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THE MURRAY NEW TOWN AREA
PROGRESS REPORT NO. 1

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South Australia —

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

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CONSTRUCTION MATERIALS AND FOUNDATION CONDITIONS

Client: State Planning Office

by

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GEOLOGICAL SURVEY
MINERAL RESOURCES DIVISION

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SUMMARY AND CONCLUSIONS

A geological investigation of construction materials and foundation conditions has been carried out within and adjoining the Murray New Town area. The investigation of construction materials has been extended beyond the immediate area because useful deposits occur outside it. The investigation of foundation conditions has been restricted to the 175 square miles (450 km^2) of the area itself.

The materials most commonly occurring in the area investigated are Lower Palaeozoic bedrock including schist and greywacke of the Kanmantoo Group and the Monarto Granite; and Cainozoic sediments, including Mannum Formation limestone, and deposits of calcrete, alluvial clay and aeolian sand.

Rock for coarse aggregate used for concrete, and for railway ballast and road base course and screenings occurs on the margin of the eastern Mt. Lofty Ranges and within the Murray New Town area at Monarto and near Pallamana. The best of this material is the Monarto Granite. A single quarry at this site surrounded by an open space area to provide a buffer zone, could be developed which would cause little nuisance to the proposed town.

Alternative sources of granite are the granite near Pallamana, the Palmer Granite near Pfeiffer Hill 12 miles north of the proposed site and the granite near Long Ridge (Monier quarry for dimension stone) 44 miles north of Murray Bridge.

The granite near Pallamana is within the proposed site and a buffer zone would be required around a quarry in this area. The rock near Pfeiffer Hill is very coarse-grained and is deeply weathered in places, and although granodiorite from this area has been used for lock construction it may not be suitable for concrete. The granite at Long Ridge - although of excellent quality - is near the limiting distance for construction material in this situation.

Other sources of less suitable aggregate are greywacke and schist (the Guerin Quarry in Hd. Mobilong, Section 533) and limestone of the Mannum Formation cropping out in river cliffs, particularly in the area immediately north of Murray Bridge.

The experience of the Highways and Local Government Departments is that it is cheaper to use aggregate for road surfacing from operating quarries at Montacute and Brighton, than to open up a new quarry in this area. This applies only to the present situation, and there is no doubt that a quarry in the vicinity of the New Town will be required to supply this material.

Logistical problems could arise if quarries were sited on the opposite side of main roads to developing areas in which the quarry product is required. Provision of overpasses would eliminate this problem.

Foundation conditions are good in areas where bedrock is close to the surface. However, it is doubtful whether it is practicable to build on granite outcrops because of the highly irregular nature of the outcrop surfaces.

Excavation in granite would require extensive blasting, and ripping by heavy duty tractor and some blasting would be required in areas of bedrock, and calcrete.

Deposits of sand and clay occur within the area, some of which could be used for fine aggregate and brickmaking materials. However, deposits of this kind are not restricted to the area and sufficient supplies for the needs of the proposed town could be located with further exploration.

No difficulty is expected in obtaining either sand for fill or rubble for sub-base in road construction outside of the proposed site.

Younger Cainozoic sediments and soils in the southern areas (Qpd on map 72-613) present more foundation problems than those in the north (Qrs). The overall cost of house construction in the south may be increased by as much as 3% because of this factor.

Where the soil cover is thick, and this applies to the southern soils in the area designated Qpd, foundation conditions are relatively poor, and extensive soil testing would be required before foundations could be designed.

Excavation of drainage trenches could be easily carried out by earthmoving equipment throughout the soil covered areas.

INTRODUCTION

A proposed new city referred to as Murray New Town, with a possible population of 250 000, is to be built in the Murray Bridge area, west of the Murray River. The city will occupy an area of approximately 175 sq. miles (450 km^2). This report has been prepared following a request from the State Planning Office to provide information on construction materials and building foundation conditions which will influence the selection of a site for the new city. The work was undertaken at short notice as a matter of some urgency. The conclusions reached are based upon a study of recorded information, supported by information from Councils and by field reconnaissance.

The Murray New Town area is on the western margin of the Murray Basin and occupies an uplifted block of gently undulating plains country with altitudes ranging from 950 ft (290 m) to 25 ft (7.5 m) above sea level. The Murray River flows on a north-south course along the eastern side of the area near the town of Murray Bridge.

The area is bounded to the north by Salt Creek and Long Gully, and to the west by the Bremer Fault Scarp. The Pallamana Fault Scarp and Murray River together form the eastern boundary. The southern boundary runs between Bremer and Camel Trig. Stations then swings south to within 2.5 miles (4 km) of Lake Alexandrina.

The text is accompanied by a locality map of the area investigated showing the main geological features, by a detailed geological map showing the location of construction materials previously worked or investigated, and by a geological and topographical map relating to foundation conditions. The location and nature of materials previously worked or investigated is set out in some detail on tables of construction materials and these should be consulted in conjunction with the map showing their distribution.

GEOLOGICAL SETTING

LOWER PALAEOZOIC

The western and northern portions of the Murray New Town area are underlain by Cambrian rocks of the Kanmantoo Group which form the eastern Mount Lofty Ranges. These rocks also occur within the remainder of the area in low rises or beneath a thin veneer of younger sedimentary rocks. The original sediments of the Kanmantoo Group were mainly of greywacke type with minor developments of carbonate rocks and other clastics. Intense regional metamorphism during the Lower Palaeozoic Delamerian Orogeny has altered the original sediments to meta-greywacke, schists and gneiss.

Complete granitization of Kanmantoo Group rocks has produced the Monarto Granite body. This elongate body is about 6 miles (10 km) long and 2 miles (3 km) wide, and lies 5 miles (8 km) west of Murray Bridge. The granite was probably formed during the early Ordovician Delamerian Orogeny.

In the Murray New Town area the Kanmantoo Group forms an uplifted fault block (horst) between the western Bremer Fault and the Pallamana Fault to the east. The basement rocks are folded, and both folds and faults have a south to southeast trend.

LATE PALAEOZOIC:

Permian marine, fluvio-glacial and other deposits include the till, sands and clays of the Fleurieu Peninsula named the Cape Jervis Beds, and equivalents which have been revealed in oil exploration wells at the west end of the Padthaway Ridge south east of Murray Bridge.

