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SAND AND GRAVEL DEPOSITS AND EXTRACTION OPERATIONS IN THE
CANBERRA REGION, ACT AND NSW, 1977

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by

P.H. Vanden Broek.

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1. Operating sand and gravel deposits, Canberra region, May, 1976.

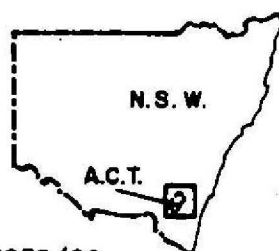
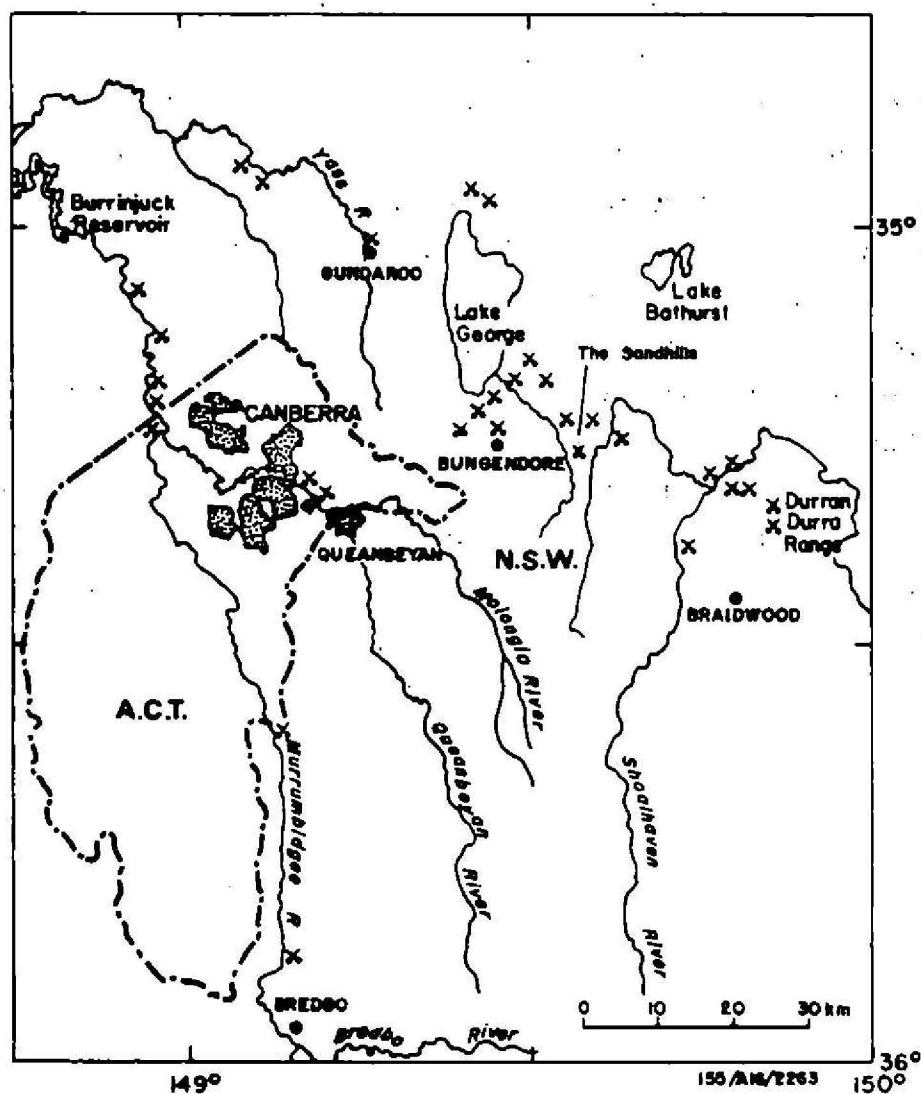
ABSTRACT



A detailed review of resources at operating and non-operating sand and gravel deposits within the region has been carried out. Thirty deposits are worked for five main sand types, these are: coarse-grained river sand and medium-grained lake sand, used mainly in concrete manufacture; fine to medium-grained windblown sand, used mainly for plaster mortar; fine-grained windblown sand, used for brick mortar; and very fine-grained windblown sand used for filling or additive purposes. In addition gravel is extracted and marketed as screened pebbles or as crushed-rock aggregate.

The deposits are located in five main sand-and-gravel-supplying areas: the Murrumbidgee River, Shoalhaven River, Lake George, Durran Durra Range, and The Sandhills areas. Production from these areas was $950\,000\text{ m}^3$ for the 12-month period July 1975 to June 1976, and reserves are in the order of $79 \times 10^6\text{ m}^3$, which is more than sufficient to meet expected demand to the year 2000. In addition a further $31 \times 10^6\text{ m}^3$ of sand reserves are inferred at locations not presently worked and there is also a certain amount of replenishment of coarse river sand each year, particularly during river flooding.

It is recommended that the sand and gravel deposits at Dairy Flat and in the East Basin of Lake Burley Griffin be set aside as a possible reserve for use at some future date, and that the deposits in the Burrinjuck Reservoir be looked at more closely.

The Canberra region's sand and gravel reserves should be reviewed in the late 1980s.



-  Built-up area
-  Operating sand or sand and gravel deposit

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Fig.1 Location map. Sand and gravel deposits in the Canberra region.

INTRODUCTION

In October 1974, the National Capital Development Commission requested the Bureau of Mineral Resources to make a survey of operating and non-operating sand and gravel deposits* in the Canberra region, with the view to determining where future supplies are likely to come from (Fig. 1). The Canberra region in this study is defined as 'the area lying within an economic haulage distance of Canberra City' (about 80 km at present). The study was carried out between April 1975 and May 1976, and was subsequently updated by information obtained from the Department of Capital Territory and by limited fieldwork in September 1977.

The aims of the investigation were to:

- (1) Determine the nature and uses of sand and gravel currently being extracted
- (2) Identify and describe all operating sand and gravel deposits within an economic transport haulage radius of Canberra
- (3) Assess the approximate production and likely reserves available at each operating deposit
- (4) Look briefly at reserves available from non-operating sand and gravel deposits
- (5) Broadly determine total reserves available in the region
- (6) Predict the ability of the industry to cope with demand to the year 2000.

In addition, the present costs associated with operating a sand and gravel deposit were examined, and some predictions about future developments, with respect to supply and costs, were made on the basis of the study.

* The term 'sand and gravel deposit' is used loosely in this report and may include operations where gravel is not extracted.

A number of previous studies for sand supply to Canberra have been carried out by Gardner (1958, 1965, 1966, 1967), the Commonwealth Department of Works (1972), Coffey & Hollingsworth (1973) and Goldsmith & Pettifer (1977).

NATURE AND USES OF SAND AND GRAVEL CURRENTLY EXTRACTED

Sand and gravel operators extract a large variety of products from rivers, lakes, and hills, each product being suitable for a particular use in the building and construction industry.

Sand and gravel extracted from rivers of the region is either bed-load (Fig. 2) or levee bank material. Bed-load material is usually referred to as 'washed river sand' and 'crushed river gravel', though in many instances river sand is not washed in practice. Levee bank material is finer-grained, contains more fines (passing 200 sieve), and commonly has quite a high percentage of organic material.



Figure 2. An aerial view of river bed-load deposits on the Shoalhaven river, looking east. Three operators are working this deposit.
(Negative No. M/2371/32)

Sand and gravel extracted from lake areas (Fig. 3) is, in contrast to river sand, commonly more mineralogically mature (that is, contains a higher percentage of silica sand and less feldspar and mica), more rounded, and better sorted. Material extracted includes shoreline 'strand' deposits (Fig. 4), near-shore windblown sand, and at greater depth, stream bed-load deposits.



Figure 3. An aerial view of abandoned sand pits southeast of Lake Bathurst, looking southwest. No restoration of this has yet been attempted. (Neg. No. GB 2196)



Figure 4. A cross-section through a lake shoreline strand deposit at Emersley, south of Lake George. The stratification is caused by successive sand layers deposited by changing strandlines. M/2371/25

Sand extracted from hill areas is commonly referred to as dune sand (Fig. 5) and is mostly wind-blown in origin. It is commonly finer-grained than either river or lake sand deposits, generally well-sorted and mineralogically mature, though not necessarily well-rounded. The individual sand grains are usually coated with a surface staining of red, orange, or yellow iron oxides.



Figure 5. A section through a windblown sand deposit at Deep Willows (Durran Durra Range). The lower layer appears to have been a dune sand and shows cross-bedding structures, whereas the upper layer has no structure or soil profile development and is therefore very recent in origin (Neg. No. M/2371/26)

Descriptions of the various sand and gravel materials currently being extracted, from working deposits, and notes on their occurrence, mineralogy, grade, and uses are included in Table 1. Notes on the uses of the materials extracted are set out below, and the grainsize analyses of samples are shown on the charts in Appendix 1.

USES

Most sand and gravel extracted in the region is used as fine aggregate for the manufacture of concrete at ready-mixed concrete batching plants and on the site of large construction projects. The second largest use of sand is in the manufacture of concrete products such as bricks, pipes, and tiles: this is followed by sand for pipe bedding and filter purposes. Bricklayers' and

plasterers' sand together make up most of the remainder of sand extracted. The balance is mostly additive sand - that is, sand which is added to road-base gravel.

Concrete aggregate sand

Concrete aggregate sand is generally made up of a blended mixture of river bed-load and lake sand, mixed in such proportions as to give a desirable or acceptably graded sand. The blending depends to some extent on the locality from which the sands were derived. It must be made up of durable mineral or rock particles which are sound and fairly well-rounded, and it must be free of coloration, organic material (charcoal, sticks etc.), clay lumps, and alkali-reactive constituents (Australian Standard 1465-1974 applies).

