolitre in 1988 to $60.90 in October 1990. The higher charges reflect increased costs following the installation of a more sophisticated treatment facility. The facility was not built to treat hazardous wastes such as volatile solvents. Industry is required to undertake its own pre-treatment of hazardous components of the waste and solvents are not accepted into the treatment plant. As a result the Health Department of Western Australia has reported a large increase in the quantities of industrial wastes recycled. Since December 1989, the Health Department has required all solvent wastes, produced in the metropolitan area of Perth, to be recycled. Recovery and reprocessing of solvents increased from 1000 litres per month prior to December 1989 to over 50 000 litres per month for most of 1990.

Waste stream sources

There are three major sources of waste chemicals. The first is excess stock due to a change in the manufacturing process, or where chemicals have suffered some deterioration. The second is chemicals which have failed to meet quality specifications in the production process. The third and major source is chemical waste from production processes. Table 5.3 illustrates the source of chemical wastes in the industrial waste stream in Victoria. A similar total quantity is thought to be produced in New South Wales.

Chemical waste classes

The following comments focus on chemical waste groups which are commonly recycled or are of concern to the community with regard to their environmental effects.

Organic chemicals

Recycling of organic chemicals is generally restricted to solvents and lubricating oils. Lubricating oils were discussed above. Organic chemicals include the chlorinated hydrocarbons or organochlorins, which are toxic and very stable. If not recycled, chlorinated hydrocarbons pose a problem as intractable waste.

Table 5.3: Chemicals: Waste stream sources in Victoria, 1986.

Waste description	*Estimates of waste generated (excluding Latrobe Valley)*			
	Liquid	*Sludge*	*Solid*	*Total*
Electroplating	839	580	3	1 422
Acids	11 832	497	59	12 388
Alkali	20 154	6 976	5 529	32 659
Inorganic waste	3 925	3 020	429	7 374
Paints and resins	6 811	8 009	1 361	16 181
Organic solvents	600	-	-	600
Textile waste	1 042	3 098	-	4140
Contaminated containers	-	-	138	138
Organic chemicals	523	97	-	620
Pesticides	70	-	-	70
Total	45 796	22 277	7 519	75 592

Source: EPA survey cited in MMBW 1986

Solvents

Solvents in industrial use are generally organic chemicals, characterised by a high flash point (evaporation) and toxicity if chlorinated or fluorinated. A number of companies specialise in recycling organic solvents, usually on a batch basis. The source, type and quantities of solvent vary greatly. Re-solve indicated that solvent wastes are generated by industries producing paint, ink, adhesives, printing products, plastics and furniture, together with panel shops, aerosol packers, instrument manufacturers, drum reconditioners, electronics and machinery shops. Solvents commonly recycled include diesel fuel, white spirits, kerosene, turpentine (xylene and toluene) and ketone solvents (acetone, diacetone).

The process of purification involves distillation. Although a large number of solvents are in use, the recycler is able to quickly determine the properties which are important in selecting the appropriate distillation procedure. The type of distillation equipment used will determine solvent losses due to fugitive emissions and distillation residues. Losses are estimated to be between 15 and 40 per cent.

About 9000 tonnes of chlorinated hydrocarbons are imported into Australia each year by the major chemical companies. Of this, only about 3000 tonnes are recycled, the remainder being lost in use (cleaning formulations, aerosols), evaporation and illegal disposal. About 6000 tonnes of 1,1,1-trichloro-ethane (TCE) are used each year in Australia in a number of products and processes including silicon sealant manufacture. About 3000 tonnes of perchloro-ethylene are used in the dry cleaning industry and are recycled in-house on a continuing basis. About 3000 tonnes of TCE are used each year in the electronics industry for cleaning printed circuit boards.

The use of TCE in the manufacture of silicon sealants leads to a silicon-contaminated solvent waste. Recyclers use the distillation method to remove silicon and other impurities. The distillation residues contain silicon and less than 1 per cent solvent in a polymerised inert state. These residues are then disposed in landfill.

Recyclers of TCE estimated that collection, transport and processing costs total between 20 and 50 cents per litre. They receive 70 cents to $1 per litre for the recycled product. This compares with $1.80 per litre for the virgin product. The extent to which the recycled product is substitutable for the virgin product depends on its required characteristics in use. Electronics manufacturers need a very pure product, while paint manufacturers find the recycled solvent suitable for washing vats.

Ethylene glycol

Ethylene glycol, the most common coolant used in vehicle radiators was identified as a material which could be recycled. However, licences and permits are required from environment protection authorities and Councils to collect and process chemical wastes. Some companies consider this to be a disincentive owing to the difficulty in acquiring suitable premises within metropolitan areas which would satisfy the requirements.

Polychlorinated biphenyls (PCBs)

PCBs are used in coolants and lubricants of electrical machines, generators and transformers. They are highly toxic and persistent. Because of their environmental consequences their use has been discontinued in Australia and many other countries, but they remain a problem in marine environments. PCBs are not recycled because they are banned substances. They are presently either stored or destroyed by high temperature incineration. The plasma arc furnace being developed by CSIRO could eventually be used to recycle PCBs into commercially useful chemicals.

Chlorofluorocarbons (CFCs) and bromofluorocarbons (BFCs)

CFCs are organic compounds containing chlorine and fluorine, while BFCs contain bromine and fluorine. Their recovery and reuse is desirable because of their depleting effect on stratospheric ozone and their contribution to 'greenhouse' gases.

CFCs came into use in the 1930s. Their non-toxic, non-flammable and non-corrosive qualities have since encouraged their use in many industries, particularly as propellants in aerosol sprays (which have now been mostly phased out), refrigeration and as CFC blown foam. Other uses have been as liquid solvents for cleaning printed circuit boards in computer manufacture. BFCs are used as fire suppressants in fire fighting equipment.

In March 1989 the Commonwealth Government passed the Ozone Protection Act, which implements the requirements of the Montreal Protocol, an international agreement to halve the use of CFCs by the end of the century. Since December 1989, Commonwealth bans have been placed upon the use of CFC in aerosol cans, polystyrene insulation and packaging and dry cleaning equipment if it has been designed to use CFCs. Mandatory recycling and legislation designed to control and eventually phase-out the use of CFCs has been introduced by Western Australia and is being considered by other States. In South Australia it is illegal to release more than 3 kilograms of CFC into the atmosphere.

Control measures have centred around substitution of CFCs with more benign materials and where possible recovery and reuse as a second best option.

The eventual banning of CFCs will make recycling less relevant as a control measure.

Usage of CFCs and BFCs in Australia has been reduced according to the Association of Fluorocarbon Consumers and Manufacturers (AFCAM), from some 15 000 tonnes in 1986 to 8000 tonnes in 1990. The air-conditioning and refrigeration industry account for 30 per cent of usage. Because CFCs and BFCs are dispersed in use as either a propellent or as fire suppressants, the potential for recycling is limited to refrigerator/air-conditioner industries, computer industries and CFC blown foam. Emissions of CFCs from refrigerators occur mainly during servicing or decommissioning. To forestall mandatory recycling schemes, industry has established codes of practice which are planned to reduce consumption and fugitive emissions of CFCs. However, the Australian Environment Council (AEC 1989) notes that an expected expansion of the refrigerator/air-conditioner market will offset reductions in CFC emissions made as a result of the self-imposed codes. Any overall decrease in CFC emissions may not be significant.

The extent of recycling

There is little recovery of CFCs when refrigerators are serviced or decommissioned. AFCAM estimates that only 15 per cent of refrigeration specialists and workshops have facilities which enable them to recover CFCs. CFCs in foam are not recovered because of the high costs involved.

The City of Marion in South Australia provides a kerbside pickup service for electrical appliances. About 10 refrigerators per month are recovered for disposal, but due to leakage of the gas during service, only small quantities of CFCs can be recovered.

Factors affecting the level of recycling

AFCAM said that CFC recovery costs during servicing of refrigerators are about $50 per unit. This greatly exceeds the value of CFCs recovered, estimated at about $2.50. The costs of CFC recovery (mainly labour) are passed on to consumers during servicing.

The Melbourne City Council has conducted trials for the recovery of CFCs from refrigerators collected at tips. AFCAM reported that the Council was able to reduce recovery costs to about $13 per unit. The City of Marion decommissions refrigerators in groups of 10 units at a cost of $35. The cost is less than receipts from the sale of motors ($10 per motor) and metal scrap from the refrigerators ($25 per tonne).

Insulating foam in refrigerators contains about 500 grams of CFC with a recovery value of $5. If the foam is not recovered the CFC is released slowly into the atmosphere as it disintegrates. Technology exists to recover CFCs from foam, however the recovery cost is estimated to be about US$29 for each refrigerator (Economist 1990b).

CFC substitutes

Development of CFC substitutes which are not ozone-depleting may eventually reduce the need to recover coolant gases from refrigerators. A number of CFC-substitutes collectively known as hydrofluoroalkanes (HFAs) are being developed abroad by DuPont and ACI. However, they are estimated to be four times the current price of CFCs (Economist, 1990b). AFCAM estimates that switching to CFC substitutes will cost some $200 million over the next 10 years in Australia.

The AEC (1989) reported that Sweden has introduced an environmental levy on new CFCs. As all refrigerator compressors used in Australia are imported, legislation specifying the use of CFC substitutes is aimed at selective import requirements implemented by the Commonwealth Government.

Disincentives to recycle CFCs

- Recovery costs which may exceed the value of CFC;
- a shrinking market for CFCs as they are phased out; and
- the quality of the recovered CFC may in some cases affect the manufacturer's warranty. The AEC (1989) said that some vehicle manufacturers do not continue warranty cover of air-conditioners if the quality of the recycled CFC is suspect.

Incentives to recycle CFCs

Prices of CFC substitutes are generally higher than those of CFCs;

- the use of substitutes often requires equipment changes; and
- less efficient coolant gases used in refrigerators may result in increased consumption of electricity.
- Inorganic chemicals, salts and heavy metal solutions

Inorganic wastes include salt solutions, metals and non-metals.

Textile and tannery wastes

These consist of organic or inorganic dyes, solvents, salt and water. The Victorian Environment Protection Authority (EPA) requires the removal of toxic substances before the wastes enter the sewerage system. Recycling of these substances is not considered viable in this industry. Solvents are removed by burning or by activated charcoal. There is a tendency in the industry to use less toxic dyes which are biodegradable. Chromium from tannery wastes can be recycled, but the costs are generally considered too high at the concentrations of metal and volumes of waste available.

Electroplating rinsewater wastes

Electroplating solutions contain metals such as chromium, copper, zinc, gold, silver and nickel. With use, these solutions become contaminated and must be replaced. They are generally discharged into the waste stream. Ion-exchange systems can be used for recovery of these metals. However, the EPA indicated that the process is generally considered to be too expensive to recover metals except gold and silver. Some metals are removed from spent solutions by precipitation before discharge into the sewerage system. These metals are generally not recovered from the precipitate and therefore go to landfill. CSIRO has developed ‘magnetic particle technology’, a process which is said to substantially reduce the cost of metal recovery, water usage and sewage disposal costs to industry (Bolto 1990).

The Commission understands that in 1980 a company in the United States, Reliable Plating Co. was able to reduce its purchase of chromium by 90 per cent and water use by about 98 per cent (Durso-Hughes 1982), following the installation of an ion-transfer system for chromium recovery in the company's nickel/chromium-plating operation.

Sulphur

Sulphur emissions are of major concern in heavily industrialised countries because of its contribution to acid rain. Sulphur is a by-product of oil refining and smelting of copper, lead and zinc. Incitec in Brisbane produces sulphuric acid from recovered sulphur, for use in the production of superphosphate. Sulphuric acid is also produced by Pasminco Metals BHAS Pty Ltd as a by-product of lead smelting in Port Pirie, South Australia.

Acids and alkalis

Recycling options for acid and alkali waste depend on the concentration and level of contamination when it is received by the reprocessor. Uncontaminated solutions may be reused directly. If the level of contamination is high it may be feasible to recover the metal or organic contaminant and the solution. Acid sludges generally have a low potential for recycling and are usually disposed in landfill. Acid solutions which cannot be recycled due to the level of contamination are neutralized by mixing with other wastes and disposed in landfill.

Recovery of chemical waste

Agricultural and household collections: The Victorian EPA and the Melbourne Metropolitan Board of Works (MMBW) in conjunction with the Department of Agriculture and Rural Affairs (DARA) operate a ‘rural chemical collection scheme’ and a ‘metropolitan chemical collection scheme’. The aim is to provide a convenient disposal point for toxic chemicals used by households and farms. A ‘once-off’ pick-up service is provided where contractors accept chemical wastes and sort it on site.

The materials and quantities recovered are summarised in Table 5.2. In New South Wales the WMA operates a drop-off system at the Lidcombe (Sydney) disposal facility.

Industrial waste exchange: It is common practice overseas to facilitate the use of recovered materials through a 'waste exchange'. This may serve brokers, or be a clearing house for information on wastes available or wanted. Such institutions can also disseminate information on new reclamation technologies.

The New South Wales WMA and the Victorian EPA maintain recycling registries which list wastes that companies have available or are seeking to obtain. Rala Publications is to publish a national register (DITAC, 1990).

Table 5.4: Chemicals: Collection of used or surplus chemicals in rural areas of Victoria 1990

Material received	*Quantity*
	Kilograms
Heavy metals (arsenic, mercury etc)	27 013
Poisons (cyanide, strychnine etc)	1 020
Organochlorins (DDT, dieldrin etc)	33 318
Other pesticides	61 764
Oils, paints and solvents	6 162
Other substances	13 937
Unknown material	18 504

Source: MMBW personal communications, Roberts D. 13 July 1990

Industrial containers

Some steel drums of the type used in fuels and chemicals (44 gallon/285 litre) are cleaned, reconditioned and painted for further use. Reconditioning is undertaken on a 'fee for service' and a 'purchase and resale' basis. Recycling of agricultural and veterinary chemical containers (200 and 400 litres) has been largely on a trial basis.

The extent of re-use of industrial containers

Drum Reconditioners (NSW) Pty Ltd advised that about half of the market for large drums in New South Wales is met by reconditioned drums.

Factors affecting the level of re-use

A constraint on higher rates of re-use is the cost of collecting drums which are not returned through dealers. Other problems arise in disposing of residual fuels, fats, etc returned in the used drums, and the large quantities of liquid waste generated in the cleaning/reconditioning processes. The major benefit from the re-use of steel drums is the avoided cost of purchase of new drums.

The further use of containers which have held chemicals is constrained by a range of Commonwealth and State government legislation dealing with the transport, storage and disposal of dangerous goods. The Agricultural and Veterinary Chemicals Association of Australia (AVCAA) said that as a general rule it is illegal to recycle used containers. The AVCAA also referred to problems stemming from non-uniform regulations. For instance, there is a requirement under the NSW Pesticides Act for containers used for farm chemicals to be registered for use in that State. Registration does not apply in other States. A study commissioned by AVCAA identified 85 items of legislation relevant to the management of farm chemical containers.

In 1989 Monsanto Australia Ltd received NSW approval for the use of returnable 400 litre polyethylene containers in the transport of pesticides. And since May 1990, the company's ‘Roundup’ range of herbicides has been supplied in returnable containers. Distributors are paid a service fee for returns. Other initiatives have focussed upon the shredding of farm chemical containers that have first undergone rinsing to remove residual chemicals. In Griffith, NSW, a private facility has been established to crush and interr drums on a site approved by the local council.

AVCAA referred to a pilot scheme to collect and recycle the stock of 200 litre steel drums held on properties growing cotton in New South Wales and Queensland. The drums were collected from stockpiles and transported to the recycler's plant where they were rinsed in solvent and caustic, given a new plastic liner, repainted and sold to chemical companies for refilling. Some 18 000 drums were removed in a period of 12 months.

The company concerned was prepared to meet the cost of collection, cleaning and reconditioning if assured of a market for the drums. The cost of a new drum is approximately $50 and the estimated cost of a recycled drum $25 ex-plant. The AVCAA said that industry tended to reject recycled containers because of product liability aspects.

In Victoria, Cycle Drums Pty Ltd recycles containers which have held the water soluble farm chemical ‘Roundup’. Washings are used as a further input to the manufacturing process and acceptable containers are recycled as new product containers. The AVCAA said that initial farmer response, in returning containers, has been poor.

Organochlorin compounds used in agriculture were said by AVCAA to account for less than 2 per cent of Australia's intractable waste. No other farm chemicals are classified as intractable waste.

The Commission understands that the Standing Committee on Agriculture has established a working party to explore options for container management.

Costs and benefits of reprocessing chemical waste

Benefits of reprocessing

The major benefit to society of reprocessing chemical wastes is the avoided environmental cost of improper disposal by removing toxic substances from the waste stream. The benefits to the waste generator are the avoided disposal charges and the price received for the waste material if sold to a reprocessor. If the waste is reprocessed in-house, then the benefits to the waste generator include reduced input costs.

Benefits of industrial container reuse

The cleaning and re-use of drums can give benefits in terms of avoided environmental damage. The Commission understands that drums need not be cleaned before dumping and that some oils and other residues enter landfill by this means.

Drum Reconditioners (NSW) Pty Ltd recommended that collection points for drums be established at waste disposal sites.

A recycled drum can cost $25 compared with $50 for a new drum. However, this saving is offset to some extent where users are concerned about possible contamination and liability problems.

Costs of reprocessing

Reprocessing of toxic chemical waste maintains a market for toxic substances and may discourage the use of more benign alternatives in the production process. This could adversely affect the health of employees using these substances or damage the environment if these substances are leaked.

Costs of improper disposal

The high costs of disposal and pre-disposal treatment may encourage some waste generators to dispose of wastes illegally through the sewer system, natural waterways or burial, causing contamination of groundwater. The costs of illegal disposal can be high if toxic wastes are disposed in the environment. The cost to society is mainly the deterioration of health and may include increased rates of cancer and tumours associated with the release of carcinogens such as PCBs and other organochlorins.

Costs of disposal

Disposal may be directly into landfill or after specialised waste treatment. If the wastes are toxic special pre-treatment is generally required before discharge. This is carried out by private contractors, generators of waste or by State authorities. The purpose of treatment is to convert the wastes into a form that presents no hazard when discharged into the environment. The costs depend on the treatment required but may range from $143 per tonne to over $1000 per tonne.

Table 5.2: Costs and benefits of used oil reprocessing

Cost to the waste oil reprocessor	*Comments*	*Benefits to reprocessor*	*Comment*
Cost of collection and transport of waste oil	Depending on distance of collection about 5 to 8 cents per litre	Market value of rerefined oil	About $1.50 per litre
Value as a fuel additive	about 15 cents per litre		
Rerefining and processing costs	Depending on type of processing: - acid/clay 16 cents per litre - thin film evaporation 10 cents per litre - high temperature distillation, more than 10 cents per litre		
Disposal of toxic residue	If landfilled, $200/tonne		

Additional costs to society	*Comment*	*Additional benefits to society*	*Comment*
Inconvenience in case of DIY market		Avoidance of pollution from improper disposal	Costs can be very high in watercourses, less so for land disposal or if burnt
Energy used in collection and reprocessing			
Toxic residues from acid/clay filtration	Risk of environmental damage from leachate, if landfilled		

Source: Submissions from Queensland Government, AIP, Victorian Government

Waste disposal authorities in major cities provide 'secure landfill' disposal facilities for liquid and sludge wastes. This disposal option is taken when pre-treatment costs are high or removal of toxicity is not possible. Disposal charges for chemical wastes in landfill can be high with some Authorities requiring a detailed and costly chemical analysis of the waste. These tests are generally conducted by private laboratories to meet waste authority guidelines. Charges for disposal range from $50 per tonne if collected in sludge bins or $200 per tonne ($50 per drum) for drummed wastes.