CAINOZOIC:

Undifferentiated sands, clays and siltstones of Palaeocene to Eocene age near Coonalpyn are called the "Knight Group". The sequence includes the Middle Eocene to Upper Eocene Moorlands Lignite Member. This sequence in the Murray Basin northeast of the Padthaway Ridge has been named the Renmark Beds (Harris, 1966). The "Knight Group" beds are overlain by the marine Buccleuch Beds.

The Compton Conglomerate which crops out near "Kalibar" Homestead, and the Ettrick Formation which crops out at the base of the river cliffs near Tailem Bend, mark the Oligocene marine transgression.

The Mannum Formation, which is overlain in places by Finniss Clay, is widespread in the area and overlies bedrock near Monarto South on the basin margin. This unit gives way to the younger Morgan Limestone north of the Murray New Town area.

Younger sediments occurring in or near the Murray New Town area are Pliocene Loxton Sands and Parilla Sand, Pleistocene to Recent deposits including Blanchetown Clay, Bridgewater Formation, Ripon Calcrete and younger calcretes, alluvial Pooraka Formation and Callabonna Clay, aeolian Molineaux Sand, riverine Coonambidgal Formation and thin overlays of sand and soil.

CONSTRUCTION MATERIALS

The basic construction materials required in the building of a new city are hard rock for coarse aggregate used in concrete and in road construction for both base course and screenings; selected quartz sand for fine aggregate; clay for brick making; sand-sized material for use as fill; and rubble for use as sub-base in road construction.

Preliminary work shows that requirements for coarse aggregate can be met from deposits of granite near Kinchina or Pallamana. Useful deposits of limestone from immediately north of Murray Bridge would supplement the deposits of granite, particularly where high strength aggregate is not required.

Highway requirements (base course and bitumen screenings) are supplied at present in the main by Rockfell Quarry near Woodside (Hd. Onkaparinga, Section 54). The material used is a dolomitic siltstone. Bitumen screenings are obtained from commercial quarries at Montacute and Brighton (Linwood). Material from the Guerin quarry near Murray Bridge (Hd. Mobilong, Section 533) has been used, but the product contains too much schist. Highways are currently investigating a granodiorite quarry at Mannum which was used some years ago during lock construction. Generally speaking, Highways find it cheaper by $1/yard to purchase from commercial quarries, and this amount covers transport costs.

A detailed investigation for brick clays and sand for use in concrete will be required. A search of bore records carried out during this work suggests that these materials occur in the area, but their extent and quality can only be determined by drilling, sampling and testing. No important deposits of sand occur within the present proposed boundaries of the town.

Materials for use as fill and for sub-base work in road construction are abundant in the area and elsewhere and will not affect site selection to any degree.

The investigation of coarse aggregate, fine aggregate, brick clay and other construction materials shows that aggregate used in concrete is of major importance and should be given careful consideration during site selection.

COARSE AGGREGATE

Hard rocks of the Palaeozoic Kanmantoo Group crop out in the eastern slopes of the Mt. Lofty Range. These rocks form locally prominent and distinct ridges and consist mainly of interbedded schists and greywackes in which a pronounced lineation and cleavage is developed. According to Johns (1961), ballast, road construction materials and aggregate for civil construction projects have all been derived from these Palaeozoic rocks and from the Tertiary limestones nearby. Quarries located in the Kanmantoo Group of sediments provide coarse aggregate for base course and finer material for sealing of roads with bitumen in areas where they are required.

In summary, the most important source of coarse aggregate is undoubtedly the Monarto Granite near Kinchina. The next most important source is southwest of Pallamana (See Mobilong geological map). The limestone of the Mannum Formation immediately north of Murray Bridge and at other sites in the river cliffs close to the Murray New Town area provides a useful supplementary source of coarse aggregate for purposes where uniform high-strength material is not required. However, it will be necessary to locate limestone with less clay content than in the existing quarry.

Individual Deposits

The schists of the Kanmantoo Group have been quarried as a source of aggregate, but associated greywacke is mineralogically the most suitable rock. A quarry in greywacke occurs in Pt. Section 2001, Hundred of Monarto, 0.5 miles (0.8 km) east of Bremer River on the Kanmantoo-Monarto Road. Potential quarry sites exist near the present quarry in Section 357, Hundred of Monarto, and a few miles west of Murray Bridge in Section 175, Hundred of Mobilong. Because the greywacke is strongly foliated and breaks into platy and tabular fragments, laboratory testing of representative samples is required before a quarry is established (Hiern, 1967).

Mica schist and schistose fine-grained greywacke near "Kalibar Homestead" (See Mobilong geological map) is weathered and soft ~~or~~ to moderately hard. It is not an alternative source of coarse aggregate, although it could be used for sub-base in road construction.

A quarry 5.5 miles (8.8 km) due east of Kanmantoo was put down in schist and greywacke associated with pyritic sediments. The quarry adjoins the Murray Bridge-Kanmantoo road, the Murray Bridge-Onkaparinga pipeline, and a powerline passes over the quarry itself. Although hard greywacke for coarse aggregate occurs there, the site is not now suitable as a quarry and it is being filled in.

A pale grey fine-grained granitic rock, the Monarto Granite, crops out extensively in the area to the west and northwest of Kinchina. The rock usually has a faint lineation of mica and shows gradations with the enclosing rocks (Johns and Kruger, 1949). The rock is thought to have originated from in situ granitising processes rather than a magmatic intrusion as in the case of the "Murray Bridge Granite".

The Monarto Granite has the most potential as a source of coarse aggregate because of its proximity to Murray Bridge and its physical properties. The granite is exposed in the Kinchina Quarries (Sections 517, 518, 520, Hd. Mobilong) and in a railway cutting in Section 38, Hd. Mobilong. Samples of granite from the Kinchina Quarries were tested exhaustively as a source of concrete aggregate for the Chowilla Dam project. Los Angeles abrasion soundness values were in the range generally accepted for aggregate. Granite from the surface zone of two of the four test quarries returned L.A. losses in excess of 50%, but fresh rock from shallow depth was satisfactory (Stapleton, D.H. and Harris, B.M., 1966).

