Waste and Recycling in Australia

Amended report

19 November 2009

Hyder Consulting

A Report Prepared for the Department of the Environment, Water, Heritage and the Arts

Waste and Recycling in Australia

Amended report

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Executive summary

In February 2006, Hyder Consulting produced a report titled *Waste and Recycling in Australia*. This paper informed the then Department of Environment and Heritage's submission to the Productivity Commission's inquiry into waste generation and resource efficiency in Australia.

The objective of this current report is to update and supplement the information contained in the 2006 report and to provide additional information to illustrate the current picture of waste and recycling in Australia. This report endeavours to provide the most up-to-date and comprehensive picture of waste and recycling activity in Australia. However, the data contained within the report should be used with caution as it has been drawn from a range of sources with varying data quality and methodologies. The scope of the report is the three major solid waste streams: municipal solid waste (municipal or MSW), commercial and industrial (C&I) and construction and demolition (C&D). It should be noted that, unless specifically stated within a particular report section, we have endeavoured to exclude the following waste streams from the reported data: hazardous, prescribed or clinical wastes; biosolids; contaminated soils; fly ash; mining and mineral processing wastes; agricultural and forestry operations wastes; quarantine waste from ships; other gaseous or liquid wastes and self-managed farm wastes.

This amended report has been produced to incorporate updated data for some states/territories and for some organic materials that has become available since the publication of the report in 2008.

1.1 Data on waste disposal and recycling in Australia

Table E-0-1 shows the level of waste generation (disposal and recycling) and diversion rates across Australia during 2006/07. Table E-0-2 shows this information on a per capita basis and Table E-0-3 shows total waste generation by sector within each state.

Table E-0-1 Waste generation and diversion rates for Australia, estimated, 2006/07

State / territory	Disposed	Recycled[1]	Total Generated	Diversion Rate
	Tonnes ('000)			Percent
NSW	7,365	7,995	15,360	52%
VIC[2]	3,925	6,360	10,285	62%
QLD[3]	4,302	3,779	8,081	47%
WA[4]	3,539	1,708	5,247	33%
SA	1,144	2,173	3,318	66%
ACT	197	587	784	75%
TAS	446	75	521	Unknown
NT[5]	151	30	181	Unknown
Total	**21,069**	**22,707**	**43,777**	**52%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.
[1] Victoria, Queensland, WA and ACT recycling data appears to include all organic material categories (See Section 3 for categories); NSW, SA, Tasmania and NT include only some organic material categories.
[2] The Victorian landfill figures represent the amount of waste accepted at licensed Victorian landfills, excluding material used as cover. The *Environment Protection Act* 1970 provides a rebate for cover material of 15% (at the relevant municipal rate) for each tonne of waste deposited at a landfill. The figures shown above were calculated by taking the tonnes of material received at landfills (including cover material sourced off site) and reducing this by 15% to allow for cover material. It is noted that some landfills source cover material on-site (e.g. from quarrying activities) and that this is not measured in the tonnes of waste received at landfills. Where landfills have claimed a recycling rebate, this has been subtracted from the figures.
[3] Queensland landfill and recycling data includes biosolids
[4] Landfill data for WA has been extrapolated from municipal landfill data.
[5] The NT landfill data is only for the Darwin region. The NT recycling data is municipal data for NT plus green organics and other recycled material for Darwin City Council only.

Variation in overall waste generation is expected given the population size of the different states/territories. This is corrected for by presenting the data on waste generation on a per capita basis. This is included in Table E-0-2.

Table E-0-2 Per capita waste generation and diversion rates for Australia, estimated, 2006/07

State / territory	Population	Disposed	Recycled[1]	Total Generated	Diversion Rate
		Kilograms per capita			Percent
NSW	6,888,000	1,070	1,160	2,230	52%
VIC	5,205,000	750	1,220	1,980	62%
QLD[2]	4,181,000	1,030	900	1,930	47%
WA[3]	2,106,000	1,680	810	2,490	33%
SA	1,584,000	720	1,370	2,090	66%
ACT	340,000	580	1,730	2,310	75%
TAS	493,000	Unknown			
NT[4]	215,000	Unknown			
Total	**21,015,000**	**1,000**	**1,080**	**2,080**	**52%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.
[1] NSW, Victorian, Queenland, WA, and ACT recycling data appears to include all organic material categories (see Section 3 for categories); SA, Tasmania and NT include only some organic material categories
[2] Queensland landfill and recycling data includes biosolids.
[3] Landfill data for WA has been extrapolated from municipal landfill data.
[4] Per capita data for TAS and NT is not stated as the data on waste disposed and recycled is for part of the state only and therefore could not be calculated using statewide population figures.

Table E-0-3 Waste generation by sector for Australia, 2006/07

State / territory	Disposed *('000 tonnes)*				Recycled[1] *('000 tonnes)*				Generated *('000 tonnes)*			
	Municipal	C&I	C&D	Total	Municipal	C&I	C&D	Total	Municipal	C&I	C&D	Total
NSW	2,408	2,921	2,036	7,365	1,483	2,297	4,216	7,995	3,891	5,218	6,251	15,360
VIC	1,727	1,060	1,138	3,925	1,056	2,357	2,946	6,360	2,783	3,417	4,084	10,285
QLD[2]	1,735	1,101	1,466	4,302	1,365	1,797	617	3,779	3,100	2,898	2,083	8,081
WA[3]	1,015	585	1,939	3,539	408	891	409	1,708	1,424	1,476	2,348	5,247
SA[4]	344	496	304	1,144	408	610	1,155	2,173	753	1,106	1,460	3,318
ACT[5]	85	91	21	197	278	102	206	587	363	194	227	784
TAS[6]	287	145	14	446	53	22	unknown	75	340	167	14	521
NT[7]	44	57	51	151	30	Unknown	Unknown	30	74	57	51	181
Australia	**7,645**	**6,456**	**6,968**	**21,069**	**5,082**	**8,076**	**9,549**	**22,707**	**12,727**	**14,532**	**16,517**	**43,777**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.

[1] NSW, Victorian, Queenland, WA, and ACT recycling data appears to include all organic material categories (see Section 3 for categories); SA, Tasmania and NT include only some organic material categories

[2] Queensland landfill and recycling data includes biosolids.

[3] Landfill data for WA has been extrapolated from municipal landfill data. The estimated C&I and C&D disposal to landfill stream have been estimated based on the average proportion of MSW/C&I/C&D waste streams for 1998-2004 reported on www.zerowaste.wa.gov.au

[4] The split of total disposal to landfill (MSW/C&I/C&D) for SA was estimated based on a landfill audit undertaken in 2007.

[5] ACT municipal disposal to landfill includes material collected at kerbside and material delivered privately to landfills.

[6] The Tasmanian split of recycling (MSW/C&I/C&D) was provided by Tasmanian Department of Primary Industries, Parks, Water and Environment.

[7] The NT landfill data is only for the Darwin region. The NT recycling data is municipal data for NT plus green organics and other recycled material for Darwin City Council only.

1.1.1 International comparison

Australia has been described as being a high producer of waste when compared to other countries. Australia's waste and recycling performance was compared with a range of countries with similar geographical and /or socio-economic features. Data on waste generation from all sectors was not available for all countries, but data on the municipal waste stream is more widely available. Municipal waste stream data is presented on a per capita basis in Table E-0-4. Of the five countries being considered, Germany has the highest diversion rate at 61%. Australia had a diversion rate of 40%, followed by USA at 33%, England at 31% and Canada at 29%.

Table E-0-4 Per capita municipal waste generated, disposed and recycled per annum.

Country	Disposed	Recycled	Generated	Diversion rate (%)
	kilograms			
Canada[1]	292	118	411	29%
United States[2]	625	302	927	33%
Germany[3]	215	341	555	61%
England[4]	398	176	574	31%
Australia[5]	364	242	606	40%

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.
[1]Data for 2006. Sources: Statistics Canada (2008); Statistics Canada (2008)
[2]Data for 2006. Sources: United States Environment Protection Agency (2007); Population Division, U.S. Census Bureau (2007)
[3]Data for 2005. Sources: Statistisches Bundesamt (2005); Statistisches Bundesamt (2006)
[4]Data for 2006/07. Sources: Department for Environment, Food and Rural Affairs (2007); Office for National Statistics (2007)
[5]Data for 2006/07. Population data source: ABS (2008)

Municipal waste stream data was available for a wide range of countries. The figures below provide an indication of how Australia is performing relative to these countries. A comparison of Australia's waste and recycling performance with this wide range of countries shows that Australia sits mid-range in terms of both waste generation and resource recovery for the municipal solid waste stream.

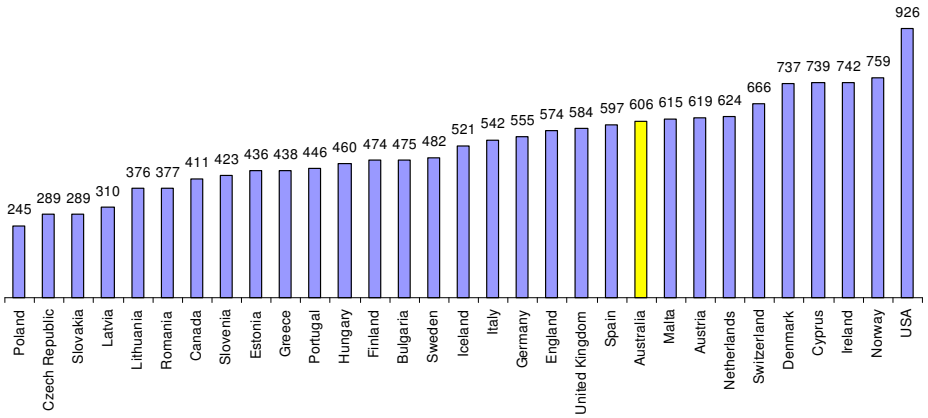


Figure E-1 **Municipal waste generation per capita (kg), selected countries**
Source: Eurostat (2006) Except Australia, Germany, England, USA, Canada (see references above)

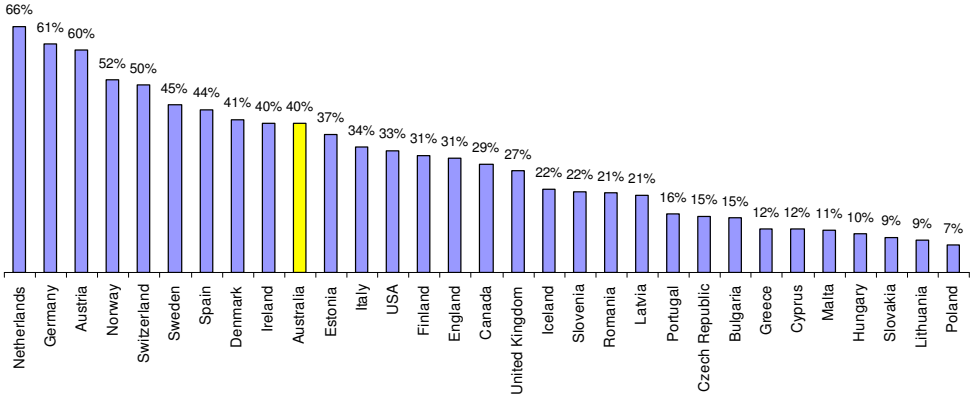


Figure E-2 **Diversion rate for municipal waste, selected countries**
Source: Eurostat (2006) Except Australia, Germany, England, USA, Canada (see references above)
Diversion includes all material that is not landfilled or incinerated. It is unclear whether diversion includes material used for energy production in some instances.

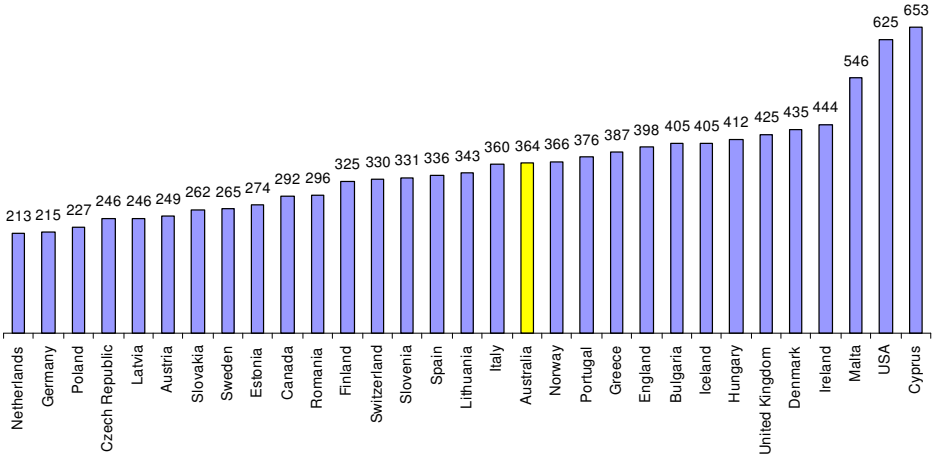
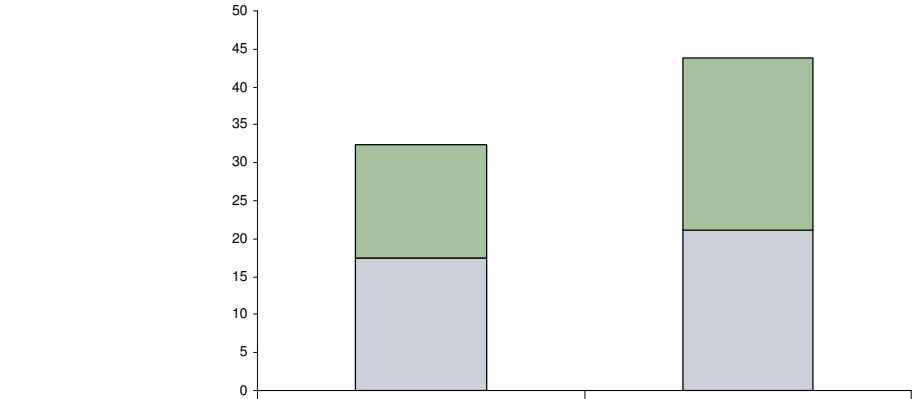


Figure E-3 **Disposal to landfill per capita for municipal waste, selected countries**
Source: Eurostat (2006) Except Australia, Germany, England, USA, Canada (see references above)

1.1.2 Trends in waste and recycling

Figure E-0-4 shows the reported data on disposal to landfill and recycling activity in Australia for 2002/03 and 2006/07 data. This includes material from all sectors: MSW, C&I and C&D. The total reported waste generation has increased significantly in this period, with increases in both landfill disposal and recovery. Overall reported waste generation has increased from 32.4 million tonnes in 2002/03 to 43.8 million tonnes in 2006/07. The increase in reported waste generation seen in Figure 2-12 is due in part to an actual increase in the amount of material generated by Australians, however, an unknown proportion of this increase is due to improved reporting of waste and recycling data. For example, in 2002/03, no data was available for Tasmania or the Northern Territory, and data on disposal of material to landfill in Western Australia was only available for metropolitan areas. When you correct to a common base (excluding WA, NT and Tasmania) waste generation increased by 31%.



	2002/03	2006/07
Recycled (million tonnes)	15.0	22.7
Disposed of to landfill (million tonnes)	17.4	21.1

Figure E-0-4 Waste disposal and recycling, all sectors, Australia, 2002/03 and 2006/07
Note: Australian data for 2002/03 excluded Tasmania and NT and had only metropolitan data for WA

1.2 Organics

Organic waste, including food, garden/ green organics, paper and cardboard and wood/ timber, is generated mostly in the municipal and commercial and industrial sectors. In the municipal sector this material is primarily produced by households, with food organics, paper and cardboard and garden material being a large proportion of the overall waste stream. A variety of sources of organic waste exist in the commercial and industrial sector. Two sources examined in this study were supermarkets and restaurants. Food and paper/cardboard make up a large proportion of the overall generation of material from these sources. The major supermarket chains currently recover a large proportion of cardboard (Hyder Consulting, unpublished data). Opportunities exist across the C&I and municipal streams for reducing organic waste to landfill through recovery for reuse (particularly in the C&I sector) or recycling.

The annual survey of organics reprocessors provides a comprehensive overview of current levels of organics recovery by composters, as well as the end products for this material. The estimated recovery of organics in 2006/07 across Australia is presented in Table E-0-5.

Table E-0-5 Organic material recovered for reprocessing, Australia, 2006/07

Material type	Amount recovered ('000 tonnes)
Paper and cardboard	2,318
Garden organics	2,535
Wood/timber/sawdust	688
Food organics	91
MSW (organic fraction)	238
Other - biowaste	16
Other - miscellaneous	166
Biosolids, grit, screenings	618
Oils, grease trap, sludges	164
Straw	14
Manure	478
Animal bedding	24
Animal mortalities	11
Paunch	26
Other - miscellanous agricultural organics	67
Other - Paper pulp/sludge	54
Sawdust (from forestry residuals)	331
Barks (from forestry residuals)	336
Total	8,171
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain. Primary source: Recycled Organics Unit (2007) Other sources: DECC (2008b), Sustainability Victoria (2008), Cardno (2008), Hyder Consulting (2008), ACT NoWaste (2008a), Darwin City Council (2008b), DPIPWE (2009)	

1.3 Priority products

An assessment of consumption, disposal and other relevant aspects provides a means of prioritising products for attention in product stewardship or other programs to increase lifespan, reuse and recovery. Table E-0-6 shows the consumption and disposal (both in '000 tonnes) of a range of products.

Table E-0-6 2005 product consumption and disposal ('000 tonnes)

Product	Consumption ('000 tonnes)	Disposal ('000 tonnes)
Building Products		
Asphalt road materials	8,200	3,814
Bricks[1]	14,141	7,920
Cables	121	2
Concrete paving and construction	58,561	14,597
Wire fencing	143	84
Insulation[1]	153	80
Office fittings	80	15
Piping (plastic)	246	34
Roofing iron	347	136
Roofing tiles	822	406
Structural timber[2]	4,312	1,112
Window glass[1]	303	92
Hot water systems	36	25
Chemical products		
Paint	74	6
Electrical & electronic equipment		
Computers	68	30
Printer & computer peripherals	48	32
Televisions	65	11
Mobile phones	<1	<1
Compact fluorescent lamps	2	<1
Fluorescent lamps	5	4
Power tools	15	8
Small appliances	28	16
Whitegoods	389	179
Fixed line phones[3]	<1	<1
Heaters	26	16
Video & stereo electronic peripherals	29	9
CD media	11	5

Product	Consumption ('000 tonnes)	Disposal ('000 tonnes)
DVD media	11	2
Smoke detectors	<1	<1
Elemental Products		
Tyres[4]	240	240
Gas cylinders	9	6
Automotive batteries	91	77
NiCad batteries	2	2
Personal batteries	7	7
Furnishing products		
Carpet	109	111
Outdoor plastic furniture	<1	3
Packaging products		
Packaging – general[5]	4,230	4,230
Retail carry bags	27	27
Freight packaging - flexible film	34	34
Disposable nappies	48	48

[1]This data is has been extrapolated from WA specific data.
[2] Calculated based on the estimated apparent consumption of sawnwood and wood panel products in Australia in 2004/05 as reported by ABARE (2006) Australian Forest & Wood Product Statistics Report, September and December quarters 2005. Volume of products consumed converted to tonnes based on density estimates.
[3]The fixed line phone data is from 2002/03. This is the most recently available information.
[4]The tyre data is from 2004. This is the most recent available information.
[5]Packaging – general includes beverage, food and other grocery packaging.
Disposal includes current levels of recycling or recovery.
All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

1.4 Priority rating

Following the assessment of all products, each product category was scored with its overall priority rating. The product priority ratings and the scoring system results are outlined in Appendix 3. The eight products that scored a very high priority rating and eleven products that scored a high priority rating are outlined in Table E-7. Some rated high due to a higher toxicity rating while others rated near the top due to their high consumption or recyclability ratings.

Note this method is being offered by Hyder Consulting as one means of facilitating national discussion on priorities for action under future waste polices. Hyder Consulting recognises that further discussion and development of the methodology and the rankings is likely to be needed.

Table E-0-7 Materials/ products with a very high and high priority rating

Product	Rating	Product	Rating
Concrete paving and construction	VH	Asphalt road materials	H
Roofing iron	VH	Bricks	H
Televisions	VH	Roofing tiles	H
Compact fluorescent lamps	VH	Hot water systems	H
Fluorescent lamps	VH	Computers	H
Whitegoods	VH	Printer & computer peripherals	H
Automotive batteries	VH	Small appliances	H
NiCad batteries	VH	Heaters	H
		Tyres (2004 data)	H
		Gas cylinders	H
		Disposable nappies	H

1 Introduction

1.1 Background

In February 2006, Hyder Consulting produced a report titled *Waste and Recycling in Australia*. This paper informed the then Department of Environment and Heritage's submission to the Productivity Commission's inquiry into waste generation and resource efficiency in Australia.

The objective of this current report is to update and supplement the information contained in the 2006 report and to provide additional information to illustrate the current picture of waste and recycling in Australia.

The four areas addressed in this report are:

- Data on waste disposal and recycling in Australia
- Key waste management strategies/ policies
- Environmental impacts of waste management
- Barriers to resource recovery

This amended report has been produced to incorporate updated data for some states/territories and for some organic materials that has become available since the publication of the report in 2008.

The data contained within the report should be used with caution as it has been drawn from a range of sources with varying data quality and methodologies. Nonetheless, the report endeavours to provide the most up-to-date and comprehensive picture of waste and recycling activity in Australia. The scope of the report is the three major solid waste streams: municipal solid waste (municipal or MSW), commercial and industrial (C&I) and construction and demolition (C&D). It should be noted that, unless specifically stated within a particular report section, we have endeavoured to exclude the following waste streams/materials from the reported data: hazardous, prescribed or clinical wastes; contaminated soils; fly ash; mining and mineral processing wastes; quarantine waste from ships; other gaseous or liquid wastes and self-managed farm wastes. Biosolids and bark and sawdust from forestry operations have been included within the report as it was not possible to exclude them from the data provided by all jurisdictions.

Definitions for the three waste streams have been provided in Section 1.2. Where possible, potential discrepancies or uncertainties were identified during the examination of published definitions within each of the data sources used. Some data sources did not include a definition for the reported waste streams and as such, discrepancies within the data that cannot be identified are inevitable. The allocation of material into these streams should therefore be considered a 'best estimate' and the data should be used with caution. These areas are considered further in Section 9.6 (Data gaps).

1.2 Methodology

1.2.1 Data on waste disposal and recycling in Australia

Available data on each area of consideration was accessed through desktop research, industry knowledge and consultation with state agencies. Data was sourced through publicly available reports except where state agencies were able to provide unpublished data that was more up-to-date. The data sources are specified in the discussion on each state (Section 2.2). Differences in methodology were noted and where possible, data reported in the most consistent format in terms of categories and inclusions of materials. All figures reported in tables throughout this report have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

The following definitions are a guide for the three waste streams. Some discrepancies were identified between the definitions adopted within each state/territory. In some cases, definitions were not provided in published data reports.

- Municipal: Solid waste generated from domestic (household) premises; also usually includes council activities such as street sweeping, litter and street tree lopping; waste dropped off at recycling centres and transfer stations; and construction waste from owner/occupier renovations.
- Commercial and industrial: Solid waste generated by the business sector (offices, factories etc) as well as solid wastes generated by state and federal government entities, schools and tertiary institutions. Generally also includes biosolids and forestry by-products (bark, sawdust) where reported.
- Construction and demolition: waste from residential, civil and commercial construction and demolition activities, such as fill material (e.g. soil), asphalt, bricks and timber. Generally excludes construction waste from owner/occupier renovations, which are included in the municipal waste stream.

Unless specifically stated within a particular report section, we have endeavoured to exclude the following waste streams/materials from the reported data: hazardous, prescribed or clinical wastes; contaminated soils; fly ash; mining and mineral processing wastes; quarantine waste from ships; other gaseous or liquid wastes and self-managed farm wastes. These were excluded because they were waste streams/materials were considered outside of the scope of the report and were able to be excluded from most state/territory data. Biosolids, bark and sawdust from forestry operations and some agricultural wastes have been included within the report as it was not possible to exclude them from the data provided by all jurisdictions.

This section of the report has been amended from the 2008 report.

1.2.2 Key waste management strategies/policies

Desktop research was undertaken to obtain an overview of the key waste management strategies/policies in place in Australia at the state and territory level. Where there was

little information available, state agencies were contacted to confirm any further details. This section of the report has not been amended from the 2008 report.

1.2.3 Environmental impacts of waste disposal and greenhouse gas impacts of waste management

Desktop research, drawing together information from a wide range of sources, was undertaken in order to provide an overview of the environmental impacts of waste disposal and more broadly, greenhouse gas impacts of waste management. This section of the report has been amended only slightly from the 2008 report.

1.2.4 Barriers to resource recovery

The assessment made in the 2006 report was updated and enhanced based on the latest available data and Hyder's understanding of how the identified barriers have progressed. Information from a wide range of sources was drawn together to provide an updated perspective on the barriers to resource recovery. This section of the report has not been amended from the 2008 report.

2 Australian data on waste and recycling

2.1 Introduction

This section summarises information collated on waste disposal to landfill and recycling data in Australia. It includes figures on:

- the quantity generated each year on a state/territory and national basis
- the composition of the waste stream by sector and by material
- historical and projected trends.

The amount of waste disposed of to landfill and recycling performance varies greatly between states and territories throughout Australia. In addition, a number of methods for data collection and classification were encountered. Therefore, one of the aims of this report is to collate data using consistent definitions and assumptions, where possible, to enable comparison. Inconsistencies between data collection methodologies have also been identified where possible.

This report collates the available data for each state/territory. No primary research has been undertaken in producing this report. Data gaps have been identified and are highlighted in Section 9.6.

2.1.1 Data types

The two most common fates of generated waste materials are either disposal, generally to landfill, or recovery (generally to mechanical recycling). Policy objectives for each management option vary and require different performance indicators and data. Informed decision making requires that performance is measured in accordance with the policy objectives of waste management based on best available data and methods.

2.1.2 Traditional data requirements

Reduction of waste to landfill has traditionally been a guiding policy objective of waste management across all jurisdictions in Australia. Measured as the quantity of waste disposed to landfill per capita or per unit of gross domestic product (GDP) for aggregated waste streams, it serves as a potential indicator of environmental pressure caused by human activity (wastefulness) as well as an indicator of landfill related impacts. Recycling, measured as the quantity of material diverted per capita or per unit of GDP, indicates the response of society to managing environmental concerns through potential recovery of resources, as well as avoided impacts such as global warming and landfill site impacts.

2.1.3 Data needs for resource efficiency and sustainability

More recent policy objectives that target waste avoidance and seek to decouple environmental impact and economic growth, and facilitate resource efficiency, require

different data sets and assessment tools. A continual focus on waste generation gives us a stronger focus on community resource use. Another data set that builds a picture on resource sustainability is the generation of data on product/ material consumption and disposal. In order to understand the role of waste management data in policy decision making, it is important to consider the different goals of waste management and the associated data sets and their application. These are summarised in Table 2-1.

Table 2-1 Different goals of waste management, associated data sets and their application

Policy objective	Waste management strategy	Data type	Data quality / source	Data application for policy
Waste minimisation	Reduce waste to landfill	**Waste to landfill** ***Mass of waste by stream:*** *Municipal solid waste (i.e. Council & domestic)* *Commercial & industrial* *Construction & demolition*	Data sourced from quarterly returns of depot operators. Collated by state authorities. Reliable data on landfill disposal tonnages for municipal solid waste, but not for commercial & industrial and construction & demolition.	Used to indicate trends in materials intensity (wastefulness) of human activity. Measure of impact associated with landfill space depletion. Potential for expanding recycling recovery.
Resource Efficiency Decouple growth and impact	Commodity recycling	**Material Recovered** ***Mass of Material*** *(e.g. steel, glass, etc)*	Data sourced by surveys, most accurate when rebate schemes operate.	Measure trends in the effectiveness of policy responses.
	Resource Efficiency & Waste Avoidance (disassembly, repair, extend life, renovation National Resource Accounting)	**Input output flow analysis** ***By product sales*** *Consumption & fate (e.g. computers, batteries, etc)*	Limited and poor waste data available for many products.	Used to inform strategies for recovery of materials. Identify most effective point of interception for life extension, recovery, repair etc.
		National Resource Accounts ***By sector*** *Input/Output analysis by: virgin material (mineral ores and biotic assets)*	Increasingly available. Most OECD countries have developed national accounts.	Used to measure actual material throughput of different sectors for priority setting. Material flows per capita measured as 200 tonnes/person/year[1].
		Life Cycle Assessment *Product or service measured by resource inputs & pollutant outputs*	High availability, Rigorous International standard, data quality improving but still poor. Most OECD countries have invested in LCA and Waste Management data.	Used to assess goods and services in terms of: materials intensity, environmental impact, net externalities. Environmental value of kerbside recycling (avoided externalities) estimated at 68 dollars per person per year[2]
		Substance Flow Analysis *Region by substance*	Leadership by academic institutes on substance flows (lead, zinc etc).	Identify the substances of regional concern and trace to related industrial activities.
		Ecological Footprint *Hectares of land/capita*	Most OECD countries have measured and reported footprint impacts.	Easy to communicate measure of materiality as hectares of land. Neglects air and water pollution.
		Materials Intensity per Unit Service - *throughput*	Limited to selected academic institutes. No international standard.	Used to assess goods and services in terms of materials intensity. Neglects environmental significance of material load.

[1]ABS (2002)
[2]Nolan-ITU (2002)

2.2 Disposal and recycling

This section presents a consolidation of available information on disposal and recycling performance across the states of Australia. References and explanations of assumptions and calculations are also provided. Unless otherwise noted, data presented in this report is for the 2006/07 financial year. The available information (in terms of type and quality) from each state/territory varies greatly.

2.2.1 National totals

Table 2-2 shows the level of total waste generation (disposal and recycling) and diversion rates across the main states of Australia during 2006/07.

Table 2-2 Waste generation and diversion rates for the states of Australia, estimated, 2006/07

State / territory	Disposed	Recycled[1]	Total Generated	Diversion Rate
	Tonnes ('000)			Percent
NSW	7,365	7,995	15,360	52%
VIC[2]	3,925	6,360	10,285	62%
QLD[3]	4,302	3,779	8,081	47%
WA[4]	3,539	1,708	5,247	33%
SA	1,144	2,173	3,318	66%
ACT	197	587	784	75%
TAS	446	75	521	Unknown
NT[5]	151	30	181	Unknown
Total	**21,069**	**22,707**	**43,777**	**52%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.
[1] Victoria, Queensland, WA and ACT recycling data appears to include all organic material categories (See Section 3 for categories); NSW, SA, Tasmania and NT include only some organic material categories.
[2] The Victorian landfill figures represent the amount of waste accepted at licensed Victorian landfills, excluding material used as cover. The *Environment Protection Act* 1970 provides a rebate for cover material of 15% (at the relevant municipal rate) for each tonne of waste deposited at a landfill. The figures shown above were calculated by taking the tonnes of material received at landfills (including cover material sourced off site) and reducing this by 15% to allow for cover material. It is noted that some landfills source cover material on-site (e.g. from quarrying activities) and that this is not measured in the tonnes of waste received at landfills. Where landfills have claimed a recycling rebate, this has been subtracted from the figures.
[3] Queensland landfill and recycling data includes biosolids
[4] Landfill data for WA has been extrapolated from municipal landfill data.
[5] The NT landfill data is only for the Darwin region. The NT recycling data is municipal data for NT plus green organics and other recycled material for Darwin City Council only.

The data sources and materials that are included / excluded for each state/territory are discussed further in the sections following.

Variation in overall waste generation is expected given the population size of the different states/territories. This is corrected for by presenting the data on waste generation on a per capita basis. This is included in Table 2-3. ACT, South Australia and Victoria have the highest amounts of recycling per capita. Queensland, Victoria and South Australia have the lowest levels of total waste generation per capita. ACT, South Australia and Victoria have the highest diversion rates.

Table 2-3 Per capita waste generation and diversion rates for the states of Australia, estimated, 2006/07

State / territory	Population	Disposed	Recycled[1]	Total Generated	Diversion Rate
		Kilograms per capita			Percent
NSW	6,888,000	1,070	1,160	2,230	52%
VIC	5,205,000	750	1,220	1,980	62%
QLD[2]	4,181,000	1,030	900	1,930	47%
WA[3]	2,106,000	1,680	810	2,490	33%
SA	1,584,000	720	1,370	2,090	66%
ACT	340,000	580	1,730	2,310	75%
TAS	493,000	Unknown			
NT[4]	215,000	Unknown			
Total	**21,015,000**	**1,000**	**1,080**	**2,080**	**52%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.
[1] Victoria, Queensland, WA and ACT recycling data appears to include all organic material categories (See Section 3 for categories); NSW, SA, Tasmania and NT include only some organic material categories.
[2] Queensland landfill and recycling data includes biosolids.
[3] Landfill data for WA has been extrapolated from municipal landfill data.
[4] The NT landfill data is only for the Darwin region. The NT recycling data is municipal data for NT plus green organics and other recycled material for Darwin City Council only.

Table 2-4 shows the estimated consolidated disposal, recycling, generation and diversion rates for each sector – municipal, commercial and industrial (C&I), and construction and demolition (C&D) – across Australia. Table 2-5 shows this data on a per capita basis. Material based summaries for disposal and recycling by state/territory are presented in Appendix 1. These summaries, and the detail provided for each state/territory in this section highlight the inconsistencies in reporting and classification.

