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Draft Sydney regional environmental plan - extractive industry : technical working papers

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Draft Sydney Regional Environmental Plan - Extractive Industry

Technical Working Papers

Department of Environment and Planning

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PREFACE

The draft regional environmental plan to which this document relates has been prepared in accordance with the provisions of Division 3 of Part III of the Environmental Planning and Assessment Act, 1979.

The draft plan, together with a planning report, has been published in a separate volume. The proposals have been placed on exhibition to facilitate public comment. The purpose of this document is to provide additional technical details on the management strategies put forward in the draft plan.

Following exhibition of the draft plan pursuant to section 47 of the above Act, and consideration of submissions received, a final plan will be sent to the Minister for Planning and Environment for approval.

R.B. SMYTH
Director of Environment
and Planning

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1. CLAY/SHALE

1.1 Clay/Shale Production in the Sydney Region

Clay/shale extracted in the Sydney Region is used for the manufacture of structural clay products such as bricks, pipes, and roofing and quarry tiles. Data on clay/shale production in the region from 1968-69 to 1983-84 are presented in Table 1, with clay brick production figures for the Sydney statistical division from 1977-78 to 1983-84 shown in Table 2. Of the total amount of clay/shale produced in any one year, an average of 91.5 per cent is used in brickmaking with the remainder used to produce tiles and pipes and in other ceramic applications. The total quantity of clay/shale produced in the region averaged 2.51 million tonnes per annum over the 16 year period 1968-84. Brick production has decreased sharply in the past 2 years, compared with production levels in 1979-80 to 1981-82. This pattern is reflected in lower clay/shale production figures over the same period. There is currently an over-production of bricks in the Sydney Region with the industry operating at 65 per cent of total capacity.

In the structural clay product industry, it has been usual for manufacturing plants to locate close to their raw material sources. As abundant resources are located within the Sydney Region, these plants have in turn located close to their markets. Brickworks generally locate at the source of their raw material (adjacent to the extraction pit) and then supply the local market. Nearly all of the bricks produced are consumed within the region. Tile and pipe manufacturing plants are more likely to be situated away from the extraction pit but the raw material is generally obtained from within the region. As a rule, the only raw material imported into the region has been white-firing material for ceramic and some quarry tile production.

As a result, supplies of clay/shale have been relatively cheap in the region. In the case of a brickworks utilising its own clay/shale deposit, adjacent to its manufacturing plant, the cost of the raw material accounts for less than 5 per cent of the value of the brick. When a brickworks buys light-firing material from an independent supplier, the price of the raw material will depend on the quantity, distance and royalty charge (if applicable). For brickworks importing light-firing clay/shale, the cost of the raw material increases from 5 to 15-20 per cent of the value of the brick. Importation of white-firing clay/shale for specialist uses from Mudgee costs approximately 3 times as much as material produced within the region.

1.1.1 Clay/shale types

Plasticity and fired colour are the principal properties which determine the commercial applications of particular types of clay/shale. Consumer tastes and preferences require that a wide range of product colours is available and this can be achieved by either blending 2 or more types of clay/shale, each with a different fired colour, or by selective extraction of horizons within the Bringelly Shale to obtain material of a particular fired colour. (Bringelly Shale is a formation within the Triassic Wianamatta Group occurring over a large part of Western Sydney). The necessity for variations in fired colour is particularly applicable to brick and quarry tile production. In brickmaking, the use of clays and shales of different fired colours, allows the manufacturer to make a variety of coloured bricks ranging from dark red/brown to salmon/pink through to cream.

TABLE 1

CLAY/SHALE PRODUCTION, SYDNEY REGION
(All figures in million tonnes)

Year	Brick clay and shale	Clay (for pipes and terracotta tiles)	Other clays	Total clay and shale
1968-69	2.58	.09	.22	2.90
1969-70	2.60	.09	.27	2.96
1970-71	2.51	.10	.21	2.82
1971-72	2.42	.08	.16	2.66
1972-73	2.38	.07	.17	2.62
1973-74	2.61	.12	.11	2.83
1974-75	2.04	.09	.10	2.23
1975-76	2.35	.09	.12	2.55
1976-77	2.03	.09	.07	2.19
1977-78	2.02	.09	.12	2.23
1978-79	1.84	.09	.13	2.06
1979-80	2.60	.08	.11	2.79
1980-81	2.53	.10	.12	2.74
1981-82	2.72	.08	.08	2.88
1982-83	1.75	.06	.03	1.84
1983-84	1.77	.06	.03	1.86

Source: Australian Bureau of Statistics

TABLE 2

CLAY BRICK PRODUCTION, SYDNEY STATISTICAL DIVISION

Year	'000 bricks produced
1977-78	412,013
1978-79	484,214
1979-80	616,339
1980-81	637,486
1981-82	611,660
1982-83	453,217
1983-84	461,229

Source: Australian Bureau of Statistics

Clay/shale within the region is either classified as red-firing or light-firing. Red-firing clay/shale fires apricot, brown and red, while light-firing clay/shale includes clay/shales firing cream and buff through to white.

Plasticity refers to the ability of clay/shale to be moulded and it is expressed numerically by a plasticity index. Bricks can be made either by a dry press method (utilising low to moderate plasticity clay/shale) or by extrusion (which requires a more plastic clay/shale).

On the basis of plasticity and fired colour, the clay/shale resources of the Sydney Region can be grouped into 5 major types as outlined in Table 3.

TABLE 3

CLAY/SHALE TYPES

Clay/shale type		End product
1.	RL - red-firing, low plasticity, mainly Ashfield Shale.	Mainly used for dry press bricks. Fires apricot, brown and red with lighter bricks produced by adding cream or white-firing clay/shale.
2.	RM - red-firing, low to medium plasticity, mainly Bringelly Shale.	Mainly suitable for the manufacturing of extruded bricks. Fires apricot, brown and red with lighter colours produced by selective extraction or by adding cream or white-firing clay/shale.
3.	CM - cream-firing, low to medium plasticity, mainly Bringelly Shale.	Suitable for making lighter coloured extruded bricks. Commonly mixed with red-firing Bringelly Shale to produce bricks which vary in colour from red to apricot and buff through to cream.
4.	WM/H - white-firing low to medium and high plasticity, mainly shale lenses in the Hawkesbury Sandstone.	Used either alone or more commonly to produce bricks and quarry tiles in the cream to white range.
5.	RH - red-firing, medium to high plasticity, Tertiary clay from Londonderry, Moorebank and Maroota.	Used in the manufacture of terracotta tiles and pipes.

Data are also available on the production of clay/shale in each of the divisions listed above, obtained from annual returns submitted by producers to the Department of Mineral Resources.

TABLE 4

CLAY/SHALE PRODUCTION IN THE SYDNEY REGION 1979-80 TO 1983-84

	Percentage of total production(1)			Total production in tonnes	
	1979-1980	1982-1983	1983-1984	1982-1983	1983-1984
1. RL	27	31	26	578,599	483,225
2. RM	35	35	34	646,921	633,761
3. CM(2)	23	27	34	504,184	616,916
4. WM/H	7	1	2	23,606	25,857
5. RH	8	5	4	90,226	79,987
TOTAL	100	100	100	1,843,536	1,839,746

(1) Any errors are due to rounding.

(2) A distinction is not made between red-firing and cream-firing Bringelly Shale production in the annual returns submitted to the Department of Mineral Resources. This information is obtained through personal communication with producers.

The production of Bringelly Shale (RM plus CM) has increased from 58 per cent of total production in 1979-80 to 68 per cent of total production in 1983-84. This increase reflects the trend in modern brick manufacturing which is to use the more plastic Bringelly Shale with automatic extrusion equipment to produce a range of coloured bricks. Bringelly Shale usually fires no lighter than cream to buff and is therefore often used as the major component in a clay/shale blend designed to achieve a specific colour within the range cream to red. Smaller quantities of white-firing material from weathered Hawkesbury Sandstone Shale lenses and Tertiary clay from the Maroota sand are often added to Bringelly Shale to produce off-white and lighter cream products. The increase in cream-firing Bringelly Shale from 23 per cent in 1979-80 to 34 per cent of total clay/shale production in 1983-84 reflects the continuing popularity of lighter coloured bricks.

The recorded production of white-firing clay/shale extracted from Hawkesbury Sandstone Shale lenses has decreased from 8 to 2 per cent over the 5 year period (Table 4). However, the majority of extraction is unrecorded as it is carried out under the guise of agricultural dam construction. Production from these sources is more likely to be in the order of 7 to 8 per cent of total demand.

Production of low plasticity red-firing Ashfield Shale has averaged 28 per cent of total production over the 5 year period. Production has decreased over the years as the older dry press plants traditionally located in the inner city area are replaced by modern manufacturing plants producing extruded bricks from more plastic Bringelly Shales. Red-firing medium to high plasticity Tertiary clay which is used for manufacturing tiles and pipes currently accounts for around 5 per cent of the raw materials used in the structural clay/shale industry.

1.2 Demand Forecast for Clay/Shale Consumption in the Region

In the Regional Environmental Study for Sydney's Extractive Industry, forecasts were made of future clay/shale requirements in the region. An annual growth range of zero to 2 per cent compounded was adopted, based on regional population projections. The forecasts were divided into 3 categories in line with the division of past production into red, cream and white-firing clay/shales. A base production level of 2.35 million tonnes of brick clay/shale was assumed for 1981, based on the average production since 1968-69. In each year an allowance of 200,000 tonnes was added to include the production of terracotta and other clays.

The region's consumption of or demand for clay/shale is closely reflected in production data for the region as nearly all clay/shale produced within the region is consumed internally, and only small quantities of clay/shale are imported from outside the region. Therefore, in examining the production data presented in Tables 1 and 2, a number of demand trends can be observed:

(i) There was a steady decrease in the annual consumption of clay/shale from 2.90 million tonnes in 1968-69 to 2.06 million tonnes in 1978-79.

(ii) From 1979-80 to 1981-82, there was a significant increase in consumption of clay/shale with production levels reaching a peak of 2.88 million tonnes in 1981-82.

(iii) In the last 2 years of recorded data, there has been a very large decrease in demand to levels below 2 million tonnes per annum.

(iv) Over the past 16 years there have been small cyclical fluctuations in demand of 2 to 3 years duration.

The current drop in demand for clay/shale may be part of these cyclical fluctuations with consumption returning, over the next few years, to the high levels recorded in 1979-82. Alternatively, these lower consumption levels may be part of the fairly steady decrease in consumption of clay/shale which has continued since 1968-69 (with the exception of peak production between 1979-80 and 1981-82).

As the majority of structural clay/shale is used in brick production (91.5 per cent), the demand for clay bricks has a significant impact on the demand for clay/shale. The consumption of clay bricks is influenced by the level of housing and construction starts which are in turn influenced by general growth in the economy related to interest rates, money supply, business activity and population growth.

Increasing productivity in the industry, mainly through the development of extruded bricks, has enabled many modern brickmaking plants to use less clay/shale per brick than traditional dry press plants. These changes may continue and may be reinforced by greater market acceptance of hollow or lightweight bricks. Hollow bricks are essentially a clay shell with thin inner walls to give strength. The walls generally do not exceed 19 millimetres in thickness. Lightweight bricks are manufactured by adding a combustible substance such as sawdust to the raw clay mixture. The added material is burnt out during firing. However, in the past 2 years, 2 new dry press plants were constructed in the Sydney Region reflecting the steady demand and

TABLE 5

ESTIMATED CLAY/SHALE EXTRACTION IN THE SYDNEY REGION, 1986 - 2020

Years	RL		RM		CM		WM/H	
	0%	2%	0%	2%	0%	2%	0%	2%
1986-1990	3.57	3.79	4.08	4.33	3.57	3.79	.895	.95
1991-1995	3.57	4.18	4.08	4.78	3.57	4.18	.895	1.05
1996-2000	3.57	4.62	4.08	5.29	3.57	4.62	.895	1.16
2001-2005	3.57	5.10	4.08	5.83	3.57	5.10	.895	1.28
2006-2010	3.57	5.63	4.08	6.44	3.57	5.63	.895	1.41
2011-2015	3.57	6.21	4.08	7.11	3.57	6.21	.895	1.56
2016-2020	3.57	6.87	4.08	7.85	3.57	6.87	.895	1.72
TOTALS								
1986-2000	10.71	12.59	12.24	14.40	10.71	12.59	2.685	3.16
2001-2020	14.28	23.81	16.32	27.23	14.28	23.81	3.580	5.97
1986-2020	24.99	36.40	28.56	41.63	24.99	36.40	6.265	9.13

Years	RH		TOTAL	
	0%	2%	0%	2%
1986-1990	.64	.68	12.76	13.54
1991-1995	.64	.75	12.76	14.94
1996-2000	.64	.83	12.76	16.52
2001-2005	.64	.91	12.76	18.22
2006-2010	.64	1.01	12.76	20.12
2011-2015	.64	1.11	12.76	22.20
2016-2020	.64	1.23	12.76	24.54
TOTALS				
1986-2000	1.92	2.26	38.28	45.00
2001-2020	2.56	4.26	51.04	85.08
1986-2020	4.48	6.52	89.32	130.08

preference on the part of consumers for "solid" dry press bricks. As a result, a decreasing clay/shale per brick ratio was not included in the forecast.

Demand forecasts for clay/shale consumption in the Sydney Region over the next 35 years are presented in Table 5. Separate demand functions are calculated for each of the 5 types of clay/shale. A base consumption level of 2.55 million tonnes is assumed for 1985. This is the average level of annual production for the years 1968-83. The breakdown of total consumption is held constant over the forecast period and for 1985 is shown in Table 6.

TABLE 6

ANNUAL BREAKDOWN OF CLAY/SHALE CONSUMPTION

		Million tonnes	Percentage of total consumption	
1.	RL	.714	28	
2.	RM	.816	32	
3.	CM	.714	28	pale-firing
4.	WM/H	.179	7	= 35%
5.	RH	.128	5	
	TOTAL	2.551	100	

Assumptions were made when estimating the breakdown of total consumption into each of the 5 clay/shale types as outlined in the sections below.

1.2.1 Red-firing Ashfield Shale

The Department of Mineral Resources estimates that the demand for Ashfield Shale has reached a base level at 28 per cent of total production and that this level will only be reduced as "older style" inner city brick manufacturing plants close. It is expected that the demand for Ashfield Shale will remain at its existing level for some time to come as 2 brick companies in Sydney have recently built dry press plants.

1.2.2 Red-firing and cream-firing Bringelly Shale and white-firing Hawkesbury Sandstone Shale

It is predicted that Bringelly Shale will account for 60 per cent of total consumption over the forecast period. Bringelly Shale is expected to be the major source of raw material used in the structural clay/shale industry because of:

(i) the continuing trend towards extruded bricks which require a low to medium plasticity clay/shale;

(ii) the effects of urbanisation which have led to the sterilisation of inner city brickpits on Ashfield Shale and the relocation of

of the industry to the outskirts of the city on Bringelly Shale; and

(iii) the continuing consumer preference for a range of lighter coloured bricks which can be obtained by selectively extracting the lighter-firing horizons within the Bringelly Shale.