Granite crops out over a wide area southwest of Pallamana. The rock is massive and coarse-grained. Although the zone of weathering appears to be thin, the rock is not well jointed and would probably be difficult to work. Despite the lack of jointing, this granite provides the most useful source of large quantities of high quality coarse aggregate after the granite at Kinchina.

Other granitic rocks crop or are covered by a thin veneer of younger rocks on the Padthaway Ridge, which is about 30 miles (48 km) wide and runs southeast parallel to the Coorong from near Murray Bridge to the vicinity of Lucindale. Generally, the granite is too coarse-grained for construction materials.

Crystalline limestone of the Mannum Formation from various small quarries near Murray Bridge is used for aggregate, but the rock is of variable quality and is not considered to be suitable for high quality concrete.

The most important limestone deposits crop out in the river cliffs and over a wide area immediately north of Murray Bridge. This material has been quarried for ballast at a site in the river cliffs 2.5 miles (4 km) upstream from Murray Bridge on the west bank, but the material proved to be unsuitable because of the presence of sandy clay in thin irregular interbeds. The limestone is crystalline and quite hard and should be suitable for some kinds of coarse aggregate. Detailed exploration will be required to select better quality materials relatively free of clay. When this work is carried out, high features in the terrain should be avoided because they may be veneered with Parilla Sand, Blanchetown Clay or Bridgewater Formation. Overburden on lower cliffs and rises consists mainly of a thin veneer of calcrete and Molineaux Sand. The calcrete is suitable for use as sub-base in road construction, and the Molineaux Sand is useful as fill.

Other deposits of limestone of Mannum Formation occur north of "Kalibar" Homestead within the Murray New Town area, and to the southwest between Callington and Strathalbyn. These deposits are too thin and variable in composition and strength to be of use for anything but rubble for use as sub-base in road construction and, perhaps, as fill.

FINE AGGREGATE

Deposits of fine sand occur throughout the area. The two most commonly occurring are the Pooraka Formation and Molineaux Sand (Qrs and Qpd on the accompanying Mobilong geological map). The Pooraka Formation contains too much clay near surface (in fact this formation was the original source of "brick clay" in the Adelaide area), and both units are too fine-grained for use as fine aggregate.

Sands which may be of use for fine aggregate are recorded in a number of bores marginal to the granite outcrops and within the area of the Mobilong geological map. Sands have also been recorded within the riverine deposits drilled recently in Hd. Mobilong, Section 594. Dredging of these deposits may be feasible.

It is apparent that detailed exploration will be required to prove adequate supplies.

Individual Deposits

Tertiary sand shown 0.5 miles (8 km) E. of Monarto proper on the Mobilong geological map is not visible at the surface, where there is a thin veneer of aeolian Molineaux Sand. It is unlikely that useful deposits will be found and drilling will be required to test the kind of deposit, its thickness and extent.

Erosional remnants of Parilla Sand capped by ferruginous sandstone occur in Sections 233, 235, Hd. Monarto and also near "Lucernbrae" in Hd. Monarto. The grain size of these deposits may be too uniform for concrete aggregate.

Johns (1961) refers to gravels and grits at the base of Mannum Formation near Hartley which may be of use as fine aggregate.

Sand and gravel overlie the Permian glacial clays over a wide area south-west of Strathalbyn. Well exposed sections are reported to occur in the banks of Giles Creek, northwest of Finniss.

Other deposits of uncertain stratigraphic position have been recorded at a number of places. Coarse sand and grit were logged in the upper section of drainage bores in the vicinity of the Murray Bridge Hospital.

Clayey sand, fine to coarse-grained, was logged from 0-10 ft (0-3 m) in a bore in Section 346, Hd. Mobilong where Rocky Gully emerges onto the plains west of Murray Bridge. Clayey sand and gravel up to 60 ft (18 m) in depth were recorded in bores at Callington township and in Section 2061A, Hd. Monarto, 0.5 miles (0.8 km) to the east of the town.

Fine sand was intersected beneath 5-10 ft (1.5-3 m) of clay in bores in Sections 121, 123 and 3561, Hd. Freeling on the eastern side of the River Bremer, 10-12 miles (16-19 km) south of Callington. White and yellowish siliceous sand and calcrete of Quaternary age blanket almost the entire of the Murray Plains, but are too fine for concrete aggregate.

BRICK CLAY

The development of the clay brick industry in the Adelaide area shows a shift away from thin alluvial deposits occurring at ground surface - such as Pooraka Formation of the Adelaide Plains - to large deposits of weathered shale and Tertiary clay. It is probable that deposits of weathered shale similar to those of the Adelaide area will be discovered in the ranges to the west of the Murray New Town area. Tertiary clays may also be found north and south of the Murray New Town area in structurally depressed areas.

As with the industry near Adelaide, blends of weathered shale and alluvial clay will probably prove most suitable. The discovery of suitable quantities of clay will probably require detailed exploration outside the present area of interest.

Individual Deposits

Nixon (1960) has reported on red and white clay suitable for brick making. The following notes are taken from his report.

In Sections 235 and 248N, Hd. Monarto, the rock types include greywackes bleached in the vicinity of quartz veins forming isolated pockets of limited size and sporadic occurrence. In Sections 82, 114 and 179 the rock types are essentially horizontally disposed red-brown sandy clays of Pleistocene-Recent age. In all, 16 holes were drilled totalling 272 ft (83 m). Of these, 10 holes totalling 127 ft (39 m) were drilled in testing for white clay, and the remainder for red clay.

The white clay investigated is a bleached and weathered greywacke of Cambrian age occurring as an isolated body around a quartz vein. The extent of white clay as outlined by auger drilling is insufficient to warrant opening up for use in the manufacture of cream bricks.

Red sandy clay occurs as a flat-lying sediment of Pleistocene to Recent age occurring over a relatively extensive area. Drilling has proved adequate reserves of red sandy clay in Section 114, Hd. Monarto.

Ceramics Research Laboratory results indicate that bricks from red sandy clay in Section 114 would be suitable for use as interior bricks only. If used outside some exterior rendering would be necessary.

Other small deposits of sedimentary clay occur in the river cliffs near Mannum (Finniss Clay) and at a number of small sites between Mannum and Tailem Bend (Blanchetown Clay).