Table 2-4 Waste generation by sector across the states of Australia, estimated, 2006/07

State / territory	Disposed *('000 tonnes)*				Recycled[1] *('000 tonnes)*				Generated *('000 tonnes)*			
	Municipal	C&I	C&D	Total	Municipal	C&I	C&D	Total	Municipal	C&I	C&D	Total
NSW	2,408	2,921	2,036	7,365	1,483	2,297	4,216	7,995	3,891	5,218	6,251	15,360
VIC	1,727	1,060	1,138	3,925	1,056	2,357	2,946	6,360	2,783	3,417	4,084	10,285
QLD[2]	1,735	1,101	1,466	4,302	1,365	1,797	617	3,779	3,100	2,898	2,083	8,081
WA[3]	1,015	585	1,939	3,539	408	891	409	1,708	1,424	1,476	2,348	5,247
SA[4]	344	496	304	1,144	408	610	1,155	2,173	753	1,106	1,460	3,318
ACT[5]	85	91	21	197	278	102	206	587	363	194	227	784
TAS[6]	287	145	14	446	53	22	0	75	340	167	14	521
NT[7]	44	57	51	151	30	Unknown	Unknown	30	74	57	51	181
Australia	**7,645**	**6,456**	**6,968**	**21,069**	**5,082**	**8,076**	**9,549**	**22,707**	**12,727**	**14,532**	**16,517**	**43,777**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.

[1] Victoria, Queensland, WA and ACT recycling data appears to include all organic material categories (See Section 3 for categories); NSW, SA, Tasmania and NT include only some organic material categories.

[2] Queensland landfill and recycling data includes biosolids.

[3] Landfill data for WA has been extrapolated from municipal landfill data. The estimated C&I and C&D disposal to landfill stream have been estimated based on the average proportion of MSW/C&I/C&D waste streams for 1998-2004 reported on www.zerowaste.wa.gov.au

[4] The split of total disposal to landfill (MSW/C&I/C&D) for SA was estimated based on a landfill audit undertaken in 2007.

[5] ACT municipal disposal to landfill includes material collected at kerbside and material delivered privately to landfills.

[6] The Tasmanian split of recycling (MSW/C&I/C&D) was provided by Tasmanian Department of Primary Industries, Parks, Water and Environment.

[7] The NT landfill data is only for the Darwin region. The NT recycling data is municipal data for NT plus green organics and other recycled material for Darwin City Council only.

Table 2-5 Per capita waste generation by sector across the states of Australia, estimated, 2006/07

State / territory	Disposed *(kilograms)*				Recycled *(kilograms)*				Generated *(kilograms)*			
	Municipal	C&I	C&D	Total	Municipal	C&I	C&D	Total	Municipal	C&I	C&D	Total
NSW	350	424	296	1,069	215	333	612	1,161	565	758	908	2,230
VIC	332	204	219	754	203	453	566	1,222	535	657	785	1,976
QLD[2]	415	263	351	1,029	326	430	148	904	741	693	498	1,933
WA[3]	482	278	920	1,680	194	423	194	811	676	701	1,115	2,492
SA[4]	217	313	192	722	258	385	729	1,372	475	698	921	2,094
ACT[5]	251	269	61	581	819	301	606	1,726	1,070	570	668	2,307
TAS[6]	581	294	28	904	108	45	0	152	689	339	28	1,056
NT[7]	202	263	237	702	141	Unknown	Unknown	141	344	263	237	843
Australia	**364**	**307**	**332**	**1,003**	**242**	**384**	**454**	**1,081**	**606**	**692**	**786**	**2,083**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.

[1] Victoria, Queensland, WA and ACT recycling data appears to include all organic material categories (See Section 3 for categories); NSW, SA, Tasmania and NT include only some organic material categories.

[2] Queensland landfill and recycling data includes biosolids.

[3] Landfill data for WA has been extrapolated from municipal landfill data. The estimated C&I and C&D disposal to landfill stream have been estimated based on the average proportion of MSW/C&I/C&D waste streams for 1998-2004 reported on www.zerowaste.wa.gov.au

[4] The split of total disposal to landfill (MSW/C&I/C&D) for SA was estimated based on a landfill audit undertaken in 2007.

[5] ACT municipal disposal to landfill includes material collected at kerbside and material delivered privately to landfills

[6] The Tasmanian split of recycling (MSW/C&I/C&D) was provided by Tasmanian Department of Primary Industries, Parks, Water and Environment.

[7] The NT landfill data is only for the Darwin region. The NT recycling data is municipal data for NT plus green organics and other recycled material for Darwin City Council only.

2.2.2 New South Wales

The NSW data is drawn from a number of reports published by the NSW Department of Environment and Climate Change (DECC).

Total waste generation and recycling by sector for 2006/07 are taken from NSW DECC (2008) Waste Avoidance and Resource Recovery Progress Report. Disposal, generation and recycling and diversion rate by sector are presented in Table 2-6. The disposal data includes daily and intermediate landfill cover material. Some states/territories do not include this material in their disposal data and for some it is unclear whether it is included. As such, generation and disposal rates for NSW may be higher than some other states/territories.

Table 2-6 NSW generation, recycling and disposal and diversion rates by sector, estimated, 2006/07

Sector	Disposal	Recycling	Total generation	Diversion rate
	Tonnes ('000)			% by weight
Municipal	2,408	1,483	3,891	38%
C&I	2,921	2,297	5,218	44%
C&D	2,036	4,216	6,251	67%
Total	**7,365**	**7,995**	**15,360**	**52%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

Total recycling activity for NSW during 2006/07 was reported in the NSW DECC (2008) report. The report also provided some information on recycling by material, based on the annual NSW Resource Recovery Industries Survey. More detailed information from this survey was reported in four fact sheets available from the NSW DECC website:

- paper reprocessing and reuse
- organics recovery
- textiles reprocessing and reuse
- rubber reprocessing and reuse

A full report on the 2006/07 Resource Recovery Industries Survey did not appear to be available during the report amendment period. NSW DECCW have advised that the following organics categories were included in the analysis of waste generation and recovery: garden organics, wood/timber/sawdust from commercial and industrial sources and food.

In addition to the information from the DECC reprocessors survey, three other sources were used to identify the amounts of materials recycled in each waste stream. The National Environment Protection Council report on the implementation of the Used Packaging Materials NEPM (NEPC, 2007) was used to identify the municipal recycling stream materials where possible. Data on plastics recycling, gathered by Hyder Consulting during the preparation of the annual Plastics and Chemicals Industry Association (PACIA) Plastics Recycling Activity Study was used to identify plastics recycling by sector. This data was for the 2006 calendar year. The Waste Management

Association of Australia (WMAA) (2008) Resource Recovery Industry Survey: Construction and Demolition Sector report was used to provide further detail on materials recovered from the C&D sector.

The NSW DECC (2008) report included information on the composition of the mixed commercial and industrial and domestic disposal to landfill streams. These compositions were based on audits conducted by or on behalf of DECC. These compositional breakdowns were assumed to be representative of the overall breakdown of these waste streams and were applied as such. Data on the composition of the construction and demolition disposal to landfill stream was taken from NSW DECC (2007b) *'Report into the Construction and Demolition Waste Stream – 2000-2005 Sydney Metropolitan Area'.* The composition of construction and demolition waste sent to landfill, excluding asbestos, asbestos contaminated wastes and contaminated soil, was used to estimate the amount of C&D waste by material.

Material based summaries for disposal and recycling from each waste stream are presented in Appendix 1.

2.2.3 Victoria

Victorian data has been sourced from the Sustainability Victoria waste model (waste quantities tracking system). The model draws on the following sources:

- '*Annual Survey of Victorian Recycling Industries 2006-2007*' (Sustainability Victoria, unpublished)
- '*Local Government Data Collection 2006-2007*' (Sustainability Victoria, unpublished)
- EPA Victoria landfill levy returns 2006/07
- '*Report on Waste Profile Study of Victorian Landfills*' (Golder Associates 1999)
- '*Solid Industrial Waste Plan Data* Report' (Sustainability Victoria 2002).

The model provides estimated waste landfilled, recovered and generated, by material type and sector, for Victoria.

The following explanation of the landfill data included within the model has been provided by the Victorian EPA: "The Victorian landfill figures represent the amount of waste accepted at licensed Victorian landfills, excluding material used as cover. The *Environment Protection Act* 1970 provides a rebate for cover material of 15% (at the relevant municipal rate) for each tonne of waste deposited at a landfill. The figures were calculated by taking the tonnes of material received at landfills (including cover material sourced off site) and reducing this by 15% to allow for cover material. It is noted that some landfills source cover material on-site (e.g. from quarrying activities) and that this is not measured in the tonnes of waste received at landfills. Where landfills have claimed a recycling rebate, this has been subtracted from the figures."

Two minor changes were made to the data provided by Sustainability Victoria. An estimate of recovery of food organics from one metropolitan council was added within

the recycling breakdown and total for the municipal sector. The reported tonnage of food organics recovered from the C&D sector was moved to the C&I sector as it seemed unlikely that food was recovered from the C&D sector.

These estimated figures for disposal to landfill, recycling and overall generation are provided in Table 2-7 (by Sector) and Table 2-8 (by material). Material based summaries for disposal and recycling from each waste stream are presented in Appendix 1. Recycled tonnage for Victoria includes some material transferred from interstate for reprocessing in Victoria. It was not possible to determine precisely which organic material categories are included within the total recycling estimates. It is assumed that the 'other organic' category is comprensive and includes the materials listed in Section 3.

Table 2-7 Disposal of waste to landfill, recycling, generation and diversion rate, by sector, estimated, Victoria 06-07

Sector	Disposed	Recycled	Generated	Diversion Rate
	Tonnes ('000)			% by weight
Municipal	1,727	1,056	2,783	38%
C&I	1,060	2,357	3,417	69%
C&D	1,138	2,946	4,084	72%
Total	**3,925**	**6,360**	**10,285**	**62%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

Table 2-8 **Disposal, recycling, generation and diversion rate by material, estimated, Victoria 2006/07**

Material	Disposed	Recycled	Generated	Diversion Rate
	Tonnes ('000)			% by weight
Paper/cardboard	334	822	1,156	71%
Plastic (codes 1-3)	89			
Other plastic	149	111	350	32%
Glass	135	202	337	60%
Metals	148	1,261	1,409	89%
Food waste	906	37	943	4%
Garden waste	372	302	674	45%
Wood/timber	340	196	536	37%
Other organic (incl. sawdust)	154	250	404	62%
Clean excavated materials	475	Unknown	475	Unknown
Concrete/ bricks/ asphalt	516	3,170	3,686	86%
Textiles	77	8	84	9%
Other	230	0	230	
Total	**3,925**	**6,360**	**10,285**	**62%**
All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.				

2.2.4 Queensland

Queensland data on disposal, recycling and overall generation for the municipal, C&I and C&D waste streams was published by Queensland Environment Protection Agency (EPA) in their 2008 report titled 'The State of Waste and Recycling in Queensland 2007'. The report provided a comprehensive assessment of disposal to landfill and recycling/recovery of eight waste streams. Five of these have been included within this report: domestic, green, biosolids, construction and demolition and commercial and industrial. The remaining three; fly ash, contaminated and acid sulphate soils and other regulated wastes, have not been included. The biosolids stream was included because it appeared to have been included within the recycling total figures for a number of other states and it was felt that to exclude it from the Queensland data would therefore be understating the diversion rate for Queensland in comparison with other states. Similarly, fly ash was excluded because it appeared to have been excluded from the recycling totals within other states (except South Australia, for which we excluded it specifically in this report).

The green waste stream was assumed to have been sourced primarily from the municipal sector with the exception of some (5%) of recovered green waste being

sourced from the commercial and industrial sector. The biosolids waste stream was assumed to have been sourced from the commercial and industrial sector as it would have undergone an industrial process prior to disposal or recovery. It was reported that most of the biosolids waste stream would have originated in the municipal sector (DERM Qld 2009, pers.comm).

The total quantities of municipal, C&I and C&D waste disposed to landfill and recycled are presented in Table 2-9.

Municipal recycling data (excluding plastics and organics) was sourced from Qld EPA (2008). Plastics recycling data for each sector has been sourced from unpublished data held by Hyder Consulting as part of the PACIA survey for the 2006 calendar year. Organics recycling data was taken from Recycled Organics Unit (2007) *'Organics Recycling in Australia: Industry Statistics 2007'*. Material based summaries for disposal and recycling from each waste stream are presented in Appendix 1. There were no available audits by which to estimate the breakdown of the disposal to landfill stream by material.

Table 2-9 Disposal, recycling, generation and diversion rate by sector, estimated, Queensland 2006/07

Sector	Disposed	Recycled	Generated	Diversion Rate
	Tonnes ('000)			% by weight
Municipal	1,735	1,365	3,100	44%
C&I	1,101	1,797	2,898	62%
C&D	1,466	617	2,083	30%
Total	**4,302**	**3,779**	**8,081**	**47%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

2.2.5 Western Australia

There was little readily available information for Western Australia in terms of waste disposal. Landfill disposal for the municipal sector was taken from the WA DEC (Department of Environment and Conservation) (2007) *'Zero Waste Plan Development Scheme (ZWPDS) Phase 1 Report 2006/07'*. The average percentage split between the municipal, C&I and C&D landfill streams during the period 1998-2004 was calculated from landfill data published on www.zerowastewa.com.au. This percentage split was used to extrapolate the municipal landfill figure to provide overall waste to landfill and tonnes for each waste sector.

To estimate the composition of garbage disposed to landfill from the municipal sector, compositional data was used from a study conducted by Murdoch University in 1999 for the City of Stirling (cited in WMB 2003). To estimate the composition of garbage disposed to landfill in the C&I and C&D sectors, compositional data from a report on disposal based audits conducted by Waste Audit and Consultancy Services (2007a) on behalf of the WA DEC was used.

Data on recycling activity in Western Australia has been drawn from the report Cardno BSD (2008) *'Review of total recycling activity in Western Australia 2006*/07'. This report provided total recycling activity across a range of material categories as well as the

split between the municipal, C&I and C&D sectors. The recycling activity report includes all organics categories reported by Compost Australia (ROU, 2008), although there appeared to be a discrepancy between the total green organics recovery figure reported within the Cardno report and the amount reported by Compost Australia. The Cardno data has been used in this report. The breakdown of recycling by material within each sector was estimated using the Cardno (2008) reported total material recovered in each sector and the breakdown of recycling by material for MSW, C&I and C&D.

Quantities of municipal, C&I and C&D waste to landfill and recycled are provided in Table 2-10 and material based summaries are provided in Table 2-11.The latter are presented in more detail in Appendix 1.

Table 2-10 Disposal, recycling, generation and diversion rate by sector, estimated, WA 2006/07

Sector	Disposed[1]	Recycled	Generated	Diversion Rate
	Tonnes			% by weight
Municipal	1,015	408	1,424	29%
C&I	585	891	1,476	60%
C&D	1,939	409	2,348	17%
Total	**3,539**	**1,708**	**5,247**	**33%**

[1]The disposal figures for C&I, C&D and total are extrapolated from municipal disposal figures.
All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

Table 2-11 Disposal, recycling, generation and diversion rate by material, estimated, WA 2006/07

Material	Disposed	Recycled	Generated	Diversion Rate
	Tonnes			% by weight
Paper & Cardboard	261	226	487	46%
Plastic	87	18	105	17%
Glass	68	20	88	23%
Metals	75	497	571	87%
Organics (all)	799	541	1,341	40%
Concrete, sand, brick and rubble	1,833	395	2,228	18%
Rubber	3	5	8	63%
Textiles	19	2	20	8%
Other Waste	395	4	399	1%
Total	**3,539**	**1,708**	**5,247**	**33%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

2.2.6 South Australia

The total quantity of waste disposed to landfill for South Australia is taken from landfill data collected by the SA EPA. The percentage split between the municipal, C&I and C&D landfill waste streams was taken from a landfill audit conducted by Waste Audit and Consultancy Services (2007b) *'Disposal based survey, Zero Waste South Australia, October/November 2007'*. This indicated that the split between these three waste streams was municipal (30.1%), C&I (26.6%), C&D (43.3%). This audit report has also been used to provide composition of waste disposed of to landfill in the C&I and C&D streams.

Data published in the 2003 State of the Environment Report for South Australia (EPA 2003) was used to estimate the municipal disposal to landfill composition.

All recycling data, including the split between the municipal, C&I and C&D waste streams, is drawn from the report '*Review of Recycling Activity in South Australia'*, prepared for Zero Waste SA by Hyder Consulting in 2008. However, the recycling data presented here excludes fly ash, which is reported as recycled in the Hyder (2008) report. The exclusion of some 261,000 tonnes of this material from the C&I recycling stream has lowered the overall diversion rate for South Australia from 68% to 66% and the C&I diversion rate from 64% to 55%. This material has been excluded in the recycling data presented here because it appears that fly ash is not reported in the recycling/recovery data for other states/territories. However, only Queensland report fly ash separately thus ensuring that this material can be excluded. As such, it is possible that other states/territories that do not report their recycling data by material have included fly ash.

South Australia do not include all organics materials within their reported recycling. They include biosolids, animal bedding, animal mortalities, paunch, miscellaneous agricultural organics, paper pulp/sludge within the other organics category.

Table 2-12 provides disposal, recycling, generation and diversion rate for each sector and Table 2-13 provides the same characteristics by material. Material based data by sector are presented in Appendix 1.

Table 2-12 Disposal, recycling, generation and diversion rate by sector, estimated, SA 2006/07

Sector	Disposed	Recycled	Generated	Diversion Rate
	Tonnes			% by weight
Municipal	344	408	753	54%
C&I	496	610	1,106	55%
C&D	304	1,155	1,460	79%
Total	**1,144**	**2,173**	**3,318**	**66%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

Table 2-13 Disposal, recycling, generation and diversion rate by material, estimated, SA 2006/07

Material	Disposed	Recycled	Generated	Diversion Rate
	Tonnes			% by weight
Paper & cardboard	91	175	266	66%
Plastics	69	17	505	86%
Steel		324		
Aluminium		21		
Non-ferrous metals (ex. Al)		24		
Glass		50		
Concrete	22	794	816	97%
Brick & tile/rubble & soil	282	107	390	28%
Asphalt	0	84	84	100%
Timber	35	275	310	89%
Garden organics	79	210	289	73%
Food organics	214	4	218	2%
Textiles	12	2	15	16%
Rubber	39	1	40	4%
Other organics	32	83	115	72%
Foundry sands	58	2	60	3%
Other waste	210	0	210	
Total	**1,144**	**2,173**	**3,318**	**66%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

2.2.7 Australian Capital Territory

Disposal and recycling figures were available from material published on the ACT NoWaste website, except municipal recycling which was taken from the '*National Environment Protection Council annual report 2006-2007, NEPC Report on the implementation of the Used Packaging Materials NEPM'* (NEPC 2007) and plastics data which was taken from unpublished data held by Hyder Consulting as part of the PACIA survey for the 2006 calendar year. The distribution of some recycling categories of MSW, C&I and C&D were estimated.

Two amendments were made to the recycling data for ACT. Motor oil, cooking oil and salvage/reuse, all of which were reported by ACT NoWaste, were excluded from the data that is presented here. Additional material derived from Compost Australia (ROU 2007) data (sawdust and barks from forestry operations) was included within the data in addition to the data reported by ACT NoWaste. Both of these amendments were made to improve consistency with data on a national level.

Disposal and recycling by sector are included in Table 2-14.

The municipal garbage composition was drawn from the results of a kerbside waste and recycling audit conducted in November 2007 (APC 2007).

The composition of C&I waste disposed of to landfill was provided by ACT NoWaste (ACT NoWaste 2008, Pers. Comm.) The composition of C&D waste disposed of to landfill is based on the ACT Waste Inventory completed in May 1997, presented in '*The Next Step in the No Waste Strategy*' (ACT No Waste 2000).

Material based disposal, recycling and generation figures by sector for the ACT are presented in Appendix 1.

Table 2-14 Disposal, recycling, generation and diversion rate by sector, estimated, ACT 2006/07

Sector	Disposed	Recycled	Generated	Diversion Rate
	Tonnes ('000)			% by weight
Municipal	85	278	363	77%
C&I	91	102	194	53%
C&D	21	206	227	91%
Total	**197**	**587**	**784**	**75%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

2.2.8 Tasmania

Data for disposal to landfill, recycling and composting was provided by the Tasmanian Department of Primary Industries, Parks, Water and Environment (pers.comm). Landfill data, including the sector source (MSW, C&I, C&D) was reported by landfill operators. Tasmania does not classify dirt as a waste material. This may lead to lower waste generation rates than other states/territories. It appears that the data for the C&D sector is underreported, possibly due to the use of a default reporting code that favours the C&I stream.

Splits between sector for recyclables and green organics are as estimated by a representative from the Tasmanian Department of Primary Industries, Parks, Water and Environment (pers.comm).

Data for disposal, recycling and generation is presented in Table 2-15. Material based summaries are presented in Appendix 1.

Table 2-15 Disposed and recycled by sector, Tasmania, 2006/07

Sector	Disposed	Recycled	Generated
	Tonnes ('000)		
Municipal	287	53	340
C&I	145	22	167
C&D	14	Unknown	14
Total	**446**	**75**	**521**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

2.2.9 Northern Territory

There is currently no state-wide data available for waste disposal in the Northern Territory. Landfill data was provided by Darwin City Council (pers.comm) for the Shoal Bay landfill. The sector split of material disposed of to landfill was estimated by a representative from the Darwin City Council (pers.comm).

Recycling data for Northern Territory was taken from the '*National Environment Protection Council Annual Report 2006-2007, NEPC Report on the implementation of the Used Packaging Materials NEPM*' (NEPC 2007) and the Darwin City Council report on the National Environment Protection (Used Packaging Materials) Measure (green organics and other recyclable material only). The green organics recovery material was reported in cubic metres and was converted using a factor of 0.15 tonnes / cubic metres. The other recyclable material reported by Darwin City Council was material that was recycled during the pre-cyclone clean-up program for residents.

A summary of the available data is presented in Table 2-16 and in Appendix 1. While still incomplete, this represents a significant improvement on previously available disposal and recycling data for the Northern Territory.

Table 2-16 Disposal and recycling for Darwin City Council, NT (municipal recycling only)

	Disposed	Recycled	Generated
	Tonnes ('000)		
Municipal	44	30	74
C&I	57	Unknown	57
C&D	51	Unknown	51
Total	**151**	**30**	**181**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

2.2.10 Municipal solid waste stream

A definition of 'municipal solid waste' (MSW) is provided in Section 1.2.1 as a guide to identify the general inclusions within this waste stream. MSW generally includes not only solid waste from households but also council activities such as street sweeping, litter and street tree lopping and construction waste from owner/occupier renovations. Waste from small businesses is also sometimes included as MSW where SMEs use council waste services or drop material at landfills or transfer stations that are used primarily for household materials. The definition provided in Section 1.2.1 is a guide only as not all published data reports provided a definition of the waste stream inclusions and in some cases, data was available only on an aggregated basis across all waste streams and other sources were required in order to make an estimate of the split between the waste streams.

A number of available data reports were examined to establish a deeper understanding of the proportion of MSW that comes from households rather than council operations and/or the commercial and industrial sector. The examination focused on Victoria and Queensland due to the availability of information.

Victoria

The Victorian Local Government Annual Survey 2006-07 (Sustainability Victoria 2008b) provides information on the waste management and recycling services provided by local governments. An analysis of this report provides some insight into the component of the MSW stream managed by local governments within Victoria. The report provides data on material collected and/or recovered from:

- kerbside waste and recycling services
- hard waste collections
- landfills and transfer stations (recovery of recyclables only)
- litter bins and traps
- illegally dumped rubbish and road side litter.

No data was generated by the survey on the amount of material collected through street sweeping services, nor was drop-off of green organics for recovery at landfills and transfer stations reported during 2006-07.

An analysis of the material disposed of to landfill in the above categories indicates that that 4.3% of the landfill disposal stream originated from council operations rather than directly from households.[1] This estimate can be supplemented by data from a major landfill site that accepts household and council waste from a number of municipalities. Weighbridge data from the site show that council waste represented 10.4% of MSW in 2008 and 11.0% in 2007. This data excludes construction and demolition material from council roadworks.

The Sustainability Victoria report contained no data on the level of recovered material (recyclables and green organics) that originated from council operations, nor was it possible to identify the proportion of the MSW disposal to landfill or recycling streams that originated in the C&I sector. The report noted that local governments were requested to exclude C&I properties from their reporting of the domestic kerbside services however it was often not possible for the cost and amount of material to be excluded.

Queensland

The State of Waste and Recycling in Queensland 2007 Technical Report (EPA Queensland 2008) provides data on waste management in Queensland. Among other aspects, the report provided estimates of the total amount of material disposed of to landfill from kerbside collections and self-delivered domestic waste, as well as the amount received by commercial landfill operators from industry that was reported within the domestic waste stream. This data (confirmed by DERM Qld 2009b, pers.comm) suggests that of the material reported within the domestic waste to landfill stream, 10% was received from sources other than households[2]. This excludes green organic material reported separately in the report (EPA Queensland 2008). No information was available within the report on the amount of material that was generated specifically from council operations or the amount of the recycling stream that originated from sources other than households.

Estimated proportion of MSW from council operations

Based on the limited data available it is estimated that 10% of MSW originates from council operations rather than direct household sources. Insufficient data is available to estimate of amount that originates from the C&I sector or to provide a more specific breakdown by geographic area (metropolitan/non-metropolitan) or by material.

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[1] Household disposal to landfill was assumed to be material disposed of from the kerbside collection services (including material that was unable to be recovered from the recycling and green organics collections) and material disposed of to landfill from the hard waste service; Council operations disposal to landfill was assumed to include material from litter bins and traps, illegally dumped rubbish and road side litter.

[2] 166,768 tonnes of 'domestic' waste received by commercial landfills from industry compared with a total domestic waste to landfill or incineration of 1,663,000 tonnes. Note this excluded the material disposed of to landfill that was reported in Queensland EPA (2008) as 'green'.

2.3 International data comparison

Australia's waste generation, disposal and recycling is compared below with selected countries. Australia's waste generation is compared with selected countries with similar geographical and /or socio-economic features; Canada, the United States of America (USA), Germany and England. Canada and the USA were selected as they have similarly dispersed populations across a large land mass. England and Germany were selected as they have similar socio-economic features and would provide a further range of comparison. The data for each of these countries is discussed briefly. Per capita municipal waste generation and diversion is also compared with these countries and a wide range of other countries in the European Union.

2.3.1 Total waste generation and diversion

Data for total waste generation, disposal and recycling was unavailable for USA and England. The available data for Canada and Germany is presented in Table 2-17 as a comparison with the figures produced in this report for Australian waste disposal, recycling, generation and diversion.

Table 2-17 Total waste generated, disposed and recycled per annum (includes MSW, C&I, C&D)

Country	Population ('000)	Disposed	Recycled	Generated	Diversion rate (%)
		Tonnes ('000)			
Canada[1]	31,613	27,249	7,749	34,998	22%
United States	298,755	Not available			
Germany[2]	82,438	52,705	199,352	252,057	79%
England	50,793	Not available			
Australia	21,015	21,069	22,707	43,777	52%

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.
[1]Data for 2006. Recycling includes material that is diverted from the waste stream and is remanufactured into a new product or is used as a raw material substitute. The C&D waste stream data for Canada excludes materials from land clearing on areas not previously developed as well as materials that include asphalt, concrete, bricks and clean sand or gravel. Source: Statistics Canada (2008) Waste Management Industry Survey: Business and Government Sectors 2006.
[2]Data for 2005. Recycling includes material treated for recycling, excludes thermal treatment. Source: Statistisches Bundesamt 2005, Waste disposal channels of disposal.

The recycling figures for Germany exclude material that was recovered for thermal use. Table 2-17 indicates that Germany has a very high diversion rate (79%). This is mostly due to the large amount of construction and demolition material (around 159,500,000 tonnes) that was recycled. It is unclear whether this included other materials that would not be included in the data for other countries, although it did specify that excavated earth was excluded from the calculation. The diversion rate for the C&D waste stream in Germany in 2005 was 86%.

The relatively low levels of overall waste generation, disposal and recycling for Canada is likely due to the exclusion of a range of materials generally included within the construction and demolition waste stream: asphalt, concrete, bricks and clean sand or gravel. These materials were not included in the waste disposal and recycling data captured by Statistics Canada through their waste management industry surveys.

The overall waste generation, disposal and recycling is presented in Table 2-18 as kilograms per capita.

Table 2-18 Per capita waste generated, disposed and recycled per annum (includes MSW, C&I, C&D)

Country	Disposed	Recycled	Generated	Diversion rate (%)
	Kilograms per capita per year			
Canada[1]	862	245	1,107	22%
United States	Not available			
Germany[2]	639	2,418	3,058	79%
England	Not available			
Australia	1,003	1,081	2,083	52%

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.
[1]Data for 2006. Recycling includes material that is diverted from the waste stream and is remanufactured into a new product or is used as a raw material substitute. Source: Statistics Canada (2008) Waste Management Industry Survey: Business and Government Sectors 2006; Statistics Canada (2008) Population and dwelling counts, for Canada, provinces and territories, 2006 and 2001 censuses - 100% data, www.statcan.ca
[2]Data for 2005. Recycling includes material treated for recycling, excludes thermal treatment. Source: Statistisches Bundesamt 2005, Waste disposal channels of disposal; Statistisches Bundesamt (2006) Germany's population by 2050. Results of the 11th coordinated population projection. www.destatis.de

Table 2-18 indicates large discrepancies between the per capita generation, disposal and recycling for Canada, Germany and Australia. As discussed, construction and demolition materials appear to have a large impact on the total waste stream. The next section of the report excludes the construction and demolition and commercial and industrial waste streams, focusing on municipal waste only.

2.3.2 Municipal waste generation and diversion

Data on the municipal waste stream is more widely available. The total amount of material disposed, recycled and generated, and the associated diversion rate, is presented in Table 2-19.

Table 2-19 Total municipal waste generated, disposed and recycled per annum.

Country	Population ('000)	Disposed	Recycled	Generated	Diversion rate (%)
		Tonnes ('000)			
Canada[1]	31,613	9,238	3,745	12,983	29%
United States[2]	298,755	186,840	90,168	277,008	33%
Germany[3]	82,438	17,698	28,093	45,791	61%
England[4]	50,793	20,207	8,937	29,144	31%
Australia	21,015	7,645	5,082	12,727	40%

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.
[1]Data for 2006. Residential non-hazardous wastes disposed includes solid waste produced by all residences and includes waste that is picked up by the municipality (either using its own staff or through contracting firms), and waste from residential sources that is self-hauled to depots, transfer stations and disposal facilities. Source: Statistics Canada (2008)
[2]Data for 2006. Source: United States Environment Protection Agency (2007)
[3]Data for 2005. Source: Statistisches Bundesamt (2005)
[4]Data for 2006/07. Source: Department for Environment, Food and Rural Affairs (2007)

Diversion rates for the municipal waste stream only are less variable than those reported for the total waste stream. Of the five countries being considered, Germany has the highest diversion rate at 61%. Australia followed at 40%. USA was at 33%, followed by England at 31% and Canada at 29%. This data is presented on a per capita basis below in Table 2-20.

Table 2-20 Per capita municipal waste generated, disposed and recycled per annum

Country	Disposed	Recycled	Generated	Diversion rate (%)
	Kilograms per capita			
Canada[1]	292	118	411	29%
United States[2]	625	302	927	33%
Germany[3]	215	341	555	61%
England[4]	398	176	574	31%
Australia[5]	364	242	606	40%

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
[1]Data for 2006. Sources: Statistics Canada (2008); Statistics Canada (2008)
[2]Data for 2006. Sources: United States Environment Protection Agency (2007); Population Division, U.S. Census Bureau (2007)
[3]Data for 2005. Sources: Statistisches Bundesamt (2005); Statistisches Bundesamt (2006)
[4]Data for 2006/07. Source: Department for Environment, Food and Rural Affairs (2007); Office for National Statistics (2007)
[5]Data for 2006/07. Population data source: ABS (2008)

Table 2-20 indicates that of the five selected countries, generation of municipal waste per capita is highest in USA at 926kg per capita in 2006. Australia is the next highest at 606kg per capita. The lowest generation was Canada with 411kg per capita. Despite this low generation, Canada's diversion rate was only 29%.

Figure 2-5, Figure 2-6 and Figure 2-7 compare these five countries with a more broad range of European countries. Australia appears in the mid to high range of countries both in terms of municipal waste generation per capita (kg) and diversion of municipal waste (% by weight). Many countries have higher waste generation but also higher diversion rates than Australia. This applied for Ireland, Denmark, Switzerland, Norway, Austria, and Netherlands. Most of the countries with lower waste generation are Eastern European nations with lower household incomes.

