SER/NSWSPCC
SAN/74

THE SAND AND GRAVEL EXTRACTION INDUSTRY

IN

THE NEPEAN – HAWKESBURY RIVER VALLEY

SUBMITTED TO

THE STATE POLLUTION CONTROL COMMISSION

BY

THE QUARRY MASTERS ASSOCIATION OF N.S.W.

AND

THE SAND PRODUCERS ASSOCIATION OF N.S.W.

MAY 1974

LAURIE, MONTGOMERIE & PETTIT PTY. LTD.
CONSULTING ENGINEERS, SYDNEY


RAECO

SER/NSWSPEC
SAN/F74

SAND AND GRAVEL EXTRACTION INDUSTRY IN THE NEPEAN-HAWKESBURY RIVER VALLEY ...

933586 M 10327

DATE DUE	BORROWER
31 NOV 1995	G. Rennie WEC
29 FEB 1996	W. Hawkesbury Inc

THE SAND AND GRAVEL EXTRACTION INDUSTRY

IN

THE NEPEAN – HAWKESBURY RIVER VALLEY

SUBMITTED TO

THE STATE POLLUTION CONTROL COMMISSION

BY

THE QUARRY MASTERS ASSOCIATION OF N.S.W.

AND

THE SAND PRODUCERS ASSOCIATION OF N.S.W.

STATE POLLUTION CONTROL COMMISSION
26 OCT 1978
LIBRARY

MAY 1974

ENVIRONMENT PROTECTION AUTHORITY
LIBRARY
SEA/NSWSPCC STAN/74
LOC:
ACCN: 933586

LAURIE, MONTGOMERIE & PETTIT PTY. LTD.
CONSULTING ENGINEERS, SYDNEY

TABLE OF CONTENTS

THE SAND AND GRAVEL EXTRACTION INDUSTRY

IN

NEPEAN-HAWKESBURY RIVER VALLEY

SUMMARY

From now to the turn of the century, industry and development in the Sydney Metropolitan Area will utilise some 290 million tonnes of coarse aggregate and some 190 million tonnes of sand. Gravel and sand deposits in the Hawkesbury-Nepean River Valley will have to be developed to meet this demand.

To achieve maximum conservation of geological resources for the community it is recommended that action be initiated in the following areas:

(i) Identification and reservation of resources by appropriate zoning.

(ii) Governmental control of the extractive industry to be rationalised under one controlling body incorporating industry representation.

(iii) Protection of the environment by such measures as buffer zoning and the development of practical operating procedures by this controlling body.

Another submission will show that, where the above principles have been applied to one area in the valley, co-operative action is leading to a plan for extraction and restoration.

1. INTRODUCTION

The Director of the State Pollution Control Commission has announced that the Commission will carry out an environmental investigation under the terms of the State Pollution Control Commission Act, 1970, into matters arising from the extraction of sand and gravel in the vicinity of the Hawkesbury and Nepean Rivers. Written submissions from interested organisations concerning any aspect of sand and gravel extraction have been invited. In response to this request the Quarry Masters Association of N.S.W. and the Sand Producers Association of N.S.W. jointly tender this submission.

This submission demonstrates to the Commission that maximum extraction of the Hawkesbury and Nepean gravels and sands is in the best interests of the people in the Sydney Metropolitan Area and that this extraction can be achieved with a minimum disturbance to the environment.

Another submission will jointly be made by five member companies of the Quarry Masters Association of N.S.W. and the Penrith City Council concerned with extraction and subsequent reclamation of the Cranebrook Area. That submission is an indepth study of a defined area in which definite problems and solutions are presented. In contrast, this submission is more concerned with identifying general problems and presenting class solutions over a wider area.

The member firms of the Quarry Masters Association of N.S.W. involved in this submission are:

Farley and Lewers Ltd.
Pioneer Concrete (N.S.W.) Pty. Ltd.
Blue Metal Industries Ltd. and its subsidiaries
Ready Mixed Concrete (N S.W) Pty. Ltd. and its subsidiaries
Gravel and Sand Suppliers Pty. Ltd.
Albion Reid (N.S.W.) Pty. Ltd.
Hy-Mix Quarries Pty. Ltd.

The member firms of the Sand Producers Association of N.S.W. involved in this submission are:

Those firms as listed above, excluding Ready Mixed Concrete (N.S.W.) Pty. Ltd.
Breen Holdings Pty. Ltd.
Concrete Industries (Monier) Ltd.
Davidsons Washed Sands Pty. Ltd.
Martin Bros. (Transport) Pty. Ltd.
P. B. White (Minerals) Pty. Ltd.
Witwall Pty. Ltd.
Cobbity Sand and Soil

These firms are responsible for some 95% of the extraction of sand and gravel from the Hawkesbury-Nepean River area. The remainder is carried out by firms or Local Councils who do not have membership to the Association.

2. DEMAND FOR COARSE AGGREGATE AND SAND

Coarse aggregate and sand are essential and major components of modern day building and road construction. They are vital to the growth of the State.

The alluvium deposits in the Hawkesbury-Nepean Basins are a mixture principally of gravel, sand, silt and clay in varying proportions. The industry is engaged in separating the sand and gravel, crushing the oversize gravel and marketing sand, round river gravel and crushed aggregate. Round gravel is only approximately 10% of the production of crushed aggregate. Coarse aggregate is a collective name for round or crushed aggregate greater than 5 mm. diameter. Sand is that fraction less than 5 mm. diameter.

These products have a multitude of uses, some of which are listed below:

Coarse Aggregate:

1. Portland cement concrete in reinforced and unreinforced structures.
2. Precast concrete products such as pipes, prestressed concrete beams, etc.
3. Bituminous concrete and bitumen seal in road work.
4. Exposed aggregate surfacing.

Sand:

1. Portland cement concrete.
2. Asphaltic concrete and bitumen road seal.
3. Cement bricks and tiles and concrete blocks.
4. Lime-silica bricks.
5. Cement render.
6. Filling and pipe bedding sand.

