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A study of the demolition industry in the Sydney Region

A STUDY OF THE DEMOLITION INDUSTRY IN THE SYDNEY REGION

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1 INTRODUCTION

1.1 REASONS FOR THE STUDY

Demolition waste forms a significant percentage (approximately 20%) of the total waste stream deposited in landfill sites in the Sydney region. A large proportion of this material could be recycled or reused; however, existing Australian demolition practices and current landfill disposal pricing policies militate against reuse of potential resources. The demolition industry is largely driven by economic factors and, therefore, financial incentives are the most effective method of encouraging recycling of a substantial proportion of the present demolition waste stream.

European and American examples show that recycling of demolition material can be less expensive than landfill disposal in that a valuable raw material can be produced for resale, and valuable landfill space is not taken up unnecessarily. It was observed by the Trade and Industry Committee of the United Kingdom House of Commons (1984) that 'the benefits of recycling are obvious: rarely do environmental and economic factors so unambiguously support the same goal'.

The Waste Management Authority of New South Wales (WMA) is responsible for administration and management of solid waste in the area covered by the forty metropolitan local councils in the Sydney Basin. Owing to increased usage of existing landfill sites, the WMA has adopted a total management approach. Strategies are being considered to minimize the generation of waste products, and methods of recycling portions of the waste stream are being investigated to further reduce demands on landfill sites.

Previous information (WMA Annual Report) on the content of the waste stream indicated that approximately 55% of the solid waste disposed of in Sydney during 1989 was from a commercial, industrial or demolition source and that this percentage has been increasing rapidly over the past five years. Consequently, the WMA is keen to expand and improve its data base relating to non-domestic waste.

This study of the demolition industry was undertaken by Kinhill Engineers Pty Ltd for the WMA as part of the WMA's overall study of Sydney's industrial waste disposal. The overall study includes examination of the:

- demolition industry
- food, beverage and tobacco industries
- wood, wood products and furniture industries
- retail industry.

1.2 OBJECTIVES

The objectives of this study are to:

- define demolition and related wastes;
- describe the demolition industry in the Sydney region with regard to its size, distribution and economic viability;
- assess the generation of demolition and related wastes in relation to building activity in the Sydney region;
- describe the types of demolition and related wastes currently being generated;
- provide an estimate of the cost of demolition activity to the building industry;
- provide an estimate of the cost of waste disposal to the building industry;
- assess the extent to which demolition waste in Sydney is reused and recycled;
- assess the potential for increasing reuse and recycling of demolition waste;
- recommend strategies for increasing reuse and recycling of demolition waste.

1.3 DEFINITION OF DEMOLITION AND RELATED WASTES

For the purposes of this study, 'demolition and related wastes' are defined as 'any material that arises as a result of the demolition of a building or structure, or its refurbishment.'

Demolition and refurbishment wastes include a wide range of materials such as bricks, tiles, concrete, steel, glass, timber, plastics and other products generally used in the building industry. Refurbishment was included in the definition because it appears that refurbishment activity is becoming an increasingly important source of waste material in Sydney. This study does not include road construction or reconstruction waste in the volume estimates; however, reference is made to the types of processes that are available for recycling this material because of the similarity of product types (e.g. concrete, crushed sandstone etc.).

1.4 DATA SOURCES

There are a number of sources from which data have been obtained; however, a range of inquiries was necessary as much of the information was not in a form that provided meaningful results. There is very little published literature on Australian operations and, because of the differences in construction materials and techniques in the different capital cities, direct use of examples outside the Sydney region was considered of limited value. Published data largely dealt with building activity, from which demolition activity had to be inferred. The most useful information was gained through interviews with private operators of both large and small companies; however, the commercially sensitive nature of much of the information meant that many firms were reluctant to provide detailed data.

Information for this study was gained largely from industry sources, and a full list of people consulted is presented in Appendix A. In general terms, information has been gained from the following industries and sources:

- demolition contractors
- building contractors
- demolition recycling operators
- quantity surveying consultants
- the transport industry
- waste disposal depot operators
- building materials suppliers
- data collection sources e.g. Australian Bureau of Statistics (ABS)
- the Commonwealth Industry Commission
- literature searches.

Thirty-nine metropolitan local councils were contacted in the WMA catchment to obtain estimates of the number of building applications and development applications processed annually. Inquiries as to the types of developments, the extent of demolition of existing structures, and the destination of the waste were also made. Unfortunately, the quality of information received was highly variable, with very limited quantification of different types of structures. The data obtained could not be used to calculate total volumes of demolition material generated; however, some interesting generalizations were drawn from the data provided. Disposal localities were generally stated as the regional landfill depots, with only one transfer station and two private depots specifically mentioned. It was a common response from town planning staff that the disposal of waste was the responsibility of the demolisher and that planning approvals did not impose conditions or controls on the method or location of disposal.

At the beginning of this study, the Demolition Contractors Association of New South Wales was approached for assistance. The Secretary stated that the Association had been in existence for only about eighteen months, and that it only acted for demolition contractors on commercial and industrial relations matters. The Secretary also advised that, to gain an understanding of the pricing policies and structure of the industry, it would be necessary to approach individual demolition contractors as this information is of a confidential nature. Other organizations that were approached but did not hold relevant information included the Australian Institute of Quantity Surveyors and the Australian Institute of Building Surveyors, NSW Chapter.

The wide range of data sources used in this study reflects the highly variable quality of reporting of demolition waste generation and disposal within this industry. This finding is supported by the Commonwealth Industry Commission's (October 1990) investigations in its recent draft report on recycling in Australia.

2 THE DEMOLITION INDUSTRY IN THE SYDNEY REGION

2.1 INTRODUCTION

The demolition industry is strongly affected by the cyclical nature of the building industry, which is in turn subject to broader economic conditions. In the past, demolition has been regarded as a small subset of the construction industry, and there has been very little attempt to separate the reporting of this activity from the larger industry analysis that has been periodically undertaken.

Notwithstanding the relatively small percentage of expenditure on demolition compared with the total costs of construction, the total volumes of material requiring disposal have been steadily increasing. At a time when landfill disposal sites are becoming more remote from the sources of waste generation, the cost of waste disposal is having a greater impact on the structure of the demolition industry.

This section of the study provides an overview of the demolition industry in the Sydney region. It places particular emphasis on the size, distribution and economic viability of the industry. The following analysis was based on data provided by the ABS and the WMA, and on information contained in the 1973/74 to 1991 annual editions of *Telecom yellow pages* for Sydney.

2.2 STUDY AREA

The ABS definition of the Sydney region does not strictly correspond with the area of coverage in the Sydney *Telecom yellow pages* and the area of Sydney for which the WMA has responsibility. According to the ABS's definition, the Sydney region extends from the east coast to the Blue Mountains in the west; to Hawkesbury, Gosford and Wyong in the north; and to Wollondilly in the south (Department of Planning 1988; ABS Catalogue No. 82071). The area of coverage in the Sydney *Telecom yellow pages*, however, excludes outer areas such as Hawkesbury, Gosford, Wyong, the Blue Mountains and Wollondilly.

The area managed by the WMA includes the forty local councils in the Sydney Basin, and excludes outer areas such as Gosford, Wyong, the Blue Mountains and Wollondilly. In addition, it is noted that the Wollondilly Shire Council disposes of some of its wastes in areas that are subject to WMA jurisdiction.

Despite the different areas of coverage, it is considered that an analysis that compares data obtained from the ABS, the WMA and *Telecom yellow pages* is still valid. The outer regions of the study area are dominated by rural or other low density development, where demolition materials are commonly disposed of on site and do not form a significant proportion of the waste stream for disposal at registered landfill sites.

2.3 SIZE OF THE DEMOLITION INDUSTRY

The size of the demolition industry is strongly affected by the number of building commencements, which are linked to economic factors. The poor reporting of demolition is also reflected by the absence of detailed information on the size and number of demolition projects. The larger contractors are commonly public companies but their annual reports do not reveal detailed information on the annual costs of the operations. Smaller companies do not generally publish annual reports.

An indication of the number of demolition contractors in the Sydney region can be gained from *Telecom yellow pages*. This source was considered a reliable indicator of the number of demolition contractors in Sydney because of the commercial nature of the industry and, therefore, the need to advertise availability and services. Telecom Australia's Sydney library has records dating back to the 1973/74 financial year. The historical numbers of demolition contractors in the Sydney region registered in *Telecom yellow pages* are summarized in Table 2.1.

Table 2.1 **The number of demolition contractors in the Sydney region**

Year	Number	Change (no.)	Change to previous year (%)	Change to 1973/74 (%)
1973/74	79	n.a.	n.a.	n.a.
1974/75	74	-5	-6.33	-6.33
1975/76	70	-4	-5.41	-11.39
1976/77	67	-3	-4.29	-15.19
1977/78	63	-4	-5.97	-20.25
1978	60	-3	-4.76	-24.05
1979	68	8	13.33	-13.92
1980	76	8	11.76	-3.80
1981/82	78	2	2.63	-1.27
1982	77	-1	-1.28	-2.53
1983	75	-2	-2.60	-5.06
1984	74	-1	-1.33	-6.33
1985	80	6	8.11	1.27
1986	86	6	7.50	8.86
1987	101	15	17.44	27.85
1988	109	8	7.92	37.97
1989	125	16	14.68	58.23
1990	140	15	12.00	77.22

n.a. Not applicable.
Source: 1973/74 to 1991 annual editions of Telecom yellow pages.

2.4 ECONOMIC VIABILITY OF THE DEMOLITION INDUSTRY

Table 2.1 indicates that throughout much of the 1970s there was a reduction in the number of demolition contractors in Sydney and a large increase in the number of demolition contractors during recent years. This fluctuation in the number of demolition contractors suggests that the economic viability of individual demolition businesses is linked with the fluctuations in building activity in Sydney. This point is illustrated by comparing the number of demolition contractors with the level of building activity in the Sydney region during the period 1980 to 1989. For comparative purposes, data regarding the value of building commencements in Sydney were used rather than values of building approvals, work undertaken or completed, because commencement data provide the most accurate available indication of any site preparation work (including demolitions) undertaken in a given period. These data were inflated into 1989 dollar values in order to compare the 'real' value of building commencements with changes in the number of demolition contractors in Sydney. Rawlinsons International Pty Ltd's (Rawlinsons) building price index for Sydney was used for this inflation (Appendix B).

Data collection by the ABS for building commencements only started in 1980 and, therefore, it was not possible to assess the fluctuations in the number of demolition contractors in relation to building activity prior to 1980. Nevertheless, it appears that downturns in building activity are associated with a reduction in the number of demolition contractors (Table 2.2 and Figure 2.1).

Industry sources suggest that the increase in the number of demolition contractors may be associated with a degree of diversification by excavation contractors who applied similar plant and machinery to demolition projects as they had previously to excavation. This is generally confirmed by the number of advertisements by the same companies in *Telecom yellow pages* under both the classifications of 'demolition' and 'excavation' contractors.

Table 2.2 **A comparison of the number of demolition contractors in the Sydney region with the value of building commencements in the region (expressed in 1980 constant prices)**

Year	Value of commencements ($ millions)	Demolition contractors (no.)	Change in no. of demolition contractors
1980	1,137.8	76	+8
1981	1,066.0	78	+2
1982	810.6	77	-1
1983	940.0	75	-2
1984	1,122.4	74	-1
1985	1,410.9	80	+6
1986	1,691.7	86	+6
1987	1,386.1	101	+15
1988	1,841.4	109	+8
1989	2,597.3	125	+16

Note: *Deflated using Rawlinsons' building price index (Appendix B).*
Sources: *ABS Catalogue No. 8752.1;* Telecom yellow pages.

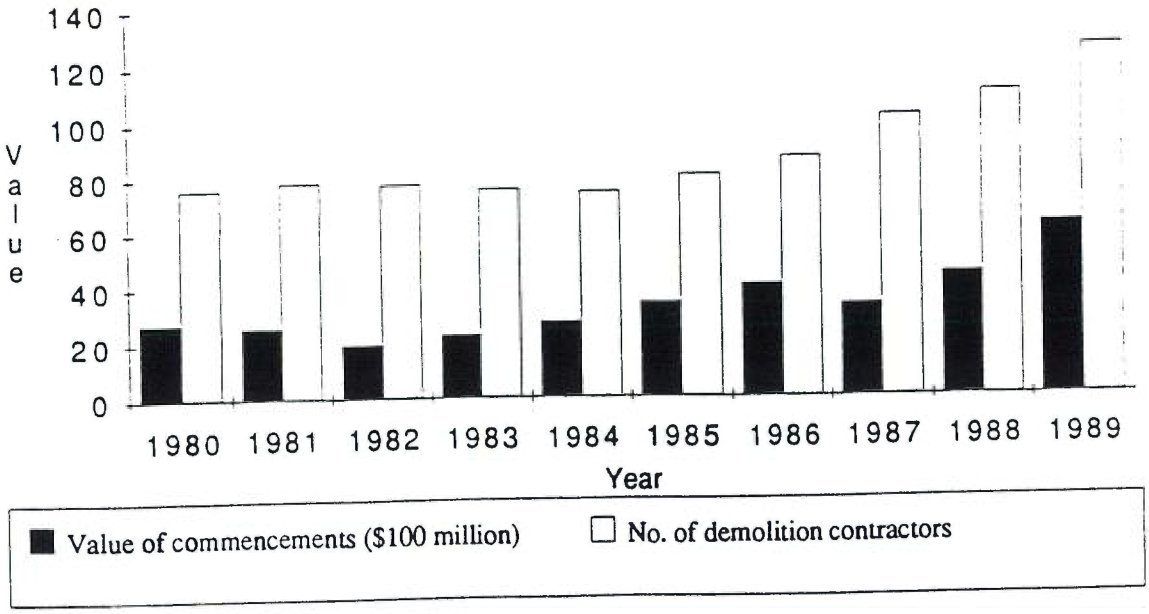


Figure 2.1
NUMBER OF DEMOLITION CONTRACTORS COMPARED WITH THE VALUE OF BUILDING COMMENCEMENTS

A further indication of the apparent volatility of the industry is provided by information from Telecom Australia that only eleven out of the seventy-nine (13.9%) demolition contractors listed in the 1973/74 *Telecom yellow pages* were still listed in 1990. A list of these contractors and their telephone numbers is provided in Table 2.3.

Table 2.3 **Demolition contractors still listed in the 1991 *Telecom yellow pages***

Name	Suburb	Telephone number
R.J. Brady Pty Ltd	Botany	666 3333
H. and M. Habib	Lakemba	759 6539
M. Hassarati and Co. Pty Ltd	Lakemba	750 9566
Kennedy Contracting Pty Ltd	Kellyville	629 2030
N. Khoury	Granville	637 5875
Manly Vale Demolitions Pty Ltd	Balgowlah	946 464
Menere Demolitions Pty Ltd	Sydney	264 6987
Millers Demolishers Pty Ltd	Vineyard	627 2872
Neville Platt Demolition Pty Ltd	Kingsgrove	502 3640
Whelan the Wrecker Holdings Pty Ltd (Consulting Service)	Brunswick (Victoria)	(03) 387 1588
Williams Demolitions Pty Ltd	Sydney	211 1472

This lack of continuity of demolition operators suggests that there are relatively few contractors with long-term experience in the industry. With the high capital costs of specialist equipment for reprocessing demolition waste, only larger companies with substantial capital and long-term commitment to the industry are likely, or able, to become involved in reprocessing and recycling demolition waste.

2.5 INDUSTRY LOCATION

The location of the offices of demolition contractors does not have a major bearing on the operations of these firms because the principal criteria for selection of demolishers are the quoted price, availability and reliability of the organization. These factors are strongly influenced by market conditions rather than office location. The cost of transporting plant and equipment to a site is generally a small proportion of establishment costs and, therefore, does not provide a strong commercial advantage to companies based close to the demolition site.

3 GENERATION OF DEMOLITION AND RELATED WASTES IN THE SYDNEY REGION

3.1 GENERATION OF DEMOLITION AND RELATED WASTES COMPARED WITH BUILDING ACTIVITY IN THE SYDNEY REGION

The data sources for the following analysis were the ABS's building commencement data for the Sydney Statistical Division, and the WMA's data regarding the delivery of demolition and building wastes to waste depots in the Sydney region. As already indicated in Section 2, ABS building commencement data provide the most accurate available indication of demolition activity that may have been undertaken in a given period.

On the basis that demolition activity is closely associated with building commencements, it is important to recognize the cyclical nature of activity within the building industry. Analysis by BIS Shrapnel Pty Ltd (1990) identifies the 'strong relationship between (property) prices and (building) activity through the building investment cycle'.

This building investment cycle follows a reasonably regular pattern of accelerated building development followed by a significant slowing of activity. Commonly, this is followed by a period of relative inactivity, which is again followed by an investment development phase, often in response to an underlying demand that develops during the period of stagnation.

These cycles of building activity were experienced in the Sydney region during the 1970s and 1980s. The steady upward trend of building activity in the 1960s and early 1970s was followed by a marked decrease in the number of dwelling approvals from 1974/75. The 'boom' period of 1978 to 1981 was followed by a relatively 'depressed' market until mid-1987, when sudden increases in prices forced development of new housing to meet demand. Sustained high interest rates have caused a 'sharp contraction' of housing construction since about mid-1989.

Figure 3.1, which is taken from the *Australian* (19–20 January 1991, 53), shows the cyclical nature of the office construction industry. Industrial and residential housing markets also follow a similar cyclical pattern; however, the investment time lags are different from commercial development, and variations from Figure 3.1 would therefore be expected for these sectors of the construction industry.

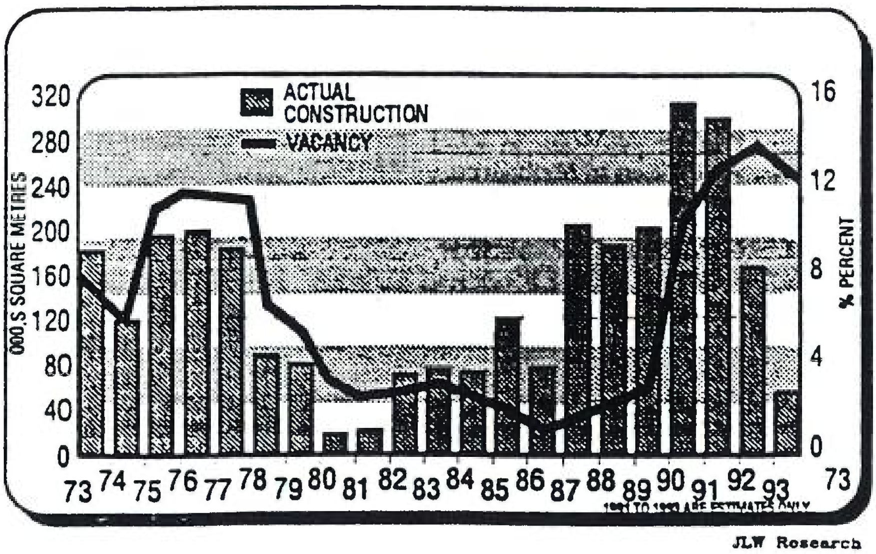


Figure 3.1
CONSTRUCTION CYCLE VACANCY—SYDNEY CENTRAL BUSINESS DISTRICT 1973–93

3.2 COMPARISON OF BUILDING COMMENCEMENTS WITH DELIVERIES OF DEMOLITION AND RELATED WASTES TO LANDFILL DEPOTS

Because of the close connection between the construction industry and the demolition industry, the extent of activity in the construction industry should be reflected in the amount of demolition waste disposed of at landfill sites. The analysis below indicates that there is limited direct relationship between these two activities; however, it is suggested that this is because of reporting methods rather than a lack of correlation between demolition waste generation and building activity.

3.2.1 ADJUSTED VALUES OF BUILDING COMMENCEMENTS BY INDUSTRY SECTOR

Table 3.1 provides a comparison of the real value of building commencements (i.e. adjusted for inflation) with the delivery of demolition and building wastes to depots in Sydney between 1983 and 1989. The table illustrates activity in an expansion phase of Sydney's building investment cycle, during which time the level of demolition activity is apparently higher than the contraction phase. The table also illustrates that, although the ratio of demolition and building wastes to building commencements fluctuated during this period, the volume of demolition and building wastes delivered varied in accordance with the level of building activity.

ABS data for construction of detached houses are not available; however, other residential building activity with a value of $10,000 or more and non-residential projects with a value of $30,000 or more are fully enumerated (refer to footnotes for Table 3.1). This is because the ABS estimates the value of construction of detached houses in New South Wales on the basis of a survey that is too limited for accurate estimation of house building activity in Sydney. However, for the purpose of comparing building commencements with deliveries of demolition and building wastes to depots, this is not a significant deficiency in the analysis. Demolitions related to residential building activity are usually associated with commencements of higher density accommodation rather than replacement of detached houses. This assumption is supported by the progressive implementation of urban consolidation strategies (i.e. efforts to increase urban housing density) in the Sydney region (State Environmental Planning Policies 25 and 28).

3.2.2 REPORTED DELIVERIES OF DEMOLITION WASTE TO LANDFILL SITES

Table 3.2, which is based on information provided by the WMA, and Figure 3.2 provide an insight into the changing focus for demolition waste disposal, depending on the cost of disposal. The tonnages recorded reflect a growth phase of the construction cycle and display a significant shift from disposal at regionally significant council tips to privately operated landfill sites. The enormous increase in amounts received at regionally significant council tips between 1983 and 1986 coincided with the operation of the Sydney Brick Pit landfill site, which was receiving material at relatively low charge to encourage rapid filling to make way for planned developments. That operation ceased in 1986, which is reflected in the sudden drop to pre-1983 volumes, and an approximately equal increase in deliveries to privately operated landfill sites.

The rapid increase in total deliveries to landfill sites between 1983 and 1985 is partly a response to the increase in building activity, and partly a result of the stricter licensing and reporting requirements imposed by the WMA. This suggests that records of deliveries prior to 1985 may have been substantially under reported.