OTHER DEPOSITS OF CONSTRUCTION MATERIAL

There will probably be an increasing demand as development proceeds for relatively small quantities of building and ornamental stone and large quantities of fill and for rubble for use in road construction. These requirements can be met fairly easily and only brief general notes are provided at this stage.

Building Stone

Small outcrops of coarse-grained pink granite occur in the Murray River valley downstream from Murray Bridge. Early quarrying was carried out near Sturt Reserve, and more recently near Swanport where reserves are large.

The Monarto Granite has also been quarried in the past for use in kerbing and as a building stone.

Currently operating quarries are the norite quarry at Black Hill north of the River Marne, and the granite quarry at Long Ridge, in Hd. Bagot, Section 216 on the Sedan to Stonefield Road.

Durable freestone with a high compressive strength has been mined selectively from limestone of the Mannum Formation near Murray Bridge for use in the district and in Adelaide.

In the past, farm buildings have been constructed from greywacke in the hilly country, and from calcrete on the plains.

Fill

Aeolian sands of the Molineaux Sand are widespread and, together with Pooraka Formation north of the Murray New Town area, should provide ample supplies of fill.

Rubble

Rubble for use as a sub-base in road construction also occurs in large quantities over a wide area as calcrete or as calcreted limestone of the Tertiary Mannum Formation.

FOUNDATION CONDITIONS

KANMANTOO GROUP (Є k)

Rocks of the Kanmantoo Group occur mainly in the north and north-western parts of the investigated area, apart from a zone of gneiss and schist (migmatite) which lies 2.5 km (1.5 miles) west of Murray Bridge, and a belt of schist, adjacent to the Bremer Fault, which extends south to 0.5 miles (1 km) north of Bremer.

The area of Kanmantoo Group rocks forms low undulating hill country with slopes of 10^{o} or less. Bedrock is usually poorly exposed, and covered by up to 10 ft (3 m) of red-brown, silty fine sand (SP) and sandy silt soil (ML)* with abundant rock fragments.

Locally, slopes may be as steep as 25^{o} to 30^{o}. The main area of steep slopes lies 1 mile (1.5 km) west of Monarto, where Preamimma Creek has cut a valley through the hills. Here, weathered to fresh, medium strong to strong micaceous siltstone and fine sandstone outcrop as bars, parallel to steeply-dipping bedding, which protrude up to 1.5 ft (0.5 m) above the ground surface. The areas between rock outcrops are covered by a thin layer of dark brown fine sandy silt Soil (ML).

* Terms underlined and in brackets are defined in Appendix B.

Schists and gneisses of the migmatite belt are overlain by 2 ft (0.6 m) of fine sand (SP) of off-white calcareous silt soil (ML) with nodular calcrete in the vicinity of the Murray Bridge-Onkaparinga pipeline (Boucaut, 1969).

About 1 mile (1.5 km) northeast of Gifford Hill, weathered gneiss underlies up to 2 ft (0.6 m) of medium to coarse grey sand (SP) and red-brown clayey sand (SC) grading down to moderately reactive ** ("expansive") sandy clay soil (CH) (Morris, 1971).

The areas underlain by Kanmantoo Group have generally favourable foundation conditions for all types of buildings. Bedrock is usually within 3 ft (1 m) of the ground surface, and covered by non-reactive sandy and silty soils. However, the thickness of soil is irregular, and may exceed 10 ft (3 m) in places.

No evidence of significant slope instability was observed.

MONARTO GRANITE

The Monarto Granite is a massive to weakly foliated, medium to coarse-grained pale grey rock composed of quartz, feldspar, biotite and muscovite (Stapledon and Harris, 1966).

The granite outcrops in two areas, each about 2 miles (3 km) in diameter. One area lies to the north of the Monarto-Sedan Railway, about halfway between Monarto and Pallamana. The other area is between Rocky Gully and Princes Highway, 4 miles (6.5 km) west of Murray Bridge.

The granite does not outcrop as continuous masses, but forms groups of characteristic large rounded boulders ("tors") standing up to 6 ft (2 m) above the surrounding flat to gently undulating country. Spheroidal weathering along widely spaced horizontal and vertical joints, followed by erosion, has produced the distinctive outcrops. The granite also occurs as

** Reactive clays are subject to volume changes with changes in moisture content. Movements of up to 5 cm at the ground surface may occur with highly reactive soils.

flat outcrops, close to ground level, up to 100 ft (30 m) in diameter.

The rock is mostly fresh to slightly weathered, strong to very strong, but surfaces of outcrops are sometimes weathered, weak to very weak. The surrounding soil is a red-brown, loose, silty fine sand (SP). This soil is irregular in thickness but is not likely to be thicker than 3 ft (1 m) in the vicinity of outcropping granite.

Although the granite is a strong rock and can withstand large loadings, it is doubtful whether it is practicable to build on areas of outcropping granite because of the highly irregular outcrop surface. However, structures could be built in areas surrounding granite outcrops, and could be founded either wholly on underlying granite or wholly on the overlying topsoil, depending on foundation loadings.

MANNUM FORMATION (Tm)

The Mannum Formation is a fossiliferous marine limestone of Miocene age. It is exposed in cuttings of the Adelaide-Melbourne Railway, 6 miles (9.5 km) west of Murray Bridge.

Here, the Mannum Formation is an off-white, highly weathered, weak to very weak coarse-grained rock, with a few weathered, strong bands. The limestone was extensively lateritized during late Tertiary peneplanation. Some layers within the limestone are completely replaced by iron oxides. The limestone is overlain by 3 ft (1 m) of strong calcareous nodular laterite, with white kaolinitic silt soil (ML), and 1.5 ft (0.5 m) of strong blocky calcrete. The Compton Conglomerate at the base of the Mannum Formation is composed of coarse lateritised gravels derived from the Kanmantoo Group.