Gravel

Rounded water-worn rocks, suitable for crushing to gravel sizes occur in many of the river deposits that are being worked. They comprise pebbles, cobbles, and boulders of hard, durable rock types such as quartzite, dacite, rhyolite, hornfels, etc., or of milky quartz, though at a few deposits alkali-reactive constituents, such as chert and flint, appear to be present. Rounded river rocks are either crushed, screened, or stockpiled, depending to some extent on the amount of crushable material available but also on the cost structure of a particular deposit. The crushing of rounded river rocks is only marginally viable on account of rock hardness. Also the use of the crushed product is restricted to non-structural purposes (paving, etc.), and consequently does not command the high price of quarry aggregate. Often the rock component is screened for the gravel and pebble sizes which are sold for back-fill filter use, road surfacing, or ornamental use; the larger sizes are stockpiled.

Manufacturing sand

Sand used for the manufacture of concrete products such as bricks, pipes, and tiles is similar to that used for general concrete manufacture, except that the grades are more closely controlled in the medium and medium-coarse grainsize ranges, depending on the application. For certain specialised applications, such as the manufacture of white concrete bricks, a special pure white, almost entirely quartz sand must be used.

Pipe bedding and filter sands

Pipe bedding sand is usually untreated river bed-load material that is relatively rock-free. It is used as a substitute for quarry reject material (scalpings), which has become less readily available in recent times. Filter sand is all bed-load material which is finer than 25 mm. It is used principally under sportsfields, behind retaining walls, in dam construction, and surrounding subsurface (agricultural) drains.

Bricklayers' and plasterers' sands

Bricklayers' and plasterers' sand is fine to medium-grained and commonly wind-blown in origin. Plasterers' sand differs from bricklayers' sand in that it is usually coarser and does not contain a fines (passing 200 sieve) fraction. This ensures that mortar made from plasterers' sand sets more quickly and dries faster than mortar made from bricklayers' sand. Bricklayers' mortar must remain workable for a longer period of time and be more plastic while being worked. Plasterers' sand is said to be 'sharp'; by contrast, bricklayers' sand which is sharp is treated with a soap-based additive to improve workability.

Additive sand

Additive sand, the finest sand extracted, is of wind-blown origin and typically found at a considerable distance (5-10 km) from its source of origin. It is added to quarry-crushed rock base-course (pavement) gravel, to give it the desired plasticity. Additive sand is also used in the manufacture of bituminous concrete, where it acts as a filler.

TABLE 1. NATURE AND USES OF SAND AND GRAVEL IN THE CANBERRA REGION

<u>Sand type and dominant grainsize range</u>	<u>Colour</u>	<u>Origin</u>	<u>Occurrence</u>	<u>Constituents</u>	<u>Grade</u>	<u>Impurities</u>	<u>Uses</u>	<u>Notes</u>
Coarse-grained sand (0.6-2.0 mm size range)	Pale yellow to pale grey, depending on composition	An erosion product from weathering, disintegration and transport of granitic & volcanic rock	Chiefly as bed-load and bank deposits in the major rivers; also at shallow depths around southern margin of Lake George, associated with prior streams	Quartz 70-90%; feldspar (mostly plagioclase) 5-20%; rock fragments, including micaceous schist, 5-10%	10-30% fine gravel; 50-85% coarse sand; 5-40% medium sand	Silt and clay, charcoal, mica, soft rock fragments, sticks.	Mainly as concrete aggregate; also for pipe bedding, filter material for subsurface drains, e.g. beneath sports grounds	River bed-load material that is rock-free is used for bedding sand. Filter sand is all material <25 mm including medium and fine gravel sizes. Concrete aggregate sand usually washed and wet screened <5 or <6 mm. Coarse concrete aggregate sand is only dry-screened <8 or <10 mm. Washing removes charcoal and sticks
Medium-grained lake-beach sand (0.2-0.6 mm)	Pale yellow to pale grey; sometimes yellow to orange	Lake shoreline deposits (reworked alluvial sands)	Around the margin of Lake George from close to the surface to a depth of 3 m in places	Quartz 75-90%; feldspar (mostly plagioclase) 5-20%; rock fragments 0-10%	35-50% coarse sand; 48-58% medium sand; 2-22% fine sand	Minor amounts of muscovite and soft schistose rock fragments	Chiefly concrete aggregate, blended, with coarse river sand 1:1 or 2:1 depending on specification. Also brick, pipe, and tile manufacture	Generally free from impurities and is only dry-screened before loading. Sand is won from pits, and sometimes blended on site for use as concrete aggregate sand, or mixed with finer sand for use as plasterers' sand. Colour is an important consideration; the white sands are used selectively for white brick and white concrete manufacture
Fine to medium-grained windblown sand (0.15-0.3 mm)	White, pale grey, or pale yellow honey-coloured	Coarser wind-blown sand, winnowed out of river-flat or lake-beach sand deposits	Peripheral and upslope from lake-beach sand deposits 1-2 m depth in The Sandhills.	Mostly quartz 85-95%; plagioclase feldspar 5-15%	5-30% coarse sand; 45-80% medium sand; 10-35% fine sand	Organic materials: tree roots and sticks	Mainly plasterers' sand, sometimes washed but generally dry-screened only	Some of this sand is also used for concrete aggregate sand, and as an additive to road-base coarse gravel. It is sometimes blended with coarser sand for plasterers' sand, concrete aggregate, and manufacturing sand for concrete brick's, tiles, etc.
Fine-grained windblown sand (0.1-0.25 mm)	Commonly pale yellow to orange or pale red to deep red	Fine wind-blown sand, winnowed out of other sand deposits	Commonly farther upslope on windward slope of hills, generally located on the eastern margins of river valleys and lake basins	Mostly quartz coated with iron oxides	0-15% coarse sand; 40-45% medium sand; 36-60% fine sand	Mainly organic material: tree roots and sticks; also clay and silt	Mainly bricklayers' sand, less commonly in concrete aggregate	Sand is generally dry-screened to remove stones and sticks. Some clay and silt are desirable to provide workability
Very-fine-grained windblown sand (0.06-0.1 mm)	Commonly pale yellow, mauve, or pink	Very fine windblown sand winnowed out of river flats or lake-beach deposits	Commonly on the leeward side of hills on the eastern margins of river valleys and lake basins	Mostly quartz, commonly surface-coated with iron oxides	6-15% medium sand; 60-80% fine sand; 10-25% silt	Organic material: tree roots and sticks	Chiefly an additive sand for road-base coarse and bituminous concrete mixtures	Rarely used in concrete aggregate sand because it tends to make concrete too 'fat', causing high shrinkage on drying.

* See Fig. (1) Appendix 1 for particle size domains of each sand type

TABLE 1. DESCRIPTION OF OPERATING DEPOSITS

Operating deposit	1:100 000 map series no. and co-ordinates	Location (see Plate 1)	Operator	Material Extracted	Plant Employed	Size of workings	Indicated reserves	Distance to markets	Notes
1) Benview, Dog Trap Road	8627-753163	NSW; 14 km N of ACT border on Murrumbidgee R	Tharwa Sands P/L (J.H. Hyles, Prop.)	Coarse-grained concrete aggregate sand (washed river sand), sandy loam topsoil	20 cm suction dredge, 5 mm vibrating screen, cyclone, loader, tractor-scraper	Medium	Large; Replenishable	32 km Belconnen, 42 km Fyshwick, 52 km Tuggeranong	For each 200 m ³ of sand treated about 10 m ³ of river gravel is extracted. Has potential to greatly expand output
2) Kellys Flat, Holmwood	8627-780113	NSW; 10 km N of ACT border on Murrumbidgee R	ReadyMix Concrete P/L	Coarse-grained concrete aggregate sand (dry-screened river sand) bedding sand	Vibrating screen (8 mm approx.), 60 cm jaw crusher (crushing to -75 mm)	Large	Large; replenishable	29 km Belconnen, 39 km Fyshwick, 49 km Tuggeranong	Deposit leased from J.H. Hyles, Prop.
3) Woodgrove, Currajong Hole	8627-772038	NSW; 6 km N of ACT border on Murrumbidgee R	Canberra Sand & Gravel P/L (J. Trevillion, Prop.)	Coarse-grained concrete aggregate sand (washed river sand), bedding sand, crushed river gravel	60 cm jaw crusher, 38 cm gyratory crusher, screens, dragline, loader	Medium	Medium; Replenishable	30 km Belconnen, 38 km Fyshwick, 50 km Tuggeranong	Mostly scoops sand from river bank, but uses dragline in river when bank deposits are depleted
4) Parkwood, Cusacks Crossing	8627-770025	NSW; 2 km N of Murrumbidgee R	Southern Haulage (T. Jackson, Prop.)	Bedding sand, filter sand	Loader	Small	Small; replenishable	4 km Belconnen	Plans to dry screen when equipment arrives
5) Woodstock	8627-793985	ACT; 2 km S of NSW border on Murrumbidgee R	Capital Washed Sand and Metal P/L (T. Georgio, Prop.)	Coarse-grained concrete aggregate river sand, bedding sand, crushed river gravel	Loader, dragline 45x55 cm jaw crusher, 50 cm gyratory crusher, screens, cyclone	Medium	Large; replenishable	24 km Belconnen, 32 km Fyshwick	Uses - 5 mm screen for washed sand. Has potential to increase production
6) Angle Crossing	8726-911597	NSW; just S of ACT border on Murrumbidgee R	Snowy River Sand Supply P/L (R.F. Rowe, Prop.)	Coarse-grained concrete aggregate sand (dry-screened river sand)	Screen (-7 mm), loader	Small	Medium; replenishable	40 km Fyshwick, 48 km Queanbeyan, 50 km Tuggeranong	Extracts medium-coarse bank sand deposits and coarser river channel deposits. Has potential to increase production
7) Bumbalong, Collinton	8726-927290	NSW; 10 km N of Bredbo on Murrumbidgee R	J. Murray	Bedding sand, brick-layers' sand topsoil	Loader, tractor-dozor	Small	Medium; replenishable	77 km Fyshwick, 85 km Queanbeyan, 87 km Tuggeranong	Formerly worked by Universal Sands & Minerals P/L. Has potential to increase production
8) Cappawidgee, Bredbo	8726-991142	NSW; 8 km SE of Bredbo on Bredbo R	Loplatto Bros. P/L	Bedding sand	Loader	Small	Medium; replenishable	90 km Fyshwick, 92 km Queanbeyan	Sporedic operations; slackens off with fall in demand
9) Fyshwick	8727-985889	ACT; on Molonglo R upstream from Dairy Flat Bridge	Canberra Sand and Gravel P/L	Coarse-grained concrete aggregate sand (washed river sand) bedding sand, crushed river gravel, topsoil	Bucket dredge, suction dredge, crushers, screens (-6 mm for washed sand), cyclone, loaders, etc.	Large	Medium; replenishable	5 km Fyshwick	Obtains 200 m ³ washed sand and 100 m ³ crushed river gravel for every 1000 m ³ alluvium treated
10) Elizabeth Fields	8728-912340	NSW; 8.5 km NE of Murrumbateman	T. Elvin	Bricklayers' sand plasterers' sand, topsoil	Screen (-7 mm), loader	Small	Small; non-replenishable	43 km Belconnen	Formerly operated by Canberra Washed Sands P/L