Another major use for crushed aggregate is in road base to build up the foundation of the road. Formerly this usage was catered for by naturally occurring gravels. However, in recent years with depletion of suitable gravels and more exacting specifications, crushed rock is now almost exclusively used. The specification for road base is adequately satisfied by supplies from hard rock quarries in the Sydney Metropolitan area and very little river gravel is used for this purpose.

In recent years statistical records have been kept of the annual production of coarse aggregate and sand. This data has been plotted on Figures 2.1 and 2.2. An attempt has been made to predict the annual demand for these products up to the year 2000 by a straight line extrapolation. This prediction should be regarded only as a reasonable estimate as it is conceded that argument can be produced that the future demand should be either more or less than that indicated. The important feature of the graph, however, is that the area under the graph shows the total consumption and this total consumption is not significantly changed with small changes in the slope of the line. The total consumption for the years 1974 to 2000 for the County of Cumberland so derived is:

Coarse Aggregate - 290,000,000 tonnes
Sand - 190,000,000 tonnes

The annual production of sand and gravel in the Nepean-Hawkesbury Area is also plotted on the graphs to show its contribution to the Sydney market to date.

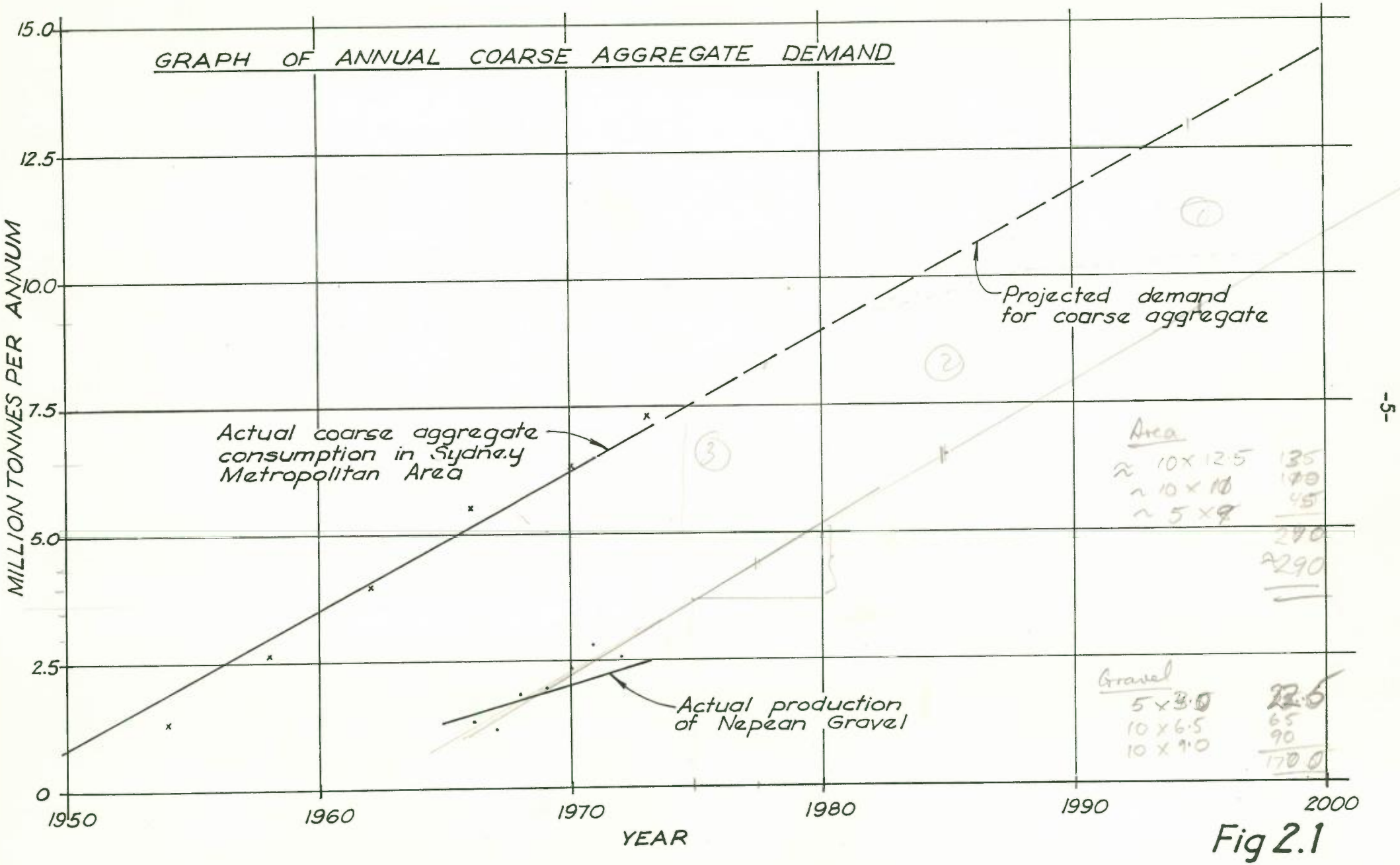
GRAPH OF ANNUAL COARSE AGGREGATE DEMAND
MILLION TONNES PER ANNUM
15.0
12.5
10.0
7.5
5.0
2.5
0
1950
1960
1970
1980
1990
2000
YEAR
Projected demand for coarse aggregate
Actual coarse aggregate consumption in Sydney Metropolitan Area
Actual production of Nepean Gravel