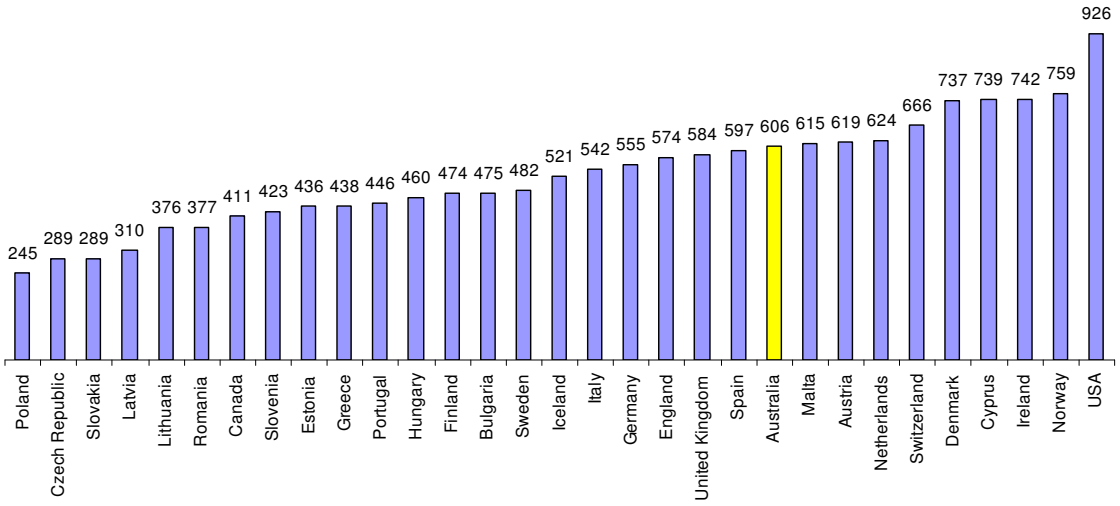


Figure 2-5 Municipal waste generation per capita (kg), selected countries
Source: Eurostat (2006) Except Australia, Germany, England, USA, Canada (see references above)

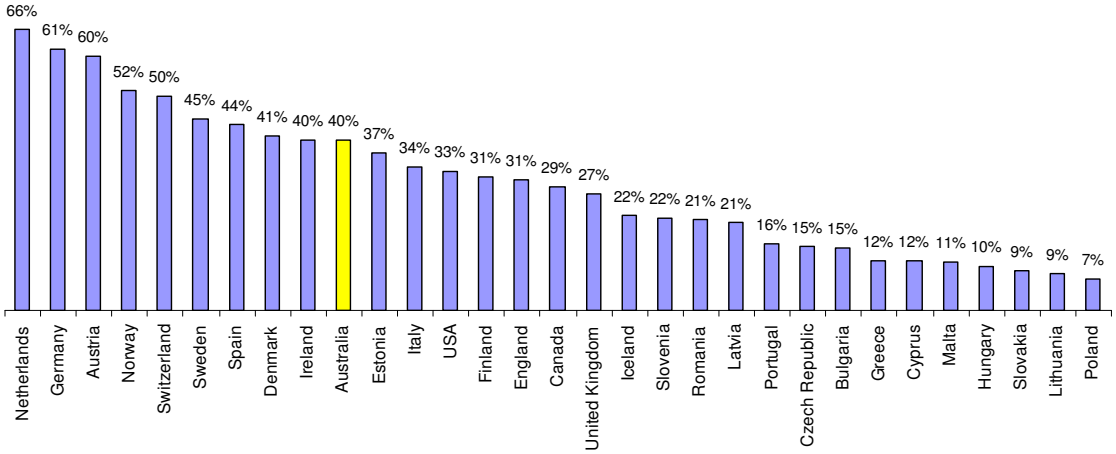


Figure 2-6 Diversion rate for municipal waste, selected countries

Source: Eurostat (2006) Except Australia, Germany, England, USA, Canada (see references above)

Diversion includes all material that is not landfilled or incinerated. It is unclear whether diversion includes material used for energy production in some instances.

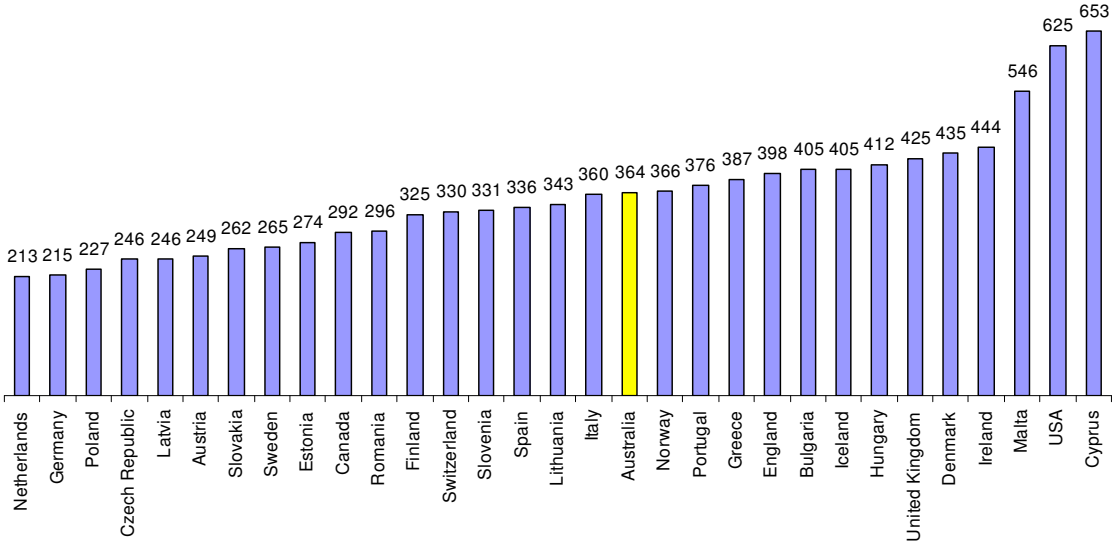


Figure 2-7 Disposal per capita for municipal waste, selected countries

Source: Eurostat (2006) Except Australia, Germany, England, USA, Canada (see references above)

2.3.3 Canada

The data provided for Canada was derived from a report produced by Statistics Canada (2008) that collated two waste management industry surveys. This data does not include waste managed on site, waste transported directly to secondary processors, most agricultural waste or materials reprocessed for reuse and resale. Thus, generation was defined as the 'sum of total non-hazardous residential and non-residential solid waste disposed of in an offsite disposal facility and the total materials processed for recycling at an off-site recycling facility'.

As discussed previously, in Section 2.3.1, an analysis of the data on waste generation showed Canada with a much lower waste generation per capita than other countries. This may have resulted from the exclusion of concrete, brick, asphalt or clean soil and gravel in the accounting of waste and recycling from the construction and demolition sector. There is no known explanation for the exclusion of these materials.

The disposal data includes incineration, but no indication is given as to the proportion of disposed waste that is incinerated. An earlier report (Statistics Canada, 2005) stated that in 2000, 5% of the total amount of waste disposed of in Canada was incinerated. This figure did not include incineration at the site of waste production, for example in the forestry industry. Recycling is defined as 'the process whereby a material (e.g., glass, metal, plastic, paper) is diverted from the waste stream and remanufactured into a new product or is used as a raw material substitute,' and thus does not include energy recovery. Municipal waste management practices in Canada are depicted in Figure 2-8.

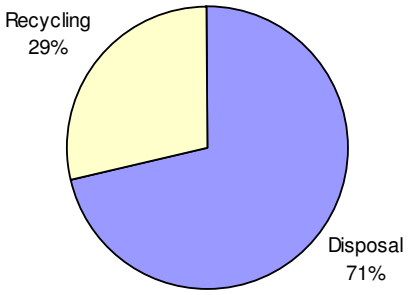


Figure 2-8 **Municipal waste management in Canada** Source: Statistics Canada (2008)

2.3.4 United States

Data for the United States was from reports produced by the US Environment Protection Authority (EPA). The data was based on a materials flow approach for the characterisation of the municipal solid waste stream. This approach is based on production data for materials and products in the waste stream. Adjustments are made for imports and exports of materials and the lifetimes of various products.

Recycling includes mechanical recycling and composting but does not include energy recovery. In addition to the 81.8 million tonnes of municipal solid waste recycled or composted in 2005, 28.5 million tonnes of municipal solid waste was processed by combustion with energy recovery. This is included in the overall disposal figures stated previously. Disposals to landfill also included combustion without energy recovery. This is not quantified separately. Municipal waste management practices for the United States are depicted in Figure 2-9.

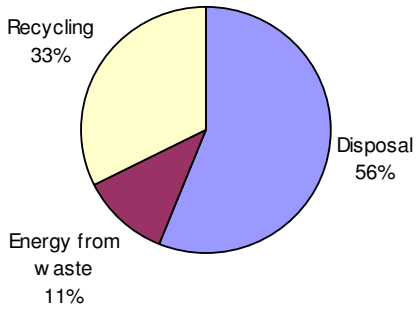


Figure 2-9 **Municipal waste management in the United States** Source: US EPA (2007) Recycling rate includes recovery for composting.

2.3.5 Germany

Data for Germany was taken from a table published by Statistisches Bundesamt (2005). The publication noted that the data was collected from the operators of waste disposal plants, with individual data aggregated to obtain the total amount of waste generated and double counting eliminated where possible. Little information was provided as to the inclusions or exclusions for each category. The publication outlined the destination of material from the municipal waste stream. This is depicted in Figure 2-10.

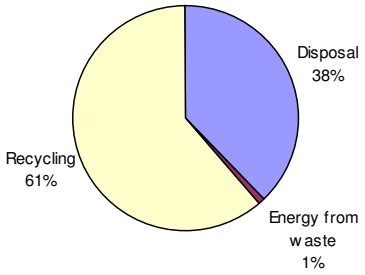


Figure 2-10 **Municipal waste management in Germany** Source: Statistisches Bundesamt (2005)

2.3.6 England

The data for England was taken from collated data published by the Department of Environment, Food and Rural Affairs. This data was collated from data entered by local authorities onto WasteDataFlow, a web-based system for quarterly reporting on municipal waste data by local authorities to central government. In 2005/06 all local authorities in England made four quarterly returns on WasteDataFlow, giving a 100% response rate.

The total municipal waste figure is based on collected municipal waste, rather than waste that is disposed or sent for recycling/composting.

Data given for waste that is recycled/composted includes household and non-household sources sent for recycling or for centralised composting; home composting estimates are not included in this total. It also includes small amounts of materials sent

for reuse. Material which was collected for recycling but actually rejected at collection, by the MRF or at the gate of a recycling reprocessor is excluded. 'Other' disposal methods include material which is sent for Mechanical Biological Treatment (MBT), mixed municipal waste sent for Anaerobic Digestion (AD) and that disposed through other treatment processes. Municipal waste management practices in England are depicted in Figure 2-11.

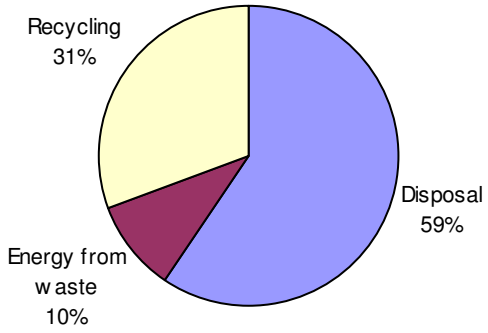
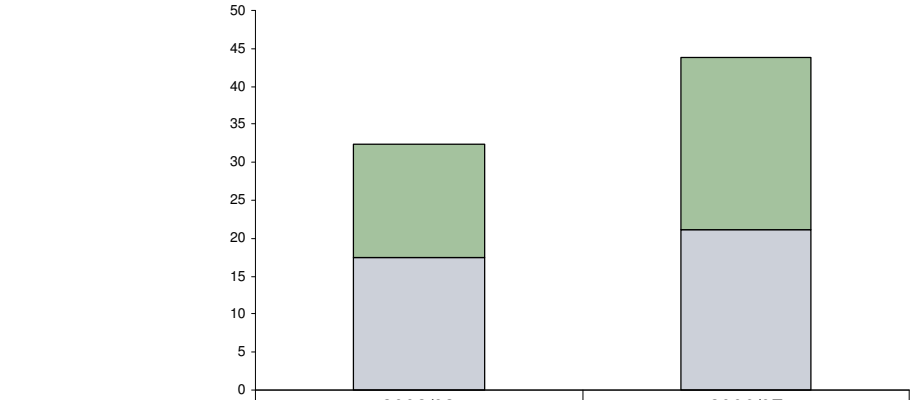


Figure 2-11 **Management of municipal waste in England 2005/06.** Source: Department for Environment, Food & Rural Affairs (2007)

2.4 Trends in waste and recycling

Figure 2-12 shows the reported data on disposal to landfill and recycling activity in Australia for 2002/03 and 2006/07 data. This includes material from all sectors: MSW, C&I and C&D. The total reported waste generation has increased significantly in this period, with increases in both landfill disposal and recovery. Overall reported waste generation has increased from 32.4 million tonnes in 2002/03 to 43.8 million tonnes in 2006/07. The increase in reported waste generation seen in Figure 2-12 is due in part to an actual increase in the amount of material generated by Australians, however, an unknown proportion of this increase is due to improved reporting of waste and recycling data. For example, in 2002/03, no data was available for Tasmania or the Northern Territory, and data on disposal of material to landfill in Western Australia was only available for metropolitan areas.



	2002/03	2006/07
Recycled (million tonnes)	15.0	22.7
Disposed of to landfill (million tonnes)	17.4	21.1

Figure 2-12 Waste disposal and recycling, all sectors, Australia, 2002/03 and 2006/07

Note: Australian data for 2002/03 excluded Tasmania and NT and had only metropolitan data for WA

Source: Data for 2002/03 from Hyder Consulting (2006)

Table 2-21 shows the percentage change in reported disposal to landfill, recycling and overall generation across all sectors from 2002/03 to 2006/07. As with the data for Australia as a whole, an unknown proportion of the change in the reported data for each state/territory is due to improvements in reporting of the amount of material both disposed of to landfill and recycled. The improvement in data provision over time was noted in the report on the State of Waste and Recycling in Queensland 2007 (Queensland EPA, 2008).

There was a substantial increase of 11.4 million tonnes or 35% over the amount of waste generated between 2002–03 (32.4 million tonnes) and 2006–07 (43.8 million tonnes). Some of that increase can be attributed to better and more extensive data collection. Correcting for those factors, waste generation in Australia increased by 31 per cent between 2002–03 and 2006–07.

Table 2-21 Change in reported disposal to landfill, recycling and overall generation for all sectors, by state

State / territory	Disposed	Recycled	Total Generated
	% increase from 2002/03 to 2006/07 (or current reporting period)		
NSW	16%	37%	26%
Victoria	-6%	44%	19%
Qld	58%	202%	103%
WA	31%	107%	49%
SA	-10%	1%	-3%
ACT	-5%	26%	16%
Australia	21%	52%	35%

Australian data for 2002/03 excluded Tasmania and NT and had only metropolitan data for WA
Source: Data for 2002/03 from Hyder Consulting (2006)

Reported generation has increased in all states, with the highest increases in Queensland (103%) and Western Australia (49%). Reported disposal has increased in three states, with the highest increases again in Queensland (58%) and Western Australia (31%). Reported disposal has decreased in three states, with a 10% decrease in South Australia, 6% in Victoria and 5% in the ACT. Recycling has increased in all states. Again, Queensland and Western Australia had the highest increases (202% and 107%, respectively) off lower base levels. Victoria (44%), NSW (37%) and ACT (26%) all had significant increases in the level of recycling activity.

The reported waste disposal reduction may have been achieved in three states/territories (Victoria, SA, ACT) as the result of a combination of measures such as:

- very active diversion of C&D waste in these jurisdictions
- increased opportunity to divert waste at disposal sites (transfer stations)
- higher level of C&I waste sorting
- smaller residential garbage bins resulting in higher diversion

The degree of uncertainty in the actual increases in disposal to landfill, recycling and generation indicates that other data should be used for extrapolations or projections into the future.

2.4.1 Longer term trends

An examination of historical trends on a more long term basis provides a further insight into waste generation and recycling.

Two graphs from the US EPA provide an insight into the trends in waste generation and recycling. These are reproduced below in Figure 2-13 and Figure 2-14. The trend

in municipal waste generation indicates a steady climb since the 1960s in total generation, with per capita generation levelling off from the 1990's onwards. This indicates that waste generation could stabilise or continue to increase slowly on the basis of population growth. The trend for recycling rates show a dramatic rise from around 6.4% in 1960 to 29.1% in 2000, then some levelling off from then on as systems matured and further gains became harder.

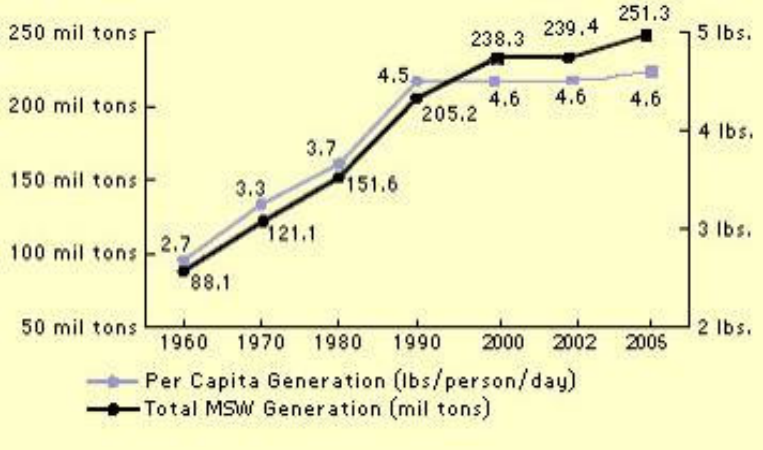


Figure 2-13 Trends in municipal solid waste generation, United States, 1960-2006
Source: US EPA website, http://www.epa.gov/garbage/facts.htm, accessed 16/7/08

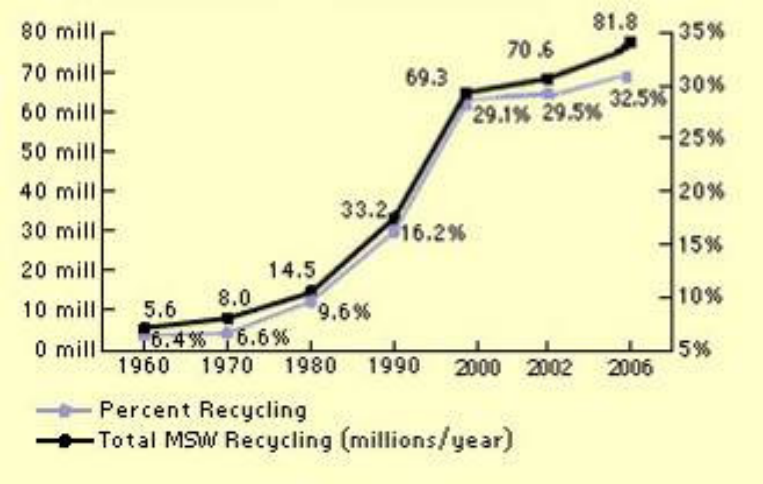


Figure 2-14 Trends in municipal recycling, United States, 1960-2006
Source: US EPA website, http://www.epa.gov/garbage/facts.htm, accessed 16/7/08

A number of state agencies have published graphs indicating the trends in waste and recycling from the 1990's until more recently.

Figure 2-15 shows total waste generation for the ACT, divided into recovered and landfilled material, from 1993/94 to 2002/03. While waste generation has increased, the amount of material disposed of to landfill has declined. This is different to the trend in Victoria, shown in Figure 2-16, where from 1994/95 to 2004/05 waste generation increased steadily and the amount of material disposed of to landfill remained fairly consistent. More recently there seems to have been a slight downward trend in waste disposed of to landfill in Victoria, as discussed previously in the trends seen between

2002/03 to 2006/07. Figure 2-16 shows the projected trends for Victoria, both under the business as usual conditions, and under the projections based on the Towards Zero Waste Strategy timeframes and targets. In both cases waste generation will increase, however under the Strategy, the growth is anticipated to be kept in check somewhat.

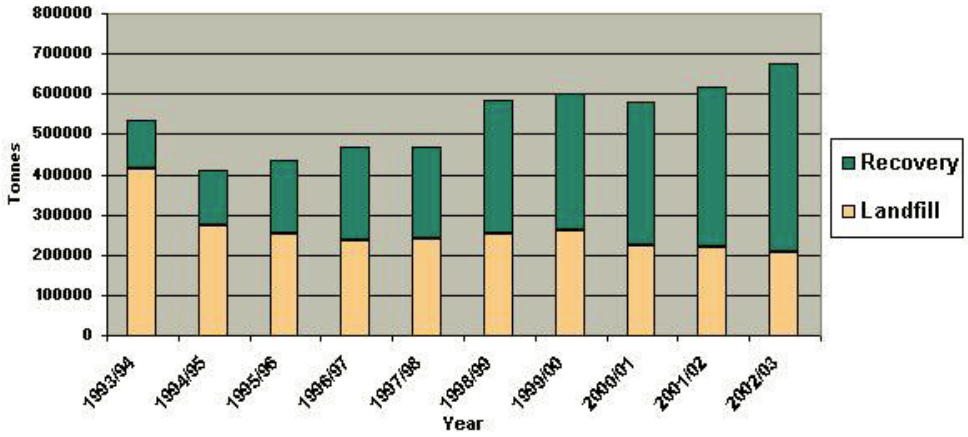


Figure 2-15 Total waste generation for the Australian Capital Territory (ACT).
Source: ACT Government (2004), p.2

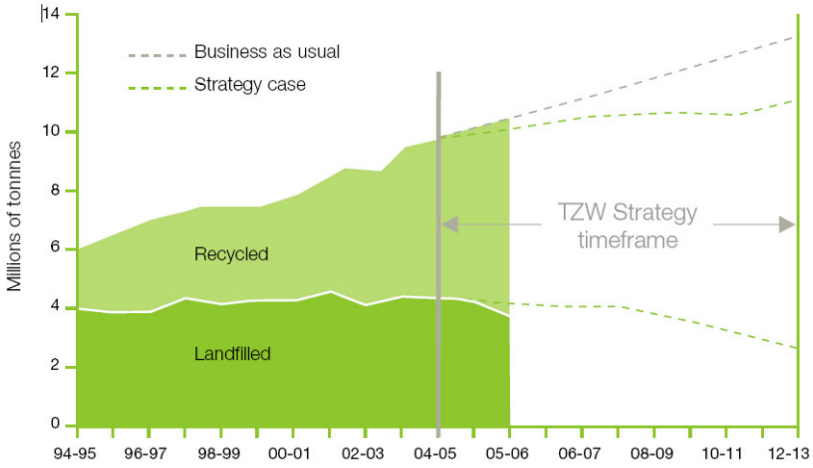


Figure 2-16 Solid waste generation in Victoria, actual and projected 1994 to 2014
Source: Sustainability Victoria (2007), p2

3 Organic waste

Materials that are typically considered to make up the organic waste stream, as well as their typical sector source, are outlined in Table 3-1. Some of these materials have been excluded from the state/territory data in Section 2. Where this is identifiable in the specific state/territory data, it has been detailed in Section 2.

Table 3-1 Organic waste stream categories

Material type	Typical source sector
Paper and cardboard	MSW, C&I
Garden organics	MSW
Wood/timber/sawdust	C&I, C&D
Food organics	C&I
MSW (organic fraction)	MSW
Other - biowaste	C&I
Other – miscellaneous	C&I
Biosolids, grit, screenings	C&I
Oils, grease trap, sludges	C&I
Straw	C&I
Manure	C&I
Animal bedding	C&I
Animal mortalities	C&I
Paunch	C&I
Other – miscellanous agricultural organics	C&I
Other - Paper pulp/sludge	C&I
Sawdust (from forestry residuals)	C&I
Barks (from forestry residuals)	C&I

3.1.1 Organic material disposed of to landfill

An estimated proportion of material within the landfill disposal stream from the three main sectors (MSW, C&I, C&D) is provided within the National Greenhouse and Energy Reporting (Measurement) Determination 2009 (Australian Government, 2009). The estimated proportions are presented in Table 3-2. These default waste stream percentages were substantially revised from those presented in the 2008 Determination. The revised default waste stream percentages provide an indication of the current understanding of the overall composition of the three waste streams, based on sources such as audits of material being disposed of to landfill.

Table 3-2 Default waste stream percentages from the NGER Determination 2009

Material	MSW	C&I	C&D
Food	35.0%	21.5%	0.0%
Paper and paper board	13.0%	15.5%	3.0%
Garden and park	16.5%	4.0%	2.0%
Wood and wood waste	1.0%	12.5%	6.0%
Textiles	1.5%	4.0%	0.0%
Sludge	0.0%	1.5%	0.0%
Nappies	4.0%	0.0%	0.0%
Rubber and Leather	1.0%	3.5%	0.0%
Inert waste (including concrete, metal, plastic and glass)	28.0%	37.5%	89.0%

In the municipal sector this material is primarily produced by households, with food organics, paper and cardboard and garden material being a large proportion of the overall waste stream. A variety of sources of organic waste exist in the commercial and industrial sector. Two sources examined in this study were supermarkets and restaurants.

Supermarkets

Supermarkets dispose of a large amount of organic material, mostly food. The breakdown of waste material from a typical supermarket is presented in Figure 3-17.

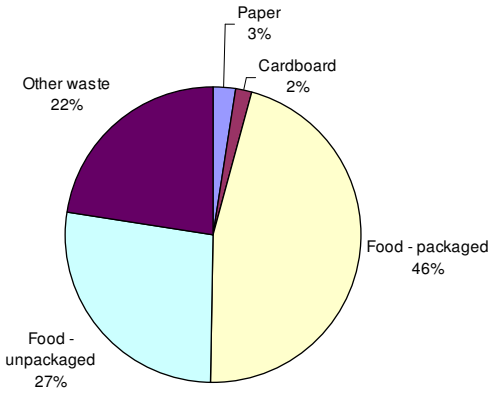


Figure 3-17 Breakdown of waste stream from a typical supermarket
Source: Hyder Consulting (unpublished data)

The major supermarket retailers have in place a range of initiatives to minimise waste to landfill from their operations. Generally they are well advanced in diversion of cardboard from landfill however the level of diversion of organic waste is still lacking.

Innovations in packaging have extended the shelf life of some food products. There is also growing interest in the diversion of food organics from landfill to composting or alternative waste treatment facilities. This is largely in the trial phase at this time and/or is subject to availability of facilities. For example, 53 Woolworths stores in Sydney send source separated food waste to a facility that processes the material into compost, fertiliser and electricity (Woolworths, 2007). The lack of such facilities outside Sydney and Melbourne and long lead-times for new facility development is a barrier to expanding this program.

Restaurants

The breakdown of the total waste stream (including cardboard and commingled recycling) and the waste-to-landfill stream from a range of commercial operators within Melbourne CBD is presented in Figure 3-18 and Figure 3-19. Although not entirely collected from restaurants and cafes, these graphs provide an indication of material being disposed from these types of businesses. The two graphs indicate that there are large proportions of food, paper and cardboard in the overall waste stream (Figure 3-18) and that current recycling services for cardboard and commingled recycling are not capturing much of the paper and cardboard that is available (Figure 3-19).

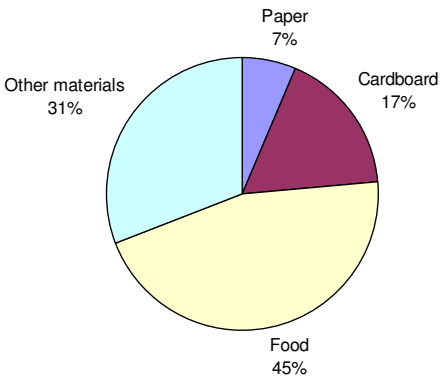


Figure 3-18 **Breakdown of waste stream from audits of waste from commercial operators in a CBD location (includes material disposed of to landfill and material recovered for recycling)**
Source: Hyder Consulting (unpublished data)

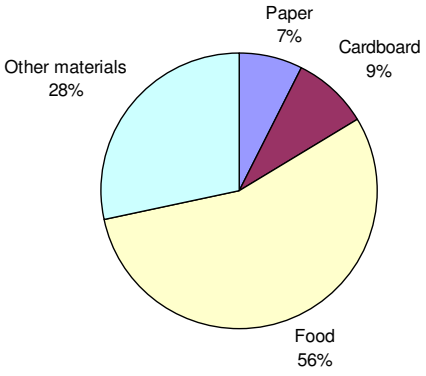


Figure 3-19 **Breakdown of disposal to landfill stream from audits of waste from commercial operators in a CBD location**
Source: Hyder Consulting (unpublished data)

3.1.2 Greenhouse gas emissions from organic material

The importance and level of greenhouse gas emissions from organic material is discussed in Section 7 of this report.

3.1.3 Organics recovery

The annual survey of organics reprocessors provides a comprehensive overview of current levels of organics recovery by composting organisations. Recovery of paper/cardboard and timber by other organisations (other than composters) is reported by some states/territories. The available data for recovery of organic materials in 2006/07 has been collated and is presented in Table 3-3. This information, is presented by state and by sector in Appendix 2.

Table 3-3 Recovery of organic materials, Australia, 2006/07

Material type	Amount recovered ('000 tonnes)
Paper and cardboard	2,318
Garden organics	2,535
Wood/timber/sawdust[1]	688
Food organics	91
MSW (organic fraction)	238
Other - biowaste	16
Other - miscellaneous	166
Biosolids, grit, screenings	618
Oils, grease trap, sludges	164
Straw	14
Manure	478
Animal bedding	24
Animal mortalities	11
Paunch	26
Other - miscellanous agricultural organics	67
Other - Paper pulp/sludge	54
Sawdust (from forestry residuals)	331
Barks (from forestry residuals)	336
Total	8,171

Estimates of waste generation, recycling and landfill disposal have been developed based on the best available data for each state/territory. Data comparisons between the jurisdictions must be undertaken with great caution because of differences in the ways that waste is categorised and waste data is collected and reported. Inconsistencies have been eliminated where possible but, because the differences are not always documented, it is inevitable that various inconsistencies remain.
Primary source: Recycled Organics Unit (2007)
Other sources: DECC (2008b), Sustainability Victoria (2008), Cardno (2008), Hyder Consulting (2008), ACT NoWaste (2008a), Darwin City Council (2008b), DPIPWE (2009)
[1] South Australian data on recovery of sawdust and barks from forestry residuals and other sources is reported within this category rather than the individual categories for these materials.

Information provided by the paper industry indicates that in 2007, 1,437 million tonnes of recovered fibre was used by Australian manufacturers and a futher 1,071 million

tonnes of waste paper was exported. In total, they estimate that a total of approximately 2.5 million tonnes of paper was recovered for use in Australia or overseas in 2007. This is in line with the estimated 2.3 million tonnes of paper and cardboard presented in Table 3-3.

The products that resulted from the reprocessing of organics by composting organisations in Australia in 2006/07 is presented in Table 3-4.

Table 3-4 Materials produced during organics reprocessing, Australia, 2006/07

Types of raw materials produced	Volume (m^3)
Composted soil conditioner	1,003,395
Pasteurised soil conditioner	84,542
Composted mulch	707,436
Pasteurised mulch	91,700
Raw mulch	1,431,646
Manufactured soil	1,203,650
Potting mixes	474,540
Playground resurfacing	43,132
Biofuels / solid fuels	10,000
Other - Composted product	129,500
Other - Organic fertiliser	1,620 (tonnes)
Other - Composted manure	340,765
Other - Raw manure	110,432
Other - Direct land application	181,052
Other - Aqueous compost extracts	2,102,000 (L)
Source: Recycled Organics Unit (2007)	

Location of available organic material

The Compost Supply Chain Roadmap (Compost Australia 2006) outlined the following details on sources of organic waste materials: *"In Australia, potentially recyclable organics (urban feedstock comprising green waste and bio-solids) are produced in large quantities in areas of high population density, while organic by-products (agricultural feedstock comprising feedlot, chicken, grape, pig, cotton and mushroom materials) is produced in large amounts in areas of intensive agriculture. Therefore, capital cities produce the bulk of urban feedstock and some of the agricultural source material, with areas of intensive agriculture within a couple of hundred km supplying the rest."*

This statement is backed by data on the amount of recovered organic material that is reprocessed within the immediate environments of state capital cities (Table 3-5)

Table 3-5 Percent of organic material processed within the immediate environments of state capital cities (% of state total)

City	Urban sourced	Agricultural sourced
Sydney	63%	18%
Melbourne	72%	48%
Brisbane	48%	13%
Adelaide	73%	6%
Perth	73%	60%
Source: Compost Australia (2006)		

4 Current consumer products of national significance

A number of key products of national significance are examined in this section. The range of consumer products in this assessment covers those of:

- high consumption volume
- high potential recovery
- high potential toxicity in the community and through disposal
- high public or political profile.

The four consumer products or product groups that have been considered in this section in their capacity as products of national significance are:

- E-waste (including computers, televisions and mobile phones)
- Tyres
- Packaging (including retail carry bags and flexible plastic freight packaging)
- Fluorescent lights (including fluorescent lamps and compact fluorescent lamps).

Each product is considered in terms of consumption levels, materials, sales trends, life expectancy, stockpiling, landfill disposal, reuse and recycling, and barriers to and potential for increasing lifespan, reuse and recycling. Consumption and disposal estimates are drawn from research undertaken by Hyder Consulting and in many cases the most recent data available was for the year 2005. Where available, more recent data has been included. An overview of the available data on computers and televisions is included in Appendix 5.

4.1 E-waste (including computers, TVs and mobile phones)

4.1.1 Computers

Consumption

Australians purchased over 3.5 million computers in 2005, including units that were assembled locally from imported parts. This figure includes approximately 1.2 million laptops. Apart from some computer assembly, there is no significant computer design or manufacturing in Australia.

Sales growth is across all of the commercial, government and residential sectors. Some sales are new units replacing non-performing or out-dated computers. Other sales reflect an increased level of computer ownership. Moreover, it is now not uncommon for households to have two or more computers.

There is a pattern of transferring computers from the commercial and government sectors to households. As a result the average age of a computer in commercial applications is less than for household applications. It also means that while a computer may enter the market in a commercial setting, it may be disposed of at a household level.

A key feature of sales in recent years has been the introduction of a 'buy back' aspect in many corporate computer sales contracts. The recovered computers are then sent for re-sale in the corporate and domestic markets. Under these schemes the turnover of computers has accelerated with total computer pool replacement occurring after 1-3 years.

The average weight of a computer (including the CPU box and monitor) is estimated at 19 kg. This includes lighter weight laptop units.

The weight of computers has reduced overall in recent years. This is the result of smaller computer cases and an increased market share for laptops. In addition, the switch to LCD screens has resulted in a weight reduction. This has been offset by monitor screen size increase.

This equated to a total weight of computers entering the Australian market of 67,559 tonnes in 2005.

Key materials

Computers are made from a combination of the following materials:

- plastics
- steel
- non-ferrous metals
- heavy metals
- glass.