TABLE 2 (Cont'd)

<u>Operating deposit</u>	<u>1:100 000 map series no. and co-ordinates</u>	<u>Location (see Plate 1)</u>	<u>Operator</u>	<u>Material Extracted</u>	<u>Plant Employed</u>	<u>Size of workings</u>	<u>Indicated reserves</u>	<u>Distance to markets</u>	<u>Notes</u>
11) Winnunga	8727-065235	NSW; 2.3 km N of Gundaroo Yass R	Lossano	Bedding sand	Small loader	Small	Small; replenishable	Only locally	Sporadic; not operating in May 1976
12) Winderadeen	8728-198283	NSW; 5 km S of Collector, at northern end of L George	Universal Sands and Minerals P/L (L. Doekin, Prop.)	Blended concrete aggregate sand (washed lake and fluvial sand), bricklayers' sand, additive sand, plasterers' sand, screened gravel	Trommel screen, dragline, cyclone, loaders, vibrating screen	Medium	Large; non-replenishable	35 km Belconnen, 58 km Fyshwick	Operator previously worked sand at Tharwa on Cuppacumbalong. Has potential to increase production. Blends sand on site to keep grading consistent
13) Osbornes	8727-238054	NSW; 10 km N of Bungendore near edge of L George, N of Butmaroo Ck	Monier Sands P/L	Medium-grained concrete aggregate sand	Loader	Small	Large; non-replenishable	44 km Queanbeyan, 52 km Fyshwick	Not operating in October 1977, but may resume in the near future
14) Lakelands	8727-232044	NSW; 9 km N of Bungendore near Butmaroo Ck	Woodbridge's Transport	Medium-grained concrete aggregate sand	Loader, dry screen	Small	Large; non-replenishable	43 km Queanbeyan, 51 km Fyshwick	Possibility of coarser sand at depth. Typical profile: 0.5 m topsoil underlain by 1.5 km sand
15) Ellenden	8727-263038	NSW; 10 km NE of Bungendore	Willow Sands P/L (I.R. McPherson, Prop.)	Fine-grained concrete aggregate sand	Tractor-dozers, loader, dry screen	Small	Small; non-replenishable	41 km Queanbeyan	Topsoil stockpiled for later restoration. Tidy operation. Sand deposit 1-1.5 m thick
16) Currandooley	8727-226029	NSW; 7 km N of Bungendore, adjacent to SE edge of L George	P. Osborne	Medium-grained concrete aggregate sand	Dry screen, loader	Small	Large; non-replenishable	36 km Queanbeyan, 44 km Fyshwick	Sand at surface to a depth of 1.5 m. Has potential to greatly increase output
17) Smiths	8727-213015	NSW; 6 km N of Bungendore at S edge of L George	Corkhill Bros. P/L for Readymix Concrete P/L	Medium-grained concrete aggregate sand, plasterers' sand, bricklayers' sand	Dry screens, loaders, scraper-tractor	Large	Large; non-replenishable	33 km Queanbeyan, 41 km Fyshwick	Recently tried suction dredging of lower layers; profile contains about 15 m of fine-coarse sand interbedded with clay
18) Mane Lodge	8727-212997	NSW; 4 km N of Bungendore at S end of L George	Monier Sands P/L	Medium-grained concrete aggregate sand; coarse concrete aggregate sand; brick, tile, and pipe manufacturing sand (washed lake and fluvial sands); bricklayers' sand; topsoil	Suction dredge, cyclone, wet screens, dry screens, loaders, tractor-scraper	Large	Large; non-replenishable	33 km Queanbeyan, 41 km Fyshwick	Gravel-size pebbles mixed with coarse sand at depth; up to 16 m of mixed sands with some clay layers
19) Emersley	8727-226969	NSW; 1 km N of Bungendore	Canberra Washed Sands P/L	Medium to fine-grained concrete aggregate sand	Dry screen, loader	Medium	Small; non-replenishable	31 km Queanbeyan, 39 km Fyshwick	Colour of sand is red-brown to honey yellow
20) Werrilee	8827-317984	NSW; 9 km E of Bungendore in The Sandhills	Blue Metal and Gravel P/L	Fine-grained concrete aggregate sand, additive sand	Dry screen, loader	Small	Small; non-replenishable	40 km Queanbeyan, 48 km Fyshwick	Sand is similar to that from Birkenburn; well graded, honey-yellow, dune sand

TABLE 2 (Cont'd)

<u>Operating deposit</u>	<u>1:100 000 map series no. and co-ordinates</u>	<u>Location (see Plate 1)</u>	<u>Operator</u>	<u>Material Extracted</u>	<u>Plant Employed</u>	<u>Size of workings</u>	<u>Indicated reserves</u>	<u>Distance to markets</u>	<u>Notes</u>
21) Birkenburn	8827-325977	NSW; 10 km E of Bungendore in The Sandhills	Corkhill Bros. P/L	Fine-grained additive sand	Loader	Small	Small; non-replenishable	40 km Queenbeyan, 48 km Fyshwick	Sand used as a plasticiser for road base and as a filler for bituminous concrete
22) Birkenburn	8827-335997	NSW; 11 km E of Bungendore in The Sandhills	Ro-mix Concrete P/L	Medium to fine-grained concrete aggregate sand	Dry screen, loader	Small	Small; non-replenishable	42 km Queenbeyan, 50 km Fyshwick	Sand is pale brown and coarser-grained than most sand in this area
23) Long Swamp-Menar	8827-383975	NSW; 16 km E of Bungendore on Mulloon Ck	X-Air P/L	Coarse-grained concrete aggregate sand, crushed river gravel, bedding sand	Suction dredge, cyclone, screens, crushers, loader	Small	Medium; replenishable	45 km Queenbeyan, 53 km Fyshwick	Plant formerly operated on Queenbeyan River. Operator has potential to increase production
24) Balmain	8827-512896	NSW; 15 km N of Braidwood on Shoalhaven R	L.C. Price P/L	Coarse-grained concrete aggregate sand (washed river sand), crushed river gravel	50 cm crusher, screens, loader	Small	Medium; replenishable	60 km Queenbeyan, 68 km Fyshwick	Not operating at present owing to fall in demand for sand and increased competition
25) Balmain	8827-520906	NSW; 16 km N of Braidwood on Shoalhaven R	Canberra Washed Sands P/L	Coarse-grained concrete aggregate sand, screened river gravel (pebbles)	20 cm suction dredge, cyclone, 3-deck screen (20, 10, 5 mm)	Medium	Large; replenishable	61 km Queenbeyan, 69 km Fyshwick	Stockpiles river cobbles and boulders for possible future use
26) Deep Willows	8827-522895	NSW; 14 km N of Braidwood on Shoalhaven R	Willow Sands P/L	Coarse-grained concrete aggregate sand (dry-screened river sand)	Vibrating screen, loader	Small	Large; replenishable	74 km Queenbeyan, 82 km Fyshwick	Previously extracted topsoil from river flats
27) Deep Willows	8827-540891	NSW; 15 km N of Braidwood at NE end of Durran Durra Ra	Willow Sands P/L	Plasterers' sand, white brick manufacturing sand	Trommel screen, cyclone	Small	Large; non-replenishable	75 km Queenbeyan, 83 km Fyshwick	White sand (scarce) suitable for manufacture of white bricks, concrete facing, etc. Alternative supply of white sand would come from Cowra
28) Hobbs Creek	8827-618838	NSW; 2 km E of Nerriga Road at SE edge of Durran Durra Ra	Loplatto Bros. P/L	Bricklayers' sand, plasterers' sand	Dry screen, loader	Small	Small; non-replenishable	89 km Queenbeyan, 87 km Fyshwick	Dune sand deposit; sand is 4 m thick in places
29) Spring Grove	8827-635818	NSW; 5 km E of Nerriga Rd at SE foot of Durran Durra Ra	E.J. Clarke	Plasterers' sand	Dry screen, loader	Small	Medium; non-replenishable	97 km Queenbeyan, 90 km Fyshwick	Operations sporadic (November 1977) owing to a fall in demand
30) Cronins Crossing	8827-432830	NSW; 3 km SW of Murrumbidgee Bridge on Shoalhaven R	G.W. Hockey	Bedding sand	Loader	Small	Large; replenishable	71 km Queenbeyan, 79 km Fyshwick	Sporadic operations governed by demand

OPERATING DEPOSITS

Thirty sand and gravel deposits (Table 2, Plate 1) were being operated throughout the region in 1976. Those within the ACT are coarse-grained concrete aggregate and bedding sands from the river beds of the Molonglo and Murrumbidgee Rivers. Grainsize determinations of samples collected from various deposits are shown on the particle-size analysis charts in Appendix 1.

PRODUCTION

The scale of workings at a deposit has been indicated broadly as small, medium, or large in Table 2. This scale, in terms of annual production in cubic metres, is set out in Table 3.