Fig 2.1

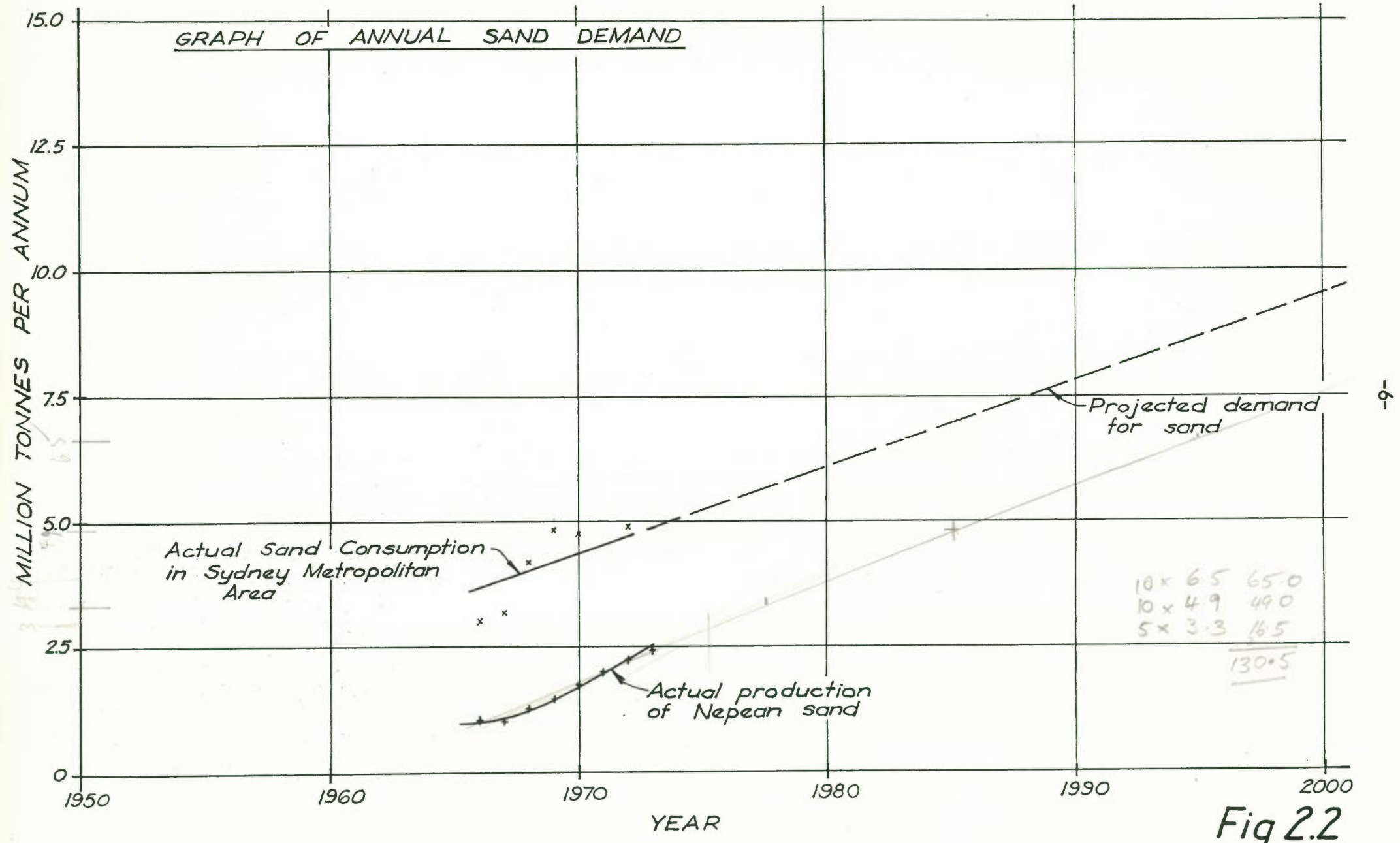
GRAPH OF ANNUAL SAND DEMAND
15.0
12.5
10.0
7.5
5.0
2.5
0
MILLION TONNES PER ANNUM
1950
1960
1970
1980
1990
2000
YEAR
Projected demand for sand
Actual Sand Consumption in Sydney Metropolitan Area
Actual production of Nepean sand
10 × 6·5 65·0
10 × 4·9 49·0
5 × 3·3 16·5
130·5

Fig 2.2

3. RESERVES

In the previous paragraph it was established that the County of Cumberland will require, over the next 26 years, some 290 million tonnes of coarse aggregate and some 190 million tonnes of sand.

With such large quantities involved the source of supply must be as close to the market as possible, otherwise crippling transport costs will be incurred. With road transport cost at about 5 cents per tonne/kilometre, the cost to the community for each additional 10 kilometres of transport for the above quantity of coarse aggregate and sand would be $240,000,000. Due to transport charges the cost of coarse aggregate and sand in Sydney is already more than it is in Melbourne. It is evident then, that the resources close to the market of Sydney should receive the most careful consideration with the object of achieving maximum exploitation.

3.1 Coarse Aggregate

The coarse aggregate reserves are the hard rock quarries and the Hawkesbury-Nepean Gravels.

3.1.1 Hard Rock Quarries

Figure 3.1 shows the location of the hard rock quarries in the County of Cumberland. Sandstone and shale underlie practically the whole of the area, but neither of these rocks is suitable for coarse aggregate production. The quarries are isolated intrusions of igneous and volcanic rock which exist in the following forms:

(i) Laccolith - The Prospect doleritic intrusion is an isolated and unique occurrence. This is the largest sing e deposit of aggregate producing rock in the Sydney area.

(ii) Volcanic Breccia Necks- These deposits are composed of cemented fragments of various rocks, altered basalt being a common constituent. They vary in area from a few hectares to over 20 hectares and although they are small in relation to the Prospect intrusion their scattered distribution and their total reserves mecns they are a valuable asset to the community. However, due to urban pressures some of these reserves are