The proportion of cream-firing Bringelly Shale consumption is expected to equal 28 per cent of total clay/shale demand. This is 6 per cent less than the level recorded in 1983-84 but is compensated by the 7 per cent consumption level estimated for white-firing Hawkesbury Sandstone Shale which includes the currently unrecorded production coming from the northern part of the region. It is predicted that the demand for white-firing clay/shale will remain at 7 per cent, and that the demand for cream-firing Bringelly Shale will approximate the production level of 1982-83. Total consumption of pale-firing clay/shale (CM plus WM/H) is estimated to be 35 percent of total demand over the forecast period which is close to the 1983-84 level of 36 per cent.

1.2.3 Highly plastic red-firing clay

Highly plastic red-firing clay is extracted predominantly for terracotta tile and vitrified clay pipe manufacture. It is predicted that demand will remain relatively constant, at 5 per cent of total demand(1).

Consistent with the approach adopted in the regional environmental study, the zero and 2 per cent compounded growth rates are included in Table 5. However, the 2 per cent compounded growth rate is considered unrealistic in light of the almost continual decline in clay/shale production since 1968-69. The inclusion of this high growth rate and the omission of any allowance for productivity changes means that the high range of values in Table 5 is likely to be a significant overstatement of future requirements. It is considered that the zero per cent growth path is a much more accurate prediction of future requirements for clay/shale consumption in the region. It is therefore expected that the annual requirements for the 5 types of clay/shale will approximate the data in Table 6, and will remain constant over the forecast period giving the totals below.

CLAY/SHALE CONSUMPTION IN THE SYDNEY REGION: PREFERRED FORECAST

	1986-2000	2001-2020	1986-2020
RL	10.71	14.28	24.99
RM	12.24	16.32	28.56
CM	10.71	14.28	24.99
WM/H	2.685	3.58	6.265
RH	1.92	2.56	4.48

(1) Etheridge, L., Clay/Shale Resources of the Sydney Region Position Paper, Geological Survey of N.S.W., Dept of Mineral Resources GS1982/011, Jan 1982 (revised June 1983).

In conclusion, there is a fairly high degree of uncertainty attached to predicting future levels of clay/shale consumption because of the uncertainty of the effects of productivity changes and the general level of economic growth on clay brick consumption. The projections made should be taken as guides only as they are based on limited data and take no account of market fluctuations and productivity changes.

1.3 Current Estimated Reserves in the Region

The clay/shale reserves of the Sydney Region are listed in the Appendix and summarised in Table 7. This data was submitted to the Department by a number of brickmakers, tile manufacturers and clay/shale producers in the Sydney Region and by the Department of Mineral Resources. Data is provided for both secured and unsecured resources.

1.3.1 Reserves of red-firing clay/shale

In the Sydney Region there is a relative abundance of red-firing clay/shale and most brickworks have sufficient reserves of red-burning Ashfield or Bringelly Shale on site. Reserves of Ashfield Shale are expected to be sufficient as the trend will be towards utilising the Bringelly Shales. Reserves of red-burning Bringelly Shale are more than adequate to supply industry's needs well into the future. Total demand to the year 2020 at the high growth rate is estimated to be 41.63 million tonnes with current secured reserves at 168.12 million tonnes.

Reserves of highly plastic red-firing clay are estimated to be 5.55 million tonnes. At the no growth level, these reserves are sufficient to meet producers' needs until 2020. However, technical requirements for pipe and tile manufacturing and the exhaustion of existing pits may mean that additional reserves will be needed earlier than this date. Industry has indicated the need to secure adequate supplies of plastic red-firing clay with acceptable water absorption and non-filterable residues. Already one terracotta tile manufacturer is searching for additional supplies to replace a deposit due to be depleted in 2 to 3 years.

1.3.2 Reserves of cream-firing Bringelly Clay/Shale

Secured reserves of cream-firing clay/shale are currently estimated to be 21.44 million tonnes. This quantity appears sufficient on paper to supply the region's needs for about 20 to 30 years. However, supply is more critical for the reasons below.

(i) There is a continuing high demand for a wide range of light coloured bricks.

(ii) Secured resources are unevenly distributed among brick companies and clay/shale producers. Some brickworks have to import all their cream-firing material while most brickworks have to import some of the material. This requires that a certain amount of the resource remain in the hands of independent suppliers or alternatively that brickworks have their own deposits. Currently 11 million tonnes or 51 per cent of cream-firing Bringelly Clay/Shale is controlled by 3 brickworks.

(iii) The cream-burning clay/shale supplied to industry generally consists of a blend of clay and shale mixed in certain

TABLE 7

TOTAL CLAY/SHALE RESERVES IN THE SYDNEY REGION

		Total secured in situ million tonnes	Unsecured million tonnes
1.	RL (Ashfield)	77.1*	.25
	(Hawkesbury)	9.7	
2.	RM (Bringelly)	168.12	12.60
3.	CM (Bringelly)	21.44	17.10
	(Hawkesbury)	.20	
4.	WM/H	.605	.32
5.	RH	5.55	8.0
	TOTAL	282.715	38.27

* This total includes 65m tonnes at Parklea (Norbrik).
Only 2.57m tonnes is recoverable.

proportions to satisfy the manufacturers' requirements. Clay is commonly added to the shale to increase the plasticity of the raw material for the production of extruded bricks. There is therefore a need to ensure that supplies of cream-burning clay are made available to industry in addition to reserves of cream-burning shale.

Table 3 in the Appendix lists the secured and unsecured reserves of cream-firing Bringelly Clay/Shale in the region. The largest unsecured reserves are located at Mulgoa and, if fully utilised, they have the capacity to supply 21.6 million tonnes of cream-firing clay and shale.

1.3.3 Reserves of white-firing Hawkesbury Sandstone Shale

The most critical need facing the industry is ensuring that adequate reserves of white-firing clay/shale are secured in the Hawkesbury Sandstone. Currently secured reserves are expected to be exhausted within a few years. White-firing clays and shales with low to medium plasticity, acceptable shrinkage and drying, and low water absorption are required for manufacturing quarry and ceramic tiles. Certain tile manufacturers cannot use cream-firing Bringelly Shales as a substitute for the white-firing Hawkesbury Sandstone Shale and as a result, import clay/shale from as far away as Mudgee and Goulburn. In addition, a number of brickmakers combine the white-firing material with Bringelly Shales to produce bricks in the cream to white range.

1.4 Conclusions

1.4.1 Red-firing Ashfield Shale

Brickworks located on Ashfield Shale deposits and Ashfield Shale brickpits should be able to continue in operation in order to reach their full economic potential subject to environmental constraints. This will ensure that the fullest possible utilisation is made of existing reserves within the region.

1.4.2 Red-firing Bringelly Shale

Brickworks and brickpits located on red-firing Bringelly Shale deposits should be able to continue in operation and realise their full economic potential subject to environmental constraints. This will ensure that the fullest possible utilisation is made of existing reserves within the region.

1.4.3 Cream-firing Bringelly Shale

There is a need to secure additional reserves of cream-firing Bringelly Shale in order to ensure supply to industry in the future. Of the 38.54 million tonnes of cream-firing Bringelly Shale (secured and unsecured) in the region, 21.6 million tonnes or 56 per cent is contained at Mulgoa. According to the Department of Mineral Resources, the Mulgoa deposit is the only identified source of cream-firing clay/shale in the Sydney Region which can guarantee continuity of supply to the brick manufacturing industry as a whole in the short term and also ensure that future requirements can be met beyond the year 2000.

The cream-firing and red-firing clay/shale reserves of the Mulgoa area are listed in Table 8. A joint local and State Government working party was established to investigate the extent of the resource and

TABLE 8

MULGOA CLAY/SHALE RESOURCES

Optimal Extraction Area	Cream-firing clay/shale (million tonnes)	Red-firing clay/shale (million tonnes)
H.C. Site 7770, Bradley St	5.1	
Mulgoa Quarries Lot 1, Bradley St	7.3	
J.P. Reddan's property	3.6	
TOTAL	16.0	10.0
Mulgoa Quarries Lot 28, Bradley St	3.1	4.9
Zacuba Lot 1, Bradley St		
Part (A)	1.0	)
Part (B)	1.5	) 2.4
TOTAL MULGOA	21.6	17.3

its cream-firing characteristics. These investigations confirmed the presence of the cream-firing material and indicated that the deposit was the largest identified reserve of its type in the Sydney Region. The working party sought to examine the possibility of achieving a co-ordinated approach to extraction and restoration in the area. At the request of the working party, the Department of Mineral Resources assessed the ceramic potential of the area and identified an optimal extraction area, containing a total of 16 million tonnes of cream-firing clay/shale.

Securing the bulk of the Mulgoa clay/shale resource for extraction is seen to be of critical importance in ensuring the supply of light-firing clay/shale to industry.

Two other clay/shale resoure areas in the region should be protected from sterilisation to allow for further testing to establish the potential of the resources for commercial extraction. These resource areas consist of:

(i) a number of sites in south-west Sydney (extending from Penrith to Camden) with potential for the economic extraction of cream-firing Bringelly Shale; and

(ii) a deposit of Pleistocene clay at Roberts Creek, the extent of which is not yet known, but it is considered to have the potential of supplying the Sydney market with a large amount of white or cream-firing clay.

1.4.4 White-firing clay/shale

Extraction of shale lenses in Hawkesbury Sandstone is mainly concentrated in the north-western sector of Sydney, south of the Hawkesbury River. The environmental costs of extraction are generally high due to the rugged terrain and the small quantity of clay/shale obtained from each deposit. In addition, deposits are often overlain by a thick band of sandstone. There are now few remaining deposits south of the Hawkesbury River as most deposits are situated within national parks or in environmentally sensitive areas. There is however the possibility of extracting white-firing clay lenses from within the Maroota sand deposit.

Extraction of the clay resource at Maroota could only be considered in conjunction with extraction of the sand deposit. Any extractive operations, on a large scale, should be viewed in light of the environmental effects of such activities on the unconfined aquifer beneath the deposit and on the three major water catchments of the Maroota area.

As with cream-firing Bringelly Shale, there is a need to secure additional reserves of white-firing material. Environmental factors could preclude further extraction of new resource areas south of the Hawkesbury River. However, there are deposits of Hawkesbury Sandstone Shale north of the Hawkesbury River, in the Mt White-Kulnura-Somersby area, which have potential for future extraction.

These lenses often occur beneath swampy areas or flattish areas which show no outcrop, and are commonly exposed in road cuttings. Many orchards and small farms cover large areas of shale lenses and landowners are often not averse to the mining of these lenses on undeveloped land. The holes formed during mining can be used as dams

when mining has been completed. The impact of extraction is less than in the rugged terrain south of the Hawkesbury River. These lenses contain white-firing clay/shale but need further investigation by the Geological Survey of N.S.W. of the Department of Mineral Resources. Some preliminary investigations have already been carried out by the Department of Mineral Resources and possible sites of white-firing clay/shale identified. All these sites have been partially tested for their ceramic potential. Some of these sites are adjacent to old quarries.

These deposits may provide an alternative to the Roberts Creek clay and other sandstone shale lenses south of the Hawkesbury River, and therefore merit further investigation.

The only alternatives to extraction of Hawkesbury Sandstone Shale lenses in the Mt White-Kulnura-Somersby area are deposits of koalin (a white clay mineral) shown in Figure 1. All these deposits are considerably further from the Sydney market than the deposits in the Gosford area. Manufacturers would have to pay approximately three times the price of locally won material to import clay/shale from these areas. A possible alternative would be to utilise the clay tailings from sand extraction operations on the Newnes Plateau for brickmaking. However, some technical problems have been experienced with this market in the past and more work needs to be done before tailings could receive large-scale market acceptance for use in brickmaking.

In summary, it would be argued that extraction should proceed in principle from deposits in the Mt White-Kulnura-Somersby area for the reasons below.

(i) A certain amount of white-firing clay/shale is needed in brick and tile manufacturing. Bringelly Shale which fires lighter than cream cannot be used as a substitute. White-firing clay/shale can either come from weathered Hawkesbury Sandstone Shale lenses in the Sydney Region or from kaolin deposits located long distances from the Sydney market.

(ii) The costs of importing kaolin into the Sydney Region are three times as high as if the material is extracted locally.

(iii) There are only a few remaining deposits of white-firing clay/shale south of the Hawkesbury River, all of which are in environmentally sensitive areas or in national parks.

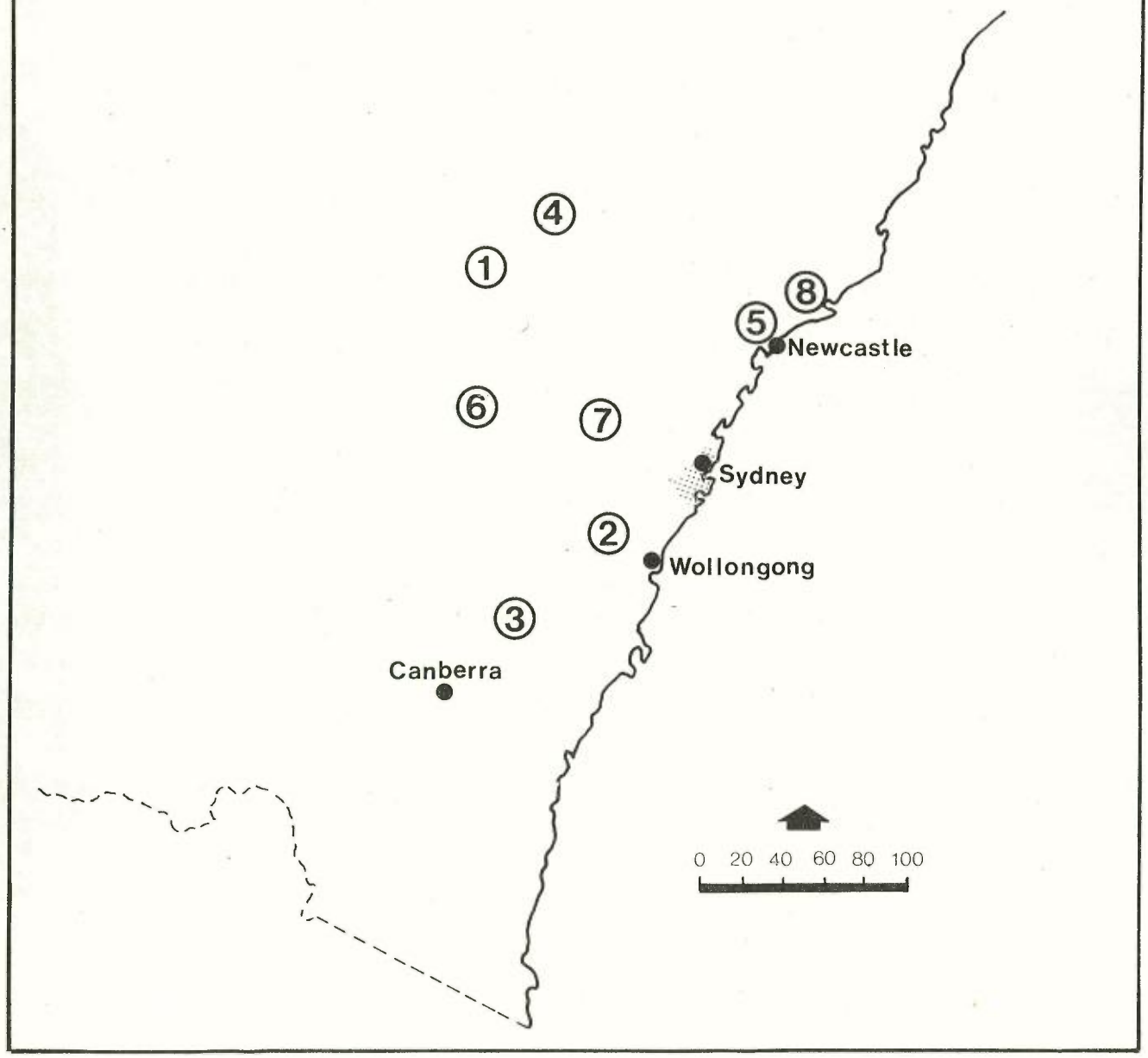
(iv) The weathered Hawkesbury Sandstone Shale lenses located in the Mt White-Kulnura-Somersby area are less environmentally sensitive than those south of the Hawkesbury River. Extraction from these deposits represents a substantial cost saving to the brick and tile manufacturing industry compared with importing kaolin from other areas in N.S.W.