TABLE 3. SIZE OF WORKINGS

OUTPUT	Annual Production (m ³)	
	Lower Limit	Upper Limit
SMALL	5 000	20 000
MEDIUM	20 000	60 000
LARGE	60 000	250 000

RESERVES

River sand deposits are typically replenishable - that is, sand extracted is likely to be replaced either by bed-load transport or by suspended-load transport during periods of flooding, provided that river flow patterns are not changed significantly by engineering works such as dams, etc. Lake sand, and sand deposits on hills, are non-replenishable.

In Table 2, the indicated reserves are based partly on specific measurement of deposits, partly on production data and partly on reasonable extensions of the deposits in accord with geologic evidence. They are classified as small, medium, or large according to the volumes set out in Table 4. For replenishable deposits, the indicated reserves are expressed as the estimated volume of replenishment per year. The volumes of non-replenishable deposits indicate the total amount of material available.

TABLE 4. CLASSIFICATION OF INDICATED RESERVES AT OPERATING DEPOSITS

<u>Size</u> <u>of</u> <u>reserves</u>	<u>Replenishable reserves (m³/year)</u>	<u>Non-</u> <u>replenishable</u> <u>reserves (m³)</u>
SMALL	5 000 - 20 000	10 000 - 200 000
MEDIUM	20 000 - 60 000	200 000 - 700 000
LARGE	60 000 - 250 000	700 000

Reserves in Table 5 list both indicated and inferred reserves at the operating deposits in the region in May 1976. Inferred reserves are based largely on a broad knowledge of the geologic character of deposits and on assumptions of their continuity or repetition for which there is reasonable

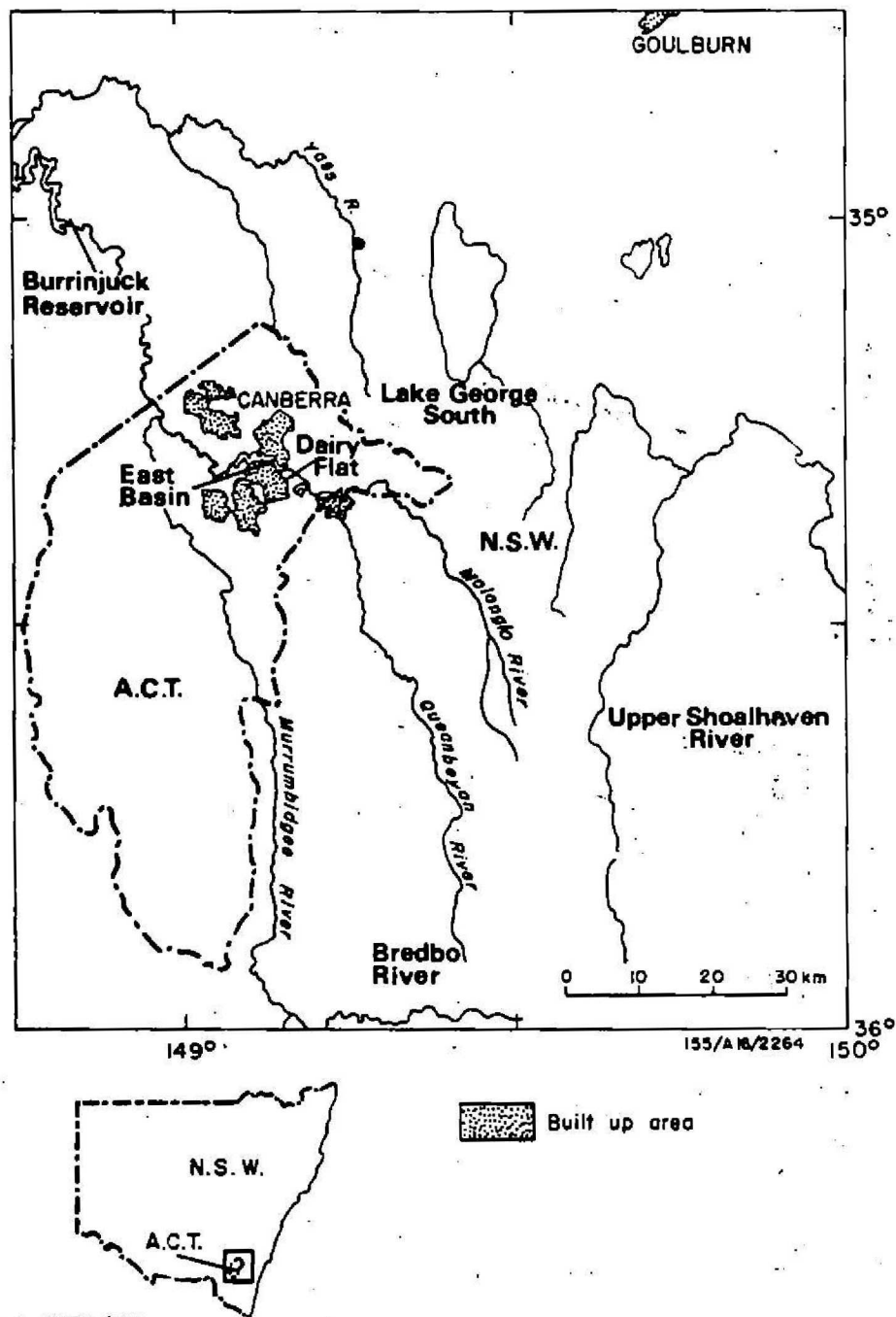
geological evidence. To protect the interests of individual operators, the reserves at worked deposits with a common genetic association have been aggregated for the particular areas, namely the Murrumbidgee River, Shoalhaven River, Lake George, Durran Durra Range, and The Sandhills (Fig. 1). Reserve figures for each extraction area in Table 5 are the totals for operating deposits only; they show that indicated reserves of $19 \times 10^6 \text{ m}^3$ of sand exist, and that inferred reserves have been estimated at another $59 \times 10^6 \text{ m}^3$ of sand. Total reserves for gravel are shown as $1.2 \times 10^6 \text{ m}^3$.

UNWORKED DEPOSITS - RESERVES

Considerable reserves exist in a number of unworked deposits of sand and gravel in the region (Table 6, Fig. 6). Most of these reserves were estimated during brief field inspections, and by volume calculations from topographic maps; they are rough approximations only.

TABLE 5. RESERVES OF SAND AND GRAVEL AVAILABLE FROM OPERATING DEPOSITS WITHIN THE REGION (MAY 1976)

Extraction	Sand or gravel type	Indicated Reserves		Inferred Reserves		Total reserves for each extraction area	
		Non-replenishable (m ³)	Replenishable (m ³ /year)	Non-replenishable (m ³)	Replenishable (m ³ /year)	Non-replenishable (m ³)	Replenishable (m ³)
Murrumbidgee River	Coarse-grained concrete aggregate sand, River gravel	2.5×10^6	600 000 20 000	5×10^6	500 000 >50 000	7.5×10^6	1.1×10^6 70 000
Shoalhaven River	Coarse-grained concrete aggregate sand, River gravel	3.2×10^6	300 000 10 000	2×10^6	200 000	5.2×10^6	500 000 10 000
Lake George	Coarse-grained concrete aggregate sand, Medium grained concrete aggregate sand, Bricklayers' and plasterers' sand, River gravel	3×10^6 6×10^6 2×10^6 200 000		15×10^6 28×10^6 2×10^6 1×10^6		18×10^6 34×10^6 4×10^6 1.2×10^6	
Durrant Durrant Range	Bricklayers' and plasterers' sands	2×10^6		7×10^6		9×10^6	
The Sandhills	Bricklayers' and plasterers' sands	200 000				200 000	
Total reserves for each sand or gravel type	Coarse-grained concrete aggregate sand, Medium grained concrete aggregate sand, Bricklayers' and plasterers' sands, River gravel	8.7×10^6 6×10^6 4.2×10^6 200 000	900 000 50 000	22×10^6 28×10^6 2×10^6 1×10^6	700 000 >50 000	50.7×10^6 34×10^6 15.2×10^6 1.2×10^6	1.6×10^6 >80 000



Record 1979/64

Fig. 6. Locations of unworked reserves of sand and gravel

TABLE 6. . INFERRED RESERVES FOR AREAS WITH UNWORKED SAND AND GRAVEL DEPOSITS

<u>LOCATION</u>	<u>TYPE OF DEPOSIT</u>	<u>INFERRED RESERVES</u>	<u>NOTES</u>
Burrinjuck Reservoir	Coarse to medium-grained concrete aggregate sand	$10 \times 10^6 \text{ m}^3$	Near Taemas Bridge. Could be made more accessible
Dairy Flat and East Basin, Lake Burley Griffin	Coarse to fine-grained concrete aggregate sand	$5 \times 10^6 \text{ m}^3$ (700 000 m^3 topsoil)	Indicated reserves based on geological and geophysical investigations (Goldsmith & Pettifer, 1977)
Bredbo River	Coarse-grained concrete aggregate sand	$1 \times 10^6 \text{ m}^3$	Mostly river bank and channel deposits
Lake George South	Coarse and medium-grained concrete aggregate sand	$10 \times 10^6 \text{ m}^3$	Located in an area not yet worked
Upper Shoalhaven River	Coarse-grained concrete aggregate sand	$5 \times 10^6 \text{ m}^3$	Not readily accessible at present

The Burrinjuck Reservoir deposits are located at the upstream end of the storage, where bed-load and suspended sediments have been deposited by the Murrumbidgee River.

Unworked reserves in the ACT are confined to Dairy Flat and the East Basin of Lake Burley Griffin. East Basin was partly worked before it was inundated to become part of Lake Burley Griffin on the closure of Scrivener Dam. There is competition for land use at Dairy Flat, and environmental considerations at both locations warrant careful examination in land-use planning; however, the reserves should not be alienated by land-use that denies access to the deposits. A comprehensive study of the sand and gravel resources in the Dairy Flat area was carried out by Goldsmith & Pettifer (1977).

Some sand and gravel deposits in the Shoalhaven River catchment will not be available for extraction when the Welcome Reef Dam is constructed, probably in the late 1980s. The reservoir level is expected to be about 600 m above sea level. Sand and gravel deposits upstream of the reservoir will be subject to control by the relevant State Authority, and extraction may not be permitted. Estimates of reserves given in Table 6 for the upper Shoalhaven catchment do not include sand and gravel deposits likely to become inundated.