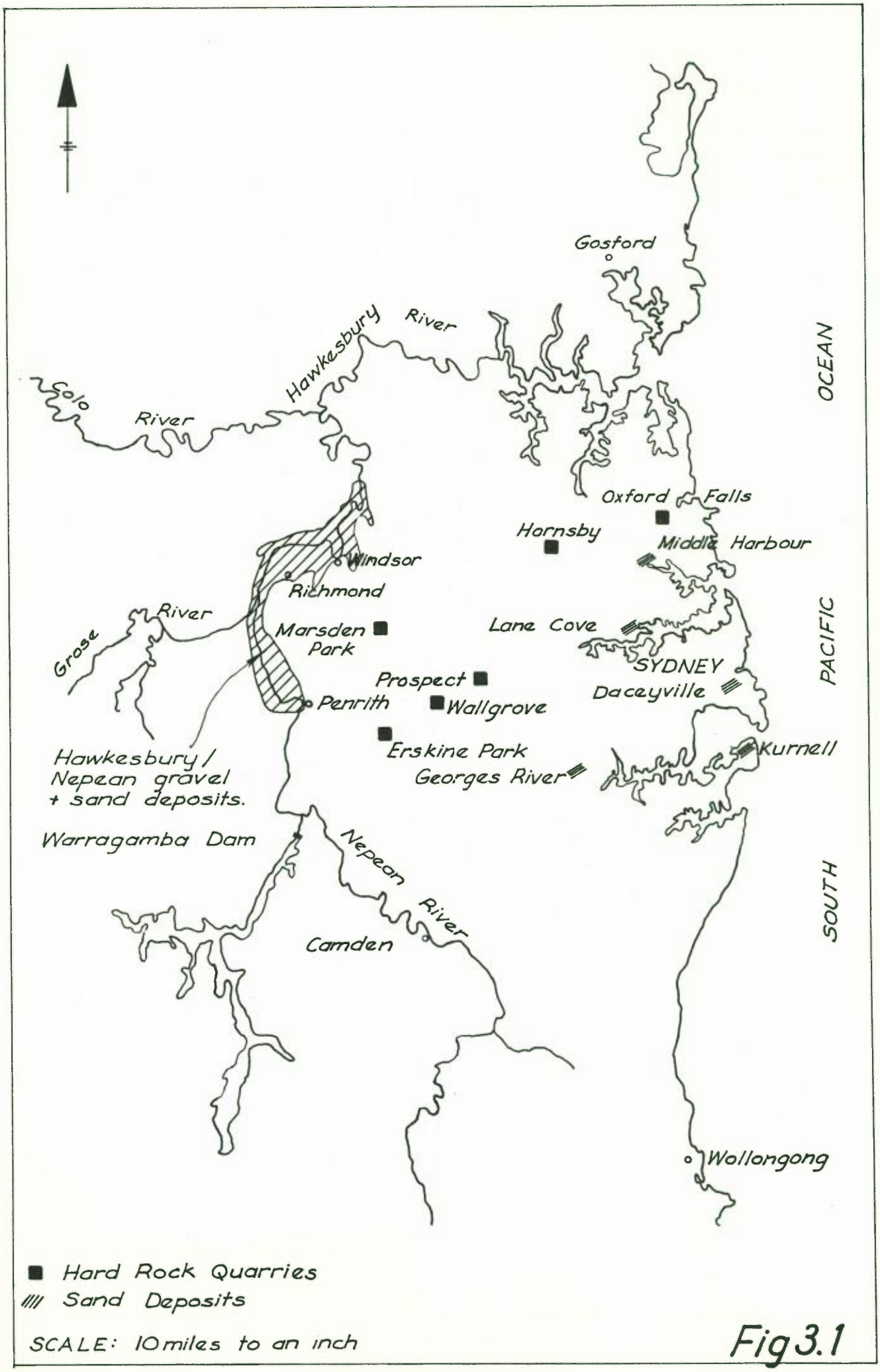
Gosford
Hawkesbury River
Colo River
OCEAN
Oxford Falls
Hornsby
Middle Harbour
Windsor
Richmond
Grose River
Marsden Park
Lane Cove
PACIFIC
SYDNEY
Prospect
Daceyville
Penrith
Wallgrove
Erskine Park
Georges River
Kurnell
Hawkesbury / Nepean gravel + sand deposits.
Warragamba Dam
Nepean River
SOUTH
Camden
Wollongong
Hard Rock Quarries
Sand Deposits
SCALE: 10 miles to an inch

Fig 3.1

already lost.

(iii) Dykes - Basaltic dykes are fairly commonly distributed throughout the area. These are narrow (up to 5 metres), fairly long, vertical intrusions of very little economic significance. There are no quarries today working these deposits.

3.1.2 Hawkesbury-Nepean Gravels

Fig. 3.2 shows the location of the gravel and sand reserves in the Hawkesbury-Nepean River basin. This is the only source of river gravel in, or adjacent to, the County of Cumberland.

This gravel is located in a restricted area extending from the vicinity of Penrith downstream to about Windsor. The source of the gravel is from the Older Palaeozoic rock of porphyry, granite, quartzite and slate in the Warragamba catchment. Replenishment of this supply is now stopped with the construction of the Warragamba Dam. Sand however continues to be carried by the Nepean River from its upper reaches and also from the McDonald, Grose and Colo Rivers to a minor extent. Downstream of the vicinity of Richmond and Windsor the river deposits are free of gravel excep- at depth.

There are older Tertiary deposits of gravel outcropping but mainly at depth to the east of the Nepean. These deposits are weathered to the extent that they are, at present, not considered suitable as a supply of coarse aggregate.

3.2 Sand Reserves

3.2.1 Hawkesbury-Nepean Sand

There are sand deposits in the Nepean River at Wallacia which are presently being worked by dredging. Proceeding downstream the major deposits commence at Penrith and extend to Pitt Town Bottoms. At Penrith, in what is known as the Cranebrook Area, the sand is associated with a predomenance of gravel. The proportion of gravel to sand decreases further downstream till Windsor where the stream bed is almost exclusively sand.