An area of calcrete, 2 miles (3 km) across, lies 0.5 miles (1 km) north of the railway cuttings. This area is covered by silty fine sand (SP) with numerous calcrete fragments to 1.5 ft (0.5 m) diameter. Road cuttings in this area, adjacent to the Murray Bridge-Onkaparinga pipeline, show a sequence of 1.5 ft (0.5 m) fine to medium sand (SP) overlying mottled, sandy calcareous silt soil (ML) with an upper layer of strong blocky calcrete, about 0.5 ft (0. 15 m) thick. The Mannum Formation is not exposed in this area, but probably underlies the calcareous soils.

Strong blocky calcrete, where present, should provide adequate foundations for small buildings. However, if strong calcrete is absent, buildings would be more suitably founded on limestone if it is reasonably close to the surface, rather than in the overlying weak calcareous soils. Multi-storey buildings could be founded on the limestone. However, tests of the rock strength would be necessary to determine safe loadings. The possibility of cavernous weathering in the limestone should be investigated when designing foundations.

QUATERNARY AEOLIAN DEPOSITS (Qpd)

Deposits of aeolian Molineaux Sand blanket all the southern part of the area investigated and cover about 60% of the total area. They are up to 55 ft (17 m) thick. The land surface is gently undulating, and the main topographic feature is a system of linear sand dunes trending in an east to southeast direction. The dunes range in length from 0.25 to 2 miles (0.4 to 3 km) and have an average width of 300 ft (100 m). Relief of the dunes above the surrounding country is of the order of 10 to 20 ft (3 to 6 m). Internal drainage between dunes forms swamps, where the underlying clayey soils are impermeable. The land between dunes is cleared, but belts of stunted eucalyptus trees still remain on dune crests.

The entire area is blanketed by about 1.5 ft (0.5 m) of loose, grey, fine to medium sand (SP), composed of rounded quartz grains. Rubbly calcrete is usually restricted to the dune crests. North of Brinkley, road cuttings through dunes show 0.6 ft (0. 2 m) layer of strong blocky calcrete overlying pale calcareous sandy silt soil (ML). Where the calcrete horizon is poorly developed, the underlying material is mottled silty fine sand (SP).

South of Monarto South, dunes are composed of sands and clayey sands 3 ft (1 m) thick, underlain by mottled calcareous clayey sand (SC). Auger holes between dunes showed a sequence of calcareous clay soil (CH) and mottled highly reactive clay soil (CH) extending from 1.5 ft (0.5 m) to at least 15 ft (4.5 m) below the surface. The surface of these areas has numerous slight depressions and rises, termed "gilgais" (Allchurch, 1965).

Weak calcareous soils and the "expansive" clays appear to be extensive through much of the southern area, and extensive soil testing would be necessary at each site before foundations for even a domestic type building could be designed. Multi-storey buildings would probably require pile-type foundations. Thus, for all building types, the foundations would be expensive in relation to the total cost of the structure. In addition, there would be drainage problems, as the swampy areas southeast of Monarto South indicated that the underlying clays are impermeable.

QUATERNARY ALLUVIUM (Qrs)

Alluvial deposits of Pleistocene Pooraka Formation and of the modern creek channels cover a large part of the northeastern area between Rocky Gully and Pallamana, and extend south along the Pallamana Fault Scarp. Alluvium also tongues onto Quaternary aeolian deposits near Monarto South.

These areas are flat to gently undulating and are covered with a layer of red-brown fine to medium sand (SP), about 1.5 ft (0.5 m) thick. Several intermittent streams (e.g. Rocky Gully and Preamimma Creek) rise in the hills and flow onto the plains, where they have cut channels up to 100 ft (30 m) wide and 3 to 6 ft (1 to 2 m) deep. The stream beds are covered by loose fine to very coarse sand (SW) with fine gravel. Red-brown silty fine sand (SP) is exposed in the walls of channels.

Road cuttings adjacent to the Murray Bridge-Onkaparinga pipeline show calcareous sandy silt soil (ML) with nodular calcrete underlying the sandy topsoil.

Bores at Monarto South encountered pale calcareous clays to a depth of 4 ft (1.2 m) overlying sandy clays (Firman, 1962).

The thickness of alluvium is highly variable, and reaches a maximum in the Monarto South area of 40 ft (12 m), and along the Pallamana Fault Scarp of 75 ft (23 m). However, the alluvium is much thinner in the northeastern area.

The areas covered by alluvium should be suitable for domestic-type buildings. However, the calcareous soils have a low bearing capacity when wet and would not be suitable for footings, which would need to be founded on a deeper stronger soil horizon. Multi-storey buildings with high loadings may have to be founded at depth on piles.

TRENCH EXCAVATION

The following table summarizes anticipated excavation conditions in the different geological units:

Geological Unit	Anticipated excavation conditions
Quaternary aeolian deposits (Qpd)	Readily excavated by earth moving equipment. Calcrete may require some blasting but otherwise rippable by heavy duty tractor.
Quaternary alluvium (Qrs)	Readily excavated by earthmoving equipment.
Mannum Formation (Tm)	Limestone could be excavated by earthmoving equipment or ripped by heavy duty tractor. Hard bands within the limestone, and overlying calcrete may require some blasting.
Monarto Granite	The granite would require extensive blasting.

Geological Unit	Anticipated excavation conditions
Kanmantoo Group (€-k)	Generally rippable by heavy duty tractor, but some blasting may be required.

SEISMICITY

Infrequent earthquake shocks (one about every 10 years), sometimes of a relatively severe nature, have been recorded at Murray Bridge and Callington, and also at Strathalbyn, Nairne, Wellington, Mount Barker and Mannum (Sutton & White, 1968).

It is likely that some of these earthquakes are related to movements on the two faults that pass through the area, the Bremer and Pallamana Faults.

Further earthquakes, possibly intense enough to damage structures of inadequate strength, can be expected in the area, but it is impossible to predict their frequency. This should be taken into consideration when designing buildings and foundations.

27th July, 1972

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APPENDIX A

These tables record known or potential sources of construction materials within the area of the Mobilong and Alexandrina 1-mile maps. The information is derived from Departmental and District Council records, Highways and Local Government crushing contracts, and from reconnaissance traverses.