The New South Wales WMA uses about 10 hectares of land a year for secure landfill of liquid industrial wastes. Land suitable for this purpose is now reported to be limited. This is expected to increase disposal charges in the future.

Costs of intractable waste disposal

The Joint Taskforce on Intractable Waste (1990) reported that the preferred method of disposal of intractable waste containing toxic or environmentally damaging substances is through high temperature incineration (refer Chapter 3, Volume I). Currently there are no high temperature incineration facilities in Australia. These wastes are transported to facilities in the USA or the UK, although facilities do exist in other European countries. Cost estimates for high temperature incineration of chlorine waste in Europe range from $1250 to $2500 per tonne (The Economist Survey 1990).

In Victoria, the MMBW disposes of about 500 tonnes of intractable wastes each year at a high temperature incineration facility in Wales. The waste is handled by a private company in Australia which transports it to the facility at a cost of $5000 per tonne which includes handling and incineration costs.

The operating costs of the Australian facility were estimated by the Joint Task Force to be $1100 per tonne in 1988 dollars, on the basis of a throughput of 12 000 tonnes per year of waste.

Suggested government initiatives

Participants recommended that plant and equipment used for recycling be made exempt from sales tax. Some recyclers purchase used plant and equipment where sales tax does not apply. Some participants viewed this as a disincentive to upgrade to new, more efficient equipment.

The chemical industry is characterised by a large number of different waste types often processed or produced by small operators. This led to a number of participants recommending that governments support recycling by assisting with research, information and advice. Participants referred to the need for:

inexpensive processes for recovery of materials;

investigation of the market potential for recovered materials;

a technical reference/information base on chemical disposal, substitution and recycling methods;

cooperative processing facilities for wastes generated by small companies; and

research into source minimisation techniques and processes.

5.3 TYRES

Used tyres present a difficult waste management problem as they are bulky and can be a fire risk in tips. In Australia the main recycling of used tyres is in retreading. Retreading is undertaken by two of the three major tyre producers and a number of small specialist companies. Other forms of tyre recycling are negligible in Australia. Overseas, particularly in Japan, old tyres are burnt as a source of energy in cement kilns or power generators.

About 75 per cent of tyres purchased are replacement tyres, the other 25 per cent being for new vehicles. Tyre ratings standards restrict the use of retreads for the replacement tyre market.

The extent of recycling

Retreading delays the disposal of a tyre casing and therefore extends its service life. It reduces the number of tyre casings dumped each year, but some used tyres are imported for retreading in Australia. Retreaded motor vehicle tyres total 4 million (industry estimate) or about one quarter of total consumption (refer Table 5.6). About 18 per cent of tyres sold for passenger vehicles and 41 per cent of tyres sold for trucks are retreads. A high proportion of used passenger vehicle tyres are unsuitable for retreading, due to carcass damage.

Table 5.6: Tyre market, Australia 1986-87

	Quantity	*Market share*
	'000	*per cent*
New tyres produced [a]	6 133	36
New tyres imported [b]	6 573	39
Total new tyres	12 706	75
Retread tyres produced [c]	4 000	24
Retread tyres imported	18	d
Used tyres imported	207	1
Total recycled	4 225	25
Total market	16 931	100

a) Passenger vehicles, motorcycle and truck. B) Passenger vehicle, truck and bus. C) Industry estimate for 1990. Over half are passenger vehicle tyres while the rest are truck tyres. D) Negligible.

Source: ABS and industry submissions

Recovery of used tyres

Used tyres are collected from tyre retailers, garages or wherever worn tyres are replaced. In Victoria, tyre retailers supply tyres to casing dealers at no charge with the requirement that all tyres must be accepted. The casing dealers sort the collected tyres. Reject tyres are dumped in tips and suitable tyres are sold to tyre retreading companies. Tyremag estimates that about 40 per cent of passenger and light truck tyres are suitable for retreading, and the other 60 per cent are disposed of as waste. South Pacific Tyres (SPT) report the reject rate to be as high as 84 per cent. Retreaders may pay up to $10 per casing if obtained from casing dealers.

Because tyres are bulky, freight costs are high relative to their value, which means that few scrap tyres are moved between capital cities or regions. This is a major consideration in determining the viability of recovery and recycling schemes.

Factors affecting the level of recycling

Retreads

Consumer demand for retreads is mainly influenced by the price compared with that of new tyres, and perceived safety. The demand for retreads is thought to be diminishing due to the longer life and lower prices of new tyres relative to retreads. Some retailers no longer market retread tyres.

Prices

The price of retreaded tyres is generally about half the price of a new tyre. This discount reflects the perceived quality differences. The price of retreads and thus the level of recycling would be expected to increase if the relevant speed ratings were revised upwards.

A recent industry survey found that the casing accounted for up to 32 per cent of the cost of producing a retread (refer Table 5.7). Production costs vary according to the price paid for the casing and the type of tyre.

Suitability of new tyres for retreading

The suitability of a tyre for retreading is influenced by the temperature and pressure used in the production process of a new tyre. The vulcanising process used in the manufacture of new tyres uses high temperatures and pressures and is referred to as curing. Curing of rubber has a cumulative effect on the molecular structure of rubber over subsequent curing processes. Over-curing will weaken the rubber. This can limit the number of times a tyre can be retreaded. The Standards Association of Australia (SAA) said that, because of technical limitations, passenger vehicle tyres can be retreaded only once. Truck and heavy vehicle tyres can be retreaded up to seven times without seriously affecting performance capabilities, but are generally retreaded less than twice according to the Australian Tyre Manufacturers Association (ATMA)

Table 5.7: Retread production costs

Production inputs	*$ per unit* [a]	*per cent*
Rubber (3.15 kg)	7.00	22
Other materials	0.22	1
General expenses	1.78	6
Electricity	1.04	3
Fixed costs (leasing, maintenance etc)	6.94	22
Labour	4.26	14
Casing	10.00	32
Total	31.24	100

a) Average costs for a range of passenger vehicle tyres.

Source: Industry survey, 1989

The Motor Trades Association of Australia (MTAA 1990) and Tyremag suggested that some manufacturers produce tyres that will not take the retreading process, and that an adjustment of the manufacturing process could increase the number of times a tyre can be retreaded. ATMA claims that the manufacturing process has been developed to produce a product which has an extended life compared to tyres produced in the past. As the tread lasts longer the casing is subjected to a greater degree of fatigue, and at the end of its tread life is less suitable for retreading. ATMA argued that manufacturers cannot alter the manufacturing process to improve tyre retreadability without sacrificing the quality and longevity of the new tyre.

SPT said that only 16 per cent of used passenger vehicle tyres are suitable for retreading. The low recovery rate led the company to argue that without importing casings (which SPT will not do), passenger tyre retreading '...is fast becoming unviable as overall demand decreases'.

Substitutability of retread tyres

Retread tyres must be retreaded and marked in accordance with the Australian Standard, measured in terms of speed ratings. 'Design Rule No. 24-Tyre Selection' requires that replacement tyres be of the same or higher speed rating applicable to the car. The speed rating of a car measures the top speed obtained when a car is accelerated from rest over a 1 km distance.

The MTAA (1990) said the industry view is that retreads can be fully substitutable for new tyres in terms of being able to meet the original speed rating of the tyre casing, if applied correctly. State and Territory regulations make it mandatory to fit vehicles with tyres of the same or higher speed ratings as the original tyres and car speed rating. It was suggested that this discriminates against the use of retread tyres, especially as many modern cars have speed ratings much higher than retread tyres. ATMA claimed that a retread could meet speed ratings tests and yet have a shorter service life and higher probability of casing failure than a new tyre. The Commission is not in a position to investigate these technical claims.

Current SAA regulations require regular monitoring of quality. Tyre samples are submitted to an independent testing facility for compliance with regulations. Retreaders are required to bear the cost of this program. Tyremag submitted that testing a tyre well below its speed capability is not appropriate and that testing should be abandoned if tests are not made more relevant to the product's actual performance capabilities. The Australian Standard for retread tyres is being revised.

Safety

The perceived quality and safety of retreads are factors limiting the recycling of passenger vehicle tyres. Consumers accept speed ratings as an indication of quality and safety. One participant has discontinued marketing passenger vehicle retreads after allegedly experiencing a failure rate of up to 17 per cent. SPT claimed that:

> ...with increasing emphasis on motorist safety and increasing demands on performance of both vehicles and tyres, retreading of passenger car tyres will become less sustainable. Further, product liability insurance premiums are constantly increasing for retreaders. Quite simply, retreading technology has failed to keep up with that of new tyres.

Imports of used tyres

Imports of used tyres increased from 207 000 units in 1986-87 to 596 000 units in 1989-90 (ABS). These are mainly tyres from wrecked or no longer serviceable vehicles in the United States and Japan which are considered suitable for continued use in Australia. Some are retreaded in Australia.

Tyre manufacturers and retreaders argue that these imported tyres compete unfairly with retreads and new tyres as they are not required to meet any quality standards when imported. They also contribute to problems in disposing of used tyres.

The standards for tyres fitted to new vehicles are set out in the various Australian Design Rules. The standards for tyres fitted to vehicles in service are the responsibility of State and Territory authorities.

Controls over the importation of used tyres are unlikely to be an appropriate response. They would accord additional protection to Australian manufacturers and, in any event, import controls which specify an end use would be difficult to administer and readily circumvented.

Nevertheless, the community has a problem in disposing of used tyres, including those imported. In Volume I (Chapter 7) the Commission discusses the scope for applying an environmental tax as part of a regulatory framework for disposing of used tyres. The conclusion reached is that with greater attention to environmental controls over the storage and disposal of tyres, and with disposal costs built into disposal charges, industry would itself have the incentive to levy an appropriate disposal fee.

Other recycling

The recycling of used tyres is presently limited by low prices of some substitute materials; for example, fuel oil, if used tyres are used as an energy source. Other constraints are relatively high costs of collection and pre-treatment such as shredding when tyres are used in asphalt or as a fuel. When used as an energy source environmental regulations can further increase operational costs.

The use of old tyres as an energy source to generate electrical power would also be limited in Australia to the extent that there are constraints upon the sale of electricity into the power grid. Examples of this type of use can be found in the United Kingdom (Elm Energy and Recycling) and the United States (Oxford Energy), as described in the following section.

Recycling overseas

Table 5.8 illustrates the methods of disposal and recycling in the United States, Japan, West Germany and the United Kingdom. At 24 per cent, Australia's retreading rate is greater than for these countries.

Road construction

Production of asphalt rubber in the United States was estimated at 30 000 tonnes in 1980 accounting for some 750 000 tyres. Tyres were incorporated into the mixture at a rate of 25 tyres per tonne (Paul 1982). Goodyear (Go 1990) reports that asphalt rubber has been applied to a total of approximately 400 kilometres of four lane highway in ten European countries.

A very small quantity of waste tyres is used in Australia in road making. Used tyres are heated with bitumen at a rate of 5 tyres per tonne and the resulting binder is used to hold together the small stones which make up the surface. The inclusion of rubber improves bitumen ductility and durability. Other advantages are that less asphalt is used for roadmaking and there is an improvement in the breaking characteristics of vehicles.

Table 5.8: Methods of disposal and recycling of tyres overseas

MethodUnited States Japan West GermanyUnited Kingdom

Method	*United States*	*Japan*	*West Germany*	*United*
		per cent		
Landfill/stockpile	74	11	30	53
Burn as fuel a	7	35	37	20
Retread	12	12	19	19
Export	4	17	11	6
Crumb	2	22	2	-
Other	1	3	1	2
Total	100	100	100	100

a) Mostly used by the cement industry but may also include power generation in some countries.

Source: Cited by South Pacific Tyers from European Rubber Journal (1990) and Go (1990)

This process has been used in Victoria. In Queensland some trials presented technical difficulties.

The asphalt/rubber mixture is twice the cost of conventional asphalt, however the benefits would be reflected in lower road maintenance costs. In 1986-87, 568 000 tonnes of bitumen were produced or imported into Australia. Applied at the rate of 5 tyres per tonne of bitumen, road construction has the potential to absorb about 3 million waste tyres per year.

*Fuel source*Tyres have an energy value of 32 megajoules per kilogram (Paul 1982) compared to about 28 megajoules per kilogram for coal (Boustead and Hancock 1982). Overseas, tyres are used as an industrial fuel in boilers and electricity generation. However, this involves high initial capital costs and pollution control costs can be a disincentive. The Lucas-Goodyear tyre burning facility in Michigan, in the United States, was shut down because of technical problems and failure to meet air pollution emission standards (Paul 1982).

A utilities firm, Oxford Energy (Oxford), in Modesto California, operates a power generating plant which burns exclusively tyres at a rate of 5 million units a year. The plant produces 14 megawatts of power and emissions are within environmental control limits.

According to the European Rubber Journal (1990) the firm is completing a 30 megawatt plant in Connecticut and has plans for another in New York State. In the United Kingdom, Elm Energy and Recycling (Elm), a United States based firm, plans to establish a $130 million plant. It will use 90 000 tons of scrap tyres (about 10 million tyres) a year to produce 30 megawatts of power. Elm has estimated it can generate electricity at about 4.5 pence (11.25 cents) per kilowatt-hour.

In Japan, the Saitama plant of Nihon Co. Ltd burns 140 000 tyres per month in its production of Portland cement. Contaminants are retained in the cement (Paul 1982).

Constraints on the use of tyres as a fuel are the relatively high costs of collection, transport and pre-burning treatments such as shredding. These can exceed the cost of alternative fuels such as coal or oil.

Pyrolysis

Pyrolysis is a process used to extract oil, gases (propylene, ethylene, and butylene) and carbon black from scrap tyres. The process has been extensively researched overseas but has been found too costly, producing carbon black of unreliable quality. In the United States it was found that the production of carbon black from crude oil was cheaper and led to a better product (Paul 1982).

Artificial reefs

Used whole tyres can be used to build artificial reefs and oyster beds. This form of disposal is not likely to cause environmental problems as rubber is an inert substance unless burnt and in the case of reef formation the tyres become encrusted with crustaceans and coral biota, thus isolating the material from the ocean environment. The same properties that cause tyres to be a problem in tip sites, their shape and cavities, make tyres a good habitat for fish and other sea creatures.

Goodyear in the United States has built more than two thousand fishing reefs (Paul 1982). One of the largest reefs is made of 3 million tyres and is about 2.4 kilometres long, off Fort Lauderdale, Florida.

Other uses

Several firms use crumbed rubber, recycled from scrap tyres, in producing athletic tracks. This material is mostly imported. Approximately 4000 tyres per month are reprocessed in Brisbane for rubber matting.

Used tyres are also used for playground equipment, as flower planters, shoe soles and cut into strips for matting. In country areas they are frequently used in erosion control.

Tyre recycling legislation overseas

In Ontario, Canada, legislation was passed in 1989 imposing a tax of Can$5 on each new tyre sold at retail. This is to fund scrap tyre disposal and tyre recycling research.

Several states in the United States have or are intending to place an environmental levy on tyres. The charges range from US25 cents to $1 per tyre. The funds will be used for tyre recycling research and grants to local governments for scrap tyre management projects.

California has applied a disposal fee of US25 cents per tyre. However unlike the Ontario initiative, the fee is applied to used tyres at point of disposal. The California Tire Dealers and Retreaders Association (CTDRA cited in Moore 1989) notes that there are a number of problems with the legislation and that if a disposal fee is applied it should be at the point of sale. CTDRA notes that a fee applied at the end of the useful life-span of a tyre, will encourage illegal dumping particularly as consumers are not required to return the used tyre to the retailer. CTDRA considers that the disposal fee is too small to cover the true cost of administration, disposal and environmental damage that is caused by used tyres.

California has also passed a retread procurement bill requiring state government vehicle fleets to use retread tyres, although exempting emergency vehicles. The Integrated Waste Management Board and the California Department of General Services will assess the performance of retreads used. The results of the study are expected to be released in 1995 (Moore 1989). The MTAA proposes that similar legislation be introduced in Australia.

Costs and benefits of recycling used tyres

Benefits of recycling

The major benefit to the retreader is the price of the retread tyre less the cost of retreading the used tyre. Benefits to the tyre dealer include the savings in tip charges. Tip charges for disposal of passenger car tyres vary from 35 cents per tyre in South Australia to $1 per tyre in Victoria. SPT reported that the current disposal costs for commercial vehicle tyres are $0.80 to $3.00 per tyre. To reduce tip space used, local governments are shredding tyres before landfill. Shredding reduces the volume by around 70 per cent. The Newcastle Regional Waste and Pollution Advisory Panel (NRWPAP in NSW) shreds scrap tyres at a cost of $1 per unit. The cost could be offset if a market were developed for the shredded material.

Environmental benefits of recycling

To society, the main benefit of recycling tyres is the saving in tip space. Additional benefits can include savings in natural resources. The energy and raw materials used in retreading are lower than those for new tyre production. When used as an energy source to fuel boilers or generators, tyres can substitute for other forms of energy resource.

About 13 million used tyres not suitable for retreading are discarded each year in Australia. Scrap tyres are a problem in tips or when stockpiled because of their volume and the fire hazard they pose. Some Councils are reluctant to accept used tyres for landfill. The NRWPAP said that illegal tyre dumping is widespread in the Hunter Region. This has resulted in the formation of two large dumps, of 500 000 units each, in the Hunter Valley.

An incident in Ontario, Canada, in February 1990 serves to illustrate potential environmental problems (Reynolds 1990). A fire deliberately set at a dump storing 14 million tyres emitted toxic gases into the air, and chemicals such as toluene and benzene into the ground. The Canadian Environment Ministry has estimated that 100 million litres of toxic oil were released, twice as much as the 50 million litres spilled in the Exxon Valdez incident. Toxic oil contaminated streams, rivers and ground-water used in agriculture, affecting production.

Although the dump was situated in a rural area, 1700 people had to be evacuated from nearby areas until the fire burnt out.

Costs were estimated at US$1 million to extinguish the fire and clean up the site. Additional costs include the effect on agricultural production and the cost of evacuating nearby residents. Environmental costs include the chronic effects of the released toxins on the nearby residents. In Western Australia, where a dump containing 500 000 tyres caught fire, the clean up cost was estimated at $700 000 to $900 000 or about $1.40 to $1.80 per tyre.

At best, the risk of fire can be minimized through proper disposal and security at tyre dumps but not eliminated.

Costs of recycling

Costs of retreading have been estimated between $21 to $31 per tyre (refer Table 5.9)

Table 5.9: Costs and benefits of tyre reprocessing into retreaded tyres

Costs to retreader	*Benefits to retreader*
Collection, transport and retreading costs at $21 to $31 per tyre	Market price of retreaded tyres.
Additional costs	*Additional benefits*
	Saving in tip space at $32 per tonne in charges. An additional $100 per tonne is saved if shredded.
	Lower fire hazard at tips and associated pollution problems

Source: Submissions from Queensland Government and Victorian Government

5.4 BUILDING AND ROAD WASTE

5.4.1 Building waste

Construction and demolition sites generate a significant proportion of the solid waste stream. Building waste represents by weight about 15 per cent of the total waste going to landfill in Sydney, 32 per cent in the ACT, 13 per cent in Adelaide and 11 per cent in Melbourne. Given its high weight to volume ratio, it accounts for a much smaller proportion in volume.

The extent of recycling of building waste

On building sites recycling of waste tends to be confined to the more valuable materials such as plumbers' and electricians' copper offcuts and some excavation material.