1.4.5 Red-firing highly plastic clay

Extraction pits located on the red-firing Tertiary clay deposits should continue until reserves are depleted in order to maximise resource availability within the region. In addition, there are two resource areas identified below which have the potential of supplying red-firing Tertiary clay to the region in the future.

FIGURE 1:

LOCATION OF KAOLIN DEPOSITS IN NEW SOUTH WALES



1. GULGONG – BUCKAROO
2. BUNGONIA – MARULAN
3. GOULBURN
4. ULAN
5. EAST MAITLAND
6. ORANGE – BATHURST
7. NEWNES PLATEAU
8. SWAN BAY (PORT STEPHENS)

(i) An area identified by the Department of Mineral Resources within the Londonderry clay/shale which is at Castlereagh adjacent to two existing clay pits. The area is immediately south of existing extraction within the Londonderry sand deposit and requires investigation by the Department of Mineral Resources to test its economic potential.

(ii) Areas outside the Sydney Region which contain deposits of Patonga Claystone, in the Gosford-Lake Macquarie area.

The Patonga Claystone consists mainly of red-brown and grey-green claystone and siltstone, with some light green sandstone. The claystone appears to have properties similar to those of the red-firing plastic Tertiary clays and would therefore be suitable for terracotta tile and pipe production. The country underlain by the claystone is generally flat to undulating, and many undeveloped and rural areas offer suitable quarry sites. Seventeen potential resource areas have been identified by the Department of Mineral Resources but the potential of these areas needs to be further investigated by the Geological Survey of N.S.W.

2. SAND

2.1 Sand Production in the Sydney Region

Data on sand production in the Sydney Region from 1968-69 to 1983-84 is presented in Table 9. Over the past 16 years, small fluctuations in sand production are evident with the continual recurrence of alternating periods of high and low production. Peak production levels were recorded between 1971-72 to 1974-75 and between 1978-79 to 1981-82. Total sand production averaged 5.7 million tonnes per annum between 1978-79 to 1981-82, which is substantially higher than the 4.3 million tonnes per annum averaged over the past 2 years (1982-83 to 1983-84). Production is currently in a slump, with output levels similar to those experienced in 1976-77 and 1977-78.

Most sand produced in any one year is used for construction purposes. This includes the production of clean sand for use in pre-mixed concrete, concrete products, sand lime bricks, plastering, fibro-asbestos cement, and mortar and filling sand. Over the past few years construction sand has represented 97 per cent of total sand production. The remaining 3 per cent has been industrial sand production which consists mainly of foundry, glass and filter sand production, and sand used as industrial fillers. Almost all of the construction sand consumed in the region is produced within the region. Small quantities of industrial sand are imported into the region, particularly sand for clear glass production from the Port Stephens area.

The sand deposits of the region can be divided into three groups:

(i) medium to coarse grained clean sand, namely river sand;

(ii) fine to medium grained clean sand - mainly estuary and dune sand; and

(iii) "fatty" sand - sand with a high clay content or mortar/ bricklayer's sand.

Sand production in 1983-84 is categorised by sand type and deposits. It is presented in Table 10. In that year, medium-coarse sand accounted for 50 per cent of total production in the region, fine-medium sand 35 per cent of total production and "fatty" sand for the remaining 15 per cent. It should be noted that only a small proportion of sand produced from the "fatty" sand deposits is used as a bricklayer's or mortar sand. Most sand (75-80 per cent) is washed and used as a general purpose construction sand. From Table 10 it can be seen that almost all the medium-coarse sand produced in the region in 1983-84 was obtained from the Hawkesbury/Nepean River and its flood plain. Thirty seven per cent of medium-coarse sand came from the river and 55 per cent from the Penrith Lakes Scheme. In total, the river and flood plain supplied 48 per cent of sand to the region in 1983-84.

Of the dune and estuary fine-medium sand, Kurnell was by far the largest supplier in 1983-84 accounting for 83 per cent of fine-medium sand production and 29 per cent of total regional sand production. In

TABLE 9

INDUSTRIAL AND CONSTRUCTION SAND PRODUCTION IN THE SYDNEY REGION

1968/69 - 1983/84
(Any errors are due to rounding)
(million tonnes)

	Construction sand	Foundry sand	Glass sand	Other	Total industrial
1981-82	5.577	.0444	.1247	.01	.1791
1982-83	4.182	.0642	.0675	.0031	.1348
1983-84	4.363	.0618	.0716	.002	.1354

1968-69	4.98
1969-70	4.63
1970-71	4.88
1971-72	5.27
1972-73	5.44
1973-74	5.32
1974-75	5.87
1975-76	4.90
1976-77	4.31
1977-78	4.28
1978-79	5.35
1979-80	5.72
1980-81	6.03
1981-82	5.76
1982-83	4.32
1983-84	4.50

TABLE 10

SAND PRODUCTION IN THE SYDNEY REGION IN 1983-84 - BY TYPE

Sand	Deposit	Production million tonnes	Percentage of total production
Medium-Coarse	Hawkesbury/Nepean River	.82	18
	Hawkesbury/Nepean Flood plain	.14	3
	Penrith Lakes	1.23	27
	Other (Minor)	.06	1
Sub-Total		2.25	49
Fine-Medium	Kurnell	1.30	29
	Chipping Norton	.19	4
	Glenfield	.10	2
Sub-Total		1.59	35
"Fatty"	Elderslie	.30	7
	Londonderry	.36	8
Sub-Total		.66	15
TOTAL:		4.50	100.00

* Of the 660,000 tonnes of "fatty" sand produced, approximately 88,000 tonnes is sold as mortar sand, 72,000 tonnes is sold for glass production, and 500,000 tonnes is sold as a general purpose construction sand.

1983-84, sand output from Kurnell exceeded sand production from the Penrith Lakes Scheme. Glenfield and Chipping Norton supplied the remaining 17 per cent of fine-medium sand to the region.

The two major "fatty" sand deposits currently being worked are located at Elderslie and Londonderry, with minor amounts of "fatty" sand produced at Maroota, Ebenezer and from small deposits in the Camden area. In 1983-84, Elderslie and Londonderry supplied 15 per cent of the region's total sand requirements. It is estimated that of the total 660,000 tonnes produced from these two deposits, 88,000 tonnes were used as mortar sand, 72,000 tonnes for amber glass production and special uses, and 500,000 tonnes for general purpose construction and fill sand.

2.2 Demand Forecast for Sand Consumption in the Region

In Table 11, three forecasts are presented for sand production to the year 2020 on the basis of the three identified sand types. These forecasts have been updated to include recent production trends. The forecasts are based on an estimated production in 1985 of 5 million tonnes of construction sand (which is just above the 16 year average of 4.9 million tonnes per annum) and 0.25 million tonnes of industrial sand (also just above the 16 year average of 0.20 million tonnes per annum). For 1985, the following breakdown of sand types is assumed, based on recent production trends.

CONSTRUCTION SAND			INDUSTRIAL SAND
2.75 -	medium-coarse		0.25m tonnes - fine-medium
1.50 -	fine-medium		
0.75 -	"fatty" sand deposit	0.56 - general purpose construction sand 0.19 - mortar sand	
TOTAL 5.0 million tonnes			

Two possible growth paths are projected: the first (no growth) assumes that production levels remain at 5.25 million tonnes per annum, the second assumes a growth rate of 2 per cent compounded annually, which encompasses population projections. In accordance with the breakdown for 1985, it is assumed that 55 per cent of construction sand will consist of clean medium-coarse sand, that 30 per cent will consist of clean medium-fine sand, and that 15 per cent of construction sand will come from "fatty" sand deposits, although only 4 per cent of construction sand will consist of mortar sand. The "fatty" sand deposits will supply approximately 11 per cent of the region's general purpose construction sand. In each year, 0.25 million tonnes of fine-medium sand has been added representing a constant allowance for industrial sand production.

It is considered that the no growth forecast, in which sand production levels are expected to average 5.25 million tonnes per annum, is the most likely. Over the past 16 years, annual sand consumption has varied from between 4 and 6 million tonnes per annum and it does not seem unreasonable to predict that sand consumption in the future will average around 5.25 million tonnes per annum. Table 12 presents estimated demand for sand to the year 2020 as well as estimates of the

TABLE 11

PROJECTED SAND EXTRACTION IN THE SYDNEY REGION - BY SOURCE
(million tonnes)

Sand	Medium-coarse sand deposits		Fine-medium sand deposits		"Fatty" sand deposits	
	0%	2%	0%	2%	0%	2%
1986-1990	13.75	14.61	8.75	9.21	3.75	3.98
1991-1995	13.75	16.12	8.75	10.05	3.75	4.40
1996-2000	13.75	17.8	8.75	10.96	3.75	4.85
2001-2005	13.75	19.66	8.75	11.97	3.75	5.36
2006-2010	13.75	21.69	8.75	13.08	3.75	5.92
2011-2015	13.75	23.94	8.75	14.31	3.75	6.53
2016-2020	13.75	26.44	8.75	15.67	3.75	7.21
1986-2000	41.25	48.53	26.25	30.22	11.25	13.23
2001-2020	55.00	91.73	35.0	55.03	15.0	25.02

TABLE 12

MOST PREFERRED FORECAST

	Demand	Source deposit/type	
1986 - 2000			
Medium-coarse	41.25	Medium-coarse	41.25
Fine-medium	34.65	Fine-medium	26.25
"Fatty"	2.85	"Fatty"	11.25
TOTAL	78.75		78.75
2001 - 2020			
Medium-coarse	55.0	Medium-coarse	55.0
Fine-medium	46.2	Fine-medium	35.0
"Fatty"	3.8	"Fatty"	15.0
TOTAL	105.0		105.0

source of the sand. It is predicted that to the year 2020 the region will require 96.25 million tonnes of clean medium-coarse sand, 80.85 million tonnes of clean fine-medium sand and 6.65 million tonnes of "fatty" sand. It is predicted that 96.25 million tonnes of Sydney's sand will be supplied from medium-coarse sand deposits, 61.25 million tonnes from fine-medium clean sand deposits and 26.25 million tonnes from "fatty" sand deposits.

2.3 Current Estimated Reserves in the Region

In Table 13, the sand deposits considered in the draft plan to be of regional significance are listed by type (medium-coarse, fine-medium and "fatty"), and estimated size in late 1984. The reserve estimates have been updated since the publication of the regional environmental study from information supplied by the Department of Mineral Resources, the Quarry Masters Association of N.S.W., and the Sand and Soil Producers' Association of N.S.W. Information relating to current and potential product end uses was obtained from the Department of Mineral Resources.

2.4 Sand Resources in Detail

This section describes in detail the options for future sand extraction in and adjacent to the Sydney Region. The sand resources are again classified according to type. The information contained in this section forms the basis of the sand management strategies presented in the planning report.

2.4.1 Medium-coarse sand resources

The main sources of medium-coarse sand include the Hawkesbury/Nepean River, the Castlereagh flood plain (Penrith Lakes) and the Richmond Lowlands. There are also extensive supplies of medium-coarse sand off-shore of Broken Bay and on the Newnes Plateau. In the short term extraction will continue at Penrith Lakes at the current rate of approximately 1-1.25 million tonnes per annum. This main source is supplemented by extractive operations in the Hawkesbury/Nepean River and other minor flood plain deposits.

In the medium to long term it is anticipated that the Penrith Lakes Scheme will continue to supply sand to the market but the extraction rate will be restricted by the demand for gravel and the ratio of gravel to sand at the point of extraction. Future extraction from the Hawkesbury River should be dependent upon a river management study which will need to determine acceptable parameters for dredging given hydrodynamic, water quality and competing use constraints. It is anticipated that in the medium to long term some extraction will need to occur from either the Richmond Lowlands, the Newnes Plateau or offshore. Commercial extraction is unlikely to be favoured from the Colo and Macdonald Rivers.

(i) Hawkesbury/Nepean River

The Hawkesbury/Nepean River is utilised as a potable and non-potable water supply, for irrigation and stock watering, for fisheries purposes, for recreational use and as an outlet for urban and agricultural run-off and sewage effluent in addition to the extraction of sand and gravel. The main challenges facing river management will be

TABLE 13

A. SAND DEPOSITS OF REGIONAL SIGNIFICANCE - CURRENTLY BEING EXTRACTED

Deposit	Sand type & end use	Estimated reserves million tonnes	Company ownership million tonnes
i) Hawkesbury/Nepean River (bed & bank extraction)	medium-coarse clean		
Menangle to Wallacia	construction(1) sand	10	1-2
Penrith to Yarramundi	construction sand	10	
Yarramundi to Cattai	construction sand	20	5.75 only 4 secured
Penrith Lakes Scheme	construction sand	49	49 partly secured
ii)	fine-medium		
Kurnell	construction & industrial		19.15 secured(2)
Glenfield	construction	1.75	1.75 secured
Chipping Norton	construction	2.7	2.5 secured
iii)	"fatty" sand		
Londonderry/ Agnes Banks	construction & industrial	7.6	7.6 secured(3)
Elderslie	construction industrial	9.4	9.4 secured(3)
Newnes Plateau (small scale extraction)	"fatty" sand - construction & industrial		unknown

(1) Construction sand refers to sand utilised in concrete, mortar, filling and plastering and sand-lime bricks.