TOTAL RESERVES - OPERATING AND UNWORKED DEPOSITS

Total reserves at both operating and unworked deposits in the region are given in Table 7.

TABLE 7. TOTAL RESERVES FOR THE REGION

<u>Sand type</u>	<u>Total reserves</u>	
	<u>Non-replenishable (m³)</u>	<u>Replenishable (m³/year)</u>
Coarse-grained concrete aggregate sand	51 x 10 ⁶	1.6 x 10 ⁶
Medium-grained concrete aggregate sand	44 x 10 ⁶	
Bricklayers' and plasterers' sands	13.2 x 10 ⁶	
River gravel	3.7 x 10 ⁶	80 000

SAND AND GRAVEL PRODUCTION AND SUPPLY TO THE YEAR 2000

Regional production of sand and gravel for 1975-76 (Table 8) was derived by adding the production figures of the operating deposits.

TABLE 8. REGIONAL PRODUCTION OF SAND AND GRAVEL
FOR THE YEAR JULY 1975-JUNE 1976

<u>Sand type</u>	<u>Regional production (m³)</u>
Coarse-grained concrete aggregate sand	425 000
Medium-grained concrete aggregate sand	225 000
Pipe bedding and filter sand	190 000
Bricklayers' and plasterers' sands	100 000
Crushed river gravel and pebbles	70 000

Total sand and gravel production for the region during the 12-month period 1975-76 was estimated to have been 1 010 000 m³ metres.

Production from within the ACT is mainly coarse-grained concrete aggregate sand and crushed river gravel from the Molonglo and Murrumbidgee Rivers; it constitutes about 25 percent of coarse-grained sand and 50 percent crushed river gravel used in the ACT. Other materials such as medium-grained sand, and brick-layers' and plasterers' sands, have been won within the ACT in the past, but most deposits have been worked out or are too small to be profitably exploited.

The demand for sand and gravel slackened in 1976/77 owing to a decline in the building and construction industry, but the demand is expected to recover to the level of 1975/76 during 1978/79. Table 9 shows the expected demand for sand and gravel at 5 yearly intervals, from 1980 to the year 2000, assuming a 10 percent annual increase in demand as a realistic upper limit to growth.

TABLE 9. EXPECTED DEMAND FOR SAND, 1980-2000
(assuming a 10 percent annual growth rate)

<u>Year</u>	<u>Coarse-grained concrete aggregate sand (m³)</u>	<u>Medium- grained concrete aggregate sand (m³)</u>	<u>Pipe bedding and filter sands (m³)</u>	<u>Bricklayers' and plasterers' sands (m³)</u>	<u>Crushed river gravel and pebbles (m³)</u>
1980	500 000	260 000	210 000	110 000	80 000
1985	798 000	416 000	336 000	176 000	126 000
1890	1 283 000	667 000	537 000	281 000	200 000
1895	2 064 000	1 071 000	862 000	449 000	321 000
2000	3 322 000	1 722 000	1 386 000	720 000	514 000
TOTAL	31 660 000	16 440 000	13 041 000	7 052 000	4 937 000

The total estimated demand in the ACT for all types of sand and gravel to the year 2000 is expected to be about $73 \times 10^6 \text{ m}^3$. The indicated and inferred reserves in the region are $112 \times 10^6 \text{ m}^3$ (Table 7) and should be more than adequate to meet the anticipated demand.

COSTS ASSOCIATED WITH THE OPERATION OF A SAND AND GRAVEL DEPOSIT

Costs vary considerably; they depend on: the amount of treatment the extracted material receives on site before it is dispatched; the distance from the deposit to market (transport costs); and the royalties charged by the landowner on whose property the deposit occurs. Treatment on site may be simple loading of material into trucks, or, more commonly, dry screening and loading (Fig. 7); it may include washing and wet screening (Fig. 8), or fairly elaborate and expensive treatment, which may include dredging, crushing, screening, flotation, and drying (Fig. 9). The estimated cost of each on-site treatment operation including transport and royalty charges - at the time of the study (1975-76) are set out in Table 10.



Figure 7. Dry screening of sand at the Canberra Washed Sands Pty Ltd Emersley, deposit, just north of Bungendore. (Neg. no. M/2371/28)



Figure 8. Washing of sand to remove fines at Deep Willows, near Braidwood (neg. no. M/2371/29)



Figure 9. Crushing, screening, and washing plant at Long Swamp-Manar (neg. no. CB/2197)

TABLE 10. COSTS ASSOCIATED WITH THE OPERATION OF A
SAND AND GRAVEL DEPOSIT (July, 1975)

<u>Operation</u>	<u>Approximate cost per m³</u>
Loading	0.50c
Dredging	0.50-0.80c
Dry screening	0.50c
Washing and screening	0.80c
Crushing, screening, and washing	\$1.60
Royalties	0.20-0.80c
Transport	(4.5-6.0c/tonne km)

SAND COSTS IN CONCRETE MANUFACTURE

Many factors affect the cost of concrete manufacture, particularly the strength of the concrete required and the application to which it will be put. High-strength concrete is costly: it requires a high proportion cement; the sand and aggregate must be clean and well graded; and the specifications must be adhered to. The cost of low-strength concrete can be reduced in many ways: for non-structural applications where moderate shrinkage can be tolerated (paving mixes, etc.), fly ash can be substituted for some of the cement at half the price; crushed river gravel can be substituted for quarry aggregate; and the materials do not have to be as free of fines, sticks, etc., or as well graded.

The approximate quantities and costs of materials needed to make a cubic metre of moderate-strength, high-quality concrete are set out below in Table 11.

TABLE 11. SAND COSTS IN CONCRETE MANUFACTURE (June, 1975)

<u>Material</u>	<u>Cost/tonne</u>	<u>Amount in 1 m³ concrete (kg)</u>	<u>Cost of mat- erial in 1 m³</u>	<u>Percentage of total</u>
Sand	\$4.50	800	\$3.60	17.9
Coarse aggregate	\$4.50	1000	\$4.50	22.3
Cement	\$40.00	300	\$12.00	59.7

FUTURE DEVELOPMENTS

The sand and gravel market in the ACT is now of considerable size, and the supply comes from many deposits, scattered mainly outside the ACT. The deposits are controlled by a large number of operators, and the material extracted is transported by a large number of independent hauliers. In this situation, it is difficult to see any major factors likely to inhibit the sand and gravel supply to the ACT in the foreseeable future, particularly when the reserves available in the region are more than adequate until the year 2000. Nevertheless, there are lesser factors operating that will affect future supply and costs in the industry; the more apparent ones are set out below:

SUPPLY

Factors likely to reduce supply

- i Flooding of the Shoalhaven River catchment by the impounded water behind Welcome Reef Dam in the late 1980s will inundate a number of coarse-grained sand deposits and extraction by dredging may not be economic or permitted. Constraints may also be imposed on deposits upstream of the reservoir by NSW Authorities once the dam is built.

- ii The replenishment rate of $1.6 \times 10^6 \text{ m}^3$ (Table 5) for coarse-grained concrete aggregate and bedding sand is not expected to be maintained indefinitely by the rivers of the region; this is because not all the sand that replenishes a deposit comes from outside the region - some of it merely moves from one deposit to another further downstream. This is particularly true along the Murrumbidgee River, where the operation of a sand trap upstream could jeopardise the future of existing working deposits further downstream.
- iii Opposition to the extraction of sand and gravel from some areas has come from local government, because of damage to country roads by heavy vehicles; from country residents, because of the noise and traffic hazards associated with sand haulage; and from conservationists, because of the lack of rehabilitation of sites after operations have ceased.
- iv One sand lease presently in force is unlikely to be renewed by the NSW Mines Department because some disagreement has arisen between the landowner and the operator regarding the working of the deposit.

Factors likely to increase supply

- i The reserves at a number of deposits are large enough for the operators to increase their output if market conditions are favourable.
- ii Expansion of dredging operations in the previously unworked area immediately to the south of Lake George is likely to increase the amount of coarse sand available to the market.

- iii Distances to a number of unworked sand deposits are only marginally further than the deposits currently being exploited, and their extraction in the future is to be expected.
- iv Existing roads are slowly being upgraded, thereby making access to some deposits easier and reducing haulage travel time.

COSTS

Factors likely to increase costs

- i Small operators welcome any price increase because most of their operations are only marginally profitable.
- ii Royalties, which remained stable at 20-40c/m³ for a long time, before the 1970s have risen to 40-60c/m³, and some landowners are asking \$0.80-1.20/m³; increased royalties could render some deposits uneconomic.

Factors likely to reduce costs

- i Some large users of sand and gravel achieve some economy of scale by obtaining supplies at well below the market price.
- ii The general decline in the building and construction industry has led to an oversupply of materials and there is increasing competition for available markets.
- iii Some medium-size operators could increase their share of the market readily by undercutting the current price.

CONCLUSIONS

1. The supply of all categories of sand and gravel to the ACT from the surrounding region is assured, and there should be no shortages of these materials before the year 2000.
2. Deposits within the ACT supply only 25 percent of coarse-grained concrete aggregate and bedding sand at present, but there are no significant resources of medium-grained concrete aggregate sand, bricklayers' sand, and plasterers' sand in the ACT.
3. Most future supplies of sand and gravel are likely to come from Bungendore-Lake George, Braidwood, and the Murrumbidgee and Shoalhaven River areas. Some reduction in resources in the Shoalhaven River catchment will result from the construction of the Welcome Reef Dam, possibly in the late 1980s. It may be advisable to make representations to the appropriate NSW authorities to ensure that deposits upstream of the proposed reservoir remain available for exploitation in the future.
4. The present ACT market for sand gravel is large, about 750 000 ³ m per annum and sources of supply are worked by 22 operators. This suggests that it would be difficult for an individual or group to control supply or market price.
5. Large deposits of sand still exist in the region that have not been worked to date.