The plastic most commonly used in computer casings is Acrylonitrile Butadiene Styrene (ABS) (including some SAN) and High Impact Polystyrene (HIPS). Less commonly used is polyphenylene oxide (PPO). These plastics often contain additives, including brominated flame retardants, which can be highly problematic for human health when they are recycled. The reprocessing of the plastic, which involves heat, can result in the release of the flame retardants in gaseous form. Flame retardants are also used in manufacture of printed circuit boards.

There is a quantity of metal in both computer boxes and in monitors. Metals include both precious metals in small quantities (e.g. gold, platinum and silver) and heavy metals which may contribute to environmental harm (e.g. arsenic, cadmium, chromium, lead, mercury and zinc). Each CRT computer monitor has an average of between two and four kilograms of lead.

Substitution of some hazardous materials has been investigated, with replacement at different stages of development and implementation for various materials. The use of lead-free solders and substitution of halogenated flame retardants is more advanced than other efforts.

Sales trends

Computer sales in Australia have nearly tripled over the last decade. At present market growth is averaging 17% per year. It is thought that the expansion of the market is starting to reach saturation point. On the other hand, the replacement of units is

continuing strongly and it is in this area that a new sale represents an addition to the stockpile or disposal of waste computers. There is a larger sales growth in laptop computers than for desktop models.

Within the desktop market, there has been an overwhelming sales trend away from Cathode Ray Tube (CRT) monitors to Liquid Crystal Display (LCD) screens. This is expected to be complete in coming years as the price difference continues to narrow. Already large manufacturers such as Sony, Sharp Electronics, Matsushita and Hitachi have either stopped manufacturing small CRT models or discontinued CRT manufacture entirely.

There is also a trend away from the home owner assembling their own computer, or upgrading specific components, as new fully assembled computer packages include the latest specifications and are very affordable.

The physical size of computers and equipment is generally decreasing despite the higher capacity. Whilst there has been an increase in screen size in more recent years, the bulk weight of the monitor has decreased. The reduction in bulk has lead to a reduction in the use of metals, plastics and other components, reducing the overall material consumption per unit.

Life expectancy

The life of a computer generally passes through several stages. The use after purchase is the first stage. Often computers are then transferred to a second owner and location. This is often a transfer from the corporate or government sector to household, school and small business use. Many computers are placed in storage before disposal. This occurs in both commercial and household environments.

The key issues that result in an end of life computer are:

- insufficient hard-drive capacity or speed
- software upgrades
- availability of a newer model
- leasing or depreciation issues
- corporate replacement policies
- failure of a unit or component.

Unlike many other electrical products, product failure is not the primary reason for end of life.

The average life of a computer before final disposal is assumed to be eight years. This typically consists of five years use by the initial owner, followed by three years of reuse elsewhere or storage. This life span of a computer is reducing as the market for second-hand computers becomes more saturated and selective. The inability to upgrade components due to incompatibility is a barrier to waste reduction.

Stockpiling, landfill disposal, reuse, and recycling

The disposal of computers is influenced by the reality that many units at end of life are still functional (if obsolete) and a lack of awareness of disposal channels. Both

corporate and domestic household users retain significant volumes of obsolete equipment. Retention and storage of used equipment is principally related to the perceived value of the equipment, either in monetary terms or in opportunities for further usefulness. Many computers would have been purchased for over $2 000 and many owners view the obsolete unit as having some residual value rather than being waste. This has led to a large scale stockpiling of computers in the community.

The best estimate of the quantity of computers disposed in Australia, based on sales growth, life expectancy and storage trends, is approximately 570,900 units or approximately 29,900 tonnes.

Approximately one-quarter of computers disposed of annually are sent for recycling. Disposal is expected to double in five years.

Currently there are some programs to capture and recycle computers once they become obsolete. There is a significant market for second-hand units (computers less than 3 years old). There is also some dismantling of computers and export of these for re-use or recycling in overseas markets.

The level of recycling has improved with the introduction of reuse schemes as supply companies handle the end of life destination.

Only a small amount of equipment is recycled in Australia, either through recovery of components for use in other equipment or recycling of materials (such as metals) for use in other processes.

Several companies have established monitor recycling operations and are active in recovery of metals and dismantling of CRT monitors. This activity is growing but accounts for a small percentage of end-of-life units.

There is widespread disposal of equipment to landfills, often due to lack of alternatives.

Barriers to increasing lifespan, reuse and recycling

The barriers to increasing the lifespan, reuse and recycling for computers are:

- the value of the materials is not equivalent to the cost of collecting and dismantling the units. This is particularly the case of old computers, monitors and peripherals such as keyboards.
- the lack of a market for plastics with flame retardant additives. Research from recovery programs overseas will be important here.

The computer industry is aware of the growing waste computer issue and has acknowledged a shared responsibility for finding a recovery solution.

The main manufacturers are members of the Australian Information Industry Association (AIIA) which represents approximately 60% of the Australian Information and Communication Technology (ICT) Industry. The AIIA is currently investigating the most cost efficient and effective form of supporting waste computer recovery. This may take the form of a funding contribution, which, when combined with the residual material value can cover the cost of collection and reprocessing.

Progress on the development of a national Extended Producer Responsibility scheme has been slow.

Potential for increasing lifespan, reuse and recycling

The potential activities to increase the lifespan, reuse and recycling of computers may include:

- slowing the rate of computer changeover through promotion of upgrade options
- facilitating the exports of functional computers to markets where re-use is viable
- working with AIIA and other states to develop a national recovery program
- ensuring all government computers (including stockpiled computers) are sent for re-use or dismantling and recovery
- restricting the disposal of computers to landfill in line with national recovery programs
- supporting research into recycling of leaded glass in lead smelters and flame retardant plastics elsewhere
- review of current drop-off sites and development of a network of drop-off sites.

4.1.2 Televisions

Consumption

Total sales of televisions into the Australia market during 2004–05 was approximately 2.05 million units. All televisions sold in Australia are manufactured overseas. The key countries of manufacture are China, Malaysia, Indonesia and Thailand.

There is enormous product diversity in the television market. Over the last decade, the average weight of televisions has almost doubled, driven by consumers steadily moving towards larger and wider screen sizes. Television screen size ranges from 5cm to over 200cm. The average size of televisions sold in Australia is 57.3cm.

The average weight of a television sold into the market today is estimated at 31 kg. This results in a total quantity of television sales to the market of around 64,700 tonnes. It is expected that the current trend towards larger screen size and consequently heavier product will continue.

Key materials

Televisions that are sold today are manufactured from a mix of:

- plastics
- glass
- steel.

Smaller quantities of other metals are also included.

The most common plastics used in the manufacture of televisions are high impact polystyrene (HIPS), Acrylonitrile Butadiene Styrene (ABS) and polyphenylene oxide (PPO). There are problems with plastic casings for recyclers due to metallised coatings and other laminates, plastic metallic stickers and identification plates, blended polymers and the inclusion of brominated flame retardants.

Glass in the form of screens and picture tubes also pose a problem for recycling. The rear glass in picture tubes contains lead, where as the remaining glass is free of lead, and can be recycled with other float (or window) glass. Therefore the lead glass needs to be reprocessed separately from the float glass.

Steel is easily recycled. The yoke of the tube and wire used throughout also contains copper. Circuit boards and other electronic scrap contain gold, silver and lead.

Inside picture tubes is a screen lining that is phosphorous based and blended with rare earth elements.

Over the years television casings have gone through the following stages:

- furniture cabinet
- metal cabinet
- particle board cabinet
- plastic cabinet.

Many televisions currently being disposed of have cabinets made of veneer covered particleboard or other timber. Televisions manufactured today, however, have cabinets made of plastic. It is projected that plastics will continue as the main cabinet construction material into the foreseeable future.

The market switch to slimline LCD/ plasma televisions is now very well advanced with no CRTs above mid-sized screens being sold into the Australian market. Over time this will see a change in the material composition of most end of life televisions.

Sales trends

There is enormous size diversity in the television market. Some portable units weigh less than 1kg, while at the other end of the market, large wide screen units can be over 100 kg in weight.

The almost total switch to LCD/plasma screens has led to a reduction in very high weight (>60 kg) large screen units.

The number of units sold into the Australian market continues to increase. In 2004/05 the television sales were 18% greater than during 2003. This increase has accelerated in recent years due to aggressive marketing and the introduction of new technologies and models. These include widescreen, flatscreen, plasma, high definition and digital technologies. The 2010 timeline for a market shift to digital technology is likely to lead to an upturn in end of life analogue televisions.

In the past, new televisions were purchased when:

- a new household was established

- the previous television failed.

Today, many televisions are purchased as additional units or when the current unit is still operational but considered old technology.

The average television ownership level today is 2.4 units per household, compared to an average ownership of 1 television per household just 25 years ago. Sales data indicates that a surge in digital television receiver sales is helping to increase the sales of widescreen televisions, plasmas and LCDs.

Life expectancy

The average life span of a television is currently estimated at 10 years. The profile of televisions currently being disposed of is different from those being sold today. Some of the current end of life televisions are typically manufactured in a particle board cabinet and are smaller in both screen size and weight than those entering the market today. The average television disposed of today has a mass of 18 kg.

The life span of televisions sold into the market today is expected be to be lower than 10 years. This is due to changing technology, reduced product durability and reduced levels of television repair.

Stockpiling, landfill disposal, reuse and recycling

Within Australia, the two main fates for end-of-life televisions are disposal and recycling. Television recycling usually involves collection, dismantling, salvaging of components with residual value and reprocessing of these components to recover commodities. There is currently little or no recycling of televisions in Australia.

The disposal of televisions is influenced by the perceived value of the equipment, either in monetary terms or in opportunities for further usefulness. Many owners view the obsolete unit as having some residual value rather than being waste. This has led to a stockpiling of televisions in the community.

According to IPSOS (2005), far more households are currently acquiring televisions than are disposing of them indicating that the potential amount of waste is growing. The current annual disposal of televisions, based on a 10 year life expectancy and sales trend data over the past decade, is estimated at 11,000 tonnes or 350,000 units. This is expected to rise considerably over the next few years due to increased product size, reduced product durability and sales growth linked to digital technologies and analogue phase-out.

Currently there is a level of re-use of televisions through donations to family, friends, and charities, as well as second-hand sales. IPSOS (2005) reported that half of the televisions disposed of today go to second use.

The current situation where sales exceed disposal cannot continue indefinitely. We are likely to see an increase in end of life televisions as an increasing number of shorter life, unrepairable units cease to function and the market reaches saturation. The switchover to digital TV by 2013 is also likely to increase the generation of end of life analog televisions.

The designs and manufacturing methods that make goods cheaper also often make them difficult, or not financially viable, to repair. This is particularly the case for televisions where the low initial sales cost is often below the cost for repairing a fault.

The television industry is currently negotiating a product stewardship agreement with the EPHC Ministers to establish product stewardship arrangements for end-of-life televisions.

Barriers to increasing lifespan, reuse and recycling

The barriers to increasing the lifespan, reuse and recycling for televisions are:

- the reduction in product quality leading to a reduced life expectancy of televisions
- the dramatic increase in television numbers and size
- the increase in the use of flat-screen televisions in commercial settings such as cafes or office buildings
- the lack of a co-ordinated recovery route and recycling infrastructure
- the cost of disassembly relative to the value of the materials recovered and recycled
- the switch to digital television in 2013.

Potential for increasing lifespan, reuse and recycling

The potential activities to increase the lifespan, reuse and recycling of televisions may include:

- work with the television industry group, the Consumers Electronic Suppliers Association (CESA), to ensure the proposed product take back scheme being negotiated at a national level applies to all Australian televisions
- encourage consumers to consider product durability in purchasing decisions
- encourage consumers to consider set top boxes rather than analogue television disposal in 2013.

4.1.3 Mobile phones

Consumption

It is estimated that over 8.1 million mobile phones were sold in Australia in 2005. Sales of mobile phones increased rapidly until 2001 when sales growth started to ease. The weight of mobile phones has dropped dramatically since their introduction to the market. Early model mobiles were large and bulky and weighed over 1 kg each. The size of the phone and the in-built battery have continued to come down with current mobile phones often now weighing less than 80 gms.

The key manufacturing countries for mobile phones are South Korea, China and Taiwan.

The overall mass of phones going into the market in Australia is estimated at 650 tonnes. The number of units in use in Australia is estimated at 20 million phones.

The mobile phone was originally purchased almost exclusively by business users. This has extended dramatically into the household market with a large proportion of recent sales, particularly new sales, being made to those under 18 years of age. The Australian Mobile Telecommunication Association (AMTA) suggests that mobile phone ownership would have reached the equivalent of 94% of the population by mid-2006.

Key materials

The types of materials used in mobile phones are diverse, mainly due to the ever-changing variety of phones, along with developments in materials engineering. Current phones often use polymer blends such as PC/ABS in the casing to achieve the desired performance characteristics. While the composition of mobile phones varies significantly from model to model, an approximate average composition can be seen in Figure 4-20 below.

Up to 1998, over 80% of mobile phones utilised nickel cadmium (NiCad) batteries as their main power supply. When the mobile phone sector changed from analogue to digital the use of NiCad batteries was discontinued.

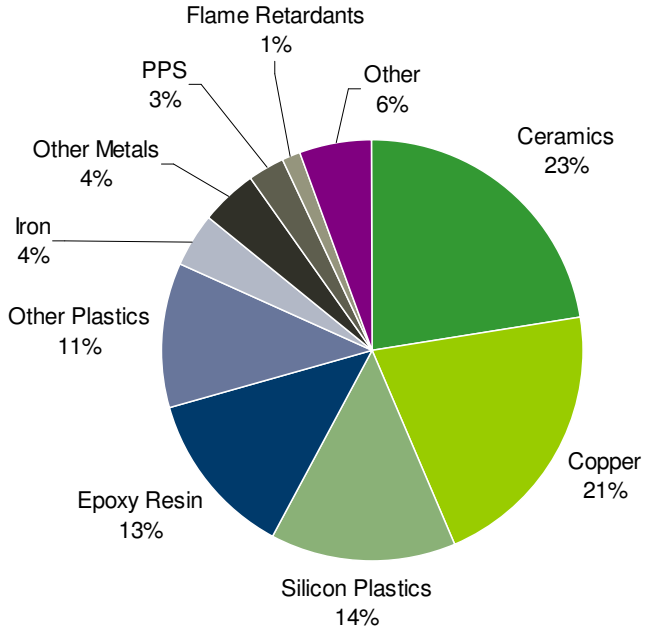


Figure 4-20 Material composition of a typical mobile phone

Sales trends

The mobile phone market is now a more mature market with a much reduced proportion of sales being to new customers. A primary recent trend has been to sell updated model phones to existing customers. This has emphasised new features including colour screens, camera, email and video capability. The sales of new models will have been, in many cases, to replace a phone that is still functional. Many

households now have a multiple number of phones. For some, the mobile phone has become the primary phone with no fixed line connection being used.

Annual sales growth averaged over 30% for much of the previous decade but dropped to approximately 10% by 2005. An exception to this trend is seen in 2004, where a substantial jump in sales led to a growth rate in this year of 43%. Anecdotal evidence suggests this may be related to the heavy marketing and popularity of camera phones.

Most sales are through dedicated phone retail outlets. These are usually operated by, or aligned to a phone company. The AMTA (Australian Mobile Telecommunications Association) is the industry association that represents phone manufacturers (and retailers).

Life expectancy

The average life of a mobile phone is now two to three years. This high turnover is in part fuelled by an aggressive marketing of new phones with new features. It also results from the linking of new handsets to contract periods. The life span of batteries is estimated at one to two years. On average, each phone will have one replacement battery in its life span. As with other electronic equipment, the cost of repair is high relative to the declining purchase cost and therefore there are less phones being repaired. The market value of two to three year old phones is minimal resulting in a very small second hand market.

Despite the low residual value of redundant phones, consumers still have a view that they are worth something and are not a 'waste' material. As a result of this and a very high turnover of phones, there are a large number of phones stockpiled around Australia. These stored phones are held in both business and households.

Stockpiling, landfill disposal, reuse and recycling

There are several forms of collection of mobile phones and their batteries. The AMTA has a program operating through some high volume retailers where unwanted phones and batteries can be deposited. There are businesses that purchase phones for sale overseas and it is acknowledged that many are being stockpiled.

The estimated weight of mobile phones in use in Australia is 1,850 tonnes. It is also estimated that in 2005, 670 tonnes reached "end of life", of which various proportions were either stockpiled, recycled or disposed of to landfill.

A survey of 900 Australians investigated what people do with their old mobile phones. Figure 4-21 outlines the results.

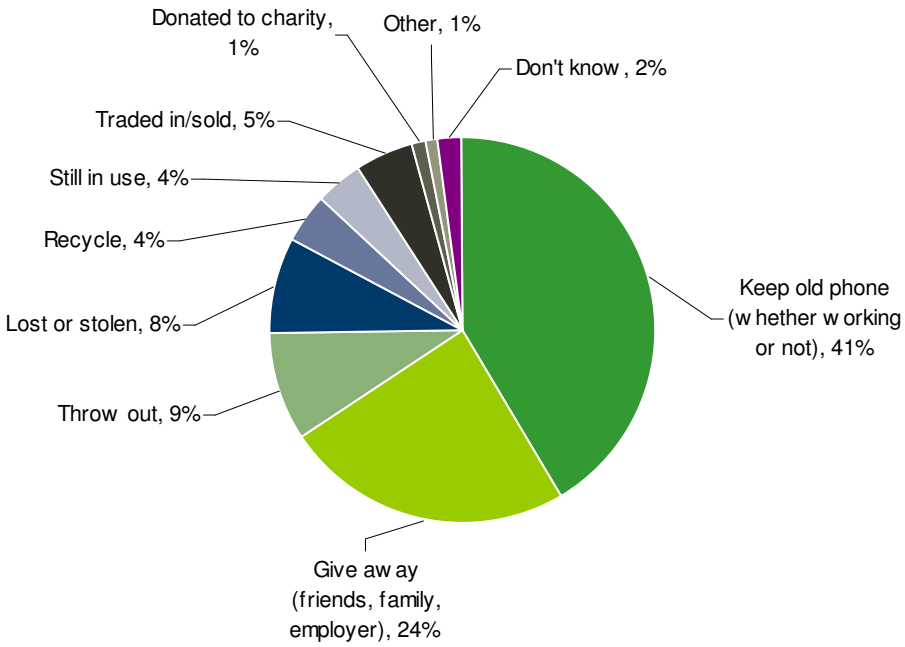


Figure 4-21 Destination of replaced mobile phones

Over 90% of the material from mobile phones is able to be recovered and then recycled. For example:

- **Batteries** include nickel which is used to make stainless steel and cobalt and cadmium to make new batteries
- **Circuit boards** include small amounts of gold and silver that is used in jewellery and other applications
- **Handset housing and casings** include plastics that are shredded and used to make fence posts and pallets
- **Accessories** include plastics and metals that are shredded, sorted and then used to make new plastic or metal products.

Barriers to increasing lifespan, reuse and recycling

The barriers to increasing the lifespan, reuse and recycling for mobile phones are:

- Marketing aimed to encourage consumers to update their mobile handset model rapidly
- the short and declining lifespan of mobile phones
- the low and declining level of phone repair
- the low level of recycling through the existing point of sale recycling service
- the reluctance of consumers to dispose of a unit perceived to have some residual value

- the perception of consumers that a phone is small and not worth recycling.

Potential for increasing lifespan, reuse and recycling

The potential activities to increase the lifespan, reuse and recycling of mobile phones may include:

- work with AMTA to increase the profile, coverage and recycling rate of the point of sale collection program
- encourage consumers to consider purchase of second hand units
- ensure phone company contracts are structured to allow retention of handsets or a trade-in system
- work with reprocessors to overcome collection, freighting or processing impediments
- relatively simple changes in mobile phone design and manufacturing would reduce impediments to cost-effective refurbishment and recycling
- introduction of product stewardship / extended producer responsibility programs.

4.2 Tyres

Consumption

In 2004 sales of tyres in Australia totalled some 240,000 tonnes of tyres. This is inclusive of heavy vehicle and passenger vehicle tyres.

Motor vehicle registration numbers increase each year, with a 12.2% increase from the start of 2003 to the end of March 2007. This continued growth in the motor vehicle market, along with increased vehicle kilometres travelled is leading to the increased consumption of tyres.

Key materials

Tyres are generally made from rubber, steel and textile, with truck tyres having a higher rubber content than passenger vehicle tyres. Heavy vehicle tyres are mechanically recycled in greater numbers due to their larger unit size and higher rubber content.

Stockpiling, landfill disposal, reuse, and recycling

Landfill disposal of tyres is increasingly becoming more difficult, particularly as state and territory bans on end-of-life tyres entering landfills are coming into effect. Victoria has banned whole tyres from landfills for many years. Western Australia has announced that it will introduce a landfill ban in Perth and large regional centres by 2011. South Australia is working towards a zero waste society, inclusive of a zero waste target for tyres. Queensland introduced a ban on whole tyres in landfill in 2001. Tasmania allows shredded tyres in landfills with fire fighting capacity only.

Some mechanical recycling of tyres takes place, with tyres shredded then crumbed before being used in new tyre manufacture, flooring, paving and as a drainage medium. Re-use of tyres is limited to the retreading of truck tyres.

In some states end-of-life tyres are used as a fuel in cement kilns. In Victoria the cement kiln operated by Blue Circle outside Geelong takes most of the end-of-life tyres in that state.

The stockpiling of tyres is controlled as the stockpiles represent a serious fire hazard, and are particularly difficult to extinguish. The toxins and pollutants in smoke from tyre fires are dangerous to human and animal health. Run-off from tyre fires contains chemicals that can pollute both groundwater and surface waters.

4.3 Packaging

4.3.1 Packaging - general

The following provides a snapshot of packaging Australia as of 2005. It should be noted that considerable discussions have been occurring during 2008 to further validate these figures. Readers particularly interested in the details of packaging consumption and waste packaging in Australia should seek further information from the National Packaging Covenant Secretariat.

Consumption

General packaging consumption in Australia was estimated at 4.23 million tonnes in 2005. This includes beverage, food and other grocery packaging consumption.

The packaging materials consumed include glass, aluminium, plastics, steel cans and paper/cardboard.

Key materials

Key packaging materials are outlined in Table 4-1.

Table 4-1 Key packaging materials, typical applications and consumption, Australia, 2005

Material	Typical applications	Estimated consumption of this packaging material (tonnes/year, 2005) (NPCC, 2007)
Glass	Glass packaging is typically used for bottles and jars for a wide range of food and beverage products.	890,000
Aluminium	Aluminium is primarily used for drink cans.	50,000
Plastics	Plastics are used in a wide range of packaging applications.	587,000
Steel	Steel can (tinplate can sheet) packaging is used in a wide range of applications, including fruit juice, instant coffee and milk modifiers.	92,400
Paper/ cardboard	Includes carton board packaging applications such as cereal/ biscuit boxes and corrugated cardboard boxes used for secondary or outer packaging.	2,600,000
All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.		

Sales Trends

The overall trend in packaging use is a moderate increase in volume. This is generally due to population increases, increased consumption and a trend towards single serve food and beverage packaging.

Life expectancy

All packaging has a short lifespan with all packaging manufactured deemed to be used within the same year. There is no significant stockpiling of packaging material at any point in the manufacturing, consumption or disposal cycle.

The only long-term retention of packaging occurs through littering where a very small amount of packaging will be littered and not recovered in a short timeframe.

Stockpiling, landfill disposal, reuse, and recycling

It is assumed that packaging is disposed of immediately after use. There may be a very small level of reuse (e.g. plastic bottles for containing tap water), however even in these instances it is assumed that the container would be disposed of well within one year of purchase.

Recovery levels for packaging are amongst the highest for any product at 56%. This is due partly to the well established understanding of consumers about the recyclability of packaging. This results in a high recycling rate through household recycling collections and also a small but growing level of recycling from away from home locations (where recycling infrastructure is in place).

Barriers to increasing lifespan, reuse and recycling

The barriers to increasing the lifespan, reuse and recycling for packaging are:

- a high proportion of beverage and food packaging is consumed away from home where collection and recycling is more difficult to manage
- the incidence of glass breakage in mechanised recycling systems is often high and much of the broken material is not recovered
- the consumption of beverages in remote locations results in a need to freight material significant distances for recycling
- there is a trend towards smaller single serve containers with a higher packaging to food / beverage ratio. These smaller sized containers are recovered at lower rates than larger containers.
- there is a broad range of plastic materials used for packaging applications and only some of these have a clear and well co-ordinated recovery and recycling route.

Potential for increasing lifespan, reuse and recycling

The potential activities to increase the lifespan, reuse and recycling of packaging may include:

- working with local government collection and sorting contractors, to ensure the increased recovery of all rigid plastics packaging
- in co-operation with PACIA and plastics reprocessors, ensure a market destination exists for all collected rigid plastics
- assisting local government to provide a reliable and convenient kerbside collection for both residential areas and smaller commercial sites.

4.3.2 Retail carry bags

Plastic retail carry bags are the most common form of retail packaging in Australia. In 2007, an estimated 3.9 billion lightweight retail carry bags were used by consumers.

The political profile of retail carry bags is high due to their widespread use, a perception by some consumers that they are unnecessary and their visibility in litter streams. Around half of the retail carry bags used are sourced from supermarkets.

Sales trend

From the early nineties until 2003, retail carry bag consumption grew rapidly. It is estimated that in 2002, approximately 5.95 billion lightweight carry bags were consumed in Australia.

Following widespread concern from consumers and community/environmental organisations, the retail industry produced a code of practice that was implemented by leading supermarket retailers which established a target to reduce lightweight bag use by supermarkets by 50% from 2002 to 2005.

These activities led to significant reductions in bag consumption and disposal. Reports from supermarket retailers in 2006 indicated substantial falls in bag use, reversing the long term growth trend, but not at levels sought by government. In its 2006 report Plastic Carry Bags: Working Towards Continuous Environmental Improvements, the Australian National Retailers Association reported that supermarkets had achieved a reduction of 45% in the use of lightweight carry bags from 2002 to 2005. It is estimated that approximately 3.92 billion lightweight carry bags were consumed in 2005.

Following the end of 2005 and the failure to achieve the reduction target adopted by the retail industry in the aforementioned code of practice, the Environment Protection and Heritage Council committed to phase out lightweight plastic bags by the end of 2008.

The steady decline in the use of lightweight carry bags experienced since 2002 continued during 2006 to 3.36 billion. However, during 2007 there was an increase in consumption from 3.36 billion to 3.93 billion

Key materials

All single use retail carry bags are made of polyethylene. The singlet style supermarket bags are high density polyethylene (HDPE), while the boutique bags are low density polyethylene (LDPE).

The efforts to reduce the use of lightweight bags have led to increased use in alternative forms of carry bags, particularly degradable plastic bags and reusable bags.

Oxo-degradable plastic bags are made of polyethylene and undergo degradation though the incorporation of 'prodegradant additives' (additives that can trigger and accelerate the degradation process). These polymers undergo accelerated oxidative defined degradation initiated by natural daylight, heat and/or mechanical stress, and embrittle in the environment and erode under the influence of weathering. (Nolan ITU et al, 2003)

Biodegradable bags can be manufactured from components such as starch and biodegradable polyester. Biodegradable plastics are defined by the Australian Standard as those which have "the ability to be broken down by micro-organisms in the presence of oxygen (aerobic) to carbon dioxide, water, biomass and mineral salts or any other elements that are present. Alternatively, the breakdown of organic substances by micro-organisms without the presence of oxygen (anaerobic) to carbon dioxide, methane, water and biomass". (Standards Australia, 2006)

Standards Australia is developing standards for the range of degradable plastics, and to date has released the AS4376–2006 Biodegradable plastics – Biodegradable plastics suitable for composting and other microbial treatment in November 2006. Standards Australia is currently in the process of developing standards for other end environments such as on soil and in fresh and marine water.

The most commonly used reusable bags are manufactured from polypropylene. Other less common reusable bag types include calico, cotton, string and hemp.

Life expectancy

Retail carry bags are short life, typically going from use to disposal in a timeframe of less than 3 months. There is a high level of reuse of bags within households for purposes such as containing rubbish and storage.

There is a small percentage (1-2%) of bags that enter the litter stream. Bags that are not recovered through clean ups (such as owner/operator maintenance or Clean Up Australia Day-type activities) generally only degrade over a long period of time. Littered carry bags can enter the aquatic environment where they can become an aesthetic problem or hazard to marine life.

Stockpiling, landfill disposal, reuse, and recycling

Reuse rates within households are estimated at 60%-70%. Around 15% of bags are recycled through services provided by major supermarkets. The vast majority of bags (85%) go to landfill, usually containing household rubbish.

Barriers to increasing lifespan, reuse and recycling

The barriers to increasing the lifespan, reuse and recycling for retail carry bags are:

- the almost universal consumer expectation of carry bags, across the retail industry and the community
- the high value placed on bags, due to their usefulness and adaptability
- thoughtless consumption, linked to the free provision of bags
- the relative expense of recycling such a lightweight product compared with the cost of manufacturing new bags from virgin material
- the resistance of retailers to charge for bag use
- the unplanned nature of shopping habits restricting the use of durable reusable bags
- reduced focus on bag reduction efforts, due to shifts in environmental concerns to climate change and water supply issues
- the introduction of degradable bags, which may be perceived as environmentally preferred alternatives

Potential for increasing reuse and recycling

The potential activities to increase the lifespan, reuse and recycling of retail carry bags may include:

- retailers charging for bags at a tangible level, resulting in a likely reduction in usage
- the adoption of bag reduction targets by retail industry

- ongoing training of retail staff to achieve efficient usage of bags and more no bag transactions
- further encouraging consumers to switch to reusable alternatives and
- further encouraging consumers to return unused bags to point of sale for recycling

A ban on plastic retail carry bags may also help encourage the uptake of resusable bags depending on how it is constructed.

4.3.3 Flexible plastic freight packaging

Consumption

A significant volume of plastic packaging is used in freighting goods on pallets between manufacturing and wholesale/retail destinations.

This material is in two different forms:

- stretch wrap – elastic film that is wrapped around items to hold them together during transport
- shrink wrap – film that is heated to contract and hold items together during transport.

Both forms of flexible plastic wrap are made from Low Density Polyethylene (LDPE) film. A variation of this material used is called Linear Low Density Polyethylene (LLDPE).

This packaging film is the largest application for LDPE and LLDPE in Australia. The quantity of material consumed in the Australian market is estimated at 34 000 tonnes/year. It should be noted that this figure is based on Australian production of flexible plastic freight packaging and does not include pallet wrap entering Australia on imported goods.

As some goods are traded interstate or internationally, there is a flow of material from its point of use to its point of disposal. As an importer of goods, Australia is likely to have at least 34,000 tonnes available for disposal. In addition to stretch and shrink wrap, some large items are wrapped in polyethylene film for protection during freighting. Examples of this are mattresses, timber and furniture. Most of this film is not stretched or shrunk. In addition there are tamper proof LDPE wraps used on many consumer products such as confectionary, software etc. Film is also the primary packaging of a range of products such as bread, rice, fresh produce and toilet paper.

Key materials

All flexible film wrap is LDPE or LLDPE. Most of this material is clear or opaque (natural) although there is some use of black or white film. Some film is written on and some have plastic, paper or metallic labels adhered.

Sales trends

There is a moderate but continuous increase in the volume of flexible film freight packaging in Australia. Stretch film wrap is gaining market share over shrink wrap in most sectors. As a packaging medium rather than a product, sales of wrap will generally be linked to growth in sales of the product.

Life expectancy

Almost all material is used to transport goods over a short period. Over 95% of film will have completed its product life within 12 months of use. There are some plastics which are retained in warehousing applications over longer periods. As the growth in this material is modest and the product life span is generally less than 12 months, the disposed quantity is likely to be similar to the purchased quantity.

In many applications, the film is in use for only a matter of days or hours before being removed and disposed.

Stockpiling, landfill disposal, reuse, and recycling

There is no reuse of flexible film possible from either the shrink or stretch wrap forms.

The recycling of flexible plastic packaging is increasing at large retail and manufacturing outlets. In some cases waste generators are linking the collection of plastic film with the collection of packaging cardboard.

There are plastics recyclers who can accept and reprocess clean LDPE film if delivered to their recycling facilities. There is a gap in collection with neither waste generators nor plastics recyclers geared to collecting plastic film. The low value of the material works against its collection costs.

At most manufacturing or retail sites, plastic freight packaging is one of the largest components of the material sent to landfill (by volume).

Barriers to increasing lifespan, reuse and recycling

The barriers to increasing the lifespan, reuse and recycling for flexible plastic freight packaging are:

- lack of collection infrastructure for freight packaging
- low value of the material recovered relative to the cost of collection and reprocessing
- low density of film makes efficient compaction and collection difficult
- some film contains sticky transit labels that are a problem in recycling.

Potential for increasing lifespan, reuse and recycling

The potential activities to increase the lifespan, reuse and recycling of flexible plastic freight packaging may include:

- promoting recycling outlets to waste generating sites

- encouraging plastics reprocessors to facilitate the compaction and collection of flexible plastics packaging
- coordinating product stewardship commitment from PACIA and plastic manufacturers to facilitate the viable recovery and recycling of film
- investigating the potential to reduce film use through the use of stillages, walled pallets and plastic strapping
- extension of kerbside collections to include flexible plastics in a semi compacted format.

4.4 Fluorescent lamps

Consumption

A total of 19.7 million straight fluorescent lamps were purchased in Australia in 2004/05. This figure excludes incandescent lamps, compact fluorescents and high intensity discharge lamps. All straight fluorescent lamps are currently imported into Australia, with most manufactured in China.

Fluorescent lamps are distributed by wholesalers and retailers for use directly by the consumer or in the assembly of products containing lamps.

For energy efficiency reasons fluorescent lamps have gained widespread usage compared to incandescent lighting. They are most commonly used in the commercial sector.

The average lamp size measures 1.2 metres in length, nearly 4 centimetres in diameter, and weighs 250 grams. On this basis, the quantity of straight fluorescent lamps entering the Australian market in 2004–05 is estimated to be 4920 tonnes.