(2) Secured subject to the terms of relevant land management study and subject to further specific approvals.

(3) Of this total 19.15 million tonnes in company ownership, it is estimated that only between 5 and 7 million tonnes will be extracted.

TABLE 13 (Cont.)

B. SAND DEPOSITS OF REGIONAL SIGNIFICANCE - NOT YET EXTRACTED

Deposit	Sand type & potential end use	Estimated reserves million tonnes	Company ownership million tonnes
i)	medium-coarse		
Hawkesbury/down-stream of Cattai	construction	40	
Castlereagh flood plain (Monier)	construction	3.5	3.5 not secured
Richmond Lowlands	construction	114	17 not secured
Colo River	construction & landscaping uses	20	
ii)	fine-medium		
Bonnie Doon Golf Course	construction & industrial	5	
Richmond Lowlands	construction	115	6 not secured
Botany Bay	construction & industrial	9	mining lease application
Port Hacking	construction	up to 15	permissive occupancy
Wrights & Wellums Creeks	construction & industrial	40-60	mining lease application
Macdonald River	construction	20	permissive occupancy application
Offshore of Broken Bay	construction	extremely large	
Offshore between South Head & Port Hacking	construction	extremely large	
iii)	"fatty" sand		
Pitt Town	construction	8	
Maroota	construction	15	4 not secured
Somersby Plateau	construction	50	
Newnes Plateau (large scale)	construction & industrial	extremely large	

to maintain an adequate water quality standard as residential development in the catchment area increases with resultant increases in the amount of effluent discharged; and to manage in an efficient manner the competing uses of the river.

In studying the impact of extraction on the Hawkesbury/Nepean River system, two main issues emerge. The first is the impact of extraction on water quality and the aquatic environment. While extraction per se is not the main cause of the poor quality of water in the river, extraction, if not carefully controlled, has the potential to exacerbate an already bad situation. Poor water quality is seen primarily to be the result of three factors: discharged nutrients and pathogenic bacteria from sewage treatment works, rural and urban run-off, and reduced water flows due to the diversion of water upstream which increases the concentration of nutrients and bacteria in the river. Extraction, if not carefully controlled, can contribute to the deterioration of water quality standards by increasing turbidity levels, especially when draglines are used, and through the removal of the river shallows and their associated plant and animal life. Productive habitats such as seagrass beds may be destroyed by extraction of the underlying sediment or degraded by associated turbidity and sedimentation. Aquatic fauna (including fish) are likely to be affected by both the loss of shallows and fine sediment smothering them.

At the present time, the precise impact of extractive operations on water quality is largely unknown. There is a general lack of published data on water quality parameters other than nutrients. The Department of Environment and Planning, in conjunction with the State Pollution Control Commission, Fisheries Division of the Department of Agriculture and Hawkesbury Agricultural College has commenced a study on the effects of extractive activity on the distribution of macrophyte beds, benthic invertebrates and fish. The study is due to be completed in late 1986.

The other relevant issue is the impact of extraction on the hydrodynamic processes of the river system. Currently, extraction from the river proceeds in an ad hoc manner with each extractive proposal being considered on its merits. The Public Works Department has expressed concern at the cumulative effects of extractive operations on the hydrodynamic and sedimentary processes of the river system. This includes the effect of extraction on river morphology, tidal flows, sediment inputs and sediment movements in channels and onto flood plains, saline intrusion, river dispersion characteristics and river dynamics, including channel movements and bank stability.

The Public Works Department considers that extraction of sand and gravel from the bed, banks and flood plains of the Hawkesbury River should be carefully planned and co-ordinated. The Department stresses that failure to do so could result in a legacy of severe environmental problems which could require enormous funds to repair. The Public Works Department recommends that studies are undertaken to develop predictive models of the hydrodynamic and sedimentary processes associated with tidal and flood flows, so as to determine the cumulative effects of sand and gravel extraction on the river system. The objective of the studies would be to provide a range of extraction options which have acceptable impacts on the river system.

. General guidelines for future extraction

The guidelines below have been set for future sand extractive operations in the Hawkesbury/Nepean River.

(a) Future extraction from the Hawkesbury/Nepean River should only proceed from defined areas under strict environmental and planning guidelines. The major concerns are to ensure that:

- all future extractive applications are assessed in terms of the cumulative impact of the proposal on the hydrodynamic and sedimentary processes of the river;

- the impact of extraction on water quality and the aquatic environment is minimised; and

- extraction does not severely limit or interfere with other competing river uses.

(b) Estuarine wetlands (comprising saltmarshes and mangroves) are to be preserved and protected from extractive operations.

(c) Recognised fishing grounds are also protected from extractive industries. Commercial and recreational fishing and the oyster farming industry should not be disadvantaged by extraction.

(d) Cutter suction dredges are used in preference to dragline operations so that turbidity is minimised.

. Site specific guidelines

(a) Nepean River: Menangle to Wallacia - in this section of the river, channel flows are controlled by a series of weirs. Extraction would assist in clearing out the river channel and could considerably reduce the incidence of minor flooding of the horticultural flats. Extractive operations however would need careful control and future proposals considered in the light of existing operations. Extraction is not desirable at Bents Basin and upstream of Menangle Bridge.

(b) Nepean River: Wallacia to Penrith - extraction is not desirable from this section of the river as there is very little extractable material remaining. In addition, access is poor in many locations and the Water Resources Commission has suggested that there is some evidence of appreciable erosion of the river bed downstream of the Warragamba confluence.

(c) Hawkesbury-Nepean River: Penrith to Yarramundi - extraction may be acceptable in this section of the river subject to environmental considerations. Extraction proposals must give consideration to the environmental impact of the operation on water quality, the aquatic habitat and sediment dynamic processes operating in this section of the river.

(d) Hawkesbury River: downstream of Yarramundi - the State Pollution Control Commission has made a preliminary investigation into the possible effect of extractive operations on water quality between Yarramundi and Wilberforce Reach. The Commission has expressed

concern at the possible effect that loss of shallows in this section of the river will have on water quality. The shallows section of the river performs a number of important environmental functions including control of saline intrusion, assisting the assimilation of nutrients and providing valuable habitat for certain bird and fish species. The Commission does not support further extractive operations in the river between Yarramundi and Wilberforce Reach until more studies are completed.

It is concluded that prior to granting further approvals for extraction of sand and gravel from this section of the river, sand mining companies in co-operation with the relevant State Government departments consider preparing a river management study to:

- identify where extraction should be located in the river in relation to the hydrodynamic processes of the river system; and

- assess the impact of extraction on water quality and the aquatic environment.

The objective of such a study would be to provide a range of extraction options which have acceptable impacts on the river on the basis of hydrodynamic and water quality parameters. It is anticipated that this would form the basis for the development of a plan of management for future river-based extractive operations. The study area would cover the Hawkesbury River downstream of Yarramundi at the Grose River confluence.

Such a study would include the following information:

- hydrodynamic processes: the study would need to develop predictive models of the hydrodynamic and sedimentary processes associated with tidal and flood flows. The models would be used to determine the cumulative effects of all potential sand and gravel extraction from the bed and bank of the Hawkesbury River in relation to:

    . river morphology including channel depths, bank erosion, channel widths, morphological features such as sand bars, sand shallows, river alignment, sinuosity, channel migration, meander pattern, bend cut-offs;

    . tidal parameters such as range of tides, mean tide level and tidal lags;

    . river dispersion characteristics;

    . sediment inputs and sediment movements in-channel and onto flood plains and sediment supply to the downstream areas and the coast;

    . river dynamics including channel movements and bank stability; and

    . flooding behaviour.

- water quality and aquatic habitat - the study would need to determine the acceptability of sand and gravel extraction in relation to the following parameters:

  . salinity penetration;

  . turbidity increases;

  . terrestrial flora and fauna;

  . aquatic flora and fauna;

  . impact on aquatic fauna when estuarine wetlands (comprising saltmarshes, mangroves and seagrass beds) are destroyed or modified;

  . the impact on nutrient assimilation when estuarine wetlands are destroyed or modified; and

  . siltation.

It is suggested that such a study should be a joint project between industry and the State Government, and that industry should give consideration to funding the study, at least in part. The Public Works Department has already begun preliminary investigations into the sedimentary processes of the river and should be the authority in charge of the overall supervision and co-ordination of the project.

The study should also be carried out in consultation with other relevant government departments, particularly the State Pollution Control Commission in relation to water quality matters, the Fisheries Division of the Department of Agriculture, the Water Resources Commission, the Department of Environment and Planning, and the Department of Mineral Resources.

It is anticipated that such a study would take between 2 and 3 years to prepare at an estimated cost of as much as $2 million.

(ii) The Colo River

Commercial extraction is not favoured in the Colo River as the river valley is one of outstanding scenic beauty which offers unique recreational opportunities in close proximity to north-west Sydney.

However, remedial dredging of the river for the purposes of channel clearance may be required. In some sections of the river, sand bars are extensive, making navigation, even by canoes, difficult. Remedial dredging could benefit passive recreational users of the river and reduce the incidence of minor flooding. Any remedial dredging would need to be carried out in consultation with the Water Resources Commission (for non-tidal waters) and the Public Works Department (for tidal waters) with the objective of benefiting the whole river system.

(iii) Penrith Lakes Scheme - Castlereagh flood plain

The sand and gravel resources of the Penrith Lakes Scheme area are currently the subject of a draft regional environmental plan. The objectives of the plan are to provide for the rehabilitation of the area into a large recreational lakes scheme.

The extractive resources of the Penrith Lakes Scheme area should be utilised in accordance with the recommendations outlined in the regional environmental study and plan.

(iv) Richmond Lowlands

There is a total of 229 million tonnes of fine-medium and medium-coarse sand in the Richmond Lowlands, making it the largest onshore deposit of sand in the region. In considering the acceptability of extraction for the Lowlands, three issues of importance emerge:

. Agriculture

The soil of the flood plain is classified by the Department of Agriculture as being either Class 1 or Class 2(1). The rich alluvial soil is the only remaining Class 1 agricultural land in northern Sydney and the only large pocket of Class 1 agricultural land left in the Sydney Region (small scattered pockets of Class 1 land are found near Camden). The Lowlands are primarily used for vegetable production and turf farming. The area is capable of year round production unlike inland vegetable growing areas. This is due to the relatively mild climate, few frosts and ample irrigation water. There is also the advantage of reduced transport costs as the wholesale markets are located only 45 kms away.

The significance of the Richmond Lowlands flood plain to agricultural production in the Sydney Region has been greatly increased through the loss of the Nepean flood plain at Castlereagh to extractive industry (Penrith Lakes Scheme). This land is also classified Class 1 by the Department of Agriculture. In addition, the Department of Agriculture expects that in the future greater pressure will be placed on the Richmond-Windsor area for market gardening as the older, traditional market garden areas at Ryde, Blacktown and Warriewood are undergoing rapid urbanisation.

. Wetlands

The Lowlands contain a number of important freshwater wetlands which have high regional significance for wetland and waterbird conservation. They form part of the wetland network of the Hawkesbury Valley, are a valuable breeding resource and form a vital refuge during drought periods when birds move from the inland to the coast for survival. Any reduction in the area or quality of these wetlands may cause significant irreversible changes in the usefulness of the regional wetland resource.

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(1) Definitions of Agricultural Land Classifications:
CLASS 1 LAND: suitable for regular cultivation - no special soil conservation works or practices are required.
CLASS 2 LAND: suitable for regular cultivation - soil conservation practices such as strip cropping, conservation tillage and adequate crop rotation are required.

. Heritage

The farms of the Lowlands are among the oldest in Australia. The Hawkesbury/Nepean River was discovered within two months of the First Fleet's arrival and by 1799, the acreage cultivated by the Lowlands' farms approached just over half that of the Colony as a whole.

Extraction on the Lowlands should be carefully controlled in the context of the constraints below.

. Any extractive operations should not adversely affect or interfere with the natural operation of the wetlands system.

. The Department of Agriculture should assess the economic value of agricultural production in the Lowlands with a view to identifying which areas are of the highest priority for agricultural production. The Department of Environment and Planning in conjunction with the Department of Mineral Resources could then identify areas to be scheduled for extraction in accordance with the findings of the agricultural assessment.

It is anticipated that due to the limited rate of extraction of sand from the Penrith Lakes Scheme, additional reserves of medium-coarse sand will be required in the short to medium term. However, extraction from the Lowlands should only be considered in the medium to long term in the light of the possible extraction of additional resources in the Hawkesbury/Nepean River, the Newnes Plateau and any offshore extraction.

(v) Offshore marine aggregate

Marine aggregate extraction provides a possible alternative to onshore extraction. The majority of sediment offshore consists of fine to medium sand and gravel, but there are some deposits of medium to coarse grained sand offshore from Broken Bay. The majority of offshore sediment would be suitable for construction purposes rather than industrial uses. The potential for marine aggregate extraction as well as the problems that need to be overcome before marine aggregate can become a viable alternative to onshore extraction are discussed in the next section of this report.

2.4.2 Fine-medium sand resources

At the present time, fine-medium sand is produced at three locations in the region: Kurnell, Glenfield and Chipping Norton. Kurnell is by far the major source of fine-medium sand and produced 82 per cent of Sydney's fine-medium sand requirements in 1983-84. Sand production on the Kurnell Peninsula is the subject of a Commission of Inquiry and it is expected that extraction will proceed for at least 5-7 years at the current rate of approximately 1 million tonnes per annum. This resource, combined with reserves at Glenfield and Chipping Norton of 4.45 million tonnes represents a very limited supply of sand for the region. Problems are already being experienced with supply of fine-medium sand (Department of Mineral Resources). It is imperative that alternative sources of fine-medium sand are secured for the short to medium and medium to long term, especially when extraction at Kurnell ceases.

There are four major alternatives for the extraction of fine-medium sand, once extraction from Kurnell ceases: the sand resources of the Macdonald Valley (Macdonald River and Wrights and Wellums Creeks); the Richmond Lowlands; marine aggregate (principally Botany Bay, Port Hacking and off the coast of N.S.W.); and the sand resources on the Newnes Plateau which have the potential of supplying fine-medium sand for industrial and construction applications. Marine aggregate extraction should be investigated as a possible alternative to large-scale onshore extraction. In relation to onshore deposits, it is unlikely that extraction would be favoured from the Macdonald River. Potential does exist however, for extraction from Wrights and Wellums Creeks, the Newnes Plateau and partial extraction from the Richmond Lowlands.