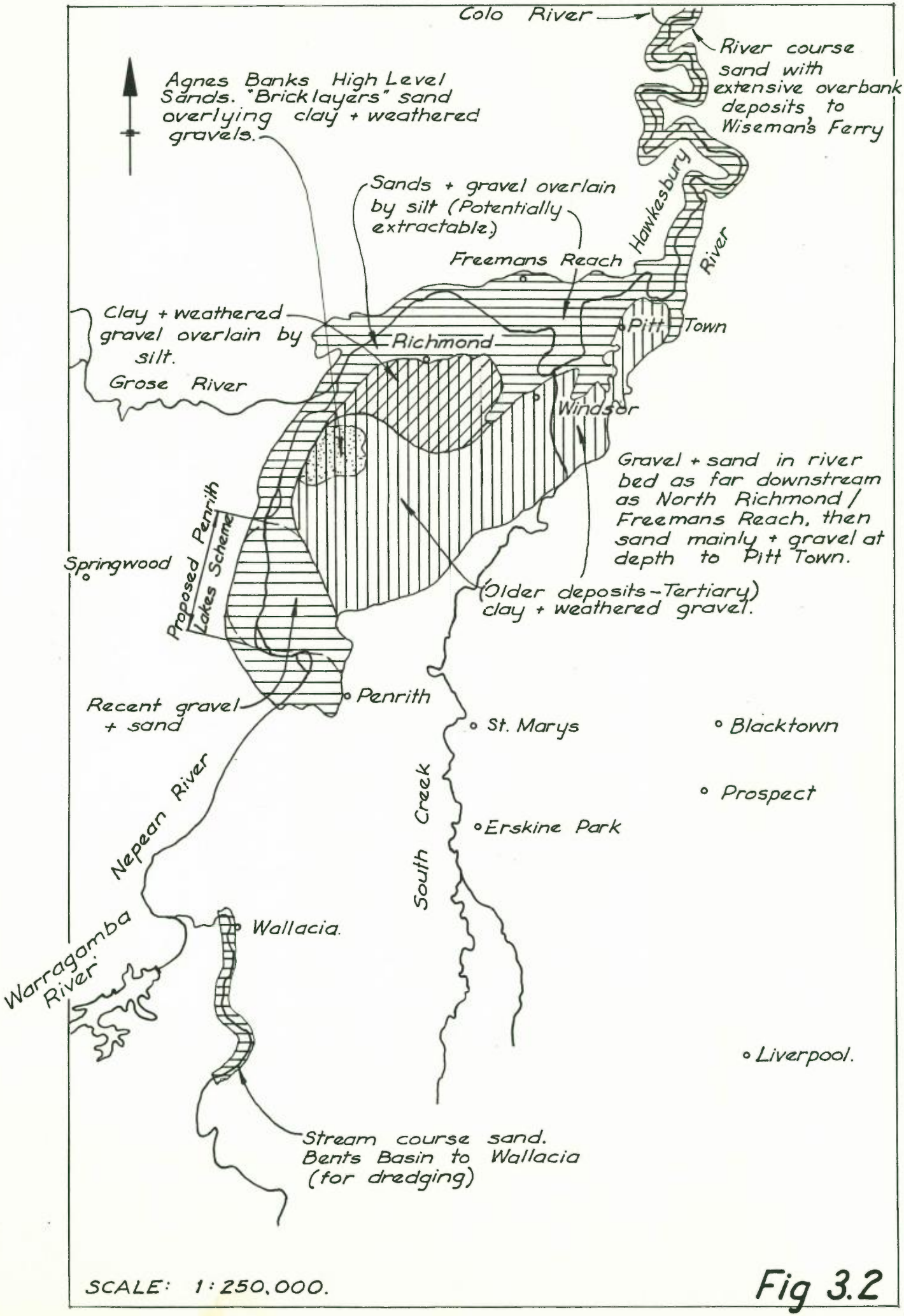
Colo River
River course sand with extensive overbank deposits to Wiseman's Ferry
Agnes Banks High Level Sands. "Bricklayers" sand overlying clay + weathered gravels.
Sands + gravel overlain by silt (Potentially extractable)
Hawkesbury River
Freemans Reach
Clay + weathered gravel overlain by silt.
Grose River
Richmond
Pitt Town
Windsor
Gravel + sand in river bed as far downstream as North Richmond / Freemans Reach, then sand mainly + gravel at depth to Pitt Town.
Springwood
Proposed Penrith Lakes Scheme
(Older deposits - Tertiary) clay + weathered gravel.
Recent gravel + sand
Penrith
St. Marys
Blacktown
Prospect
Nepean River
South Creek
Erskine Park
Wallacia.
Warragamba River
Liverpool.
Stream course sand. Bents Basin to Wallacia (for dredging)
SCALE: 1:250,000.

Fig 3.2

In the Londonderry and Pitt Town area there is a high level extensive deposit of sand and sandy loam which is being worked to win a bricklaying sand. This sand, traditionally has a high proportion of fines to give a smooth, workable mortar.

3.2.2 Other Sand Deposits

The other significant sand deposits in the Sydney area are located in the Kurnell area and Georges River centered around Milperra. Although sand will continue to be won from Middle Harbour, Daceyville-Pagewood area and Lane Cove River for a few more years, these deposits have very limited resources.

It is understood that a submission by the Geological Survey of N.S.W. will be made to the State Pollution Control Commission, wherein detailed reporting on the geology and reserves of the subject area will be made. Reference should be made to that report for further details on the subject.

In summary, the table below sets out estimates of the resources of coarse aggregate and sand available in the County of Cumberland. Resources already alienated through urban development are not included.

Coarse Aggregate		
Hard Rock Quarries	-	100,000,000 tonnes
Nepean-Hawkesbury Gravel	-	350,000,000 tonnes
		430,000,000 tonnes
Sand		
Nepean-Hawkesbury	-	250,000,000 tonnes
Other	-	30,000,000 tonnes
		280,000,000 tonnes

In connection with the foregoing it should be noted:

1) The Nepean-Hawkesbury deposits, other than the Cranebrook area, have not been proven so the above figures are estimates only.

2) The picrite rock at Prospect has not been included as it is considered to be unsuitable as a source of coarse aggregate.

3) The breccia reserves at Oxford Falls have been included.

From the foregoing tables of reserves and the projected consumption over the next 26 years, it is evident that the Hawkesbury-Nepean deposits must continue to be exploited unless supplies are transported in from outside the County. The nearest alternative supplies of any significance are the Carboniferous volcanics at Raymond Terrace to the north, the Permian volcanics at Shellharbour to the south and the Tertiary volcanic rock deposits in the Mittagong-Moss Vale area. These reserves will be utilised in the Sydney area following exhaustion of the close-in supplies. Such supplies should now be reserved for future use.

4. METHODS OF EXTRACTION OF GRAVEL AND SAND

The Hawkesbury-Nepean gravels and sands are found in combination in varying proportions, with varying overburden and located either in the river bed or in the adjacent flood plain. Accordingly, different methods of mining and processing are adopted. The typical methods of extraction adopted by the industry are discussed below.