The current level of sales for compact fluorescent lamps in 2008 is estimated at 16.7 million units. This is expected to rise to a possible 63 million unit/year before stabilising at 30 million units/year (DEWHA 2008, unpublished).

Key materials

The key material components of fluorescent lamps are:

- glass
- aluminium
- phosphor powder
- mercury.

The amount of mercury in fluorescent lamps varies widely. The average mercury content of a standard fluorescent lamp is approximately 14 milligrams per lamp. The quantity in compact fluorescent lamps is lower at 4.4 mg – 15 mg per lamp.

Continuing technological development by many fluorescent lamp manufacturers over the last 15 years has resulted in increased lighting efficiency and a reduction in mercury content (apart from high-pressure sodium lamps). However, currently there are no viable alternatives to mercury for the majority of lamps.

Sales trends

Sales of straight fluorescent lamps have increased at an average rate of 3% per annum over the past decade. Sales are closely linked to new commercial building activity and replacements. Sales of compact fluorescent lamps have increased dramatically in 2007 and 2008 and this is expected to continue with the phase out of incandescent globes.

Life expectancy

Straight fluorescent lamps are most commonly used in the commercial sector and are generally replaced as they fail or show a drop in efficiency. The average life expectancy of a fluorescent lamp is 4.7 years. Compact fluorescent lamps are likely to have a similar life expectancy. Their recent wide scale introduction to the market means that there are currently very few compact fluorescent lamps entering the waste stream.

Stockpiling, landfill disposal, reuse, and recycling

It has been estimated that the vast majority of fluorescent lamps used in Australia annually end up in public landfill sites. There is a small level of recovery and recycling of fluorescent lamps in Australia.

Fluorescent lamps and compact fluorescent lamps currently recovered for recycling in Australia are sent to a recycling plant in Campbellfield, Victoria operated by CMA.

Waste lamps or compact fluorescent lamps are crushed and sorted into glass, aluminium, other metals and phosphor powder. The phosphor powder, which contains the mercury, is then subjected to a fully enclosed vacuum distillation process, in which more than 99% of mercury contained in it is recovered for re-use.

Glass, aluminium and other metals separated in the process of recycling are sold for re-use. Glass is used as a raw material by manufacturers of glass product or building insulation, the metals are also reused as raw materials. The phosphor powder, after it has been stripped of mercury is currently being evaluated as a soil additive supplementing a number of trace elements and phosphorus, needed for plant growth.

The current recycling rate for lamps is estimated at 4%.

Barriers to increasing lifespan, reuse and recycling

The barriers to increasing the lifespan, reuse and recycling for fluorescent lamps are:

- the light weight nature of the product means the total tonnage is not significant
- the dispersal is wide throughout Australian households and businesses
- there is no widespread return route for recycling
- no co-ordinated product stewardship arrangements are in place
- the lamps are difficult to handle due to potential for breakage
- landfill disposal is much cheaper than recovery for recycling.

Potential for increasing lifespan, reuse and recycling

The potential activities to increase the lifespan, reuse and recycling of fluorescent lighting may include:

- a ban on direct landfill disposal
- development of a return system through a form of product stewardship arrangement
- development of the reprocessing industry to recover the mercury and steel.

5 Other key products in Australia

In addition to the products considered in some detail above, a range of other key products have been examined. This includes products in the areas of: building products, paint, electrical and electronic equipment, elemental products (tyres, gas cylinders and batteries), furnishing products and packaging products. The assessment of these products considers the estimated annual consumption and disposal (including recycling/recovery) of these products and then applies a set of criteria in order to give an idea of priority when considering policies or programs to increase lifespan, reuse, recycling/recovery and waste reduction. Consumption and disposal data is based on previous work conducted by Hyder. A variety of sources have been used to estimate both consumption and disposal for each product. Disposal estimates are based on modelling taking into account estimated historical consumption and lifespan. The data is indicative only and is intended to provide an indication of the relative volumes of different types of products and materials.

5.1 Consumption and disposal

Table 5-1 shows the consumption and disposal (both in '000 tonnes) of products during 2005.

Table 5-1 Product consumption and disposal, estimated, Australia, 2005 ('000 tonnes)

Product	Consumption ('000 tonnes)	Disposal ('000 tonnes)
Building Products		
Asphalt road materials	8,200	3,814
Bricks[1]	14,141	7,920
Cables	121	2
Concrete paving and construction	58,561	14,597
Wire fencing	143	84
Insulation[1]	153	80
Office fittings	80	15
Piping (plastic)	246	34
Roofing iron	347	136
Roofing tiles	822	406
Structural timber[2]	4,312	1,112
Window glass[1]	303	92
Hot water systems	36	25
Chemical products		
Paint	74	6
Electrical & electronic equipment		
Computers	68	30
Printer & computer peripherals	48	32

Product	Consumption ('000 tonnes)	Disposal ('000 tonnes)
Televisions	65	11
Mobile phones	<1	<1
Compact fluorescent lamps	2	<1
Fluorescent lamps	5	4
Power tools	15	8
Small appliances	28	16
Whitegoods	389	179
Fixed line phones[3]	<1	<1
Heaters	26	16
Video & stereo electronic peripherals	29	9
CD media	11	5
DVD media	11	2
Smoke detectors	<1	<1
Elemental Products		
Tyres[4]	240	240
Gas cylinders	9	6
Automotive batteries	91	77
NiCad batteries	2	2
Personal batteries	7	7
Furnishing products		
Carpet	109	111
Outdoor plastic furniture	<1	3
Packaging products		
Packaging – general[5]	4,230	4,230
Retail carry bags	27	27
Freight packaging - flexible film	34	34
Disposable nappies	48	48

[1]This data is has been extrapolated from WA specific data.
[2] Calculated based on the estimated apparent consumption of sawnwood and wood panel products in Australia in 2004/05 as reported by ABARE (2006) Australian Forest & Wood Product Statistics Report, September and December quarters 2005. Volume of products consumed converted to tonnes based on density estimates.
[3]The fixed line phone data is from 2002/03. This is the most recently available information.
[4]The tyre data is from 2004. This is the most recent available information.
[5]Packaging – general includes beverage, food and other grocery packaging.
Disposal includes current levels of recycling or recovery.
All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

5.2 Priority rating system

A number of approaches are available that can be applied to prioritise products for increased recycling and reuse activity and waste reduction. The approach adopted in

this report has been to develop scores against key criteria and then to weight the criteria. Weighted scores for each criterion are then added and normalised to obtain an overall product 'priority' score.

The common list of criteria ensures that all products were subjected to the same assessment. All assessment criteria will not be considered of equal importance and therefore a weighting of the scoring under each criteria was used. Different stakeholders may apply a different weighting to this exercise. In this report, Hyder have used a weighting agreed to by SA and WA state government agencies during previous projects. The weighting used is outlined in Table 5-2. By adjusting the weighting DEWHA or others could test the sensitivity of the prioritising and may decide to apply a different set of criteria weighting.

It is possibly to review the weightings given to each assessment criteria and even to 'switch off' certain criteria. The assessment criteria scores are listed in Appendix 3. DEWHA has access to run different scenarios for discussion and review purposes.

Toxicity is a difficult criterion to include in the assessment as the toxicity profile of each product differs across its product life. In this assessment a toxicity rating is given to a product that is potentially hazardous in its end of life disposal. This could relate to the handling (e.g. gas cylinders) or disposal to landfill (e.g. mercury containing fluorescent lamps). Note this method is being offered as one means of facilitating national discussion on priorities for action under future waste polices. Hyder Consulting recognises that further development of such methodologies and eventual rankings may be needed.

5.2.1 Assessment criteria and scoring system

The seven assessment criteria, their definitions and the relative weighting applied to each are outlined in Table 5-2.

Table 5-2 Assessment criteria, definition and relative weighting.

Criteria	Definition	Relative weighting
Consumption	total quantity entering the Australian market	5%
Disposal level	total quantity reused, recycled, and disposed of to landfill	20%
Level of recycling or reuse	proportion of total 'disposal' which is recycled and reused	15%
Toxicity	the potential for adverse human health and environmental impacts from inappropriate disposal	30%
Product stewardship arrangements	whether there is a formal national and/or state industry agreement with government to develop and implement recycling and reuse initiatives across the industry	5%
Ease of collection/ material separation	ease of collecting, separating and sorting products for recycling (i.e. it is generally more difficult with products that have multiple materials)	10%
Recyclability and market availability	ease of reprocessing, and the existence of existing commercial markets for the reprocessed products	15%

The adopted assessment criteria scoring system for each parameter is given in Table 5-3.

Table 5-3 Rating key for product impact rating

Criteria	Very Low (VL)	Low (L)	Medium (M)	High (H)	Very High (VH)
Consumption (tonnes)	0-100	100-1,000	10,00-10,000	10,000-100,000	100,000+
Disposal Level (tonnes)	0-100	100-1,000	1,000-10,000	10,000-100,000	100,000+
Level of Recycling or Reuse	80+	80-50	50-10	10-0	0
Toxicity	Very Low	Low	Medium	High	Very High
Product Stewardship Arrangements	Very Poor	Poor	Medium	Good	Very Good
Ease of Collection/Material Separation	Very Poor	Poor	Medium	Good	Very Good
Recyclability & Market Availability	Very Poor	Poor	Medium	Good	Very Good

5.2.2 Priority rating

The results of the priority rating assessment outlined above are presented in Table 5-4. The scores against each criterion are provided in Appendix 3.

Table 5-4 Priority rating, all products

Product	Priority rating	Product	Priority rating
Building Products		**Elemental Products**	
Asphalt road materials	H	Tyres	H
Bricks	H	Gas cylinders	H
Cables	VL	Automotive batteries	VH
Concrete paving and construction	VH	NiCad batteries	VH
Wire fencing	M	Personal batteries	M
Insulation	L	**Furnishing Products**	
Office fittings	M	Carpet	M
Piping (plastic)	L	Outdoor plastic furniture	M
Roofing iron	VH	**Packaging Products**	
Roofing tiles	H	Packaging - general	L
Structural timber	M	Retail carry bags	H
Window glass	L	Other grocery packaging	H
Hot water systems	H	Freight packaging - flexible	H
Chemical products		Freight packaging - pallets	VL
Paint	M	Disposable nappies	H
Electrical & Electronic Equipment			
Computers	H		
Printer & computer peripherals	H		
Televisions	VH		
Mobile phones	VL		
Compact fluorescent lamps	VH		
Fluorescent lamps	VH		
Power tools	M		
Small appliances	H		
Whitegoods	VH		
Fixed line phones	VL		
Heaters	H		
Video & stereo electronic peripherals	M		
CD media	M		
DVD media	M		
Smoke detectors	M		

The priority rating assessment resulted in eight products being classified as a 'very high' priority and a further eleven classified as 'high' priority. These are summarised in Table 5-5. Some rated high due to toxicity issues while others rated near the top due to their high consumption or recyclability. The scores against each criteria are included in Appendix 3.

Table 5-5 Materials/ products with a very high or high priority rating

Product	Rating	Product	Rating
Concrete paving and construction	VH	Asphalt road materials	H
Roofing iron	VH	Bricks	H
Televisions	VH	Roofing tiles	H
Compact fluorescent lamps	VH	Hot water systems	H
Fluorescent lamps	VH	Computers	H
Whitegoods	VH	Printer & computer peripherals	H
Automotive batteries	VH	Small appliances	H
NiCad batteries	VH	Heaters	H
		Tyres	H
		Gas cylinders	H
		Disposable nappies	H

6 Waste management strategies/ policies

6.1 Overview

An examination of key strategies and policies in place at the state and territory level highlight a number of similarities. These are outlined briefly here:

- Landfill levies – many states have a levy applied to waste disposed of to landfill, on a dollar per tonne basis. Some states vary the levy based on source sector of the waste or by geographic area.
- Strategy documents – all states/ territories have a current waste strategy or are in the process of developing such a document. In most cases, these documents include targets for diversion of waste from landfill and other areas such as reductions in littering or overall waste generation.
- Landfill performance standards/ best practice – many states have landfill performance standards and/or guidelines for best practice landfill operations. In some cases the current standards were developed in the 1990s.
- Extended producer responsibility – many of the states have developed a list of priority products.
- Partnership programs with local government and industry – a wide range of programs are being implemented to assist local government in their programs and to encourage industry to reduce waste and increase recycling.

6.2 New South Wales

Information on the programs and strategies being implemented in NSW has been sourced from:

- Department of Environment and Climate Change website, www.environment.nsw.gov.au
- NSW DECC (2007c) Waste Avoidance and Resource Recovery Strategy 2007Overview Report
- NSW Government (2006) State Plan, A new direction for NSW
- The website of Renew NSW, http://regionalwasteforum.com/

The NSW Department of Environment and Climate Change (DECC) oversees a regulatory and policy framework that aims to minimise harm to the environment, avoid waste and increase resource recovery. The framework is administered under the principal legislation of the Protection of the Environment Operations Act 1997 (POEO Act) and the Waste Avoidance and Resource Recovery Act 2001.

Waste is administered across three geographic regions in NSW. These are the Sydney metropolitan area (SMA), the Extended Regulated Area (ERA) which covers the Hunter, Central Coast and Illawarra regions; and the Non-regulated Area (NRA) which encompasses the remainder of the state. The majority of waste is produced in the SMA and ERA.

6.2.1 Waste Avoidance and Resource Recovery Strategy

The Waste Avoidance and Resource Recovery Strategy, developed in 2003 and revised in 2007, provides targets for waste reduction and diversion and sets the programs and policies to achieve these targets.

The strategy sits under the NSW Government's recently adopted State Plan, A New Direction for NSW. Three key goals are outlined in the area of Environment for Living: a secure supply of water and energy, practical environmental solutions and improved urban environment. The Waste Avoidance and Resource Recovery Strategy contributes to a number of priorities within the State Plan.

The 2007 strategy has retained the four key result areas identified in 2003. These areas, as well as broad targets for each, are outlined in Table 6-1.

Table 6-1 NSW WARR Strategy key result areas and broad targets

Key result area	Broad targets
Preventing and avoiding waste	To hold level the total waste generated for 5 years from the release of *Waste Strategy 2003.*
Increasing recovery and use of secondary materials	By 2014, to: Increase recovery and use of materials from the municipal waste stream, from 26% (in 2000) to 66% Increase recovery and use of materials from the commercial and industrial waste stream, from 28% (in 2000) to 63% and Increase recovery and use of materials from the construction and demolition sector, from 65% (in 2000) to 76%.
Reducing toxicity in products and materials and	By 2014 or earlier: To phase out priority substances in identified products as a first choice or, if not possible, to achieve maximum recovery for re-use.
Reducing litter and illegal dumping.	Reduce total amount of litter reported annually. Reduction in total tonnages of illegally dumped material reported by regulatory agencies and RID (illegal dumping) squads annually.

A review of the 2003 strategy, undertaken in 2006, provided detail on the achievements of the strategy. A selection of programs and achievements are provided in Table 6-2.

Table 6-2 NSW WARR Strategy initiatives

Initiative	Details
Greengoods	The Greengoods website was launched in 2004 to assist government agencies and other organisations to implement sustainable procurement policies and to encourage environmentally preferred goods.
Learning for sustainability	200 schools across NSW are involved in the Sustainable Schools and young people's participation in sustainability program, part of the Learning for Sustainability program. This includes implementation of school environmental management plans.
Our Environment, It's a Living Thing' (OEILT) Council partnership program	This program has been extended to the local level through integrated and locally relevant projects. Assistance has been provided to councils to develop sustainability education programs as well as mentoring support for council educators.
Local Council Partnership Program	This program provides a structured learning program for council environmental educators, supporting the planning and delivery of community education projects to address local waste issues.
Industry Partnership Program	This program focuses on activities to reduce resource use, including raw materials, water and energy, and to reduce the volume and toxicity of waste and other emissions.

6.2.2 Waste and environment levy

The waste and environment levy is a regulatory mechanism designed to provide an economic incentive to reduce waste disposal and promote alternative waste technologies. Under Section 88 of the POEO Act, licensed waste facilities pay a contribution for waste received at the facility. A range of exemptions and deductions are applied to the levy in order to promote resource recovery. The levy rates increase annually. The rates for 2007-08 and 2008-09 are outlined in Table 6-3.

Table 6-3 Landfill levy prices, NSW, 2007/08 and 2008/09

Geographic area	Levy per tonne	
	2007-08	2008-09
Sydney metropolitan area (SMA)	$38.60	$46.70
Extended regulated area (ERA)	$31.60	$40.00

6.2.3 Extended producer responsibility

NSW legislation[3] allows for extended producer responsibility (EPR) schemes to be introduced in NSW. An annual priority statement is released by the Department of Environment and Climate Change. The first priority statement was released in 2004. The 2007 priority statement retained the wastes of concern nominated in the 2005/06

[3] Waste Avoidance and Resource Recovery Act 2001

statement and recommended that the products currently identified as priority wastes for national action by the Environment Protection Heritage Council (EPHC) could have EPR schemes initiated by NSW during 2007-08. These wastes are: lightweight plastic bags, tyres, televisions and computers.

6.2.4 Other programs of interest

A number of other programs or initiatives of interest have been identified in Table 6-4.

Table 6-4 Other programs or initiatives of interest, NSW

Program	Details
Local council waste service performance payments	These payments reward councils in the SMA and ERA who meet certain standards relating to waste management and resource recovery in their local government area.
Regional waste management groups	Renew NSW develops and implements regional waste management and resource recovery plans. Renew NSW consists of eight voluntary regional waste management groups. These groups cover 90% of rural and regional NSW, representing over 100 councils and 1.2 million residents.
Greenhouse Gas Abatement Scheme	This scheme provides incentives for smaller landfill sites to capture landfill gas and use it to generate electricity and for projects that divert putrescible waste from landfill to make electricity.
Environment protection licences	These licences are issued to owners or operators of various industrial premises. Licence conditions relate to "pollution prevention and monitoring and cleaner production through recycling and reuse and the implementation of best practice"[4].
Household chemical collections	This program allows a free collection service for householders to safely dispose of household hazardous waste such as paints, oils, lead acid batteries, cleaning products etc. In 2006/07 the DECC program provided collections across 51 councils as well as a hotline and website.
Waste Reduction and Purchasing Policy (WRAPP)	All NSW government agencies and state owned corporations must develop and implement a WRAPP Plan aimed at reducing waste and increasing purchase of products of recycled content materials. This includes items such as paper and cardboard, office consumables, toner cartridges, computers and monitors, vegetation waste and construction and demolition waste.

6.3 Victoria

Information on the programs and strategies being implemented in Victoria has been sourced from:

- State Government of Victoria (2008) Draft Metropolitan Waste and Resource Recovery Strategic Plan, available from www.sustainability.vic.gov.au
- www.mwmg.vic.gov.au
- www.sustainability.vic.gov.au
- www.epa.vic.gov.au
- State Government of Victoria (2005) Towards Zero Waste Strategy

[4] http://www.environment.nsw.gov.au/licensing

6.3.1 Towards Zero Waste strategy

The Victorian Towards Zero Waste Strategy (TZW) sets the strategic direction for solid waste management in Victoria. It seeks to minimise waste generation and maximise recovery of materials. It has targets to 2014 and covers solid waste from all sectors. The targets are outlined in Table 6-5.

Table 6-5 Victorian TZW Strategy targes

Target	Description
Target 1	A 1.5 million tonne reduction in the projected quantity of solid waste generated, by 2014.
Target 2	75% by weight of solid waste recovered for reuse, recycling and/or energy generation by 2014
Target 3	Sectoral targets achieved by 2008-09 and 2014
Target 4	A 25% improvement, from 2003 levels, in littering behaviours by 2014.

The sectoral targets referred to in Target 3 are outlined in Table 6-6.

Table 6-6 Victorian TZW Strategy sectoral targets

Recovery rate (by weight)	2002/03	2008-09 Progress target	2014 Target
Municipal waste	35%	45%	65%
Commercial & Industrial waste	59%	65%	80%
Construction & Demolition waste	57%	65%	80%
All solid waste streams	51%	60%	75%

The Towards Zero Waste Strategy also outlines the priority materials and products for each sector. Criteria for determining priority materials has focused on the quantity currently disposed to landfill, the adequacy of recycling systems in place, and the environmental and social costs associated with disposal. Priority products have the same criteria but an emphasis on shared responsibility across the product life cycle. Priority materials and products identified for the municipal sector are outlined below in Table 6-7.

Table 6-7 Priority Materials and Products within the municipal sector

	Municipal
Materials	Garden organics
	Food organics
	Paper/ cardboard
	Timber
Products	Electrical and electronic appliances (including televisions and mobile phones)
	Computers and peripheral IT equipment
	Tyres
	Consumer packaging
	Paint
	Mercury-containing lamps including fluorescent lamps
	Treated timber
	Batteries
	Plastic shopping bags
	Motor vehicles

6.3.2 Landfill levy

A levy on waste sent to landfill was introduced in metropolitan Melbourne in the early 1990s and expanded to all other areas of Victoria in the latter part of the decade. The levy provides a financial incentive for diversion of waste from landfill and, through hypothecation, has funded a variety of waste minimisation programs and initiatives. In 2002 the current schedule of rates, based on geographic location and type of waste, was set in place. The amount payable since July 2002 is set out in Table 6-8.

Table 6-8 Amount payable under the landfill levy

Location of landfill:	Amount payable ($/tonne)			
	Melbourne		Victoria (outside Melbourne)	
Source of waste:	Municipal	Industrial	Municipal	Industrial
	$4	$5	$2	$3
1 July 2003 to 1 July 2004	$5	$7	$3	$5
1 July 2004 to 1 July 2005	$6	$9	$4	$7
1 July 2005 to 1 July 2006	$7	$11	$5	$9
1 July 2006 to 1 July 2007	$8	$13	$6	$11
1 July 2007	$9	$15	$7	$13

Funds collected through the landfill levy are distributed as per the *Environment Protection (Distribution of Landfill Levy) Regulations 2002.* Most of the funds are provided to the agencies responsible for waste management in Victoria: Environment Protection Authority (EPA), Sustainability Victoria and regional waste management

groups (RWMGs). The remainder is allocated to a Sustainability Fund, which supports projects and programs that aim to promote sustainability.

6.3.3 Regional waste management groups

The Metropolitan Waste Management Group (MWMG) was established in October 2006 under the Environment Protection (Amendment) Act 2006. The MWMG is the successor to the four former Regional Waste Management Groups within metropolitan Melbourne. The role of the MWMG[5] is to:

- Plan for waste management and resource recovery facilities and services across metropolitan Melbourne
- Facilitate procurement of efficient and sustainable resource recovery and residual waste disposal services for Councils
- Help build the capacity and knowledge of Councils and their communities of world best practice waste minimisation and the opportunities and options available to reach the Towards Zero Waste targets and beyond.

In addition to the MWMG, there are 12 Regional Waste Management Groups covering all of Victoria outside of metropolitan Melbourne.

6.3.4 Metropolitan Plan

The Draft Metropolitan Waste and Resource Recovery Strategic Plan was released in early 2008. Once finalised, the Strategic Plan will "articulate the direction for resource recovery and waste management in metropolitan Melbourne in the long term"[6]. The draft Strategic Plan includes three components, the Metropolitan Plan, the Municipal Solid Waste Infrastructure Schedule and the Metropolitan Landfill Schedule.

[5] www.mwmg.vic.gov.au

[6] State Government of Victoria (2008) Draft Metropolitan Waste and Resource Recovery Strategic Plan, available from www.sustainability.vic.gov.au

6.3.5 Product specific programs

A number of programs have been implemented in Victoria, focusing on improving diversion of specific products or materials. These are outlined in Table 6-9.

Table 6-9 Product specific programs, Victoria

Program	Product focus	Details
Batteryback	Rechargeable batteries from products such as laptops, phones and cameras.	Batteryback, an industry-government initiative, provides a free recycling service via containers located in some retail stores.
Detox Your Home	Household hazardous waste, including paint, cleaners and pesticides	A series of collections are held across Victoria each year, with each local government area hosting a collection roughly every two years. A number of permanent Detox your Home centres have also been established.
Byteback	Computer equipment and peripherals	A number of permanent collection locations have been established for residents and small business owners in Victoria to safely dispose of unwanted, old and unused computers for recycling.
Paintback	Unwanted paint and paint product packaging	This program allowed unwanted paint and packaging to be returned to a retail location for recycling. This service is still available through the permanent Detox your Home centres. The paint industry is now developing plans to roll out a national collection program for unwanted paint.

6.4 Queensland

Information on the programs and strategies being implemented in Queensland has been sourced from the EPA Qld (2007) *Let's Not Waste Our Future Queensland Waste Strategy Discussion Paper for Public Comment.*

In October 2007, Queensland Environment Protection Authority (EPA) released the Let's Not Waste Our Future Queensland Waste Strategy Discussion Paper for Public Comment. The discussion paper invited comment by December 2007 on a range of issues relating to the new waste strategy. The proposed waste strategy will apply to the whole of the state, including island communities. It would cover "all solid and some liquid waste generated in Queensland by households, business and industry, primary production and government activities and waste transported into Queensland to be recycled or disposed of" (EPA Qld 2007).

The discussion paper proposed four outcomes for the new strategy:

- an effective policy framework
- more accurate data collection and analysis
- reduce waste and optimise resource recovery
- fostering partnerships and sustainable behaviour.

The current Waste Management Strategy for Queensland, released in 1996, aims to minimise or avoid adverse impacts on the environment due to waste management, while allowing economic development and improving Queenslanders' quality of life.

The new strategy will look more broadly and will follow the waste hierarchy approach of avoidance, recovery for reuse, recycling or energy and management of residuals.

The new strategy will be strongly linked to other strategies and policies, such as the Smart Queensland: Smart State Strategy 2005–2015 and the South East Queensland Regional Plan 2005–2026.

One consideration in developing the new waste strategy is the implementation of economic instruments such as a landfill levy or other instruments. A range of these options were included in the discussion paper for the new strategy. The strategy is due for release in late 2008.

6.5 Western Australia

Information on the programs and strategies being implemented in WA has been sourced from:

- DEC WA (2004) 'Statement of strategic direction for waste management in Western Australia'
- www.zerowaste.com.au

6.5.1 Strategy and policy

The *Statement of strategic direction for waste management in Western Australia',* released in September 2004, gave a vision, goal and principles for waste management. These are outlined in Table 6-10.

Table 6-10 Western Australia vision, goal and principles for waste management

Vision	Towards zero waste in Western Australia
Goal	That all western Australians live in a waste free society
Principles	Principle 1: Prevention – to avoid the creation of waste Principle 2: Recovery – to efficiently re-cover, re-treat and re-use all wastes Principle 3: Disposal – to responsibly manage waste into the environment

Five key areas of priority were outlined. These were:

- government
- Business and industry
- Community
- Strategy and policy
- Communication.

6.5.2 Landfill levy

The landfill levy, introduced in 1998, applies to waste generated within metropolitan Perth and wastes disposed at landfill sites within the metropolitan area. The levy acts

to increase the price of landfill compared with recovery options in order to make the latter more cost effective, and to provide resources for strategic programs. The funds generated by the levy are hypothecated for programs in the areas of management, reduction, reuse, recycling, monitoring or measurement of waste. The landfill levy in 2008/09 was $6 per tonne at putrescible landfill sites and $3 per cubic metre at inert landfill sites.

6.5.3 Programs

A range of programs are outlined on the ZeroWaste WA website. These are outlined in Table 6-11.

Table 6-11 Western Australia programs

Title	Details
Zero Waste Plan Development Scheme (ZWPDS)	This plan is intended to assist local governments in Western Australia with the preparation of a Strategic Waste Management Plan (SWMP) in order to facilitate enhanced planning for waste management and recycling. Phase 1 of the ZWPDS, which closed on 28 September 2007, consisted of an online survey to establish baseline characteristics for all local governments across the state. 91 per cent of local governments participated in this initial data collection phase. Phase 1 reports the Data collected by local councils to get a profile of local governments infrastructure and waste levels. Phase 2 of the ZWPDS involves the development of a SWMP.
Buy Recycled Guide	This guide provides a list of products that contain recycled materials to help consumers buy recycled.
Extended producer responsibility (EPR)	In 2005 the Department of Environment developed a policy statement on EPR. The aim of the statement was to shift the focus from the end of the lifecycle to waste avoidance, resource efficiency and the development of closed loop systems. It emphasises the need for producers and suppliers to accept a direct responsibility for their products through design, manufacture and sales through to end-of-life. It acknowledges that there is a shared responsibility with government, consumers and other key stakeholders.
Investigation into best practice CDL for WA	In 2006 the WA Minister for the Environment formed a Stakeholder Advisory Group (SAG) on Best Practice Container Deposit Systems. The SAG investigated the potential for the introduction of container deposits on beverage containers. The report of the investigation stated that the SAG expected container deposits to significantly increase recycling beyond current levels for WA. This was noted to be especially the case for containers of beverages consumed away from home.
The Household Hazardous Waste Program	Upgrading of the existing local government household hazardous drop-off centres located throughout the metropolitan area. These facilities provide interim storage and some recovery and disposal avenues for various household hazardous wastes that are deposited by householders and the general public. Promotion of the safe storage, recovery and disposal of household hazardous A strategy to seek long-term funding to sustain the program Promotion of product stewardship to identify and avoid the production of harmful household hazardous wastes.
National Packaging Covenant	Development of an action plan

Title	Details
Other	Community Grants Scheme: The Community Grants Scheme (CGS) has been established to support local, community-scale projects that improve the management of waste in Western Australia. Strategic Waste Initiatives Scheme: The Strategic Waste Initiatives Scheme (SWIS) is aimed at providing support and encouragement to business and industry, local government, community groups and individuals in tackling priority waste issues. Support Scheme Funded Projects: A list of all projects approved by the Waste Management Board for each round of SWIS and CGS from 2004, including descriptions of the projects, funding amounts, organisations involved and Case Studies where applicable.

6.6 South Australia

Information on the programs and strategies being implemented in South Australia has been sourced from:

- Zero Waste SA (2005a)'Waste Strategy 2005-2010'
- SA EPA (1996) 'Integrated waste strategy for metropolitan Adelaide 1996-2015'
- Hyder Consulting (2007) 'Review of Solid Waste Levy', prepared for Zero Waste SA
- http://www.wow.sa.gov.au/
- www.epa.sa.gov.au
- www.zerowaste.sa.gov.au

6.6.1 Waste strategy

The state's first waste strategy, South Australia's *'Waste Strategy 2005-2010'* sets out the direction for waste management. The waste management hierarchy is the foundation for the strategy. Five objectives provide a focus for the strategy:

- Fostering sustainable behaviour
- Reduce waste
- Implement effective systems
- Implement effective policy instruments
- Cooperate successfully.

Specific targets are also given in the strategy. These are presented in Table 6-12.

Table 6-12 SA Waste Strategy targets

Waste stream	By 2008	By 2010	By 2014
MSW	50% of all material presented at the kerbside is recycled	75% of all material presented at the kerbside is recycled (if food waste is included)	Reduce waste to landfill by 25% (as required by South Australia's Strategic Plan)
C&I	15% increase in recovery and use of C&I materials	30% increase in recovery and use of C&I materials	
C&D	35% increase in recovery and use of C&D materials	50% increase in recovery and use of C&D materials	
Note: The targets for 2006 outlined in the strategy are not included in this table.			

A mid-term review of South Australia's Waste Strategy will be undertaken in 2008.

6.6.2 Adelaide waste strategy

A pre-cursor to the state-wide Waste Strategy was the *'Integrated Waste Strategy for Adelaide 1996-2015'*, released by the South Australian EPA in 1996.

6.6.3 Landfill levy

South Australian has a landfill levy that increased to $23.40/tonne in metropolitan areas and $11.70/tonne in non-metropolitan areas in July 2007, up from $11.20 and $5.60 respectively prior to that date. There is no differentiation made based on the type of waste being deposited. Of the funds that are received, 50% are paid to the Waste to Resources Fund for Zero Waste SA to use for programs aimed at improving waste management and waste minimisation in SA, 5% goes to Environment Protection Fund for specific environmental projects and 45% goes to the EPA recurrent funding for operations and environmental programs.

6.6.4 Other programs

Other South Australian programs of interest are outlined in Table 6-13.