(i) Kurnell

Future sand mining on the Kurnell Peninsula will be determined by the Minister for Planning and Environment following the findings of the Commission of Inquiry into sand extraction on the Peninsula.

(ii) Glenfield

The Glenfield deposit occupies a terrace of the Georges River and lies between the river and the main southern railway line. It contains an estimated 1.75 million tonnes of fine-medium sand suitable for construction purposes and fill and has good access to the market.

Extraction is proceeding under existing use rights in conjunction with a waste disposal operation. The land is zoned regional open space in which further extractive industry is prohibited. It is not significant from an agricultural point of view. The soils are susceptible to wind erosion, and flooding could constrain the amount of recoverable resources, the method of extraction and the range of post-extractive uses. Extension of extraction beyond that area covered by existing use rights should not be considered.

(iii) Chipping Norton

Remaining recoverable reserves of about 5 million tonnes of fine-medium sand suitable for concrete and fill are estimated to be contained in the Chipping Norton area.

The Chipping Norton Lake Authority was formed in response to the need to co-ordinate the extraction and rehabilitation of the area. A planning and development study has been completed for the area detailing the post-extraction landscape. The Public Works Department is the controlling authority for the lake scheme and has jurisdiction over extraction within the river.

Extraction should continue within the guidelines of the planning and development study for the lake, paying particular attention to the possibility of bank erosion and scouring of the bed above and below the scheme.

(iv) Crown land at Bonnie Doon

Bonnie Doon Golf Club Limited currently leases 38.5 hectares of land at Banks Avenue, Pagewood from the Crown under Special Lease 1961/33, Metropolitan. The term of the lease is 28 years (1 January 1963 to 31 December 1990) and for the purpose of the appraisement of the rent, is divided into 4 periods of 7 years each. The purpose of the lease is for the erection of buildings, a club house and golf links, with special conditions that provide for a sand removal operation by a Crown operator. To this end, it is stated that:

> "No excavation shall be made on the land without the approval of the Minister" (for Local Government and Lands); and
>
> "The right is reserved to all persons authorised by the Minister to enter upon the land with all necessary plant, vehicles, etc. and to remove sand without compensation of any kind to the lessee but subject to repair of any damage to structures or other improvements as the Minister may deem reasonable."(2)

In April 1980, the Department of Lands prepared an environmental impact statement for sand mining at Bonnie Doon Golf Course. The proposal consisted of removing 5 million tonnes of high quality fine-medium sand over a period of 35 years by extracting to a depth of 7 metres below the water table. It was proposed that the sand would be extracted in 4 stages with no more than 2 hectares being worked at any one time. By utilising vacant Crown land to the west of the existing golf course, a full 18 holes of golf would remain playable during the entire removal operation. Final restoration would reconstruct the existing landform, clean hard fill would be used for backfilling and then topped by a thick band of sand and revegetated. In essence, the original golf course structure would be re-established. The subject land is bordered by main roads on the south, an industrial area on the east and open space (recreation) to the north and west. This would minimise the potential noise impact of sand extraction on surrounding residential areas.

Consideration should again be given to the extraction of the sand held on Crown land at Pagewood under Special Lease 1961/33, Metropolitan, for the reasons below.

. The sand is high quality, medium-grained and relatively low in shell content. It has the potential to be used as a glass sand and as

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(2) Department of Lands, Special Lease 1961/33 - Metropolitan Special Conditions, provisions, exceptions, covenants and reservations.

fine-medium aggregate in concrete making. There is currently no sand available in the Sydney Region suitable for the production of clear glass, with the raw material requirements coming from Port Stephens. The deposit would provide a valuable source of 5 million tonnes of sand and some of this would be suitable as glass sand.

- The deposit is in an excellent location for serving the eastern part of the region. The deposit is only 8 kilometres south of Sydney, in close proximity to the city and eastern suburbs. There are currently few sand deposits which are being extracted close to eastern Sydney. There is a need to ensure that some sand extraction continues in close proximity to this part of the region.

- There is likely to be a shortage of fine-medium sand in the short term, after sand extraction from Kurnell ceases. The sand from Bonnie Doon could provide a useful source of sand until long-term alternatives can be implemented.

- There are currently three golf courses in very close proximity to Bonnie Doon and a few kilometres away there is another golf course. These recreation areas are all located on deposits of high quality sand currently in short supply. The environmental impact statement prepared by the Lands Department would enable the extraction of sand from one of these many golf courses while still maintaining the 18 hole course while extraction is in progress. Once extraction is completed, the golf course would remain. Given the importance of the sand resource, and the fact that the golf course will remain operative during the extraction period, the draft plan supports extraction here in favour of premature sand mining of more environmentally sensitive areas.

A new updated environmental impact statement would have to be prepared to address the environmental issues of concern which include potential problems of sand drift, noise, traffic and the protection of groundwater in Botany Basin.

(v) Macdonald Valley

The Macdonald River is a tributary of the Hawkesbury River which it joins at Wisemans Ferry 80 kilometres to the north-west of Sydney. Wrights and Wellums Creeks are both tributaries of the Macdonald River and flow into it from the north-east, just below St Albans.

There are two indicated sources of sand in the Macdonald Valley - the Macdonald River, and Wrights and Wellums Creeks. There are currently mining lease applications over Wrights and Wellums Creeks, and one sand mining company has made an application to the Department of Lands for a Permissive Occupancy over 8 kilometres of the bed of the Macdonald River between its confluence with the Hawkesbury River and St Albans Common, for the purpose of dredging the river for sand. The sand resources of the entire valley are the most extensive onshore sand deposits of the region. The amount of sand in Wrights and Wellums Creeks is second in size only to the Richmond Lowlands sand resource.

In addition to the value of the sand resource, the valley has landscape and heritage importance. The National Trust has made a submission to Hawkesbury Shire Council, recommending that the land within the catchment of the Macdonald River and its tributaries be rezoned Environmental Protection (Scenic) 7(d). The purpose of this

rezoning would be to protect the existing landscape quality of the valley by ensuring that agriculture remains the dominant land use and by prohibiting extractive industries. The Trust considers the valley to be a valuable part of the nation's heritage, and in 1977 the valley's entire landscape was given classified listing in the Trust's Register. The Trust believes that in the case of the Macdonald Valley, it is not possible to both protect rural land of scenic significance and reserve the same land for extractive purposes.(3)

Based on advice from the Department of Agriculture, in relation to agricultural production, the value of the land in the Macdonald Valley is not high and soil quality is generally poor. The majority of farms in the valley are hobby farms and for a number of years, agricultural production and the population of the valley has been declining. The main benefits of preserving agricultural land use as the dominant activity of the river valley would be to preserve the unique history and landscape of the valley for present and future generations. The valley in its existing state is particularly suited to passive recreational pursuits including horse-riding and scenic driving.

In relation to scenic amenity, environmental impact and resource quality, it would seem on initial investigation that extraction from Wrights and Wellums Creeks would be preferable to dredging the Macdonald River. It is believed that the intrinsic qualities of the valley, its scenic character and recreational potential can be better maintained by recommending against commercial dredging of the Macdonald River in favour of extraction from the tributaries. The issues of scenic amenity, potential environmental impact and variations in resource quality in relation to the river and its tributaries are discussed in more detail below.

. Scenic amenity

The visual impact of extraction from Wrights and Wellums Creeks would not be as great as dredging the Macdonald River since both creek valleys are surrounded by hillsides covered with natural vegetation, except where they enter the Macdonald River. The bends in both valleys form hillside boundaries between potential extraction sites and the main road (Settlers Road) that runs adjacent to the Macdonald River. As the potential extraction sites would not be visible from the Macdonald River and the main road, it is considered that the visual impact of any proposed extractive activity for the general public would be minimal. The main visual impact that extraction would have on the river valley would occur through transporting the sand by trucks, which would require significant upgrading of the main road.

. Potential environmental impact

Dredging of the Macdonald River may cause potential environmental problems due to the characteristics of the river channel. The river is in an unstable state and major floods have brought about dramatic changes in its cross-sectional profile and the elevation of the river bed. Between June 1949 and February 1955 the Macdonald River trebled the width of its bed for more than 30 kilometres above the tidal zone, aggraded its bed by almost 30 metres and in so doing completely changed the shape of its channel.

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(3) National Trust of Australia (N.S.W.), Planning for the Protection of Scenic Landscapes: The Macdonald Valley - A Case Study, November, 1982.

In addition, the Water Resources Commission of N.S.W. is opposed to any dredging of the Macdonald River which would destroy the indurated clay bar or nick point at Flemings Creek. The Commission states that the bar is a significant bed control. It would not therefore be desirable to dredge the river at this point for commercial purposes or to dredge the Lower Macdonald to a level deep enough to permit the transportation of sand by barge down the river.

. The sand resource

The sand quality of the Lower Macdonald River is not as high as that of the tributaries. Upstream of the tidal limit the sand is medium grained, relatively clean quartz sand which would be useful for construction purposes. Downstream of the tidal limit, the sediment becomes progressively more contaminated with estuarine mud. In contrast, the sand contained in the tributaries is a clean silica sand and has grading characteristics that make it suitable, after beneficiation, for the manufacture of coloured glass and possibly float glass, as well as for concrete making and general construction.

If extraction were to proceed from the valley the transportation of extracted material would be a considerable problem as road access to the creeks is very poor. Material could be brought down by truck along Settlers Road (after upgrading) to Wisemans Ferry, and then barged down the Hawkesbury River or taken by truck to Sydney. In this way, traffic generated by the extractive operations would not affect St Albans. Any extractive operation would need to carefully examine transport options with a view to selecting the one with the least impact on the area.

Other issues to be addressed if extraction were to proceed would be the protection of the wetland areas (which cover part of the tributary valleys) and drainage from the extraction sites. Wrights and Wellums Creeks have been classified as Protected Waters by the State Pollution Control Commission which prescribes that any discharge of effluents is restricted to those with a water quality similar to that required as a "raw" source of potable water. In addition, all surface run-off from the creeks eventually discharges into the Macdonald River. Extraction of the resources from either valley could have a detrimental impact by increasing the sediment loads (especially silt and clay-sized particles) of the creeks' drainage area.

In summary, both the heritage and landscape values of the Macdonald River Valley and the sand contained within the valley are considered to be significant. In relation to possible future extraction in the valley:

(a) commercial extraction would not be favoured from the Macdonald River due to environmental and scenic amenity constraints; and

(b) commercial extraction would be favoured from Wrights and Wellums Creeks subject to environmental impact assessment procedures.

(vi) Richmond Lowlands

See the discussion relating to medium-coarse sand.

(vii) Marine aggregate extraction

Marine aggregate extraction has the potential of supplying very large quantities of sand to the Sydney market. It is seen as being capable of meeting most of the region's construction sand requirements in the

medium to long term. The draft plan supports further investigation into the development of marine aggregate as a possible source of construction sand for the Sydney market for the reasons discussed below.

The majority of sand deposits supplying the region with fine aggregate are located in the north-west, west and south-western sections of the Sydney Region. In addition, the future possible sand extraction areas are to the west and north-west, on the outskirts of the region. While these deposits are well located in relation to the western suburbs, where most of the future growth will occur, it is also desirable to maintain some sand extraction in close proximity to the north, eastern and south-eastern sections of the region. By keeping haulage distances to a minimum, the cost of sand can be kept down. There is also the advantage of minimising the number and length of truck movements which will reduce traffic and wear and tear on city roads. Marine aggregate extraction could provide a large amount of sand in close proximity to eastern Sydney, which would be particularly valuable when extraction from Kurnell ceases.

For nearly all the onshore sand deposits of regional significance there will be some conflict between sand extraction and other forms of land use. Before extraction can proceed a decision will have to be made at the time of extraction between the value of the resource compared with the alternative possible land uses. As development in the region continues the demands for residential subdivision and land for recreation/open space will intensify. Marine aggregate extraction could provide a valuable alternative to the continuation of demand for large land-based extractive operations.

At the present level of urban development in the region, future sand extraction areas are now largely restricted to the Hawkesbury/Nepean corridor (including the Macdonald Valley sand deposits). If marine aggregate is not developed as a viable alternative then in the future, most of the region's sand supply will come from this corridor. This is not considered to be a desirable alternative, as this area offers scenic and recreational opportunities which are in relatively close proximity to the city's population. It is desirable that some of these areas remain untouched for the scenic beauty and the recreational opportunities they offer. Development of marine aggregate would take pressure off the need to obtain sand from the Hawkesbury/Nepean corridor.

Another advantage of marine aggregate extraction is the immense size of the resource. Although initial capital expenditure may be considerable, enormous amounts of sand and gravel would be made available and these resources would eliminate any potential shortage of sand in the future.

. Environmental considerations

Although the environmental impact of marine aggregate extraction is not yet fully known, the impact may well be less than for onshore extraction. Additional studies need to be undertaken especially to determine the effect of extraction on sediment transport to or away from the coast. However, marine aggregate extraction could occur in locations and in a manner which would minimise any impact it may have on beach erosion. For example, any extraction off the coastline extending from just south of Port Hacking may have a reduced impact on beach erosion as the coastline in this section is predominantly rocky with only small pocket beaches.

Other advantages of marine aggregate extraction are that the mining companies would no longer be faced with the cost of rehabilitating extracted areas and the community would not be faced with the problem of finding adequate final uses for land once extraction has ceased. In addition, the usual disadvantages of onshore extractive operations to the community such as noise, dust and vibration would be avoided with offshore extraction.

. Additional considerations

Despite the positive benefits which could accrue if marine aggregate extraction were to proceed on a large scale, a number of issues will have to be addressed before it can become a viable alternative to the extraction of onshore resources. The main problems follow.

(a) The nature of the continental shelf - In contrast to many shelves of the world, the continental shelf off south-eastern Australia is very narrow and steep. The shelf becomes very deep very quickly; one kilometre offshore water depths reach 40 metres and within 3 kilometres of the coast, depths exceed 80 metres. The implication is that sand dredging operations would generally require the introduction of overseas technology as dredges currently operating around Australia are limited to 20-25 metre depths.

(b) Weather conditions off the coast of N.S.W. - Storms can be severe and winds affect coastal morphodynamics in at least 4 ways. They generate waves; they generate currents; they cause changes in water level in the form of wind setup or setdown against the coast and in the form of storm surges; and they cause direct movement of sand. Winds would have an impact on any sand dredging proposal in two distinct areas: they would affect the stability of beaches through the response of waves and currents to weather conditions; and they would affect the dredging operation itself through prevailing weather conditions and changes in weather(4).

(c) Costs could be prohibitive for at least 2 reasons - Ship time is slow and expensive and sand would have to be double-handled before it gets to the stockpiling stage. First, it would have to be dredged and deposited on the boat and then it would have to be taken from the boat and deposited on land. In addition, the need to introduce overseas technology for offshore extraction would mean large capital expenditure at the outset of the operation.