There is a greater level of recycling at the demolition stage. The more valuable materials such as marble, period fittings and non-ferrous metals are recovered. Generally structural steel is re-used or reprocessed. Brick and concrete and rubble is crushed for foundations or other uses such as road base, retaining walls and aggregate for concrete. Building and demolition waste can be used to reclaim land, or to form parks and golf courses. Some is also useful as cover for putrescible waste and as temporary road material on landfill sites. Some building materials such as bricks, windows and other fittings are reused but on a small scale. The amount of demolition rubble in Sydney is believed to be of the order of 500 000 tonnes per annum. About four-fifths is crushed and recycled.

Factors affecting the level of recycling of building waste

For builders and demolishers, the decision to recycle will depend on the benefits of recycling - the revenue or the cost avoided - relative to the costs

Table 5.10: The costs and benefits of recycling building waste

Costs to the recycler	*Comment*	*Benefits to the recycler*	*Comment*
Costs of recycling: - collection - sorting and cleaning - transport - any costs of re-sale - any special costs in re-use		Value of items for re-use or re-sale Savings in landfill charges	 $18 to $38 per tonne at disposal sites in Sydney

Additional costs to society	*Comment*	*Additional benefits to society*	*Comment*
Health hazards from re-use, e.g. lead content of old paint or pipes		The social cost of tip space in excess of actual tip fee The value of materials which may become available for re-use by the public at no cost	

incurred in the recycling process (refer Table 5.10). Government regulations, building and engineering standards also influence the level of recycling.

In Australia the relatively low proportion of older buildings, low population densities and hence high transport costs, high labour costs and the greater access of virgin material are constraints on recycling and reuse. However, where old buildings are being renovated, compatible materials may be available only from old or demolished buildings of the same vintage.

Costs and benefits

To a builder or demolisher, a private benefit of recycling is avoiding the cost of transporting waste to landfill sites and disposal charges. According to Concrete Recyclers tip sites around Sydney charge from $18 to $38 per tonne to take building waste. Another benefit is the return on the materials recycled - that is the price received or the cost avoided in not having to purchase new materials.

Concrete Recyclers said that the last four years have seen a steady growth in the recycling of building rubble in Sydney. This was attributed to higher tip fees and the increasing distance to landfill sites. Recycling plants are more centrally located than tips and offer cheaper disposal fees because the crushed product can be resold. Fees are between $8 and $15 per tonne.

The price obtained for recycled materials will depend on its value as a substitute for virgin material. Prices can be depressed by the perception that recycled materials are substandard, or that additional costs will be incurred in design or construction. Attitudes may change after other users have assessed the performance of particular materials.

Government standards limit the use of some second hand materials. Concrete Recyclers was critical of the standards which must be met by crushed concrete for road base. The standards are those applying to more traditional road making materials. The company argued that residential roads are designed to unnecessarily high specifications, and that this restricts the use of recycled material.

The benefits from use of recycled materials have to be weighed against the costs of collection, sorting, cleaning, transport and sometimes the greater costs of using the material relative to alternatives. The retrieval of used materials may also add to the time required to demolish a structure.

The incentive to incorporate resource conserving features (such as ease of demolition and reuse) into the design of a building is low in part because current owners discount the future more than society does. The higher value of the building (arising from these features) when it is dismantled is inadequately reflected in the current assessment of its present value. The social costs of reuse on the other hand may exceed private costs in the case of health hazards arising from the recovery of building materials such as asbestos.

In Sydney recyclers of demolition rubble have objected to an increase in the WMA levy that applies to all waste received by Councils and waste depot operators. The levy is to be increased in 1991 from 56 cents to $2 a tonne. The increase will generate around $1.75 million which will fund a Council recycling rebate scheme. Councils will receive a rebate according to the tonnages of materials recycled in their areas. Based on present recycling estimates, the rebate is expected to be $17.50 per tonne of material recycled. Recyclers of demolition rubble see this as a tax on their activities to subsidise the recycling of material collected by Councils. The WMA is considering measures to address this problem.

5.4.2 Road waste

Recycling or reuse of road material is undertaken to a limited extent in Australia. It is normal practice to retain the old road base when a road is reconstructed. Surface pavement material such as asphalt is sometimes reused as a lower grade material. This can occur where repair work involves simply adding a new surface, in which case the original one becomes a substrata, or where removed pavement material is crushed and used as road base.

The extent of recycling

Even when road waste goes to landfill, it often performs a useful purpose as cover or temporary roads. The recycling of asphalt back into asphalt is carried out on a small scale in Australia, but appears to be increasing. The NSW Roads and Traffic Authority has 30 000 to 40 000 tonnes stockpiled in the Sydney area.

Factors affecting the level of recycling

The Queensland Government submitted that recycling of road waste is increasing steadily as the road system ages and requires reconstruction and widening. This appears to be true for much of Australia.

The rising cost of new aggregate for pavement and road base provides an incentive to recycle. Quarries around major cities are becoming exhausted and access to other reserves is restricted for environmental reasons. On the other hand, prices of imported crude oil from which bitumen is produced have fallen in real terms. Because of high transport costs, distance from landfill is a significant factor in determining whether road waste is recycled or reused.

New technologies favour asphalt recycling. Queensland and NSW are trialing a method that lifts the old asphalt and re-lays it after a heating process that adds a rejuvenating oil. An alternative technology crushes the old asphalt and re-lays it after adding a binding agent. In another technology cement is added to old pavement material as a binder instead of bitumen. Until recently the only method for recycling asphalt involved mixing old crushed asphalt with new hot mix. Only a small proportion of old material could be incorporated into the new asphalt.

Recycling of paving materials can be constrained by poor quality and the intrusion of clay from the subgrade. Moreover, the use of *in situ* techniques for recycling asphalt is only possible where the road base does not need regrading and where there is no danger of the heavy equipment damaging pipes and cables. These techniques appear to achieve the necessary scale economies only on large projects.

5.5 BIODEGRADABLE ORGANIC WASTE

Biodegradable organic waste is a major component of the waste stream. It is generated by households, councils, industry and intensive agriculture. It includes: sewage, lawn clippings and garden and park waste, food scraps, paper, hair, leather and organic fabrics, and animal manure. Sewage is discussed separately at the end of this section.

Food or garden waste comprises about half of the solid waste generated by households. A NSW study (van den Broek 1989) indicated that 145 kg of organic waste is produced per person per year in NSW, of which 83 kg is food waste and 62 kg garden waste.

Few data are available on the amount of organic waste generated by industry and commerce. Substantial quantities are generated by the food industries but waste is reduced to the extent that the by-products of one process are used for other purposes. For example in the meat processing industry, what would otherwise be waste is used for pet food and blood and bone meal. On the other hand refuse from restaurants and takeaway food outlets mostly enters the normal waste stream.

5.5.1 Composting

The main form of recycling of organic waste is composting. This is a process of biological decomposition of organic materials by micro-organisms, mainly bacteria and fungi. Composting can be undertaken by householders on their own premises or undertaken on a larger scale by municipalities, waste management authorities or private firms.

Many householders compost food scraps and garden waste. It may involve the use of special bins, added lime, small shredders or simple heaps of compostable waste. In a 1985 study of Doncaster-Templestowe in Melbourne, it was found that between 15 and 19 per cent of residents composted organic domestic refuse to the extent that there was a significant reduction in garbage weight (Hawkins 1985, p. 30). The data from the study suggests a composting rate for food and garden waste of about 9 per cent. The study estimated food and garden waste production to be 11.4 kg per household per week. This is equivalent to 592 kg per household per year. Assuming an average household size of 3 to 4 persons, this is equivalent to 148 to 197 kg of waste per person per year, roughly similar to the figure of 145 kg per person in the NSW Study mentioned above. Extrapolating the NSW waste production figure to the rest of Australia, this is equivalent to 2.3 million tonnes of organic waste produced in Australia each year. If the composting rate of 9 per cent observed for Doncaster-Templestowe is reasonably typical, for Australia, composting of organic waste by householders would amount to some 210 000 tonnes.

Non-domestic composting systems range from simple windrowing methods, which involve open-air maturation of long horizontal piles of waste with occasional turning and requiring little mechanisation, to more complex enclosed systems. In the enclosed systems incoming material is usually processed in a reactor of some kind for 3 to 5 days and then placed in windrows for further maturing which can take up to three months.

These systems either have separation of compostable and non-compostable material at source or have front-end or back-end treatment of the incoming or outgoing material, ie processing such as air classification, magnetic separation or crushing with screening to remove or treat the non-compostable components such as metals, glass or plastics. Post-source separation is far more capital intensive than at source separation. Large composting systems sometimes involve co-composting where both solid organic waste and sewage sludge are treated. There are no composting facilities in Australia employing post-source separation. The City of Perth is examining the feasibility of such a facility.

Non-domestic composting of waste in Australia is confined to source separated tree, garden and park waste. There is no significant composting of organic waste entering the normal municipal garbage collection system. Garden waste that has been kept separate from the rest of the waste stream is relatively easy to compost. It requires fewer controls on the composting process itself and yields products that tend to have low levels of contaminants. According to the Waste Management Authority in Sydney, 60 kg per head per annum of garden waste that could be composted or mulched is currently disposed of through the domestic waste stream.

Many councils produce compost or mulch from their own garden and leaf waste. There is also an increasing trend towards the provision of facilities for householders to drop off garden , waste for mulching or composting. In Canberra, Corkhill Bros. Sales Pty Ltd has a garden waste facility adjoining a tip. Camberwell in Melbourne deploys a mobile chipper that moves around the municipality and takes residents' tree loppings. These, together with other garden waste and organic waste, are used to produce compost for council use. The Ku-ring-gai Municipal Council in Sydney is about to establish facilities capable of processing 10 000 tonnes of vegetable material into a compost for use in the wholesale nursery industry. Within three years this is expected to increase to 30 000 tonnes. About 60 per cent of Ku-ring-gai's domestic waste consists of vegetative material. Brisbane is about to introduce chippers at its tip sites with mulch offered for sale. The transfer stations to be established under the new waste disposal contract for Brisbane will have collection areas for garden waste and mulching facilities. At Albert Shire on the Gold Coast a contract chipper operates at one of its main tip sites at which people can drop off tree loppings, logs and other timber. It is used for the production of hardwood and softwood chips and for mulch. This is sold both to the public and the council. This facility is expected to reduce the need for burning off for land clearing for new sub-divisions. In Adelaide commercial quantities of compost are produced by Jeffries Garden Soils. The company produces around 15 000 cubic metres of compost annually using lawn clippings, leaves and selected vegetable matter.

In some municipalities such as Heidelberg and Diamond Valley in Melbourne, residents are permitted to put out tree waste with the hard waste collections. This is put through a chipper and the resulting mulch left at various locations for the use of residents.

There are about 200 large scale composting plants operating worldwide. In Sweden 25 per cent of solid waste is composted; in the United States 1 per cent (Miller 1990, p. 468). There were 5 facilities in the United States processing mixed municipal solid waste. The largest by far is in Wilmington, Delaware with a capacity of 700 tonnes per day. Others are also planned. These include a 400 tonnes per day facility in Cape May County, New Jersey and a 500 tonnes per year facility in Norton, Massachusetts. Leaf collection and composting is carried out extensively in the United States and several yard waste research projects are being conducted by universities. A project at Illinois State University is monitoring the feasibility of applying leaves directly to corn and soybean fields. In West Germany in 1988 there were at least 71 facilities processing source separated organic waste (Congress 1989, p. 88). These facilities served an estimated 430 000 households and composted 90 kg per person of organic wastes each year. In some parts of Germany, however, concern about toxic metal contamination has restricted compost to use as a filler and in sound reduction barriers on motorways (Johnson 1990, p. 28). According to the City of Marion (SA), a composting plant in Auckland which had successfully produced compost for about a decade was forced to close because of increasing difficulty meeting odour, heavy metal and vermin control requirements.

Factors affecting the level of composting of waste

Factors affecting the composting of waste include the value of the end product, available space and facilities, costs and any side-effects. In Australia, low population densities and a high level of garden ownership tend to encourage composting. But waste disposal costs are also low and provide an incentive to dump compostable waste.

Homes in Australia often have garden space for some composting. This is not the case in central city, high density and high rise areas. The demand for compost stems from its use as a soil improver and fertiliser by home gardeners, commercial gardeners, and for municipal parks and gardens. The costs of producing domestic compost include its use of garden space, and the time and effort of householders. Composting can bring increased fly and rodent populations and subsequent health risks. These can be minimised by the use of a bin, the possible addition of lime, and the addition of blood and bone as a ‘starter’.

Limitations on higher levels of composting

Higher levels of domestic composting face a number of constraints:

- it requires effort on the part of the householder;
- material requiring a heavy shredder cannot be composted;
- the available organic material may limit the quality of compost;

- there is no necessary connection between the amount of organic waste created and the amount of compost required, for example, households without gardens have limited use for compost;
- non-domestic composting may allow organic waste to be put to higher valued commercial uses;
- composting can generate odours and pose a public health risk.

Community or large-scale composting also faces difficulties. First there is the problem of obtaining the right mix. As indicated by Diaz and Golueke (1990,

p. 40):

> Even in the days before packaging and paper products contributed to the prodigious extent that they now do, the carbon content of MSW [municipal solid waste] in the US was unfavorably high for use as a compost substrate. On the other hand, the nitrogen content of the waste was almost negligible.

There is also the problem of post-source separation (Diaz and Golueke 1990, p. 43):

> The quality of the finished compost product depends heavily upon the effectiveness of the separation process. The difficulty is that providing a satisfactory mechanical separation setup is far from an easy task.

Some inquiry participants referred to a potential problem of contamination due to the presence of heavy metals arising particularly from dry cell batteries and also other toxic substances such as pesticides, paints and solvents. Perth City Council has commissioned research by the Department of Environmental Science into ways of dealing with the heavy metal problem.

The market for compost

Compost products are mostly used as soil conditioners. They can be produced in a range of products to suit different applications. For example, coarse immature compost can be used in vineyards, medium sized mature compost for horticultural applications and fine mature or special compost for

market gardens and domestic applications.

A feasibility study for a municipal composting plant undertaken for the City of Perth indicated that in order to achieve a significant market penetration a fine grade of compost would be required, containing only very minor quantities of glass. This would mean high quantities of material being rejected and disposed of to landfill. Home gardening, market gardens, orchards and playing fields were identified as the main potential markets.

A Working Party on Composting in 1987 estimated that the market for organic fertiliser in Sydney was in the order of 577 000 cubic metres per year. This was broken down into the markets shown in Table 5.11.

Table 5.11: Consumption and cost of commercial compost in Sydney, 1987

Market	*Consumption*	*Av. Price delivered*
	m^3 per year	*$ per m^3*
Nurseries (Retail and Wholesale)	170 000	15
Cut flowers (Greenhouse)	65 000	n.s.
Landscape Contractors	77 600	23
Market Gardeners	50 000	8
Mushroom Growers	15 000	8
Turf Growers	30 000	30
Golf Courses (Private)	9 335	15
Councils	23 100	17
Government Bodies	105 897	21-32
Others	31 068	11-21
Total	577 000	

n.s. Not specified

Source: Working Party on Compositing, Composting and Sydney's Waste, Metropolitan Waste Disposal Authority, Sydney, 1987.

This market is currently met by products such as manure and composted agricultural wastes. The demand for compost produced from the waste stream will depend in part on its competitiveness in this market in terms of price and quality.

Government initiatives

Some local governments have produced and distributed information on home composting. These leaflets typically describe the benefits of composting together with instructions on how to build and maintain a compost heap. Some councils are promoting composting through the subsidised or at cost provision of composting bins. For example, the City of Marion (SA) has arranged a bulk rate deal with a local wholesaler to provide compost bins to residents at $20 and $30 depending on the size of the bin

The EPA in Victoria funds a number of municipal composting initiatives through the Municipal Waste Minimisation Grant Scheme In 1989-90, the WMA in Sydney earmarked $400 000 in financial support for mulching and composting of garden waste.

Underpricing by government agencies of existing methods of waste disposal may reduce the incentive to compost waste. The incentive will be increased if households have to bear the costs of alternative disposal or receive a financial benefit.

Costs and benefits of composting

The benefits of composting include the value of the compost produced and the saving on landfill costs. The costs of composting include collection and processing, and also any increased health risk. The social cost of the latter may be greater than the private cost to the compost producer.

A 1987 Sydney study found that the cost of operating a 200 tonnes a day composting system based on post-source separation would be between $41 and $53 per tonne (Working Party 1987, p. 14). This is significantly more than existing landfill charges. However, it is significantly less than the true social cost of landfill. The same study considered that composting would be cheaper than incineration for at least part of the metropolitan area.

The major costs and benefits of composting are illustrated in Table 5.12.

5.4.2 Contaminated hospital waste

The disposal of contaminated hospital waste has aroused some concern in Australia, although the quantities involved are small. In Sydney landfill used to be the main form of disposal, but this ceased in July 1990. While many hospitals have their own incineration facilities, there appear to be significant economies of scale favoring larger facilities servicing a number of hospitals. There is also a concern that existing hospital incinerators do not meet the required design and control standards. A new privately run incinerator has

Costs to the composter	*Comment*	*Benefits to the composter*	*Comment*
Domestic composting			
Compost bins $30 to over $400 Some councils supply at a discount. Cheaper methods of composting are possible		Savings on purchase of compost, fertilisers and soil conditioners	
		Savings to the composter of waste disposal charges	
Garden shredders, $320			
Lime, 80c per kg; blood & bone, $1 per kg			
Labour and inconvenience			
Non-domestic composting			
Collection	According to a 1987 Sydney study, the cost of operating a 200 tonnes per day composting facility would be between $41 and $53 per tonne		
Transport			
Capital cost			

Additional costs to society	*Comment*	*Additional benefits to society*	*Comment*
Possible odours and fly and rodent infestations		The social cost of tip space in excess of the actual tip fee	
Possible environmental problems with heavy metals in the compost			

Source: Prices for domestic composting equipment obtained from retailers.

Been established in Sydney. The service includes waste pick-up at charges between $700 and $1000 per tonne. In Melbourne, where most contaminated hospital waste is incinerated on site, there is expected to be a move towards larger scale off-site facilities.

5.4.3 Sewage disposal and recycling

Sewage is another form of organic waste. It is either disposed of through a sewerage system or treated in household septic systems. The latter tends to apply in less built up areas. Waste water from sewerage systems is either disposed of into the sea or waterways, or recycled for irrigation after treatment. Sewage sludge residue form the same process is either disposed of into landfill, the ocean or waterways, incinerated, treated to extract oil or methane, or recycled as a soil conditioner or fertiliser.

Forms of sewage treatment used and the extent of recycling vary from area to area. In Sydney most sewage simply receives primary treatment[4], with the sludge being landfilled or incinerated and the waste water going to ocean outfall. At inland facilities, where waste water is disposed of into rivers, the sewage receives secondary treatment.

There are plans for greater recycling of sludge. As part of its Special Environment Program (SEP), funded by a levy on ratepayers over the next five years, the Sydney Water Board will spend $47 million to develop and implement sludge recycling. A number of trails are underway. At Castlereigh dewatered sludge is mixed with sawdust and other compost ingredients. The compost is sold to local landscapers. At Bellambi

4 There are three different levels of sewage treatment. Primary treatment entails screening and storage in sedimentation tanks in which greases and scums that drift to the surface and a sludge sediment are removed. The materials removed from the effluent may then undergo various forms of treatment. Secondary treatment of effluent employs natural biological processes to remove pollutants including pathogenic organisms. Additional sludge is also removed at this stage. Tertiary treatment entails filtration and chlorination.

dewatered sludge is composted with wastes such as municipal garbage, lawn clippings and coal tailings. It is then used on the Water Board's Illawara properties. The Water Board is also trialing a technology which mixes sewage sludge and steel works dust to create a fuel and reductant in steel smelting. Heavy metals are also extracted in the process and could be either included in the steel or sold for use in pigments or pharmaceuticals. At Glenfield Veterinary Research Station, the Water Board and Department of Agriculture are trialing the direct use of digested sludge on agricultural land. At Homebush, worm-breeding has been investigated. At Wagga (NSW), the CSIRO is testing treated sewage as a fertiliser for eucalypt and radiata pine trees.