4.1 Gravel and Sand in the River Bed

These deposits are usually excavated under water by dragline operating from a temporary access road built out into the stream. The material excavated is relatively free of silt and clay so that turbidity through digging is usually not a problem. The river banks are not excavated. The sand gravel mixture is loaded onto trucks and transported to the processing plant. Here the sand and gravel is wet screened and the oversize is crushed. This produces river sand and several size gradings of round and crushed aggregate. The wash water is settled in ponds and the resulting settled water either recirculated to the processing plant or returned to the river.

The deposits are 8 to 20 metres deep, getting deeper further downstream. The river is left this much deeper following extraction. Wianamatta Group shale and Hawkesbury sandstone form the bedrock.

4.2 Gravel and Sand in the Flood Plain

It is these extensive deposits in the Cranebrook area for which the Penrith Lakes Scheme is proposed following extraction. The deposits are some 8 metres thick overlain with 6 metres of overburden consisting of silt and loam. The overburden is stripped and stockpiled or used directly for backfilling. Excavation of overburden is usually by scraper and bulldozer. The gravel is excavated by truck and front-end loader or by the use of dragline and trucks where the deposits are below the water table.

Processing consists of washing, screening, crushing and stockpiling as before. The wash water is cleaned in the settling ponds before returning to the river.

There are river flats, other than the Cranebrook Area, where similar deposits occur. These extend from Agnes Banks to Pitt Town and form the source of future supplies of gravel.

4.3 River Sand

Below Richmond the river bed is composed mainly of sand. Permissive Occupancy has been granted in some locations to reclaim this sand by dredging. A typical plant consists of a suction cutter dredge pumping to a process plant on the river bank. Here the sand is washed, classified, screened and stockpiled to give one or two gradings of sand. The water is returned to the river via settling ponds.

Restrictions are placed on the operator with respect to the depth of dredging and batter slope of excavation depending on the Council concerned. The river is left, after dredging, up to 10 metres deeper. However, this hole is refilled with subsequent river flooding; in fact, for a one-kilometre stretch below the Windsor Bridge, the river has been dredged three times in the past 10 years and has been refilled each time.

4.4 High Level Sand

At Londonderry and Pitt Town there are deposits of fine sand suitable for brick-laying mortar. These surface deposits are some 5 metres deep and are underlain with clay. The sand is excavated by front-end loader and transported by truck to a central plant where it is processed mainly by screening and washing. The sand is also used for the manufacture of lime-silica bricks.

5. EFFECT ON THE ENVIRONMENT

The industry is well aware that their operations can have an adverse effect on the environment and it has taken active steps to minimise such effects. Those features of the industry which do have an environmental impact will now be discussed in some detail.

5.1 Pollution of the River

Mining operations in or adjacent to a river can result in the river being polluted with water borne silts or turbid waters. Such pollution can be caused by:

a) Underwater excavation; or

b) Return of wash water to the river.

For the first, dragline excavation of clean gravels produces little turbidity. However, if silty deposits are excavated the area to be excavated can be enclosed within a bund so that the dirty water is contained and not released to contaminate the stream. Excavation by suction cutter dredge tends to suck up most of the turbidity caused by the cutter. Proper ponding and recirculation of wash water minimises any river discolouration through this cause.

By these and other means, pollution of the stream can be prevented or minimised to tolerable levels. There are also Government regulations which control the level of turbidity caused by the mining operations.

5.2 Noise Pollution

Due to excavating, hauling, crushing and screening, the sand and gravel industry is a noisy one. Palliative measures can and are taken through enclosing crushing equipment inside brick buildings and fitting silencers to the exhausts of diesel motors. However, noise cannot be eliminated and buffer zones between the extraction area and urban development are required.

5.3 Visual Pollution

The excavating, processing and stockpiling of gravel and sand is rather an ugly and confused sight. At the outset the processing plant should be sited where it least obtrudes on the public view. The workings can further be screened from public view by judicious tree planting; this is especially effective where long range planning is employed, enabling the establishment of the trees before the plant is constructed.

Additionally the equipment should be housed in neat modern buildings where this is possible. Examples of all these methods of beautifying and screening can be seen in the present workings. With long term planning ard stability within the industry much more can be done in this field.

5.4 Dust Pollution

Again by the nature of the industry, excluding sand dredging, dust is an inherent problem. Through bitumen sealing of major haul roads, brooming, watering with water carts and water sprays the dust pollutant is being minimised. A buffer zone around the area is ideally required. Further, proper planning can reduce the incidence of dust through such measures as the transport of material by conveyors rather than mobile equipment from the point of excavation to finished product where such methods are economically feasible.

5.5 Transport

To move the large quantities of material involved out of the area there will, of necessity, be increased activity to and fro on the adjacent main roads. Some reduction in truck movements has been achieved by railing part of the product.

The amount of material transported out of the area per working day in 1973 for a 220 day working year was approximately 1200 tonnes by rail and 21,400 tonnes by road.

Perhaps more could be done to utilise the railway but the wide dispersal of the delivery of the product acts against this. Banning the industry and forcing it to move elsewhere only shifts this problem to another locality.

5.6 Damage to River Bank

Onerous restrictions have been placed on the sand dredge operators with respect to depth of dredging and batter slope of excavation to preclude damage to the river bank. However, the river banks from upstream of Penrith to downstream of Windsor have a long record of bank slumping after large floods[1]. The Windsor to Freemans Reach Road has been cut and relocated six times since 1904. With the construction of the Warragamba Dam the river lost a large source of replenishment sediments. Man made controls to the river flow are also imposed by the spillway gates. It is therefore reasonable to expect that changes in the river regime will occur. Some research into this matter has been undertaken by the Public Works Department but more is required. Regulations with respect to dredging can be formulated in a more uniform manner when this and related studies are completed.

5.7 Derelict Land

The condition of the land on completion of mining has the most important effect on the environment. With respect to those deposits on the flood plain, as such a large volume of material is removed, it is impossible to restore the ground to its original condition. In the past exhausted gravel pits have been left as a series of unrelated, dry or water filled holes, waste dumps and barren land. This is no longer the case and the industry is paying increasing attention to ensure that the worked out areas are left in a fit state for industrial, residential or recreational purposes.

Worked out areas in Emu Plains have been backfilled and new industries established on the reclaimed area. The Penrith Lakes Scheme will provide a recreational feature of tremendous value to the western suburbs of Sydney.