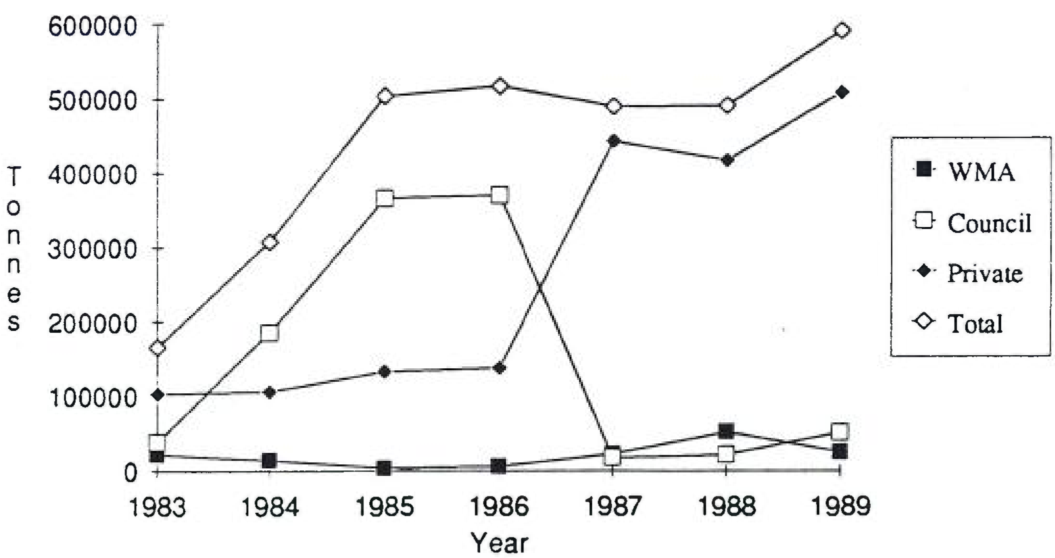


Figure 3.2
DELIVERIES OF DEMOLITION AND BUILDING WASTES TO WASTE DEPOTS IN THE SYDNEY REGION

Table 3.1 **The value of building commencements in the Sydney region ($ millions) expressed in 1989 constant prices* compared with deliveries of demolition and building wastes (tonnes) to landfill depots**

Year	Other residential buildings**	Hotels, etc.	Shops	Factories	Offices	Other bus. prem.	Education	Religion	Health	Entertain. & rec.	Misc.†	Total††	Dem. & build. wastes	Ratio of waste to activity (t/$000)
1983	398.0	103.2	268.1	298.2	671.7	196.5	123.4	16.5	38.7	66.1	67.6	2,248.2	165,048	73
1984	512.2	25.4	217.4	250.3	1,042.7	193.1	179.2	10.1	58.3	117.0	68.6	2,673.6	308,126	115
1985	518.4	109.9	287.1	327.9	1,228.2	270.0	217.8	12.0	163.0	180.0	67.0	3,381.6	504,035	149
1986	554.8	155.3	389.5	318.2	1,486.2	407.9	300.2	16.5	102.1	224.0	74.2	4,028.8	516,678	128
1987	458.8	152.2	267.9	312.2	1,143.0	404.1	278.0	12.3	47.5	107.7	107.2	3,290.6	490,287	149
1988	671.2	384.3	323.7	400.0	1,692.6	429.4	201.3	15.1	107.5	117.8	81.1	4,423.3	492,269	111
1989	793.1	862.1	289.7	535.1	2,285.3	725.0	188.2	18.0	83.4	224.1	179.9	6,184.0	591,590	95

* *Inflated using Rawlinsons' building price index.*

** *Includes blocks of flats, home units, attached town houses, villa units, terrace houses, semi-detached houses and maisonettes; excludes cottages, bungalows, detached caretakers'/managers' cottages, and rectories.*

† *Includes law courts, homes for the aged, orphanages, gaols, barracks, mine buildings, glass houses, livestock sheds, shearing sheds, fruit and skin-drying sheds, public toilets and ambulance, fire and police stations.*

†† *Due to rounding off of data values for the various types of buildings, totals may not add up exactly to actual totals for each year.*

Sources: ABS Catalogue No. 8752.1; WMA.

Table 3.2 **Deliveries of demolition and building wastes to waste depots in the Sydney region (tonnes)**

Depot	1983	1984	1985	1986	1987	1988	1989
WMA	21,868	14,556	3,728	6,231	22,897	52,111	25,716
Regionally significant council tips	38,585	184,667	365,724	370,811	17,952	21,747	51,779
Other council tips	1,675	3,694	2,046	1,896	6,472	2,767	4,602
Private* tips	102,920	105,209	132,537	137,740	442,966	417,644	509,493
Total	**165,048**	**308,126**	**504,035**	**516,678**	**490,287**	**494,269**	**591,590**

* *Includes annual Section 29 reports only.*

Source: WMA.

Other council tips have not recorded significant amounts of demolition waste, which may be a result of misreporting demolition waste into other categories. The generally low level of recorded deliveries of demolition waste at WMA depots is discussed in Section 3.3; however, the decrease in deliveries from greater than 21,000 tonnes (1983) to less than 4,000 in 1985, at a time when the real price of waste disposal at tips was not increasing, suggests inaccurate identification of waste types rather than actual changes in volumes received at these depots.

3.3 RELIABILITY OF EXISTING DATA ON DEMOLITION MATERIALS GENERATION

The wide range of data sources reflects the lack of direct information available on demolition materials disposal in Australia. European experience has shown a similar pattern of poor reporting until the late 1970s, when the problem of landfill disposal became more acute. Improved reporting since that time has assisted in providing the background data for many of the waste management strategies now followed.

Investigations by the Australian Commonwealth Industry Commission into waste management and recycling, as presented in the *Draft report on recycling in Australia* (October 1990), have very limited reference to the demolition waste industry. The Director of the Commission, Mr Ray Jeffery, has observed that there is a general lack of information on the waste disposal industry generally. Mr Jeffery has suggested that waste generation is significantly under estimated in general and that there is an almost complete lack of information on demolition waste. The Commission's investigations were Australia wide, and Mr Jeffery stated that much of the better data came from the WMA.

Direct sources of data on the quantities of demolition waste generated in the Sydney region are restricted to the information collected by the WMA. The amount of demolition and building wastes delivered to Sydney's landfill sites is likely to be significantly higher than indicated in the WMA data in Table 3.2 (591,590 tonnes in 1989). This is due to likely under-reporting of deliveries of these wastes at private depots and inaccurate identification and recording of demolition material into other categories of waste type.

3.3.1 UNDER-REPORTING, MISREPORTING AND NON-REPORTING OF DEMOLITION MATERIALS

As indicated above, there are a number of areas where the reported levels of demolition materials do not reflect the total volumes of waste from this sector of the industry.

Under-reporting

Under-reporting of deliveries of demolition wastes to private depots probably occurs because reporting to the WMA through the monthly Section 29 reports is the responsibility of the landfill operator. Operators of private tips are currently required to pay the WMA a levy of $2 per tonne of waste (as at 12 January 1991) accepted at their depots. Consequently, there is an incentive to under report waste deliveries in order to reduce levy payments to the WMA. With only three WMA inspectors for the entire

Sydney region and limited methods of cross-checking deposited material after burial, there are opportunities for private operators to under report the amounts received.

Error can also result from the methods used to calculate tonnage. There are no weighbridges at the majority of private landfill sites, and tipping charges are determined at the gate on the basis of sample weights for particular types of vehicles. The use of sample weights provides an indirect incentive for waste disposal contractors to overfill vehicles, as there is no extra disposal charge and there are limited methods of checking actual weights.

The weight factors currently used by the WMA are shown in Table 3.3.

Table 3.3 **Weight factors currently used by the WMA to calculate the amount of demolition waste deposited at landfill sites without weighbridges**

Vehicle type	Weight factor (t)
Cars, station wagons and sedans	0.060
Utes, panel vans, small box trailers	0.200
Open trucks (general waste)	
0–5 t GVW*—Small Diahatsu etc.	0.864
5–12 t GVW—Single-axle tippers	2.306
12–20 t GVW—Bogie tippers**	4.430
Over 20 t GVW—Tipping semi-trailers and eight-wheelers†	5.786
Open trucks (hard fill and demolition wastes)	
0–5 t GVW—Small Diahatsu etc.	2.000
5–12 t GVW—Single-axle tippers	4.000
12–20 t GVW—Bogie tippers	10.000
Over 20 t GVW—Tipping semi-trailers and eight-wheelers	15.000
Compaction vehicles	
Small Diahatsu type (5 m^3)	0.500
Medium (15 m^3)	2.250
Large (25 m^3)	5.500
Dumpmaster (front loader)	4.500

GVW Gross vehicle weight.

* *Tare (unladen weight) + payload = GVW.*

** *Generally range from 8–9 tonne tare, and from 10–11 cubic metres carrying capacity. Will have a GVW of >20 tonnes if fully laden with sands and soils. May even have a GVW of up to 27 tonnes if fully laden with a heavier material such as ripped rock (i.e. 9 tonne tare + 18 tonne payload = 27 tonne GVW; for ripped rock etc., 1 cubic metre ≈ 1.6–1.8 tonnes per cubic metre).*

† *Twin steers or eight-wheelers: Generally range from 10–11 tonne tare; average carrying capacity is 15 cubic metres, but may be up to 22 cubic metres.*

Source: WMA, Sydney, January 1991.

A technique mentioned by a number of operators in the demolition industry was for some quantities of hard fill material to be placed at the bottom of a truck or skip and covered with general waste. This vehicle would attract the general waste charge, although the weight of material being deposited could be substantially higher than the sample weight that would be applied. As levies to the WMA are paid on the basis of weight, it could be in the financial interests of the landfill operator to record a greater proportion of received material as general waste, rather than as heavier demolition waste.

A large amount of the responsibility for identification and recording of waste type and charges rest with the gate attendant. Although not quantifiable, a number of comments were made by demolition contractors that suggested inducements provided to gate attendants could reduce the cost of waste disposal. This extra source of potential under-reporting would probably not be known to the landfill operator.

Discussions with one of the major private landfill operators that does employ a weighbridge for fee calculation, Camide Pty Ltd (Camide), suggests that the incidence of under-reporting at private depots could be up to 20% of recorded deliveries; however, discussions with other operators suggest that this is a very conservative estimate. Notwithstanding the under-reporting by operators of private depots, Table 3.2 indicates that in recent years these depots have become the most important disposal sites for demolition and building wastes in Sydney, receiving over 85% of the recorded tonnage.

Misreporting

Demolition and building wastes are also incorrectly categorized as commercial and industrial wastes at waste depots (where categorization of waste types is undertaken). Of four major WMA customers involved in disposal of demolition/renovation and building wastes, a total of 41,000 tonnes of material was deposited at WMA landfill sites during 1989/90 (WMA records). Of this, it was estimated by the waste management companies that at least 30,000 tonnes were demolition or building wastes. Records from the WMA show that only 90 tonnes of material from these operators were recorded as demolition or building material during this period. As these larger contractors generally operate on an account basis with the WMA, it is probable that the fee collectors at the gate consider this account to be commercial and, therefore, register the waste as being generated from a commercial source.

The high degree of error in categorizing waste is exacerbated by the general use of high-sided trucks and covers over the load, which make observation of contents, and therefore accurate identification of waste type, more difficult. This results in substantially under-reported volumes of demolition waste. The reverse situation—the categorization of commercial or industrial waste as demolition waste—appears to be very uncommon and, consequently, a percentage of the waste recorded as commercial or industrial material should be included in the demolition waste volumes. In view of the significant misallocation of waste type by four major waste contractors, it is suggested that the total misreporting of demolition materials as commercial/industrial waste may be as high as 10% of the recorded commercial/industrial waste stream.

Non-reporting

Existing recycling operations have not previously come within the scope of WMA reporting. The volumes removed from the waste stream by these operations are discussed in detail in Section 3.4; however, a total volume of approximately 650,000 tonnes per annum would avoid registered landfill disposal and therefore would not be recorded in the WMA figures shown in Table 3.2.

A significant proportion of the total volume of demolition material is not reported when the material is taken to recycling depots, clean fill sites, or is dumped illegally in bushland or other locations. Although clean fill is defined by the WMA as including natural excavation material, and excluding concrete, bricks and rubble, the demolition industry is often not rigorous in making this distinction. The WMA does not have jurisdiction over natural excavation material (*Waste Disposal Act 1970* [NSW]) even though this material requires disposal in some form. This anomaly has allowed disposal of some demolition materials in clean fill sites. It is common, particularly on small fill sites, for a portion of bricks and concrete to be mixed with naturally occurring excavation material from a demolition site, and incorporated in filling, even though it is not classified as clean fill under the WMA definition.

Clean fill sites can range in size from individual residential blocks to large industrial sites, where ground levels need to be raised for the proposed development. All sites that accept non-naturally occurring materials for filling should be subject to WMA licensing; however, in a number of situations, particularly for relatively small operations, the WMA is not informed of the filling, and is therefore not in a position to license, or even record, the volumes of material deposited.

Where licences have not been applied for, records are not kept for these operations, and there are presently no accurate methods of gauging the total volume of demolition material disposed of at these sites. From information provided by demolition contractors, it was suggested that more than 100,000 tonnes per annum of demolition material are incorporated in clean fill sites in the Sydney region. One contractor observed that 'there would be more than ten sites that have accepted more than 5,000 tonnes of demolition material, and many more that had accepted smaller quantities'. Therefore, the estimate of 100,000 tonnes per annum is considered conservative, and has been adopted in this study (Table 3.4).

Demolition material processed, but not transported from the demolition site, does not fall within WMA jurisdiction (*Waste Disposal Act 1970* [NSW]). The present charges for waste disposal are an incentive to use as much of the demolition material on site as possible. Discussions with the two major suppliers of crushing plants (Bradys Pty Ltd and Portaplant Australia Pty Ltd) suggest that the majority of crusher usage was for on-site reuse rather than off-site disposal. One industry source identified a specific industrial site where two crushers were operating for six months reprocessing demolition rubble. It was estimated that 60,000 tonnes of material were reprocessed for fill and used on site without having to be transported to a landfill disposal site.

It is estimated, on the basis of discussions with these operators and building contractors, that suppliers of crushing equipment reprocessed more than 340,000 tonnes of demolition material during 1990 for reuse on demolition sites. The present downturn in the construction industry during late 1990 and 1991 would reduce the amount of material presently being processed.

Table 3.4 **Estimates of 1989 demolition material generation in the Sydney region**

Materials destination	Reported tonnage	Rationale for revised estimate	Estimated tonnage
Private tips	509,493	Section 29 reports	509,493
		Under-reporting 20%	102,000
		Under estimating 10%	61,000
WMA facilities	25,716	Gate reporting	25,716
		Misreporting, includes 10% of commercial/industrial	116,000
Regionally significant council tips	51,779	Section 29 reports	51,779
		Misreporting and on-site recycling e.g. Kimbriki Rd tip	50,000
Other council tips	4,602	Section 29 reports	4,602
Recycling—timber	n.a.	Industry sources	15,000
Recycling—bricks	n.a.	Industry sources	50,000
Recycling—rubble	n.a.	Industry sources	240,000
Recycling—other	n.a.	Industry sources	5,000
Reuse on site—rubble	n.a.	Industry sources	340,000
Clean fill sites (public authorities)	n.a.	Industry and council sources	100,000
Clean fill sites (private)	n.a.	Industry and council sources	100,000
Illegal dumping	n.a.	Industry and council sources	200,000
Total	**591,590**		**1,970,590**

n.a. Not available.

Illegal dumping in bushland and at other sites has increased with the increased cost of transport and disposal of waste material. In the Shire of Warringah, two unregistered sites received over 300,000 tonnes of demolition and excavation material in a two-year period (1986–88). At another site, 160 loads from 10 tonne trucks were dumped in a council reserve. Many truck loads have been found on fire trails and in other bushland areas. These types of events have forced council to require a development application for any landfill in the shire, and increase the fines for illegal dumping to $500 per offence. Even so, prosecutions have been few, and the practice of illegal dumping is difficult to control. Similar experiences have been reported in other shires with extensive bushland including Baulkham Hills, Hornsby, Penrith, Hawkesbury, Camden, Liverpool, Blacktown and Sutherland.

On the basis of discussions with officers from a number of councils where illegal dumping is prevalent, 200,000 tonnes per annum is considered a conservative estimate of the volume of demolition material illegally dumped.

In addition to the issues discussed above, statutory authorities such as the State Rail Authority, the Roads and Traffic Authority, local councils and the Water Board produce demolition and excavation material that is not fully reported. With the large land holdings of these authorities, significant amounts of material are stockpiled on otherwise unused sites until required for other developments. These materials rarely enter the waste stream and, therefore, the volumes are generally unreported. A current example is the development of the Lilyfield Railway yards (adjacent to Lilyfield Road) by the State Rail Authority, where over 70,000 tonnes of natural excavation material and demolition rubble are being used in a reinforced earth construction.

Under-reporting, misreporting and non-reporting are significant in terms of estimating the real level of disposal of demolition and building debris in the Sydney region.

3.4 ESTIMATED TOTAL VOLUMES OF DEMOLITION AND RELATED MATERIALS GENERATED IN THE SYDNEY REGION

As discussed in Section 3.3, there are a number of areas where the volumes of material are inaccurately recorded or where no records are available. Table 3.4 is considered a very conservative estimate of the generation of demolition material during 1989. The information in the table suggests that, of the total volumes of material recorded at landfill depots, a further 55% is received at these sites, but is either unreported or misreported as material other than demolition waste. The table also indicates that approximately 650,000 tonnes of material is presently recycled by a range of established industry operations and does not enter the landfill disposal waste stream.

4 TYPES OF DEMOLITION AND RELATED WASTES CURRENTLY GENERATED IN THE SYDNEY REGION

4.1 SOURCES AND COMPOSITION OF DEMOLITION WASTE

To assess the broad structure of demolition waste generated in the Sydney region, information was sought from local councils on the number and type of building and development applications processed annually. There was a wide range in the quality of information gained from the thirty-nine councils contacted. The data for 1990 were largely incomplete, so the information presented below is mostly for 1989, with inclusion of 1990 data where possible, and 1988 data where no other information was available. The total number of building approvals from sixteen councils was 21,670, and the total number of development approvals from twenty-five councils was 11,743.

For building approvals, only eight councils could provide information divided into residential and commercial categories, with Penrith Council the only one to record building approvals for industrial constructions (sixty-two) in 1988. Approximately 75% of building approvals were for residential dwellings, and 25% for commercial buildings; however, this does not include information from councils where considerable residential development is occurring (e.g. Bankstown, Hawkesbury and Hornsby shires). Although commercial developments are likely to generate more demolition material where they replace existing commercial buildings, it was stated (by the Building Inspector at Liverpool City Council) that the majority of approvals were for upgrading existing structures rather than new constructions. In terms of demolition material generation, it is suggested that residential dwellings would produce approximately 60–70% of waste produced as a result of building approval, with 30–40% resulting from commercial demolition or refurbishment. Industrial developments are usually the subject of development applications.

Only ten councils separated development approvals into categories: 58% were for residential dwellings, 29% commercial developments, and 13% industrial developments. The proportion of industrial development was biased by three councils (Canterbury, Holroyd and Liverpool) recording 516 development approvals, being over 80% of the total industrial approvals. A number of the other councils in major industrial areas did not provide information. Development applications for residential dwellings are generally required for higher density accommodation, as development approval is not usually necessary where the zoning allows residential development. In terms of demolition material generation, it is suggested that residential dwellings would provide the majority of waste, between 50% and 60%, as a result of development approval. Commercial developments, including office accommodation and retail activities,would account for 20–40%. The remaining demolition waste would be made up of industrial buildings and other structures including schools, hospitals, religious centres and other public buildings.

The types of demolition and related wastes produced in the Sydney region are determined by the types and ages of structures being demolished. Different proportions of materials result from demolition of residential dwellings compared with offices, with a completely different waste stream resulting from refurbishment and renovation. In view of the selective and relatively limited level of recycling presently being undertaken, waste deposited at landfill sites is generally a mixed waste consisting of concrete, mortar, bricks, timber, plaster, steel, aluminium, plastics, floor and wall tiles, glass and a range of other minor constituents.

Composition of waste from a range of demolition and refurbishment activities is discussed below, and an indication of the composition of waste from three different activities is provided in Table 4.1. It must be emphasized that there is a large variation within each category, depending on the specific character of the structure.

Table 4.1 **Indicative composition (% by volume) of materials generated during demolition or refurbishment.**

Type of material	Older residential dwelling (%)	Newer residential dwelling (%)	Multi-storey office demolition (%)	Office internal refurbishment (%)
Bricks and concrete/mortar	44	68	75	5
Internal walls/ceilings	2	8	7	55
Fittings: bathroom, kitchen, lights	2	2	2	5
Floor coverings: carpets, tiles	2	2	2	15
Metals/plastics/glass	5	2	12	15
Timber: beams, studs, flooring, trim	35	10	2	5
Roof tiles	10	8	-	-

Note: *These percentages can vary significantly depending on the construction of particular buildings.*
Sources: *Currie & Brown, Cameron & Middleton Quantity Surveyors; I.R. Malouf Demolitions.*

The potential health problems associated with handling asbestos products has created a specialist market of contractors who deal with this material. These products are usually stripped from a building and disposed of separately from the remaining materials. Because of the separate handling and disposal procedures, asbestos materials are not included in the following discussion of demolition and related wastes.

4.2 RESIDENTIAL DWELLINGS

Demolition of individual houses in order to replace them with another individual dwelling is uncommon, except in the case of change of materials—for example, replacement of a weatherboard structure with brick. The majority of residential dwelling demolition is to make way for higher value land uses, such as commercial property, as retail and other activities expand around commercial centres. Development of medium and high density housing in areas of previously low density accommodation is probably one of the larger contributors of demolition material to the waste stream.

The majority of residential dwellings in the Sydney region are of brick and tile construction, as evidenced by the 'red roof' of Sydney when flying over the area. Timber has generally been used for roof framing, as floor bearers and joists, and for internal wall construction. Older constructions formerly on the fringes of metropolitan development were commonly timber frame constructions with ferro-cement cladding and corrugated iron roofing. These structures have largely been replaced and no longer represent a major proportion of the waste stream. Changes in construction techniques include increased use of poured concrete slab as flooring and foundations, and a re-introduction of corrugated iron and other light-weight materials such as Colorbond for roofing. The use of steel framing has not significantly replaced timber as the preferred construction material.

Materials generated during residential dwelling demolition are essentially removed in three stages. The first stage—the 'stripping out' stage—involves removal of fittings such as kitchen, bathroom and light fixtures for resale. Special items such as fireplaces, stained glass, marble and doors are usually recovered for reuse, and commonly achieve a premium price. Any other features that can be reused and that provide an economic return, such as architraves, doors and window frames, are recovered during this stage of the project.