(d) Uncertainty as to the extent and exact location of marine sand deposits and the incomplete understanding of sediment dynamic processes off the coast of N.S.W - Sediment dynamic processes need to be more fully understood so that the possible impact of any dredging operation on beach erosion can be assessed.

In summary, it is suggested that:

(a) industry give consideration to committing resources to investigate the feasibility of offshore extraction in the medium to long term;

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(4) Roy, P.S., Marine Sand Bodies on the South Sydney Shelf, S.E. Australia, Coastal Studies Unit Technical Report No. 85/1, April 1985.

(b) the State Government commit itself to the further testing of sediments within bays and estuaries and off the coast of N.S.W., with the objective of providing to industry additional basic information on resource assessment; and

(c) the State Government commit itself to completing additional sediment dynamic studies with the objective of gaining a better understanding of sediment dynamic processes operating off the coast of N.S.W.

. Botany Bay

One sand mining company has recently applied for a mining lease for marine aggregate extraction over parts of the sand resource in Botany Bay. Proposals to dredge the bay for port improvements have previously been made by the Maritime Services Board. In December 1980, Cabinet approved a proposal for a new crude oil berth to allow larger tankers into Botany Bay, in conjunction with the construction of an undersea pipeline to run from Kurnell Jetty to Bombora Point. As part of this project, plans were made to dredge 3 million tonnes of sand from the mouth of the bay and 4.8 million tonnes of sand from the port area, over a 6-9 month period. The proposed development did not eventuate when Australian Oil Refining Pty Ltd decided against proceeding with the pipeline for economic reasons.

The sand resource in Botany Bay has been tested by the Department of Mineral Resources in co-ordination with and funded by the Maritime Services Board. Sands were tested in two locations: at the mouth of the bay and adjacent to Port Botany. There are approximately 3.5 million tonnes of sand at the mouth and 5.4 million tonnes of sand adjacent to Port Botany. The tests identified two types of sand, one with potential for a general purpose construction sand and the other high quality sand suitable for industrial applications.

Dredging of sand from Botany Bay is favoured for commercial uses. This would release a possible 9 million tonnes of sand to the market, most of which would be clean, high quality, fine-medium, silica sand. Extraction should only occur at the mouth of the bay and adjacent to Port Botany and not from the southern sections of the bay near Weeney Bay or Quibray Bay. The main issues to be resolved in dredging the bay would be selecting a suitable site for stockpiling the resource and the time within which extraction could occur. Ideally the sand would be extracted over a 5-10 year period, rather than extracted over a short time span.

. Port Hacking

Port Hacking is subject to serious shoaling which severely limits the recreational use of the area for boating. Shoaling naturally occurs in two areas: the riverine delta and the marine delta.

In the riverine delta, sediment is transported downstream by the Hacking River and, over time, the river has been building a delta between Audley and Grays Point. As a result, a shallow channel has formed with a natural depth of slighly less than 1 metre. The delta is gradually moving downstream resulting in the deposition of about 10,000 cubic metres of sand per annum.

In the marine delta, large shoals exist between the entrance of the waterway and Lilli Pilli. The westward movement of sand is responsible for the progressive formation of shoals in the area opposite Burraneer

Bay and Burraneer Point and a shallow channel of 2 metres depth has formed.

The total surface area of the Port Hacking tidal delta is 4.1 square kilometres and the shoaled area covers 2.3 square kilometres including Deeban Spit. The sands of the tidal delta have been investigated by the Department of Mineral Resources and are composed of two materials: quartz and shell particles. The shell content within the sand body varies from 4 to almost 100 per cent.

The weed beds on the estuary floor are important feeding areas for fish but there is limited knowledge about the rest of the aquatic ecosystem. The impact of dredging on the aquatic flora should be assessed prior to any extractive operations in Port Hacking.

The main problems facing commercial dredging in Port Hacking are related to accessibility and the high shell content of the sand. With regard to accessibility, transporting the dredged sand by road would be difficult primarily because of Royal National Park to the south, and residential areas to the north. There is, however, the possibility of either transporting the sand by barge to Botany Bay or constructing a pipeline to Botany Bay where the resource could be stockpiled.

Due to its high shell content, the sand would only be suitable as a low quality construction sand, and for both fill and general purpose concrete. Under current Australian standards, shell content cannot exceed 10 per cent, if the sand is to be used as a fine aggregate in concrete. Overseas however, especially in Britain, shell content in fine aggregate of at least 30 per cent by weight is acceptable for use in concrete (Department of Mineral Resources). Consideration should be given to reassessing the maximum standard acceptable for shell content in sand used as fine aggregate in concrete making, especially in light of overseas experience.

Extraction of the sand resource of Port Hacking for commercial use is favoured subject to relevant environmental impact assessment. As long as sand mining continues at Kurnell, it may be uneconomic to extract sand from Port Hacking. However, in the event of the termination of mining at Kurnell, the economic viability of commercial dredging of Port Hacking would increase. Access problems could be minimised by transporting sand to Botany Bay, and stockpiling and processing the resource there. The sand could then be upgraded by blending it with coarser-grained, low shell sand from other deposits.

Any extractive proposal in Port Hacking would have to be carried out in consultation with the Public Works Department. That Department is currently carrying out a comprehensive study on the shoaling processes in operation and this will result in the development of waterway management options once shoaling processes are understood.

. Offshore extraction

Detailed studies of sedimentation processes off the coast of N.S.W., have been carried out for a section of coastline extending from Broken Bay to Port Hacking. These studies were commenced in the late 1960s and early 1970s with surface sediment sampling and reconnaissance seismic surveys. Much of the work on sediment transport has been instigated by the Metropolitan Water, Sewerage and Drainage Board (MWS&DB) in order to assess the feasibility of constructing deep water sewerage outfalls for the Sydney metropolitan area. In 1978-79, the MWS&DB commissioned seismic and sidescan surveys of the seabed off North Head, Bondi and

Malabar, and in 1980 had rotary drilling carried out to assess sub-surface rock conditions along the routes of the proposed tunnels. Diffusers are to be sited at Bondi and Malabar just seawards of the sand bodies in water depths of 60 and 79 metres respectively. As little is known about sediment movements at this depth, the MWS&DB commissioned the Geologic Survey of N.S.W. to undertake detailed sediment studies of the seabed and the Public Works Department (PWD) to investigate sediment movements in the vicinity of the diffuser sites.

In 1977, and largely independent of the MWS&DB, the Coastal Branch of the PWD and the Geological Survey of N.S.W. commenced a study of the seabed morphology and surface sediments off the Sydney coast. The program was designed to assess coastal erosion and offshore sand resources for beach nourishment and for industrial uses. As part of this work, the PWD carried out very detailed bathymetric and sidescan sonar surveys of a 60 kilometre long sector of the inner shelf between Broken Bay and Bate Bay. In addition, the PWD commenced in the late 1970s a sediment dynamic study of Broken Bay, which is due to be completed in 1987. Detailed geological and environmental work was also carried out offshore of Broken Bay by Consolidated Gold Fields Australia Limited in the 1970s.

Consideration should be given to further investigating the potential of marine aggregate extraction offshore, as a possible source of sand and gravel for the Sydney Region.

2.4.3 "Fatty" sand resources

Deposits of "fatty" sand are found in high level river terraces, that is, above existing flood plains, and also in areas of leached sandstone (e.g. Central Coast and Newnes Plateaus). Currently, extraction of "fatty" sand occurs at Agnes Banks and Elderslie with some minor extraction occurring at Maroota, Menangle Park, Ebenezer and Cattai. In addition, there are 3 sand mining operations on the Newnes Plateau producing approximately 250,000 tonnes of sand per annum. Most of this production supplies the local Blue Mountains Region, with some material coming to Sydney for use in concrete tiles and moulded concrete products.

The continued extraction of "fatty" sand is needed for 2 reasons: to supply the necessary requirements of "fatty" sand to the market (that is, sand required to have a high clay content for its end-product use); and secondly, to provide needed sources of general purpose construction sand after the clay content has been removed. It is anticipated that in the future, up to 75 per cent of the sand produced from "fatty" sand deposits will be washed and sold as general purpose construction sand.

It is suggested that in the future:

(i) extraction continue from the Elderslie and Agnes Banks sand deposits until resource depletion, within environmental constraints;

(ii) environmental studies and land use management plans be prepared for possible extraction of sand from Maroota and Pitt Town in the short to medium term; and

(iii) consideration be given to possible extraction in the medium to long term on the Newnes and Central Coast Plateaus to ensure the continued availability of "fatty" sand, and construction sand. (The sand resource of the Newnes Plateau is particularly

significant as both fine, medium and coarse sand is present, making it suitable in a wide range of industrial and construction applications.)

(i) Elderslie

Sand reserves in the Elderslie deposit are suitable for mortar, construction and possibly glassmaking. The Elderslie area also contains a soil deposit of about 3 million tonnes. A management study of the deposit has been completed which outlines the extraction and rehabilitation processes and details the post-extraction zoning and land use. Extraction should proceed within the guidelines of the Elderslie Sand and Soil Deposits, Land Management Study, prepared in 1978.

(ii) Londonderry/Agnes Banks

Extraction of the Agnes Banks sand deposit is proceeding within the framework of a sand management and rehabilitation plan prepared in 1978. The plan outlines a total area for extraction of approximately 3.7 square kilometres which is located on the south-east side of Castlereagh Road between Rickards Road and the Agnes Banks village. The majority of the deposit is on Crown land and the responsibility for the management of the area rests with Penrith City Council and the Crown Lands Office.

The land within the area designated for extraction comprises grasslands, areas formerly under cultivation and areas of original bushland. Generally, the original bushland reflects the sandy terrain with a cover of low eucalypts and banksias. Some of the vegetation contained within the designated sand mining area is significant from a conservation viewpoint as some of the associations (including the banksias) are normally only found on coastal dunes. In addition, a number of the species are classified as rare or endangered. There is a nature reserve on the southern boundary of the sand extraction area which is small and only contains 2 of the 5 vegetation communities of the Agnes Banks area.

The Heritage Council of N.S.W. has recently issued an Interim Conservation Order over plant communities at the southern end of the mining area, adjacent to the existing nature reserve. The Order is effective for up to 2 years from its gazettal date of 27 September 1985. Two sand mining companies have recently submitted development applications and environmental impact statements to Penrith City Council for additional sand extraction in the designated mining area. The Interim Conservation Order covers part of the land subject to the abovementioned development applications for sand extraction.

Extraction should proceed within the designated sand mining area which lies to the north of the land covered by the Interim Conservation Order.

(iii) Pitt Town

The Pitt Town area has already been subjected to strong pressure for urban development and as a result 35 per cent of the sand deposit has already been sterilised. It is estimated that approximately 8 million tonnes of sand remains extractable.

Extraction will be restricted primarily due to 3 factors: namely the location of the Pitt Town township and public school on the southern

boundary of the deposit; the location of the Vermont development at the northern end of the deposit; and the individual houses located mainly between Wells and Hall Streets. A recommendation has already been made to Hawkesbury Shire Council that the deposit be protected from further sterilisation by preventing the further subdivision of rural landholdings.

Extraction of the Pitt Town deposit should be considered subject to the preparation of a land use management plan, as it represents a valuable source of mortar and construction sand in close proximity to north-western Sydney. Due to the pressures in the area for urban development, it is important that the sand resource is extracted as soon as possible. It is suggested that the landholders and/or companies interested in extracting the deposit co-operate to prepare a land management study in consultation with Hawkesbury Shire Council, the Department of Environment and Planning, and the Department of Mineral Resources.

Such a study would need to include a detailed outline of extraction areas, a staged extraction plan, the location and extent of buffer zones, the location of the central plant, processing area and ancillary services, and an outline of detailed rehabilitation measures.

(iv) Maroota

The Maroota deposit is located 50 kilometres north-west of Sydney and comprises gravel, sand and clay which range from unconsolidated sand and gravel to partly consolidated clay and clayey sand. In general, the deposit is poorly sorted (has a relatively even distribution of grain sizes within any one sample) and has a silt-clay content which ranges from 5-32 per cent with an average of 15 per cent.

Many small existing and abandoned pits occur throughout the Maroota area. The majority of these pits are in Hawkesbury Sandstone Shale lenses, either adjacent to the sand, or where removal of sand and gravel has uncovered a shale basement. Gravel for local main road and council road construction was obtained from a now abandoned pit located in the southern part of the deposit, adjacent to Old Northern Road. Sand for mortar and fill applications is currently being extracted from a number of minor pits within the Maroota sand. Similarly, ceramic clay is currently being extracted from clay lenses within the sand deposit.

A number of companies have shown an interest in extracting sand from parts of the deposit. Two companies have conducted investigations into the potential for sand in the Haerses Road area and the area south of Maroota Trig. Both companies have also shown an interest in other parts of the deposit, especially the area east of Old Northern Road.

There are a number of environmental and land use issues which would have to be addressed if extraction of the Maroota deposit were to proceed. These issues are discussed below.

. Land use

The area is occupied by citrus orchards and market gardens. Sand extraction to basement level would result in the elimination of the sandy, free-draining soils required for successful citrus cultivation. In addition, there are increasing pressures on the area for residential subdivision which will result in further sterilisation of the Maroota sand if extraction does not proceed in the short to medium term.

. Groundwater

Groundwater constitutes an important source of irrigation water for the orchards and market gardens, especially during protracted periods of low rainfall.

Major sand extraction in the Maroota area could have the potential of reducing the groundwater resource available for irrigation. In this respect, major sand extraction may preclude continued citrus orchard cultivation unless equivalent quantities of water could be provided from some alternate source.(5)

. Drainage pattern

The Maroota area has 3 major catchment and drainage zones all of which eventually discharge into the Hawkesbury River. Surface run-off from one of the catchment areas flows largely through Marra Marra National Park, entering the Hawkesbury River below Wisemans Ferry. Extraction of sand, if not managed properly, could have a detrimental impact on the adjacent national parks by increasing the sediment loads (especially silt and clay-sized particles) of the creeks draining the area.

. Visual impact

The Maroota sands overlie a basement of Hawkesbury Sandstone and possible Ashfield Shale, at an altitude of between 170 metres and 239 metres. At this altitude extraction could be easily visible from a number of directions. In addition, the two main roads in the area, located on the main ridge system, pass through the sand deposit. Extraction would be easily visible from the road and it would be necessary to use vegetated bund walls as screens around the localised extraction and processing sites.

At present, there are a number of extractive operations occurring within the Maroota sand deposit. In the past, the practice of piecemeal extraction left some areas badly eroded and unrehabilitated. It would be desirable to put an end to this situation by providing for a co-ordinated approach to the extraction and management of the resource. Large-scale extraction of the clay and sand resources of the Maroota deposit would provide a valuable source of mortar sand, filling sand, general purpose construction sand and white-firing clay/shale for brickmaking.