The Water Board is expected to choose a combination of technologies from a short list of eight tenders. One proposal would use dewatered sludge as fuel for a small power station. The remaining ash would be mixed with cement to fix the heavy metals and produce a construction material. Another system would make fuel oil from the fats and greases in sewage and use the residual char to provide a fuel for the process and to make construction materials. A microwave technology kills the pathogens in sludge which can then be used for horticultural products.

Even though sales of by-products would bring in some revenue with all of these processes the Water Board would still have to cover some of the costs.

Another technology being looked at by the Water Board as an option in the longer term is the Vertech process. This involves drilling a hole more than one kilometre into the earth and pumping sewage sludge down to the bottom where it would be destroyed by the extreme temperature and pressure.

Tertiary treated waste water or effluent is used, or has recently been used, for irrigation or dust suppression on agricultural land, on golf courses, road construction and Warwick Farm Racecourse. There is a proposal to establish a sewage treatment plant in Sydney's north west (Rouse Hill) capable of providing up to 300 000 householders with recycled water for gardens and toilets. Dual water systems would be installed.

Melbourne has two major treatment plants, the Eastern and Western systems, and 10 smaller plants. At the Western system at Werribee sewage receives tertiary treatment prior to discharge into Port Phillip Bay. Waste water is also recycled to irrigate pasture that supports cattle and sheep grazing, effectively reducing operational cost of treatment by about 30 per cent. Werribee Farm is a major wildlife habitat, and in 1983 was designated by the International Union for the Conservation of Nature as a ‘Wetland of International Importance’. At the Eastern system at Carrum sewage undergoes both primary and secondary treatment before discharge into Bass Strait. At the Carrum plant pilot trials have demonstrated than an effective soil improver can be produced by blending inert sludge with organic material such as tree cuttings, wood chips and sawdust. Large scale trials are planned prior to market testing. In Victoria as a whole 26 per cent of sewage effluent is recycled, the main uses being Werribee Farm and wetlands.

Most of Brisbane's treated sewage effluent is secondary treated and disposed of into waterways, although a small amount is used to irrigate golf courses. Most sludge is disposed of to landfill, but the Brisbane Council is examining the possibility of either composting or extracting oil from sludge.

In Adelaide 10 per cent of waste water from the sewerage system is reused for irrigation and about 70 per cent of sludge (16 000 dry tonnes) is used as fertiliser. The Engineering and Water Supply Department (EWS) aims to cease discharges of sludge into the sea by the end of 1993. Irrigation applications include recreational areas, agriculture and more recently silviculture trials. The EWS has a 20 hectare woodlot trial at Bolivar. Once air dried in lagoons, sludge is sold to a fertiliser manufacturer for processing which includes kilning prior to sale.

Ulverstone Council in Tasmania composts its sludge with sawdust for sale at $2 a trailer-load. The Hobart City Council has established an interdepartmental committee to examine the possibility of recycling sewage. It is considering the production of soil conditioner from anaerobically digested sludge and the reuse of waste water for sports grounds etc. At present it is retrieving methane from the sludge. Sludge is dewatered and put to landfill while wastewater is released into the Derwent River. Other major municipalities in Hobart are considering the need to recycle. In Tasmania, however, there is extensive use of systems employing oxidation lagoons.

These are not conducive to composting.

Thirty per cent of the Perth metropolitan area is not sewered, but relies on septic tanks. Almost all the sewage from the sewage system receives secondary treatment with the effluent going to ocean outfalls and the sludge sold to garden soil suppliers. The composting plant planned for Perth is expected to co-compost sewage sludge.

Recycling overseas

Composting of sludge grew significantly in some countries in the 1980s. In the United States, for example, the number of sludge composting facilities nearly doubled from 61 in 1983 to 115 in 1988; and it is expected that more than 200 sludge compost plants will be in operation within five years (Diaz and Golueke 1990, p. 42).

A technology that extracts oil from sludge has recently been developed in Canada and Australia by Enersludge Incorporated and is to be adopted by the Toronto sewerage authority. It involves the drying and burning of sludge and produces as by products clean water, an ash that can be used in the manufacture of concrete products, and a synthetic fuel which powers the furnace used in the process.

In many countries including Japan, South Korea and China sewage is returned to the land in vegetable-growing greenbelts around cities. In other cases sewage is used as food for algae that is in turn consumed by fish. In Calcutta, a sewage-fed aquaculture system provides 20 000 kilograms of fish each day.

Factors affecting sewage recycling

The extent of sewage recycling is influenced by the value of the recycled product, relative to the costs of recycling, and the valuation placed on avoided discharges into waterways and the marine environment.

One of the costs is in keeping contaminants (particularly heavy metals) within acceptable limits. The use of sludge as a soil conditioner ceased in Hobart some years ago for this reason. The NSW Health Department is concerned about any risk from heavy metals, but according to the Sydney Water Board, its experimental sludge products have shown heavy metal concentrations well within overseas health standards. Not all metals present a danger. Some, such as iron, copper and zinc, are necessary for plant metabolism and growth. Unless properly treated the use of effluent for irrigation can cause health hazards or have excessive levels of nutrients for some purposes. Contamination can be reduced by increasing controls on industrial discharges into the sewers and by advances in treatment methods.

The cost of pumping effluent to agricultural land and the seasonal nature of demand would be a constraint on the recycling of effluent as irrigation water. The scope for recycling may be limited in the short term by the existing sewage treatment arrangements. For example, the amount of sludge extracted, and hence available for recycling, is less in the case of primary treatment compared with secondary or tertiary treatment. The effluent from primary treatment is also less suitable for irrigation purposes. New technologies will also have an effect on sludge recycling. For example, a new form of treatment under test at Ballarat in Victoria enables phosphorous to be ingested by bacteria so that it is it retained in the sludge when the latter is separated from the effluent (Brett 1990). This has the advantage of both enriching the sludge and avoiding the eutrophication of waterways that results from excessive phosphorous and other nutrients.

The quantity of sludge available for recycling can be affected by the technologies employed. For example, a system developed by Bacterial Water Quality Pty Ltd pours ‘microbugs’ into the sewerage system (DITAC 1990, p. 35). These digest waste that would otherwise become sludge and produce oxygen. The scope for production of methane from sludge is reduced by increasing controls on industrial discharges into the sewers.

In Sydney, greater recourse is being made to sludge recycling because of government decisions to restrict disposal into the ocean and waterways and the increasing costs of landfill.

In some instances the limited capacity of the sewerage system may encourage processing of organic wastes. At Ballarat, McCains Foods treats starchy water waste from its potato processing plant to produce biogas (methane) which it then adds to natural gas to heat its steam boilers.

Cost and benefits of sewage disposal and recycling

In Australia sewage disposal is mostly a municipal responsibility. Hence private costs and benefits are in most cases those experienced by municipal authorities. Sewage sludge recycling costs include the capital costs of plant and equipment, and operating costs. The major ‘private’ benefit is the return from sewage compost and wastewater sale or use, if any, and the avoided cost of landfill or incineration. Sewage sludge can also improve the quality of compost from municipal waste by adding soil nutrients such as nitrogen, phosphorous and potassium. The major social benefit from sewage sludge recycling is the reduced environmental damage from discharges into the sea, lakes and rivers or from disposal by landfill or incineration.

The main problems with sewage disposal are those associated with toxic industrial waste and bacteria and other organisms in human waste. Where sewage is disposed of into waterways or ocean outfalls there is the problem of heavy metals and other pollutants affecting marine life and entering the food chain. Swimmers may become infected with sewage-borne bacteria and viruses.

These costs and benefits are set out in Table 5.13.

Table 5.13: Costs and benefits of sewage reprocessing

Costs to sewage authority	*Comment*	*Benefits to sewage authority*	*Comment*
Sewage treatment and sludge extraction facility: capital and operating costs	In Sydney the WaterBoard is spending $47 million over 5 years to develop and implement sludge recycling	Value of compost and waste-water (if any) for sale and/or use - compost as soil conditioner and fertaliser - waste water for irrigation or industrial use	

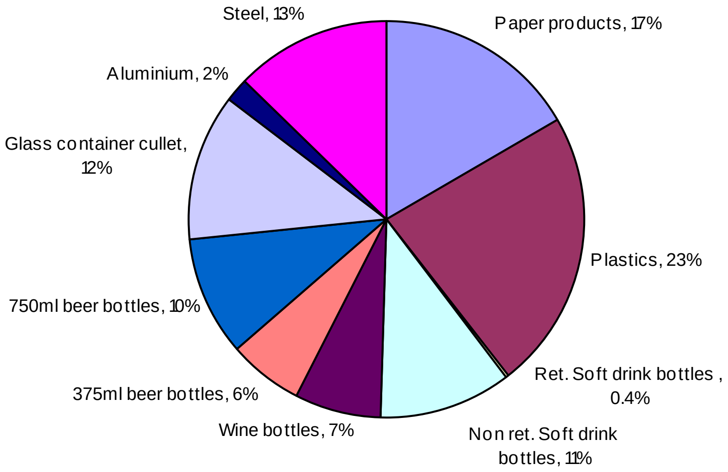
Additional costs to society	*Comment*	*Additional benefits to society*	*Comment*
Possible problems with contaminants such as heavy metals in the compost	This problem is being addressed through research into treatment methods and controls on industry discharges into the sewerage system	Avoided discharges of sewage sludge into marine, lake and river environments	

6 PACKAGING

Recycling is closely associated with the use of glass, aluminium and plastic as packaging for beverages and food.

The Packaging Council of Australia estimated that packaging represents about a third of domestic urban waste and about 10 per cent of total urban waste by-weight. Figure 6.1 indicates the proportion by weight of different materials in domestic packaging waste. Glass is the largest at 46 per cent.

Figure 6.1: Packaging content of domestic waste (proportion by weight)



Source: Environment Protection Authority, *Garbage Analysis Program - stage four - May 1984 to February 1985,* Publication 233, East Melbourne, 1985.

6.1 Use of packaging

The choice of glass, aluminium, steel, plastics or paper in the packaging of goods has an influence on the level of recycling and the economic incentives to do so. These materials are substitutable for each other to some extent in some of the major uses of packaging. For example, drinks and fruit juices may be sold in recyclable single-trip glass containers, refillable glass containers, plastic in the form of PET or HDPE bottles, paperboard containers such as 'Tetra Pak', and tinplated steel cans.

Packaging includes both the primary packaging of products and that used in transport and storage. The main materials used, in order of relative value, are paper and paperboard (36 per cent), plastics (26 per cent), metal (24 per cent) and glass (11 per cent). About 34 per cent of packaging is used for food and 27 per cent for beverages (refer Table 6.1).

Packaging is a significant market for the materials used: paper and paperboard 46 per cent, plastic 27 per cent, aluminium 30 per cent , steel 13 per cent and glass 28 per cent.

Packaging can improve community wellbeing by allowing food to be stored, preserved and transported, and reducing wastage. It adds to convenience and consumer choice, reduces the frequency of shopping and makes possible pre-prepared food products. Food poisoning is rare because of hygienic processing and packaging. Inadequate packaging is a factor in the very high spoilage rate for food in the Third World. The PCA claims that most goods would cost more but for packaging.

Some participants were concerned about excessive packaging and the choice of packaging that failed to take account of its recyclability and other environmental impacts. The Bathurst Conservation Group considered that there is overpackaging of items such as perfumes, toys and electrical goods. It also considered that packaging of multiples of items such as screws, bolts and batteries is excessive.

The PCA contended that the appearance of 'excessive' packaging such as for cosmetics and liquor can be a consequence of the products being frequently purchased as a gift. Ostensibly excessive packaging may also allow savings in handling and by facilitating self service.

of the Earth (Perth and Sydney) were concerned about the choice of materials that are not reusable or recyclable. Plastic and plastic coated cardboard containers were criticised. The PCA contended that more than one material is frequently necessary to achieve the multiple functions required of packaging.

FOE (Sydney) criticised plastic - packaging because it is not reusable and recyclable, and because of environmental problems associated with its production and disposal. Reference was made to hazardous materials used or emitted in the production process; the non-biodegradability of plastic in landfill or litter; and plastic in the oceans posing a threat to birds and marine life.

Table 6.1: End use markets for packaging by material, 1985-86

Material used	*Food*	*Beverage*	*Cosmetics Toiletries*	*Cleaners/ Detergents*	*Paints/ Chemicals*	*Other*	*Per cent of total*
			per cent				
Plastic	22	18	42	47	20	34	26
Glass	6	28	17	-	1	2	11
Metal	24	34	16	15	58	10	24
Paper & paperboard	45	19	26	38	19	47	36
Other	3	1	-	-	40	8	3
Total	100	100	100	100	100	100	100
Per cent of total	34	27	3	3	5	28	100

Source: PCA, *Packaging Today*, April, 1987, cited in Litter Research Association Submission, No. 256, p.5.

FOE (Sydney) considered that there are inadequate opportunities for consumers to bring their own containers to retail outlets. Food cooperatives, where customers bring their own containers for refilling, were seen as models of what can be done.

However, the PCA argued that the use of packaging can reduce the amount of food waste entering the waste stream. Packaging allows increased food preparation at the production stage with the result that food waste such as inedible portions are concentrated in large quantities that can be more easily used as by-products. The use of orange peel from juice production in stock feed, the wastes from the processing of canned or frozen corn and peas in cattle feed and fertiliser, and meat trimmings in the manufacture of hamburgers, pies and pet food were cited as examples.

The PCA also points out that there has been considerable lighweighting of packaging. This means a reduced call on resources, lower waste and lower transport costs. Weight reductions of up to 30 per cent have been achieved for non-refillable glass bottles over the last five years and current prototypes are expected to halve the current weight of bottles within the next two years. The typical steel food can weighs 18 per cent less than it did 10 years ago and the aluminium can now weighs 29 per cent less than it did when introduced in Australia 20 years ago. The weight of medium weight paperboard shipping cartons has declined by 30 per cent over the last 20 years. The weight of gable top milk and juice cartons has been reduced by 20 per cent over the last 15 years. PET soft drink bottles have been reduced in weight by 38 per cent since their introduction in the late 1970s.

In August 1990, leading companies in the packaging industry announced the establishment of the Packaging Environment Foundation of Australia (PEFA). The Foundation has a charter which commits it:

> to develop and promote public, industry and community policies which ensure that all operations and all activities in the production, use, disposal and recycling of packaging materials are carried out in the most ecologically and economically sustainable fashion throughout Australia.

6.2 The choice of packaging

The choice of packaging is influenced by relative prices and by differences in physical characteristics. Table 6.2 identifies some of the characteristics of various packaging materials.

Glass, plastic, aluminium and paper products are able to compete on price as packaging materials. Glass has been the material traditionally used for packaging beer, soft drinks and foods such as spreads and sauces

Glass is relatively heavy to transport and handle. It is also breakable but if made of an adequate thickness it can be collected and washed for reuse. It allows a long shelf life, and the contents can be seen. However, its wider use is limited by the availability of substitutes such as steel and aluminium cans.

Plastic has captured a large share of the soft drink market in the form of PET and a share of the milk market in the form of HDPE. Plastic films and containers are widely used for food, and the development of vacuum packaging has allowed food to be preserved chilled in plastic wrappers. Incentives to use plastic include its lightness, transparency (in some cases), and flexibility in application. Disincentives include the high costs of disposal, lack of biodegradability, the environmental damage done by items such as plastic six pack rings in the marine environment, and the limited recycling applications for post-consumer plastic.

Aluminium is widely used as a single serve beverage container for beer and soft drinks. Incentives for its use include relative lightness for transport, and durability, which make it suitable for vending machines.

Paper containers now have many of the characteristics of other forms of packaging due to the development of the UHT process for preserving milk and foods, and of long-life containers such as `Tetra Pale. Plastic coated paperboard is widely used in packaging milk, cream and frozen foods. Long-life paper-based containers are also used for products such as custards and coconut milk.

Modern forms of packaging add to convenience and consumer choice. They allow food and beverages to be transported even to isolated communities with minimum, spoilage.

Government policy can affect the choice of packaging. Until a recent High Court decision overruled the practice, South Australia's container deposit legislation set a lower deposit for refillable beverage containers than for non-refillable. This had the effect of encouraging the use of refillable containers.

Table 6.2: Characteristics of packaging materials

	Advantages	*Disadvantages*
Glass	good preserving qualities, contents visible	heavy and breakable, costly to transport and unsuitable for vending machines
	readily recycled	
Plastic	light and not prone to breakage	may chemically react with some products
	the contents can be visible	limited scope for recycling
Aluminium	light and not prone to breakage	may chemically react with some products
	suitable for vending machines	
	readily recycled	
Paper and paperboard	particularly suitable for cartons used in transport and storage	damaged relatively easily
	recyclability depends on use	more expensive special containers needed for long life applications

6.3 Extent of recovery

The extent of recovery after use varies significantly from one kind of packaging to another. As already discussed in Volume II, recovery rates are high for glass bottles, aluminium cans and cardboard cartons. By contrast there is little recovery for recycling of steel cans, plastic bottles, and paper and cardboard packets.

At the product distribution stage there is recycling of discarded bulk supply packaging such as cartons, crates and other containers.

Table 6.3: Rate of recovery for types of packaging

	per cent
Refillable glass bottles	65
Non-refillable glass bottles	26
PET bottles [a]	3
HDPE milk bottles [b]	3
Aluminium beverage cans	62
Paper board for primary packaging of food and beverages	0
Packaging and industrial papers as a whole	51
Steel cans	<1

a) PET producers expect the recovery rate to rise to 15 per cent by 1992.

b) HDPE producers expect this to exceed 10 per cent in 1991.

Source: Product chapters of this volume.

6.4 Additional costs and benefits involved in the choice of packaging

The beverage or food processor or distributor makes a choice between types of packaging according to their price and physical and aesthetic characteristics. The disposability and biodegradability of the packaging, the costs of disposing of it, and the environmental damage which it can cause as litter, are not necessarily reflected in market prices. This means that the choice made between forms of packaging may not be one which is best from the point of view of society as a whole. These are issues considered in Volume I.

6.5 Government initiatives

The Australian and New Zealand Environment Council has released draft guidelines on all packaging produced and used in Australia (ANZEC 1990a). The draft was prepared by the Packaging Task Force comprising representatives from government, industry and consumer and conservation groups.

The guidelines are intended to encourage 'the most efficient packaging practices that recognise the need to balance the essential role of packaging with minimisation of resource use, litter and pollution' They call for targets directed at a reduction in packaging waste.

The targets are to be refined as the data base is improved, but the provisional target for domestic packaging suggests a 50 kg per capita reduction by weight by 31 December 2000 over 1991 levels. The corresponding target for industrial packaging implies a 50 per cent reduction over 1992 levels. The draft guidelines state that a regulatory framework may be necessary if monitoring indicates lack of progress in achieving targets by voluntary means. The draft was released for public comment. during the period November 1990 - February 1991.

As discussed in Chapter 7 of Volume 1, the Commission considers that the community should avoid an unduly regulatory approach to waste minimisation and recycling. Rather, the focus should be upon reforms which will allow waste management and recycling markets to work better. Reforms in these areas will benefit the community in their own right - whether or not they lead to less packaging or more recycling.