The second stage of demolition involves dismantling of the roof structure and recovery of tiles, timbers, corrugated iron, Colorbond panels and other saleable material. The primary considerations for a contractor in dismantling roof structures, sorting the material and selling the products are the time required and the added value to be achieved. In many circumstances, the quality of the material, and therefore the resale price, does not warrant the effort of separating the different components. In these circumstances, it is likely that this stage of the process would be avoided and the contractor might go directly from stripping out to total demolition.

The third stage of demolition for a residential dwelling usually involves use of heavy machinery, such as dozers or excavators, to push down the remaining walls and load directly on to trucks for landfill disposal. In some cases, bricks are separated and cleaned for reuse, particularly if they are sandstock or some other valuable material; however, such reuse tends to involve a small proportion of the total number of bricks involved in demolition.

A number of issues affect the decision to reuse materials gained from demolition; for example, the incidence of separation and sorting will be much greater if the material can be reused on the same site for the construction that is to follow demolition. Roofing tiles in good condition are commonly sorted and stacked on site for reuse or resale.

A private demolition contractor indicated that, as a general rule, a modest timber structure with 'fibro' or other light cladding, constructed on brick piers, will generate approximately 60 tonnes of demolition material. This is roughly divided into 30 tonnes of brick and cladding material, and a further 30 tonnes of mixed waste. For a double-brick construction of similar size, an extra 60 tonnes of material would be generated.

4.2.1 A RECENT EXAMPLE OF A RESIDENTIAL DWELLING DEMOLITION

A three-bedroom residential dwelling was demolished at Newport in late 1990 by an independent contractor in order to provide a cleared block for a new development. The structure consisted of three sides built of double brick, with the remaining side built of framed timber with weatherboard cladding. All internal walls were framed timber with gyprock and timber panelling. The roof was framed timber with galvanized iron cladding.

Stripping out included removal of carpets and linoleum floor coverings, and detachment of bathroom and kitchen fittings. There were no door frames, mantle pieces or architraves considered worth recovering. Three doors, four windows and the majority of flooring were recovered for resale. All bathroom fittings were sold to a second-hand dealer. Roofing materials were detached and stacked on site for resale. Thirty sheets of 14 foot galvanized iron were sold at $1 each.

The roof framing and internal walls were disassembled and stacked on site for sale and transport to timber recyclers. The timbers included all major bearers, as well as minor studs, and were sold to the recycler for 40 cents per linear foot. The nails were not removed from the timbers prior to transport from the site. A 10 tonne flat-bed truck was fully loaded with resaleable timber, which achieved a sale price of $600 for the demolisher.

The contractor observed that the labour costs of timber recycling were about break even, as timber stacking and truck loading required double handling of the material, and was therefore time consuming. The major benefit was the absence of waste transport and disposal costs, with minor benefits gained from the unrecorded cash sale at the site.

All the work up to this stage of demolition was undertaken by manual labour; there was little opportunity for plant or machinery to be used in view of the small scale of the project.

The remainder of the structure was demolished by dozer, which generated a mixed waste largely consisting of bricks with minor amounts of broken timbers, gyprock, electrical wiring, plumbing, floor and wall tiles, and concrete. The majority of this mixed waste (approximately 30 tonnes) was deposited in a 30 cubic metre skip for disposal at the nearest landfill site (Kimbriki Road waste disposal depot).

Apart from the large skip to remove the mixed waste, two other smaller (5 cubic metre) skips were used during the demolition for roofing materials such as flashing and sundry small items including broken timber, glass, guttering and floor coverings. Because of the nature of this material, there is little opportunity for recycling, and the material tends to consist of the bulky, noncompactable portion of the waste generated. The ten cubic metres were estimated as about 5 to 7 tonnes as deposited at the landfill site.

4.3 MULTI-STOREY OFFICE BLOCK DEMOLITION

Because of planning controls on the location of types of development, multi-storey office blocks are largely confined to commercial areas within business districts. There are a number of business districts within the Sydney region that have multi-storey office blocks of varying age. Apart from the Sydney Central Business District (CBD) and the nearby North Sydney areas, there are major regional centres at Parramatta, Chatswood, Hornsby, Bondi Junction, Strathfield, Bankstown, Hurstville and Liverpool, and others are developing at an accelerating rate. These newer regional centres have largely developed high rise buildings over the last thirty years and some locations are now in the process of redevelopment.

The older CBD of Sydney has been subject to a number of periods of redevelopment, which will continue with the extent of activity associated with the cyclical nature of the building industry and the demand for office space. In view of the longer history of development within Sydney, there are a number of older buildings that have reached the stage where the land value exceeds the present return on the property and redevelopment is inevitable.

It is estimated (Malcolm Patterson, General Manager, Group One Interiors Pty Ltd, in the *Weekend Australian* 10–11 November 1990) that there are approximately 2,400 buildings in Sydney within the area bounded by Circular Quay, Railway Square, Sussex Street and Elizabeth/Macquarie streets. The *Weekend Australian* (11–12 November 1990) states that 'more than 600 of these were built over the last 15 to 30 years and have not been refurbished for the past 5 years.' Property prices and requirements of tenants will result in demolition or refurbishment of these properties within the next ten years.

Multi-storey office blocks are in areas where the value of property is generally high, and there is commonly a degree of urgency to bring the site back to rental income generation. Demolition, as the first stage of redevelopment, is often seen as an area for reducing the total time of construction. Consequently, there is pressure on the demolition contractor to minimize the time on site and, in view of the relatively small costs of waste disposal compared with the value of the building, there tends to be a disincentive for reuse or recycling of materials if the time appears excessive.

The sequence of demolition commences with stripping out, removal of roofing, and progressive knocking down of wall and floor structures from the upper storeys working downwards. For relatively recent buildings (constructed after 1960), removal of the curtain wall is the first stage of major demolition following stripping out.

A number of technological advances have improved current techniques used for demolishing larger structures. This has reduced the time taken to demolish buildings in business district sites; however, this has also tended to reduce sorting at site with a consequent reduction in opportunities for recycling of materials. It is now common practice for hydraulic excavators with cutting tools or hydraulic hammers to be lifted to the uppermost level of a building to drag the external walls, flooring and bearing members towards the centre of the structure to drop to the basement.

Since the 1960s, office partitions have generally been constructed in modular form and are easily removed, although the availability of used partitions appears to be substantially greater than the market demand for such products. The materials for partitions have largely been particle board covered with fabrics, and are not generally recycled. Floor coverings also tend to have a very limited resale value, and are generally considered a disposable item.

4.3.1 EXAMPLES OF MULTI-STOREY BUILDING DEMOLITION

In terms of waste minimization, the greatest opportunities lie in gaining a consistent waste material. This can be achieved by detailed stripping out to provide a relatively uniform core structure that is available for reprocessing to aggregate materials.

There are a number of examples of waste minimization; however, a notable site for effective waste management was at the Mark Foys Building at the corner of George and Goulburn streets in central Sydney during the early 1980s. As a precursor to current practices, the demolishers undertook recycling on site to provide a range of crushed and sorted aggregates. This material was loaded on to trucks and provided free of charge to any builder requiring raw materials. The majority of material was removed from the site at relatively low cost to the operator because the cost per tonne of reprocessing material was significantly less than the cost of transport and landfill disposal.

Demolition of multi-storey office blocks commonly requires a greater degree of waste removal because of the increased volume of materials resulting from the demand for more underground parking in new buildings. In the Sydney region, this increased volume of excavated material often comprises sandstone, which is generally fairly uniform and is recyclable as subgrade or fine crushed rock.

4.4 OFFICE REFURBISHMENT

The *Weekend Australian* (1–2 September 1990) reported that the refurbishment of offices has become one of Australia's most active property sectors, growing from a $50 million industry in 1980 to an estimated $1 billion market in 1990/91. The report noted that Sydney's CBD is at the forefront of this boom. It was also reported that analysis undertaken by the Building Owners and Managers Association indicated that 110,300 square metres of office space was refurbished in 1990, while in the previous year only about 25,000 square metres of office space was refurbished in Sydney's CBD.

There are a number of reasons for the increase in refurbishment activity:

- It is a natural follow-on from the record amount of office construction during the last development boom. Many office buildings in Sydney's CBD were built in the late 1960s and have reached full maturity, and now need extensive refurbishment, regardless of market conditions.

- Due to rapid advances in technology, it is estimated that office buildings will have to be upgraded every ten to fifteen years to keep pace with advances in computer and lift technology and overall communications services. Regular refurbishment can also improve the energy efficiency of a building.

- It is common for refurbishment to be undertaken while tenants are occupying the property. This substantially reduces the impact on rental income during the period of refurbishment.

- As the majority of work to the building is internal, dependence on weather conditions is reduced, and greater certainty can be applied to project timetables and therefore project costs.

It has been suggested that these factors will ensure that the office refurbishment market will continue to grow in the long term, even during cyclical downturns in building activity. The level of waste generation due to refurbishment in these conditions is likely to become a more significant component of Sydney's building wastes in future years.

Some more recently constructed buildings require refurbishment because of the demands of tenants for improved technological facilities and associated infrastructure. For example, most offices require computer facilities, which often need special isolated ducting for cables. Flooring and other materials that reduce static electricity are also preferred in computer areas. Improved air-conditioning is necessary for sensitive machinery and employees. Communications equipment such as telephone connections for modems and facsimile machines require upgraded facilities that were not necessary for buildings constructed more than ten years ago.

The materials that result from this type of refurbishment commonly consist of carpets, partitions, ducting and plastic in a variety of forms. At present, there is little opportunity for reusing or recycling these materials, the majority of which are disposed of in landfill sites. These materials are generally bulky with a very low weight to volume ratio (approximately 0.2 to 0.5 tonnes per cubic metre). An indication of the composition of refurbishment waste is presented in Table 4.1.

Complete demolition of larger buildings provides a different mix of waste, with a larger amount of reinforced and other concrete material forming the majority of the waste products. Brick construction was common in older buildings; however, poured concrete has dominated high rise construction since the 1960s.

Large amounts of glass have been used in curtain wall types of construction; therefore, it can be expected that increased volumes of high strength glass will result from demolition of buildings constructed in recent architectural style. Reuse or recycling of this glass should be a consideration in the waste management plan prepared for demolition of these types of buildings; however, this high strength glass is not presently recyclable as cullet in glass manufacture.

In its simplest form, a waste management plan identifies the type and volume of material that will be generated during demolition of a structure, and proposed methods of disposal. Cost estimates are usually prepared by a tenderer and incorporated in the total demolition price; however, it is not currently common practice for these estimates and, therefore, disposal methods and locations, to be subject to review by regulatory authorities.

Detailed waste disposal planning can be cost effective for larger demolition projects because of the relative uniformity of large volumes of material. For large demolitions, effective sorting on site can substantially reduce waste disposal costs; however, smaller projects may not gain a similar benefit.

Shredding non-recycleable material to decrease its bulk can assist in transporting the material from site and compacting it in a landfill location. Shredding has become common practice in many European centres to reduce space taken up in landfill sites.

4.4.1 EXAMPLES OF MAJOR OFFICE REFURBISHMENT

A number of office refurbishments are presently being undertaken in the Sydney CBD. These are discussed in greater detail in newspaper articles presented in Appendix C. At the fringe of the CBD, a number of former warehouses are being converted to offices or upgraded from previous conversions.

At 645 Harris Street, Ultimo—a four-storey former warehouse—refurbishment involved upgrading the air-conditioning system, replacing carpet floor coverings, painting the external facade, tiling the entrance areas and lift vestibules, painting common areas such as corridors, and installing new lighting. This was essentially a cosmetic refurbishment, which cost approximately $200,000 and generated about 120 cubic metres of waste material in strip out and construction offcuts. This waste material was generally low density; however, it would have cost approximately $5,000 to hire skips and have the material removed by a waste disposal company. The transport and tipping fees would have been approximately $2,000.

4.5 COMMERCIAL BUILDINGS

Discussions with twelve major retail operations did not reveal the extent of data anticipated. One organization, Norman Ross Discounts, indicated that as the majority of its operations were in leased buildings, it had little involvement in external refurbishment, and internal refurbishment was undertaken on a needs basis i.e. approximately every five years for minor refurbishment and approximately every ten years for major refurbishment.

Minor refurbishment consisted of replacement of floor and wall coverings, and other minor works. Major renovations included replacement of floor coverings and removal of walls to restructure the floor plan layout, as well as replacement of counters and installation of new equipment such as cash registers, security equipment, lifts and air-conditioning. Most of the department store operators suggested that this was a fairly typical approach both in timing and in staging.

Although volumes of material could not be identified due to the variations between stores, it was noted that the majority of materials had little recycling value. Removal and disposal of waste material were part of the contractor's responsibility and formed part of the refurbishment contract.

It was noted that shop appearance and presentation were becoming increasingly important in the property market, particularly with regard to increasing market share of the retail trade. In light of this, it is expected that the frequency of refurbishment may increase slightly in the future.

The other significant contributor of waste during refurbishment of commercial buildings is the hotel industry. It was estimated by the Second Hand Building Centre that five major hotels were refurbished annually. Most of the 'hard' fittings such as bathroom provisional cost items and lights were sold to building industry recyclers. An example of this is the resale of 150 bathroom basins from one recent inner city hotel refurbishment.

Other items included furniture and decor finishes, which were sold separately to a different recycling market. The majority of remaining materials are not generally considered reusable and consist of carpets and other floor coverings, wall plaster, and floor and wall tiles. As with retail shop refurbishment, this remaining material is relatively bulky with a low weight to volume ratio (approximately 0.2 to 0.5 tonnes per cubic metre).

Recycling of this remaining mixed waste is presently uneconomic; however, considerable reductions in the volume of this material could be achieved by shredding prior to landfill disposal. Although it is probably not very efficient to operate shredders at each refurbishment site, considerable savings in landfill space would be achieved by increasing the compaction of these materials.

4.6 INDUSTRIAL DEVELOPMENTS

The nature of industrial activities is such that the majority of structures are designed for light weight construction, so that the minimum of materials cover the maximum floor space. In general, older buildings have a poured cement floor with corrugated iron or single brick walls, and corrugated iron, asbestos cement or ferro-cement sheeting for roofs. More recent structures still have the high strength concrete flooring, with metal framing and sheet metal wall cladding using products such as Colorbond or other light-weight materials. Heavier industrial uses tend to have increased floor strength, and therefore reinforced concrete thickness, while maintaining light-weight wall and roofing.

There is ample opportunity for recycling depending on the quality and condition of the wall and roofing materials. In light of the relatively large scale of demolitions and consistency of products, recycling of these materials is commonly undertaken. Removal of flooring is often a more demanding task. Economic factors generally determine whether on-site reprocessing of material is viable, and to what extent it will be undertaken. The general consistency of reinforced concrete flooring encourages use of reprocessing equipment; however, contaminants such as oil, acids or other fluids soaked into the concrete can restrict resale marketing opportunities.

Purpose-built structures such as power stations or storage silos generally have a large rubble component; however, the extent of contaminants may limit the reuse of these materials even after reprocessing.

5 COST OF DEMOLITION ACTIVITY AND WASTE DISPOSAL TO THE BUILDING INDUSTRY IN THE SYDNEY REGION

5.1 INTRODUCTION

The demolition and building industries are largely driven by economic factors. Costs of production are strongly affected by wages and interest rates (essentially fixed costs), both of which are closely related to time spent on the job. Variable costs such as tipping fees, depending on the volume of material disposed of, must be traded off against the cost in time and labour of separating the material at the site. Considerable incentives are often applied to reduce time spent on site, and this consequently encourages bulk waste disposal rather than separation at source.

The discussion below does not reflect the total costs of demolition waste disposal in that the costs involved in reuse, recycling or clean fill disposal are not included. As shown in Table 3.4, demolition and excavation material from a range of unreported sources may account for a significant proportion of the total waste generated, even though it is not recorded as disposed of at landfill sites.

5.2 COST OF DEMOLITION ACTIVITY

Details of the cost of demolition activity to the building industry are taken from the 1983–90 annual editions of Rawlinsons' *Australian construction handbook*. This handbook provides indicative costs of various demolition tasks. These cost estimates are compiled by Rawlinsons' quantity surveyors for each Australian capital city on the basis of surveys of demolition contractors and the firm's own market knowledge.

The tables in Appendix D provide a detailed analysis of Rawlinsons' indicative demolition cost estimates since 1985. Real price movements (i.e. after adjusting for inflation) are also provided in these tables using Rawlinsons' building price index, which is included in Appendix B.

The tables in Appendix D illustrate the following points regarding the Sydney region:

- Between 1985 and 1990 there was a significant reduction in the real price of demolition charges, with the notable exception being activity related to the removal of asbestos materials. Discussions with Rawlinsons indicated that this occurred as a result of improved technological expertise in the demolition industry. However, the substantial increase in the number of demolition contractors in the Sydney region since 1984, as illustrated in Table 2.1, may have also slowed down price increases because of the pressure of competition.

- Since 1988 the cost of demolition activity has risen substantially. Discussion with Rawlinsons indicated that this has principally been due to two factors: firstly, a tightening of regulations in the Sydney region regarding demolition activities to ensure higher safety standards; and secondly, the recent increases in fees for the tipping of demolition wastes at waste depots.

5.3 COST OF WASTE DISPOSAL TO THE BUILDING INDUSTRY

The cost of disposal of demolition and related wastes to the building industry is determined by two distinct factors: firstly, the transportation of material to waste depots; and secondly, disposal charges at the waste depots. Each of these factors has been analysed separately. The results of the analysis were then combined to provide an overall estimate of the cost of waste disposal to the building industry.

5.3.1 COST OF WASTE TRANSPORTATION

Analysis of the cost of waste transportation was based on haulage rates on a cost per hour basis as provided in the 1983–90 annual editions of Rawlinsons' *Australian construction handbook*. This handbook provides indicative costs of haulage rates for vehicles with carrying capacities of 5 tonnes, 8 tonnes, 12 tonnes, 16 tonnes and 20 tonnes. Discussions with Camide indicated that about two-thirds of demolition materials are transported on 12 tonne trucks, with the remainder being transported on 20 tonne trucks. Consequently, Rawlinsons' quoted rates for these types of trucks were used for this study (Table E.1). It should also be noted that the upper limit of Rawlinsons' price estimates were used in this analysis and that it was assumed that a return trip for each load of demolition wastes on average involved a two-hour journey. This assumption was adopted as a result of discussions with Leighton Contractors Pty Ltd.

Rawlinsons' upper limit estimates of hourly haulage rates were adjusted for inflation to 1989 dollar values in order to provide a direct comparison of this cost with the real value of building commencements in the Sydney region. The inflator used in this instance was the ABS Consumer Price Index. This inflator was used on advice from the New South Wales Road Transport Association.

The transportation charges that were derived on the basis of these assumptions were applied to the WMA's data regarding the delivery of demolition and building wastes to depots in order to estimate the transportation costs of these materials. These estimates were also compared with ABS data on the value of building commencements in the Sydney region in order to estimate the cost of transporting demolition wastes to landfill depots as a proportion of the value of building activity. These estimates are summarized in Table 5.1. This table indicates that in 1983 the cost of transporting demolition wastes to waste depots accounted for an insignificant proportion of the value of building commencements in the Sydney region. Although transportation costs increased as a proportion of the value of building commencements in subsequent years, it still remains an insignificant cost in terms of the overall value of building activity. Appendix E provides detailed information regarding the way in which these estimates were calculated.

Table 5.1 **Estimates of the cost of transporting demolition and building wastes as a proportion of the value of building commencements in Sydney***

Year	Cost of transportation ($ millions)**	Value of building commencements ($ millions)†	Transport costs as a proportion of building activity (%)
1983	1.008	2,248.2	0.04
1984	2.113	2,673.6	0.08
1985	3.466	3,381.6	0.10
1986	3.538	4,028.8	0.09
1987	3.189	3,290.6	0.10
1988	3.287	4,423.3	0.07
1989	3.950	6,184.0	0.06

* *All dollar values expressed in constant 1989 prices.*
** *Inflated using the ABS's Consumer Price Index.*
† *Inflated using Rawlinsons' building price index.*
Sources: 1983–90 annual editions of Rawlinsons' Australian construction handbook; ABS Catalogue No. 6401.0.

5.3.2 TIPPING FEES

Present tipping fees for commercial and industrial waste (which includes demolition waste for the purposes of charging) are $20.20 per tonne at WMA landfill sites, and $41.70 per tonne at WMA transfer stations. This price differential is intended to discourage disposal at transfer stations as it is clearly inappropriate for the WMA to provide a cheaper transport option to final disposal sites for demolition contractors. It is the view of the WMA that trucks loaded with demolition material should not gain a financial advantage by off loading material at transfer stations so that the WMA has to then load and transport material for final disposal. Where a truck is loaded with waste material, the operator should be encouraged, by cost incentives, to transport the material to the final destination rather than pass this responsibility to the WMA.

Price differentials in disposal fees are becoming more common at non-WMA landfill sites such as the Kimbriki Road waste disposal depot. Fees for loads greater than 1 tonne of mixed waste are $50 per tonne. Where the material is sorted and rubble is available for reprocessing, a charge of $10 per tonne is applied. The incentive for relatively rigorous sorting at the demolition site is directly associated with tipping fees, which provide the opportunity for effective recycling of demolition rubble at the disposal site. This approach of differential pricing has been implemented at a number of landfill sites in the Sydney region.

Analysis of the cost of depositing demolition materials at Sydney's waste depots was based on the WMA's disposal charges and advice from Camide regarding the cost of disposal charges at Sydney's private waste depots. The costs provided by Camide were applied to all deliveries of demolition and building wastes in the Sydney region apart from those to the WMA's depots. The rates quoted by Camide used in this analysis represent the upper limit of Camide's cost estimates. These tipping fee estimates were also adjusted to 1989 dollar values in order to provide a direct comparison of this cost with the real value of building commencements in the Sydney region.

As with the transportation cost analysis, the inflator used was the ABS's Consumer Price Index. These tipping fee estimates are summarized in Table 5.2 and presented in graphical form in Figure 5.1. Table 5.2 indicates that in 1983 tipping costs represented just over one-tenth of 1% of the value of building commencements in the Sydney region. Although tipping costs increased as a proportion of the value of building commencements in subsequent years, it still remains an insignificant cost in terms of the overall value of building activity.