Extraction of the Maroota sand deposit may be appropriate subject to the preparation of a land use management plan. The objective of such a plan would be to provide a framework for the co-ordinated extraction and management of the deposit. It is recommended that interested

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(5) Etheridge, L.T., Geological Investigation and Resource Assessment of the Maroota Tertiary Alluvial Deposit, Geological Survey of N.S.W, Dept of Mineral Resources; Report No. GS1980/201, August 1980.

landholders and/or proponent companies prepare the management plan in consultation with the Department of Environment and Planning, the Department of Mineral Resources and the two local councils.

(v) Central Coast plateau lands (Somersby Plateau)

The plateau lands of the Central Coast are situated to the north-west of Gosford and lie approximately 60 kilometres north of Sydney. These lands form part of the Hornsby Plateau, which borders the Cumberland Basin. Much of the plateau surface is covered by deeply weathered, soft and friable Hawkesbury Sandstone. The plateau lands are currently an important source of construction sand, hard rock aggregate and dimension stone. Potential also exists for the extraction of clay/shale for use in brick and tile manufacturing from shale lenses within the Hawkesbury Sandstone. The friable sandstone has grading characteristics making it suitable for medium to high strength concrete, mortar sand, filter sand, foundry sand and glass sand (both colourless and amber glass). At present, there is an estimated 8-10 million tonnes of readily accessible fine-medium sand on the plateau, contained within the established boundaries of existing operations.

The main constraint to extraction is the agricultural value of the land. A recent study by the Department of Agriculture categorised the plateau lands of the Central Coast into various classes based on the suitability of the land for the production of vegetables, fruit, crops and grazing. In addition, extraction is further limited by the creation of small-scale subdivisions for urban release, and the presence of environmentally sensitive swamp and wetland areas.

In the future it is anticipated that the sand resources of the Somersby Plateau will predominantly supply the local Gosford market with smaller quantities of sand supplying the northern Sydney market. Extraction should be considered from the lower valued agricultural land while extraction from higher valued agricultural land should be more stringently controlled. Sensitive swamp and wetland areas should be protected from extraction.

(vi) Newnes Plateau

The Newnes Plateau is located approximately 110 kilometres west of Sydney in the Blue Mountains and contains very large resources of readily extractable leached sandstone. It is the largest plateau area in the Blue Mountains, comprising 300 square kilometres of natural bushland, at an altitude in excess of 1,000 metres above sea level. The plateau is bounded on the south by the Bells Line of Road and the main western railway line, on the west by the Coxs River Valley, on the north by the Wolgan Valley and on the east by the Wollangambe River catchment. The area to the east is now covered by the Wollemi and Blue Mountains National Parks. The major watersheds on the plateau are the Wolgan River to the north and Wollangambe River to the east, both of which drain into the national parks.

Much of the plateau is covered by thick sequences of leached sandstone which belong to the Banks Wall Sandstone. The sandstone is composed primarily of quartz (50-80 per cent); kaolinitic clay (30-50 per cent); and a small percentage of lithic fragments. The quartz grains are poorly rounded and poorly sorted (which means a maximum range of particle sizes are contained within the deposit). These characteristics make the sandstone ideally suited to the production of a wide range of

high-strength and precast moulded concrete products; mortar and filling sand; and a wide range of industrial applications including glass sand, foundry sand, filter sand and specialised industrial filler sand.

Most of the plateau is covered by State Forest which produces native hardwoods and introduced softwoods. About 2,000 hectares have been clear-felled for plantation pines. The only other commercial land uses are sand extraction and coal mining. There are currently 3 sand mining operations producing approximately 250,000 tonnes of sand per year for both the local and Sydney markets. Sand produced from these operations is used for moulded concrete products, ready mix concrete, mortar and filling. The Clarence Colliery is the first and so far the only colliery to commence mining from the top of the plateau. The underground mine commenced operations in 1977 and now produces 2 million tonnes per annum of export thermal coal. Development consent was granted by the Department for the operation of another colliery, but development of the mine was postponed for economic reasons.

The plateau is also used as access for active recreation such as bushwalking and rockclimbing, and the historic Newnes oil shale mining site in the Wolgan Valley attracts many campers and visitors. The old oil shale railway, which crosses the plateau from Newnes to Newnes Junction, also has heritage value.

The leached sandstone resource of the Newnes Plateau is already a significant source of special purpose construction sand and has the potential of being a major source of sand for the Sydney Region in the medium to long term. The resource is of significance to the Sydney Region, due to its immense size and the fact that it contains fine, medium and coarse grained sand, making it suitable for a wide range of both construction and industrial applications. If marine aggregate is developed as a major source of fine-medium construction sand, then the Newnes Plateau sand resource would supply a valuable source of medium and coarse grained construction sand and sand suitable for industrial applications.

Investigations should be made into the potential environmental impact of extraction of the sand resource of the Newnes Plateau. The major environmental problem will be the disposal of tailings (clay and silt particles) which have to be washed out if the sand is to be used for industrial applications and as a fine aggregate in concrete. The Commonwealth Scientific and Industrial Research Organisation is currently investigating a new method for tailings disposal which eliminates the need for large tailings dams and may produce a saleable plastic clay by-product. The National Parks and Wildlife Service will oppose any extractive operations which increase the sediment loads of the Wolgan and Wollangambe Rivers, as they both drain into national parks. The Service places the highest priority on protecting the Wollangambe River catchment from environmental degradation. Consideration will also have to be given to the heritage and recreational values of the plateau and to the potential access problems which may occur if extraction proceeds on a larger scale.

The Department of Mineral Resources has delineated a number of areas on the plateau with potential for extraction. Two of these areas are contained within pine plantations established by the Forestry Commission of N.S.W. Further consultation should proceed between the Department of Mineral Resources and the Forestry Commission, in consultation with the National Parks and Wildlife Service on the potential of future extraction on the plateau.

3. COARSE AGGREGATE

3.1 Coarse Aggregate Production in the Sydney Region

Coarse aggregate production in the Sydney Region for 1982-83 and 1983-84 is presented in Table 14. Production can be classified as either first class or second class aggregate. First class aggregate consists of crushed and broken stone (being predominantly dolerite, basalt and latite) and river gravel. First class aggregate is used primarily as a concrete aggregate, for railway ballast and for some roadmaking applications such as bituminous road sealing. Production of first class aggregate totalled 3.285 million tonnes in 1982-83 (60 per cent of total coarse aggregate production) and 3.809 million tonnes in 1983-84 (62 per cent of total coarse aggregate production).

Second class aggregate consists of lesser quality material, predominantly lower quality dolerite, volcanic breccia and sandstone. Second class aggregate is used primarily for prepared roadbase and sub-base. Production of second class aggregate totalled 2.196 million tonnes in 1982-83 and 2.290 million tonnes in 1983-84. In addition, in 1983, some 400,000 tonnes of slag from Port Kembla was processed into construction products. Most of the material was used in prepared roadbase blends with a small proportion used as aggregate. An additional 530,000 tonnes was used as road sub-base and fill.

Total production of coarse aggregate for the Sydney Region from 1968-69 to 1983-84 is presented in Table 15. The overall level of production for the region in 1982-83 and 1983-84 was substantially lower than in previous years. Total production was 5.48 million tonnes in 1982-83 and 6.10 million tonnes in 1983-84, whereas the average level of production between 1968-69 and 1981-82 was just below 8 million tonnes per annum. Over the past 16 years, the production of coarse aggregate for the region has been quite variable with alternating periods of high and low production. The Department of Mineral Resources has suggested that these wide fluctuations in production, despite the steady increase in the population, are largely due to the injection of public funds for major construction projects or downturns in the construction industry which are tied to the general level of economic growth in the economy.

3.2 Demand Forecast for Coarse Aggregate Consumption in the Region

In the regional environmental study, coarse aggregate requirements were projected to the year 2020. Over the forecast period, 60 per cent of production was assumed to be river gravel and hard rock or first class aggregate, and 40 per cent second class aggregate or prepared roadbase. Two growth rates were projected: the first, no growth, assumed that production of coarse aggregate would remain at 8 million tonnes per annum. This level was based on the average rate of consumption between 1968-69 and 1981-82. The second growth rate was 2 per cent compounded annually to encompass population projections for the region.

In the years since the projections were made, coarse aggregate consumption has fallen well below the no growth level of 8 million tonnes per annum. However, this is only seen to be a temporary slump and production levels should increase again in the next few years. Consumption is difficult to predict because of its close link with large investment projects and cannot be realistically tied to population projections for the region.

TABLE 14

COARSE AGGREGATE PRODUCTION FOR THE SYDNEY REGION

1982-83 AND 1983-84

(million tonnes)

	1982-83	1983-84
PROSPECT QUARRIES		
- Crushed and broken stone	.441	.615
- Prepared road base	.825	.523
TOTAL	1.266	1.138
SYDNEY VOLCANIC BRECCIA QUARRIES		
- Crushed and broken stone	.227	.234
- Prepared road base	.638	.826
TOTAL	.865	1.06
RIVER GRAVEL	1.837	2.180
SANDSTONE	.733	.941
TOTAL PRODUCTION SYDNEY REGION	4.701	5.319
IMPORTS (Illawarra, Kulnura and Southern Highlands Quarries)	0.78	0.78
TOTAL CONSUMPTION SYDNEY REGION	5.481	6.099

Source: Department of Mineral Resources

TABLE 15

COARSE AGGREGATE LOCAL PRODUCTION AND IMPORTS

1968-69 and 1983-84

(million tonnes)

YEAR	Total production (including imports)	Production from Sydney Region quarries
1968-69	6.49	6.31
1969-70	6.92	6.72
1970-71	7.38	6.92
1971-72	8.78	8.20
1972-73	8.28	7.40
1973-74	8.09	7.14
1974-75	9.38	8.23
1975-76	6.79	5.72
1976-77	6.57	5.57
1977-78	6.61	5.41
1978-79	8.33	7.08
1979-80	9.62	8.17
1980-81	8.0	6.94
1981-82	8.45	7.47
1982-83	5.48	4.70
1983-84	6.10	5.32

Source: Department of Mineral Resources

Because of this uncertainty in predicting coarse aggregate demand, it is considered appropriate to base future estimates on historical patterns of production. The no growth path of 8 million tonnes per annum is slightly higher than the average of 7.6 million tonnes of coarse aggregate consumed annually between 1968-69 and 1983-84. It is predicted that in the future, coarse aggregate consumption will continue to fluctuate widely but average out at approximately 8 million tonnes per annum. In the next few years, the consumption of coarse aggregate will probably reach another peak with the Commonwealth Bicentennial road projects under construction. It is assumed that the ratio of first class to second class aggregate will remain at 60 to 40 per cent respectively, although this ratio could conceivably change in the future depending upon market trends in the construction industry.

It is estimated that to the year 2020 consumption will approximate the following amounts:

	1ST CLASS AGGREGATE million tonnes	2ND CLASS AGGREGATE million tonnes	TOTAL million tonnes
1986-2000	72	48	120
2001-2020	96	64	160
1986-2020	168	112	280

It should also be noted that the above forecast is to be taken as a guideline only. For this reason, the management strategy should be flexible to allow early or late extraction from coarse aggregate deposits depending upon demand fluctuations.

3.3 Current Estimated Reserves in the Region

Reserves of first and second class coarse aggregate are recorded in Tables 16 and 17. Company reserves (both secured and unsecured) were obtained from the Quarry Masters Association of N.S.W. and are stated as at August 1984. Deposit sizes are also included.

3.3.1 First class aggregate

Reserves of crushed and broken stone are restricted to deposits of dolerite at Prospect and small quantities of volcanic breccia. The rest of Sydney's hard rock requirements are met through imports of basalt from Kulnura and Oxley Hill (Bowral) and latite from the Illawarra Region (Albion Park, Dunmore, Bass Point and Bombo). Reserves of quality dolerite at Prospect are estimated to be sufficient for only 5 to 10 years at the current rate of production. Companies have secured reserves of hard rock aggregate in the Gosford-Wyong area of 33.4 million tonnes and in the Kiama-Shellharbour area of 172.9 million tonnes.

These reserves, while also required for local markets, have significant potential for supplying a large percentage of Sydney's hard rock aggregate requirements in the future. In addition, there is

TABLE 16

RESERVE ESTIMATES FOR FIRST CLASS COARSE AGGREGATE

AS AT AUGUST, 1984

Deposit	Rock type	Deposit size	Company reserves Secured	Unsecured (million tonnes)
A. INSIDE REGION				
1. Penrith Lakes	Gravel	101.0		minority secured
2. Prospect	Dolerite	5.8	4.7	1.10
3. Mogo Hill	Basalt	3.5	3.5	
4. Hawkesbury/Nepean River	Gravel	5.0	0.3	1.20
5. Richmond Lowlands	Gravel	61.0		12.0
6. Peats Ridge	Basalt	13.4	13.4	13.4
7. Kulnura	Basalt	20.0	20.0	
8. Basalt Hill	Basalt	5.0		5.0
SYDNEY REGION TOTAL		214.7	41.9	19.3
B. OUTSIDE REGION				
Kiama/Shellharbour:				
9. Albion Park (Readymix)	Latite	40.3	38.8	1.5
10. Dunmore (BMG)	Latite	91.1	61.1	30.0
11. Bass Point (Pioneer)	Latite	54.0	54.0	
12. Bombo (Boral)	Latite	19.0	19.0	
13. Dunmore (Blue Circle)	Latite	70.0		70.0
KIAMA/SHELLHARBOUR TOTAL		274.4	172.9	101.5
Wingecarribee:				
14. Cotswold Farm	Syenite	8.0		
15. Exeter	Basalt	10.0	3.5	3.0
16. Mt Flora	Syenite	80-100		47.0
17. Mt Gingenbullen	Dolerite	30.0		
18. Mt Misery-Hurdle Ridge	Microsyenite	170.0		
19. Oxley Hill	Basalt	6-8	2.0	6.0
WINGECARRIBEE TOTAL		304-326	5.5	56.0

Source: Quarry Masters Association of N.S.W. (Company Reserves)
Department of Mineral Resources (Deposit Sizes)

TABLE 17

RESERVE ESTIMATES FOR SECOND CLASS COARSE AGGREGATE

AND SANDSTONE AND FILL MATERIALS

AS AT AUGUST, 1984

	Deposit	Rock type	Company reserves Secured (million tonnes)	Unsecured
1.	Prospect	Dolerite, Picrite & Others	86.6	8.5
2.	Hornsby	Volcanic Breccia	15.0	
3.	Erskine Park	Volcanic Breccia	2.5	
4.	Wallgrove	Volcanic Breccia	15.0	
5.	Marsden Park	Volcanic Breccia	4.3	
TOTAL			123.4	8.5
	Sandstone and Fill:			
6.	Sandy Point	Sandstone	4.2	
7.	Mt Hunter	Sandstone	.2	.9
8.	Homebush Bay	Sandstone	.6	2.4
9.	Menangle	Sandstone	2.0	
10.	Wallacia	Sandstone	11.0	
11.	Kenthurst	Sandstone	5.0	15.0
12.	Mulgoa	Sandstone	8.0	
13.	Glenfield	Sandstone	2.1	
TOTAL SANDSTONE AND FILL			33.1	18.3

Source: Quarry Masters Association of N.S.W.

approximately 304 to 326 million tonnes of hard rock in the Wingecarribee area. This represents a major potential source of first class aggregate for the region. At present, only 60 million tonnes of this resource is in company ownership.