If large areas are allocated for mining, then the final land form can be planned to achieve worthwhile objectives. This land form can usually be obtained during the

---

[1] The Hawkesbury River Valley Environmental Study Background Report.

mining operation at very little additional cost by judicious planning of excavation and backfilling operations. It is possible that under such conditions the land could have more value to the community, in the broad sense, after mining than it had before.

6. VALUE OF THE INDUSTRY TO THE AREA

The gravel and sand extractive industry supports a large work force in the district, directly and indirectly. Related industries established in the area are engaged in the manufacture of roof tiles, prestressed concrete beams, reinforced concrete pipes, lime-silica bricks and ready mixed concrete. The number of men employed directly in the extractive industry is estimated at 400 and 2,700 men are estimated to be employed in the related industries.

The annual wages paid to the men in the extractive industry is some $2 million and $16 million to employees in related industries. A large proportion of this money is spent locally. The local economy is further stimulated by an annual local spending of $2 million in goods and services for the extractive industry.

A further contribution is made to the local economy by the farm lands owned and worked by some member companies of the Quarry Masters Association and the Sand Producers Association. These farm lands are now engaged in dairying, citrus growing and market gardening. The farms are held as reserves for future gravel and sand production.

7. CONTROL OF THE INDUSTRY

Benefits will accrue from rationalising management of the industry and abandoning the present piecemeal approach to the extraction of the sand and gravel.

Within the broad confines of the valley, control over the extraction process is at present exercised, to one degree or another, by a number of authorities, including:

Local Councils
Lands Department
Water Conservation & Irrigation Commission
Mines Department
Department of Public Works
Metropolitan Water Sewerage & Drainage Board
Maritime Services Board of N.S.W.
State Planning Authority of N.S.W.
Health Commission
State Fisheries

The vesting of control in one body, with these existing authorities acting in a consultative role, would have the obvious advantage of facilitating planning and regulating operations on a broad basis.

The industry itself has developed significant expertise and will continue to make an important contribution to planning and control in the future. Consequently, it is believed that the industry should also have direct involvement in the planning process. The work carried out for the Penrith Lakes Scheme shows the advantage of large scale planning together with direct industry involvement in the planning process.

From such a body would also flow a common set of practical control policies designed to meet the specific needs of the area, taking particulcr note of local conditions.

The problems and shortcomings associated with the present divided responsibilities among the various tiers of government is discussed in C. L. Adamson's paper "The Approaching Geological Resources Crisis in the Sydney Basin", Australian Mining, March 1974.

The capital now invested in the industry is about $42,000,000. To meet future production demands further heavy investment of capital is called for. Also, as has been explained in preceding paragraphs of this report, planning and new plant and equipment are required to safeguard the environment. A climate of stability and assured reserves are required to encourage the investment of capital so necessary tc an efficient industry.

To achieve conservation of geological resources, it would appear that one body, involving industry representation, should be firmly in control and that other sections of government, with particular expertise or interest, would act as consultants to the responsible body.

The sand and gravel industry would benefit in that clear government policy would evolve and the application of that policy to the industry would be uniformly and fairly applied.

8. CONCLUSIONS

To meet the demands of the expanding Sydney markets it is essential that the Hawkesbury-Nepean River gravels and sands be fully developed with due regard being paid to the environmental impact of such development. Such development will work for the betterment of the whole of Sydney and for the local extractive area.

A new phase in the operation of the sand and gravel industry is in the offing. The key-notes of this new phase are:

(1) Rationalised control under a single body to initiate and implement policy for maximum conservation of geological resources.

(2) Such policy to include the establishment of protective zoning on and around established reserves for future operations.

(3) Pre-planning the mining of large blocks of land by the industry so that planned land forms are attained for future development on completion of the mining phase.

PHOTOGRAPHIC SUPPLEMENT

1. CRUSHING PLANT
2. FLOOD PLAIN GRAVEL PIT
3. WASH PLANT
4. MODERN CRUSHING PLANT
5. SECONDARY INDUSTRY ON RECLAIMED LAND
6. GRAVEL RESERVES
7. PICNIC GROUNDS
8. DRAGLINE WORKING IN THE RIVER
9. LONDONDERRY SAND STOCKPILES
10. SCREENING WITH TREE PLANTINGS
11. SCREENING OF PROCESS PLANT

PLATE 1: Old and New Processing Plants, Product Stockpiles and Pit Backfilling.

PLATE 2: A Flood Plain Gravel Pit showing ponding of Wash Water, Excavation of Gravel and Factory on Reclaimed Ground.

PLATE 3: Gravel Wash Plant at Emu Plains.