Table 5.2 **Estimates of the cost of tipping demolition and building wastes as a proportion of the value of building commencements in Sydney***

Year	Cost of tipping** ($ millions)	Value of building commencements† ($ millions)	Tipping costs as a proportion of building commencements (%)
1983	2.731	2,248.2	0.12
1984	5.405	2,673.6	0.20
1985	9.022	3,381.6	0.27
1986	9.424	4,028.8	0.23
1987	8.963	3,290.6	0.27
1988	8.902	4,423.3	0.20
1989	11.729	6,184.0	0.19

* *All dollar values expressed in constant 1989 prices.*
** *Inflated using the ABS's Consumer Price Index.*
† *Inflated using Rawlinsons' building price index.*

Appendix F provides detailed information regarding the methodology used to calculate these estimates. This appendix indicates that the real charges for tipping of demolition wastes at WMA depots fell steadily during the 1980s until 1989 when substantial increases in tipping fees were imposed.

5.3.3 OVERALL COST OF DISPOSAL OF DEMOLITION AND BUILDING WASTES

The estimated costs of transporting and tipping demolition and building wastes can be added together to provide an estimate of the overall cost of waste disposal to the building industry. Table 5.3 summarizes these overall cost estimates. This table illustrates that the overall cost of disposing of demolition and building wastes represents an insignificant cost when considered as a proportion of the value of building activity. During the period 1983 to 1989, disposal costs, on average, represented about one-third of 1% of the value of building activity. Furthermore, it appears that even if a generous allowance were made for under-reporting of deliveries of demolition and building wastes at private depots and misallocation of these wastes into other waste categories, disposal costs would still not be a significant cost item to the building industry.

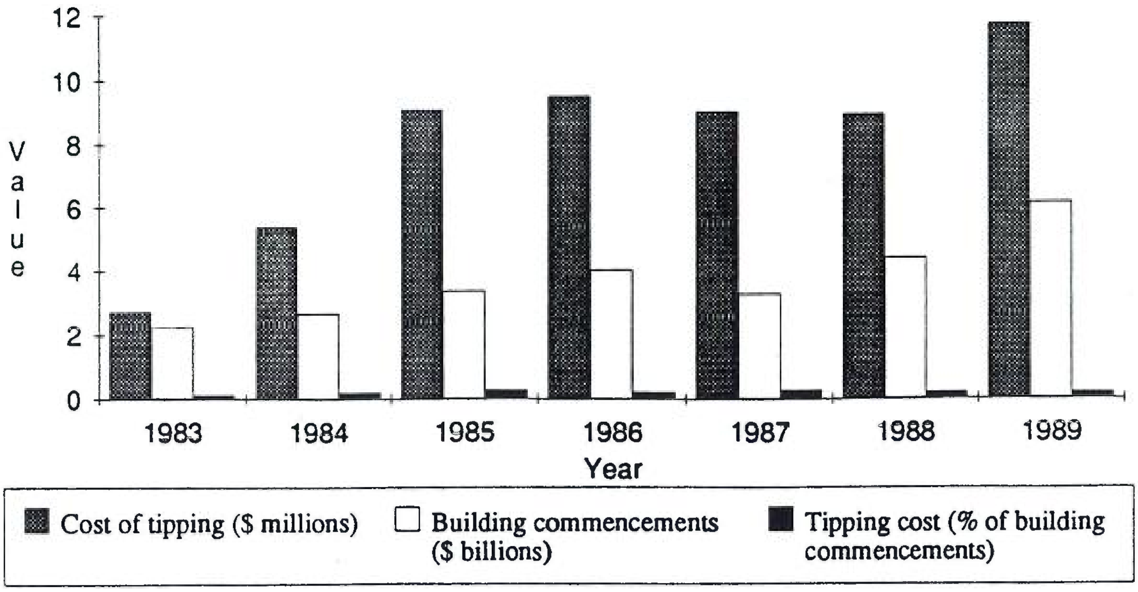


Figure 5.1
COST OF TIPPING AND VALUE OF BUILDING COMMENCEMENTS IN THE SYDNEY REGION

Table 5.3 **Estimates of the overall cost of disposing of demolition and building wastes as a proportion of the value of building commencements in Sydney***

Year	Total disposal costs ($ millions)	Value of commencements ($ millions)	Disposal costs as a proportion of building commencements (%)
1983	3.739	2,248.2	0.17
1984	7.518	2,673.6	0.28
1985	12.488	3,381.6	0.37
1986	12.962	4,028.8	0.32
1987	12.152	3,290.6	0.37
1988	12.189	4,423.3	0.28
1989	15.679	6,184.0	0.25

* *All dollar values expressed in constant 1989 prices.*

This finding supports the concern expressed by the WMA in its *Sydney solid waste management strategy* that waste disposal costs are not significant in industry's considerations (WMA 1990, 53).

5.4 PROJECT EXAMPLES

To confirm the significance of demolition costs as a proportion of total costs for individual projects and to check the accuracy of the findings of Section 5.3, discussions were held with Leighton Contractors Pty Ltd and Currie & Brown, Cameron & Middleton Quantity Surveyors. Both firms provided information on demolition costs, including transportation and tipping costs for specific projects that they had undertaken. This information is summarized in Table 5.4.

Table 5.4 **Project examples—Demolition and waste disposal costs as a proportion of total project costs**

Location	Project	Total project cost ($ millions)	Demolition and waste disposal costs ($ millions)	Demolition and waste disposal costs as a proportion of total costs (%)	Floor area of buildings demolished (m^2)	Demolition and waste disposal costs per m^2 of floor area ($)
North Sydney	Office	n.a.	n.a.	10.0	n.a.	n.a.
Burwood	Office	n.a.	n.a.	4.0	n.a.	n.a.
Manly	Retail complex	2.9	0.20	6.9	2,691	74.3
Casula*	School	29.4	0.53	1.8	12,000	44.2
Bankstown**	TAFE college	10.0	0.18	1.8	–	–
Birchgrove†	Housing	56.6	0.48	0.8	9,898	48.5
Chullora	Printing complex	108.0	0.81	0.8	18,267	44.3
Parramatta	Hotel	16.5	0.11	0.6	n.a.	n.a.

n.a. *Not available.*
* *There were approximately 100 small buildings and sheds on the site.*
** *Project did not involve total demolition, but removal of windows and walls for extension of building. No floor space was demolished.*
† *Project involved 3,136 square metres of floor space, 6,170 square metres of concrete site paving and 592 square metres of stone retaining wall.*
Sources: Leighton Contractors Pty Ltd; Currie & Brown, Cameron & Middleton Quantity Surveyors.

Table 5.4 indicates that demolition costs can represent a significant proportion of the total cost of a project. However, this will depend on the nature of the project (i.e. the type of building being demolished), what the building is being replaced with, and the location of the building.

In the case of the office development in North Sydney, the building demolished was to be replaced with a similar sized building. It was also advised that as the site was located immediately adjacent to a major road, there were restrictions on the times at which trucks could move in and out of the site. This increased the cost of demolition because much of the work was undertaken outside of normal working hours and was therefore subjected to penalty rates. Futhermore, the building demolished contained a large amount of asbestos which has become a costly item in the demolition process. The other projects outlined in this table generally indicate that demolition costs are not a significant component of project costs. The data provided in this table also suggest that the analysis of the cost of waste disposal to the building industry is likely to be reasonably accurate.

5.5 REFURBISHMENT OF OFFICE BUILDINGS

Table 5.5 summarizes Rawlinsons' estimate of the cost of refurbishing a twenty-five year old office building of approximately fifteen storeys in a central city block, with approximate waste generation figures provided from a range of other sources. It is noted that the Rawlinsons' estimate represents a national average and consequently the actual level of costs may be different in Sydney. However, this estimate still provides an indication of the relative importance (in cost terms) of the various undertakings associated with refurbishing an office building. Volumes of waste generation were identified separately with the assistance of quantity surveyors. In response to the growing interest in the refurbishment of office buildings, Rawlinsons has advised that future editions of its *Australian construction handbook* will provide separate estimates for each capital city.

Cost estimates for the disposal of external facades have not been included in Table 5.5 because of the large variation in the methods and types of materials involved. It is estimated that the total volumes of waste generated from this scale of refurbishment, not including the facade, would be approximately 460 tonnes, assuming a floor area of 1,000 square metres per storey.

Table 5.5 **Refurbishment costs of a twenty-five year old fifteen-storey office building in the CBD—National average for 1990**

Item	Total refurbishment cost ($)	Waste generation*		
		(m^3)	(t)	($)
Partial re-cladding and shaping of the exterior facade	2,350,000	n.a.	n.a.	n.a.
Partial gutting of the building interior and relocating service ducts	225,000	450	150	15,750
Recarpeting, new ceilings and redecorating throughout	1,500,000	500	250	17,500
Upgrading building services including electrical, central plant, air-conditioning and lifts, and new air handling rooms	3,750,000	45	15	1,575
Miscellaneous fittings and toilet area renovations	250,000	75	45	2,125
Fire escape and other regulation requirements	150,000	n.a.	n.a.	n.a.
Preliminary costs—Builder's site establishment and administration, plant, margins etc.	550,000	n.a.	n.a.	n.a.
Professional fees	975,000	n.a.	n.a.	n.a.
Total	**9,750,000**	**1,070**	**460**	**36,950**

* *The estimates for waste generation assume 1,000 square metres of floor area per storey, limited recycling of material, and disposal of waste by commercial skip operators.*

Sources: *Rawlinsons'* Australian construction handbook *for 1990; Currie & Brown, Cameron & Middleton Quantity Surveyors.*

Of the total costs of refurbishment, it is estimated that approximately $36,950 would be attributable to transport and disposal of waste material. This suggests that the waste management aspect of a project would be less than 0.38% of the total costs of the refurbishment.

5.6 DEMOLITION AND RENOVATION OF RESIDENTIAL DWELLINGS

The methods of demolition and types of materials produced are described in Section 4.1. From discussions with a private demolition contractor, a general cost estimate for demolishing a modest timber structure on brick piers with 'fibro' or other light cladding would be approximately $6,000. A similar structure of brick construction would cost $8,000 to $9,000 for demolition and site clearance.

It was also stated that the resale of materials from the site should pay for direct expenditure incurred during the demolition, although this would not include labour costs. It was noted that labour costs are the most expensive aspect of a demolition contract. In all demolitions, time was stated as being of the essence both for the builder to gain access to the site, and for the demolition contractor to reduce labour costs.

Usually, waste from demolition and renovation sites is disposed of in mini-skips, which generally come in sizes of 2, 5, 10, 15, 23 and 30 cubic metre capacity. These skips are hired from a waste disposal contractor for the duration of the project, with removal and disposal of waste as part of the costs associated with the contract. There are over forty contractors in the Sydney region currently providing this service.

Renovation of private dwellings is related to the building investment cycle, which is largely affected by house prices and interest rates. 'Gentrification' of inner city and near city locations has produced substantial volumes of mixed waste.

The prevalence of mini-skips around Sydney suggests that a significant quantity of demolition waste is generated from a plethora of small projects. In terms of total quantities of material, it is possible that these diffuse sources of demolition, refurbishment, renovation and building wastes may account for a substantial proportion of this waste stream.

5.7 DEMOLITION OF INDUSTRIAL BUILDINGS

The cost of demolishing industrial buildings depends on the location of the site, the size and type of construction, the materials used in the structure, the area available for establishment of temporary reprocessing plant and equipment, the extent of possible reuse of material on the site, and the time available for site clearance. Appendix D identifies a range of costs for demolition of different structures, based on a national average for the cost per square metre of building. These costs will depend on the factors listed above, as well as opportunities for economies of scale that may be available at a particular site.

As an example, a single-storey, light industrial/warehouse structure, with a reinforced concrete ground slab, framed walls and metal roof, would cost approximately $36 per square metre to demolish. This cost assumes complete disposal of all material at a landfill site. The variations in specific structures and other factors surrounding the demolition, must be assessed for each site.

6 CURRENT REUSE AND RECYCLING OF DEMOLITION MATERIALS IN THE SYDNEY REGION

6.1 EXTENT OF REUSE AND RECYCLING OF DEMOLITION WASTES

It was a commonly held view of the operators in the recycling industry that they were not involved in waste management, but were involved in a manufacturing or retail industry that merely used demolition products as the raw material. Recyclers of a variety of products including specialist fittings such as windows, doors, stained glass, fireplaces and mantle pieces, as well as resellers of bulk items such as bricks, timber and rubble, perceived their position as being in competition with waste disposal. The cost to a demolisher in transport, wages to clean, separate and sort material, handling and the present relatively low prices for landfill often resulted in valuable, reusable products being 'sent to the tip' rather than made available for the second-hand market.

For the purpose of this survey, reuse was defined as 'the application of demolition materials for a purpose, without some prior treatment of these materials being required in order to make them suitable for a new use'. Recycling involves some processing before the demolition materials can be used for a new purpose. An example of this is the crushing of concrete for use as a graded aggregate and sand resource.

The extent of reuse and recycling of demolition wastes in the Sydney region was investigated through a sample survey of twenty-two demolition contractors. While all the contractors included in the survey reported that they make demolition materials available for reuse, only eleven indicated that some of the demolition materials they handled were recycled. Individual responses are provided in Appendix G.

Examples of materials that are currently reused include bricks, kitchen, bathroom and laundry fittings, galvanized iron sheeting and construction timber products.

The results of this survey suggest that although the current incidence of reuse of demolition materials appears to be reasonably widespread, by far the largest volumes of material are reprocessed for resale in another form (Table 3.4). Notwithstanding the relatively large volumes of material that are presently being recycled, there is a large supply of demolition material that could be recycled but is currently being deposited into Sydney's landfill depots.

6.2 EXISTING REUSE OF DEMOLITION MATERIALS

A limited number of operators are involved solely in recycling—for example, The Brick Pit Pty Ltd (The Brick Pit) and the Second Hand Building Centre.

Reuse or recycling of material is more common in situations where it can be used on site in the subsequent construction. Roofing tiles are commonly reused (depending on their condition), as no preparation is required and the tiles can be stored on site until needed. Bricks are sometimes reused for unexposed walls, foundations and paving; however, bricks must be cleaned of excess mortar prior to use.

Discussions with demolition contractors also involved in the construction industry indicated that the level of recycling on site is generally low, with the following estimates suggested for the average level of reuse of material on site after total demolition of a residential dwelling:

- number of houses that have more than 5% of demolition material reused on site—one in 10 (10%);
- number of houses that have more than 20% of demolition material reused on site—one in 50 (2%);
- number of houses that have more than 50% of demolition material reused on site—one in 500 (0.002%).

A larger proportion of materials recovered from a demolition site re-enter the market from second-hand dealers.

6.2.1 TIMBER PRODUCTS

Timber products, particularly detailed features such as doors, architraves, mantle pieces, skirting boards and picture rails, have been recovered from buildings for a number of years, usually by specialist companies dealing with restoration of period buildings. Reuse of structural timbers has increased in the last ten years, mainly because of the availability of materials from a number of central points of sale.

There are two principal operators in the timber reuse industry in Sydney that deal with approximately 80% of structural timber recovered from demolition sites: Second Hand Building Centre, Rockdale, and Metropolitan Demolishers Pty Ltd, St Peters. The majority of other operators tend to deal in a wide range of second-hand products or to specialize in interior fittings such as restoration materials including doors, windows and fireplaces.

Recovered timber is sold by demolishers to dealers on a 'super foot' (12 inch by 1 inch) basis i.e. 1 foot of 6 inch by 2 inch timber equals 1 super foot. Standard prices are generally in the range of $25 to $40 per 100 superfoot, depending on the quality of the timber. In bulk volume, this averages out at $300 per cubic metre of timber. It was estimated that one of the dealers processed 5,000 cubic metres of timber per year, which suggests that approximately 10,000 cubic metres of structural timber is recovered annually by the two major operators. A further 5,000 cubic metres of structural timber would be used by a number of small operators or reused on site.

Recovered timber is generally transported to the central point of sale for processing and distribution. Processing involves removing nails and sawing the timber to specification sizes prior to resale. Offcuts of the timber are transported to a dealer in Penrith for sale as firewood. At present, the Second Hand Building Centre has a staff of fourteen people involved in all aspects of the operation, of which more than half are directly employed for reprocessing and sale of timber products.

An issue with reuse of structural timber is compliance with the Local Government Act. Under Ordinance 70, Part X, which deals with materials and workmanship, there are a number of general statements regarding faulty or unsuitable materials. There is no specific statement that eliminates the use of second-hand materials, although council can require testing of the materials at the discretion of the Building Inspector. The current practice of many councils is for the request to use second-hand timber to be included in the building application. The timber is usually inspected prior to use, and it was stated that 'second-hand timber is often better than new material, particularly for roofing members, as it is well seasoned' (Dennis Boyd, pers. comm., March 1991).

6.2.2 REUSE OF BRICKS

As discussed above, bricks can be reused in construction after they have been cleaned to remove mortar and other foreign materials. The cleaning process is undertaken by hand, and mortar or other foreign matter is removed from each brick individually. It is usual practice to begin brick cleaning after the walls have been knocked down. The bricks are hand picked from the pile of bricks and rubble, cleaned, and stacked near the demolished wall. The stacks must be out of the way of other activities on the site so that removal of remaining waste can be undertaken and foundation work can commence.

The present cost of cleaning bricks for reuse varies depending on availability of labour, and the condition of the bricks; however, an average price of about $25 per hundred bricks appears to be a commonly used rate. The cost of approximately equivalent new bricks ('dry pressed commons') is $340 per thousand. A modest three-bedroom double-brick home of 12 to 14 squares would use approximately 18,000 to 20,000 bricks. For a similar sized brick veneer house, 7,000 to 9,000 bricks would be required. Second-hand bricks are almost never used for facing, although an increased proportion of recycled bricks can be used if the building is to be cement rendered. In brick veneer homes, reuse of bricks is limited to foundations and walls to be rendered, which generally form a small part of these constructions.

Where cleaned bricks are moved from the site, loading and transport costs increase the total costs and reduce the price difference between the cleaned bricks and new materials. The sale price of second-hand bricks from dealers is variable, but is usually within the range of $280 to $340 per thousand; however, loading and transport are additional costs.

The largest specialist reseller of used clean bricks in the Sydney region is The Brick Pit at North Ryde. A number of sources in the industry suggested that The Brick Pit handled approximately 50% of the total Sydney market, with the remainder handled by a number of operators that carried a broader range of products.

The Brick Pit has a turnover of approximately 100,000 bricks per week, with the vast majority (99.9%, Don Holt, pers. comm., January 1991) being 'commons'. The resale price ranges from $280 to $340 per thousand bricks, although speciality bricks such as sandstock are sold in much smaller volumes and can be up to $1 per brick. It is industry practice for the bricks to be cleaned at the demolition site and transported to the resale yards in mini-skips or on pallets.

Bricks weigh approximately 4 tonnes per thousand, which suggests that approximately 40,000 tonnes of bricks are reused annually from sales through second-hand dealers. It is not possible to identify accurately the amount of bricks that are reused at individual construction sites; however, it is estimated that the total amount reused on site would be at least 25% of the amount sold to recyclers. This suggests that an additional 10,000 tonnes of bricks are reused annually by the Sydney construction industry.

6.2.3 OTHER DEMOLITION PRODUCTS

The majority of the remainder of demolition waste is rubble, with lesser amounts of reusable materials. Building rubble is disposed of in a variety of ways, the principal three methods being reuse on the demolition site as fill, landfill disposal, and reprocessing rubble to make new specification aggregate products. This latter category is discussed in greater detail in Section 6.3.

Roofing tiles can be stored on site, until required for completion of the roofing, or transported to resale yards. As the tiles are the first items to be removed and the last items to be placed to achieve the 'lock-up' stage of the development, it is necessary to have sufficient storage space on the site that is not required for other stages of building. The process involves removal of tiles from the roof, separation of damaged tiles, and hand stacking of each tile in layers. Further processing of tiles for reuse is not required. Where space is available and tiles are to be used in the proposed structure, reuse of roofing tiles can be cost effective. A modest three-bedroom house would use approximately 2,000 roofing tiles at a price of about $1.50 each. The reduction in transportation costs and reduced disposal charges are good incentives to reuse these materials.

Galvanized iron from roofing in good condition with limited rust, has a strong demand for reuse. The Second Hand Building Centre experiences a sustained demand for galvanized iron sheeting (Chris Barber, Managing Director, pers. comm., January 1991), which remains at the sale yards for a very short period. It is estimated that over 1,000 to 1,500 tonnes of this material would be reused annually in the Sydney region.

Fittings such as bathroom, kitchen and laundry items, as well as usable light fittings, will be removed in the initial strip out of a building. There are a number of specialist organizations, including the Second Hand Building Centre, that sell these second-hand items. (These items include sinks, baths, shower recesses and basins, which are not generally heavy but can take up considerable space in landfill sites unless broken or crushed.) It is estimated that approximately 2,500–3,000 tonnes of fittings would be recycled and avoid landfill disposal.

Other items such as doors, cast iron fireplaces, mantle pieces, stained glass windows, wrought iron and other speciality features fetch a premium price on the resale market, and are eagerly sought by companies involved in restoration. Organizations such as Architectural Heritage in Glebe have a high turnover of these items. It is estimated that the restoration industry would absorb over 1,000 tonnes annually of reusable speciality items from demolition sites.

6.3 EXISTING RECYCLING AND REPROCESSING OF DEMOLITION RUBBLE

Recycling of building rubble is undertaken by a number of contractors in the Sydney region. There are essentially two systems in operation: Firstly, portable machinery that is moved to specific sites for the duration of a demolition; and secondly, fixed installations where the raw materials are delivered to a central reprocessing site.

The portable machinery is generally available at an hourly rate, and is used on larger scale demolitions where the floatage, establishment and operational charges can be amortized against the benefits of reduced disposal costs.

As discussed in Section 3.3, the majority of portable crushers are used for on-site reprocessing of material to be compacted as fill for the proposed development. This is the principal method of reusing demolition rubble, with approximately 340,000 tonnes reused annually. However, this figure is considered conservative because many sites would not employ crushing machinery, but would simply use heavy dozers and rollers to compact rubble on site.

There are presently three fixed installation operators—Bradys Pty Ltd, Recycled Resources Pty Ltd and Concrete Recyclers Pty Ltd—that reprocess material for sale to the construction industry. These operators collectively produce approximately 240,000 tonnes per annum of specification materials; however, with the recent downturn in building activity (1990–91), this volume has decreased. An additional 50,000 tonnes (approximate) were reprocessed in 1990 at Kimbriki Road waste disposal depot (Bill Brideau, pers. comm., March 1991), and were available for resale to the construction industry and used in council construction.