TABLE 1 - COARSE AGGREGATE

MURRAY BRIDGE CONSTRUCTION MATERIALS

District etc.	Location Hundred	Section	Materials and Use	Authority/ Operator	Comments	Year
Karoonda	Hooper	18	Limestone. Roadmaking	Highways	H.L.G. Contract	
"	McPherson	30	" "	"	" "	
Marne	Angus	104, 110	"Limestone" Road Construction	"	H.L.G. Crushing contract.	62
Meningie	Seymour	G & H	Clay. May be pyritic.		Moorlands Coalfield. Doubtful (Ceramics Research Laboratory)	
"	"	G	Hornfels and slate.		Johns (1959) Min. Rev. 111. Moorlands Coalfield.	
"	"	371, 372, 373	Limestone. Screenings	"	H.L.G. Contract.	
"	"	501	Granite		Not worked by Council.	
"	"	1097	Mannum Formation limestone and hard calcrete. Coarse aggregate for concrete. Screenings also.	Council Highways	"River rock is ripped and both materials are put through crusher at Tailem Bend."	
Mobilong	Brinkley	815,1121, 1163	Calcrete	Highways	H.L.G. Crushing contract. 1121 and 1163 not located on plan.	
"	Etterick	63	Limestone. Roadmaking	"	H.L.G. Contract.	
"	Burdett	158	Calcrete. Roadmaking. Rubble	Council of M.B. Corporation	Further supplies available to S.W. Clay content too high for binding with bitumen.	

District etc.	Location Hundred	Section	Materials and Use	Authority/ Operator	Comments	Year
Mobilong	Mobilong	114	Calcrete. Roadmaking.Rubble		Clay content too high for binding with bitumen.	
"	"	209	Granite		Intensely fractured (Hiern, 1967).	
"	"	175	Greywacke		Strongly foliated platy fragments. (Hiern,1967).	
"	"	517, 518, 520	Monarto Granite at Kinchina. High quality concrete.		Moderately well pointed, but hard to blast (Hiern, 1967).	
"	"	520	Monarto Granite. Rd. metal. 900 00 cu.yds.		Very little jointing revealed, low relief.	
"	"	526	Granite. 280 000 yds. cubic quarry opened up (9/10/67).	Guerin	Best site in this area. Internally fractured (Hiern, 1967). Closely jointed. Wegener, 1952 (RB.33-77) refers.	
"	"	527	Monarto Granite. Rd. Metal. 800 000 cu. yds.		Very little jointing revealed, low relief.	
"	"	533	?Schist Bruckunga Formation. Concrete.	"	Guerins crusher supplies. Albion Reed concrete plant at Murray Bridge.	
"	"	Stone Reserve No. 3	Monarto Granite. Rd. Metal. 100 000 cu. yds.			

District etc.	Location Hundred	Section	Materials and Use	Authority/ Operator	Comments	Year
Mobilong	Monarto	231	Granite.		Favourable site may exist.	
"	"	358	"Blue Stone"	Guerin	"Not used anymore".	
"	"	Pt. 2001	Greywacke. Quarry		Gibson (1954). Reported to be 0.5 miles (0.8 m) E. of Bremer River on Kanmantoo Monarto Road. This locality is probably in Hd. Kanmantoo. Quarried for aggregate (Hiern, 1967). Johns (1959). Hiern. Reg. 111. Moorlands Coalfield.	
Sedan	Bagot	?216	Granite	Monier	Opened up for dimension stone, but could also be used for coarse aggregate (including rail ballast).	

TABLE 2 - FINE AGGREGATE *

District etc.	Location Hundred	Section	Materials and Use	Authority/ Operator	Comments	Year
Mobilong	Freeling	121, 123, 3561	Fine sand under J-10 of clay.		East side of Bremer R. 10-12 miles S. of Callington.	
"	"	Near 3539	Sand.		Bed of Bremer River. (Boucaut pers. com.)	
"	Monarto	233, 235	Parilla Sand capped by ferruginous sandstone.		Grain size may be too uniform for concrete aggregate. Also near "Lucernbrae" in Hd. Monarto.	
"	"		Clayey sand, fine to coarse-grained.		Where Rocky Gully emerges into the plains west of M.B. (0.5 miles (0.8 m) E. of Callington). This locality is given as Hd. Mobilong Section 346, but probably Monarto.	
"	Monarto Callington		Sand and gravel up to 60 ft in depth.			
"	Monarto		Quartz sand 15 ft under 30 ft of sandy clay and soil.		Silo site. May outcrop in valley walls under soil cover.	
"	M.B. Corporation		Coarse sand and grit.		Drainage bore near M.B. Hospital.	

* Detailed investigation may show that some of these materials are suitable only as fill.

TABLE 3 - BRICK CLAY *

District etc.	Location Hundred	Section	Materials and Use	Authority/ Operator	Comments Remarks	Year
Mobilong	Mobilong	209	Red clay overlying granite		M.N.H. (Pers. com.) Opened Guerin for granite, and probably abandoned.	
"	Monarto	82 (not located on plan) 114, 179	Red-brown, sandy clay		Interior bricks only unless exterior rendering used.	
"	Monarto	Monarto South	White clay (bleached shale)		Small quantity	
"	"	"	Sandy clay 15 ft thick under 5 ft soil.		Silo. J.B.F. (1962).	

* Detailed investigation and testing is required before any of the materials listed are accepted for brickmaking.

APPENDIX B

ENGINEERING CLASSIFICATION OF ROCK MATERIAL

1. ROCK CONDITION

TERM	ABBRN	DEFINITION
Fresh	(F)	No weathering effects visible to naked eye.
Weathered	(W)	Shows visible effects of chemical decomposition caused by air and ground-water. Can be subdivided:
Slightly weathered	(SW)	- change in appearance but no loss in strength
Moderately weathered	(MW)	- change in appearance but with significant loss in strength.
Highly weathered	(HW)	- considerable change in appearance and loss in strength. Material is still a rock but normally very weak.
Completely weathered	(CW)	- has soil properties and often shows complete change in appearance.
Altered	(A)	Shows chemical and physical alteration to rock fabric caused by temperature, pressure or injection of other material.

2. ROCK STRENGTH

Can be correlated with unconfined compressive strength tested in the laboratory.