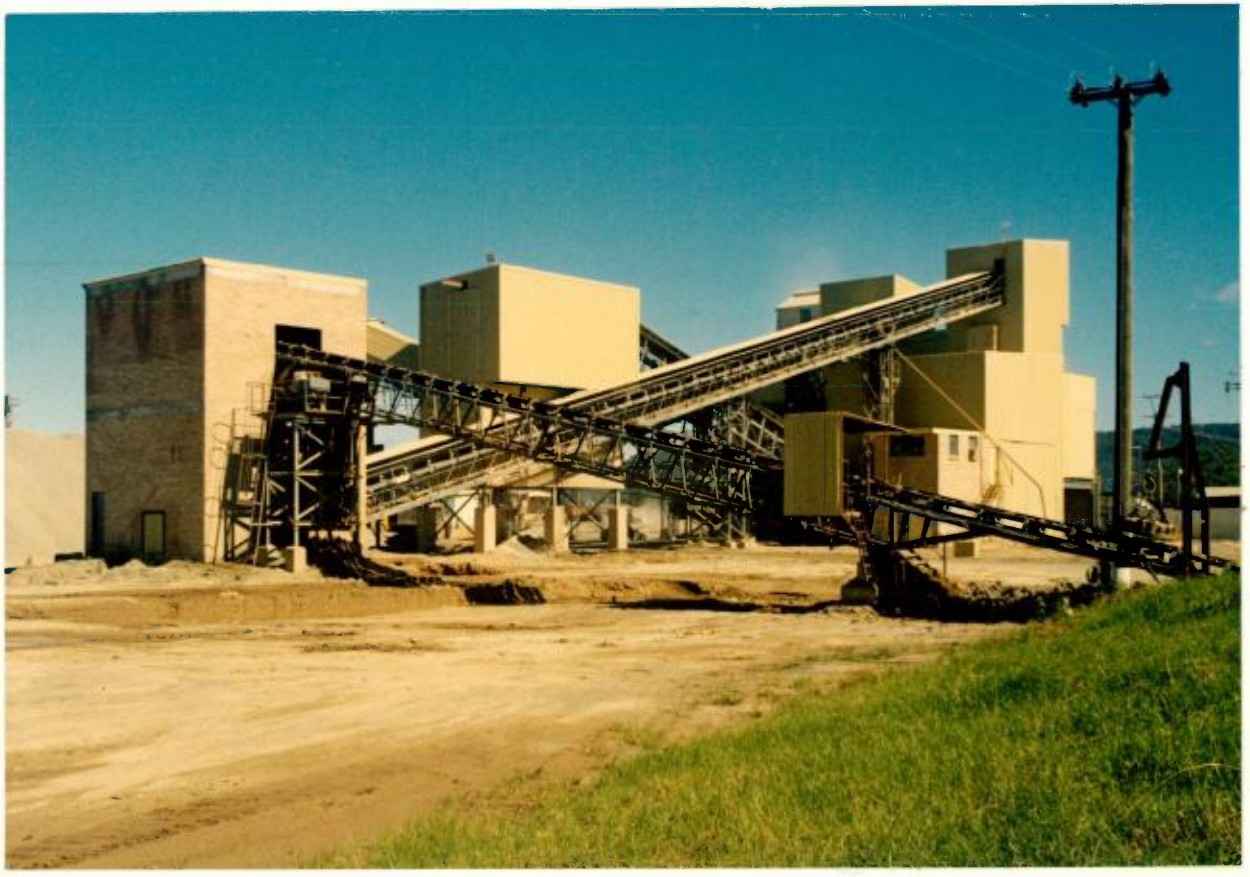

PLATE 4: Modern Crushing and Screening Plant with Brick Building for Noise Suppression.

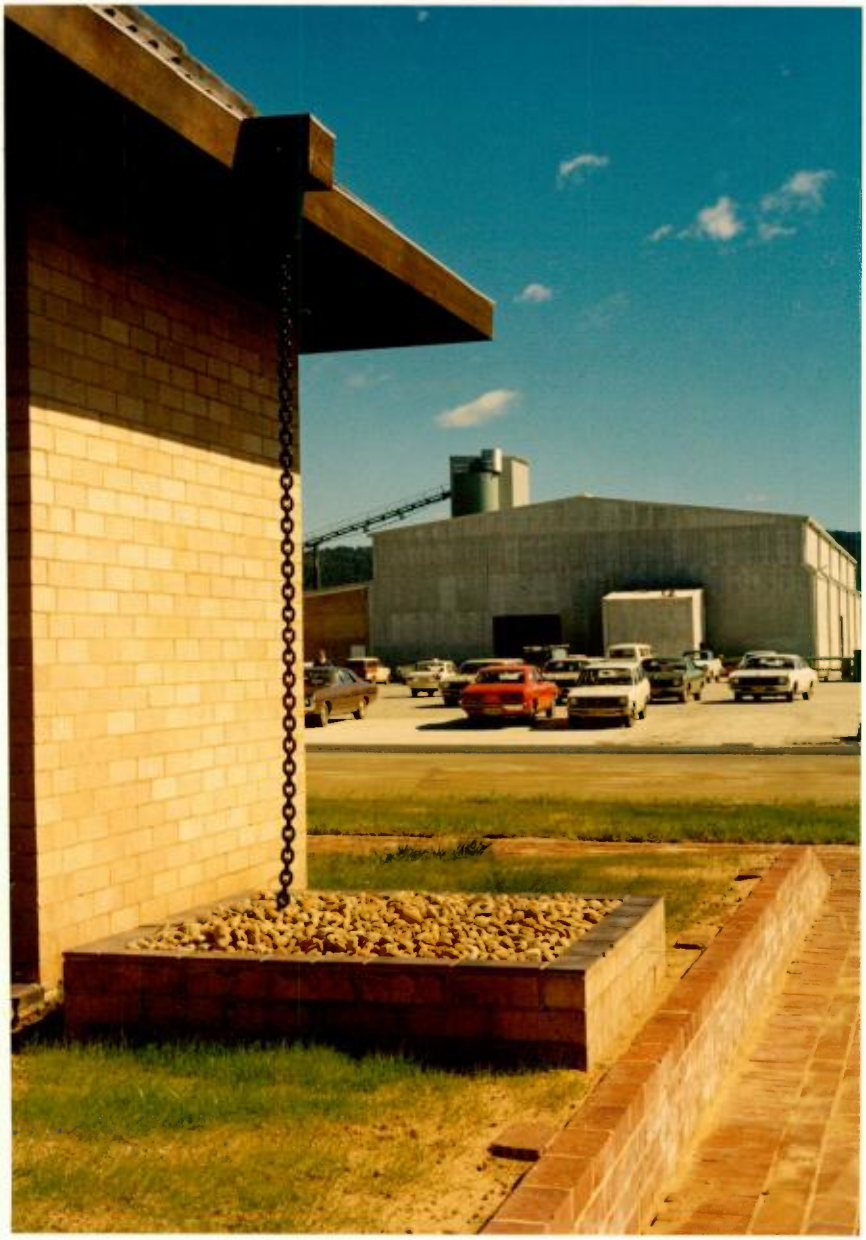

PLATE 5: Roof Tile Factory on Reclaimed Land.

PLATE 6: Industry owned Dairy Farm on Gravel Reserves.

PLATE 7: Public Picnic Ground provided by the Extractive Industry.

PLATE 8: Underwater River Gravels being excavated by Dragline and Trucks.

PLATE 9: Londonderry Sand Stockpiles.

PLATE 10: Three Rows of Tree Plants to provide Screen for Future Operations.

PLATE 11: Fence and Tree Planting Provide Visual Screen to the Process Plant from the Road.

Q622.362
7