The major operators with equipment for reprocessing demolition rubble in the Sydney region are:

• Bradys Pty Ltd	96a Bay Street, Botany
• Portaplant Australia Pty Ltd	8 Loftus Street, Riverstone
• Recycled Resources Pty Ltd	134 Carnarvon Street, Silverwater
• Sydney Earthmovers Pty Ltd	Perimeter Road, Mascot
• Davis Earthmoving and Quarrying Pty Ltd	138 Wirreanda Road, Ingleside
• Kari and Ghossayn Pty Ltd	169 Haldon Street, Lakemba
• Concrete Recyclers	Bennelong Road, Homebush.

6.3.1 TYPES OF REPROCESSING EQUIPMENT

The majority of reprocessing operators in the Sydney region use primary jaw crushers. Cone crushers and ball crushers have limitations on the size of feed materials and are generally not used for primary crushing; however, they can be used in secondary reprocessing. Davis Earthmoving and Quarrying Pty Ltd, and Portaplant Australia Pty Ltd have the only impact crusher presently operated in the Sydney region.

Almost all of the recycling plants currently operating in the United Kingdom utilize jaw crushers, whereas recycling plants in the rest of Europe favour the use of impact crushers, (Mulheron 1988). Normally, impact crushers produce a more angular product than jaw crushers and also have a larger reduction factor. Mulheron (1988) states that:

> this is important because for the same maximum size of coarse recycled aggregate an impact crusher will generate twice the amount of fines produced by a jaw crusher. The majority of other equipment currently in use in the UK has been obtained second hand from quarry plant manufacturers and modified to meet the requirements of demolition debris. In part this helps explain why the quality of recycled aggregates produced in the UK is generally lower than that produced in some parts of Europe.

The benefits of impact crushers are also noticeable in operational aspects of processing reinforced concrete. The method of action of an impact crusher, together with its rotating fly wheel, can flail off concrete from reinforcing steel and provide a relatively clean product for scrap metal merchants. Jaw crushers, by their 'squeezing' pressure action, have a greater tendency to jam when processing reinforced concrete, and are more likely to retain lumps of concrete on the steel. A more detailed comparison of the various types of equipment and the resulting products is presented in Hansen (1986). In general terms, impact crushers produce higher quality products (with a larger proportion of finer particles than jaw crushers), but are more expensive to purchase and operate.

The separation of crushed material generally involves a self-cleaning electromagnet for ferrous metals, followed by a sequence of vibrating screens to sort the products to a range of sizes for stockpiling. In fixed-site operations, secondary crushers or granulators are sometimes used for greater differentiation of product sizing. Figure 6.1 is a schematic diagram of the processing arrangement that can be used in fixed-site operations. This set-up is very similar to the operation of Recycled Resources Pty Ltd at Silverwater.

Plates 6.1 and 6.2 show the components and layout of a fixed installation reprocessing plant using a primary impact crusher.

6.3.2 TYPES OF PRODUCTS PRODUCED

Appendix H is an advertisement from Recycled Resources Pty Ltd that identifies the prices for accepting a range of demolition materials and the range of products available from the reprocessing operation. The price per tonne of the various products is generally less than the equivalent price for natural raw materials ex-pit; however, there is also a

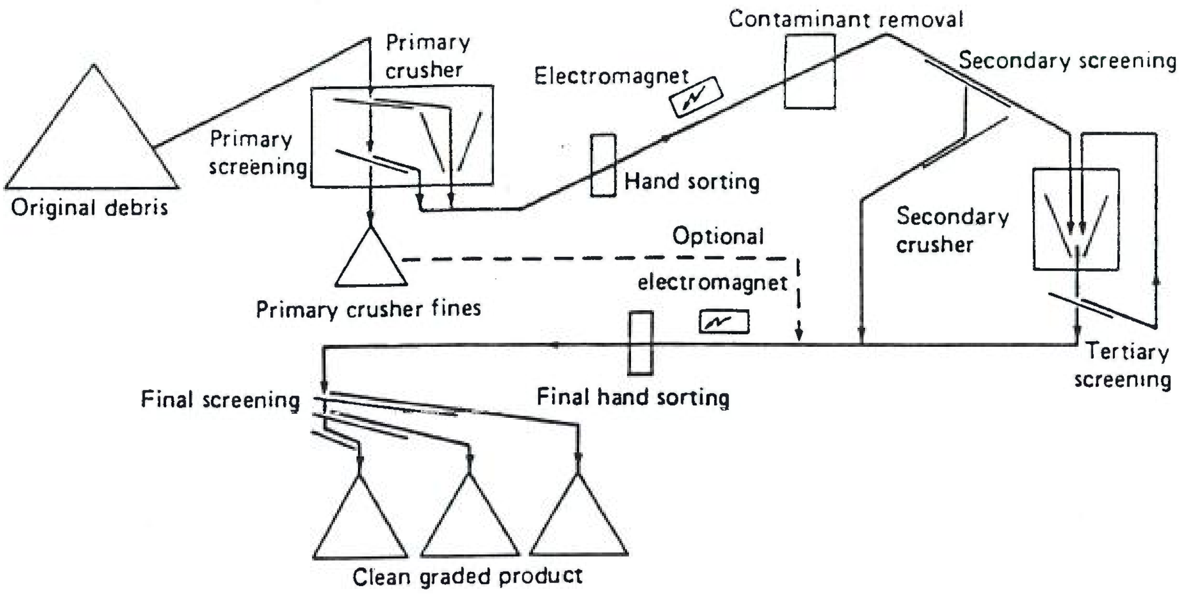


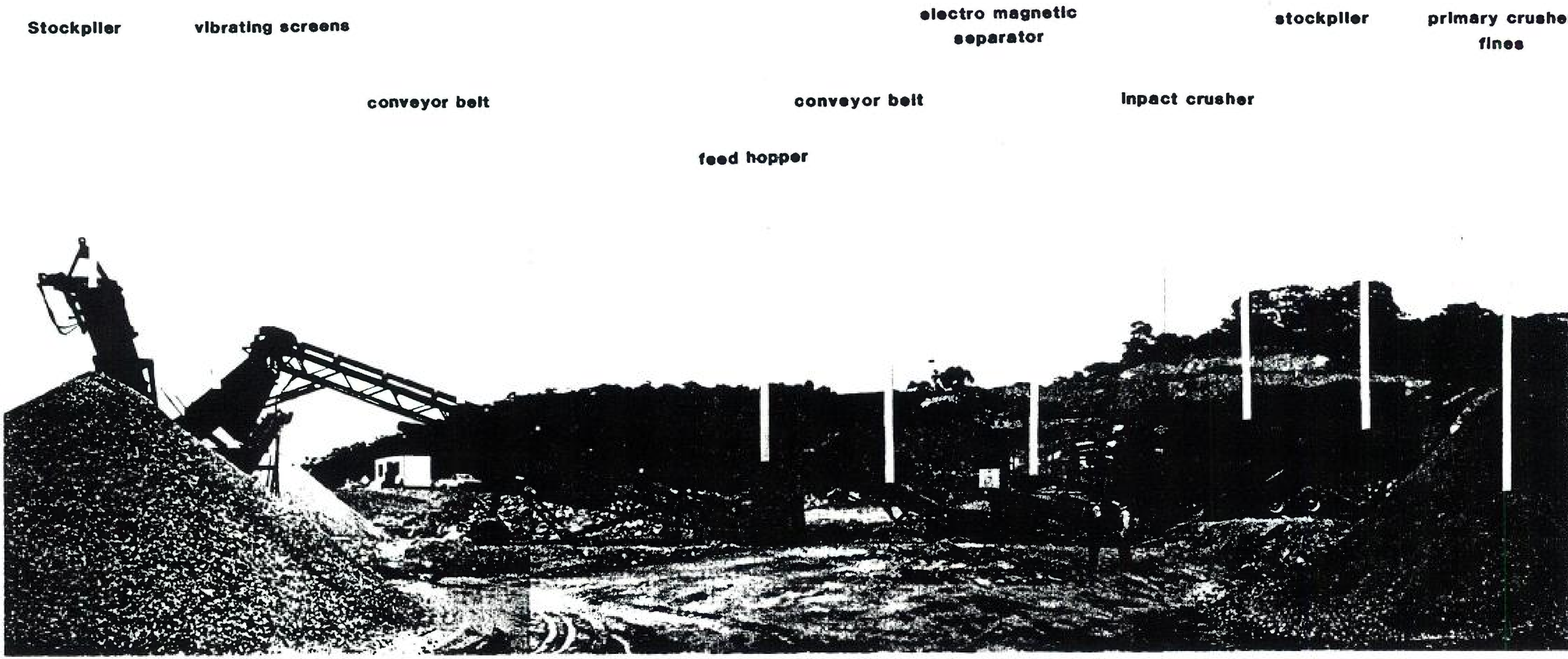
Figure 6.1
TYPICAL LAYOUT OF A FIXED-SITE RECYCLING PLANT

significant transport cost advantage for areas east of Silverwater, as the natural raw materials largely come from western Sydney in the Hawkesbury–Nepean area. Products generally available include roadbase (<30 mm) and sand equivalent materials (<75 mm) in a range of grades, with costs varying from $6 to $8 per tonne.

Plate 6.3 indicates the range of materials that can be produced from reprocessing demolition rubble. Secondary crushing and a variety of screen sizes can produce a number of products to various specifications outside those shown in Plate 6.3.

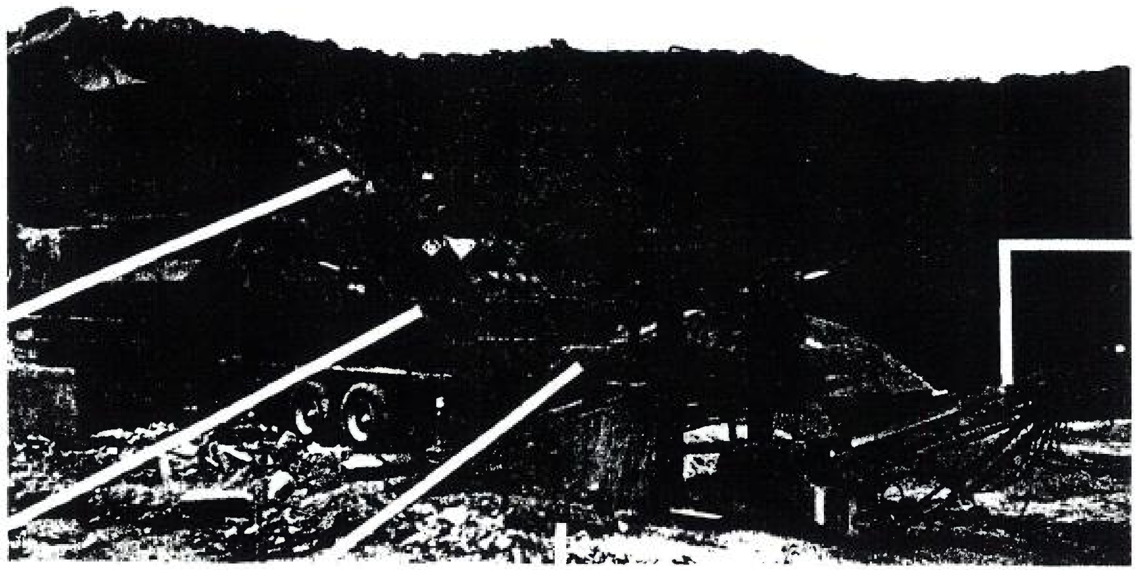
The quality of the resaleable product is largely determined by the extent of contamination of the raw material. Where the material is free of timber, plastics, metals and other contaminants, the products for resale can be generally consistent quality. A range of methods have been used to encourage delivery of uncontaminated material.

One fixed installation recycler insists on dumping the material delivered to the site in order to inspect the rubble. If the debris is contaminated, the driver must reload the material for disposal elsewhere. Even though the driver may not be aware of material originally being loaded on to the truck, the threat of non-acceptance of material is a very strong economic incentive for delivery of clean material. The result of this strict quality control of delivered material has been a higher standard of saleable products, with more consistent specification materials.



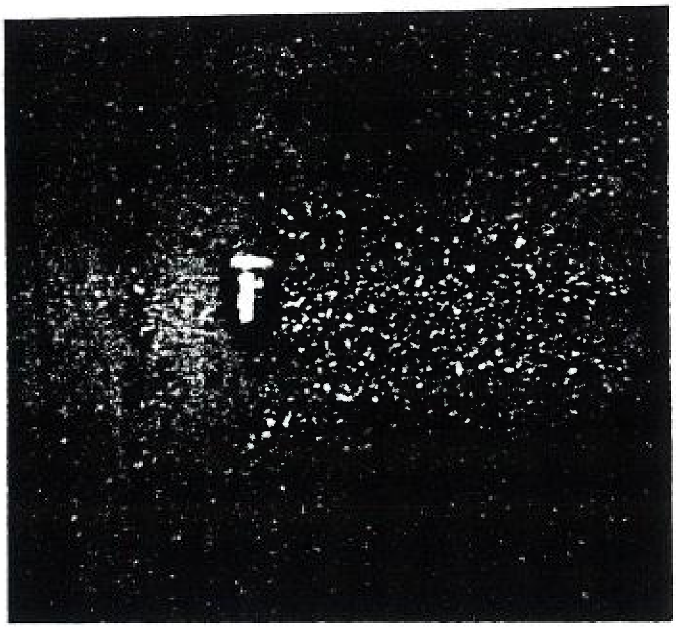
LAYOUT OF A FIXED INSTALLATION
DEMOLITION RUBBLE REPROCESSING OPERATION

PLATE 6.1



LAYOUT OF A FIXED INSTALLATION DEMOLITION RUBBLE REPROCESSING OPERATION

PLATE 6.2



sand fraction

minus 20mm
aggregate

minus 50mm
aggregate

note: film canister for scale

REPROCESSED MATERIALS FROM DEMOLITION RUBBLE

PLATE 6.3

There is a high demand for crushed terracotta as evidenced by its acceptance at Recycled Resources Pty Ltd (at no cost) and the price of $70 per tonne for 'decorative red gravel'. Because of the long wearing and attractive nature of terracotta products, there is a sustained demand for this material, which has led to several niche markets, including pavement surfacing for driveways and private roads.

Although reprocessed demolition rubble has not been universally accepted as an alternative to natural raw materials, the buyers of existing supplies have included private building contractors, local councils and State government authorities.

7 POTENTIAL FOR INCREASED REUSE AND RECYCLING OF DEMOLITION WASTES IN THE SYDNEY REGION

7.1 INTRODUCTION

With waste minimization as the cornerstone of the *Sydney solid waste management strategy* (WMA 1990), alternative methods of handling demolition materials must be supported to avoid disposal in landfill sites. This encouragement can come in a variety of ways, from tighter regulation of demolition waste by mandatory preparation of waste management plans as a condition of approval, to pricing structures at landfill sites to generate a stronger incentive to find alternative disposal methods.

Economic criteria are the primary control over improved resource management of demolition materials. The present disincentives to recycling appear to be due to a combination of the following factors:

- the relative cheapness of raw materials;
- the relative cheapness of landfill disposal;
- the lack of depots and facilities for recycling demolition waste;
- limited market acceptance for use of reprocessed materials;
- the lack of large operators with long-term experience in both the building and the demolition industries.

One issue gaining acceptance is the broader consideration of economic issues rather than direct costs to industry. The Commonwealth Industry Commission (1990) has included social costs and benefits, and resources management issues in its analysis of recycling. By including these 'externalities' in its review of the economic structure of the building and demolition industries, it foreshadows a readjustment of existing priorities.

7.2 INTERNATIONAL EXAMPLES OF DEMOLITION MATERIAL RECYCLING

In Europe, the United States and Japan, landfill disposal costs have increased because of shortage of sites and increased transport costs. Consequently, a significant amount of research has been directed towards reuse and recycling of demolition debris. Investigations and improvements to management of the rubble waste stream have largely been towards recycling of materials rather than landfill disposal. Developments in disposal of other waste materials have focused on incineration or more efficient packing of material into remaining landfill sites.

7.2.1 EUROPEAN DEMOLITION MATERIAL RECYCLING

A variety of approaches have been taken in different parts of Europe, as described in the report titled 'Demolition waste' (Environmental Resources Limited 1980); however, a number of common principles underly the successful operations. Mulheron (1988), in a useful summary of the present position in the United Kingdom, stated the following:

- Recycling of debris by demolition contractors is 'essentially a profit motivated operation resulting from the high cost of transporting and tipping demolition debris in urban areas'.

- 'Whilst high tipping costs encourage recycling of demolition debris it is also necessary that there is a market for the recycled product'.

- 'For recycled aggregates to compete with natural aggregates, a minimum price differential of between 1 and 2 pounds (approximately A$2 to A$4) per tonne is required' (1985 prices).

- 'Whatever the economics of the recycling operation, unless the recycled product is acceptable to the local authorities its use will be severely limited'.

In summary, Mulheron found that, in the United Kingdom:

> recycling of demolition debris is carried out by a limited number of demolition contractors and only when the economics of the operation are favourable. In almost all cases the level of processing that occurs is limited to simple crushing, followed by sieving and hand sorting. As a result the quality of the recycled product is largely determined by the type of debris being processed and is normally only suitable for fill and sub-base applications.

Investigations have been undertaken in the United Kingdom by Lindsell and Mulheron (1986) to examine the qualities of crushed and reprocessed concrete for use as aggregate in new concrete applications, as well as other value-added uses for reprocessed material. Detailed studies of the relative grading and strength of concrete made from crushed and screened concrete products have been undertaken with a view to establishing the range of alternative markets for reprocessed demolition material.

It is common practice in Europe for unsorted demolition waste to be deposited at reprocessing depots. This mixed waste can require up to twenty different sorting, separation and processing activities. These sophisticated installations have very high capital and operating costs; however, they are viable because of limitations on landfill sites and the unavailability of raw materials. These facilities can accept a wider range of materials and therefore receive a larger proportion of the demolition waste stream.

Intensive recycling of demolition materials is now practised in the Netherlands and the northern part of Germany (Zurbrugg 1986). In the Netherlands, more than sixty stationary and mobile recycling plants have been established. The largest plant, at Rotterdam, has an annual capacity of 200,000 tonnes. In what was the Federal Republic of Germany, there are over sixty recycling plants with a total capacity of 10 million tonnes per year, which is more than 65% of all available structural rubble (Hansen 1986).

The strong motivation for this development is the shortage of gravel deposits and the high long distance transport costs. In southern Germany and Switzerland, raw materials are more readily available; however, the shortage of landfill disposal sites has encouraged a greater degree of demolition waste recycling (Zurbrugg 1986).

In Zurich, two sorting plants have been commissioned, the first in 1988, to separate mixed demolition waste. Analysis of an average waste sample from the region showed that approximately 10% of the waste was ferrous metals, 57% (by volume) was flammable items (wood, plastics, paper etc.), 28% (by volume) was concrete and bricks, and 5% (by volume) was disposed of at landfill sites. This recycling of mixed demolition waste significantly reduced the demands on landfill disposal, and is an increasing trend.

The first major permanent recycling installation in France commenced operations in 1986 at Gennevilliers, north of Paris. This plant has an annual capacity of 150,000 tonnes of rubble, which is converted by a series of crushers and screens to coarse material (<30 mm) for filling ditches during highway construction (approximately 50%), sand grade (15%), chippings (20%), and mixed fill for road embankments (15%). The primary motivation for this recycling approach was the shortage of raw materials, particularly aggregate, and the expense of transporting products for construction purposes (Schulhof 1986).

In the USSR, it has been reported by Zagurskij and Zhadanovskij (in Hansen 1986) that eighteen reprocessing plants are presently operating across the country in association with precast concrete factories. Four of these plant are based in the Moscow area. Collectively, these plants have a total annual capacity of 720,000 cubic metres.

7.2.2 OTHER RECYCLING PRACTICES

In the United States there has been extensive research into recycling of road materials for use in freeway construction. The material to be reprocessed is commonly from the existing highway and is, therefore, relatively uniform, with limited contaminants of wood, glass or plastics. This has been found to be a very inexpensive substitute for natural raw materials. The cost benefits of this approach have encouraged the Federal Highways Administration to establish two and three-man teams to assist State highway departments in the recycling of old pavements, and to offer to underwrite part of the costs involved (Hansen 1986).

Although not specifically identified, it has been observed that the 'numerous commercial concrete recycling plants in major metropolitan areas around the US are of greater economic significance than concrete pavement recycling projects' (Hansen 1986). Limited recycling of demolition materials has been reported in other areas; however, demands on landfill sites and the costs of transporting natural raw materials will create a stronger market for recycled material.

Use of reprocessed demolition debris as specification sub-base for airport construction has occurred at Love Field Airport in Dallas, Texas, and Jacksonville Florida International Airport. At Volkel Airport in the Netherlands, recycled concrete was used in the lean concrete base course and in the concrete pavement.

An interesting development in the United States not mentioned in other literature is the recycling of gypsum wall board by National Gypsum, using technologies devised for reuse of offcuts in the manufacturing process (*Economist*, 8 September 1990). Gyprock is one of the more difficult contaminants to remove from mixed waste. It has a negative impact on the quality of reprocessed sand-sized material for use in concrete—it is highly water retentive, floats and tends to form a point for failure—and, therefore, development of cost-effective reuse for this material will broaden the markets for less contaminated reprocessed demolition waste products.

Japan has a greater urgency to maximize the reuse of construction materials because of the limited availability of natural materials. Discussion of the extent of reprocessing and use of crushed concrete and cement is outlined by Yoda et al. (1988). Studies have been undertaken on the strength of concrete produced from recycled concrete aggregates, and the opportunities for recycling of pre-stressed and steel reinforced concrete structures. A Standard has been proposed for the 'Use of recycled aggregate and recycled aggregate concrete'; however, acceptance of this Standard by authorities has not been resolved (Hansen 1986).

7.3 OPPORTUNITIES FOR DEMOLITION MATERIAL RECYCLING IN THE SYDNEY REGION

Standards for acceptance of demolition materials at reprocessing sites vary, and this results in products with different levels of contamination by wood or gyprock particles. The nature of the concrete and construction industry is such that many materials are acceptable as long as there is consistency of supply to a stated specification. For example, in concrete manufacture a range of materials from a variety of sources can be blended to achieve the required specification. The issue that determines the sources of raw feed are the delivered costs, including transport, of the competing products.

It is the variability of raw materials that provides the greatest problems in reuse of reprocessed materials. Where the quality of products is not consistent, there is little opportunity for the market to become accustomed to the strengths and weaknesses of particular materials. The strict standards applied by some of the fixed installation operations have increased market confidence in the quality of available products. As the consistency of products from operators becomes more universal, the market acceptance will also increase.