6. There seems to be no immediate need to exploit deposits at Dairy Flat and East Basin, but these deposits should not be lost to future exploitation through the alienation of these areas for other planning purposes.
7. The sand and gravel reserves in the Canberra Region should be reviewed in the late 1980s.

REFERENCES

- COFFEY & HOLLINGSWORTH, 1973 - Report on the survey of sand resources in the Gudgenby and Murrumbidgee Rivers, Angle Crossing area, A.C.T. Report No. 4750/1.
- COMMONWEALTH DEPARTMENT OF WORKS, 1972 - Report on sand quantities in the Murrumbidgee and Gudgenby rivers in Tuggeranong. Report for the Department of Interior (Unpubl.).
- GARDNER, D., 1958 - Sources of sand in and near Canberra City district, A.C.T. Investigations completed before July, 1958. Bur. Miner. Resour. Aust. Rec. 1958/72 (unpubl.).
- GARDNER, D.E., 1965 - Alluvial deposits of East Basin, Canberra A.C.T. (unpubl. ms.).
- GARDNER, D.E., 1966 - Dune sand in the Molonglo River valley, A.C.T. Bur. Miner. Resour. Aust. Rec. 1966/156 (unpubl.).
- GARDNER, D.E., 1967 - River flat alluvium, blocks 3 and 24, Pialligo, and blocks 36 and 51, Fyshwick, A.C.T. Bur. Miner. Resour. Aust. Rec. 1967/85 (unpubl.).
- GOLDSMITH, R.C.M., & PETTIFER, G.R., 1977 - Dairy Flat, A.C.T., report on sand and gravel investigations 1973-76. Bur. Miner. Resour. Aust. Rec. 1977/54 (unpubl.).
- STANDARDS ASSOCIATION OF AUSTRALIA, 1974 - Dense natural aggregates for concrete. Aust. Stand. 1465-1974.

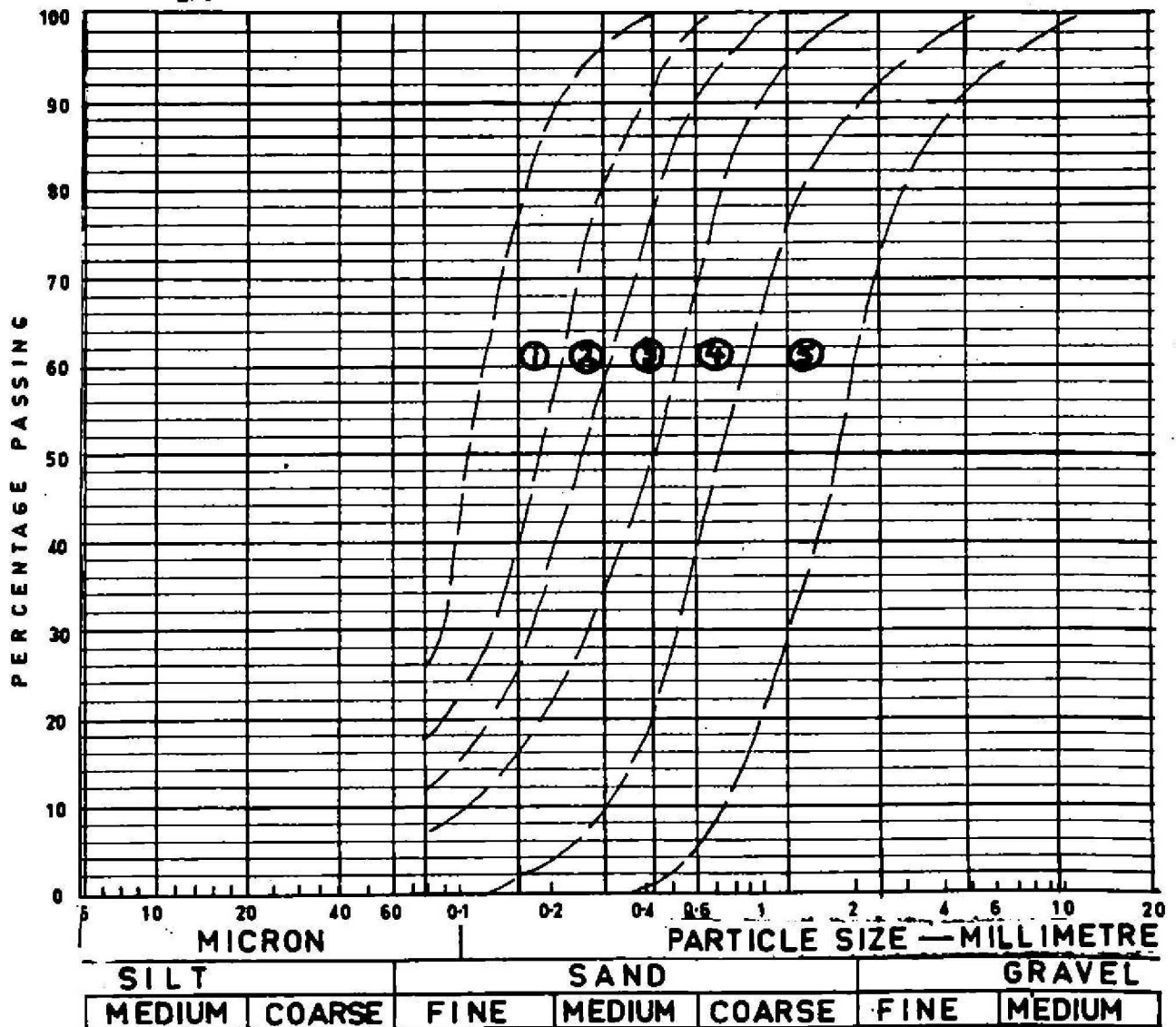
APPENDIX 1. PARTICLE-SIZE ANALYSES

Domains for the various types of sand

Domain

1. Very fine-grained windblown sand (additive sand)
2. Fine-grained windblown sand (bricklayers' sand)
3. Fine to medium-grained windblown sand (plasterers' sand)
4. Medium-grained lake sand (medium concrete aggregate sand)
5. Coarse-grained river sand (coarse concrete aggregate sand)

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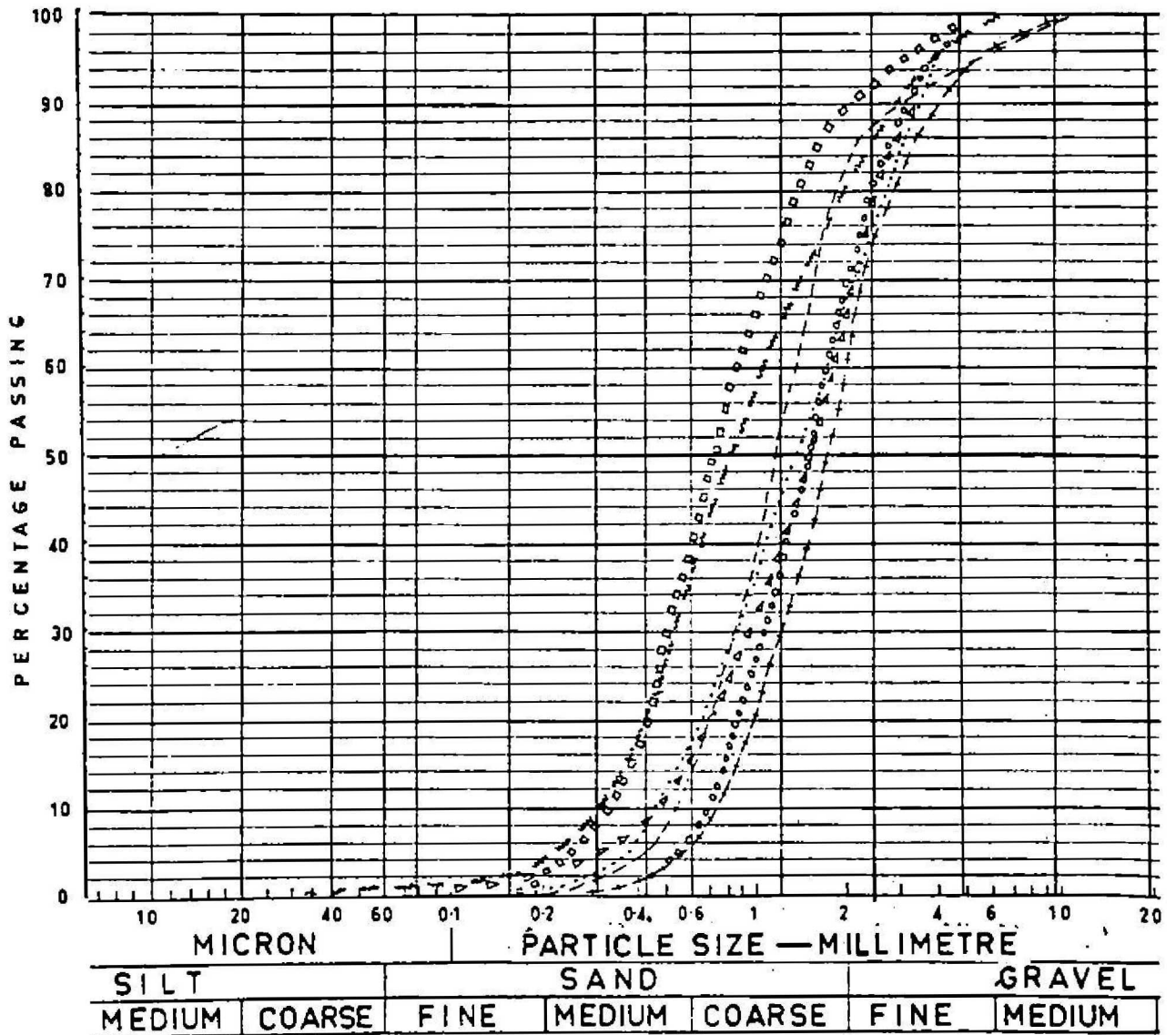