There is a danger that by targeting packaging, governments will contribute to a greater use of resources in other ways. Packaging adds to convenience and consumer choice and lessens spoilage and waste. Impediments to the best use of packaging are not addressed by the blanket targeting of packaging waste.

7 CONTAINER DEPOSIT LEGISLATION (CDL) AND REUSE

Across Australia current recycling and refilling[1] schemes achieve about a 53 per cent recovery rate (by weight) of beer and soft drink containers. Container deposit legislation (CDL) is one option to increase recovery rates.

South Australia is the only State with CDL. The legislation requires a mandatory deposit to be paid on certain nominated containers. Great interest was shown by participants in the CDL issue and its implications for recycling. One group, comprising the producers of containers, argued strongly against it and against any extension of the legislation to other States. Others, including Friends of the Earth, Conservation Council of South Australia, Wilderness Society, Australian Consumers Association, Ecopaper Pty Ltd, Marine Collectors Association of Western Australia, the South Australian Waste Management Commission, and the South Australian Government argued for CDL.

7.1 The South Australian scheme

The deposit scheme in South Australia is governed by the Beverage Container Act 1975 (and amendments). The legislation requires a deposit on containers for products defined as beverages under the Act, with exemptions granted by Regulation. Containers which have been exempted are glass containers for cider, wine and spirituous liquors; containers (other than those made of plastic) for. milk; cardboard and/or plastic and/or foil casks containing at least one litre of wine, wine-based beverage or water; and sachets constructed of plastic and/or foil containing at least 250 ml of wine. Fruit juices are presently not defined as beverages under the Act and as such are exempt from the scheme[2]. Refillable softdrink containers have

[1] Recycling refers to the reuse of products (eg a glass bottle) or their packaging materials (eg cullet) in new forms (eg a new glass bottle or food jar) while refilling refers to the reuse of products (eg glass bottle) after washing and cleaning in their original form.

[2] Jam/pickles/ baby food and other non-beverage jars are also excluded from the deposit scheme. For a comprehensive list of exempt containers refer 'Regulations under the Beverage Container Act, 1975, No. 45 of 1990,' *South Australian Government Gazette*, 5 April 1990, pp. 968-971.

been exempted from the Act by Regulation but have voluntary deposits of 10 cents and 20 cents per container (refer Table 7.1).

In South Australia, CDL took effect from September 1977. The aims were essentially three-fold: to reduce litter; to reduce solid waste; and to bring about a rational policy for the conservation of resources. These aims were to be achieved by further encouraging the use of refillable bottles or discouraging any trend toward non-refillable containers by making packaging manufacturers and users accept some responsibility for the containers they use.

The Act attempts to make the user of a container who discards it rather than recycles it pay by losing the refundable deposit, as well as give an incentive to others to collect discarded containers in order to claim the refund. The rationale is mostly based on the 'public good' argument that without institutional enforcement of some kind, the users of containers do not pay for the cost of littering the environment and are not rewarded for the thoughtful disposal of rubbish.

7.2 Deposits payable

On 5 April 1990, subsequent to a High Court judgment[3] making it invalid to discriminate between refillable and non-refillable containers serving the same market, the South Australian Government introduced a new set of deposits for containers. Current deposit levels payable on containers in

[3] High Court of Australia, *Castlemaine Tooheys Ltd and others vs. The State of South Australia,* 7 February 1990. In 1986 interstate brewer, Castlemaine Tooheys and others (Bond brewing companies and retailers of their beer in South Australia), challenged on constitutional grounds (section 92 requires free trade between States) the validity of the South Australian CDL that (1) increased the deposit rate for non-refillable beer containers from 5 cents to 15 cents per container while leaving the deposit on refillables at 5 cents per container (2) required the use of the centralised collection system and prior approval of bottle specifications. The Court ruled that it was valid for the South Australian Government to impose the deposit and the return system but invalid for it to discriminate between non-refillable and refillable bottles.

South Australia are shown in Table 7.1. CDL deposits comprise between 2 to 13 per cent of the retail sale price; of affected containers.

As shown in Table 7.1 there was a large difference between the deposits on refillable and non-refillable containers prior to the High Court decision. This difference has been removed, but exempt containers such as cider, fruit juice, wine and spirit containers are still excluded from deposit requirements.

Refunds on containers with deposits are paid at point of sale or collection depots. Collection depots are located throughout metropolitan Adelaide and in the larger country towns.[4] From there and from sales points they are collected by industry agents for reuse or reprocessing.

7.3 Benefits and costs of CDL

The proponents of CDL stated that the key benefits of CDL include a significant increase in the rate of reuse and reprocessing of containers, a reduction in the amount of litter, and a saving in waste disposal costs. Opponents said it achieved these objectives at very high costs compared with alternative measures. They argued that the proportion of containers carrying deposits may decrease in the litter stream, but total litter levels do not fall. Rather the mix of containers used is changed away from those desired by consumers; distributors incur extra costs; beverage producers lose sales when they have to impose higher prices due to increased costs; container manufacturers also lose sales because of higher costs, and overall there may be less competition from potential new entrants into the industry.

Litter reduction

The South Australian Waste Management Commission (SAWMC) stated that CDL has generally achieved recovery of between 80 to 95 per cent of soft drink and beer bottles and cans compared with the much lower rates of

4 For details of how the system operates refer Business Regulation Review Unit (BRRU), *Container Deposit Legislation and the Control of Litter and Waste*, Information Paper No. 14, AGPS, June 1989, Chapter 2

Table 7.1: Deposits payable on beverage containers in South Australia

Container	*Deposits refundable per container*	*Proportion of retail price* [a]	*Refund payable at*
	cents	*per cent*	*location*
Voluntary			
Softdrink bottles			
500 ml and above	20	13	Sale point
Less than 500 ml	10	11	Sale point
Required by Act			
Softdrink non-refillable bottles	5	5	Sale point
Softdrink cans and spirit based mixers (cans)	5	5-Spirit 5-SDC [b]	Collection depot
Softdrink PET 2 L bottles	5	2	Collection depot
375 ml and 750 ml refillable beer bottles	5	2-750 ml 4-375 ml	Collection depot
375 ml refillable or non-refillable wine cooler bottles	5(4) [c]	3	Collection depot
Beer cans	5(15) c	4	Collection depot
Non-refillable beer bottles	5	4-local 2-imported	Collection depot
Non-refillable beer bottles	10(15) c	2	Sale point
Plastic milk containers	5	4	Collection depot
Some Exempt Containers [d]			
Non-refillable cider or juice containers	0	0	
Non-refillable wine or spirit containers	0	0	
Milk cartons other than plastic	0	0	

a) Per cent of sales price in a local supermarket, rounded to nearest whole number. B) Softdrink cans. C) Figures in brackets were deposits before the High Court decision. D) For a list of other exempt containers refer page 1 of this Chapter.

Source: SADEP, 14 August 1990

recovery of 43 per cent for beverage glass in New South Wales and about 50 per cent for cans in non-CDL States (refer Table 7.2). The SAWMC stated that it was clear from surveys that CDL had reduced the amount of bottles and cans in the litter stream compared with the States without CDL. The proportion of the litter stream comprised of beverage containers is said to have fallen in South Australia from 14 per cent in 1975 to 8 per cent in 1986. The proportion more than doubled from 9 per cent in 1978 to 19 per cent in 1986 in New South Wales. The SAWMC quoted a South Australian Department of Environment and Planning (SADEP) litter survey in Bordertown, South Australia, in 1988-89 to illustrate the effectiveness of CDL in reducing litter. The number of non-returnable bottles and cans in the litter stream not carrying deposits was nearly five times that of deposit containers.

The Litter Research Association (LRA) argued that there is little evidence to suggest that increased recycling, by itself, has any significant impact on litter. It also suggested that any extension of CDL to the other States may be followed by some decrease in the beverage component of litter but there would be little effect on total litter levels. It stated that in the United States it is commonly accepted that the proportion of litter related to beer and soft drink decreases dramatically after the introduction of CDL, while non-beverage and total litter counts are unlikely to change significantly. It stated that for South Australia the outcome is unclear and quoted Business Regulation and Review Unit (BRRU 1989) litter data for the period December 1987 to February 1988 which indicated that in Victoria, Queensland, Western Australia and Tasmania the proportion of glass and cans in litter was actually lower than in South Australia, and that only New South Wales and the Northern Territory had a higher proportion of glass in litter.

In Australia there is no agreed assessment about what the data imply about the impact of CDL on litter levels. The LRA stated that beverage-related litter accounts for about 10 to 30 per cent of all litter (by unit count) in Australia. Beverage containers contribute perhaps two thirds of this (the remainder being tops and seals). Beer and soft drink containers represent around 5 to 15 per cent of total litter, the remainder being paper cartons and plastic containers. Beer and soft drink containers therefore account for a small part of the litter stream. The LRA argued that even the removal of all beer and soft drink containers from the litter stream would leave much of the litter problem unsolved.

Container	*South Australia*	*New South Wales*	*Australia*
		per cent	
Beer bottles			
750 ml	93		
375 ml	82		
Refillable Coke bottles	95		
Beverage glass bottles	43		
Cans	85	63	56a

a) Includes SA return figures. Without these, the SAWMC estimates this figure would be about 50 per cent.

Source: SAWMC, Submission No. 67, p. 6.

Comalco said that while, Australia-wide, beverage containers constitute less than 10 per cent of the litter stream, in South Australia they account for 15 per cent of litter, the highest nationally. The figure for Victoria is less than 10 per cent. Comalco claimed that CDL, even as a measure attempting to affect only a part of the litter stream, is ineffective in its impact. The Australian Soft Drink Association (ASDA) noted that the counts done by Keep Australia Beautiful Council did not show any decrease in littering following the introduction of CDL in South Australia, and suggested that this may be due to CDL imposing a penalty (cost) which fails to discriminate between consumers who contribute to the litter and those that do not, as well as it being a measure that: only attacked a small part of the litter stream.

The BRRU study concluded from the limited data available to it that CDL had not reduced litter in South Australia. It said that litter count comparisons between States indicate that litter in South Australia is not less than in other States and that the components of the South Australian litter stream were not markedly different from those of Australia as a whole. It said however that South Australian litter appeared to have more bottle tops and juice cartons and fewer cans, suggesting that deposit legislation had caused some substitution of one type of litter for another.

The study cautioned against attributing any changes in litter counts to CDL as other activities were taking place at the same time (eg a $20 littering fine and a higher ‘Keep Australia Beautiful’ expenditure in SA than in other States). On the other, it can be argued that the threat of CDL led to antilitter activities by the LRA and would have reduced the amount of litter in other States.

Friends of the Earth (Fitzroy) submitted articles showing that the initial impact of deposits in the United States was to sharply decrease beverage container litter and encourage reuse, and also to divert about 5 per cent of the waste steam from the disposal system. The California Public Interest Research Group, University of California and the Stanford Environmental Law Society (CalPIRG-ELS) Study Group Report stated that in every State surveyed, deposit laws reduced total litter volume by about 35 to 45 per cent. Miller (1990, p. 474) quoted United States Environment Protection Authority and General Accounting Office studies which estimated that deposit laws would reduce roadside beverage litter by 60 to 70 per cent.

Hatch (1990) argued that the BRRU study had not presented adequate data on litter trends to support its finding that CDL has had little or no impact. The Hatch critique argued that because of the shortcomings of the data and the different methods of waste collection it was impossible to compare litter levels on a State to State basis. The Pearce critique of BRRU (Pearce 1990) also disagreed with the assessment that CDL did not lead to lower levels of litter. Pearce stated that this was not the experience with litter schemes overseas. He quoted studies in the United States where CDL has been associated with reductions in litter eg Maine (15%), Oregon (10.6 % reduction after one year), Michigan (beverage litter decreased) and New York (very little change in littering). Pearce stated:

> Industry sources in the US, whilst vigorously opposing CDL, tend to accept urban litter reduction estimates of 10 per cent and rural litter reductions of 20 per cent.

Assuming a 12 per cent average rate of reduction in litter levels, Pearce estimated Australian total pick-up cost savings at $6 million to $10 million (broadly in line with the BRRU estimates of $12 million to $14 million, before the BRRU report concluded that benefits were zero because CDL did not affect litter).

If litter levels are reduced by CDL (the Commission does not have conclusive evidence that supports this for Australia) total pick-up cost savings could be of the order of $15 million. There could also be benefits from avoided 'eyesore' and lower levels of injuries (eg from broken glass).

Container mix

As the South Australian CDL does not impose deposits on all beverage containers, it discriminates against those containers (and their products) affected by the CDL, compared with competing containers and their products. The outcome in respect of the mix of containers used, after CDL has been in force for some time, depends on the response of consumers and the beverage industry to CDL.

The application of CDL in South Australia favored a dominance of refillable containers over single use containers (refer Table 7.3). This has been changed by the High Court decision which has led to both refillable and non-refillable beer bottles having the same deposit redeemable at collection depots (refer Table 7.1).

Between 1976 and 1988 the South Australian beverage industry decreased its total use of cans by about 63 per cent (to 16 per cent for soft drinks and 3 per cent for beer - refer Table 7.3). It increased its already high use of refillable glass bottles for beer from 82 per cent to 96 per cent, though the volume of soft drinks sold in refillable glass fell from 64 to 58 per cent. This compares with only 10 per cent of beer sales and 3 per cent soft drink sales in refillable bottles in the rest of Australia, with the balance sold in non-refillable containers and cans.

The LRA stated that recent reports from the soft drink industry in South Australia indicate that the share of refillables has dropped sharply since

1988 and now accounts for less than 50 per cent of the market. At the same time there has been a further shift in demand away from cans, and a slower than average increase in demand for PET. In beer however, virtually the whole market is supplied with refillable bottles.

Table 7.3: Container mix, beer and soft drink: South Australia 1976, 1988 and rest of Australia 1989

Year ending June 30		*South Australia*	*Rest of Australia*
	1976	*1988*	*1989*
		per cent of volume sold	
Soft Drinks			
Refillable glass	64	58	3
Non-refillable glass	0	0	21
Cans	36	16	33
PET	0	26	43
Beer			
Refillable glass	82	96	10
Non-refillable glass	2	1	47
Cans	15	3	43

Source: LRA, Submission No. 256, p. 58, quoting BRRU, McGregor and Parish (1985) and McLennan Magasanik Associates estimates.

The LRA estimated the likely national outcome from, introducing CDL, assuming no change in the current Australian container mix (unlike the IAC [5] and the BRRU studies which assumed a South Australian container mix for the entire country). This assumption may better approximate the final post CDL outcome given the High Court decision that there were insufficient grounds to warrant the difference in treatment between refillables and non-refillables beer bottles serving the same market. The South Australian deposit rates for refillables and non-refillables are also now the same (refer Table 7.1). In addition, the South Australian market

[5] The IAC study did look at alternative scenarios but chose this as its preferred one.

had a higher proportion of refillable containers than other States even before CDL.[6]

The LRA argued that an extension of CDL would lead to many costs for different groups in the community. These costs were also analysed by the earlier studies and are discussed in the following sections.

Other effects of CDL

Apart from affecting a part of the litter and waste stream and the containers mix, CDL affects beverage producers, retailers, consumers, and container manufacturers in different ways. Details of these possible effects are discussed extensively in both the IAC and BRRU studies,[7] and have been raised widely by various participants in this inquiry, including the LRA, the South Australian Government and the South Australian Conservation Council. The Hatch and the Pearce critiques of the BRRU study also discussed some of these.

On distributors

Wholesalers, retailers and specialist container-collection agents[8] incur extra handling, transport and storage costs.

The LRA stated that retailers who accept deposits and returns allocate time, space and labour to the collection, storage and accounting required by CDL. Estimates of these costs range from 4.5 to 7 cents per container. The net cost of each soft drink non-refillable container collected (ie current collection costs less value of container) is 1.35 cents per large glass bottle,

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[6] When South Australia introduced CDL in 1977, it was a market where refillable bottles held almost two-thirds of the soft drink market and over 80 per cent of the beer market. In the rest of Australia now refillable glass holds only a 3 per cent share of the soft drink market and 10 per cent of the beer market.

[7] Refer IAC, Glass and Glassware, Report No. 404, 24 June 1987 and Business Regulations Review Unit, Container Deposit Legislation and the Control of Litter and Waste, Information Paper No. 14, AGPS, June 1989.

[8] For an extensive discussion of the roles of these operatives in the CDL system in South Australia refer BRRU, op. cit., Chapter 2.

0.5 cents per small glass bottle and about 1 cent per PET bottle. Aluminium cans are valued at about current collection costs.

The LRA assumed that all soft drink glass containers outside South Australia are returned to retailers which added $22 million annually to the costs of retailers. It is also assumed that both refillable and non-refillable

bottles are then returned through ‘supercollectors’ [9] to fillers and manufacturers at a cost of about 5.4 cents for small bottles and 9.6 cents for large bottles costing an additional $23 million annually, offset partly by savings of the order of $9 million from increased scrap value and refillable bottle saving.

Given the LRA's assumption that the container mix would not change if CDL were extended to the other States, it is unlikely that all the costs identified would be additional to the existing voluntary collection costs, and due to CDL. At least some of the supercollector costs identified would already be incurred under existing voluntary systems. It is also likely that producers and distributors would design innovative distribution and collection systems leading to lower cost increases than quoted by LRA. For example manufacturers may be arrange for the backloading of empties when delivering the next load of drinks (without going through supercollectors). Notwithstanding this, it is likely that in the long run the net costs of handling containers will remain a very important cost of the CDL system. The Syrek study (Syrek 1986) cites the New York Temporary State Commission on Returnable Beverage Containers which concludes `in the long run, prices will rise by about the total net costs of handling containers.’

On beverage producers

Beverage producers including Coca-Cola stated that CDL discriminates against beverages by imposing extra costs on them which are not imposed upon competing products such as cider and fruit juices. They argued that these higher costs are likely to result in significantly higher retail prices for

9 The CDL legislation refers to a super collector as one to whom the beverage producer pays the statutory deposit rate plus a handling fee for all deposit containers it collects.

beverages thereby placing them at a competitive disadvantage in the market.

Beverage producers affected by CDL incur additional costs associated with the retrieval of containers and washing of bottles, [10] but make cost savings from using fewer new containers and gain from unrecouped container deposits. The IAC (IAC 1987) and BRRU studies indicate that it is likely that the cost increases will outweigh the gains. Prices of beverages affected are likely to be raised and output lowered. The IAC estimated a reduction in demand of 1 to 2 per cent for packaged beer and 4 to 7 per cent for packaged soft drinks. The BRRU estimated a 6.2 per cent drop in the sales of beer and a 7 per cent drop in the sales of soft drinks. The LRA considered that retail prices of beverages would rise by about 1 per cent (they stated this much lower price rise estimate was due to the milder scenario assumed ie there will be no change in the container mix in the other States after CDL).

Some participants disputed that CDL-imposed costs on beverage manufacturers lead to beverage price increases. The Australian Consumers Association stated that ‘beer and soft drink are not more costly in South Australia.’ The Conservation Council of South Australia presented a survey of market prices per litre of soft drinks in various containers conducted between 16 February 1990 and 1 March 1990 and concluded ‘the cheapest soft drink by far ... is the soft drink with the highest deposit.’ The South Australian Government presented a comparative price survey of Coca Cola products sold in Woolworth’s supermarkets in various States on 16 January 1990 and argued:

> the price data included in our submission suggests that CDL has not resulted in any significant increase in beverage prices in South Australia compared to the rest of Australia.