Major engineering projects may encourage a shift in the current practices of demolition operators. A present example of a large reprocessing operation is the development of taxiways at Sydney (Kingsford Smith) Airport. Sydney Earthmovers Pty Ltd has been accepting demolition rubble at the airport for reprocessing since late 1989, and it has been estimated that approximately 100,000 tonnes will be used at this site (Kevin Langford, Federal Airports Corporation, pers. comm., March 1991). The criterion for acceptance is that the material is demolition, building or excavation material that is free of contaminants. The resulting products have been used as subgrade and base course for construction work.

A further example of an opportunity to use reprocessed rubble is the proposed third runway at Sydney (Kingsford Smith) Airport. It is proposed that the third runway be built parallel to the existing north–south runway at the airport on reclaimed land in Botany Bay. It is estimated that the runway would require approximately 11 million cubic metres of bulk fill material (Kinhill Engineers Pty Ltd 1990). However, for construction of a stable runway structure, the bulk fill to be used must be capable of being compacted to its densest configuration relatively quickly, and must not be subject to slip or other failure after placement (Kinhill Engineers Pty Ltd 1990, 16-1). Demolition materials such as concrete, bricks, tiles and sandstone were identified as suitable materials for use as landfill while other demolition materials such as timber, plastics and metals were considered unsuitable for a variety of reasons including ability to decompose or toxicity (Kinhill Engineers Pty Ltd 1990, 19-11).

Use of demolition materials for this project would require improved sorting at source as well as processing at the construction site. This would include crushing material to gravel and sand-sized particles with steel reinforcing being removed at this stage of processing. The Draft Environmental Impact Statement indicated that this type of fill material could be provided at an average cost of approximately $3 per cubic metre, depending on the type of material used, the speed of crushing, and assuming that the waste was delivered to the site free of charge (Kinhill Engineers Pty Ltd 1990, 19-12).

7.3.1 PROPOSED MAJOR DEVELOPMENTS IN THE SYDNEY REGION

Over the next five years there are a number of areas where the likelihood of generation of demolition rubble will increase. The State Environmental Planning Policy for medium density housing (State Environmental Planning Policies 25—Residential allotment sizes—and 28—Town houses and villa homes) will encourage urban consolidation, which will increase demolition and construction of housing in established residential areas. Discussions with thirty local councils revealed a large diversity of approach, ranging from specific areas identified for medium density rezoning, to being available at any site on a merit basis but unrestricted to localities.

Urban consolidation generally results in a large number of individual relatively small-scale projects being undertaken. Particular sites rarely provide the volumes of material to economically justify reprocessing on site; however, fixed installation operations to service a regional demolition rubble catchment could encourage significant reuse of material. The lower north shore of Sydney is a region of substantial urban consolidation and other demolition. Therefore, it is suggested that a location in the Artarmon industrial area adjacent to the waste transfer depot be acquired for a reprocessing operation. This would also assist in providing a local supply of raw materials for construction purposes.

Some specific projects are planned for the Balmain foreshores area, where the recent rezoning of the land will lead to the demolition of five major industrial installations. With the sea access and the adverse impact of truck movements on traffic on the Balmain Peninsula, it is possible that a portion of the material will be transported by barge to ocean dumping sites.

Developments in Black Wattle Bay, such as the large bulk storage grain silos, were proposed for demolition; however, the Maritime Services Board has recently decided to lease this area for a further ten years, which may delay the timing of demolition of the present structures. Other plans for redevelopment of the Pyrmont Peninsula will generate substantial volumes of demolition rubble, and provide a demand for construction materials.

Pyrmont and Balmain power stations have been targeted for decommissioning and demolition. It is estimated that over 50,000 tonnes of demolition rubble will result from each of these projects, and that this will encourage establishment of reprocessing equipment on the site for the duration of the demolitions.

The Sydney CBD is unlikely, in the current economic climate, to be an area of major demolitions over the next two to three years. However, refurbishment of office, commercial and retail properties is likely to be sustained and will probably increase during this period. Existing mechanisms for reuse of materials should accommodate this trend, but significant advantages to the demolition industry and the WMA could be achieved by more detailed separation, sorting and shredding of waste materials prior to transport and disposal at landfill sites.

Another near city site presently undergoing demolition is the Enmore Railway yards. The current demolition is restricted to removal of some of the lighter constructed (fibro and metal cladding) work sheds. The present temporary use of some of the larger halls for 'Paddys Market' will probably cease with the completion of the new Haymarket site, which may signal the further demolition of some of the Enmore Railway yards. In general, the buildings have thick reinforced concrete flooring, double-brick walls and metal cladding roof structures on metal framing. The majority of this material could be reused or recycled.

Major developments at Botany Bay include the proposed third runway at Sydney (Kingsford Smith) Airport, and the planned Port Botany extensions. Both these sites require substantial amounts of fill material, and selected reprocessed demolition rubble could assist in the provision of fill requirements.

New release areas such as the North West Sector and South Creek Valley developments will generate substantial amounts of excavation material during the construction phase. It is likely, under present policy and pricing structures, that a portion of this material would be deposited in landfill disposal sites.

7.4 PROPOSED PRINCIPLES FOR DEMOLITION WASTE STRATEGY

It is suggested that a demolition waste recycling strategy be formed and that the fundamental basis for this be incentives and disincentives i.e. pricing structures that provide an economic advantage for greater reuse of material, and cost penalties for inefficient sorting at source. The second part of the strategy would involve a degree of regulation, which would require direct and indirect support from local and State government authorities. Further explanation of these issues is presented in Section 8.

The present reuse of fittings, timber, corrugated iron and bricks is reasonably achieved with existing operators. The strongest incentive to increase this reuse would be for selective increases in landfill disposal costs for these types of materials.

Potentially, the area where the greatest gains in recycling demolition material can be achieved is in the reprocessing of building rubble. There are two matters to be addressed: how to increase the volumes of demolition rubble available for reprocessing, and how to encourage demolition contractors to provide more uniform materials for reprocessing. In terms of general principles, this can be achieved by:

- encouragement of more detailed stripping out of buildings prior to demolition;
- economic encouragement for separation of materials at source;
- encouragement of temporary installation of crushing plants for particular demolitions;
- establishment of fixed installations at strategic locations for reprocessing of :
  - demolition rubble for resale of products to the construction industry
  - mixed waste to minimize the volume of material for landfill disposal.

7.4.1 MARKET ACCEPTANCE

A primary issue in reprocessing demolition rubble for resale is the acceptance of the products by the market. It is pointless to provide large volumes of material if it cannot be absorbed into engineering and construction projects.

The market for reprocessed products will largely depend on the relative price of new raw materials, and the cost of delivering the materials to the construction site. Applying a levy to recycling operators reduces the price advantage of using reprocessed products, and shifts the emphasis back to the use of new raw materials.

Quality of products tends to be a secondary issue to the price of materials. Even so, it is very important that products satisfy particular specifications. A vital issue from the market's perspective is the maintenance of consistency of products. Even if the price is acceptable and the material is available, a contractor who is not confidant that the material is the same as that previously used will be reluctant to use the recycled product in preference to new raw materials.

7.4.2 TRANSPORT BENEFITS

As the market for raw materials is sensitive to price, the cost of transporting raw materials can have a significant bearing on selection of construction materials. The closeness of reprocessing operations to demolition sites also provides a cost advantage to contractors for disposal of demolition rubble.

In view of the transport costs to both the demolition and construction industries, there are substantial benefits to be gained by establishing fixed installation demolition rubble reprocessing operations in regionally central locations. This could provide the dual benefits of a local supply of raw materials, and a relatively nearby location for depositing demolition rubble.

7.4.3 ESTABLISHMENT OF PRODUCT STANDARDS

Local and State government authorities are the largest institutional users of raw materials, largely for infrastructure installation and maintenance. Government authorities can encourage the use of reprocessed materials in two ways: firstly, by establishing appropriate Standards for the reuse of these products; and secondly, by purchasing materials for their own construction projects.

There are many applications where reprocessed materials are adequate, if not superior to new raw materials. As there are no specifications directly applicable to reprocessed products, there is a strong reluctance by site engineers to use these materials in preference to products for which there is a defined standard. Although there is an increasing market acceptance of reprocessed products, contractors will be reluctant to use these materials until institutional purchasers become significant buyers.

Some of the councils that have used reprocessed materials include Warringah, Sutherland and Hornsby shires, with Hurstville and Willoughby municipalities also using a portion of products for maintenance and construction purposes

7.4.4 REGULATORY INITIATIVES

Industry's attitude to reprocessed products might be altered if government were to require waste management plans as part of the development approvals process.

Examples of other types of plans being required in support of a development application include erosion and sediment control plans, wetland management plans and bushland management plans. The focus of these requirements is for on-site controls; however, the off-site impacts of major developments should form part of the information provided to decision makers.

More rigorous application of the *Waste Disposal Act 1970* (NSW) or, alternatively, a relatively minor addition to Section 90 of the *Environmental Planning and Assessment Act 1979* (NSW) outlining the requirements for such plans could achieve this result.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

The principal conclusions arising from this study are outlined in Sections 8.1.1–8.1.5.

8.1.1 THE INFORMATION BASE

The information available on generation of waste from the demolition industry is extremely poor. Indirect data sources and interviews with operators across a broad range of activities were required to provide the information presented in Sections 1–7.

The present recording of waste type and volume submitted to the WMA is inadequate to accurately assess the extent of demolition material currently entering landfill depots.

The present system of levying charges on private landfill disposal operations, on the basis of Section 29 reports, is inadequate to accurately determine the types and tonnages of material presently being tipped.

8.1.2 SIZE OF THE DEMOLITION INDUSTRY

The present number of operators advertising demolition services in the Sydney region is 147. There are also a number of builders and home and office renovation companies that collectively produce significant quantities of waste but are not included in this number.

The demolition industry in the Sydney region has grown substantially during recent years; however, this growth has occurred during the expansion phase of Sydney's building investment cycle.

Comparison of the number of demolition contractors with the level of building commencements in the Sydney region indicates that the number of demolition businesses is directly linked with fluctuations in building activity. The sensitivity of individual demolition businesses to fluctuations in the building industry is further suggested by the fact that only 14% of demolition contractors listed in the 1973/74 *Telecom yellow pages* were still listed in the 1991 *Telecom yellow pages*.

8.1.3 TYPES OF DEMOLITION WASTE GENERATED

Between 50% and 70% of the demolition waste stream is generated from residential dwellings, with the other major contributor being commercial buildings (i.e. retail and offices), which account for 20–40% of demolition waste. The broad composition of these wastes is discussed in Chapter 4.

Analysis of the total production of demolition waste and the various sources of material are summarized in Table 3.4, and discussed in Chapter 3.

A sample survey of demolition contractors in the Sydney region indicates that, although the current reuse of demolition materials appears to be quite high, the same cannot be said of individual demolishers reprocessing material for recycling.

The present reuse of fittings, including bathroom, laundry and kitchen fittings, is largely conducted by second-hand dealers within the industry. Increased reuse of these materials will depend almost completely on the market for second-hand materials as compared with the price of new fittings. This is because the relative volumes in terms of total waste generated are insignificant, and costs of disposal would not be a strong incentive to increase the extent of recycling.

A number of timber products are presently reused; however, the time involved for careful stripping out is often not fully rewarded by the value of saleable material. Heritage-type materials including skirting boards, architraves, mantle pieces, windows and doors usually achieve a premium price.

Structural timbers are more variable in their reuse on a site specific basis; however, it is estimated that 15,000 tonnes of structural timber are recycled annually in the Sydney region.

Reuse of bricks is largely handled by a small number of second-hand dealers. Approximately 40,000 tonnes of bricks are resold annually through dealers, and it is estimated that at least an additional 10,000 tonnes of bricks are reused on demolition sites for subsequent construction.

Sorted demolition rubble, suitably reprocessed, can be used to provide a cost-competitive and more environmentally favourable source of raw materials than many new natural resources.

High value reprocessed products such as sand and aggregates can be readily produced from sorted demolition materials. This process reduces the amount of waste disposed of at landfill sites and slows the demand for raw materials.

Use of reprocessed rubble in higher value applications is presently limited by an absence of product standards applicable to reprocessed materials.

Office refurbishment has increased substantially over the last few years, and it is predicted that this trend will continue. Materials from office refurbishments are commonly bulky, light weight, non-reusable waste.

The volume of demolition materials fluctuates with the level of building activity. While this conclusion appears to be rather obvious, it provides a direct basis for forecasting future generation of demolition waste in light of building activity indicators.

8.1.4 COST OF WASTE DISPOSAL

It is estimated that the total cost of demolition waste disposal (including transport costs) at landfill sites in the Sydney region for 1989 was approximately $15.6 million.

The cost of landfill disposal for recorded volumes of demolition material in 1989 was approximately $11.7 million.

WMA charges for landfill disposal of demolition wastes fell behind the Consumer Price Index increases between 1983 and 1988. Recent increases (1989) in disposal costs have raised the charges to comparable charges with Consumer Price Index increases.

Although charges for tipping of demolition wastes have increased significantly in recent times, the cost of waste disposal (as measured by haulage rates and tipping fees) still represents an insignificant cost when compared with the value of building activity. For the calendar year 1989, it was estimated that the cost of disposal of demolition and building wastes represented just over one-fifth of 1% of the value of building commencements in the Sydney region.

The WMA is perceived as the price leader in the industry, and any increase in charges by the WMA will be closely followed by other operators in the industry.

A differential pricing structure for different types of materials directly encourages higher levels of recycling of demolition materials.

8.1.5 OTHER ISSUES

A number of locations (Section 7.3.1) have been identified as potential generators of demolition/excavation materials. These areas are also likely to be subject to relatively large-scale construction programmes.

The general absence of long-term operators in the industry has resulted in a limited number of firms with appropriate plant and equipment to undertake reprocessing of demolition rubble.

Reprocessing materials at fixed installation sites provides opportunities for improved quality control and increased market acceptance because of the familiarity with location and availability of materials.

8.2 RECOMMENDATIONS

The recommendations presented in the following sections are predicated on the WMA hierarchy of waste management priorities, which for the purposes of the demolition industry are based on the following premises:

- Waste minimization in the demolition industry involves maximum reduction of disposal of material at landfill sites.

- Changes to current WMA management of the present demolition waste stream should be cost effective.

8.2.1 THE PRICE MECHANISM

The strongest incentives that can be applied to the construction and demolition industries are in the form of price benefits and/or penalties. Economic advantages should accrue to operators that efficiently reduce the volumes of material that are disposed of at landfill sites. Cost penalties should be applied if the mixed waste is unsuitable for reuse or reprocessing.

Reuse and recycling of a range of materials including timber products, bricks, tiles, corrugated iron and various fittings (provisional cost items) require labour intensive application at the demolition site. This is appropriately the responsibility of the demolition contractor; however, this added labour cost to the demolition contractor should be rewarded by financial incentives in the form of increased prices for reusable products.

It is recommended that in order to achieve these general principles:

- the price of disposal of mixed waste at landfill sites be substantially increased;

- direct or indirect levies or other charges on recycling operators that act as a disincentive for delivery of materials to resale yards or reprocessing sites be avoided;

- a differential price structure at landfill sites for sorted materials compared with mixed waste be established. An example of this is at Kimbriki Road waste disposal depot, which charges $10 per tonne for sorted demolition rubble and $50 per tonne for mixed waste.

8.2.2 INVESTMENT IN RECYCLING EQUIPMENT

The simplest reprocessing systems, for example, crushers, are effective where there is detailed waste separation at source. More sophisticated systems, as used in Europe, employ a greater number of processes and can accept a wider range of waste materials. The significantly increased costs of establishing and operating reprocessing systems may be acceptable where a substantial proportion of the demolition waste stream is diverted from landfill disposal. Acquisition of some of the more sophisticated reprocessing equipment currently used in Europe would expand the range of mixed wastes available for reprocessing.

In view of the relative volumes of demolition material produced by the industry, as indicated in Table 3.4, the focus for machinery investment should be on the reprocessing of demolition rubble for new aggregate products. The large capital investment for purchase of the range of equipment required for effective reprocessing of demolition rubble has resulted in a limited number of contractors with appropriate plant and equipment presently undertaking recycling.

In some cases, the most effective location for this plant and machinery is at the landfill site, where cost penalties for contaminated products are immediate, and there is reduced opportunity for illegal dumping because the material is committed to the site, with price of disposal being the only issue.

These factors lead to the view that reprocessing operations for demolition rubble should be established by the WMA solely or in joint venture with appropriate contractors adjacent to selected landfill sites and transfer stations. Other fixed installation reprocessing sites will be controlled by market forces and planning constraints.

The benefits to the WMA of joint venture operations would be as follows:

- Capital expenditure would be delayed as the life of existing landfill sites would be extended and, therefore, the establishment of new sites postponed.

- The WMA would receive levies or other income generated by the joint venture arrangement.

- The immediate capital investment by the WMA for reprocessing machinery would be reduced.

- The operation could be managed by the contractor, and supervised by the WMA.

- Accurate assessment of total inputs and product sales could be controlled using the WMA central weighbridge.

In light of the analysis above and discussion presented in Section 7.3.1, it is recommended that the WMA consider :

- establishing regional depots for receipt of demolition rubble at strategic locations, operated by the WMA or appropriate contractors, for the purpose of reprocessing material for sale as sand and aggregate products;

- entering into joint venture arrangements with appropriate contractors for establishment of demolition rubble reprocessing operations adjacent to selected landfill depots and/or transfer stations;

- providing incentives and reducing disincentives to the receipt of demolition rubble materials that are potentially available for reprocessing to value-added products.

8.2.3 STATUTORY AUTHORITY MATERIALS SPECIFICATIONS

Government regulation presently controls a number of aspects of the reuse of reprocessed materials. A primary issue is acceptance by statutory authorities of the possible range of uses of reprocessed materials. It is common across local government, other institutional users and the construction industry to accept the Water Board or the Roads and Traffic Authority Standards to define the specifications for natural aggregates and sand products. A separate Standard for the use of reprocessed materials would define more accurately the opportunities for use of these materials. In the absence of an established Standard, there is a reluctance by private and public industry to take full advantage of the price and quality benefits of using reprocessed products.

In view of the need to establish consistent specifications for the use of reprocessed demolition materials, it is recommended that:

- the WMA approach the Water Board and the Roads and Traffic Authority to identify the opportunities for including reprocessed demolition materials in the existing specifications for aggregates and other new raw materials;

- the Standards Association of Australia be approached with a view to establishing an Australian Standard for the use of reprocessed demolition materials.

8.2.4 REGULATORY CONTROLS

The requirement to provide a waste management plan for medium and large-scale developments would encourage the demolition industry to consider the final destination of the waste and cost implications of that disposal method. A number of local councils have experienced problems with illegal and inappropriate dumping of demolition waste, and the provision of a waste disposal plan would provide greater opportunities for control of disposal sites and potential advantages to local councils for prosecution of breach of development consent.

There are two areas where government regulation could assist in implementing the requirement for a waste management plan, responsibility for which should be transferred to or administered by local government authorities. On this basis, it is recommended that:

- the existing powers to require provision of a waste management plan under the *Waste Disposal Act 1970* (NSW) be either delegated to local government or duplicated in the *Local Government Act 1919* (NSW), for administration by the local authority;

- an addition to the *Environmental Planning and Assessment Act 1979* (NSW) be incorporated by way of a minor amendment to Section 90. This amendment would require preparation of a waste management plan as part of the assessment of a development application. This would also allow councils the opportunity to apply conditions to a consent that related to waste disposal.

The exclusion of natural excavation material (including rock, sand and soil) from the jurisdiction of the WMA reduces the ability of the WMA to comprehensively manage landfill disposal. If this clean fill were to come within the authority of the WMA, closer controls could be placed on landfill sites, resulting in improved management of this waste stream and the added possibility of revenue generation.

Operational controls that could be considered by the WMA to more effectively regulate demolition material disposal at private landfill depots include the following:

- review of the present sample weights used for calculation of Section 29 reports;
- installation of automatic vehicle counters to correlate the number of vehicles entering the facility with the number reported in the Section 29 report;
- installation of weighbridges at landfill sites;
- modification of the basis for levies charged to operators from Section 29 reports, to calculations based on surveys by a registered surveyor.

8.2.5 INDUSTRY AWARENESS

Industry awareness involves both the supply and demand sides of the demolition and raw materials industries. The supply of 'clean' raw materials to the reprocessing operator is essential for consistent products to be achieved. Equally, on the demand side, sustained markets for reprocessed materials must be established to absorb these products into engineering and construction projects.

As both the construction and demolition industries are driven by price and quality considerations, it would be useful for the demolition industry to be alerted to the price advantages associated with provision of clean materials to reprocessing sites. This could be facilitated through approaches to the Demolition Contractors Association of New South Wales.

Perhaps more importantly the construction industry should be made aware of the opportunities for reprocessed materials to be used as a cost-effective alternative to new raw materials.

A key issue for demolishers is the location of the nearest disposal site.

It is recommended that:

- the WMA establish and advertise a data base of current operating landfill sites and reprocessing depots, and that this be made available for public inquiries. This 'Hotline' could assist contractors in the appropriate disposal of demolition material at the nearest site. It could also encourage operators to notify the WMA of their activities, which could provide some early indications of the remaining availability of fill space at particular sites, as well as assisting in an overview for the Sydney region.

There is also the possibility of increased revenue generation to the WMA by the advertising, as well as improved control over landfill operators;

- the WMA, in conjunction with the construction and demolition industries, develop promotional material for inclusion in the WMA's *Recycling directory* and other sources, to encourage appropriate disposal and reuse of reprocessed products from demolition materials;

- the Demolition Contractors Association of New South Wales be approached to fully inform its members of the opportunities for cost savings on disposal of demolition materials by instituting relevant practices that allow recycling of demolition rubble and other materials.

8.2.6 BUILDING WASTES GENERATED BY REFURBISHMENT OF OFFICE BUILDINGS

In light of the expected increase in office refurbishment and the limited opportunities for recycling of this type of demolition material, it is recommended that:

- specialized waste management strategies be developed and implemented to minimize the volume of waste generated by refurbishment of office and commercial buildings;

- shredding plants at transfer stations and other regionally central sites be established to assist in the increased compaction of a variety of materials (including office refurbishment waste) prior to transport to landfill disposal sites.

8.2.7 BUILDING DESIGN

The types of building construction and use of materials have a major impact on the availability of materials for subsequent demolition and reuse. Therefore, it is recommended that the WMA encourage professional organizations to prepare information for architectural and building industries, that identifies avenues for ensuring the maximum possible availability of materials for reuse and the incorporation of recycling in future building projects.