Table 6-13 Other South Australian programs of interest

instruments/policy	Waste type	Details
Container Deposit Legislation	Beverage Containers - aluminium, glass, LPB, PET, HDPE	Refundable deposit for returns Sorted and rinsed to lower contamination and increase value relative to non CDL recovered material.
Wipe Out Waste Schools	Municipal solid waste	school resource folder, website and training workshops for teachers strengthen links between community and industry Currently regarded as a template for other sustainability programs in schools
Waste Management and Reduction Guide for the Retail Industry	Commercial and MSW waste	Provide ways for shopping centre management, commercial property owners and property managers to minimise waste, maximise recycling
Used oil recycling (under the product stewardship for oil Program)	Motor oil	Provides 10 Oil collection facilities across the state Levy for oil producers and importers
Household Hazardous Waste and Farm Chemical Collection	Household and farm hazardous waste	Zero Waste SA and Local Government provides free household hazardous waste collections to help disposal of unwanted chemicals in an environmentally safe way.
Zero waste events program	AFW waste	Support for event organisers to minimise waste and maximise recycling Public education
Proposed plastic bag ban	Light weight plastic bags (polyelthelene less than 35 microns)	Ban these types of bags
Social Enterprise Grants program	Range from clothing, beverage containers, white goods, paper in 2006	targets charities, service clubs and/or other not for profit organisations involved in the recovery of re-usable resources. $75,000 available for 07/08. Grants between $500- 15,000.
Market Development Grant	Priority given to recycled content products including: aggregate and soils; recycled organics; plastics; CCA treated timber alternatives; glass; reuse/second-hand products industrial residues and slags. Other products may be considered. ;	aims to expand markets for recycled materials by stimulating investment in a diverse range of market development activities e.g. product development and reprocessing, market research, development and analysis and field trials. Grants are available from $25,000 to a maximum of $150,000 (excluding GST) per project.

instruments/policy	Waste type	Details
Kerbside Performance Incentives – targeting food waste	Food waste	In 2008-2009 it is proposed to provide funding for councils to improve kerbside recycling performance which includes food waste collection.
Metropolitan reuse and recycling infrastructure grants		increase the capacity for local reprocessing of recyclable material to high value end use products and invest in infrastructure that enables greater reuse of waste materials $100,000 to a maximum of $300,000 (not more that 50% of the total project cost)
Industry resource efficiency program.	C&I	help businesses understand, develop and implement cost saving resource efficiency measures by providing a management tool to benchmark current practices, training, and provision of technical support. SA Business Sustainability Alliance which includes the Department of Trade and Economic Development/Centre for Innovation, Environment Protection Authority and SA Water

6.7 Australian Capital Territory

Information on the programs and strategies being implemented in the ACT has been sourced from:

- http://www.tams.act.gov.au/live/Recycling_and_Waste/The_No_Waste_Strategy/nowasteawards
- ACT NoWaste (2005) *'Guide to Recycling for ACT Businesses – Recycling, It's your Business'*
- http://www.tams.act.gov.au/live/Recycling_and_Waste/schools
- ACT NoWaste (undated) *'Leaders in NOWaste Case Study Majura Primary School Spring Fair'*
- ACT Government (1996) *'No Waste by 2010 – A Waste Management Strategy for Canberra'*
- ACT Government (2004) *'No Waste by 2010 – Turning waste into resources Action Plan 2004-2007*
- ACT Government (2002) *'Waste Pricing Strategy for the ACT'*

6.7.1 No Waste Strategy'

The *'No Waste by 2010 Strategy'*, released in 1996, set the vision and future directions for waste management in the Australian Capital Territory. The goal of the strategy is "a waste free society by 2010". Diversion of waste from landfill has increased from 22% in 1993/04 to 69% in 2002/03. Unlike other jurisdictions, total waste to landfill has also

declined during this period, from just over 400,000 tonnes in 1993/94 to 197,000 tonnes in 2006/07.

The *'Turning waste into resources 2004-2007 Action Plan'* outlines a range of programs underway in the ACT. These are outlined in Table 6-14.

Table 6-14 ACT No Waste Strategy programs

Title	Waste type	Details
No waste awards	C&I	The No Waste Awards have provided an opportunity for businesses, schools and community groups to gain recognition for waste reduction efforts. The awards also provide an opportunity to compare efforts with other organisations and raise the environmental profile of organisations.
Event recycling	Packaging waste produced away from home	Event organisers can obtain advice and the use of bin covers to promote recycling at events.
Waste pricing	C&I, MSW	A 2002 review of waste pricing in the ACT indicated that charges were set at less than half the actual cost of disposal. The review resulted in an increase in waste prices for private deliveries of waste material. The current pricing structure provides an incentive to divert recyclable material as the fees are based on the size of the load.
Community programs	MSW	A range of community programs are implemented under the strategy. Establishment of a Resource Recovery Estate was planned for 2004-2007 to provide a focus for the delivery of waste education programs to the community.
Business programs	C&I	Under these programs, businesses are provided with advice and encouragement to reduce waste and increase recycling. The Ecobusiness program assists in improving environmental performance. The Guide to Recycling for ACT Businesses provides advice on how to design a recycling system for business and provides resources such as recycling signage.
Waste Wise Schools	Education	This program was developed by Sustainability Victoria (formerly EcoRecycle Victoria) and adopted for ACT. The program assists schools to develop a waste wise ethic and reduce waste. The program includes workshops for teachers to attend, tours of waste facilities, and many other resources.

6.8 Tasmania

Information on the programs and strategies being implemented in Tasmania has been sourced from:

- Department of Environment (Tasmania) website: www.environment.tas.gov.au
- Blue Environment (2007) *'Draft Waste Management Strategy for Tasmania Consultation Draft'* Prepared for the Department of Tourism, Arts & the Environment
- Blue Environment (2007) *'Draft Waste Management Strategy for Tasmania Background Report'* Prepared for the Department of Tourism, Arts & the Environment
- Southern Waste Strategy Authority (2005) *'Five Year Strategy 2006-2011'*

6.8.1 Waste strategy

A draft Waste Management Strategy was prepared in 2007. The vision for the draft strategy is to "contribute towards the development of sustainable Tasmanian communities, with both current and future generations enjoying a healthy environment, an inclusive society and a prosperous economy, and delivered by government, business and the community working in partnership" (Blue Environment 2007).

6.8.2 Waste data reporting

The Tasmanian state and local governments have agreed to jointly pursue improved systems for waste and recycling data reporting. Since 2006, municipal landfill operators have been required to report on waste in accordance with the Tasmanian Solid Waste Classification System. Data from transfer stations is also recognised as an important component of the waste database. A model contract clause has been provided to local governments by the Department of Environment, Parks, Heritage and the Arts for inclusion in contracts for the operation of waste transfer stations. In December 2006-January 2007, a series of workshops were held on how to collect and report waste data.

6.8.3 Regional programs

The Southern Waste Strategy Authority (SWSA) is funded through a voluntary local government levy equivalent to $2 per tonne. The SWSA has prepared a *'Five year strategy 2006-2011'* with a focus on sustainable resource recovery.

6.9 Northern Territory

Information on the programs and strategies being implemented in the Northern Territory has been sourced from:

- Northern Territory Department of Natural Resources, Environment, the Arts and Sport website, www.nt.gov.au/nreta/
- NT Government (2007) *'Disposal Behaviour & Resource Efficiency Interim Action Plan*
- Keep Australia Beautiful website, http://www.kab.org.au/nt/01_cms/details.asp?ID=314

A Strategy for Waste Management and Pollution Control in the Northern Territory was developed in 1995 and lead to the introduction of the Waste Management and Pollution Control Act in 1998. The Environment, Heritage and Arts Division is proposing to develop a new waste management strategy for the NT focused more on recycling and resource recovery, and several of the newly established super shires are looking at developing regional waste strategies. The interim strategy '2007 Re-Thinking Waste Disposal Behaviour and Resource Efficiency Interim Action Plan is currently being implemented. This builds on the outcomes of the Northern Territory Litter Abatement and Resource Recovery Strategy (LARRS) which was adopted in 2003 with a timeframe of three years (now expired).

The goals specified in the interim strategy are:

- To identify effective incentives for appropriate disposal behaviour in the NT
- To identify opportunities to maximise resource efficiency and minimise environmental impacts in the NT
- To establish a sustainable resource-not-waste management framework and effective implementation mechanisms
- To promote greater awareness of resource efficiency issues in the NT.

A range of programs are being implemented under the interim action plan. These are outlined in Table 6-15.

Table 6-15 NT interim action plan programs

Title	Details
Re-thinking waste in schools challenge	In conjunction with Keep Australia Beautiful NT. Program aims to be an innovative and fun 'inter-school challenge approach' to make recycling and litter abatement programs in schools more effective and interesting. Schools implement recycling and waste reduction programs (or can design their own).
Building better community education resources.	A community education program focussing on identified hotspots and localities where issues such as littering or high contamination levels and poor participation rates in the kerbside recycling program are of major concern.
The Regional Infrastructure Development Project	Focuses on identifying opportunities to develop regional recycling infrastructure and more cost-effective integrated recovery processes and services. It involves: Developing partnerships to promote resource/energy recovery industries and regional development; establishing a sustainable mechanism to fund regional infrastructure and improve the capacity to reuse/recycle resources in regional and remote communities; and identifying market opportunities and processes that will facilitate resource recovery in the Territory. Two key focus areas will be assisting the establishment of new business units in remote areas and the development of local market opportunities for recovered materials.
Re-thinking waste in industry	This project focuses on improving resource recovery from two of the Territory's key industries - hospitality and building. It will involve: Working with industry to establish Codes of Practice in key waste generation industries; and Providing an appropriate incentive to minimise waste and increase the volume of resources recovered. The project will involve the Northern Territory Government working with agency and industry representatives to clarify environmental responsibilities under the *Waste Management and Pollution Control Act* in relation to waste minimisation and recycling.
Re-thinking Governance	Will ensure the responsibilities of the National Environment Protection Used Packaging Materials Measure are appropriately met in the NT. This will be achieved by: Working with industry to raise awareness of environmental responsibilities and obligations under NEPM; working with local governments to develop a better understanding of resource recovery activities in the Territory and allow more accurate reporting under the UPM NEPM.

7 Greenhouse impacts of waste management

The greenhouse implications of waste management can be considered on different levels. Standard greenhouse accounting systems consider the waste sector as an emission source, considering only the direct emissions from waste degradation. A broader perspective would consider waste management aspects such as fossil fuel emissions in the waste process and, more broadly still, the life cycle impacts including avoidance of emissions through recycling.

The following discussion covers both these perspectives. The first section considers direct emissions from waste. The subsequent two take a life cycle perspective in considering firstly landfills, and secondly on recycling and composting. Landfill management in response to greenhouse issues is discussed in the following chapter.

7.1 Direct emissions attributed to waste management

7.1.1 Emissions from landfill

The Australian National Greenhouse Gas Inventory (NGGI) provides an inventory of Australian emissions categorised into various emission sectors. Emissions from the waste sector are dominated by landfill. There is a minor contribution from wastewater treatment and a very small amount from incineration of fossil carbon, mainly in medical waste.

The greenhouse gas produced from landfills is methane resulting from the anaerobic degradation of organic material. Landfill gas typically consists of about 50% methane and about 50% CO_2. By convention, this CO_2 from organic material degradation is not counted as an emission from waste since it is derived from biogenic sources. In the NGGI, CO_2 fluxes between the atmosphere and biogenic system are accounted for in the emission sector 'land use, land use change and forestry'.

In 2006 emissions from landfills were 13.2Mt or 2.3% of Australia's greenhouse total (DCC 2008). This is a reduction of 11% since 1990, which can be mainly attributed to methane capture and oxidation. The methane recovery rate has increased from a negligible proportion in 1990 to around 26% in 2006.

Emissions from waste have some characteristics that are quite different from those of other sectors. Firstly, most activities that result in emissions (e.g. burning fossil fuels) cause those emissions to arise instantaneously. Deposit of waste in landfill, on the other hand, causes emissions to be generated over several decades. Secondly, the emissions from most other sectors can be estimated with a reasonable degree of accuracy whereas emissions from landfills are highly variable and difficult to predict even when data on waste composition is available. These characteristics create significant policy challenges and could result in the exclusion of waste from the future emission trading system.

The NGGI model for estimating emissions from waste is built up material-by-material based on various assumed factors. These include quantities disposed, average composition, degradable organic carbon content and degradation rate. Similar factors are used in other Department of Climate Change (DCC) publications that provide

guidance on how to estimate landfill-specific emissions or indirect Scope 3 emissions from an organisation's waste.

The Scope 3 method applies net emission factors ignoring the time factor of emission and can be used for estimating net greenhouse impacts by material stream and by waste type as shown in Figure 7-22. According to the figure paper & paperboard are the most significant streams in both C&I and MSW streams. One of the implications of this is that some landfills currently classified as inert but able to accept commercial wastes may generate high levels of greenhouse gases.

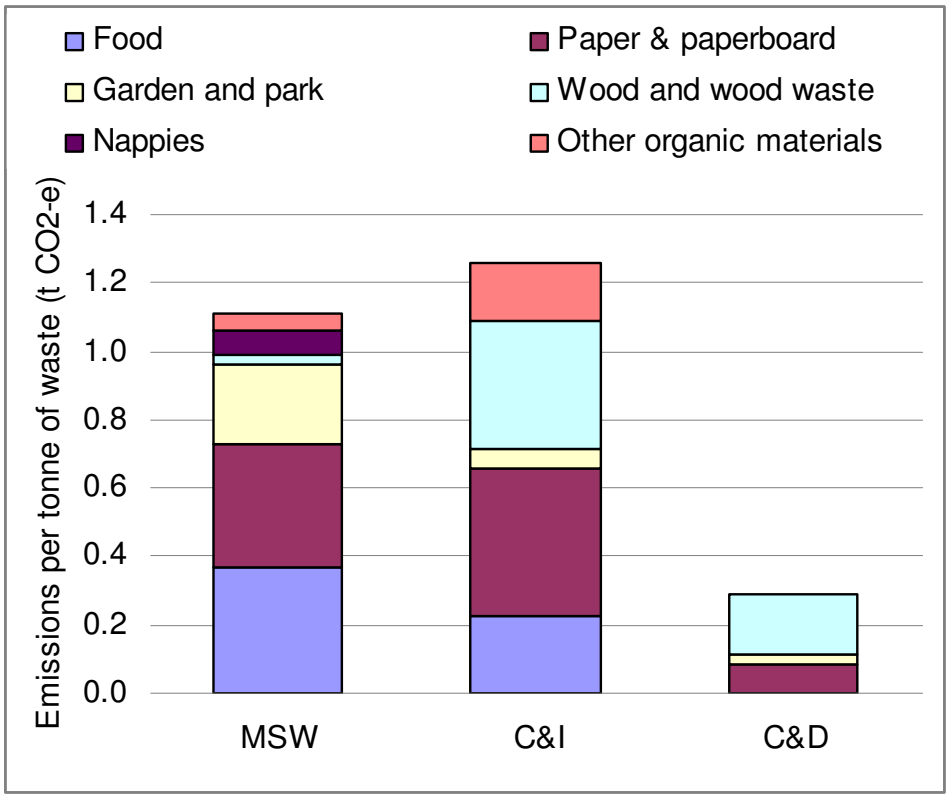


Figure 7-22 **Predicted overall emissions from deposition of a tonne of waste in a landfill without gas capture, based on Department of Climate Change methods and default values (June 2009)**

7.1.2 Other direct emissions from waste operations

Some other sources of direct emissions from waste management operations are not included in inventory methods. These include the transport emissions from waste collection and transfer, and the emissions from operation of waste management facilities. Some anaerobic degradation may occur during open windrow composting, particularly in poorly managed operations, and some of this may escape from the compost heap without being oxidised. The IPCC (2006) provides factors to be used in NGGIs but they are fairly small and are ignored in Australia's NGGI.

In general all these emission types are small compared with methane generation in landfills. Some illustrative estimates and values are tabulated below in Table 7-1 These estimates and values can be contrasted with the estimated typical emissions (prior to gas recovery) of over 1t $CO2_{-e}$ / t waste from degrading organics (Figure 7-22).

Table 7-1 Illustrative greenhouse emissions from waste operations

Activity	Emission factor	Source / comment
Landfill construction	8 kg CO_2-e / t waste	Hyder estimate
Landfill operation	2 kg CO_2-e / t waste	Average reported from three confidential landfills
Composting	24 kg CO_2-e / t waste	Case study in Recycled Organics Unit (2001)
Kerbside waste collections	3,123 t CO_2-e / yr	Hyder estimate for a large Melbourne municipality

7.1.3 Issues in comparing methane with carbon dioxide

Methane and other gases are compared with CO_2 by means of their relative global warming potential. It is often overlooked that this is a problematic and slightly arbitrary measure.

A molecule of methane is typically resident in the atmosphere for a few decades whereas a molecule of CO_2 is likely to remain in the atmosphere for several centuries. This creates a difficulty in comparing global warming potentials – if we compare warming impacts over the whole lifespan of the gases we are placing the same importance on warming taking place centuries from now as we place on warming set to occur in the immediate decades. On the other hand, if we compare the warming over the residency period of the shorter-lived gas we are ignoring warming occurring after that time. The standard compromise to this dilemma is to compare gases over a 100-year time frame.

The estimates of the impact of landfills given above are based on the 100-year time frame, on which basis the DCC puts methane as having a global warming potential of 21 times that of CO_2. The Intergovernmental Panel on Climate Change is proposing to increase the equivalence factor to 25, which would increase the emissions from landfills proportionally (Forster *et al*. 2007: 212).

If the warming effects of the two gases are compared over a 20 year period methane has 72 times the global warming potential of CO_2 (Forster *et al*. 2007: 212). Some leading climate change scientists have argued that methane management should be considered a separate management issue that is more urgent than standard CO_2 equivalence measures suggest (Hansen and Sato 2007). Based on a 20 year assessment time frame, it can be calculated from NGGI data that Australian landfills would emit 45.3Mt CO_2-e or 5% of the revised total for Australia.

7.2 A life cycle perspective to landfill emissions

The discussion above is based on standard inventory and accounting approaches for emissions from landfills using DCC factors and methods. For some purposes it is better to consider the greenhouse gas implications of landfilling from a more holistic life cycle perspective, taking into account secondary effects. Significant additional factors are:

- ‘Credits’ from reuse of landfill methane to offset the electricity generated from standard means, and similar credits for recovery of recyclables. (Recycling is considered separately below and is not assessed further in the context of landfill management.)
- Long-term storage of carbon in landfills, preventing an alternative of degradation to carbon dioxide.

The importance of these two factors as a counterbalance to methane emissions varies with the waste types and the greenhouse profile of electricity generated from standard means. Using standard DCC factors and modelling to consider a landfill in Victoria, which has the most greenhouse-intensive electricity, inclusion of these two factors in the balance means that a landfill could be considered ‘carbon neutral’ by recovering about 57% of the landfill gas it generates over its whole life-cycle (Figure 7-23). This rate is thought to be readily achievable at a well-managed landfill. If the storage factor is discounted the threshold rate would be around 80%. Many researchers and landfill operators maintain that this level of capture over the whole life cycle of the landfill is achievable.

On the other hand, if the assessment period for global warming potential is shortened to 20 years so that the global warming potential of methane is 72, then for carbon neutrality (taking storage into account) a whole of life capture rate of over 85% would be required.

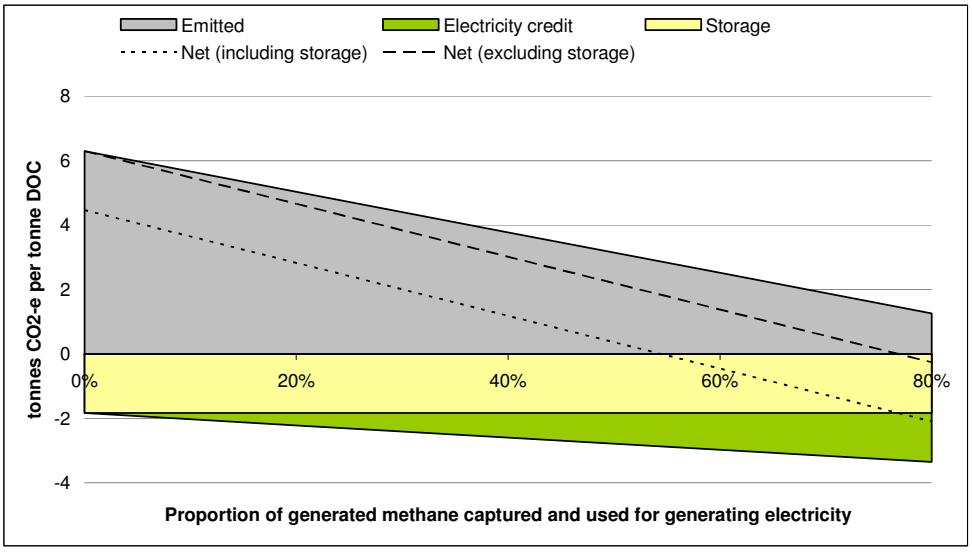


Figure 7-23 Life cycle considerations in the greenhouse implications of landfilling (Victorian electricity)

7.3 The greenhouse implications of recycling and composting

Life cycle assessments have consistently demonstrated that for most materials and most circumstances, recycling results in net savings in energy and net reductions in greenhouse gas emissions (Ackerman 1997, Grant et al. 2003, Eriksson et al. 2005, Diaz and Warith 2006). The most recent Australian study was carried out by Hyder Consulting for ACOR (2008). It suggests that recycling saved 8.8Mt CO_2-e in 2006, equivalent to about 1.5% of Australia’s total emissions. Figure 7-24 is derived from that

report and shows the greenhouse benefits of recycling various materials on an annual basis.

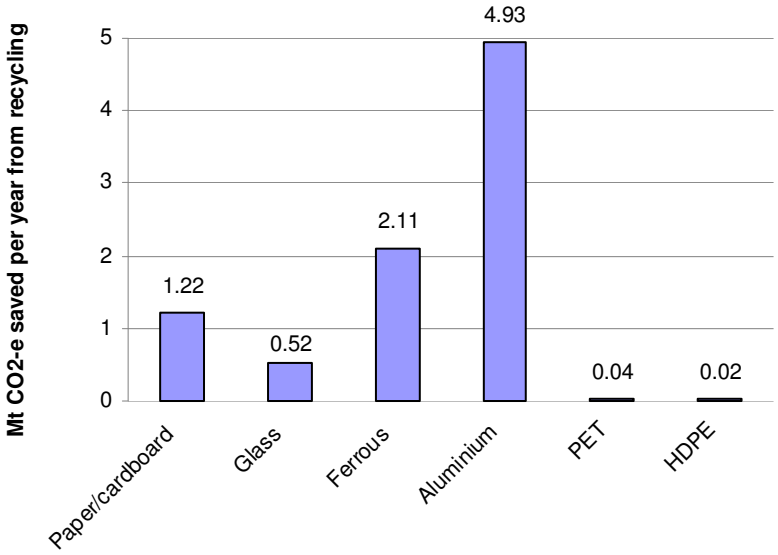


Figure 7-24 The greenhouse benefits of recycling by material type
Source: ACOR (2008)

There is also a greenhouse benefit from the use of compost. This is derived from substitution of chemical fertilisers (the manufacture of which is greenhouse intensive) and from long-term enhancement of carbon in soil humic materials. The magnitude of these benefits is difficult to estimate and circumstance specific.

A major European study (Smith *et al*. 2001) attempted to estimate rough average values for these factors. It assigned a credit of 35 kg CO_2-e from offsetting fertiliser use for each tonne of compost used in agriculture. It also estimated that a rough average of 8% of carbon in compost would remain stored after 100 years, which is equivalent to 54 kg CO2-e per tonne of compost. Both of these quantities are relatively small compared with the methane potential of organic inputs. This means that the main benefit of compost would typically be avoidance of landfill emissions, but this benefit would be debatable where landfill gas recovery rates are high.

8 Environmental impacts of waste disposal

In Australia, legally disposed of waste is nearly all delivered to landfill. This section of the report discusses landfill types, numbers and capacity, and also their emissions and how they are managed.

8.1 Types of landfill

Australia's solid waste stream is divided into three primary sectors: municipal solid waste (MSW), commercial and industrial (C&I) waste, and construction and demolition (C&D) waste. Each of these produces a substantial waste stream, but on a state-wide basis C&D waste is usually the largest portion. MSW is dominated by kerbside collections, the bulk of which (by weight) is usually of biotic origin, especially food, paper and green waste. A trend towards increased organic content can be attributed to increased recovery of recyclables. C&I wastes typically comprise a mixture of office, retail and industrial wastes and often includes a high proportion of paper. C&D wastes generally comprise a mixture of dense, inert materials and a low organic content, but may include substantial quantities of timber.

Landfills are regulated by the various state environmental agencies and can generally be classified into three categories: hazardous, putrescible and inert. Around half of the total waste to landfill is sent to putrescible sites and nearly all of the rest goes to inert sites (Wright 2000). There are a few specialist hazardous waste sites, but most hazardous waste is sent to high-quality engineered putrescible sites. Waste sites and their inputs are categorised in Table 8-1.

Table 8-1 Landfill types and wastes received

Landfill type	Waste types received
Hazardous	Production waste, contaminated soil and similar
Putrescible	Organic-rich materials, mainly MSW and C&I
Inert	Low organic and not readily degradable material. Mainly C&D; also some C&I

Modern putrescible landfills are engineered structures, usually in large holes in the ground, with a liner, leachate collection system, and often a gas collection system. Waste is usually placed in contained cells and covered daily, typically with soil. When cells are completed they are covered, capped, rehabilitated and generally used for parkland or sports fields.

Inert sites are more variable. In Victoria the design standards are not much different from putrescible landfills but in NSW and some other states the design requirements are much more limited. In addition, the material types allowed in inert landfills vary between the states. NSW sites are able to accept paper and garden waste, both of which are prohibited from inert landfills in Victoria. Queensland also allows the disposal of paper to inert landfill sites. WA's Department of Conservation states that 'inert landfills are intended to accept only inert wastes' but until 2005 it provided a 5% allowance (by weight) for putrescible waste in inert landfill. This has now been scaled back to 0.5% and excludes green or food waste (WA DEC 2005).

Landfill sites in Australia are generally owned by local governments or waste management companies. Over time, the proportion of non-government owned landfills has increased, especially in urban areas. In addition, many council-owned sites are now managed by private operators on a contract basis.

8.2 Landfill inventory

Over the past two decades there has been a rationalisation of landfills and the closure of many smaller sites, driven mainly by stricter environmental standards. Recycling facilities and transfer stations have been established in their place.

The tables in Appendix 4 summarise the number and characteristics of landfills across Australia. It is derived from a Waste Management Association of Australia (WMAA) database, which was compiled from a 2006 survey and reporting in 2007. The WMAA database is the most comprehensive listing of landfills in Australia; containing information about 446 sites that (according to WMAA) receive more than 95% of Australia's waste stream. The landfill survey provides the best available data on landfills across Australia. However, the accuracy of these figures is unable to estimated given that the exact coverage of the survey in terms of number of landfills or amount of the total waste stream covered. A repeat of the landfill survey has recently been undertaken.

8.3 Landfill emissions and their management

Landfill emissions are of two main types: liquids (leachate) that may be discharged to groundwater or sometimes surface water, and landfill gas. Emissions result mainly from the decomposition of organic waste or contamination of stormwater. Decomposition of organics proceeds in a series of phases characterised by different chemical environments. These phases are occurring in a predictable sequence but their timeframe varies between and even within landfills. Consequently, the types, quantities and timeframes of landfill emissions are difficult to predict.

Construction of new landfills is highly regulated in most states. Government approval is needed, usually from a specialist environment agency, at each stage of the siting, design, operation and rehabilitation phases. There is typically an operational licensing arrangement including performance monitoring and reporting, and this may extend for up to 30 years post-closure. Due to amenity concerns, some states may require a liaison arrangement with local residents. A more recent trend is the imposition of financial assurances to mitigate the risk of a bankruptcy or failure to fulfil post-closure responsibilities. These requirements have driven up the standards for environmental management of landfill emissions as discussed below.

8.3.1 Landfill leachate and its management

Pollutants found in MSW landfill leachate fall into four categories:

- dissolved organic matter
- inorganic macro components: calcium, magnesium, sodium, potassium, ammonium, iron, manganese, chloride, sulphate and hydrogen carbonate

- heavy metals: cadmium, chromium, copper, lead, nickel and zinc
- xenobiotic organic compounds formed from household and industrial chemicals, such as aromatic hydrocarbons, phenols and pesticides

The potential contamination of groundwater supplies by leachate varies greatly from one site to another according to a number of factors (Kjeldsen *et al*, 2002) including:

- the height of the water table (leachate is partially filtered as it passes through soil layers)
- the permeability of the soil
- the waste profile
- the concentration of contaminants in leachate.

Usually, pollutant concentrations tend to attenuate as the leachate plume passes through clay in the soil. However, regulatory requirements generally do not permit discharges.

Modern landfills in all states are required to manage their leachate. There are a range of siting, design and management methods for this purpose:

- Siting standards in some states prohibit the development of landfills below the water table, preventing groundwater intrusion into the waste mass. WA banned the construction of new landfill sites on its coastal strip from 1990 due to the risk of groundwater contamination in areas where this resource is used for drinking water.
- Modern landfill design typically incorporates small cells that are rapidly filled and capped, limiting the stormwater contamination.
- To further control stormwater intrusion, waste is placed in a small area and regularly covered with soil.
- Putrescible landfill cells are generally lined with a layer of compressed clay and often a composite of clay combined with a geosynthetic or plastic layer. This limits leachate leaks and groundwater intrusion. Composite systems are standard practice in Victoria, NSW, WA and SA.
- A high permeability drainage layer is usually placed at the bottom of the cell from which a series of perforated collection pipes drain leachate to a low point. Leachate is usually restricted to a depth of 300 millimetres in order to reduce the head on the liner, preventing leaks. Leachate is pumped up from collection sumps for treatment.
- Landfills apply a range of leachate treatments. In drier environments such as WA it can be evaporated in shallow ponds and the residue returned to the landfill. Some treat the leachate in on-site facilities then spread the treated liquid on the site for dust control. Others discharge to sewer, often after pre-treatment. In some cases, leachate is recycled back through landfill, partly as a means of promoting decomposition and so reducing the period of post-closure aftercare.

Adoption of these landfill techniques has greatly limited groundwater pollution from landfills. There remains a legacy of older or smaller facilities that do not meet modern standards, and from which the pollution risks are higher. These will be phased out over time.

The Waste Management Association of Australia (WMAA) survey conducted in 2006 provided information on landfill lining within landfills across Australia (Table 8-2). Of the 446 sites that were surveyed, 185 had a liner in place and 259 did not. Although there were more landfills unlined than lined, the lined landfills received over 70% of the material by weight and it was reported that these landfills served over 3.8 times the population served by the unlined landfills.

Table 8-2 Landfills lined and unlined: Australia

	Lined	Unlined	Unspecified	Total
Number of sites	185	259	2	446
Tonnes received	14,666,475	5,710,768	22,000	20,399,243
Population served	2,424,289	3,197,406	25,000	15,646,695

The unlined landfills tended to receive less material and serve a smaller population than the lined landfills. 93% of the unlined landfills received 50,000 tonnes of material per year or less. 94% of the unlined landfills served a population of 50,000 or less. This suggests that the unlined landfills are likely to be in smaller regional centres and rural areas than lined landfills.

Table 8-3 Landfill liner status by size (tonnes received annually), Australia

Tonnes received annually	Lined	Unlined
<1000	12%	36%
1000-10,000	19%	40%
10,000-50,000	30%	17%
50,000-100,000	13%	3%
100,000-250,000	15%	4%
250,000-500,000	10%	1%
>500,000	1%	0%

Table 8-4 Landfill liner status by population served, Australia

Population served	Lined	Unlined
<1000	4%	29%
1000-10,000	22%	39%
10,000-50,000	36%	26%
50,000-100,000	12%	4%
100,000-250,000	13%	1%
250,000-500,000	5%	1%
500,000-1,000,000	6%	1%
>1,000,000	1%	0%

The number of sites that reported being lined or unlined in each state, are presented in Table 8-5. Tasmania and Victoria had the highest proportion of lined sites, with 73% and 72% of sites lined, respectively. This was followed by New South Wales (55%) and Queensland (47%).

Table 8-5 Landfill lining by number of sites, by state/territory

State/ territory	Lined	Unlined	Liner status unspecified	Total	Percentage lined (by number of sites)
VIC	42	16	0	58	72%
NSW	46	38	0	84	55%
QLD	47	53	0	100	47%
WA	21	101	0	122	17%
TAS	8	3	0	11	73%
SA	21	48	2	71	30%
NT				0	
ACT				0	
	185	259	2	446	

The reported number of tonnes received in lined and unlined landfills, by state, are presented in Table 8-6. Over 85% of the tonnes reported as entering landfills in Victoria, Queensland and South Australia were entering landfills that were lined.

Table 8-6 Landfill lining by tonnes received, by state/ territory

State/ territory	Tonnes into:			Total tonnes	Percentage lined
	Lined	Unlined	Liner status unspecified		(by number of sites)
VIC	4,314,363	707,900	0	5,022,263	86%
NSW	4,231,050	2,211,671	0	6,442,721	66%
QLD	3,531,976	498,142	0	4,030,118	88%
WA	1,237,256	1,966,060	0	3,203,316	39%
TAS	235,850	185,200	0	421,050	56%
SA	1,115,980	141,795	22,000	1,279,775	87%

8.3.2 Landfill gas and its management

Landfill gas production begins on a large scale during the methanogenic phase of degradation. It typically consists of approximately equal measures of carbon dioxide and methane, with trace quantities of various other gases including hydrogen sulphide and VOCs.

There are several reasons why landfills may need to manage their landfill gas:

- Accumulations of landfill gas can give rise to on-site and local risks of explosions or asphyxiation. Venting systems are usually sufficient to alleviate this risk.
- Landfill gas is associated with odours that can impact on neighbours and contribute to reduced air quality. Regulators have often required operators to install flares to manage this problem.
- The methane in landfill gas is a powerful greenhouse gas but can be destroyed by oxidation. Greenhouse policy responses have helped spread this practice by allowing operators to sell credits for reducing emissions. Credits have been sold in Australia and also to overseas purchasers.
- Landfill gas is rich in methane, and at larger sites can be profitably collected and used for generating electricity and heat. Again, greenhouse policy responses have helped to spread this practice by pushing up the price for renewable biogenically derived power.

The greenhouse implications of waste and landfills are an increasingly significant issue and are addressed separately in the previous chapter. A wide range of methods are available for managing the methane emissions from landfills.

- Diversion of organic materials from landfill. This is a favoured response policy. Green waste composting is well-established and some diversion of food waste is now occurring. Technologies that control odour risks and that deal with mixed waste streams are becoming available, including mechanical-biological treatments, anaerobic digestion and controlled environment composting.
- Maximising methane oxidation in the upper layers. As methane passes through landfill covers and caps microbial action can oxidise a proportion of the gas to CO_2. The proportion that is oxidised can be increased by reducing the timeframe for completion of cells and by encouraging emitted methane to pass through organically rich materials, such as compost-rich capping layers or biofilters. As government reporting requirements do not recognise this aspect of methane management, they provide no incentive for its adoption.
- Delaying anaerboic conditions. In recent years, some landfills in the US, Europe and Japan have trialled techniques to delay anaerobic decomposition in landfills by circulating air through pipes laid in the waste mass. This technique offers an opportunity to reduce overall methane generation. Again, government reporting requirements do not recognise this aspect of methane management and so provide no incentive for its adoption.
- Maximising methane recovery. Methane is generally recovered through vertical wells drilled into the waste body after completion of the cap. Strategies for enhancing gas collection include:
    - constructing small cells that are rapidly capped so that gas collection can start quickly
    - using low permeability caps with below-cap aggregate layers that encourage gas migration to collection points
    - establishing horizontal gas collection pipes within the waste mass to increase the recovery rate and allow recovery before the site is capped (e.g. Veolia's Woodlawn facility in NSW)
    - managing sites as bioreactors (see separate discussion below)

- establishing gas collection contracts that focus on maximising recovery rather than profitability.
- Maximising the use of the energy content of methane through prioritising cogeneration and green power rather than just flaring. In addition, landfill gas can be compressed and used as a transport fuel, or stripped of CO_2 and sent to the gas pipeline network.