Coarse-grained sand

Key

- Readymix Concrete P/L: Kellys Flat, Holmwood
- ~ ~ ~ Universal Sands P/L: Winderadeen
- + + + Capital Sands P/L: Woodstock
- Δ Δ Δ Monier Sands P/L: Mane Lodge
- • • Snowy River Sand Supply P/L: Angle Crossing
- L.C.Price P/L: Balmain
- □ □ X-air P/L: Long Swamp-Manar

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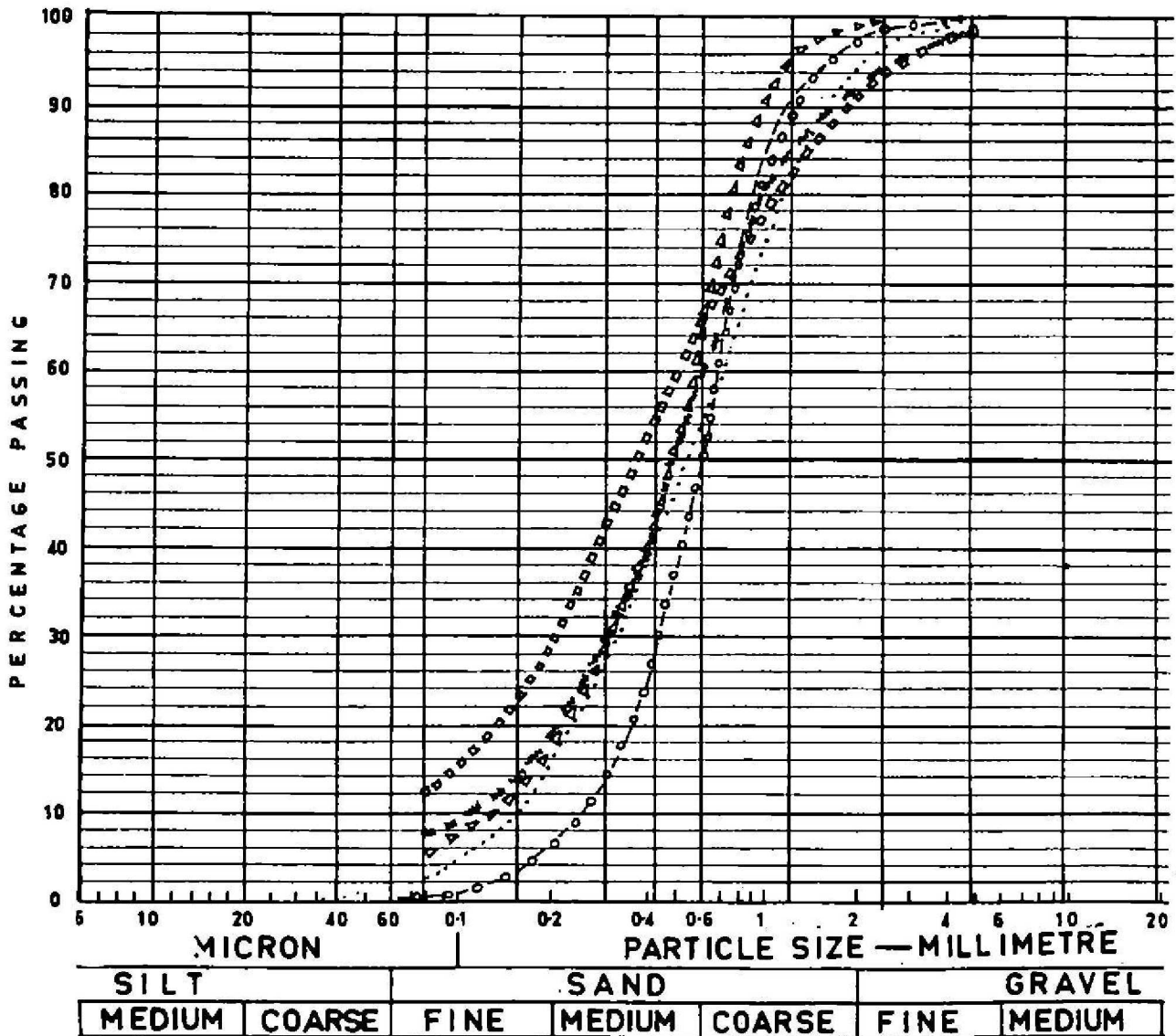


Medium-grained sand

Key

- - - P.Osborne P/L: Currandooley
- Woodbridges Transport P/L: Lakelands
- o o o Canberra Washed Sands P/L: Emersley (coarse layer)
- ~ ~ ~ Universal Sands P/L: Winderadeen
- □ □ Monier Sands P/L: Mane Lodge
- △ △ △ Monier Sands P/L: Osbornes

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Fine to medium-grained windblown sand

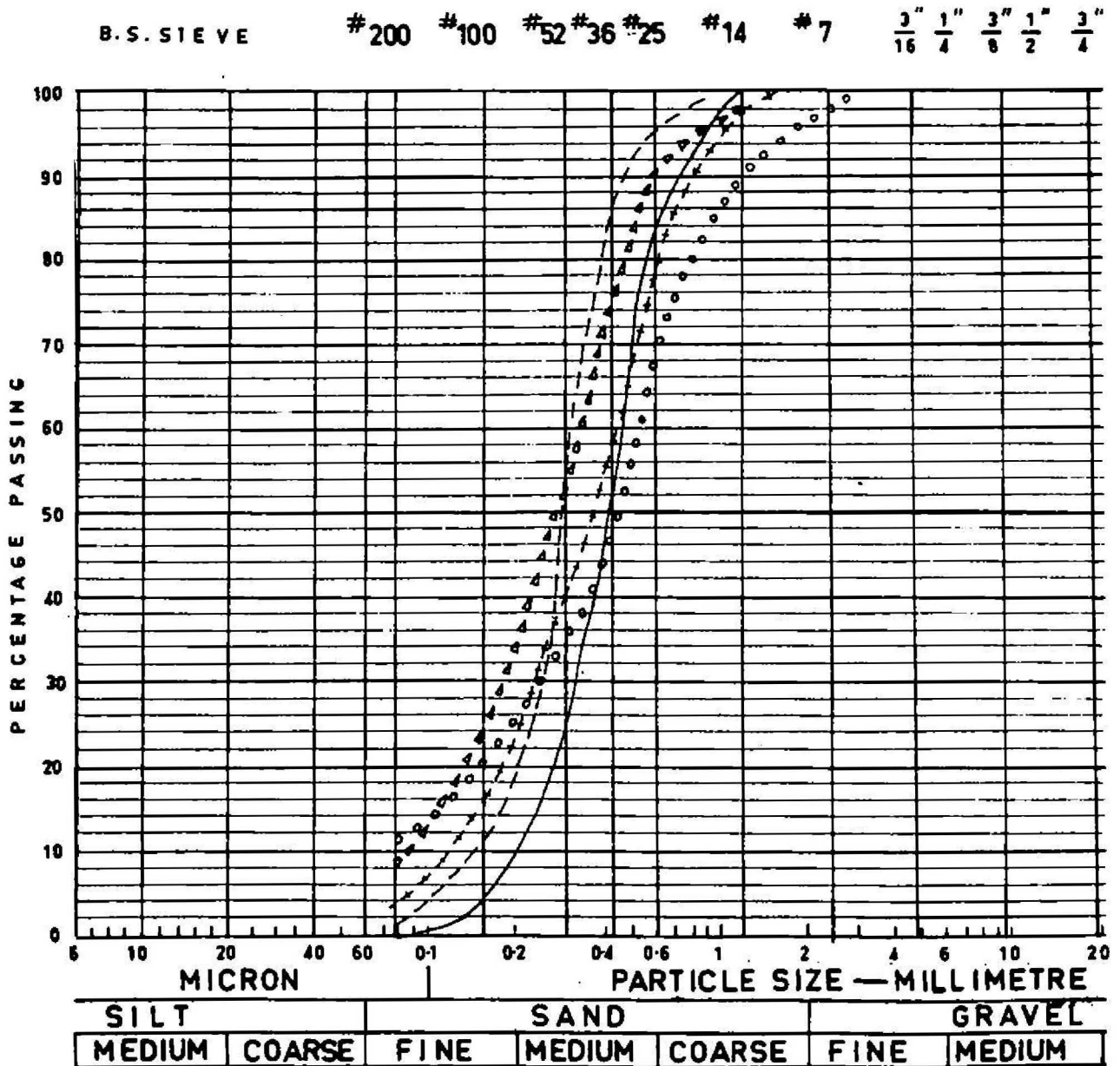
Key

Plasterers' sand

- E.J. Clarke: Spring Grove
- + + + Willow Sands P/L: Deep Willows
- o o o Readymix Concrete P/L: Smiths, Grantham Park (blended)

Sand for other uses

- - - Blue Metal and Gravel P/L: Werriwa (concrete-plasterers'-additive)
- A A A Canberra Washed Sands P/L: Emersley (concrete sand, blended)