Appendix A

PEOPLE CONSULTED FOR THIS STUDY

Appendix A

PEOPLE CONSULTED FOR THIS STUDY

The following people were consulted in the preparation of this study:

Don Alcock, Managing Director, Johnson Transport Industries;

Iain Baillie, Resident Principal, Rawlinsons International Pty Ltd (Perth);

Chris Barber, Managing Director, Second Hand Building Centre;

Brad Bell, Director, Currie & Brown, Cameron & Middleton Quantity Surveyors;

Dennis Boyd, Senior Health and Building Inspector, Warringah Shire Council;

Bill Brideau, Project Manager (Waste Management), Warringah Shire Council;

Edward Byron, Manager, Urban Consolidation Branch, NSW Department of Planning;

Ken Dick, Waste Management Authority of New South Wales;

George Freeman, Editor, *The Building Economist, Journal of the Australian Institute of Quantity Surveyors*;

Peter Hammond, Resident Principal, Rawlinsons International Pty Ltd (Sydney);

Don Holt, Manager, The Brick Pit Pty Ltd;

Tom Jackson, Director, Portaplant Australia Pty Ltd;

Ray Jeffery, Director, Commonwealth Industry Commission;

Dennis Jolliffe, Australian Bureau of Statistics, Sydney Office;

Chris Kelly, Waste Management Authority of New South Wales;

Kevin Langford, Project Manager, Federal Airports Corporation, Sydney Airport;

Doug Lock, Sales Representative, Bowral Bricks and Pavers;

Col Macalpine, Manager, Recycled Resources Pty Ltd;

Ian Malouf, Director, Dial-A-Dump, and I.R. Malouf Demolitions;

Stewart Maxwell, Currie & Brown, Cameron & Middleton Quantity Surveyors;

Bob McCartney, New South Wales Road Transport Association;

David McConnarchie, Manager, Publishing, Telecom Australia (NSW & ACT Region);

David McLintock, Materials Engineer, Warringah Shire Council;

Rob Neil, Manager, R.J. Brady Pty Ltd;

Mike O'Sheay, Director, Currie & Brown, Cameron & Middleton Quantity Surveyors;

Anthony Peake, Secretary, Demolition Contractors Association of New South Wales;

Neil Phelps, Managing Director, Camide Pty Ltd;

Jim Sibree, BIS Shrapnel Pty Ltd;

Graham Singh, Operations Manager, Norman Ross Discounts;

Peter Verwer, Research Director, Building Owners and Managers Association of Australia, NSW Division;

Bruce Watters, Shire Engineer, Warringah Shire Council;

David Whitford, Manager, independent demolisher;

Peter Young, Chief Estimator, Leighton Contractors Pty Ltd.

Appendix B

RAWLINSONS BUILDING PRICE INDEX FOR SYDNEY

Appendix B

RAWLINSONS BUILDING PRICE INDEX FOR SYDNEY

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
June 30	29.12	31.76	36.47	38.24	42.94	43.24	49.12	68.24	71.44	75.06	77.12	82.94
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	
March 31	90.59	102.94	121.94	149.06	153.47	156.03	170.15	194.79	213.70	233.29	253.94	
June 30	93.53	108.82	128.74	155.59	152.18	160.94	175.84	200.23	219.26	237.57	258.90	
Sept 30	94.71	110.29	139.38	161.29	152.71	167.71	180.48	205.88	215.95	245.84	262.00	
Dec 31	100.00	116.26	144.56	161.44	155.54	168.82	186.85	209.39	229.28	247.75	267.60*	

* *Provisional*

Note: *This index is compiled by Rawlinsons International Pty Ltd on the basis of market knowledge and surveys, and is supplemented by use of the Australian Bureau of Statistics' building materials price indices i.e. Catalogue No. 6407.0 and Catalogue No. 6408.0.*

Appendix C

RECENT NEWSPAPER ARTICLES ON OFFICE REFURBISHMENT

THE WEEKEND AUSTRALIAN October 27-28 1990

Timely face-lift to protect returns on P&O Building

By ANDREW INWOOD

WESTPAC Investment Management Pty Ltd will spend about $50 million on a face-lift for P&O Building at 55 Hunter Street, Sydney.

The chairman of Westpac Investment Management, Mr Jim Goldman, said the building's future investment performance would have been inhibited, despite its location, without extensive refurbishment.

The building, built in 1964 at the corners of Hunter, Elizabeth and Castlereagh streets in Sydney's central business district, was bought by Westpac Investment Management for $25 million in 1981.

Westpac bought the 17-storey building on behalf of the Australian Staff Superannuation Scheme and is to give it a new facade, a two-storey entrance and a new services core and plant room.

"Being a 1960s building, 55 Hunter Street's typical floor services are inadequate to cope with the requirements of modern tenants in regard to air-conditioning, computer and communications cabling and security systems," Mr Goldman said.

"Because the property houses several features of both public and heritage interest, our chosen design solution was arrived at only after extensive studies and analysis in conjunction with Lend Lease interiors and the Heritage Council of NSW."

The building, which is diagonally opposite the Chifley Square development, houses the Tom Bass Fountain, The Mermaid sculpture in its lobby and Douglas Annand's Animals sculpture over the Hunter Street entrance to the building.

The granite and glass facade planned for the two-storey entrance will provide a walk-through plaza connecting the entrances of Elizabeth and Castlereagh streets.

By refurbishing the building, Westpac hopes to encourage tenants into a high-quality buiding at a discount to the cost of new space.

One analyst said the timing of the Westpac move was impeccable.

"The Chifley Square end of the CBD has been going backwards for some time, but with the arrival of the Gateway Building and Chifley Square coming on line, it is possible the city centre will start to drift that way again," the analyst said.

While the P&O Building could not rival new buildings in the area for quality of space, good refurbishment would be attractive to firms seeking location and image, without the cost of substantial floor space.

Office refurbishment

From cottage industry to a booming $1bn market

By ROD READER

THE refurbishment of offices has become one of the most active property sectors, growing from a $50 million cottage industry in 1980 to an estimated $1 billion market in 1990-91.

Across the nation, as the development sector grinds to a halt under the weight of crippling interest rates and general economic uncertainty, the refurbishment of older-style office buildings has become the focus of the commercial real estate industry.

Its growth can been noted in research by the Building Owners and Managers Association, which estimates that there will be a 70 per cent increase in office space being refurbished this year.

A total of 105.895sq m of office space was refurbished last year, 90.159sq m of which was in central business district buildings.

Industry sources price refurbishment at $1750 a square metre in CBDs and $1250 a square metre in suburbs, which makes the market worth $177.5 million.

This is expected to increase to more than $500 million this year and double in 1991.

Setting a cracking pace for the rest of the country is Sydney's CBD.

BOMA's July report shows that 110.300sq m of office space will be refurbished this year, representing almost a third of the total new building supply of 314.000sq m.

Last year, only about 25.000sq m of space was refurbished in the CBD.

The main refurbishments are taking place at 48 Martin Place, 19.000sq m; 309 Kent Street, 17.400sq m; Goldfields House, 1 Alfred Street, 12.300sq m; and O'Connell House, 15 Bent Street, 10.260sq m.

A further 58.700sq m is already due for refurbishment next year. The main work will be at the Grace Building at 77-79 York Street.

BOMA says 14.340sq m of office space will be refurbished in Melbourne this year. This compares with 380.000sq m of new space due for completion in the CBD.

The main work in Melbourne will be Slough Estates Australia Pty Ltd's building at 390 Lonsdale Street, in which 8100sq m of office space will be refurbished.

Next year, 10.660sq m in Central Equity's Cromwell House in Bourke Street will be renovated.

In other cities, the refurbishment spree is not as great.

There are three main reasons for the increase in refurbishment:

IT is a natural follow-on from the record amount of office buildings built during the last development boom. Owners of older buildings have to keep their properties competitive against a plethora of new towers.

Inherent in this is the profit threshold, which dictates when an older building is no longer financially competitive in terms of rent rises, yields and internal rates of return.

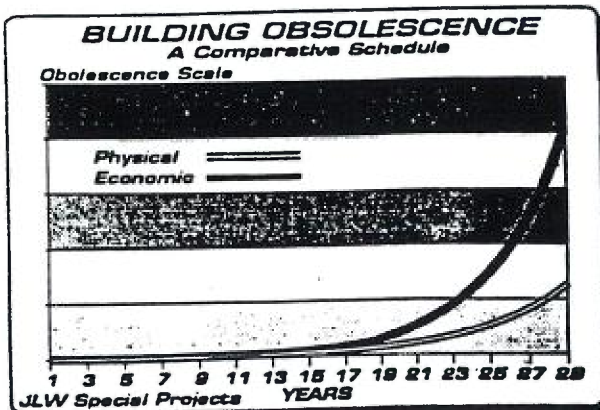
RAPID advances in technology. It is estimated that between every 10 and 15 years, office buildings will have to be upgraded to keep pace with advances in computer and lift technology and overall communications services.

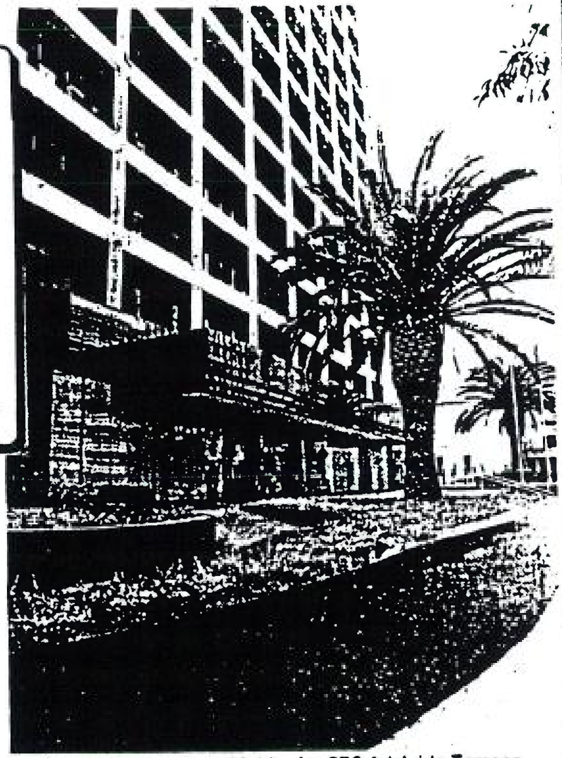
MANY office buildings were built in the late 1960s and have reached full maturity and need extensive refurbishment, regardless of market conditions.

These factors ensure the office refurbishment market will continue to flourish in the long term, even during cyclical downturns such as that at present.

THE WEEKEND AUSTRALIAN September 1-2 1990

The high-tech remedy for premature ageing





A new forecourt and lobby for 256 Adelaide Terrace

By LOUISE SCHOFIELD

WHILE an office building may stand solid as a rock a century after its construction, it is already approaching obsolescence after 10 years.

Physically it may not be considered obsolete, but economically its value to the owner is rapidly decreasing.

The building's income growth is threatened by its declining ability to compete for tenants.

New buildings will be offering technology which was unavailable a decade ago, while their decor and architectural features may be considered more prestigious.

To avoid losing tenants, the owner of the older building has two choices.

Centenarian in mint state

He can allow the rents which have been steadily climbing over the years to plateau — he may consider dropping them — or he can refurbish the building to make it more competitive in the marketplace.

In Perth, the time has come for the owners of many older buildings to make these choices, particularly in the central business district.

With severe office oversupply looming for 1991-92, the CBD leasing market has become very competitive.

Building owners must keep pace with the changing needs of their tenants or risk losing them.

For the average building, economic obsolescence — where it loses the ability to attract tenants and command high rents — begins to take effect after 10 to 15 years and accelerates rapidly after 20 years, according to the special projects director of Jones Lang Wootton (Perth), Mr Michael Thompson.

But this trend cannot be taken for granted as buildings are now approaching economic obsolescence at a much earlier stage than they did 10 years ago.

Technology is changing rapidly and so tenants are demanding increasingly sophisticated building services.

"For example, five years ago a building's riser duct capacity or cable reticulation management system was not of primary importance," Mr Thompson said.

"With the increasing trend towards greater computerisation, such features are now virtually a prerequisite."

Other features increasingly demanded are advanced security systems, sophisticated temperature controls and power supply interrupters.

As well as being a means of keeping abreast of technology, refurbishment can also correct any design faults of a building to increase tenant comfort and convenience.

Another, and relatively new, factor in refurbishment is energy efficiency.

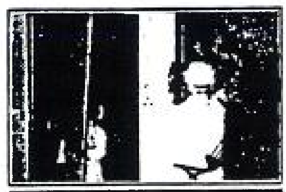
According to Perth architect Mr Geoff Baverstock, of Baverstock Paolino & Partners, a building can be made more energy efficient with regular refurbishment for about $600 to $800 a square metre.

Solar collectors for water and air heating, shade panels on windows, energy-efficient fluorescent lights and other energy-saving devices can cut power usage in commercial buildings by 60 to 90 per cent.

In 1987, Baverstock Paolino and its associated project manager, Tecto Projects, refurbished 159 Adelaide Terrace, Perth, at a cost of $1 million.

Big energy savings were made possible, rents were doubled and the formerly empty building was filled with tenants in three months.

In many refurbishment programs, however, the emphasis is on aesthetics as much as practicalities.



OFFICE REFURBISHMENT
A SPECIAL REPORT

Some of Perth's older but prestigious buildings have recently had face-lifts or are undergoing them.

The National Mutual Building on the corner of St Georges Terrace and William Street completed a multi-million-dollar refurbishment program last year.

Opposite, the AMP Building — whose tenants include Mr Robert Holmes a Court's Heytesbury Group — is undergoing a face-lift which will boost its competitiveness in the primary market.

This week, stage one of a refurbishment program for 256 Adelaide Terrace was finished.

Owned by Armstrong Jones Management Ltd, the building has been given a new look in its forecourt, lobby and lifts at a cost of $2.5 million.

Office planner Mr Jeffrey Morfesse, who is part of the refurbishment team, said that in stage two tenants would be given their own identities.

The lift lobbies on each floor would be refurbished according to different themes, thus "avoiding the continuity of everything".

Some buildings are never too old for refurbishment, as the century-old Perth Mint can attest.

Refurbished in 1988 under a team co-ordinated by architectural group Hames Sharley Australia, the $2.2 million refurbishment converted the interior of the building to suit the financial working environment of the 21st century.

This meant that the State Government authority, GoldCorp, did not have to seek office accommodation elsewhere in the city, and at the same time it was able to maintain a link with the industry's heritage.

But for the average tenant or owner-occupier, refurbishment may be less costly and less ambitious.

The first step in ensuring a successful refurbishment program is identifying the needs of staff, now and in the future.

Architect Mr Christopher Keen, of KTA Partnership, specialises in the preliminaries of refurbishment.

He said among the many factors to consider were the accommodation of services such as computers and telephones, environmental matters such as noise and temperature, and a layout that would best serve the needs of staff.

Growing trend towards refurbishment

By MAREA DONNELLY

ALMOST 60 per cent of the new office stock available in North Sydney this year will be in refurbished projects, a study by Aust-Wide Property Research has shown.

Aust-Wide reports that strict building codes imposed by North Sydney Council have made it financially unattractive to replace old and semi-obsolete buildings.

As a result, of the new office supply to be completed in 1990, 58 per cent is in refurbished projects. This compares with 44 per cent of new office stock completed in 1989 in refurbished projects, and 18 per cent in 1988.

In a quarterly study of the North Sydney office space market, Aust-Wide reports the increase in refurbished stock also illustrates the lack of new building sites available in the North Sydney CBD, which although only a quarter the size of the Sydney CBD is the next largest commercial market in Sydney.

With 768,462sq m of office space, North Sydney is nearly twice the size of Parramatta and 3.5 times larger than the Chatswood office market.

Redevelopments of older-style buildings within the North Sydney CBD are restricted by council requirements to a maximum floor space ratio that for many buildings is lower than that under which they were built, according to Aust-Wide.

Aust-Wide predicts that for North Sydney to hold and attract tenants, demolition of some buildings will be necessary, but it is possible that for a number of sites, council concessions similar to those obtained 15 years ago would be difficult to obtain today.

"This would result in a decrease in the net lettable area of the replacing developments and place increased pressure on building owners to amalgamate sites," Aust-Wide says.

Demand for quality office space north of the harbour bridge remains strong, according to Aust-Wide, with tenants moving out of the Sydney CBD and into North Sydney when space becomes available.

But as North Sydney is only one-fifth the size of the Sydney CBD and the net increase in office space is so small, significant amounts of space become available in North Sydney only when a North Sydney firm moves.

The attraction of corporate signage in the North Sydney CBD is a significant factor for some firms, increasing the potential income that building owners can receive.

Another factor is the North Sydney "culture" that has developed over the past few years, increasing tenant loyalty to the area. Many workers enjoy the less congested and more relaxed atmosphere North Sydney can offer.

Metroplaza is the only major development expected to come on to the North Sydney office market over the next two to three years, according to Aust-Wide.

Due for completion in 1992, the project will go on to the leasing market this year and tenant interest for the 35,000sq m of space is keen.

Other smaller projects under way include the total refurbishment of 201 Miller St and the development of Enery House and Elizabeth Plaza.

PROPERTY SOAPBOX

Shifting trends in building facades

By BRUCE BARNARD
Senior Consultant, Polymex Consultants

THE architectural facades and cladding on larger commercial and industrial buildings can cost up to 20 per cent of the construction value.

Important changes are taking place in this market and designers and builders need to understand new cladding materials. At the same time, suppliers need to know about trends in materials and issues of concern to their customers.

To find out what cladding materials and systems are being used on different buildings and what users think about them, Australian Industrial Research, a division of Polymex Consultants, the industrial market research consultants, undertook a study on behalf of several clients. The study analysed the cladding on 260 commercial and industrial buildings around Australia to provide a better focus on the size and operation of this segment of the construction industry.

Bruce Barnard

The study revealed surprises in a national cladding market of nearly 3 million sq m, with an installed value of about $900 million.

Pre-cast concrete, including tilt-up, held a bigger than expected market share of 28 per cent by area and 20 per cent by value.

Opaque glass (about 5 per cent by value) was found to have a much lower share than expected, while certain proprietary cladding products, particularly high quality aluminium-coated products, are starting to become significant.

Glass is considered to be aesthetically less desirable today. Granite's popularity and share have been growing quickly (now 8 per cent by value), marking a move towards natural materials.

Bricks still have an important place because they have features that other modern materials find hard to emulate and they accounted for about 14 per cent by area – mainly in the smaller buildings.

Windows had about 30 per cent of the national facade market by area or 47 per cent by value.

On CBD buildings with a completed construction value of more than $20 million, the shares held by the various materials differ substantially from the overall picture. Granite and other natural stones hold a 30 per cent share by value, while opaque glass drops to about 13 per cent by value and pre-cast to 17 per cent.

Another surprise was the strength of the market for refurbishing older buildings. This is rapidly becoming a significant part of the total market.

There are four principal driving forces behind this trend:

- replacing old facades after deterioration;
- the improved rents and occupancy rates of a refurbished building;
- time and money saved by refurbishment;
- to retain generous plot ratios.

Sydney CBD . . . unprecedented growth will continue

Downturn disguises underlying trends

By MALCOLM PATTERSON*

THE fundamentals of Sydney's building and property market remain strong despite its present difficulties.

The downturn is a reaction to excess that disguises underlying trends, including a growth in Sydney's population of a million people over the next 20 years.

Since 1983 we have had the biggest free-spending boom in our industry's history, with the resulting oversupply followed almost immediately by a sharp downturn that was driven even deeper by high interest rates.

While a quick-fix is not possible in these circumstances, we should not be unduly pessimistic and contribute to erosion of investment confidence.

Sydney will continue to grow at a pace unprecedented in our history. Government planning conservatively predicts a growth of one million people, with the attendant need for infrastructure and buildings.

This growth is part natural expansion of the population, part migration (including investment-oriented migration) and part the focus on Sydney as the emerging natural major Asia-Pacific identity of the country.

The impact of this growth will extend from the CBD to the suburbs. Refurbishment will play a large role. There are something like 2400 buildings in the central Sydney area alone, in that small area extending from Circular Quay to Railway Square, bounded by Elizabeth and Macquarie streets to the east and Sussex Street to the west.

More than 600 of these were built over the past 15 to 30 years and have not been refurbished for the past five years.

They will become prime investment targets over the next five years, warranting substantial investment in improvements.

New fitouts and refurbishment will increase in value by billions of dollars over the next couple of decades. It will be a natural flow-on from vastly expanded building to cope with city growth and from a pool of ageing buildings.

Astute investors — the counter-cyclical buyers — are realising the opportunities presented by well-sited buildings available at very favourable prices.

While the market will remain in the buyers' favour for some time, equally certainly it will return to a high level of activity within a few years.

** Mr Patterson is general manager of Group One Interiors Pty Ltd.*

THE WEEKEND AUSTRALIAN September 1-2 1990

Tenants support owner's strategy

By ANDREW INWOOD

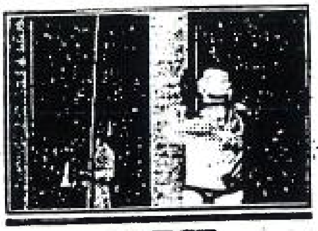
THE ongoing refurbishment of the Australian Stock Exchange building at 20 Bond Street, Sydney, has already paid dividends for its owners Armstrong Jones Management Ltd.

The $22 million stage one of the $80 million refurbishment is scheduled for completion this month and the value of the building has already leapt 15 per cent.

The value of the building, which is held by the Armstrong Jones Growth Fund, jumped from $425 million to $500 million between June last year and June this year, despite the significant downturn in the value of Sydney central business district property.

Armstrong Jones decided to refurbish the 11-year-old building when it bought it in 1988 in order to make it competitive with the newer buildings in the CBD.

The supply of prime space in the CBD is expected to peak in the next few years and Armstrong Jones decided that to keep their key tenants from moving to surrounding new developments, such as No 1 O'Connell and Chifley Square, it was best to refurbish.



OFFICE REFURBISHMENT

A SPECIAL REPORT

Push for quality

A spokesman for Armstrong Jones said this week that although the Exchange Centre, as it was known, had the best location in the CBD, it would have to compete in other areas to keep key tenants.

"In the 1990s the demands are even greater for buildings that offer the highest level of services — from prestigious common foyer entrances, to state-of-the-art telecommunications and effective building management systems," he said.