TERM	ABBRN	Kg cm^2 (p.s.i.)	FIELD TEST	
Very weak	VW	70 (1 000)	Breaks and crumbles easily in the hands.	
Weak	W	70-200 (1 000-3 000)	Breaks easily with hammer tap.	(Normal (range (of (concrete
Medium strong	MS	200-700 (3 000-10 000)	Rings and breaks to firm hammer blow	
Strong	S	700-1800 (10 000-25 000)	(Very difficult to break with hammer ((and requires sledge. (	
Very strong	VS	>1800 (>25 000)		

3. USE OF CLASSIFICATION

Note that Condition and Strength terms do not necessarily correspond. Strength depends on the type of rock while condition depends on external effects, e.g.

Rock Material	Condition	Strength
Granite	Fresh	Strong
Schist	Fresh	Weak

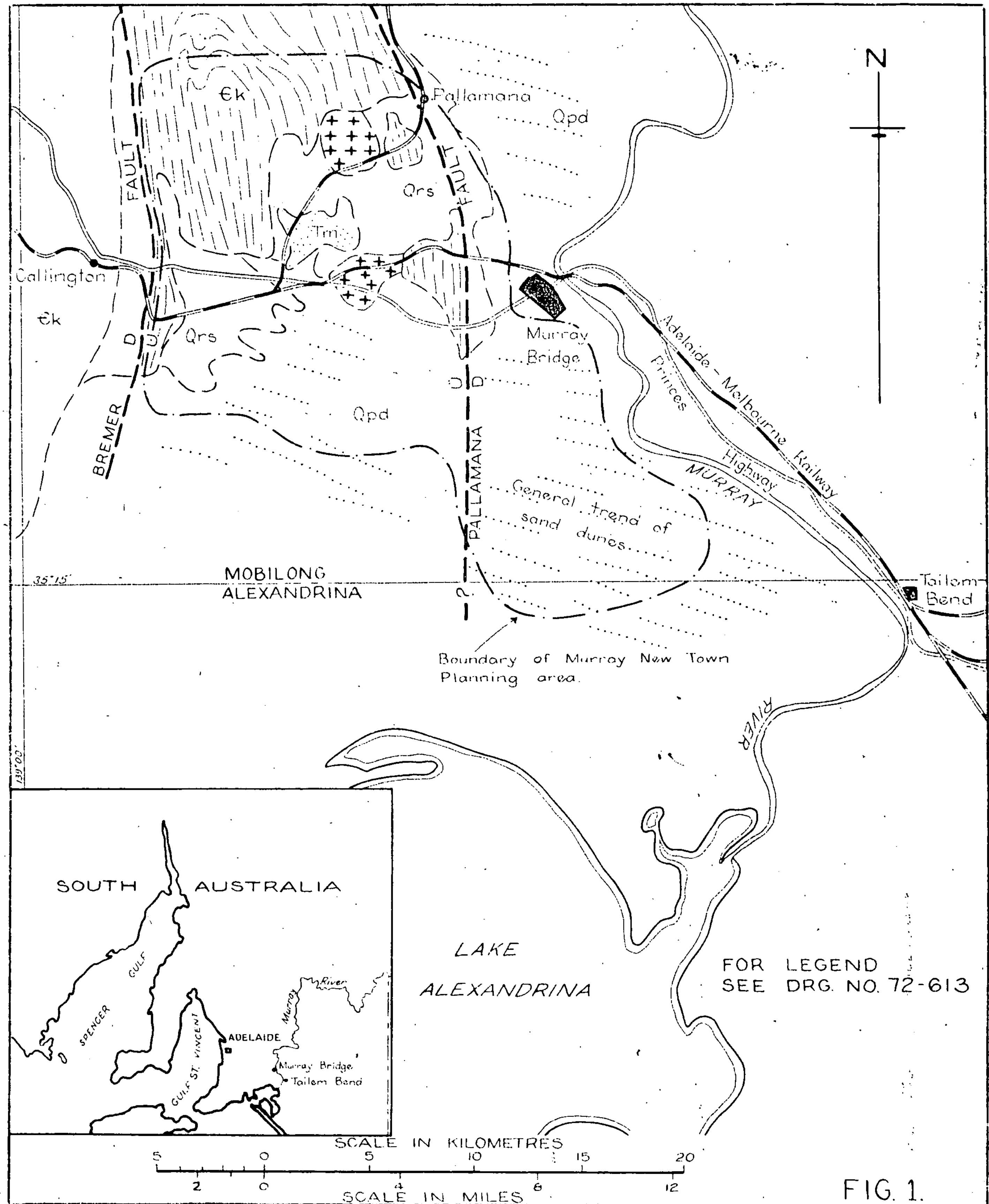


FIG. 1.

Engineering Geology Section	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: 1:250,000 (orig)
Compiled: P.A.R.	MURRAY NEW TOWN AREA	Date: 12TH July 1972
Drn. M.A.S. Ckd. P.R.	Hds. of Brinkley Mobilong and Monarto	Drg. No.
	LOCALITY PLAN SHOWING REGIONAL GEOLOGY	S9918 Hb8

1M–2.70 A1510

COARSE-GRAINED SOILS
More than 50% of material is larger than No. 200 B.S. sieve size

FIELD INVESTIGATION PROCEDURES Excluding particles larger than 7·5cm and basing fractions on estimated weights			GROUP SYMBOL	GROUP NAME and typical materials
GRAVELS More than 50% of the coarse fraction is larger than 2mm. (retained on B.S.7 sieve)	**CLEAN GRAVELS** Little or no fines	Wide range in grain sizes, and substantial amounts of all intermediate particle sizes	GW	GRAVEL, well graded; gravel sand mixtures, little or no fines
		Predominantly one size or a range of sizes, with some intermediate sizes missing	GP	GRAVEL, poorly graded; gravel sand mixtures, little or no fines
	DIRTY GRAVELS Appreciable amount of fines	Non-plastic fines—for indentification see ML below	GM	GRAVEL, excess silty fines; poorly graded gravel-sand-silt mixtures
		Plastic fines—for identification see CL below	GC	GRAVEL, excess clayey fines; poorly graded gravel-sand-clay mixtures
SANDS More than 50% of the coarse fraction is smaller than 2mm. (passing B.S.7 sieve)	**CLEAN SANDS** Little or no fines	Wide range in grain sizes, and substantial amounts of all intermediate particle sizes	SW	SAND, well graded; well graded sands, gravelly sands, little or no fines
		Predominantly one size or a range of sizes, with some intermediate sizes missing	SP	SAND, poorly graded; poorly graded sands, gravelly sands, little or no fines
	DIRTY SANDS Appreciable amount of fines	Non-plastic fines—for indentification see ML below	SM	SAND, excess silty fines; poorly graded sand-silt mixtures
		Plastic fines—for identification see CL below	SC	SAND, excess clayey fines; poorly graded sand-clay mixtures