As discussed in the previous chapter, the recovery of methane from landfills has increased rapidly and now represents more than a quarter of estimated methane generation. There remains capacity for much greater gas recapture. The WMAA National Landfill Divisions suggest that a 50% average capture rate for methane across all landfills could be achieved by 2014 (WMAA National Landfill Division 2008).

The WMAA landfill database, based on the survey conducted by WMAA in 2006, indicated that 48 sites of the 446 examined had facilities for landfill gas flaring and/or energy recovery (i.e. gas was captured and either burnt in a flare or used to produce energy). The great majority of landfill gas collected in Australia is used for energy recovery, which nearly always includes electricity generation and may also provide for capture of heat. Sites equipped only with flares usually generate insufficient gas for energy recovery to be viable.

The 48 sites reported that they received about 9.25 million tonnes during the previous year, or 45% of total tonnes reported as received by the 446 sites that responded to the survey.

Some inconsistencies are apparent in the WMAA database in relation to these and other response categories related to energy recovery. However, the data is supported by two studies undertaken by Hyder Consulting for the Department of Climate Change (DCC). The first, a survey of methane recovery from landfills undertaken in late 2007, identified some 46 sites (including about 15 that no longer accept waste) as recovering energy from landfill gas and at least 18 (including at least one closed site) that flared but do not recovery energy. This total of about 64 sites comprising about 48 open and 16 closed is consistent with the WMAA database. The second, undertaken in 2008, involved surveying major sites with gas recovery about the quantity of waste they received. Total receipts were around 8.8 million tonnes of waste, which is also consistent with the WMAA figures.

8.3.3 Dry tomb vs bioreactor

Debate currently exists around the best method for managing MSW landfills. Traditionally, the ‘dry tomb’ strategy has been popular, in which waste is buried in an isolated and enclosed cell. The theory behind this strategy is that as long as wastes are kept dry, gas and leachate production will be minimised. The approach has been criticised since it relies on indefinite maintenance of the integrity of the liner system. It is proposed that this simply places the pollution risks and management responsibilities on to future generations.

Growing in popularity is the ‘biocell’ or ‘bioreactor’ strategy in which moisture is cycled through the waste mass. This is designed to enhance fermentation and flush leachable chemicals, and so decrease the time taken to achieve stabilisation. The optimum

moisture content for this process is 40%. Leachate is often used as the source of moisture for this process, but may need to be supplemented by additional moisture.

Bioreactor management can reduce the intergenerational liability of the landfill, and by concentrating the methane generation period can enhance the viability of methane recovery. However, bioreactors are considered a not fully proven technology and one that may pose groundwater pollution risks.

8.4 Future landfill capacity

There is a trend towards fewer, larger and better managed landfills. Stricter regulations regarding the design and management of landfill sites has meant greater financial commitment on the part of landfill operators, favouring landfill operation by larger waste management companies with a greater long-term capacity. Landfills in Western Australia epitomise this trend, with many councils intending to regionalise their facilities and rely on a greater number of transfer stations (DEC WA 2007).

In January 2001, Sydney had a putrescibles waste capacity of 20.8 million tonnes (Mt), with input to be restricted to 1.2 Mt/yr (Wright 2000). However, Sydney is limited in terms of future potential landfill sites and government policy is focusing on waste reduction and diversion strategies (Wright 2000).

Victoria generally has sufficient landfill space but there are some areas of localised shortages. Melbourne has an estimated airspace of around 120Mt at existing sites. Capacity is shifting towards the west and north-west of the metropolitan area, which has about ten times the capacity of the south and east. A number of landfill closures in the north and south-east has reduced disposal rates in these areas by about 25%, increasing disposal in the west. The draft schedule set out in the Metropolitan Waste and Resource Recovery Strategic Plan, provides for the closure of over a third of landfills in metropolitan Melbourne by 2017. Current sites will provide adequate capacity over this period, although another solid inert landfill may be required (Victorian Government 2008).

In Western Australia, the majority of landfills reported a life expectancy of less than 10 years from 2007. Exceptions to this figure were generally rural councils, where land is abundant and waste generation minimal (DEC WA 2007).

Adelaide is currently served by six landfill sites licensed to receive metropolitan waste streams. At current disposal rates, these landfills are expected to meet Adelaide's disposal requirements for several decades (ZWSA 2005b).

9 Barriers to resource recovery

There are numerous political, economic, social, technological, environmental, legal and institutional barriers to the improvement of resource recovery in Australia. Several key barriers are discussed below.

A number of aspects should be borne in mind when considering the discussion below. First, it is presumed here that increased resource recovery levels are desirable due to the environmental and social benefits that they deliver. Secondly, it is presumed that the optimal point of resource recovery in Australia has not yet been reached. Thirdly, the reality is that different barriers apply in different measure to different materials and products; the discussion here is necessarily of a generalist nature.

9.1 Resource Pricing

Pricing structures and signals strongly affect resource recovery in Australia.

As a result, resource recovery levels tend to be higher and more sustainable for materials and products where:

- The price of the recyclate material compares favourably to the price of the competing non-recyclate (or virgin) material;
- As a result of the above factor, there is a clear profit to be made from the sale of the recyclate material following the cost of the material's collection and reprocessing; and/or
- There is a strong market demand for the recyclate material.

Key materials that the above points relate to are ferrous and non-ferrous metals, cardboard and newspaper.

Conversely, resource recovery levels tend to be lower and less sustainable for materials and products where:

- The price of the recyclate material does not compare favourably to the price of the competing non-recyclate (or virgin) material;
- There is limited market demand for the recyclate material;
- As a result of the above factors, the price paid for the recyclate material does not necessarily meet the cost of the material's collection and reprocessing; and
- Forms of subsidisation are necessary to fund the gap between the price of the recyclate material's sale and the cost of the material's collection and reprocessing.

Plastics are notable in the above regards, as are computers, televisions, white goods, batteries, tyres, and some other materials and products.

The recovery and utilisation of printing and writing paper in Australia is a clear example of how comparative pricing influences recovery. Most of this grade of paper is recycled into packaging in Australia rather than higher grades (such as tissue or back into printing and writing paper) because the costs of collection and sorting are much less when mixed grades are collected. This is despite the high environmental credits that would be delivered if bleached virgin pulp was displaced by the recycled substitute pulp.

Mixed paper is collected either from kerbside or commercial sources. This grade has less predictable performance characteristics than sorted office papers and therefore attract a lower market price. For higher grade recovery of printing and writing papers, the cost of the required collection, contaminant screening and de-inking of the recycled fibres, means that virgin pulp is cost competitive at US $ 400 per tonne. The market for recyclable paper materials is generally linked to the USA commodity price and has always fluctuated dramatically for spot market traders, ranging from an upper level of US $400 per tonne waste down to $5 per tonne for post-consumer mixed papers.

There are several reasons why the price of a recyclate material may not compare favourably to the price of a competing non-recyclate (or virgin) material. These include:

- **Technical efficiency**. Virgin resource extraction and refining activities have economies of scale beyond those possible in the collection and reprocessing of secondary materials. Often, there is a level of technological and engineering complexity that adds to cost. Equally, because the overall market for the recyclate material tends to be emerging and smaller, there can be less than optimal investment and innovation in technological and engineering processes.

  This is the case for most commodity materials. For some materials, such as aluminium and steel, the sorting and collection stages reduce the cost competitiveness of the material notably. For other materials there are added complications in the reprocessing stages – plastics are an example here, particularly PET bottles when recycled back into PET bottles due to contamination issues.

- **Quality**. The quality of the non-recyclate (or virgin) material may be superior to that of the recyclate material or better conforms to manufacturers' specifications and requirements.

  This is typically the case where structural performance (building materials such as concrete) or food grade quality is required (plastics in food packaging).

Subsidies. The production and supply of the non-recyclate (or virgin) material benefit from some form of direct or indirect public subsidisation. In 1996, it was estimated that the cost of direct financial subsidies to natural resources in Australia in 1994 to be $5.7 billion per year (Department of Environment Sport and Territories 1996). Direct subsidies include low access fees, tax treatment and public agency costs subsidisation.

The aluminium industry is noted for the level of subsidy that its electricity supply receives. While the precise benefit is reported as commercial-in-confidence, the Australia Institute have modelled and reported on government subsidies to the sector. Such subsidies are typically not available to the fragmented industries operating in the waste collection and reprocessing fields.

The removal of direct subsidies, it is argued, will bring improvements in the financial efficiency of the economy whilst achieving greater welfare benefits. It is reported that the inappropriate appraisal of financial values distorts markets and suppresses economic growth (Department of Environment Sport and Territories undated). The 1998 OECD report, entitled *Improving the Environment through Reducing Subsidies*, concluded that many subsidies damage the environment by encouraging over-production and the wasteful use of inputs.

9.2 Disposal pricing

As a whole, society chooses what to do with its post-consumer material. A key influencer in this decision is the relative cost of two main options:

- Disposal to landfill
- Various methods of resource recovery through collection, reprocessing, and recycling.

On the whole, the financial unit cost for disposal of waste to landfill is cheaper in Australia than the financial unit cost for resource recovery of most materials. This is fundamentally because current landfill charges do not include the full social costs of use, including full allowance for loss of environmental amenity for host communities, insurance against future environmental contingencies, and remediation of sites.

Nevertheless, this barrier is lessening as landfill costs have risen considerably in recent years. In the Sydney metropolitan area, for example, the costs to dispose one tonne of domestic waste to landfill was $18 in 1990. The equivalent 2003–2004 cost was $77 (exclusive of GST). This is due to several reasons. One is the partial internalisation of some social and environmental externalities, such as stricter environmental regulations, increasing financial allocation for rehabilitation, and ongoing post-closure environmental management of landfill sites. In some jurisdictions, there is also the related use of landfill levies. Another reason is increasingly limited supply of suitable disposal locations close to major metropolitan cities due to competing land uses. However, these factors vary significantly between population centres; some jurisdictions, for instance, continue to have no landfill levy.

In relation to landfill disposal levies, these are determined and administered by state and territory environmental agencies with some yet to introduce a levy (i.e. Queensland, Northern Territory and the ACT). Current landfill levy prices are detailed in Table 9-1.

Table 9-1 Current landfill levy amounts (EPA Qld 2007)

State/ territory	Current levy amount	
NSW	Sydney Metropolitan Area $30.40	Extended Regulated Area $23.10
Victoria	Metro $9.00 (MSW) $15.00 (Industrial)	Rural $7.00 (MSW) $13.00 (Industrial)
South Australia	Metro $11.20	Non-metro $5.60
Western Australia	$6.00 putrescible (Metro Perth only)	$3.00 inert
ACT[1]	Non-commercial levy: Small $8.00 Medium $16.00	Large $24.00 >0.5 tonnes $62
Tasmania[2]	$0.00	
NT	$0.00	
Queensland[3]	$0.00	

[1]ACT charge commercial operators a charge but no levy <0.25 tonnes $22.0/t >0.25 tonnes $88.00/t
[2]Tasmania has no state-wide levy
[3]Queensland does not charge a levy

Additionally, there is the issue of the point in the production / consumption / disposal chain at which the cost of disposal and/or resource recovery is allocated. For the most part, waste management costs are increments to rates rather than user charges related to either consumption behaviours or resource recovery behaviours. On the one hand, waste and/or resource recovery costs are not incorporated or internalised into product prices where this may be effective and efficient. On the other hand, there is generally no differentiation between waste disposal costs and resource recovery costs in most rates notices and, therefore, no signal to the consumer to incentivise resource recovery.

In sum, the comparatively lower cost of landfill disposal, and the lack of transparency in waste management and resource recovery price signals, are barriers to improved resource recovery.

9.3 Community awareness

Australians' attitudes toward waste issues are complex and constitute a barrier to improved resource recovery.

On the one hand, research paints an overall picture of people "wanting something done about waste and wanting the opportunity to do something about waste". The majority of Australians are concerned about the environment, and rank waste and/or garbage disposal in the top five or six issues of environmental concern after climate change, air pollution, freshwater pollution, ocean/sea pollution, and destruction of habitats. A survey for Sustainability Victoria found that 98 per cent of respondents agreed that "the way we collect and dispose of waste in Victoria is an important environmental issue".

In fact, the behaviours that are most commonly performed to help the environment are related to waste minimisation. The majority of Australian households recycle (98%) and reuse waste (87%) (ABS 2006). Over the last decade, kerbside recycling is consistently cited as the behaviour that is most commonly performed to help the environment.

On the other hand, it would appear to be the case that the community's concern about waste translates into only a limited range of resource recovery behaviours and practices, e.g. largely kerbside recycling and, more recently, shopping bag reuse.

These embraced behaviours tend to:

- be affordable
- be easily accessible
- be linked easily to environmental benefit.

For example, kerbside recycling is seen by the community as a tangible and accessible way of easily making a difference.

Resource recovery and waste minimisation behaviours where the convenience is lower, benefits are less tangible and/or the participation costs are higher, are less well supported. This includes:

- participation in home composting
- participation in the resource recovery of items requiring "take-back" activity, such as mobile phones, tyres, batteries, and electronic goods.

Generally, and while the studies in this area are by no means robust, there appears to be a reasonably low willingness to pay for resource recovery.

It should also be noted that kerbside recycling of packaging and paper has been strongly supported by awareness raising and educational activity for approaching 20 years in Australia. Recent efforts to promote reuseable bags for shopping have also been extensive. On the other hand, efforts to make the community aware of the waste impacts of non-packaging and non-paper items and to communicate alternative resource recovery opportunities to them have been much less developed or non-existent.

At the broader level, while environmental concern in the community remains high, it has declined steadily over the last decade, from 75% in 1992 to 57% in 2004 (ABS 2007). This appears related to the main drivers for environmental concern to be falling away: immediacy of the environmental problem; perception of whether there is a solution at hand, and; competing concern about other issues.

This is also reflected in the current state of concern about waste in Australia. For example, most waste-related impacts are "out of sight and out of mind". Personal

exposure to landfills is not a common experience for many urban Australians. At the same time, easy access to kerbside recycling of packaging and paper creates a perception that the waste problem is being managed. Finally, the number of issues and media messages competing for public attention has never been greater and the "war on waste" pales in comparison to real wars and also to other environmental issues.

In sum, improvement in resource recovery is confronted by the following community-related barrier:

- A lower level of awareness about and motivation to act on non-packaging and non-paper waste items
- A lower level of willingness to participate in resource recovery efforts that are not cheap, convenient, and featuring tangible benefits.

9.4 Infrastructure availability

The lack of appropriate infrastructure is another barrier to improved resource recovery in Australia. Significant infrastructure expansion would be necessary to:

- Substantially increase resource recovery levels from current household organic waste
- Substantially increase resource recovery levels from current household residual waste (through alternative waste treatment)
- Substantially increase resource recovery levels from current household bulky items waste, such as tyres, computers, furniture, white goods, etc.
- Increase the resource recovery levels from all non-domestic settings (e.g. the commercial and industrial sector), starting with common materials such as packaging, paper and organics.

Infrastructure requirements range from collection and transport systems, transfer and bulk up stations, sorting facilities, reprocessing facilities, and remanufacturing facilities.

There is a lack of necessary infrastructure for at least the following reasons:

- Lack of public support for resource recovery infrastructure
- The resource recovery industry's lack of certainty about planning policy
- The resource recovery industry's lack of surety of supply
- The resource recovery industry's unwillingness to bear total risk.

In the first respect, resource recovery is necessarily burdened with the stigmas associated with historic waste management. This is very difficult to overcome in terms of achieving public acceptability for resource recovery facilities in any proximity to residential areas. This is somewhat ironic given the community's genuine overall desire to address waste issues.

In the second respect, experience[7] has shown that it is often very difficult to get development approval for resource recovery infrastructure even if:

- there is limited to no community opposition
- it provides a state-of-the-art, necessary solution
- existing zoning is appropriate.

While in NSW recent planning reform appears to have brought some unity and improvement into approval processes (Stone 2005), the industry remains concerned on a national basis about possible split responsibilities regarding zoning, planning, works approvals and siting between a multitude of agencies and spheres of government.

In the third respect, as with any industry, the resource recovery industry will generally only make capital investments and provide infrastructure where there is security of supply of material and sufficient volumes of material. Where the organisation of resource recovery of some materials is via local government, there exists an effective mechanism for achieving surety of supply. Namely, industry can contract with a clear and reasonably limited number of parties for an estimable amount of supply of recyclable materials.

Materials that require such supply security include paper, and in some cases, garden organics. In terms of many of the materials that require improvement in resource recovery (such as virtually all those produced in the commercial and industrial sector), there is currently no clear path to achieving such surety of supply. Namely, there are literally hundreds of thousands of businesses involved, few of whom have significant drivers to improve their own resource recovery performance.

In the fourth respect, state and territory governments – with the exception to date of Victoria - have not significantly supported resource recovery infrastructure development by the private sector in Australia. For its part, and considering the previously discussed factors, industry is in turn hesitant to bear 100% risk for what it argues is in part the delivery of environmental outcomes dictated by public policy, or a social service / public utility.

9.5 Policy instruments

Waste management policy is a potentially powerful tool to drive resource efficiency throughout the entire economy. Policy instruments can not only minimise the impact of waste but also operate to retain materials within the economy by recycling and remanufacture. In this way, waste policy can not only reduce the losses of primary extractive raw materials but provide macroeconomic gain by reducing the loss of value previously added to materials by prior production processes.

Policy instruments include:

[7] Rethmann aborted plans to establish a much needed resource recovery facility despite initial consent of the Land and Environment Court due to persistent resistance by Botany Council.

- ***Landfill levies*** – these can be set to reflect externalities or to drive a level of behaviour by ensuring that disposal as a management option is less cost competitive against resource recovery practices.

  Differential pricing based on the environmental performance of alternative management options is an effective option to encourage best practice. Where an environmental benefit is achieved (e.g. recycling), a credit or subsidy rather than levy could be provided. The justification of such a scheme rests squarely on the environmental cost benefit and as such is consistent with National Competition Policy.

- ***National resource recovery targets*** and objectives for products and materials.

  National targets for packaging materials have historically enabled the effectiveness of packaging recovery schemes to be measured and reported against.

- ***Producer Responsibility*** - this may include shared responsibility programs such as the National Packaging Covenant or producer responsibility programs requiring nominated levels of industry responsibility. Extended Producer Responsibility has been legislated for in some states.

  There are a few examples of producer responsibility programs in Australia. These include the beverage industry, recycled oil, electronics and batteries. Initiatives taken range from manufacturer redesign considerations (electronics and beverage) to collection schemes (oil) and levy schemes (tyres). Success is often dependent on the degree of government involvement or threat of more mandatory measures.

- ***Purchasing Policies*** - this includes offering incentives for recycled content products (RCPs) or environmentally preferable products by the public or private sectors, or the general community.

- ***Labour support schemes.*** Resource recovery activities are typically more labour intensive than production processes based on virgin resources. Activities might require dismantling of component parts, skilful repair and restoration or sorting into precise grades. Schemes which assist the supply of labour to these sectors could ensure that the recovered product was more cost competitive with the non-recovered alternative.

  The life of computer hardware, for example, could be extended by labour support to assist small boutique industries working in hardware repair and recovery. While some firms operate profitably by repairing computers that are 3 – 5 years old, beyond this, extending the life of obsolete computers requires that they are disseminated either free of charge or for a nominal charge. After 3 - 5 years, hardware units are typically obsolete in commerce. A computer may be re-used once in a cost effective way but after that time, recovery is largely a not-for-profit exercise with dissemination to sectors of the community such as pensioners and the unemployed.

- ***Support for resource recovery infrastructure investment.***

While there are waste strategies and their targets in place in various states, the situation remains that:

- some waste streams have different targets in different constituencies
- some waste streams have no targets.

As a result, there is a lack of focus on the part of all players in respective waste/resource chains on what needs to be achieved and by whom. There has been no national overall waste or resource recovery target since the early 1990's.

With the exception of the businesses who are now subject to and/or participants in negotiations with jurisdictions about their "extended producer responsibilities" and those businesses that are signatories of the National Packaging Covenant, there is virtually no reason for businesses to improve their resource recovery performance. The "pro-active" drivers associated with cost reduction opportunities or brand reputation are limited. The "reactive" drivers associated with compliance with public policy are virtually non-existent. In fact, the vast majority of governmental activity has been aimed at facilitation and encouragement rather than compulsion or regulation. This may well be a strategic error given the limited commercial benefits of voluntary resource recovery activity for many businesses. By way of contrast, businesses throughout the country are subjected to specific regimes and expectations in terms of other environmental impacts, such as energy usage, water usage, and pollution.

There is limited effort to stimulate resource recovery through policy instruments that influence recyclate demand and, thereby, create greater pull in the resource recovery system. On the one hand, and in contrast to overseas jurisdictions, there are no targets, financial incentives, or mandatory requirements in terms of recycled content purchasing for public sector agencies. Public sector efforts are limited to internal facilitation, information, and reporting. There is virtually no policy effort and/or public sector contribution to encouraging companies and consumers to purchase recycled content products.

9.6 Data gaps

The following issues and data gaps have been identified:

- There is a lack of consistency between the material inclusions and definitions used for disposal and recycling in reports produced by different states/territories. For example, solid waste generated from council activities is not always specified as included with municipal or C&I waste stream; green or garden organics is sometimes reported as a separate stream with the source sector not reported. Similarly, inconsistencies exist in the classification of cover material and soil. It was not possible to identify whether this material was included in waste generation and disposal tonnages for all states/territories. In NSW, daily and intermediate cover material is included in the data, whereas the Victorian data excludes cover material applied to landfills in their waste disposal data. Tasmania does not classify soil as a waste material and thus do not include it in their reported waste disposal data.
- All states/territories except Tasmania and Northern Territory generate waste to landfill and recycling activity data on an annual basis, although there is a long lag-time in publication of the data in some states
- Western Australia, Tasmania and Northern Territory have no system in place to collect data on waste disposal for all waste streams on a state/territory level and

Tasmania and Northern Territory have no quantification of recycling beyond kerbside systems.

- Australian Capital Territory has no sector breakdown for recycling activity.
- Australian resource consumption data is available only for a small number of materials (e.g. plastics, paper).
- Consumption data by product is also not widely collected and published. For some products data is calculated but not published while others have no data collection at all.
- For most material and products, data on imports is not compiled.
- In relation to packaging there is no active calculation of imported packaging related to imported goods.
- There are inconsistencies in how the interstate transfer of recyclables is recorded with some double counting as a result.
- The suite of materials recorded as 'recycled' varies by state with inconsistency mainly in relation to agricultural and industrial products (slags, ash, sands, animal by-products and timber residues).
- Recycling services to non-residential sites is not fully recorded by local government.
- There is little data gathering in relation to life expectancy and tonnes of product currently 'in use' across society.
- For durable goods there is minimal information on the delay between sales and disposal.
- Internationally there is no consistent format/ method for generating waste and recycling data, making comparisons and benchmarking much harder.

10 References

ABS (Australian Bureau of Statistics) (2002) Measuring Australia's Progress – Consumption

ABS (Australian Bureau of Statistics) (2006) Environmental issues: People's views and practices, March 2006, 4602.0.

ABS (Australian Bureau of Statistics) (2007) 2007 Year Book Australia.

ABS (Australian Bureau of Statistics) (2008) 3101.0 Australian Demographic Statistics TABLE 4. Estimated Resident Population, States and Territories (Number), www.abs.gov.au

Ackerman F (1997) Why Do We Recycle: Markets, Values, and Public Policy. Island, Washington, DC

ACOR (Australian Council of Recyclers) (2008) Australian Recycling Values – A Net Benefits Assessment. Prepared by Hyder Consulting, Sydney, January. http://www.acor.org.au/whatsnew.html.

ACT Government (1996) No Waste by 2010 – A Waste Management Strategy for Canberra

ACT Government (2002) Waste Pricing Strategy for the ACT

ACT Government (2004) No Waste by 2010 – Turning waste into resources Action Plan 2004-2007

ACT NoWaste (2000) The Next Step in the No Waste Strategy

ACT NoWaste (2005) Guide to Recycling for ACT Businesses – Recycling, It's your Business

ACT NoWaste (2008a) How much is being reused and recycled? http://www.tams.act.gov.au/__data/assets/pdf_file/0005/118436/2007-08_How_much_reuse_and_recycling_ACT.pdf

ACT NoWaste (2008b) Pers comm. Michael McGee, 4/8/08

ACT NoWaste (undated) Leaders in NOWaste Case Study Majura Primary School Spring Fair

APC (2007) Domestic Waste Audit for Thiess Services and ACT NoWaste November 2007

Australian Greenhouse Office (2007) National Greenhouse Gas Inventory 2005.

Australian Government (2009) National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2009 (No. 1) National Greenhouse and Energy Reporting Act 2007

Australian National Retailers Association (2006) Plastic Carry Bags: Working Towards Continuous Environmental Improvements

Blue Environment (2007) Draft Waste Management Strategy for Tasmania Background Report, Prepared for the Department of Tourism, Arts and the Environment

Cardno BSD (2008) Review of total recycling activity in Western Australia 2006/07, Prepared for the Department of Environment and Conservation

Compost Australia (2006) Compost Supply Chain Roadmap, available from www.compostaustralia.com.au

Darwin City Council (2008a) Managing rubbish, www.darwin.nt.gov.au

Darwin City Council (2008b) National Environment Protection (Used Packaging) Measure data, Annual Report by Local Government Authorities (Darwin City Council) for the reporting period 01/07/06 - 30/06/07

Darwin City Council (2009) Pers. Comm. Shelley Inglis, 17/08/09

DCC (Department of Climate Change) (2008a) National Greenhouse and Energy Reporting (Measurement) Determination 2008. available from www.greenhouse.gov.au/reporting/

DCC (Department of Climate Change) (2008b) National Greenhouse Gas Inventory 2006, available from www.greenhouse.gov.au/inventory/2006/index.html

DEC WA (Department of Environment and Conservation Western Australia) (2004) Statement of strategic direction for waste management in Western Australia

Department for Environment, Food and Rural Affairs (2007) Municipal Waste Management, available from www.defra.gov.uk/environment/

DEC WA (Department of Environment and Conservation Western Australia) (2007) Zero Waste Plan Development Scheme, phase 1 report 2006/07

DEC WA (Department of Environment and Conservation Western Australia) (2005) Review of waste classification and waste definitions 1996, Available from http://portal.environment.wa.gov.au/portal/page

Department of Environment and Resource Management (DERM) Queensland (2009) Pers. Comm. Faiz Kahn, 18/08/09

Department of Environment Sport and Territories (1996) Environmental Economics Research Paper No 2 Subsidies to the use of Natural Resources.

Department of Primary Industries, Parks, Water and Environment (Tasmania), pers comm. Jaimie Clarke, 13/08/09

DEWHA (Department of the Environment, Water, Heritage and the Arts) (2008) Consultation Regulatory Impact Statement for End-of-Life Tyres Management

DEWHA (Department of the Environment, Water, Heritage and the Arts) (2008, unpublished) Draft Assessment of Fluorescent lamp waste and the EPHC waste filter criteria

Diaz R and Warith M (2006) Life-cycle assessment of municipal solid wastes: development of the WASTED model. Waste Management 26(8) pp.886-901.

EPA New South Wales (1996) Environmental Guidelines: solid waste landfills.

EPA Queensland (2007) Let's Not Waste Our Future Queensland Waste Strategy Discussion Paper for Public Comment

EPA Queensland (2008) The State of Waste and Recycling in Queensland 2007

EPA Victoria (2001) Best Practice Environmental Management: siting, design, operation and rehabilitation of landfills.

Eriksson O, Carlsson Reich M, Frostell B, Björklund A, Assefa G, Sundqvist JO, Granath J, Baky A and Thyselius L (2005) Municipal solid waste management from a systems perspective. Journal of Cleaner Production 13 pp.241-252.

Eurostat (2006) Environmental Data Centre on Waste, 2006, http://epp.eurostat.ec.europa.eu/portal/page?_pageid=3155,70491033,3155_70521316&_dad=portal&_schema=PORTAL.

Forster P, Ramaswamy V, Artaxo P, Berntsen T, Betts R, Fahey DW, Haywood J, Lean J, Lowe DC, Myhre G, Nganga J, Prinn R, Raga G, Schulz M and Van Dorland R (2007) Changes in Atmospheric Constituents and in Radiative Forcing. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch02.pdf.

Grant T, James KL and Partl H (2003) Life Cycle Assessment of Waste and Resource Recovery

Hansen J and Sato M (2007) Global Warming: East-West Connections. NASA Goddard Institute for Space Studies and Columbia University Earth Institute, http://www.columbia.edu/~jeh1/East-West_070925.pdf.

Hyder Consulting (2006) Waste and Recycling in Australia. Prepared for the Department of the Environment, Water, Heritage and the Arts (then Department of Environment and Heritage)

Hyder Consulting (2007) Review of Solid Waste Levy. Prepared for Zero Waste SA

IPCC (Intergovernmental Panel on Climate Change) (2006) 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste.

IPSOS (2005) Household Electrical and Electronic Waste Survey 2005

Kjeldsen, Peter, Morton Barlaz, Alix Rooker, Anders Baun, Anna Ledin, and Thomas Christensen (2002) Present and long-term composition of MSW landfill leachate: a review, Critical reviews in Science and Technology 32: 397-336.

NEPC (2007) National Environment Protection Council annual report 2006-2007, NEPC Report on the implementation of the Used Packaging Materials NEPM

Nolan ITU, Exelplas Australia and Centre for Design at RMIT (2003) The impacts of degradable plastics in Australia, September 2003

Nolan-ITU (2002) Independent Assessment of Kerbside Recycling in Australia

Nolan-ITU (2003) Life Cycle Assessment of Waste and Resource Recovery Options (including Energy from Waste) Prepared by the Centre for Design at RMIT and Nolan-ITU for EcoRecycle Victoria, Melbourne.

NPCC (National Packaging Covenant Council) (2007) The National Packaging Covenant 2005-2006 Annual Report

NSW DEC (Department of Environment and Conservation) (2003) Disposal-based Commercial and Industrial Waste Characterisation Survey, Sydney Metropolitan Area, May-July 2003

NSW DECC (Department of Environment and Climate Change) (2007a) Waste Avoidance and Resource Recovery Strategy 2007

NSW DECC (Department of Environment and Climate Change) (2007b) Report into the Construction and Demolition Waste Stream – 2000-2005 Sydney Metropolitan Area

NSW DECC (Department of Environment and Climate Change) (2007c) Waste Avoidance and Resource Recovery Strategy 2007 Overview Report

NSW DECC (Department of Environment and Climate Change) (2008) Waste Avoidance and Resource Recovery Progress Report

NSW Government (2006) State Plan, A new direction for NSW

NT Government (2007) Disposal Behaviour & Resource Efficiency Interim Action

Office for National Statistics (2007) Population estimates, www.statistics.gov.uk/CCI/nugget.asp?ID=6 Accessed 15/7/08

Population Division, U.S. Census Bureau (2007) Annual Estimates of the Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2007 (NST-EST2007-01)

Recycled Organics Unit (2001) Greenhouse Gas Emissions from Composting Facilities. Prepared for the Central Coast Waste Board of NSW by ROU at the University of New South Wales.

Recycled Organics Unit (2007). Organics Recycling in Australia: Industry Statistics 2007. Report prepared for Compost Australia by the Recycled Organics Unit. Internet publication www.compostaustralia.com.au

SA EPA (1996) 'Integrated waste strategy for metropolitan Adelaide 1996-2015'

SA EPA (2003) State of the Environment Report for South Australia

Smith A, Brown K, Ogilvie S, Rushton K and Bates J (2001) Waste management options and climate change. Prepared for the European Commission, D

Southern Waste Strategy Authority (2005) 'Five Year Strategy 2006-2011'

Standards Australia (2006) AS4376-2006 Biodegradable plastics – Biodegradable plastics suitable for composting and other microbial treatment, November 2006

State Government of Victoria (2005) Towards Zero Waste Strategy

State Government of Victoria (2008) Draft Metropolitan Waste and Resource Recovery Strategic Plan, available from www.sustainability.vic.gov.au

Statistics Canada (2005) Human Activity and the Environment, Annual Statistics 2005.

Statistics Canada (2008) Population and dwelling counts, for Canada, provinces and territories, 2006 and 2001 censuses - 100% data, www.statcan.ca

Statistics Canada (2008) Waste Management Industry Survey: Business and Government Sectors 2006, www.statcan.ca

Statistisches Bundesamt (2006) Germany's population by 2050. Results of the 11th coordinated population projection. www.destatis.de

Statistisches Bundesamt 2005, Waste disposal channels of disposal, www.destatis.de

Stone, Y. (2005) Presentation to the NSW Waste Conference 2005.

Sustainability Victoria (2002) Solid Industrial Waste Plan Data Report, Prepared by Nolan-ITU for EcoRecycle Victoria

Sustainability Victoria (2007) Towards Zero Waste Strategy Progress Report 2005/06

Sustainability Victoria (2008) Victorian Recycling Industries Annual Survey 2006/07.