Fine and very fine-grained windblown sand

Key

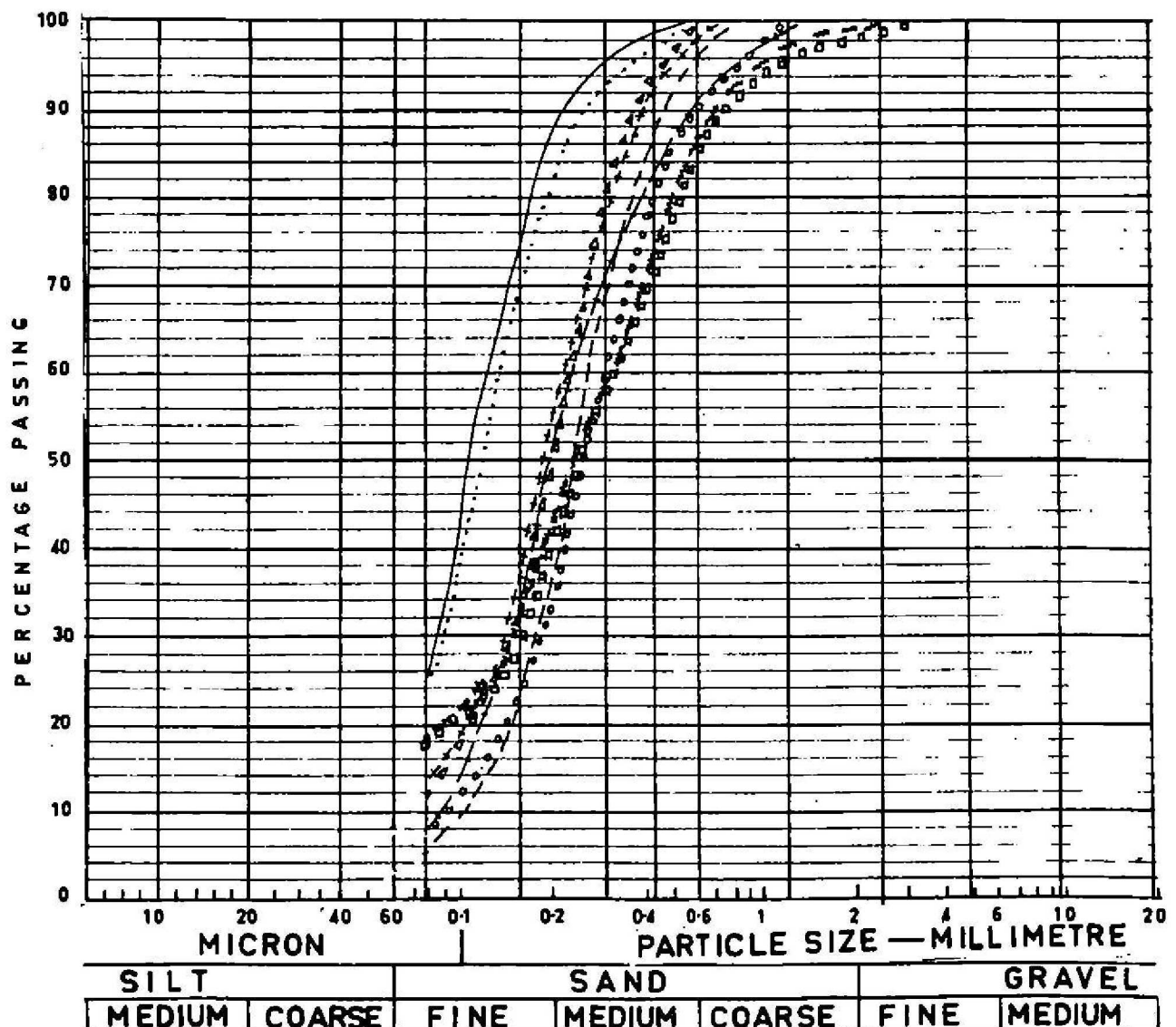
Bricklayers' sand

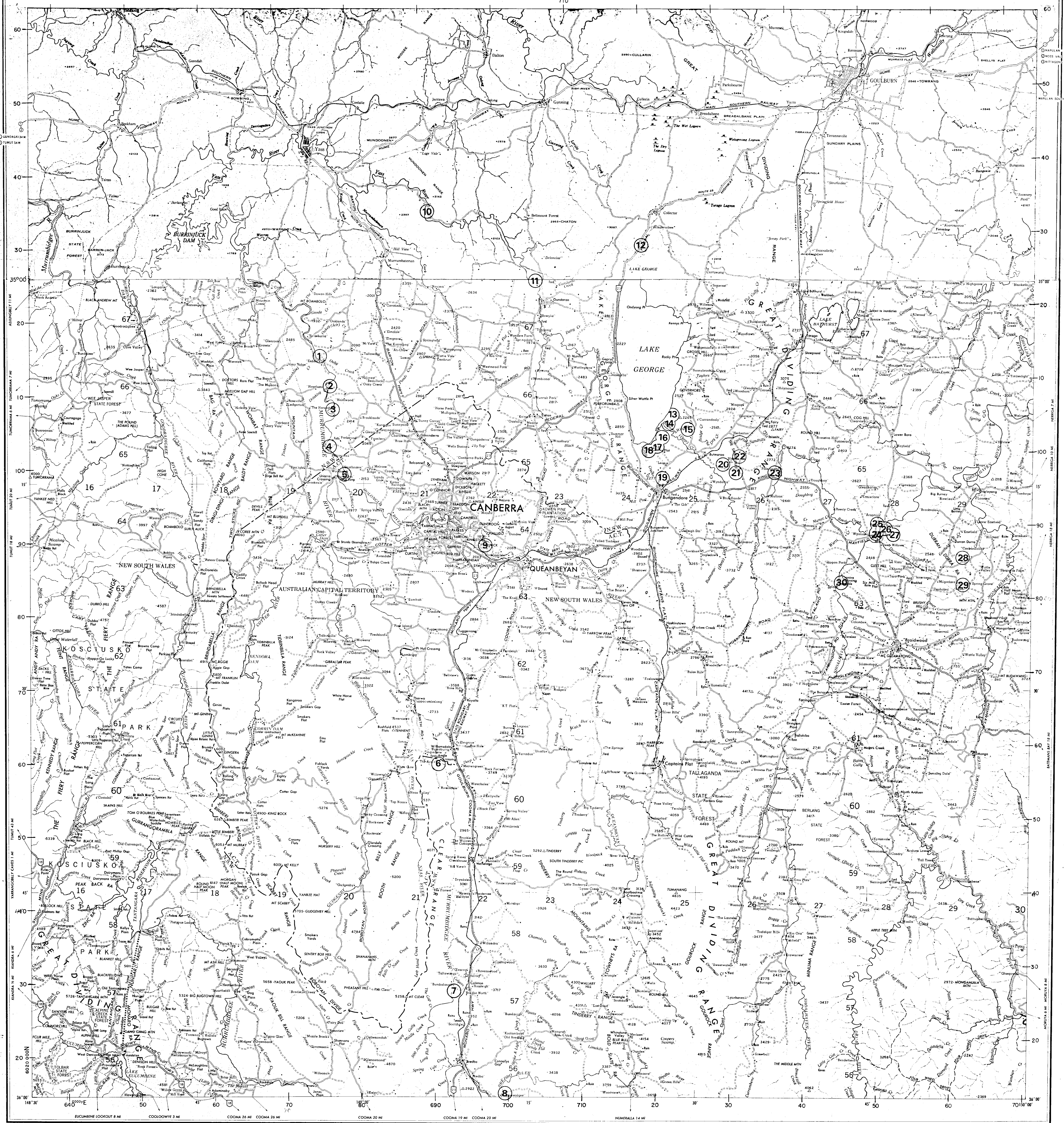
- ooo T.Elvin P/L: Elizabeth Fields
- +++ T.Elvin P/L: Sandy Vale
- △△△ J.Murray P/L: Bumbalong
- Readymix Concrete P/L: Smiths-Leonie (blended)
- Monier Sands P/L: Mane Lodge
- Lopilato Bros. P/L: Hobbs Creek
- + + Willow Sands P/L: Ellenden (used for concrete)

Additive sand

- Corkhill Bros. P/L: Birkenburn
- Snowy River Sand Supply P/L: Birkenburn (used for concrete)

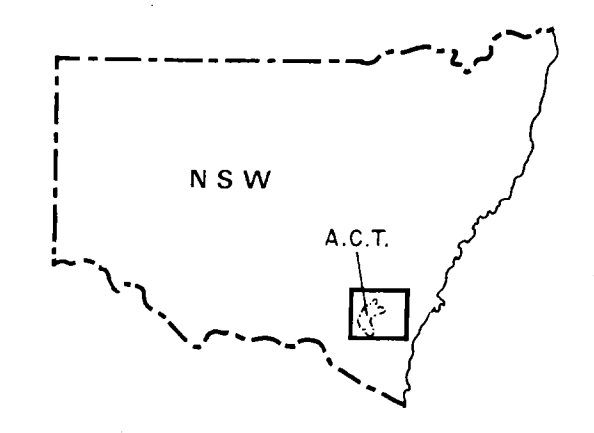
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OPERATING SAND & GRAVEL DEPOSITS
CANBERRA REGION-MAY 1976

- 1 "Benview" Dog Trap Road
- 2 Kellys Flat "HOLMWOOD"
- 3 "WOODGROVE" Curragong Hole
- 4 "PARKWOOD" Cusacks Crossing
- 5 "WOODSTOCK" Uriarra Crossing
- 6 Angle Crossing
- 7 "BUMBALONG" Colinton
- 8 "CAPPAWIDGEE" Bredbo
- 9 Fyshwick
- 10 "ELIZABETH FIELDS"
- 11 "WINNUNGA"
- 12 "WINDERADEEN"
- 13 Osbornes
- 14 "LAKELANDS"
- 15 "ELLENDEN"
- 16 "CURRANDOOLEY"
- 17 Smiths "LEONE" and "GRANTHAM PARK"
- 18 "MANE LODGE"
- 19 "EMERSLEY"
- 20 "WERRIWA"
- 21 "BIRKENBURN" Corkhills
- 22 "BIRKENBURN" Ro-Mix
- 23 "LONG SWAMP" Manar
- 24 Balmains Price
- 25 Balmains Canberra Washed Sands
- 26 "DEEP WILLOWS" River sand deposit
- 27 "DEEP WILLOWS" Dune sand deposit
- 28 "HOBBS CREEK"
- 29 "SPRING GROVE"
- 30 "CRONINS CROSSING"



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COMMONWEALTH OF AUSTRALIA		
BUREAU OF MINERAL RESOURCES		
CANBERRA, A.C.T.		
PROJECT: SAND & GRAVEL DEPOSITS & EXTRACTION OPERATIONS IN THE CANBERRA REGION, A.C.T. & N.S.W. 1977		
COMPILED AND CHECKED:		SENIOR GEOLOGIST
P. VANDENBROEK		G. JACOBSON
SUPERVISING GEOLOGIST		
E. G. WILSON 15-6-1979		
Record: 1979/64	Drawn by:	Filing Number
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