FINE-GRAINED SOILS
More than 50% of material is smaller than No. 200 B.S. sieve size

FIELD INVESTIGATION PROCEDURES on fraction smaller than 0.4mm. (passing B.S. 36 sieve)							GROUP SYMBOL	GROUP NAME and typical materials
	SOIL CAST (soil wet)	SOIL THREAD	SHINE	DILATANCY	ODOUR	DRY STRENGTH		
SILTS AND CLAYS Liquid limit less than 50	Forms fragile cast Cracks form when kneaded while moist	Thick crumbly thread; easily broken	None to very dull	Distinct	Not significant	None to slight	ML	SILT SOIL, low plasticity; inorganic silts and very fine silty or clayey sands, rock flour
	Cast maybe handled freely without breaking Can be kneaded moist without cracking Material adheres to the hand	Thread can be pointed as fine as a lead pencil but is fragile	Moderate	None to slight	Not significant	Moderate	CL	CLAY SOIL, low plasticity; inorganic clays of low to medium plasticity, gravelly clay, sand, clays, silty clays, lean clays
	Cast fragile to cohesive material will adhere somewhat to the hand	Soft, weak thread	None to very dull	Slight to distinct	Decayed organic matter	Low	OL	ORGANIC SOIL, low plasticity; organic silts and silt clays of low plasticity
SILTS AND CLAYS Liquid limit more than 50	Moderately plastic and cohesive Material adheres somewhat to the hand	Weak to medium thread May be crumbly	Dull	None to slight	Not significant	Moderate Powdered soil feels floury	MH	SILT SOIL, high plasticity; inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	Very plastic and cohesive Material very sticky to the hand Greasy to touch	Very tough thread, can be rolled to a pin point	Very glossy	None	Strong earthy	High to very high Cannot be powdered by finger pressure	CH	CLAY SOIL, high plasticity; inorganic clays of high plasticity, fat clays
	Plastic and cohesive Feels slightly spongy Greasy to touch	Weak to medium thread Often soft and fibrous	Moderate to very glossy	None	Decayed organic matter	Moderate to high Powdered soil may be fibrous	OH	ORGANIC SOIL, high plasticity; organic clays of medium to high plasticity
	Readily identified by colour, odour, spongy feel and frequently by fibrous texture						Pt	PEATY SOIL; Peat and other highly organic soils

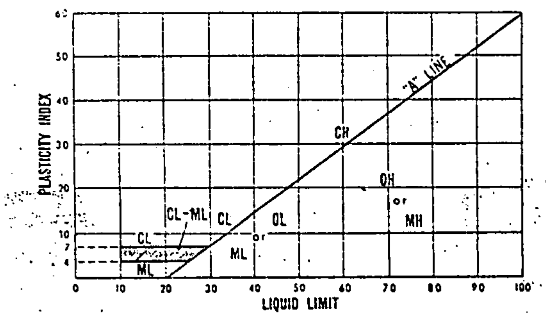
LABORATORY CLASSIFICATION CRITERIA

GRAIN SIZE CURVES to be used to identify soil fractions

Coarse-grained soil classified on basis of percentage of fines, as follows

PERCENT OF FINES — GRAVELS / SANDS
- Less than 5: GW GP / SW SP
- More than 12: GM GC / SM SC
- 5 to 12 Borderline cases, use 2 symbols

GW	$C_u = D_{60}/D_{10}$ Greater than 4 $C_c = (D_{30})^2 / D_{10} \times D_{60}$ Between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits below "A" line or PI greater than 7	
SW	$C_u = D_{60}/D_{10}$ Greater than 6 $C_c = (D_{30})^2 / D_{10} \times D_{60}$ Between 1 and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
SC	Atterberg limits below "A" line or PI greater than 7	



PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE-GRAINED SOILS

NOTE: BOUNDARY CLASSIFICATIONS: Soil possessing characteristics of two groups are shown as a combination of two group symbols, eg. GW-GC, well graded gravel with clay binder.

Based on "The Unified Soil Classification System" United States Department of the Interior, Bureau of Reclamation "Earth Manual" First Edition, Denver COLARADO 1960.

70–641 Bull.44

LEGEND

PLEISTOCENE TO RECENT	Qrs	Shallow alluvial deposits of creek channels and floodplains.
	Qpd	Aeolian dune sands ; calcrete.
TERTIARY – ?PLIOCENE	Tfe	Pisolitic laterite.
TERTIARY – MIOCENE	Tm	Mannum formation – fossiliferous marine limestone
PALAEOZOIC CAMBRIAN		Monarto granite (Ordovician?).
	Єk	Kanmantoo Group – greywacke and schist (Єk)
		Geological boundary.
	U D	Fault, showing upthrown and downthrown sides.
		Major road.
		Minor road.
		Railway.
	300	Surface contour (interval, 50ft).
		Swamp
		Outline of area investigated.

SCALE IN KILOMETRES

1 0 1 2 3 4 5 6 7 8 9 10

1 0 1 2 3 4 5 6

SCALE IN MILES

Note: Geology based on Mobilong and Alexandrina 1 mile sheets

FIG. 2

DEPARTMENT OF MINES – SOUTH AUSTRALIA			
MURRAY NEW TOWN AREA HUNDREDS OF BRINKLEY MOBILONG AND MONARTO GEOLOGICAL AND TOPOGRAPHICAL PLAN			
ENGINEERING GEOLOGY SECTION	Paul A. Rogers 21st July '72 GEOLOGIST	Drn. P.R.	SCALE: 1:63,360
		Tcd. M.A.S.	72-613 Hb8
		Ckd. P.A.R.	
Director of Mines	SUP-GEOLOGIST	Exd.	DATE: 20th July 1972