The ASDA submitted wholesale price data from three of its members showing that the net wholesale prices were in general highest in South Australia. However, ASDA's data refer only to softdrinks in PET containers and cans. The South Australian Department of Environment and Planning suggested these could cost more in South Australia for a

10 In addition refillables cannot be used on high speed filling lines as they are not engineered to fine enough tolerances

range of reasons other than the impact of CDL. They referred in particular to increased costs resulting from the fact that these containers constitute a much smaller share of the market in South Australia, where refillable bottles predominate. The Department argued that PET production costs are higher in South Australia because there are not the economies of scale and that canned softdrinks would have higher transport costs because there is no can manufacture in that State.

A large soft drink manufacturer submitted confidential data to the Commission on the average wholesale price of five of its different soft drink products (net of deposit) sold by it over the last five years in all the major capital cities. The data show that the price was highest in Adelaide for at least three or four products every year compared with the price of the same product in other capital cities.

ASDA argued that wholesale prices were better indicators of cost of production than retail prices. It stated:

> Retail prices will be directly affected by not only the production cost but also the labour costs of retailing and other economic considerations peculiar to the state.

Comparing prices of beverages is of limited use in assessing the impact of CDL. Retail prices for example vary significantly for the same product in different locations and at different times, and sometimes even at the same location and time (eg stock of different dates). Prices vary for a host of reasons including products used as the promotional package or loss leader. Coca Cola stated that as the 1 litre refillable bottle in South Australia is a package that can be returned to the point of sale (unlike cans and PET which must be returned to a collection centre to have the deposit refunded) some sellers favor the 1 litre glass container because it invariably means repeat sales. In addition, it stated that as a loss leader (soft drinks are one of the highest selling items in a foodstore), foodstore chains promote leading brand soft drinks at a loss just to encourage consumers into the store on the expectation they will purchase other items. The entire market conditions have to be taken into account when comparing retail prices between capital cities.

On container manufacturers

Container manufacturers affected by CDL are likely to face a fall in the demand for their containers arising from a fall in beverage demand if retail beverage prices increase (net of deposit).

The IAC estimated that for the combined beer and soft drink market the demand for new containers would decline by 56 per cent. The BRRU estimated that the demand for new containers would fall by about 69 per cent for glass containers (82 per cent for softdrink and 63 per cent for beer containers), 76 per cent for aluminium cans and 45 per cent for PET containers.

The South Australian Government disputed these estimates. It said that the estimates reflect views based on a confusion between the effects of adjustment costs and real long-run costs and that:

> where the outcome is unknown because there is insufficient quality information, there should not be speculation as to percentage declines. If manufacturers such as South Australian Brewing are able to gain a competitive advantage from CDL then there must even be potential for reduced costs and increased sales.

Hatch stated:

> the nexus between costs and prices is complex, but there is no evidence of a cost disadvantage in S.A.

On competition

The imposition of deposits on containers also acts as a trade barrier as bottle collection is very costly and can make it uneconomic for importers or competitors to supply from distant sources outside South Australia. In the EEC some governments have introduced deposit legislation where:

> It is clear ... that protection for home industries is the real motive for the legislation - environmental protection has emerged as a legitimate cover (Stocker, 1989)

Table 7.1 shows that in South Australia the deposit rate for non-refillable beer bottles at sale point (where any competition from interstate beer is most likely to take place) is 10 cents per container compared with 5 cents at collection depots. This difference reflects in part the cost of operating depots. It could however constrain competition from interstate beer producers, as they may not find it economic to accept the bottles collected, unlike local manufacturers facing relatively lower transport charges. The SADEP nevertheless will be reviewing the deposit rates schedule to ensure that the CDL cannot be challenged under Section 92 of the Constitution.

The system of licensing collectors adopted in South Australia also constrains competition between collectors and the entry of new collectors into the system as existing central collectors would have to be prepared to take delivery of a new collector's containers. Manufacturers wanting to set up their own collection centres are also prevented from doing so by the Act.

The LRA quoted studies that claim that dominant established producers would be favored and there would be decreased competition (McGregor and Parish 1985), and that future technological innovation would be constrained (Scott 1983).

On consumers

Consumers are likely to face increased prices for beverages affected by CDL. This is because producers and retailers would pass on some of their increased costs. The South Australian Department of the Environment disputes this argument; in a study of the economic impact of CDL in South Australia published in March 1980 it concluded that CDL did not increase the retail price of beverages. The LRA contests the results of this study on the grounds that it was based on a system in which refillable bottles already controlled a large portion of the market. The LRA stated that the retail prices would increase by about 1 per cent and the quantity demanded decrease, implying a loss to the consumer of about $100 million annually (being a transfer this is not included by the LRA as an economic cost).

The IAC study in 1987 estimated that consumer prices would increase by 2 to 5 per cent for beer and by 7 to 14 per cent for soft drinks. The BRRU report estimated price increases of 7 per cent for beer and 3.5 per cent for soft drink. Hatch disputes both of these estimates, arguing that the cost-price impact of CDL on beverages is not known and that smaller assumed price changes give significantly lower consumer and producer losses.

Consumers face inconvenience costs relating to the time taken to store and transport containers to recover money outlaid on deposits, which can only partly be offset by a switch in consumption to beverages in less-preferred but lower deposit containers. The IAC estimated inconvenience costs to consumers to be about 1.9 cents per litre for beer and 2.9 cents per litre for soft drinks in 1985-86 prices. The BRRU estimated inconvenience costs to be 3 cents per litre for both beer and soft drinks. The LRA estimated this inconvenience cost to be about 2 to 2.4 cents per container in 1989-90 prices or about $82 million in aggregate annually. Both the increased prices and inconvenience costs will contribute to lower beverage sales.

Hatch argued that the increasing awareness of environmental matters may have decreased the amount of deposit required to encourage the return of containers by consumers. Hatch considered the BRRU estimate of the inconvenience of the order of $51 million to be ‘a considerable overestimate’. The Hatch study has not established that inconvenience costs would decrease, but that they could be transferred to those consumers who gain satisfaction from participating in the CDL program (including any perceived environmental and other benefits from it).

Brickwood Holdings Pty Ltd claimed that it is inequitable and possibly illegal, and contrary to the public interest, for the South Australian Government to allow a carton, made from imported board, to flourish, while imposing a deposit on HDPE milk containers. There is no recycling of milk cartons in South Australia. Brickwood argued that any system that imposes a penalty on one package and not the other would have effects quite contrary to those desired by the community. It stated that no milk is packaged in HDPE in South Australia or Tasmania whereas it is in Victoria, New South Wales, Western Australia and New Zealand.

On resource use

The LRA agreed that an extension of CDL Australia-wide would result in some conservation of materials: mainly sand, bauxite etc, some conservation of energy and a decrease in total landfill used by up to 3 per cent per annum. The ASDA stated that when CDL is introduced water, fossil fuel, and energy resources are needed to service the system. Water is required to wash and sterilise the containers, fossil fuel to transport empty containers and electricity is used to wash refillable containers. These issues are discussed in Volume I.

The South Australian Government stated that this argument assumed that a CDL system must lead to the use of refillable containers. It argued that this is not necessarily the case and that CDL worked equally with non-refillable and refillable containers.

On waste and recycling systems

To the extent CDL forces reuse of some containers and reduces beverage demand, it saves community outlays on solid waste collection and disposal costs. On the basis of 1987-88 data, the BRRU estimated that the introduction of South Australian-type CDL in the rest of Australia would result in about 277 000 fewer tonnes of household garbage being delivered each year to landfills, leading to a saving of some $13.85 million annually (the BRRU assumed a solid waste collection and disposal cost of $50 per tonne). This compares with the IAC's estimate of savings in waste disposal costs of $26 million per year.

Hatch challenged the BRRU's estimates as being too low as they did not fully take into account the high cost of land alienation in densely populated areas. In addition, Hatch stated that given the likelihood of more distant tips having to be used in the future, landfill costs can be expected to rise in real terms over time, as the opportunity costs of inner urban land rises. Pearce also considered that the benefits from reduced waste disposal will rise as the availability of suitable space for landfill sites diminishes. These intertemporal effects of CDL need to be considered in addition to others (such as the likely decrease in consumer inconvenience costs over time), suitably discounted to present value equivalents. Such analysis will make large demands on data and depend on the assumptions used, such as the discount rate.

The ABS/IC waste management survey indicates that the total outlay for waste collection and disposal by local government councils and regional authorities in 1989 was $469 million. In Table 7.4 this and other data are used to estimate the waste collection and disposal savings. The saving of about $28 million (in 1989 dollars) is less than the IAC's estimate in real terms. The higher total waste collection and disposal outlays are partly offset by the lower proportion of containers in the total waste. The data available to the IAC in 1987 indicated that the proportion of containers in the waste stream was 12.6 per cent for glass (now believed to be 8.6 per cent) and 0.7 per cent for aluminium cans (now 0.3 per cent). Higher prices for beverages affected by CDL are, however, also likely to

lead to a shift of demand to other beverages, such as non-carbonated soft drinks or fruit juices, leading to more use of paper or plastic containers currently recycled to a lesser extent, thereby adding to the litter stream.

Table 7.4: Potential waste disposal cost savings due to Container Deposit Legislation

Container	*Cost of waste disposal* [a]	*Proportion in total waste* [b]	*Cost of waste disposal*	*Pre-CDL return rate*	*Post-CDL return rate*	*Waste disposal savings*
	$m	*%*	*$m*	*%*	*%*	*$m*
Glass bottles	na	8.6	40.3	25	75	26.9
Aluminium cans	na	0.3	1.4	55	80	0.8
Total	469	8.9	41.7	-	-	27.7

na not available.

a) Total Council outlays in 1989 for waste collection and disposal of waste (ABS/IC waste management survey, October 1990). b) Based on NSW Waste Management survey in 3 local government areas in 1986 (Waste Management Authority of New South Wales, Sydney Solid Waste Management Strategy, May 1990, p.22).

Many participants argued that CDL can encourage the return of containers to the sales points and collection depots but that such returns adversely affect the viability of multi-product kerbside collection systems. Some of the containers returned, such as glass containers and aluminium cans, are important revenue earners to any kerbside collection system. The lack of such valued materials in domestic waste can adversely affect the collection of other materials from the domestic waste stream.

Coca-Cola Amatil stated that CDL only applies to part of the waste stream and does not address the substantial solid waste problem, and is more costly than other available alternatives (eg comprehensive kerbside collection programs). It agreed with some other participants that CDL was incompatible with recycling programs as the most valuable items, aluminium cans and bottles, are taken out of the kerbside collection system. Other recyclables collected before the introduction of CDL, such as food jars and steel cans, may now not be profitable to collect and reprocess. The cost of door-to-door collection together with CDL in effect is likely to be higher than that of door-to-door collection alone.

With the introduction of CDL, multi-material door-to-door collectors and voluntary collection centres operating outside any approved collection depot system are likely be made worse off. There may be some offset by an increase in other low-skill jobs to service the return, storage and sorting of containers.

Table 7.5: Return rates for CDL option

Container	*Return rates*		*Trippage*	
	Current CDL-SA	*Likely outcome Rest of Australia*	*Current CDL-SA*	*Likely outcome Rest of Australia*
	per cent		*Number of trips*	
Soft Drinks				
Refillable glass (small & large)	95[a]	84	14	5.5
Non-refillable glass	90	84	-	-
Cans	85	80	-	-
PET	80	78	-	-
Beer				
Refillable glass				
small	82	77	5	4
large	90	82	8	5
Non-refillable glass	85	77	-	-
Cans	85	80	-	-

a) GPIA estimates that this rate is now 96 %.

Source: LRA, Submission No. 256. p. 60.

Any extension of CDL to the other States is also likely to lead to a reduction in the current ‘voluntary’ contributions to litter reduction programs by the beverage industry in non-CDL States.

The LRA estimated return rates for containers if CDL were introduced to the rest of Australia (refer Table 7.5). The overall recovery rate is expected to be 81 per cent for glass, and 80 per cent for aluminium and PET. The LRA stated that it expected there to be little recovery of those glass containers not covered by a CDL scheme (ie about 25 per cent of total glass containers).

7.4 Would CDL bring net community benefits?

Most studies undertaken indicate that using the CDL option to reduce litter and waste disposal costs by increasing the reuse of containers is costly (refer Table 7.6). These studies indicate that the total consumer/producer losses would range from about $136 million to $499 million (about $136 million to $580 million in 1989-90 dollars) while litter and waste disposal cost savings would only be between about $14 million to $26 million (about $16 million to $35 million in 1989-90 dollars). The studies by the IAC (IAC 1987) and the BRRU which showed larger losses estimated the net benefits of extending the South Australian type of CDL legislation to the rest of Australia when there was a significant difference in the deposits on refillable and non-refillable containers in South Australia. The LRA estimated the impact of any CDL extension assuming that no container mix changes occurred in the other States.

The IAC study estimated that beverage producers would lose $30 million to $49 million per annum and consumers $177 million to $294 million per annum in 1985-86 dollars, assuming a production cost increase of 10 to 20 per cent. The total loss in the beverage market would therefore be about $246 million to $396 million (including the consumer loss of $46 million from added inconvenience). This loss was stated to be highly sensitive to the assumed production cost increases. The BRRU study included measurement of the change in returns to aluminium cans and PET bottle producers, unlike the IAC study which only considered glass bottle producers in detail.

Table 7.6: Losses estimated from extending CDL to rest of Australia

Type of loss	Loss ($ millions) [a] estimated by:		
	IAC [b]	BRRU [c]	LRA [d]
1. Consumer loss from cost increase	177-294 (241-400)	349 (405)	ne ne
2. Consumer loss from added inconvenience	46 [e] (63)	51 (59)	82
3. Producer loss from costs and consumer inconvenience	30-49 (41-67)	99 (115)	ne
4. Net cost to retailers	ne	36 (42)	22
5. Net cost to collectors	ne	44 (51)	14 [f]
6. Total consumer/producer loss	246-396 [g] (335-539)	499 (578)	136
7. Litter and waste disposal cost savings	26 (35)	14 (16)	25

ne: not estimated

a) Figures in brackets are the original estimates inflated by the Consumer Price Index to 1989-90 dollars (refer ABS Cat. No. 6401.0). b) In 1985-86 dollars. c) In 1987-88 dollars. For parameter values used by BRRU refer Table 3. d) In 1989-90 dollars. e) IAC, Glass and Glassware, Report No. 404, June 1987, p. M.26. IAC assume a 10 to 20 per cent cost increase and an 8 cent deposit. f) LRA assume that all bottles are returned through supercollectors costing $23 million less scrap value and refillable bottle savings of $9 million, g) The consumer loss from added inconvenience has been included to make it comparable to the BRRU estimate.

Source: IAC 1987, *Glass and Glassware,* Report No. 404, AGPS, Canberra, 24 June. BRRU 1989, *Container Deposit Legislation and the Control of Litter and Waste,* Information Paper No. 14, AGPS, June 1989. LRA, Submission No. 256.

The BRRU study assessed the costs at $100 million against producers from reduced demand and product price increases and $400 million against the consumer (in 1987-88 dollars) from higher net cost of products (price plus deposit), the cost of retrieving deposits, and the likely reduction in the range of products. According to these studies any, benefits arising from an extension of CDL to the rest of Australia would have to be large and outweigh these costs for there to be a net gain to the community.

The LRA stated that even if there is no change in container market shares, extension of CDL Australia-wide would be associated with high costs, some industry dislocation and loss in productivity. Retail prices of beverages affected would increase and demand would fall. Consumers would also suffer inconvenience. Door-to-door collection schemes would be unlikely to continue (being financially unviable) and collection of other materials would decrease. The LRA estimated that the net annual increase in costs of such an Australia-wide CDL scheme would be $136 million (excluding the impact of the CDL on the viability of multi-material household door-to-door collection schemes). If container market shares change to be closer to those in South Australia, the LRA expects these net costs to be higher.

Hatch and Pearce criticised the BRRU study as being deficient on grounds partly discussed earlier. In particular the Hatch study stated that the BRRU results were highly dependent on suspect cost increases, data 'being based in the main on educated guesses: by "industry experts".' The Hatch critique estimated the effects of different assumed cost/price changes on the estimated total producer and consumer loss (refer Table 7.7). It did not however offer improved data to enable a better estimate of any likely cost/price effects. Instead it stated that the cost-price impact is not known, and argued that given the complex market situation, subject to technical change in containers, collection systems and rapid change in consumer preferences and perceptions, estimates of cost impacts are very problematical.

Given the High Court's decision which limits discrimination between products serving the same market, it is likely that any extension of CDL to other States in Australia would not have effects and losses as large as those assessed by the IAC and BRRU. Resulting changes to market shares of the containers used are unlikely to be as large, though distortions in production and consumption will remain from the exclusion of some products from the deposit scheme while including others. It is also likely that if the costs of setting up and running collection depots under CDL in other States are not as large as assessed by the LRA (it may be possible to replicate existing collection systems as well as introduce more innovative techniques of minimising transport, handling and other costs), the net loss to the community from any extension of CDL to the States could be less than that estimated by the LRA, ie $136 million per year.

Table 7.7: Effect of different estimates of cost/price changes on the estimated total loss, consumer plus producer

Assumed price change	*Estimated total loss with elasticity of supply = 2.7, elasticity of demand = 0.7.*		
	Beer	*Soft drinks*	*Total*
%	*$ million per annum*		
2	63	34	97
4	124	57	181
6	173	91	264
8	233	124	357
10	294	157	451
12	353	180	533

Source: Hatch, J 1990, *Review of Information Paper No. 14 of the BRRU,* The Centre for South Australian Economic Studies, Adelaide, p.17.

These costs have to be set against the benefits of any extension of CDL to the other States. These include possible maximum savings of litter pick-up costs of up to $15 million (some like the BRRU argue that there is no litter reduction and therefore no savings). In addition there are container waste disposal savings of about $28 million as well as the aesthetic benefits of a cleaner environment, the gains from fewer injuries and better health from less broken glass and litter and any lost earnings from tourism. A criticism frequently made of the studies undertaken is that they do not fully estimate these benefits of CDL in the context of rapidly changing consumer preferences and perceptions, such as a greater inclination by the public to do more for the environment. The Australian Consumers Association stated that the benefits of a cleaner, less hazardous environment, accessible beaches and cycleways have not been taken into account. The 1987 IAC study stated that given the lack of information, no attempt was made to measure the aesthetic and other benefits arising from a less littered environment between collections. The problems associated with such estimations are large and remain true today.

Hatch argued that CDL has relatively high consumer acceptance in South Australia and should be seen as part of a rapid change in consumer attitudes and tastes. It also claimed that the inconvenience costs of CDL have been overestimated in many such studies. When all these concerns are taken into account Hatch claimed that the case for or against CDL is unproven. Hatch however does not tender any conclusive studies of its own that establish that CDL leads to net benefits to the community.

The Packaging Council of Australia (PCA) stated that CDL neither controls litter nor conserves resources and its effect on waste minimisation and solid waste handling costs is minimal.

Pearce concludes:

> Only Australians can say if they would be willing to pay $60 per household per annum to make a fairly small reduction in litter, and there would have to be greater certainty that litter rates would fall.

Even if CDL has net costs or benefits the studies undertaken give no indication as to whether CDL is a better policy option than others. The net benefits from other policies may be higher. CDL is an indirect policy instrument when used to control littering. It is likely to be more efficient to control or penalise the act of littering as it is that act itself that results in littered products. The Syrek study of the cost effectiveness of litter control measures in the United States (Syrek 1986) found that litter control programs were 10 times more cost effective for beverage container reduction and 19 times more cost effective for total litter reduction than deposit legislation. Establishing and enforcing appropriate litter laws, education and anti-litter campaigns are alternatives that could be more cost effective.