He said Armstrong Jones had put into place a strategy to ensure that the requirements of the key tenants, The Australian Stock Exchange and Macquarie Bank were fully met.

"At the same time it is important this strategy enables Armstrong Jones to execute new long-term leases with those key blue-chip tenants, whose rental income streams are essential for the continued financial growth of the property."

As a direct result of the refurbishment, Macquarie Bank has signed a lease that commits it to the Exchange Centre until the year 2000.

Not only does the bank have a long-term leasing commitment, it has also taken more space.

The bank, which has a long-term lease for levels 21 to 30 inclusive, has committed to levels 12, 15, 16 and 17 when they become available this month and levels 14, 18 and 19 when they come available in January 1992.

This will mean that Macquarie Bank will have 17,000sq m of the office tower over 17 levels, or about 59 per cent of the tower space.

The executive director of Macquarie Bank, Mr Julian Beaumont, said before the bank had committed to the Exchange Centre it had made an extensive comparison of space available within the CBD.

"We looked at planned refurbishment and development alternatives before deciding to take advantage of the Exchange Centre proposal," Mr Beaumont said.

Mr Peter Watt, the managing director of Peddle Thorp and Walker, the architects handling the refurbishment, said the upgrade would focus on its dramatic presentation to Bond Street, with a realignment of Bond Street itself providing increased pedestrian access.

In addition to increasing the visual enhancements, the building's infrastructure has undergone several changes to increase its capacity and quality.

These include improved lighting, a four-fold increase in air-conditioning capacity with extensive zonal controls to improve overall efficiency, increased power supply and telecommunications and electricity cabling facilities.

The managing director of the Australian Stock Exchange, Mr Peter Marsham, said the ASX was more than happy with the building and was delighted with the refurbishment program. The ASX now occupies 32 per cent of the building.

"The building has been the home of the ASX for the past decade and continues to be the absolute heart of Sydney's financial core," he said.

Appendix D

INDICATIVE COSTS OF DEMOLITION ACTIVITY IN SYDNEY

Table D.1 **Demolition charges in Sydney for whole structures in current dollar terms**

	Type	Unit	Demolition charge* ($)						Change 1990–85 (%)		1990 cost per tonne† ($)
			1985	1986	1987	1988	1989	1990	Real**	Nominal	
1	**Factories and warehouses**										
1A	Single storey, light industry/warehouse, reinforced concrete ground slab, framed walls, metal roof	m^2	25.00	27.00	29.50	31.00	33.00	36.00	-6.7	44.0	3.20
1B	Single storey, as above, with brick walls	m^2	35.00	38.00	41.50	43.50	46.00	51.00	-5.6	45.7	6.10
1C	Single storey, heavy industry, reinforced concrete ground slab, framed walls, metal roof	m^2	30.00	33.00	36.00	38.00	40.00	44.00	-5.0	46.7	6.60
1D	Single storey, as above, with brick walls	m^2	40.00	44.00	48.50	51.00	54.00	60.00	-2.8	50.00	10.80
2	**Houses**										
2A	Single storey, timber frame with cladding, metal roof	m^2	15.00	16.50	18.00	19.00	20.00	22.00	-5.0	46.7	1.30
2B	Single/double storey, brick walls, tile roof	m^2	20.00	22.00	24.00	25.00	26.50	29.00	-6.0	45.0	2.60

* *Includes grubbing up foundations, sealing off services and removal of debris.*
** *Discount factor 1990 on 1985 = 0.648, based on Rawlinson International Pty Ltd's (Rawlinsons) building price index.*
† *Cost per tonne was estimated using a two step process. Firstly square metres (m^2) converted to cubic metres (m^3) by multiplying m^2 by a factor of 0.15. Each example then estimated in terms of cost per tonne by multiplying m^3 by a factor in the range of 0.4 to 1.2. The multiplication factor chosen depended on the type of material used in each building.*
Source: *Rawlinsons'* Australian construction handbook *1985–90 annual editions.*

Table D.1 **Demolition charges in Sydney for whole structures in current dollar terms (continued)**

	Type	Unit	Demolition charge* ($)						Change 1990–85 (%)		1990 cost per tonne† ($)
			1985	1986	1987	1988	1989	1990	Real**	Nominal	
3	**Office buildings**										
3A	Two storey, reinforced concrete ground slab, brick wall, metal roof	m^2	45.00	50.00	55.00	58.00	61.00	67.00	-3.5	48.9	8.00
3B	Six storey, as above	m^2	50.00	55.00	60.00	63.00	67.00	74.00	-4.1	48.0	11.10
3C	Fifteen storey, reinforced concrete frame and ground slab, brick/stone external walls	m^2	55.00	60.00	66.00	69.00	73.00	80.00	-5.7	45.5	12.00
3D	Fifteen storey, as above, with structural steel frame	m^2	60.00	65.00	72.00	76.00	80.00	88.00	-5.0	46.7	13.20
4	**Retail premises**										
4A	Single storey, reinforced concrete ground slab, brick wall, metal roof	m^2	40.00	43.00	47.00	50.00	53.00	58.00	-6.0	45.0	7.00
4B	Two storey, as above	m^2	45.00	50.00	55.00	58.00	61.00	67.00	-3.5	48.9	8.00
4C	Three storey, as above, with structural steel frame, timber floor	m^2	40.00	44.00	48.00	51.00	54.00	60.00	-2.8	50.00	5.40

* *Includes grubbing up foundations, sealing off services and removal of debris.*

** *Discount factor 1990 on 1985 = 0.648, based on Rawlinson International Pty Ltd's (Rawlinsons) building price index.*

† *Cost per tonne was estimated using a two step process. Firstly square metres (m^2) converted to cubic metres (m^3) by multiplying m^2 by a factor of 0.15. Each example then estimated in terms of cost per tonne by multiplying m^3 by a factor in the range of 0.4 to 1.2. The multiplication factor chosen depended on the type of material used in each building.*

Source: *Rawlinsons'* Australian construction handbook *1985–90 annual editions.*

Table D.2 **Demoliton charges in Sydney for partial demolition in current dollar terms**

Type	Unit	Demolition charge* ($)						Change 1990–85 (%)	
		1985	1986	1987	1988	1989	1990	Real**	Nominal
A Cut away concrete ground slab:									
100 mm thick unreinforced	m^2	20.00	22.00	24.00	25.00	27.00	30.00	-2.8	50.0
150 mm thick unreinforced	m^2	25.00	27.00	29.50	31.00	33.50	37.00	-4.1	48.0
100 mm thick reinforced	m^2	25.00	27.00	29.50	31.00	33.50	37.00	-4.1	48.0
150 mm thick reinforced	m^2	30.00	33.00	36.00	38.00	41.00	45.00	-2.8	50.0
B Cut away reinforced concrete suspended slab:									
125 mm thick	m^2	32.00	35.00	38.50	40.00	43.00	47.00	-4.8	46.9
200 mm thick	m^2	52.00	57.00	62.00	65.00	70.00	77.00	-4.0	48.1
250 mm thick	m^2	65.00	70.00	77.00	81.00	87.50	96.00	-4.3	47.7
C Cut away reinforced concrete:									
Walls	cum.	225.00	245.00	270.00	285.00	310.00	340.00	-2.1	51.1
Columns	cum.	200.00	220.00	240.00	250.00	270.00	350.00	13.4	75.0
Beams	cum.	210.00	230.00	250.00	260.00	280.00	350.00	8.0	66.7
Plinths, 100 mm thick	m^2	32.50	35.00	38.00	40.00	43.00	47.50	-5.3	46.2
D Demolish external brick walls:									
110 mm thick	m^2	12.50	13.50	15.00	15.50	16.50	22.00	14.0	76.0
230 mm thick	m^2	20.00	22.00	24.00	25.00	26.50	46.00	49.0	130.0
280 mm thick cavity wall	m^2	23.00	25.00	27.50	29.00	31.00	46.00	29.6	100.0
E Demolish external stone walls:									
300 mm thick	m^2	35.00	38.00	41.00	43.00	45.00	60.00	11.1	71.4
450 mm thick	m^2	50.00	55.00	60.00	63.00	66.00	90.00	16.6	80.0

* *Includes grubbing up foundations, sealing off services and removal of debris.*
** *Discount factor 1990 on 1985 = 0.648, based on Rawlinsons' building price index.*
Source: *Rawlinsons'* Australian construction handbook *1985–90 annual editions.*

Table D.2 **Demoliton charges in Sydney for partial demolition in current dollar terms (continued)**

Type	Unit	Demolition charge* ($)						Change 1990–85 (%)	
		1985	1986	1987	1988	1989	1990	Real**	Nominal
F Demolish internal walls:									
75 mm or 110 mm brick walls	m^2	15.00	17.00	18.50	19.50	20.50	21.00	-9.3	40.0
As above, plastered both sides	m^2	15.00	18.00	20.00	21.00	22.00	22.50	-2.8	50.0
Stud partition with plasterboard or asbestos both sides	m^2	5.00	6.00	6.50	7.00	7.50	8.00	3.7	60.0
Stud partition with metal lathing and render both sides	m^2	6.00	7.00	8.00	8.50	9.00	10.00	8.0	66.7
G Strip roof covering for sloped roof:									
Slates including battens and sarking	m^2	3.50	4.00	4.50	4.75	5.00	5.50	1.8	57.1
Tiles, as above	m^2	3.50	4.00	4.50	4.75	5.00	5.50	1.8	57.1
Asbestos including battens and safety mesh	m^2	6.00	12.50	17.50	18.50	19.50	21.50	132.2	258.3
Metal roofing	m^2	4.50	5.00	5.50	5.75	6.00	6.50	-6.4	44.4
H Strip roof covering for flat roof:									
Sheet metal decking including insulation	m^2	4.00	4.50	5.00	5.25	5.50	6.00	-2.8	50.0
Felt or composition roofing	m^2	7.50	8.00	9.00	9.50	10.00	11.00	-5.0	46.7
I Take down:									
Timber roof frames	m^2	3.50	4.00	4.50	4.75	5.00	5.50	1.8	57.1
Eaves lining	m^2	5.00	5.50	6.00	6.50	7.00	7.50	-2.8	50.0
Eaves gutter	m	3.00	3.50	3.75	4.00	4.25	4.75	2.6	58.3
Downpipes	m	3.00	3.50	3.75	4.00	4.25	4.75	2.6	58.3

* *Includes grubbing up foundations, sealing off services and removal of debris.*
** *Discount factor 1990 on 1985 = 0.648, based on Rawlinsons' building price index.*
Source: *Rawlinsons'* Australian construction handbook *1985–90 annual editions.*

Table D.2 **Demoliton charges in Sydney for partial demolition in current dollar terms (continued)**

Type	Unit	Demolition charge* ($)						Change 1990–85 (%)	
		1985	1986	1987	1988	1989	1990	Real**	Nominal
J Take up or strip floors:									
Timber floor frames	m²	3.50	3.75	4.00	4.25	4.50	5.00	-7.4	42.9
Floor boards including preparing:									
Joists	m²	4.00	4.50	5.00	5.25	5.75	6.25	1.3	56.3
Vinyl tiles	m²	5.00	6.00	6.50	7.00	7.50	8.25	6.9	65.0
Vinyl sheet	m²	5.00	4.50	5.00	5.25	5.50	6.00	-22.2	20.0
Parquetry flooring	m²	5.00	5.50	6.00	6.50	6.75	7.50	-2.8	50.0
Ceramic/mosaic tiles	m²	7.50	8.00	8.75	9.25	9.75	12.50	8.0	66.7
Granolithic	m²	7.50	8.00	9.00	9.50	10.00	12.50	8.0	66.7
K Remove finishes from walls (no preparation for new work included):									
Plaster	m²	7.50	8.00	8.50	9.00	9.50	10.50	-9.3	40.0
Cement render	m²	7.50	8.00	9.00	9.50	10.00	11.00	-5.0	46.7
Ceramic tiles and backing screed	m²	9.00	10.00	11.00	11.50	12.00	13.00	-6.4	44.4
L Take down:									
Suspended ceiling and metal suspension	m²	3.50	3.75	4.25	4.50	4.75	5.25	-2.8	50.0
Timber framed and sheet lined ceiling	m²	5.50	6.00	6.50	7.00	7.50	8.25	-2.8	50.0
M Take out:									
Single door and frame	no.	15.00	16.50	17.50	18.50	19.50	21.50	-7.1	43.3
Window and frame (up to 2,000 mm x 1,000 mm)	no.	30.00	32.50	35.00	37.00	39.00	43.00	-7.1	43.3
Built in room air-conditioner units	no.	18.00	20.00	21.50	22.50	23.50	26.00	-6.4	44.4
Counter/bench unit	m	10.00	11.50	13.50	14.00	15.00	16.50	6.9	65.0

* *Includes grubbing up foundations, sealing off services and removal of debris.*
** *Discount factor 1990 on 1985 = 0.648, based on Rawlinsons' building price index.*
Source: *Rawlinsons'* Australian construction handbook *1985–90 annual editions.*

Appendix E

METHODOLOGY FOR CALCULATING TRANSPORT COSTS OF DEMOLITION MATERIALS

Appendix E

METHODOLOGY FOR CALCULATING TRANSPORT COSTS OF DEMOLITION MATERIALS

Raw data

Haulage rates provided in the annual editions of Rawlinsons International Pty Ltd's (Rawlinsons) *Australian construction handbook* provided the basis for analysis. It is noted that the upper level of Rawlinsons' estimates were used in this report. Vehicles with carrying capacities of 12 tonnes and 20 tonnes were used as it was advised by Camide Pty Ltd that about two-thirds of demolition wastes are delivered in 12 tonne trucks while the remainder is delivered in 20 tonne trucks (Table E.1).

Table E.1 **Estimated costs for truck hire**

Year	Cost per hour ($)	
	12 tonne truck	20 tonne truck
1983	22–26	31–34
1984	26–30	35–40
1985	27–32	36–43
1986	29–35	39–46
1987	30–36	40–48
1988	32–40	43–53
1989	35–43	47–57

Source: *Rawlinson's* Australian construction handbook *annual editions 1983 to 1989.*

Time length of journeys

As a result of discussions with Peter Young, Chief Estimator, Leighton Contractors Pty Ltd, it was assumed that, on average, each load of demolition waste requires a return trip of about two hours.

Inflator

In order to compare transportation costs of demolition and building wastes with the real value (i.e. after adjustment for inflation) of building commencements in the Sydney region, these haulage rates were inflated to 1989 dollar values using the Australian Bureau of Statistics' Consumer Price Index. This price index was used on advice from Bob McCartney of the New South Wales Road Transport Association. The inflators that were used are summarized in Table E.2.

Table E.2 **Consumer price index inflators**

Year	Inflator
1983	1.518
1984	1.471
1985	1.379
1986	1.263
1987	1.162
1988	1.072

Source: Australian Bureau of Statistics Catalogue No. 6401.0.

Estimated haulage rates in constant 1989 dollar values

After adjusting for inflation and assuming a two-hour round trip for each load of demolition and building wastes, the following haulage rates were calculated (Table E.3).

Table E.3 **Estimated haulage rates in 1989 dollar values**

Year	Cost for two hours ($)	
	12 tonne truck	20 tonne truck
1983	79.0	103.2
1984	88.2	117.6
1985	88.2	118.6
1986	88.4	116.2
1987	83.6	111.6
1988	86.0	114.0
1989	86.0	114.0

Calculation of haulage costs

These cost estimates were applied to Waste Management Authority data regarding deliveries of demolition and building wastes to depots in the Sydney region. It was assumed that two-thirds of the volume of these wastes were transported on 12 tonne trucks, with the remainder being carried on 20 tonne trucks. The calculations undertaken are summarized on the following page.

1983 Deliveries = 165,048 tonnes

109,922 ÷ 12	=	9,160 trips x $79.0	=	$723,640
55,126 ÷ 20	=	2,756 trips x $103.0	=	$284,419
		Total	=	$1,008,059

1984 Deliveries = 308,126 tonnes

205,212 ÷ 12	=	17,101 trips x $88.2	=	$1,508,308
102,914 ÷ 20	=	5,146 trips x $117.6	=	$605,170
		Total	=	$2,113,478

1985 Deliveries = 504,035 tonnes

335,687 ÷ 12	=	27,974 trips x $88.2	=	$2,467,307
168,348 ÷ 20	=	8,417 trips x $118.6	=	$998,256
		Total	=	$3,465,563

1986 Deliveries = 516,678 tonnes

344,108 ÷ 12	=	28,676 trips x $88.4	=	$2,534,958
172,570 ÷ 20	=	8,629 trips x $116.2	=	$1,002,690
		Total	=	$3,537,648

1987 Deliveries = 490,287 tonnes

326,531 ÷ 12	=	27,211 trips x $83.6	=	$2,274,840
163,756 ÷ 20	=	8,188 trips x $111.6	=	$918,781
		Total	=	$3,188,621

1988 Deliveries = 492,269 tonnes

327,851 ÷ 12	=	27,321 trips x $86.0	=	$2,349,606
164,418 ÷ 20	=	8,221 trips x $114.0	=	$937,194
		Total	=	$3,286,800

1989 Deliveries = 591,590 tonnes

393,999 ÷ 12	=	32,833 trips x $86.0	=	$2,823,628
197,591 ÷ 20	=	9,880 trips x $114.0	=	$1,126,320
		Total	=	$3,949,958

Appendix F

METHODOLOGY FOR CALCULATING TIPPING COSTS OF DEMOLITION MATERIALS

Appendix F

METHODOLOGY FOR CALCULATING TIPPING COSTS OF DEMOLITION MATERIALS

Tipping charges

The following analysis was based on information on charges for acceptance of demolition wastes at landfill depots provided by Camide Pty Ltd and the Waste Management Authority of New South Wales (WMA) (Tables F.1 and F.2).

Table F.1 **Private depots' tipping fees for demolition wastes**

Year	Price per tonne ($)
1983	11.00
1984	12.00
1985	13.00
1986	14.50
1987	16.00
1988	17.50
1989	20.00

Source: Camide Pty Ltd.

Table F.2 **WMA tipping fees for demolition wastes**

Year	Price per tonne ($)
1983	10.25
1984	10.45
1985	10.10
1986	9.82
1987	10.30
1988	10.94
1989	16.00

Source: WMA.

Private depots

These rates were estimated on the basis of discussions with the Managing Director of Camide Pty Ltd. They represent the upper limit of Camide Pty Ltd's estimates.

WMA depots

These rates (Table F.2) were extracted from the WMA's annual reports. The average fee was used for years in which tipping fees varied between depots.

Real tipping charges

The charges in Table F.2 were adjusted to 1989 constant prices using the Consumer Price Index inflators outlined in Appendix B. The adjustment of these charges resulted in the following estimates of real tipping costs at constant 1989 prices (Table F.3).

Table F.3 **Estimated real tipping charges per tonne in 1989 constant dollars**

Year	Private depots	WMA depots
1983	16.70	15.56
1984	17.65	15.37
1985	17.93	13.93
1986	18.31	12.40
1987	18.59	11.97
1988	18.83	11.77
1989	20.00	16.00

The cost of tipping of demolition and building wastes

The following estimates of the costs of tipping demolition and building wastes were based on WMA data regarding deliveries of these wastes to waste depots in the Sydney region. The estimated charge for deliveries at private depots was applied to all waste deliveries other than those wastes that were disposed of at WMA depots. The calculations of these costs are provided below:

1983 Deliveries = 165,048 tonnes

WMA	\$15.56 x 21,868	=	\$340,266
Other	\$16.70 x 143,180	=	\$2,391,106
			\$2,731,372

1984 Deliveries = 308,126 tonnes

WMA	\$15.37 x 14,556	=	\$223,726
Other	\$17.65 x 293,570	=	\$5,181,511
			\$5,405,237

1985 Deliveries = 504,035 tonnes

WMA	$13.93 x 3,728	=	$51,931
Other	$17.93 x 500,307	=	$8,970,505
			$9,022,436

1986 Deliveries = 516, 678 tonnes

WMA	$12.40 x 6,231	=	$77,264
Other	$18.31 x 510,447	=	$9,346,285
			$9,423,549

1987 Deliveries = 490,287 tonnes

WMA	$11.97 x 22,897	=	$274,077
Other	$18.59 x 467,390	=	$8,688,780
			$8,962,857

1988 Deliveries = 492,269 tonnes

WMA	$11.77 x 52,111	=	$613,346
Other	$18.83 x 440,158	=	$8,288,175
			$8,901,521

1989 Deliveries = 591,590 tonnes

WMA	$16.00 x 25,716	=	$411,456
Other	$20.00 x 565,874	=	$11,317,480
			$11,728,936

Appendix G

THE CURRENT INCIDENCE OF REUSE AND RECYCLING OF DEMOLITION MATERIALS BY DEMOLITION CONTRACTORS IN THE SYDNEY REGION—RESULTS OF A SAMPLE SURVEY

Appendix G

THE CURRENT INCIDENCE OF REUSE AND RECYCLING OF DEMOLITION MATERIALS BY DEMOLITION CONTRACTORS IN THE SYDNEY REGION—RESULTS OF A SAMPLE SURVEY

Demolition contractors	Reuse	Recycle
AAT Excavations & Constructions Pty Ltd	Yes	Yes
R.J. Brady Pty Ltd*	Yes	Yes
Ezy Hire	Yes	No
Foxman & Sons Pty Ltd	Yes	Yes
H. Hassarati & Co Pty Ltd*	Yes	No
J.S.J. Excavations	Yes	No
Josef & Sons Contracting Pty Ltd	Yes	No
Kari & Ghossayn Pty Ltd	Yes	Yes
H. Lebnan	Yes	No
Kennedy Contracting Pty Ltd*	Yes	Yes
Metropolitan Demolitions Pty Ltd	Yes	No
Millers Demolishers Pty Ltd*	Yes	No
Orden Earthmoving Pty Ltd	Yes	Yes
Neville Platt Demolition Pty Ltd*	Yes	Yes
Power Demolitions Pty Ltd	Yes	No
Primo Demolition	Yes	No
S. & B. Demolition Pty Ltd	Yes	No
Stephen Paino Pty Ltd	Yes	Yes
Stuart Miller & Co. Pty Ltd	Yes	Yes
Super Division Demolition Pty Ltd	Yes	Yes
Western Suburbs Demolition Contractors Pty Ltd	Yes	No
Whatman Wrecking Pty Ltd	Yes	Yes

Note: Companies marked (*) have been in operation since 1973.

Appendix H

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[redacted]	[redacted]	
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Appendix I

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REFERENCES

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