United States Environment Protection Agency (2007) Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2006

Victorian Government (2008) Draft Metropolitan Waste and Resource Recovery Strategic Plan:.Executive Summary

Waste Audit and Consultancy Services (2007a) 'Disposal Based Audits for the C&I and C&D Waste Streams for the Department of Environment and Conservation'

Waste Audit and Consultancy Services (2007b) 'Disposal based survey, Zero Waste South Australia, October/November 2007'

WMAA (Waste Management Association of Australia) (2008) Construction and Demolition Sector Resource Recovery Industry Survey for the Financial Year Ending 30 June 2007; published August 2008

WMAA (Waste Management Association of Australia) National Landfill Division (Waste Management Association of Australia National Landfill Division) (2008) Discussion Paper: Carbon Trading and the Waste Management Industry

WMB, (Waste Management Board) (2003) Summary Report of Waste to Landfill, Perth Metropolitan Region.

Woolworths Ltd (2007) Doing the right thing, Sustainability Strategy 2007–2015. www.woolworths.com.au

ZWSA (Zero Waste South Australia) (2005a) Waste Strategy 2005-2010

ZWSA (Zero Waste South Australia) (2005b) Background paper to South Australia's waste strategy 2005-2010.

ZWSA (Zero Waste South Australia) (2008) 'Recycling Activity in South Australia 2006/07', prepared by Hyder Consulting

Other internet reference homepages:

www.environment.nsw.gov.au/

www.environment.tas.gov.au/

www.epa.sa.gov.au

www.epa.vic.gov.au

www.kab.org.au/

www.mwmg.vic.gov.au

www.nt.gov.au/nreta/

www.regionalwasteforum.com/

www.sustainability.vic.gov.au

www.tams.act.gov.au/live/Recycling_and_Waste/

www.tams.act.gov.au/live/Recycling_and_Waste/

www.wow.sa.gov.au/

www.zerowaste.com.au

www.zerowaste.sa.gov.au

Appendix 1

Material based summaries for disposal and recycling from the municipal, C&I and C&D waste streams across Australia.

Material disposed and recycled from the municipal, C&I and C&D waste streams, estimated, NSW 2006/07

Material	Municipal			C&I			C&D			Total		
	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate
	Tonnes ('000)	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*
Paper & Cardboard	206	407	66%	524	Unknown		41	Unknown		771	1,072	
Plastic	195	32	14%	448	34	7%	38	2	4%	680	68	9%
Glass	118	172	59%	46	Unknown		4	Unknown		168	Unknown	
Ferrous	79	51	39%	59	Unknown		64	Unknown		202	Unknown	
Garden organics	360	131	27%	100	390	80%	72	29	29%	531	551	51%
Food	819	Unknown		580	49	8%	<1	Unknown		1,399	49	3%
Other organics	69	109	61%	<1	22	100%	<1	Unknown		69	131	66%
Timber	25	Unknown		480	319	40%	268	71	21%	772	391	34%
Soil and rubble		Unknown		297	Unknown		509	394	44%		Unknown	
Concrete, asphalt, brick and sand	92	Unknown		<1	Unknown		641	2,827	82%	1,539	Unknown	
Other Recyclables	<1	2		<1	Unknown		8	Unknown		8	21	74%
Other Waste	445	Unknown		387	Unknown		392	463	54%	1,224	Unknown	
Total	**2,408**	**1,483**	**38%**	**2,921**	**2,297**	**44%**	**2,036**	**4,216**	**67%**	**7,365**	**7,995**	**52%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Estimated breakdown of disposal to landfill for each sector is based on available landfill audit data (see Section 2.2.2 for more detail).
The breakdown of total recycling by materials in each sector and in total is incomplete. Data has been included where available. Estimated breakdown of recycling for each sector is based on available data published by NSW DECC and other organisations (see Section 2.2.2 for more detail).
Total disposal and recycling by sector was reported in NSW DECC (2008) Waste Avoidance and Resource Recovery Progress Report.

Material disposed and recycled from the municipal, C&I and C&D waste streams, estimated, Victoria 2006/07

Material	Municipal			C&I			C&D			Total		
	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate
	Tonnes ('000)	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*
Paper/cardboard	171	230	57%	163	592	78%	<1	<1		334	822	71%
Plastic (codes 1-3)	50			39			<1			89		
Other plastic	76	39	31%	73	65	37%	<1	8		149	111	32%
Glass	117	168	59%	18	34	66%	<1	<1		135	202	60%
Metals	123	190	61%	14	948	99%	11	123	92%	148	1,261	89%
Food waste	658	2	0%	248	35	13%	<1	<1		906	37	4%
Garden waste	307	278	47%	46	25	35%	18	<1		372	302	45%
Wood/timber	111	5	4%	109	164	60%	121	28	19%	340	196	37%
Other organic	55	1	3%	98	249	72%	<1	<1		154	250	62%
Clean excavated materials	20	Unknown		63	Unknown		393	Unknown		475	Unknown	
Concrete/bricks/asphalt	20	138	88%	41	245	86%	455	2,788	86%	516	3,170	86%
Textiles	<1	7		65	1	2%	11	<1		77	8	9%
Other	20	<1		82	<1		129	<1		230	<1	
Total	**1,727**	**1,056**	**38%**	**1,060**	**2,357**	**69%**	**1,138**	**2,946**	**72%**	**3,925**	**6,360**	**62%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Data provided by Sustainability Victoria from their waste model, which is based on local government and reprocessor survey data, EPA landfill levy data and landfill audit data.

Material disposed and recycled from the municipal, C&I and C&D waste streams, Queensland 2006/07

Material	Municipal			C&I			C&D			Total		
	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate
	Tonnes ('000)	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*
Paper & Cardboard	Unknown	151		Unknown	Unknown		Unknown	Unknown		Unknown	151	
Plastic	Unknown	15		Unknown	11		Unknown	2		Unknown	26	
Glass	Unknown	78		Unknown	Unknown		Unknown	Unknown		Unknown	Unknown	
Ferrous	Unknown	5		Unknown	Unknown		Unknown	Unknown		Unknown	Unknown	
Non-ferrous (including aluminium)	Unknown	3		Unknown	Unknown		Unknown	Unknown		Unknown	Unknown	
Garden organics	Unknown	1,004		Unknown	53		Unknown	Unknown		Unknown	1,057	
Wood/timber/sawdust/barks	Unknown	Unknown		Unknown	154		Unknown	15		Unknown	169	
Other organics	Unknown	45		Unknown	9		Unknown	<1		Unknown	54	
Biosolids	Unknown	Unknown		48	399	89%	Unknown	Unknown		Unknown	Unknown	
Other	Unknown	1		Unknown	Unknown		Unknown	Unknown		Unknown	Unknown	
Total	**1,735**	**1,365**	**44.0%**	**1,101**	**1,797**	**62.0%**	**1,466**	**617**	**29.6%**	**4,302**	**3,779**	**46.8%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Total disposal to landfill and recycling figures were reported in Qld EPA (2008). The domestic, green, biosolids, construction and demolition and commercial and industrial waste stream data has been included within the total provided here.
The breakdown of recycled materials in each sector and in total is incomplete. Data has been included where available. Data sources are provided in Section 2.2.4.

Material disposed and recycled from the municipal, C&I and C&D waste streams, WA 2006/07

Material	Municipal			C&I			C&D			Total		
	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate
	Tonnes ('000)	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*
Paper & Cardboard	144	107	43%	111	119	52%	6	<1		261	226	46%
Plastic	14	7	33%	67	11	14%	6	<1		87	18	17%
Glass	59	16	22%	8	4	35%	<1	<1		68	20	23%
Metals	22	78	78%	24	337	93%	28	82	75%	75	497	87%
Organics, all, incl. timber	483	162	25%	275	370	57%	41	10	19%	799	541	40%
Concrete, sand, brick and rubble	<1	37		34	41	55%	1,799	317	15%	1,833	395	18%
Rubber	<1	<1		3	5	63%	<1	<1		3	5	63%
Textiles	<1	2		17	<1	1%	1	<1		19	2	8%
Other Waste	292	<1	0%	45	4	7%	57	<1		395	4	1%
Total	**1,015**	**408**	**29%**	**585**	**891**	**60%**	**1,939**	**409**	**17%**	**3,539**	**1,708**	**33%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding. Total disposal to landfill has been extrapolated from available data on disposal to landfill in the municipal waste stream. Recycling by sector and by material has been estimated from the Cardno BSD (2008) report. The breakdown of disposal to landfill has been estimated based on available audit data. See Section 2.2.5 for more detail.

Material disposed and recycled from the municipal, C&I and C&D waste streams, SA 2006/07

Material	Municipal			C&I			C&D			Total		
	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate
	Tonnes ('000)	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*
Paper & cardboard	52	44	46%	39	130	77%	<1	<1		91	175	66%
Plastics		6		8	11	56%	<1	<1			17	
Steel		42		<1	185		2	97	98%		324	
Aluminium	59	3	62%	<1	14		<1	4		69	21	86%
Non-ferrous (ex. Al)		6		<1	14		<1	4			24	
Glass		40		<1	10		<1	<1			50	
Concrete	<1	<1		<1	<1		22	794	97%	22	794	97%
Brick & tile/rubble & soil	<1	<1		12	<1		270	107	28%	282	107	28%
Asphalt	<1	<1		<1	<1		<1	84		<1	84	100%
Timber	<1	55		35	156	82%	<1	64		35	275	89%
Garden organics	76	210	73%	<1	<1		3	<1		79	210	73%
Food organics	89	<1		124	4	3%	<1	<1		214	4	2%
Textiles	<1	2		10	<1	0%	2	<1		12	2	16%
Rubber	<1	<1		39	1	3%	<1	<1		39	1	4%
Other organics	<1	<1		32	83	72%	<1	<1		32	83	72%
Foundry sands	<1	<1		58	2	3%	<1	<1		58	2	3%
Other waste	69	<1		138	<1		4	<1		210	<1	
Total	**344**	**408**	**54%**	**496**	**610**	**55%**	**304**	**1,155**	**79%**	**1,144**	**2,173**	**66%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding. Disposal to landfill total was provided by SA EPA; the split of this by sector is estimated based on the results of a landfill audit conducted in 2007. The breakdown of recyclables is based on survey data presented in Hyder Consulting (2008). The breakdown of the disposal to landfill stream is estimated based on landfill audits.

Material disposed and recycled from the municipal, C&I and C&D waste streams, estimated, ACT 2006/07

Material	Municipal			C&I			C&D			Total		
	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate
	Tonnes ('000)	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*
Paper & Cardboard	10	24	71%	27	26	48%	<1	<1		38	49	57%
Plastic	7	1	13%	9	<1	63%	<1	<1		23	1	69%
Glass	3	10	73%		4		<1	<1			13	
Ferrous	2	<1	26%		11		<1	22	99%		34	
Aluminium	<1	<1	18%		<1		<1	<1	98%		2	
Food organics	35	<1		38	<1		<1	<1		81	<1	73%
Garden organics	7	223	97%		<1		<1	<1			223	
Textiles	3	<1			5		<1	<1		56	5	82%
Other waste[1]	18	20	52%	16	56	79%	19	183	90%		259	
Total	**85**	**278**	**77%**	**91**	**102**	**53%**	**21**	**206**	**91%**	**197**	**587**	**75%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding. Total disposal data is as published by ACT NoWaste. Recycling data (totals and breakdown) is derived from published data from ACT NoWaste and data derived from ROU (2007). Landfill breakdowns by sector are based on audit data and estimates provided by ACT NoWaste.

[1] Other waste includes timber, concrete, bricks/tiles, soil/rubble/inert and batteries, tyres, paint, carpet, sullage

Material disposed and recycled from the municipal, C&I and C&D waste streams, Tasmania 2006/07

Material	Municipal			C&I			C&D			Total		
	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate
	Tonnes ('000)	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*
Recyclables	Unknown	43		Unknown	5		Unknown	Unknown		Unknown	47	
Green organics	Unknown	10		Unknown	17		Unknown	Unknown		Unknown	28	
Other	Unknown	Unknown		Unknown	Unknown		Unknown	Unknown		Unknown	Unknown	
Total	**287**	**53**	**16%**	**145**	**22**	**13.2%**	**14**	**Unknown**		**446**	**75**	**14%**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
The data included in this table was provided by the Tasmanian Department of Primary Industries, Parks, Water and Environment (pers.comm). More detail on the source of the information is provided in Section 2.2.8.

Material disposed and recycled from the municipal, C&I and C&D waste streams, Northern Territory 2006/07

Material	Municipal			C&I			C&D			Total		
	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate	Disposal	Recycling	Diversion Rate
	Tonnes ('000)	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*	*Tonnes ('000)*	*Tonnes ('000)*	*%*
Paper & cardboard	Unknown	1		Unknown	Unknown		Unknown	Unknown		Unknown	1	
Plastic	Unknown	<1		Unknown	Unknown		Unknown	Unknown		Unknown	<1	
Glass	Unknown	<1		Unknown	Unknown		Unknown	Unknown		Unknown	<1	
Ferrous	Unknown	<1		Unknown	Unknown		Unknown	Unknown		Unknown	<1	
Aluminium	Unknown	<1		Unknown	Unknown		Unknown	Unknown		Unknown	<1	
Green waste	Unknown	27		Unknown	Unknown		Unknown	Unknown		Unknown	27	
Other	Unknown	<1		Unknown	Unknown		Unknown	Unknown		Unknown	<1	
Total	**44**	**30**	**Unknown**	**57**	**Unknown**	**Unknown**	**51**	**Unknown**	**Unknown**	**151**	**30**	**Unknown**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
Disposal to landfill data was reported by Darwin City Council only. Municipal recycling data is for Northern Territory, except green waste and other recyclables. See Section 2.2.9 for more detail.

Appendix 2

Organics recovery by sector and state/territory

Organics recovery by sector and state, estimated 2006/07

	New South Wales[1]				Victoria[3]				Queensland[4]			
	MSW	C&I	C&D[2]	Total	MSW	C&I	C&D	Total	MSW	C&I	C&D	Total
Paper and cardboard	407	Unknown	Unknown	1,072	230	592	0	822	151	Unknown	Unknown	151
Garden organics	131	390	29	551	278	25	0	302	1,004	53	0	1,057
Wood/timber/sawdust	Unknown	67	71	138	5	164	28	196	Unknown	33	15	48
Food organics	0	49	0	49	2	35	0	37	Unknown	Unknown	0	Unknown
MSW (organic fraction)	109	0	0	109	0	0	0	0	45	0	0	45
Other - Biowaste	0	16	0	16	0	0	0	0	0	0	0	0
Other - Miscellaneous	0	6	0	6	1	105	0	106	0	9	0	9
Biosolids/grit/screenings	0	196	0	196	0	0	0	0	0	399	0	399
Oils, greasetrap, sludges	0	28	0	28	0	0	0	0	0	90	0	90
Straw	0	1	0	1	0	0	0	0	0	0	0	0
Manure	0	315	0	315	0	0	0	0	0	62	0	62
Animal bedding	0	4	0	4	0	0	0	0	0	1	0	1
Animal mortalities	0	8	0	8	0	0	0	0	0	0	0	0
Paunch	0	1	0	1	0	0	0	0	0	17	0	17
Other - misc. ag. org.	0	3	0	3	0	0	0	0	0	43	0	43
Paper/pulp sludge	0	4	0	4	0	0	0	0	0	0	0	0
Sawdust (forestry res.)	0	110	0	110	0	144	0	144	0	51	0	51
Barks (forestry res.)	0	142	0	142	0	0	0	0	0	71	0	71
Total	**647**	**1,339**	**101**	**2,752**	**515**	**1,065**	**28**	**1,608**	**1,200**	**828**	**15**	**2,043**

All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.
All data is sourced from Recycled Organics Unit (2007) Organics Recycling in Australia: Industry Statistics 2007, 2006 - 2007 financial year industry results, report by the Recycled Organics Unit for Compost Australia, unless otherwise stated

[1] Department of Environment and Climate Change (2008) NSW Resource Recovery Industries Survey 2006/07 - Organics Reprocessing, NSW. Note paper and cardboard total recovery does not equal the sum of the recovery from the three waste sectors, due to the lack of information on recovery in the C&I and C&D sectors.

[2] WMAA (2008) Construction and Demolition Sector Resource Recovery Industry Survey For the Financial Year Ending 30 June 2007; published August 2008

[3] Sustainability Victoria (2008) Waste Model, except 'sawdust' which was reported as 'sawdust and other forestry residuals' in the Sustainability Victoria (2008) Victorian Recycling Industries Annual Survey 2006/07.

[4] Environmental Protection Agency of Queensland (2008) The state of waste and recycling in Queensland 2007 (garden organics, C&D timber). Note: Queensland paper and cardboard includes municipal sources only, no information was available on recycling of paper and cardboard from C&I or C&D. The total figure is therefore a minimum estimate.

Organics recovery by sector and state, estimated 2006/07 (continued)

	Western Australia[5]				South Australia[6]				ACT[7]			
	MSW	C&I	C&D	Total	MSW	C&I	C&D	Total	MSW	C&I	C&D	Total
Paper and cardboard	0	0	0	0	44	130	1	175	24	26	0	49
Garden organics	110	56	0	165	210	0	0	210	223	0	0	223
Wood/timber/sawdust	0	21	10	31	55	156	64	275	0	0	0	Unknown
Food organics	0	1	0	1	0	4	0	4	0	0	0	0
MSW (organic fraction)	52	31	0	83	0	0	0	0	0	0	0	0
Other - Biowaste	0	0	0	0	0	0	0	0	0	0	0	0
Other - Miscellaneous	0	43	0	43	0	1	0	1	0	0	0	0
Biosolids/grit/screenings	0	23	0	23	0	1	0	1	0	0	0	0
Oils, greasetrap, sludges	0	21	0	21	0	25	0	25	0	0	0	0
Straw	0	6	0	6	0	7	0	7	0	0	0	0
Manure	0	28	0	28	0	68	0	68	0	5	0	5
Animal bedding	0	12	0	12	0	8	0	8	0	0	0	0
Animal mortalities	0	3	0	3	0	0	0	0	0	0	0	0
Paunch	0	1	0	1	0	7	0	7	0	0	0	0
Other - miscellaneous agricultural organics	0	4	0	4	0	16	0	16	0	0	0	0
Other - paper / pulp sludge	0	0	0	0	0	50	0	50	0	0	0	0
Sawdust (from forestry residuals)	0	14	0	14	0	0	0	0	0	13	0	13
Barks (from forestry residuals)	0	108	0	108	0	0	0	0	0	15	0	15
Total	**162**	**370**	**10**	**541**	**309**	**473**	**65**	**847**	**247**	**58**	**0**	**305**

[5] Total recovery and sector split of garden organics, total recovery of C&D recovered timber and sector split of MSW (organic fraction) from Cardno (2008) Review of total recycling activity in Western Australia 2006/07, prepared by Cardno for the Department of Environment and Conservation, Western Australia

[6] Wood/timber/sawdust and sawdust/barks (forestry residuals) categories merged for SA in order to maintain consistency with Hyder Consulting (2008) Review of Recycling Activity in South Australia 2006/07, prepared by Hyder Consulting for Zero Waste South Australia

[7] Garden organics quantity from Pers Comm ACT NoWaste (2008), who also advised an unknown quantity of timber was recovered (included as one of the categories within 'other' in their data). ACT and NSW data reported together in the ROU (2007) data.

Organics recovery by sector and state, estimated 2006/07 (continued)

	Northern Territory[8]				Tasmania[9]				Australia
	MSW	C&I	C&D	Total	MSW	C&I	C&D	Total	Total
Paper and cardboard	1	Unknown	Unknown	1	43	5	Unknown	47	2,318
Garden organics	27	Unknown	Unknown	27	0	0	0	0	2,535
Wood/timber/sawdust	0	0	0	0	0	0	0	0	688
Food organics	0	0	0	0	0	0	0	0	91
MSW (organic fraction)	0	0	0	0	0	0	0	0	238
Other - Biowaste	0	0	0	0	0	0	0	0	16
Other - Miscellaneous	0	0	0	0	0	0	0	0	166
Biosolids/grit/screenings	0	0	0	0	0	0	0	0	618
Oils, greasetrap, sludges	0	0	0	0	0	0	0	0	164
Straw	0	0	0	0	0	0	0	0	14
Manure	0	0	0	0	0	0	0	0	478
Animal bedding	0	0	0	0	0	0	0	0	24
Animal mortalities	0	0	0	0	0	0	0	0	11
Paunch	0	0	0	0	0	0	0	0	26
Other - miscellaneous agricultural organics	0	0	0	0	0	0	0	0	67
Other - paper / pulp sludge	0	0	0	0	0	0	0	0	54
Sawdust (from forestry residuals)	0	0	0	0	0	0	0	0	331
Barks (from forestry residuals)	0	0	0	0	0	0	0	0	336
Total	**28**	**0**	**0**	**28**	**43**	**5**	**0**	**47**	**8,171**

[8] National Environment Protection (Used Packaging) Measure data, Annual Report by Local Government Authorities (Darwin City Council) for the reporting period 01/07/06 - 30/06/07
[9] Department of Primary Industries, Parks, Water and Environment, pers comm. Jaimie Clarke, 10/08/09

Appendix 3

Priority product assessment criteria scores

	Consumption Rating	Disposal Level Rating	Level of Recycling or Reuse	Toxicity	Product Stewardship Arrangements	Ease of Collection/Material Separation	Recyclability & Market Availability	Priority Ranking
Building Products								
Asphalt road materials	VH	VH	VL	L	VH	H	H	H
Bricks[1]	VH	VH	L	VL	VH	H	H	H
Cables	VH	M	M	VL	H	M	H	VL
Concrete paving and construction	VH	VH	H	VL	VH	H	VH	VH
Wire fencing	VH	H	M	VL	H	M	H	M
Insulation[1]	VH	H	VH	VL	VH	L	L	L
Office fittings	H	H	H	L	VH	L	L	M
Piping (plastic)	VH	H	H	VL	VH	L	M	L
Roofing iron	VH	VH	M	VL	M	H	VH	VH
Roofing tiles	VH	VH	M	VL	VH	M	H	H
Structural timber	VH	VH	M	VL	VH	M	M	M
Treated timber	VH	VH	VH	M	VH	L	VL	VH
Window glass[1]	VH	H	H	VL	VH	L	M	L
Hot water systems	H	H	M	L	VH	M	H	H
Chemical products								
Paint	H	M	H	M	H	L	L	M
Electrical & electronic equipment								
Computers	H	H	M	M	H	L	M	H
Printer & computer peripherals	H	H	H	M	VH	L	L	H
Televisions	H	H	H	M	H	M	M	VH
Mobile phones	L	L	M	L	L	M	H	VL
Compact fluorescent lamps	M	VL	H	VH	VH	VL	H	VH
Fluorescent lamps	M	M	H	VH	VH	VL	H	VH
Power tools	H	M	H	L	VH	M	M	M
Small appliances	H	H	M	L	VH	M	H	H
Whitegoods	VH	VH	L	L	VH	M	H	VH
Fixed line phones[2]	L	L	H	L	VH	L	M	VL

	Consumption Rating	Disposal Level Rating	Level of Recycling or Reuse	Toxicity	Product Stewardship Arrangements	Ease of Collection/Material Separation	Recyclability & Market Availability	Priority Ranking
Heaters	H	H	M	L	VH	M	H	H
Video & stereo electronic peripherals	H	M	H	M	VH	L	L	M
CD media	H	M	VH	L	VH	L	L	M
DVD media	H	M	VH	L	VH	L	L	M
Smoke detectors	L	VL	VH	H	M	L	L	M
Elemental Products								
Tyres[3]	VH	VH	M	L	VL	M	M	H
Gas cylinders	M	M	M	M	VH	M	M	H
Automotive batteries	H	H	VL	M	H	H	VH	VH
NiCad batteries	M	M	H	VH	H	VL	M	VH
Personal batteries	M	M	VH	M	VH	VL	VL	M
Furnishing products								
Carpet	VH	VH	VH	VL	VH	L	L	M
Outdoor plastic furniture	M	M	VH	VL	VH	M	H	M
Packaging products								
Packaging – general[4]	VH	VH	L	VL	L	M	H	L
Retail carry bags	H	H	M	VL	M	M	H	L
Freight packaging - flexible film	H	H	M	VL	VH	M	H	M
Disposable nappies	H	H	H	M	VH	L	L	H

1. This data is has been extrapolated from WA specific data.

2. The fixed line phone data is from 2002/03. This is the most recently available information.

3. The tyre data is from 2004. This is the most recent available information.

4. Packaging – general includes beverage, food and other grocery packaging.

Disposal includes current levels of recycling or recovery. All figures have been rounded. Minor discrepancies may occur between the stated totals and the sums of the component items, as totals are calculated using the component item values prior to rounding.

Appendix 4

Landfill inventory tables (WMAA)

Key results from the WMAA Landfill Survey 2006 are summarised in Table 10-1. This table outlines the charcteristics of sites in each state. Key results that are outlined in the table are:

- - Tonnage of waste accepted: Number of sites by size of the site (tonnes of material accepted per annum)
- - Material received: Percentage of sites in each size category that receive material from each of the three key waste streams
- - Operational controls: the percentage of sites in each size category that reported having each of the seven operational controls in place.

In addition, the table provides:

- - an overview of the overall percentage of sites that receive material from each of the three waste streams
- - the overall percentage of sites and percentage of tonnes of material received in a facility that have each of the seven operational controls in place.

Table 10-1 Landfills in Australia, state by state summary, 2006

		Material received			Operational controls						
State and tonnage of waste accepted (tonnes per annum)	**Number of Sites**	**Municipal solid waste**	**Commercial & industrial waste**	**Construction & demolition waste**	**Sewage Sludge**	**Waste Compaction**	**Daily Cover**	**Leachate Treatment**	**LFG Flaring**	**Energy Recovery**	**Progressive Rest'n**
NSW											
>200,000 TPA	10	50%	90%	90%	40%	100%	100%	70%	40%	50%	70%
100-200,000 TPA	5	100%	100%	100%	40%	100%	80%	60%	0%	0%	60%
50-100,000 TPA	11	91%	82%	91%	27%	100%	73%	64%	27%	18%	64%
25-50,000 TPA	11	100%	100%	100%	18%	100%	100%	45%	0%	0%	45%
10-25,000 TPA	18	100%	94%	100%	17%	89%	89%	39%	0%	0%	61%
<10,000 TPA	30	90%	90%	90%	17%	93%	70%	33%	0%	0%	47%
Total sites	85	-	-	-	-	-	-	-	-	-	-
% of tonnes		62%	91%	92%	32%	99%	93%	58%	29%	31%	69%
% of sites		89%	92%	94%	22%	95%	82%	46%	8%	8%	55%
Queensland											

State and tonnage of waste accepted (tonnes per annum)	Number of Sites	Material received			Operational controls						
		Municipal solid waste	Commercial & industrial waste	Construction & demolition waste	Sewage Sludge	Waste Compaction	Daily Cover	Leachate Treatment	LFG Flaring	Energy Recovery	Progressive Rest'n
>200,000 TPA	5	60%	100%	100%	40%	100%	100%	80%	60%	40%	60%
100-200,000 TPA	7	57%	100%	100%	43%	86%	86%	57%	14%	14%	43%
50-100,000 TPA	8	100%	100%	88%	50%	100%	88%	25%	13%	0%	75%
25-50,000 TPA	5	100%	100%	100%	60%	100%	100%	40%	0%	0%	40%
10-25,000 TPA	10	100%	90%	100%	30%	80%	100%	30%	0%	0%	60%
<10,000 TPA	65	97%	85%	43%	12%	51%	48%	5%	0%	3%	20%
Total sites	100	-	-	-	-	-	-	-	-	-	-
% of tonnes		72%	99%	97%	49%	96%	94%	67%	40%	31%	65%
% of sites		93%	89%	62%	23%	65%	64%	18%	5%	5%	33%
Tasmania											
>200,000 TPA	0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100-200,000 TPA	1	100%	100%	100%	100%	100%	100%	100%	100%	0%	100%
50-100,000 TPA	3	100%	100%	67%	67%	100%	67%	100%	33%	0%	67%
25-50,000 TPA	1	100%	100%	100%	100%	100%	100%	100%	0%	0%	100%
10-25,000 TPA	3	100%	100%	100%	33%	100%	100%	33%	0%	0%	33%
<10,000 TPA	3	100%	100%	100%	33%	100%	100%	100%	33%	33%	33%
Total sites	11	-	-	-	-	-	-	-	-	-	-
% of tonnes		100%	100%	86%	75%	100%	82%	91%	43%	0%	70%
% of sites		100%	100%	91%	55%	100%	91%	82%	27%	9%	55%
Victoria											
>200,000 TPA	11	91%	100%	100%	0%	91%	100%	64%	27%	64%	64%
100-200,000 TPA	8	88%	100%	88%	0%	100%	88%	88%	50%	50%	88%
50-100,000 TPA	5	80%	100%	100%	20%	80%	100%	40%	40%	0%	80%
25-50,000 TPA	12	75%	92%	83%	8%	92%	92%	75%	8%	0%	42%
10-25,000 TPA	13	100%	100%	100%	0%	77%	100%	54%	0%	0%	62%
<10,000 TPA	9	78%	56%	56%	0%	89%	78%	11%	0%	0%	44%
Total sites	58	-	-	-	-	-	-	-	-	-	-

State and tonnage of waste accepted (tonnes per annum)	Number of Sites	Material received			Operational controls						
		Municipal solid waste	Commercial & industrial waste	Construction & demolition waste	Sewage Sludge	Waste Compaction	Daily Cover	Leachate Treatment	LFG Flaring	Energy Recovery	Progressive Rest'n
% of tonnes		90%	99%	96%	3%	87%	97%	72%	34%	48%	69%
% of sites		86%	91%	88%	3%	88%	93%	57%	17%	19%	60%
WA											
>200,000 TPA	10	50%	60%	100%	0%	90%	80%	30%	40%	50%	40%
100-200,000 TPA	1	0%	0%	100%	0%	100%	0%	0%	0%	0%	0%
50-100,000 TPA	5	60%	100%	60%	60%	80%	60%	40%	20%	20%	20%
25-50,000 TPA	7	57%	57%	100%	14%	86%	71%	0%	0%	0%	57%
10-25,000 TPA	11	82%	73%	82%	45%	64%	82%	9%	0%	0%	64%
<10,000 TPA	88	90%	83%	86%	31%	28%	23%	8%	1%	0%	25%
Total sites	122	-	-	-	-	-	-	-	-	-	-
% of tonnes		47%	60%	94%	10%	87%	73%	26%	29%	35%	40%
% of sites		80%	79%	87%	30%	43%	36%	11%	5%	5%	30%
SA											
>200,000 TPA	3	100%	100%	100%	0%	100%	67%	100%	0%	67%	100%
100-200,000 TPA	2	100%	100%	100%	0%	50%	100%	50%	100%	50%	50%
50-100,000 TPA	0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
25-50,000 TPA	2	100%	100%	100%	0%	100%	100%	50%	0%	0%	0%
10-25,000 TPA	6	100%	100%	100%	50%	83%	83%	17%	0%	0%	67%
<10,000 TPA	58	93%	84%	95%	10%	69%	84%	2%	0%	0%	33%
Total sites	71	-	-	-	-	-	-	-	-	-	-
% of tonnes		99%	99%	100%	5%	90%	79%	75%	17%	47%	80%
% of sites		94%	87%	96%	13%	72%	85%	10%	3%	4%	38%
Australia											
>200,000 TPA	39	67%	87%	97%	15%	95%	92%	62%	36%	54%	62%
100-200,000 TPA	24	79%	96%	96%	25%	92%	83%	67%	33%	25%	63%
50-100,000 TPA	32	88%	94%	84%	41%	94%	78%	50%	25%	9%	63%
25-50,000 TPA	38	84%	89%	95%	21%	95%	92%	47%	3%	0%	45%

State and tonnage of waste accepted (tonnes per annum)	Number of Sites	Material received			Operational controls						
		Municipal solid waste	Commercial & industrial waste	Construction & demolition waste	Sewage Sludge	Waste Compaction	Daily Cover	Leachate Treatment	LFG Flaring	Energy Recovery	Progressive Rest'n
10-25,000 TPA	61	97%	92%	97%	25%	80%	92%	33%	0%	0%	61%
<10,000 TPA	253	92%	84%	77%	19%	54%	52%	10%	1%	1%	29%
Total sites	447	-	-	-	-	-	-	-	-	-	-
% of tonnes		71%	90%	95%	24%	93%	90%	59%	32%	36%	64%
% of sites		88%	87%	84%	21%	70%	68%	27%	7%	7%	41%

Appendix 5

Data on computers and televisions

Computers

Year	Annual Sales (Aust)	Sales Growth	Average Weight	Total weight into Aust	Annual Totals (Aust) - Summary			
					Recycled	Landfilled	Stored	In storage
	(units)	(%)	(kg)	tonnes	tonnes	tonnes	tonnes	tonnes
2000	2,219,425	5.8%	19.1	42,391	4,155	13,385	20,936	108,502
2001	1,917,808	-13.6%	19.1	36,630	4,409	14,192	22,749	131,252
2002	2,100,000	9.5%	19.1	40,110	4,922	15,815	26,628	157,880
2003	2,478,000	18.0%	19.1	47,330	5,658	18,172	31,110	188,990
2004	3,023,160	22.0%	19.1	57,742	6,151	19,772	33,024	222,013
2005	3,537,097	17.0%	19.1	67,559	7,051	22,841	29,723	251,737

Televisions

Year	Annual Imports (Aust.) 2004/05	Sales Growth	Average Weight	Total weight into Aust	Annual Disposal (Aust)
	(units)	(%)	(kg)	(tonnes)	(tonnes)
2000	1,141,754	12%	26.7	30,516	6,617
2001	1,278,765	12%	28.5	36,505	7,411
2002	1,432,216	12%	30.4	43,500	8,376
2003	1,740,337	22%	33.5	58,337	9,357
2004/05	2,054,497	18%	31.5	64,698	11,040