The impact on recycling of past discriminatory deposits against non-refillable containers under CDL in South Australia has been to increase the level of reuse of refillable glass bottles and decrease that of non-refillable glass bottles and aluminium cans. CDL operates as a disincentive for the house-to-house collection of recyclables because it lowers the value of the remaining waste stream by lowering the quantities of high-value recyclables such as glass bottles, aluminium cans and any HDPE containers in it.

8 GOVERNMENT RECYCLING INITIATIVES IN AUSTRALIA

All levels of government in Australia have some influence on recycling.

Local governments have a major effect through their activities in waste disposal and in the collection and sale of some recyclables.

State and Territory governments variously affect recycling through their pricing policies for electricity, water, transport and access to raw materials such as timber and minerals. Their influence, and that of the Commonwealth Government, is also felt through industry policies and the controls they exercise over the use of natural resources and the environment. Some government initiatives, such as CDL in South Australia, are aimed directly at recycling. Others, such as constraints on the transport of toxic wastes, can have unintended consequences for recycling.

The ways in which government policies influence the incentives to recycle are discussed in Volume I of this report.

This chapter lists the announced programs and policies of the Commonwealth, State and Territory Governments in relation to the recycling of products.

8.1 Commonwealth Government

Early in 1990, a report by the Department of Administrative Services (DAS. 1990) examined aspects of recycling with emphasis upon recycled paper. It advised on technically appropriate applications for recycled paper, the establishment of a Commonwealth Government office paper recycling scheme, and an education campaign for Commonwealth employees. The report concluded that changes in government purchasing policies are unlikely to significantly change paper recycling in Australia. It recommended, *inter alia*, that the Commonwealth Government should:

- pursue an active, national policy of recycling paper from Commonwealth offices;

- encourage all departments to adopt a preferential purchasing policy towards products made from recycled materials;

- encourage all departments to adopt recycling, with the major focus on paper, glass, metal, plastic and lubricating oil; and

- ask all departments to comment on what costs will be incurred if departments are asked to pay more for recycled products, even if they are more expensive than products made from 'virgin' materials.

From January 1990, a major Commonwealth initiative to promote paper recycling has been the exemption from sales tax of certain paper products made wholly from recycled paper. The likely effects on the use of waste paper are discussed in Chapter 6 of Volume I.

The Commonwealth Department of the Arts, Sports, the Environment, Tourism and Territories (DASETT) has the responsibility for administering the environment policies of the Commonwealth, including its policies on recycling. The Minister has been active in bringing together industry, State government agencies and other interested parties at different levels to exchange information and discuss issues relating to recycling. It is proposed to establish a Commonwealth Environment Protection Authority to ensure uniformity of guidelines and standards across the country on environmental matters.

The Local Government Development Program which is administered by the Office of Local Government within the Department of Immigration, Local Government and Ethnic Affairs provides some assistance to the research or development stages of waste management or recycling schemes. In 1989-90, two out of a total of 86 projects were directly related to these fields. These were $35 000 provided to the Inner Metropolitan Regional Association in Melbourne for research into waste management and recycling, and $26 000 to the Circular Head Municipality in Tasmania for a study of the viability of recycling in sparsely populated rural areas. The two projects accounted for 3 per cent of a total funding of $2.15 million.

Many other policies of the Commonwealth Government impinge upon recycling. Of increasing importance will be policies directed at environmental protection. The Standing Committee on Agriculture has a working party to explore options for the management of chemical containers. A number of Commonwealth Government agencies are reported to be examining possible pollution and waste management measures including regulation, property rights, pricing of community-owned resources, tradable emission rights, taxes, charges, subsidies and grants (The Treasury 1990). Draft National Packaging Guidelines were released for public discussion in November 1990 (refer Chapter 6 of this volume).

8.2 State and Territory Governments

Most State and Territory Governments have released promotional material to encourage recycling. Victoria, Western Australia and South Australia have firm policies to increase recycling, whereas New South Wales, Queensland and Tasmania are still considering their approach.

New South Wales

In New South Wales recycling issues are largely the responsibility of a Recycling Committee within the Waste Management Authority, and the Recycling Administration Unit within the Department of Administrative Services. The Recycling Committee concentrates on the waste disposal part of recycling while the Administrative Unit is studying government procurement policies and other assistance to the recycling industry. There are proposals to establish an Environment Protection Authority to operate by 1 July 1991.

The Government has outlined a series of measures it is taking (or considering) to encourage recycling. In March 1990 the Government announced a strategy whereby all government departments must promote the recycling of materials such as paper, glass, metals, plastics and lubricating oil, and must adopt purchasing policies which accord preference to recycled materials. All departments are to detail their recycling performance in annual reports. In announcing the strategy the Premier said that the Government was determined to set an example in recycling ‘even if the adoption of the policies outlined meant that a higher cost had to be paid for some recycled products’.

On 30 July, 1990 the Premier stated that one of the measures being studied was legislation to make involvement in recycling mandatory for local

Councils within the Sydney, Newcastle and Wollongong regions. In a submission to the Commission, the Hunter Waste Advisory Panel expressed concern that mandatory recycling may be required, as some Councils are not currently willing to subsidise recycling services.

Other new measures under consideration include:

- setting quotas for the use of recycled material by government departments and statutory authorities (for example, 20 per cent of paper used to contain mostly recycled fibre by the end of 1991-92 with the level to increase in subsequent years).
- Local Councils which do not implement recycling programs to pay more for waste disposal than Councils that separate recyclable materials at source.
- a requirement that Local Councils provide information on their recycling performance in annual reports to their ratepayers.

A Council Recycling Rebate Scheme (CRR) announced by the WMA requires an additional $1.44 cents per tonne to be paid on all waste received by Councils or private waste depots, to be paid into a CRR fund from 12 January 1991. This fund, which will grow to about $1.75 million, will be fully rebated to Councils each quarter according to the tonnage of materials recycled in their area, on a pro-rata basis. A rebate of $17.50 per tonne of material is expected to be provided to Councils. The current levy of 56 cents will continue to be used to fund the operations of WMA.

The WMA has already provided $300 000 to fund recycling activities and research by local councils and private contractors over a 12 month period. Its brochure ‘Recycling in NSW’ has been circulated to householders throughout the State and has the stated aim of at least halving the amount of waste going out in household garbage.

The Recycling Administration Unit organises government purchasing of recycled products and is examining any impediments to purchasing recycled products, for example the implication for vehicle warranties of using recycled oil in government vehicles. The Unit is also responsible for contracting out government waste products and is gathering information on the type and quality of waste produced. A pilot project recycling various grades of waste paper, glass and aluminium is underway in several government offices.

The New South Wales Litter Research Association has provided industry funds for recycling and anti-litter purposes. The majority of its members are from the brewing, soft drink and packaging industries which provide virtually all of the Association's funds. The Association was formed in 1978 to fund voluntary environmental improvement activities and by the end of 1988 had contributed nearly $11 million to the Keep Australia Beautiful Council, the State Pollution Control Commission and the Metropolitan Waste Disposal Authority. The Association has pledged another $1 million to fund the State's ‘Do The Right Thing’ anti-litter campaign.

Victoria

Recycling issues and strategies are handled in Victoria by the Environment Protection Agency (EPA).

Following consideration of a 1984 Parliamentary report on ‘Beverage Container Deposit Legislation’, the Victorian Government placed a moratorium on deposit legislation. It directed the EPA to negotiate with industry a five year $4..2 million agreement to fund beverage container recycling and anti-litter activities. A Recycling and Litter Advisory Committee was also established with representatives from the beverage industry, recyclers, community interest groups, unions and the State Government.

A Recycling and Litter Advisory Committee (RALAC) has the task of investigating and reporting on the setting of recycling targets for each type of recyclable container where recycling is justified on social, economic or environmental grounds. It monitors performance measures for both recyclable and non-recyclable containers. The EPA is reviewing the need for a deposit system for beverage containers.

It is government policy to accord a preference to recycled paper. Several departments have implemented office paper recycling schemes and it is expected that the majority of offices will have done so by the end of 1990. The means and benefits of recycling office paper are being promoted to government employees.

A Task Force with representatives from government departments and the EPA provides advice on ways to co-ordinate government initiatives including assistance to firms proposing to develop de-inking facilities. In order to develop views and plans for newspaper recycling the EPA has also established a Newspaper Recycling Advisory Group, whose membership includes State officials and newspaper publishers. The Group's objective is to devise relief measures such as export assistance to keep waste newsprint collection services in working order until markets recover.

Funds for up to 50 per cent of project costs are available to municipalities or regional groups of councils under Municipal Waste Minimisation Grant Schemes. In the first round of applications there were 36 applicants and over $2 million worth of proposals. Other grants have been made to local governments for trial recycling projects such as a plastics shredder at the City of Nunawading recycling centre.

Grants have also been made to councils to provide residents with reusable recycling bags for the collection of glass and aluminium beverage containers. Currently 86 per cent of metropolitan councils and 40 per cent of non-metropolitan councils have kerbside collections using these bags. From May 1987 to April 1988 the EPA and RALAC assisted in a trial . recycling scheme in Geelong, based on house-to-house collection. The trial was designed to investigate ways of improving the recycling of domestic waste using a variety of source separation and collection techniques.

Financial assistance has also been provided to businesses, including a grant of $150 000 to ACI early in 1990 to assist in purchasing from the United States plant for its new PET recycling facility in Wodonga.

Public education on the benefits of recycling is addressed by promotional activities, advertising and brochures on waste minimisation, recycling and composting. A range of educational materials has been developed for Victorian school children.

In March 1989, the Government initiated the Green Spot consumer awareness program to promote environmentally sound products. An Advisory Panel was appointed to examine the feasibility and design of a scheme for labeling environmentally sound products. Its final report in December 1989 recommended that a national Green Spot labeling scheme be established immediately. The Victorian Government provided $300 000 in 1989-90 for the initial development of the scheme. The cost of a national launch was estimated at $3 million in 1990.

The EPA is reviewing Australian and international experience in recycling tyres, batteries and used lubricating oils. The aim is to establish a, program which will ensure that these wastes are minimised or recycled.

A proposed amendment to the Victorian EPA Act in 1989 would have required manufacturers to submit environmental impact reports on packaging or single use disposable products where the EPA considered that these goods could cause environmental harm or degradation. This amendment was withdrawn, but the Government has indicated that it will proceed with legislation to deal with this problem. The EPA has established a working party with the packaging industry to further develop the concept of industry codes of practice.

Queensland

A recycling program was launched by the Queensland Government in June 1990. A Ministerial recycling committee will be formed to promote recycling in government departments and the community 'by encouraging the collection of recyclable products and the use of recycled goods wherever practical and possible'. Several departments will trial the use of recycled office paper, recycled motor oil and plastic wood, and government procurement policy will include recycled products where this is practical.

Advertising and educational campaigns will be run to encourage recycling and information on recycling will be provided to schools. The Queensland Government will support local authorities which initiate their own recycling schemes.

Western Australia

In late 1989 the Government announced a goal of halving the amount of waste going to tips within 10 years. Recycling has been linked to goals of industrial development and is seen to provide opportunities for low-skilled job growth.

An Industries Recycling Unit has been established within the Ministry for Economic Development and Trade. It is to advise the relevant Ministers on matters relating to recycling and to help develop a strategy to achieve recycling objectives, including industry assistance measures. A Recycling Officer has been .appointed to the Environment Protection Authority to promote recycling to local government.

The Ministry of Economic Development and Trade has called for expressions of interest in establishing activities such as egg carton production from waste paper, and is to develop an incentives package for the establishment of recycling industries for newsprint, plastics and compost. AusTissue has a contract to collect high grade paper from all government departments.

A Community Recycling Environmental Salvage Pilot Scheme is to be jointly managed by the Ministry of Economic Development and Trade and the Department of Employment and Training. The intention is to assist in the establishment of small collection businesses. The scheme will provide opportunities for local governments to participate and will be phased in to prevent swamping the recycling market with waste.

Government purchasing policies will be amended to give preference to recycled materials, higher durability goods and minimally packaged products, provided the products are economically comparable. Increasing use will be made of recycled paper as its quality and price competitiveness improves.

The Government is reviewing legislative and regulatory mechanisms that may be hindering recycling. The merits of CDL are also under consideration.

Since January 1990, solvents of the type used in the paint and fibreglass industries and in dry-cleaning and degreasing have been banned from disposal in landfill. Solvents are not accepted into the State's industrial liquid waste treatment plant. The Industries Recycling Unit is to consider the compulsory phasing out of materials that constrain the recycling of other materials where an adequate alternative exists.

The feasibility of extracting methane gas from up to six landfill sites is under investigation.

South Australia

The Recycling Advisory Committee of the South Australian Waste Management Commission is in charge of recycling issues and strategy. Its membership is drawn from government, industry, unions and conservation groups. Its terms of reference include a requirement to evaluate recycling activities in South Australia, and to promote and investigate methods to increase recycling and waste minimisation.

South Australia is the only State that has enacted CDL. The legislation has been in force since 1 July 1977. Castlemaine Tooheys Ltd challenged the validity of CDL under Section 92 of the Constitution and in a decision handed down in February 1990 the High Court found that the South Australian Government did have powers to impose deposits but it could not discriminate between containers.

The South Australian Government subsequently passed legislation under which non-refillable beer and wine cooler bottles that are returned through container depots receive a refund of 5 cents while bottles that are returned through retailers receive 10 cents. Beverage manufacturers pay 10 cents either way owing to the handling fees they must pay to depots. Previously non-refillable bottles could not be returned through collection depots. A voluntary deposit system still applies to softdrinks and non-refillable cider, wine and spirit containers remain exempt from deposits. All other containers attract a deposit of 5 cents. The Department of Environment and Planning intends to review each category in the deposit schedule to ensure they can not be challenged under Section 92 of the Constitution.

A draft recycling strategy released in April 1990 by the Recycling Advisory Committee proposes that refundable deposits be levied on a range of consumer recyclable goods sold in South Australia. The proposal is to phase in the deposit system to household items such as paper products, tyres and lubricating oils. Other proposed measures to promote markets for recyclable goods and to assist industry in the use of recyclable materials include:

- public education about recycling;
- removal of fiscal and regulatory constraints on the use of recycled materials in products;

- affirmative action recycling programs, including recycling targets for materials and on the use of products containing secondary materials, and procurement policies favoring the purchase of products containing secondary materials; and

- government assistance packages to encourage industry to develop products which incorporate secondary materials. Assistance could be given for the design and engineering of recycling plants; for the preparation of business and financial plans; and for the purchase of recycling technology and equipment.

In November 1990 it was announced that government departments and agencies are to give preference to recycled paper, plastic and other products, even if they are up to 5 per cent more expensive. At that stage the Government was also examining its purchasing policies towards recycled lubricating oil.

From 1 July 1990 local councils, which are responsible for about 40 per cent of the 1.25 million tonnes of rubbish dumped in South Australian landfills each year, are to pay an additional 30 cents per tonne for the disposal of rubbish. Seven cents of this will go to the Waste Management Commission and 23 cents to a recycling fund. This fund is expected to reach $300 000 per year and will be used to provide grants to groups or individuals with ideas for new environmentally conscious products or improved waste disposal methods. Grants will also go to people undertaking studies of waste recycling, and to educational and promotional campaigns. The Waste Management Commission has calculated that the additional levy will cost metropolitan households about 45 cents and country households about 12 cents per year (Ogier and Satchell 1990).

Tasmania

It was announced on 14 July 1989 that all State agencies in Tasmania should implement waste paper recycling. Recycled paper is increasingly used in government offices and it is intended to develop a government procurement policy.

The Tasmanian Recycling and Litter Awareness Council is jointly funded by government and industry. It is the major body involved in promoting recycling throughout Tasmania and has implemented a domestic waste door-to-door recycling scheme. It has published an ‘Office Paper Recycling Guide’ for use within the private and public sector.

The Tasmanian Government has been consulting with three major paper companies to gain support for paper recycling, an environmental award for initiative in the use of waste paper and other recyclable products, and for the possible stockpiling of waste paper. Through the Tasmania Development Authority, encouragement has been given to the development of recycling/waste management proposals for wood, pulp and associated wastes.

Australian Capital Territory

A Parliamentary report into commercial and domestic waste management in the ACT was released in March 1990. It proposes, *inter* alia, that the ACT Government contract for a weekly door-to-door collection of recyclables. The service would be subsidised and participation by households would be made mandatory if participation rates were not acceptable.

APPENDIX A: TERMS OF REFERENCE OF INTERIM REPORT ON PAPER RECYCLING

I, PAUL JOHN KEATING, in pursuance of Section 23 of the Industries Assistance Commission Act 1973 hereby:

1. specify that as part of its inquiry into recycling of products, the Commission shall prepare an interim report by 30 April 1990* on the effects of government policies on, and the environmental and economic costs and benefits of, recycling of paper products.

2. without limiting the scope of the reference, specify that in its interim report the Commission shall:

   (a) assess the economic prospects for further recycling in Australia based on local waste paper, including the economic viability of green field and integrated developments

   (b) examine the economic viability of a world scale recycling plant processing imported waste paper, taking into consideration global sources and markets for recycled paper

   (c) identify economic, environmental and technological constraints to further recycling, e.g. segregation of waste paper into grades, removal of impurities, de-inking and treatment of resultant effluent, etc

   (d) identify products able to be produced, wholly or in substantial part, from recycled paper which satisfy technical requirements of strength, brightness, etc

   (e) examine community attitudes to the use of various grades of recycled paper products

   (f) assess the success of existing Government initiatives in promoting waste paper recycling, taking into account the recent report by the Minister for Administrative Services.

3. specify that the Commission is free to take evidence and make recommendations on any matters relevant to its inquiry under this reference.

P.J. Keating
28 December 1989

* At the Commission's request, the Treasurer extended the report date for the inquiry until 21 May 1990. The report was completed by that date.