The main source of river gravel for the region is the Hawkesbury/Nepean River and its flood plain. There are an estimated 103 million tonnes of gravel in the Castlereagh flood plain. This consists of 101 million tonnes contained in the Penrith Lakes Scheme and an additional 2 million tonnes owned by Monier at Castlereagh. This resource represents the major supply of gravel for the region. In the past, considerable quantities of gravel have been obtained from the bed of the Hawkesbury/Nepean River. There is an estimated 285,000 tonnes of gravel secured for extraction from the river and an additional 1.20 million tonnes unsecured. The other major deposit of river gravel in the region is 61 million tonnes in the Richmond Lowlands. Currently, 12 million tonnes of gravel (as yet unsecured) is held on company owned land.

3.3.2 Second class aggregate

The region's demand for second class aggregate is met by production from quarries operating within the region. Production consists of volcanic breccia from Wallgrove, Marsden Park, Erskine Park and Hornsby, lesser quality dolerite and picrite from Prospect and sandstone quarried from a number of locations within the region (see Table 17). In August 1984 secured reserves at the volcanic breccia and Prospect quarries totalled 123.4 million tonnes. In 1984, secured reserves of sandstone totalled 33.1 million tonnes. There is also potential for 2 million tonnes of blast furnace slag from Port Kembla to be utilised as prepared roadbase, sub-base and fill. In recent times, there has been a decline in the market acceptance of slag-based pavement materials due to chemical changes in the steelmaking process which have resulted in a softer slag. This softer material when mixed only with basalt fines failed to meet the Department of Main Roads specification of 10 per cent wet strength values of 100 kN.

However, in July 1985, the Department of Main Roads revised its specification for pavement material properties relative to particle crushing strength. (Department of Main Roads, Specification for the Supply and Delivery of Base and Sub-base Materials for Surfaced Road Pavements, M.R. Form No. 744, July 1985). The 10 per cent fines wet strength value has been lowered and redefined to 60 kN and the slag is now suitable as a sub-base and fill on all roads and as a roadbase on nearly all council roads. If granulated slag or lime or cement were added to the slag instead of basalt fines, there would be no restrictions at all on where the slag pavements could be used. The Department of Main Roads has approved the new specifications for slag and further tests on the acceptability of the material will be on-going. At the end of 1986 a full scale field trial is due to commence. Approval of the new specifications by the Department will facilitate the application of slag in prepared roadbase blends.

3.4 Conclusions

The region's demand for first class aggregate will be met through the supply of river gravel, and crushed and broken stone. Both materials have a high degree of substitutability being used as a coarse aggregate in concrete production and for railway ballast as well as a number of other applications.

3.4.1 River gravel

The gravel reserves of the Castlereagh flood plain will provide the major source of river gravel for the region. The Penrith Lakes Scheme has the potential, over its economic life to supply 60 to 70 per cent of the region's requirements of first class aggregate. Assuming these percentages and the demand levels outlined previously, it is conservatively estimated that the Scheme will have the following life:

GRAVEL EXTRACTION FROM THE PENRITH LAKES SCHEME

Total regional demand(1) 4.8 million tonnes per annum	Million tonnes per annum	Estimated life of project (years)
60% of estimated demand	2.88	35
70% of estimated demand	3.36	30

(1) First class aggregate only - does not include material for prepared roadbase.

It is predicted that coarse aggregate extraction from the Penrith Lakes Scheme could continue to the year 2020.

The region's demand for river gravel can be met adequately from the Scheme's reserves. There will not be a need to extract gravel from the Richmond Lowlands until extraction from the Penrith Lakes Scheme has been substantially completed.

The other potential source of river gravel in the region is from the Hawkesbury/Nepean River between Penrith and North Richmond. Any future extraction of gravel from the river bed would need to be considered in light of the availability of supply from the Penrith Lakes Scheme and the environmental concerns relating to the effects of river-based extraction on sedimentation patterns, the hydrodynamics of the river, water quality and the aquatic habitat.

3.4.2 Crushed and broken stone

At present, only limited amounts of high quality hard rock aggregate remain in the Sydney Region with supply supplemented through production in the Illawarra Region (Kiama, Shellharbour and Wingecarribee local government areas).

It is expected that over the next 35 years, the region's first class coarse aggregate requirements will be met increasingly from hard rock

deposits in the Illawarra Region. It is predicted that the amount of first class aggregate coming into the region from these outlying areas may increase from around 20 to 25 per cent of production to 30 to 40 per cent of first class aggregate production.

It is expected there will be continued supply from the Albion Park, Dunmore, Bass Point, Bombo and Oxley Hill quarries in addition to possible extraction from new resource areas. The potential resource areas considered to be of most significance are Mt Flora, Mt Misery-Hurdle Ridge and a deposit of latite at Dunmore (Blue Circle Southern Cement). Consideration should be given to the protection of Mt Flora and Mt Misery-Hurdle Ridge as potential sources of aggregate for the Sydney and local Illawarra markets.

3.4.3 Second class aggregate

In 1984, second class coarse aggregate reserves secured for extraction totalled 157.3 million tonnes. Assuming total demand approximates 3.2 million tonnes of second class aggregate per annum, existing quarries are likely to have the following economic lives:

Prospect (second class material):	over 100 years
Volcanic breccia quarries:	20-24 years
Sandstone quarries:	30-35 years

At present quarries within the region meet the total demand for second class aggregate. This is expected to continue as there is a relative abundance of lesser quality aggregate in the region and at the same time, its low value limits its extraction and transportation over long distances.

For economic and environmental reasons, the Prospect, volcanic breccia and sandstone quarries should continue in operation until reserves are depleted in preference to opening up new areas for extraction. Future applications for extraction of sandstone and volcanic breccia should be considered in light of the existing supply and demand situation.

There is also potential for up to 2 million tonnes per annum of blast furnace slag from Port Kembla to be utilised as a roadbase, sub-base and fill. This material has the potential of supplying a valuable alternative to quarrying aggregate for prepared roadbase.

APPENDIX

CLAY/SHALE RESERVES OF THE SYDNEY REGION

TABLE 1

RED FIRING LOW PLASTICITY CLAY/SHALE

PREDOMINANT RESOURCE - ASHFIELD SHALE

Owner/operator	Location	Plant on site	In situ reserves (tonnes)
Secure for extraction			
Brickworks Ltd	Eastwood	Yes	2,900,000 (A)
Clark Brick Ltd	Moorebank	Yes	1,500,000 (A)
Norbrik	Parklea	Yes	65,000,000* (A)
P.G.H. Ceramics Bricks, N.S.W.	Greenacre	Yes	200,000 (C)
Statebricks	Homebush Bay	Yes	7,500,000 (A)
	TOTAL		77,100,000

MINOR RESOURCE - SHALE LENSES IN HAWKESBURY SANDSTONE

Secure for extraction			
J. & E. Burke	Menai	No	200,000 (A)
Brickworks Ltd	Duffys Forest	No	9,000,000 (B)
C.B. Greenwood	St. Ives	No	500,000 (A)
	TOTAL		9,700,000
Not secured for extraction			
W.E. Hicks	Glenorie	No	200,000 (B)
Industrial Clay Shale Pty. Ltd.	Fiddletown	No	50,000 (B)
	TOTAL		250,000

(A) Calculated from information supplied by the owner/operator.

(B) Calculated following an inspection by a geologist from the Geological Survey of New South Wales. Reserves approximate.

(C) Estimate supplied by the owner/operator.

* Of the 65m. tonnes only 2.57m. tonnes are recoverable, due to environmental constraints placed on extraction. (Submission received by Norbrik).

TABLE 2

RED FIRING LOW TO MODERATE PLASTICITY CLAY/SHALE

PREDOMINANT RESOURCE - BRINGELLY SHALE

Owner/Operator	Location	Plant on Site	In situ reserves (tonnes)
Secure for extraction			
Abbie Quarries Pty. Ltd.	Kemps Creek	No	5,400,000 (A)
Austral Brick Co. Pty Ltd.	Wallgrove	Yes	66,000,000 (A)
Boral Brick	Badgerys Creek	Yes	5,300,000 (C)
Camide Pty. Ltd.	Wetherill Park	No	3,000,000 (A)
Clark Brick Ltd.	Prospect	Yes	6,000,000 (C)
Clark Brick Ltd.	Bringelly	Yes	40,000,000 (A)
Lion Tile Co. Pty. Ltd.	Kemps Creek (Clay)	No	300,000 (A)
NJW Contractors	Mulgoa	No	300,000 (A)
Nolan Quarry & Mining Co. Pty. Ltd.	Kemps Creek (Shale)	No	4,000,000 (A)
Nolan Quarry & Mining Co. Pty. Ltd.	Badgerys Creek (Clay)	No	7,000,000 (A)
P.G.H. Ceramics Bricks, N.S.W.	Doonside	Yes	2,600,000 (A)
" " "	Horsley Park	Yes	16,500,000 (A)
" " "	Schofields (Clay)	Yes	270,000 (A)
" " "	Schofields (Shale)	Yes	500,000 (A)
Mulgoa Quarries Pty. Ltd.	Mulgoa	No	5,700,000 (C)
Punchbowl Brick & Pipe Co. Pty. Ltd.	Wallgrove (Clay)	No	1,000,000 (C)
Statebricks	Blacktown	Yes	2,000,000 (A)
Zacuba Pty. Ltd.	Cecil Park	Yes	2,250,000 (C)
		TOTAL	168,120,000
Not secured for extraction			
Zacuba Pty. Ltd.	Mulgoa (Area A)		1,250,000*
Zacuba Pty. Ltd.	Mulgoa (Area B)		2,150,000 (C)
Kays Lot 1) J.P. Reddan)			4,300,000
Lot 28			4,900,000
		TOTAL	12,600,000

(A) Calculated from information supplied by the owner/operator.
(B) Calculated following an inspection by a geologist from the Geological Survey of New South Wales. Reserves approximate.
(C) Estimate supplied the owner/operator.
* Approval possible on this site.

TABLE 3

CREAM FIRING LOW TO MODERATE PLASTICITY CLAY/SHALE

BRINGELLY SHALE

Owner/operator	Location	Plant on Site	In situ reserves (tonnes)
Secure for extraction			
Abbie Quarries P/L	Kemps Creek (Clay)	No	600,000 (C)
Austral Brick Co P/L	Wallgrove	Yes	3,500,000 (C)
Boral Bricks	Badgerys Creek	Yes	6,200,000 (C)
Camide Pty Ltd.	Wetherill Park	No	800,000 (B)
Clinch Bros.	The Oaks (Clay)	No	60,000 (C)
Erskine Quarries P/L	Erskine Park	No	1,500,000 (C)
NJW Contractors	Mulgoa	No	750,000 (C)
Nolan Quarry & Mining Co Pty Ltd	Kemp Creek (Clay)	No	880,000 (C)
" " " "	Badgerys Creek (Clay)	No	750,000 (A)
Mulgoa Quarries P/L (Housing Commission)	Mulgoa	No	5,100,000 (C)
Statebricks	Blacktown	Yes	1,300,000 (A)
	TOTAL		21,440,000
Note: Amount controlled by Brick Manufacturers			11,000,000
Not secured for extraction			
Nolans	Kemps Creek		600,000
Mulgoa Quarries P/L	Mulgoa		7,300,000 (C)*
Zacuba Pty Ltd	Mulgoa (Part A)		1,000,000 (C)*
Zacuba P/L	Mulgoa (Part B)		1,500,000
J.P. Reddan & Lot 28			6,700,000
	TOTAL		17,100,000

LENSES WITHIN THE HAWKESBURY SANDSTONE

J. & E. Burke & Co.	Appin		80,000 (A)
J. & E. Burke & Co.	Menai		120,000 (A)
	TOTAL		200,000

PLEISTOCENE CLAY (Not yet secured)

C. & E. Egan	Roberts Creek (Clay)		Unknown (C)

(A) Calculated from information supplied by the owner/operator
(B) Calculated following an inspection by a geologist from the Geological Survey of New South Wales. Reserves approximate.
(C) Estimate supplied by the owner/operator.
*Approval possible for this site.

TABLE 4

WHITE FIRING LOW TO MODERATE PLASTICITY CLAY/SHALE

WHITE FIRING, WEATHERED SHALE FROM LENSES WITHIN THE HAWKESBURY SANDSTONE

Owner/Operator	Location	In situ reserves (tonnes)
Secure for Extraction		
J. & E. Burke & Co.	Darkes Forest (Sandy Clay)	500,000 (A)
H. Jolly	Canoelands	100,000 (A)
R. Martin	Maroota	5,000 (A)
	TOTAL	605,000
Not secured for extraction		
W.E. Hicks	Glenorie	250,000 (A)
Industrial Clay & Shale Pty Ltd	Fiddletown	50,000 (B)
"	Cowan	20,000 (A)
	TOTAL	320,000
Potential extraction area		
Pleistocene clay	Roberts Creek	Unknown

(A) Calculated from information supplied by the owner/operator.

(B) Calculated following an inspection by a geologist from the Geological Survey of New South Wales. Reserves approximate.

(C) Estimate supplied by the owner/operator.

TABLE 5

RED FIRING MEDIUM TO HIGHLY PLASTIC CLAY/SHALE

Owner/operator	Location	Plant on Site	In situ reserves (tonnes)
Secure for extraction			
(PGH) Acmil Industries Pty. Ltd.	Londonderry	No	1,000,000 (A)
Monier Ltd	Londonderry	No	1,500,000 (A)
Monier Ltd	Rosehill	Yes	50,000 (A)
Clark Brick Ltd	Moorebank	Yes	3,000,000 (A)
			5,550,000
Potential extraction area			
Pleistocene	Roberts Creek		In the order 8,000,000 (inferred)
Optimum extraction area	Londonderry		currently being assessed.

(A) Calculated from information supplied by the owner/operator.

(B) Calculated following an inspection by a geologist from the Geological Survey of New South Wales. Reserves approximate.

(C) Estimate supplied by the owner/operator.

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