APPENDIX B: LIST OF PARTICIPANTS AND SUBMISSIONS

Company/Organisation	Sub No
ACI Glass Packaging Australia	181,339
ACI Plastics Packaging	216
ACT Recycling Campaign	7
Advertiser Newspapers Ltd (News Limited)	65
Agricultural & Veterinary Chemicals	50
Alcoa of Australia Limited	239
Aldermen Alty and Bell - Hobart City Council	37
All Seasons Home Insulation Pty Ltd	232
Ankal Pty Limited	168,223
Arisa Ltd	23,317
Aspex Paper Australia Pty Ltd	172
Aspley Special School Recycling Station	192,283
Associated Liquidpaperboard Converters	97
Associated Pulp & Paper Mills - Victoria	158,364
Associated Pulp and Paper Mills, (Sydney)	193
Associated Pulp and Paper Mills (Tasmania)	221
Association of Fluorocarbon Consumers and Manufacturers	19
Association of Liquidpaperboard Carton Manufacturers Inc	310
Atherton Greenhouse Information Network	258
AusTissue Pty Ltd	21,318,363
Australian Chemical Industry Council	119
Australian Conservation Foundation (Brisbane)	88,297
Australian Conservation Foundation	134,304
Australian Conservation Foundation (Portland Branch)	185
Australian Conservation Foundation (Albury\Wodonga)	236
Australian Consolidated Press Limited	167
Australian Consumers' Association	145,313
Australian Council of Recyclers	179
Australian Customs Service	279
Australian Glass Workers' Union	177
Australian Groundwater Consultants Pty Ltd	53

Australian Institute of Environmental Health	248
Australian Institute of Petroleum Ltd.	154,347
Australian Newsprint Mills Limited - (TAS)	90,194,218,323
Australian Newsprint Mills Ltd (NSW)	224
Australian Paper Manufacturers	144,157,222,275
Australian Recycling News	277
Australian Red Cross Society	71
Australian Refined Alloys Pty Ltd	92,290
Australian Soft Drink Association Ltd	131,373
Australian Tyre Manufacturers' Association	272,341
Axtens, Mr Jon M.	282
Balranald Shire Council	4,291
Bathurst Conservation Group	136
Bayley, Mr John	325
BHP Steel	162,289
Bluhdorn Pty Ltd	195
Bob Jane Corporation Pty Ltd, Vic	340
Bowater Tissue Ltd	93
Bradken Consolidated\Commonwealth Steel Company Limited	251
Brambles Records Management	249
Brian Stafford & Associates Pty Ltd	39
Brickwood Holdings Pty Ltd	72,295
Brisbane City Council	254,294
Broken Hill City Council	141
Bunge Bioproducts Pty Ltd	215
Bunnings Ltd	22
Bureau of Rural Resources	147
Cabinet Office of NSW	178
Caring for Creation	197
Carter, Ms Patricia J	208
Cellulose Industries Pty Ltd	81
Centre for Education and Research in Environmental Strategies (CERES)	267
Centre for Human Aspects of Science and Technology	121
City of Altona	241
City of Box Hill	98
City of Brunswick	84
City of Croydon	205
City of Devonport	126
City of Fitzroy	109
City of Footscray	44
City of Fremantle	30
City of Geraldton	263

City of Gosnells	29
City of Happy Valley	35
City of Malvern	9
City of Marion (316 Confidential Supplement)	315,316
City of Melbourne	329
City of Nedlands	253
City of Prahran	91
City of Melbourne	349
City of Salisbury	365
City of South Melbourne	96
City of St Kilda	229
City of Wagga Wagga	129
City of Waverley	75
City of Werribee	17
Clough Engineering Group (now Green Recycling)	33,337
Coca-Cola Amatil Limited	180,265,299,374
Columbus Corporation Pty Ltd	54
Comalco Limited	146,351
Commercial Polymers Pty Ltd	184,319
Concrete Recyclers Pty Ltd	305
Confederation of Australian Industry - ACT	358
Conservation Council of SA	63
Conservation Council of the South-East Region and Canberra Inc	58
Coolum Wastebusters	128
Corkhill Bros Sales Pty Ltd	42
CRA Limited	169
Crooks Michell Peacock Stewart Pty Ltd	100,209
CSIRO - Division of Building, Construction and Engineering	108
CSIRO - Division of Forestry and Forest Products (Dr G Gartside)	107
CSIRO - Division of Forestry and Forest Products	83
CSIRO - Division of Tropical Crops and Pastures	182
CSR Ltd	14
D.J. Hawkins & Associates	332
David Syme & Co. Ltd	86,344
Davies Bros. Ltd (News Ltd - Hobart)	64
Department of Administrative Services	61
Department of Immigration, Local Government & Ethnic Affairs	190
Department of Primary Industry & Fisheries (Northern Territory)	166

Department of the Arts, Sport, the Environment, Tourism and Territories	24,242,293
Department of the Premier, Economic and Trade Development	261,370
Department of State Development of NSW	244
Department of State Development of W.A.	367
District Council of Minlaton	6
District Council of Orroroo	10
Dr J.T. Vnuk & Associates	276
Drum Reconditioners (NSW) Pty Ltd	201
Duaringa Shire Council	296
Eastern Regional Refuse Disposal Group	135
Ecopaper Pty Ltd	106,311
Engineering and Water Supply Department	257
Enterprise Metals (CRA) (confidential)	105
Environmental Protection Authority - Perth	353
Environment Protection Authority, VIC	352
Esperance Shire Council	55
F.T. Wimble & Co.	163
Limited Forestry Commission of NSW	155,362
Fractionated Cane Technology Ltd	124
Friends of the Earth (Fitzroy)	73,238,255
Friends of the Earth (Perth)	183,342
Friends of the Earth (Melbourne)	101
Friends of the Earth (Sydney)	103,191
GNB International Battery Group	262
Geelong West The Heritage City	176
Gosford City Council	110
Great Lakes Environmental Association	246
Greater Western Education Centre Ltd, NSW	268
Greenhouse Action Australia	102
Green Recycling (formerly Clough Engineering)	33,337
Hastings Environment Council	140
Health Department of W.A.	321
Herald and Weekly Times Ltd	115,161,359
Higgins Trading Company Pty Ltd	27
Hobart City of Holroyd Municipal Council, Merrylands - Mr Peter Rimmer	48
Hosking A.J. & Associates - N.T	355
Intershred Pty Ltd.	152
John Fairfax Group Pty Ltd	60,153,266
John H. Gleason Consultant	266
Katelaris, Dr Andrew J.	114
Keep Australian Beautiful Council (Qld)	68

Kempsey Shire Council	13
Kesab Inc	16
Kimberly-Clark Australia Pty Limited	170,220,309
Kuhne, Mr David	18
Ku-ring-gai Municipal Council	143
Lane Cove Municipal Council - Sydney	331
Leighton Group (Process Services Division)	226
Litter Research Association	256,335
Litchfield Shire Council	113
Loumbos Pty Ltd - NSW	281,368
Mackenzie, Ms Janet	207
Mackay Sugar Co-operative Association Ltd	133
Makin, Ms Susan	252
Maleny Waste Busters	120
Manly Municipal Council	230
Marine Collectors Association	204
Ma-Refine Oil International Pty Ltd (formerly SPREE International)	142
Maroochy Shire Council	260
Marrickville Municipal Council	12
Motorway Tyres Pty Ltd - Victoria	333
MIM Holdings Limited	259
Minister for Natural Resources Dept. of Lands, NSW)	202
MRI Pty Ltd	187
Municipal Association of Victoria	345
Municipality of Deniliquin	233
Murdoch University - Dr Ho	200
Muswellbrook Shire Council	5
Nambucca Valley Association	77
National Association of Forest Industries Ltd	237,346
Neutralysis Industries Pty Ltd	112
Newcastle City Council, N.S.W.	300
Newcastle Regional Waste & Pollution Advisory Panel (now The Hunter Waste Advisory Panel)	312
News Limited - Adelaide	65
News Limited - Hobart	64
News Limited - Perth	31,32
News Limited - Sydney	171,198,328,369
News Limited - Melbourne	99
News Limited - Sydney. (Mirror Australian Telegraph)	159
Nonferral Pty Ltd	206,278
Norstar Steel Recyclers	188
North Coast Environment Council	186
North Queensland Conservation Council Inc	271

North Sydney Municipality	139
Northern Regional Refuse Disposal Group	52
NSW Recyclers Association	70
Oil and Chemical Industries Pty Ltd.	148
O'Reilly , Mr R J	59,225
Outer Eastern Municipalities Association	247
Pacific Waste Management	125
Packaging Council of Australia Inc	212,371
Paper Converting Group	270
Paper & Pulp International W.A.(Confidential)	26
Paper-go-round	175
People Against Dioxins in Sanitary Products	156
Pioneer International Limited	280,356
Plastics Industry Association Inc - Melb.	89,360
Plastopan - Vic	288
Pratt Group	150,227,334
Public Record Office of SA	25
Public Record Office of Victoria	51
Public Transport Corporation - Melbourne	330
Publishers National Environment Bureau - Sydney	326
Queensland Bagasse	45
Queensland Press Ltd (News Ltd - Brisbane)	151
Queensland Wilderness Society	104
R.A.G.E. Londonderry Residents Action Group for Environment	302
Rainbow Alliance	78
Re-Solv Liquids	231
Recycle Aid	47
Recycling & Treatment Industries Assoc	34,336
Regional Dailies of Australia Ltd	217
RMIT - Faculty of Environmental Design & Construction	366
Robinvale Co-ordinating Group	15
Safety-Kleen (Worton Services Pty Ltd)	273
Shire of Ballarat	82
Shire of Eltham	117
Shire of Gisborne	43
Shire of Hastings	213,264
Shire of Marong	189
Shire of Rochester	74
Shire of Swan	56
Shire of Victoria Plains	11
Shire of Wangaratta	1
Simpson, Mr Lance C.	127
Simsmetal Ltd	122,285
Smorgon Glass	240

Smorgon Plastics	160
South Australian Government	307
South Australian Waste Management Commission	67,250
South Coast Co-operative Dairy Assoc. Ltd	85
South Eastern Regional Refuse Disposal Group	235
South Pacific Tyres (ATMA)	292
Southern Region of Councils	79
Southern Tablelands Regional Councils	149
Stationery Manufacturers of Australia	138
Stokes, Ms J B	199
Superburn	214
Sutas, Mr Algis	76
Sydney Earthmoving Pty Ltd	338
Take & Tip Pty Ltd, NSW	287
Tasman Pulp & Paper Company	46
Tasmanian Conservation Trust	28
Tasmanian Government	49,327
Tetra Pak Pty Limited	210
The Australian Brass Extrusion Industry Group	196
The Brady Group of Companies	173
The City of Noarlunga	234
The Council of the City of South Sydney	87
The Council of the City of Lismore	80
The Council of the City of Sydney	130
The Council of the Shire of Culcairn, NSW	372
The Cuddly Company - Dorrigo	357
The District Council of Lameroo	57
The Environment Centre NT Inc	8
The Hunter Waste Advisory Panel	312
The Institution of Engineers, Australia	36
The National Paper Marketing Council of Australia	132
The Printing and Allied Trades Employers Federation of Australia	165
The Pulp & Paper Manufacturers' Federation of Australia Ltd	94,95,219,274,343
The River House Group Pty Ltd	20
The Wilderness Society	69
The Women's Environment Action Group	245
Tom's Trash Paks Pty Ltd	2
Toxic Chemicals Committee	137
Trans Asia Trading Co Pty Ltd	164

Trifoleum Pty Ltd	350
Tyremag Group of Companies	269
Tredex	66,286,303
Universal Understanding	118
University of Tasmania	38
Urquhart, Mr Max	284
Victorian Government (Premier of Victoria)	243
Victoria University of Technology	354
Victorian Waste Management Association	211
WA Municipal Association	40
Waste Management Authority of N.S.W.	298,320,348
Waste Not Pty Ltd.	174,322
Watkins, Dr Glenn (University of WA)	62
Wedderburn & District Environment Protection Association	203
Western Australian Government	228
Western Region Waste Management Authority	123
Western Regional Refuse Disposal Group	116
WestPaper Pty Ltd	314,320
Whelan the Wrecker Pty Ltd - Vic	324
Wingecarribee Shire Council	3
Woolworths Supermarkets N.S.W.	301
Wollongong City Council	111
Women's Abode	41

APPENDIX C: ORGANISATIONS, COMPANIES AND INDIVIDUALS CONSULTED

NAME	DATE	VENUE
ACT Glass Packaging	8 November 1989 27 November 1989	Melbourne Sydney
ACI Petalite	8 November 1989	Melbourne
ACI Plastics Packaging	8 November 1989	Melbourne
Aspex Paper Australia Pty Ltd	22 January 1990	Sydney
Associated Pulp and Paper Mills	8 November 1989 6 February 1990	Melbourne Melbourne
Austissue	8 February 1990	Perth
Australian Conservation Foundation	19 November 1989	Melbourne
Australian Conservation Foundation	27 November 1989	Sydney
Australian Conservation Foundation	9 February 1990	Perth
Australian Consumers Association	27 November 1989	Sydney
Australian Council of Recyclers	8 November 1989	Melbourne
Australian Newsprint Mills Ltd	23 January 1990	Hobart
Australian Paper Manufacturers	29 November 1989 7 February 1990 8 February 1990	Sydney Melbourne Perth
BHP Steel	9 November 1989	Melbourne

NAME	DATE	VENUE
BHP Steel International Group	9 November 1989	Melbourne
Bowater Tissues Ltd	24 January 1990 9 February 1990	Melbourne Melbourne
Bridgestone Aust Ltd	8 November 1989	Melbourne
Dr Bob Brown, MHA Tasmania	23 January 1990	Hobart
Brisbane City Council	28 November 1990	Brisbane
Bunnings Ltd	9 February 1990	Perth
Carlton & United Breweries Ltd	19 November 1989	Melbourne
CSIRO	24 January 1990 8 February 19908	Melbourne Melbourne
City of Brunswick	8 November 1989	Melbourne
Coca-Cola Amatil Beverages	27 November 1989	Sydney
Comalco Aluminium Ltd	27 November 1989	Sydney
Comalco Ltd	27 November 1989	Sydney
Commercial Polymers Pty Lt	5 April 1990	Melbourne
Conservation Council of SA	7 February 1990	Adelaide
Containers Packaging	8 November 1989	Melbourne
CRA Limited	1 December 1989	Canberra
Department of Manufacturing and Commerce (Queensland)	5 February 1990	Brisbane
Department of Administrative Services (ACT)	17 January 1990	Canberra
Department of Environment & Planning, South Australia	24 November 1989 7 February 1990	Canberra Adelaide

NAME	DATE	VENUE
Department of Industry, Technology and Commerce	15 January 1990	Canberra
Department of Premier & Cabinet	23 January 1990	Hobart
Department of State Development (NSW)	14 February 1990	Sydney
Department of Environment and Conservation (QLD)	5 February 1990	Brisbane
Department of the Arts, Sport, the Environment, Tourism and Territories	2 November 1989	Canberra
Ecopaper Pty Ltd	27 November 1989 14 March 1990	Sydney Sydney
Environment Protection Authority (Victoria)	9 November 1989	Melbourne
Forestry Commission of NSW	22 January 1990 14 February 1990 14 March 1990	Sydney Sydney Sydney
Forestry Commission of Tasmania	23 January 1990	Hobart
Friends of the Earth (Fitzroy)	19 November 1989	Melbourne
J. Gadsen Pty Ltd	6 February 1990	Melbourne
Golden Australia Paper Manufacturers Pty Ltd	9 February 1990	Perth
Green Recycling Company of WA	8 February 1990	Perth
ICI Chemicals	29 November 1989	Sydney
Inner Metropolitan Regional Association	9 February 1990	Melbourne
Institution of Engineers	29 November 1989	Sydney

NAME	DATE	VENUE
Kimberly-Clark Australia Pty Ltd	22 January 1990	Sydney
Leighton Group Process Services Division	3 May 1990	Canberra
Litter Research Association	27 November 1989	Sydney
Local Government Association of NSW	28 November 1989	Sydney
Melbourne City Council	8 November 1989	Melbourne
Melbourne Metropolitan Board of Works	9 November 1989	Melbourne
News Limited	22 January 1990 30 November 1990	Sydney Sydney
NSW Recyclers Association	29 November 1989	Sydney
Pasminco Metals Pty Ltd	8 November 1989	Melbourne
Philip Morris Ltd	6 February 1990	Melbourne
Pratt Group of Companies	8 February 1990	Melbourne
Queensland Cane Growers Council	5 February 1990	Brisbane
Queensland Forestry Commission	13 February 1990	Brisbane
Recycling Company of WA	8 February 1990	Perth
SA Brewing Company Ltd	7 February 1990	Adelaide
SA Department of Environment and Planning	7 February 1990	Adelaide
Simsmetal Ltd	28 November 1989	Sydney
Smorgon Consolidated Industries	19 November 1989	Melbourne
Smorgon Glass	27 November 1989	Sydney

NAME	DATE	VENUE
State Pollution Control Commission (NSW)	27 November 1989 14 February 1990	Sydney Sydney
Waste Management Commission (WA)	7 February 1990	Adelaide
Waste Management Authority (NSW)	28 November 1989 14 February 1990	Sydney Sydney
Western Australian Office of the Cabinet	8 February 1990	Perth
Western Australian Department of Resources Development	30 January 1990	Canberra
Western Australian Environmental Protection Authority	9 February 1990 6 February 1990	Perth Melbourne
Woolworths Ltd	14 February 1990	Sydney
Smorgon Glass	10 September 1990	Sydney

ABBREVIATIONS

ABARE - Australian Bureau of Agricultural and Resource Economics

ABS - Australian Bureau of Statistics

ABS – Acylonitrile butadiene-styrene

ACI - Australian Consolidated Industries

ACS - Australian Customs Service

AEC - Australian Environment Council

AFCAM - Association of Fluorocarbon Consumers and Manufacturers

AGM - Australian Glass Manufacturers

AGPS - Australian Government Publishing Service

AIP - Australian Institute of Petroleum

ALCOA - Alcoa of Australia Limited

ANM - Australian Newsprint Mills Ltd

ANZEC - Australian & New Zealand Environment Council

APM - Australian Paper Manufacturers

APPM - Associated Pulp and Paper Mills

ARA - Australian Refined Alloys Pty Ltd

ARC - ACT Recycling Campaign

ASDA - Australian Soft Drink Association

ATDA - Australian Tyre Dealers Association

ATMA – Australian Tyre Manufacturers Association

AVCAA - Agricultural and Veterinary Chemicals Association of Australia

BFCs – Bromofluorocarbons

BHAS - Broken Hill Associated Smelters Pty Ltd

BHP - Broken Hill Proprietary Limited

BIE – Bureau of Industry Economics

BRRU - Business Regulation Review Unit

CDL - Container Deposit Legislation

CFCs - Chlorofluorocarbons

COMALCO - Comalco Limited

COMPOL - Commercial Polymers

COMSTEEL - Commonwealth Steel Company Limited

CROWN - ACI Crown Glassware

CSAES - Centre for South Australian Economic Studies

CSIRO - Commonwealth Scientific and Industrial Research Organisation

CTDRA - California Tire Dealers and Retreaders Association

DARA - Department of Agriculture and Rural Affairs

DAS - Department of Administrative Services

DASETT - Department of the Arts, Sport, the Environment, Tourism and Territories

DIY - Do-it-yourself

DPIE - Department of Primary Industries and Energy

ECU - European Currency Unit

EPA - Environment Protection Authority

ER&S - Electrolytic Refining & Smelting Co of Australia Pty Ltd

FOE - Friends of the Earth

GDP - Gross Domestic Product

GHG - Greenhouse gas

GJ – Gigajoules

GPIA - Glass Packaging Institute of Australia

HDPE - High Density Polyethylene

HFA - Hydrofluoroalkanes

HFCs - Hydrofluorocarbons

IAC - Industries Assistance Commission

KESAB - Keep South Australia Beautiful

LDPE - Low Density Polyethylene

LLDPE - Linear Low Density Polyethylene

LRA - Litter Research Association

MIM - Mount Isa Mines Ltd

MJ - Megajoules

ML - Megalitres

MMBW - Melbourne Metropolitan Board of Works

MRI - MRI Pty Limited

MTAA - Motor Traders Association of Australia

MWDA - Metropolitan Waste Disposal Authority

NORSTAR - Norstar Steel Recyclers

NRWPAP – Newcastle Regional Waste and Pollution and Advisory Panel

PASMINCO - Pasminco Metals BHAS Pty Ltd

PCA - Packaging Council of Australia

PCBs - Polychlorinated biphenyls

PEFA – Packaging Environment Foundation of Australia

PET - Polyethylene terephthalate

PJ - Petajoule

PIA - Plastics Industry Association Inc

PILKINGTON - Pilkington (Australia) Limited

PNEB – Publishers’ National Environment Bureau

PVA - Polyvinyl acetate

PVC - Polyvinyl chloride

RALAC - Recycling and Litter Advisory Committee

RDF - Refuse derived fuel

RMIT - Royal Melbourne Institute of Technology

SAA - Standards Association of Australia

SADEP - South Australian Department of Environment and Planning

SAN - Styrene-acrylonitrile

SAWMC - South Australian Waste Management Commission

SEP - Special Environment Program

SIMSMETAL - Simsmetal Ltd

SPCC - State Pollution Control Commission

STP – South Pacific Tyres

TCE - Trichloroethane

UBC - used beverage can

WMA - Waste Management Association

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