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Record 1978/82

CANBERRA-QUEANBEYAN RELATIONSHIP STUDY:
GEOLOGICAL FACTORS IN DEVELOPMENT PLANNING

by

G. Briscoe, J.R. Kellett, & G. Jacobson

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SUMMARY

The oldest rocks in the Queanbeyan area are folded and faulted Ordovician metasediments forming the Cullarin Horst, a dissected plateau, which is bounded by the Queanbeyan and Lake George Faults. To the east and west of the Cullarin Horst are interbedded Silurian volcanic and sedimentary rocks which have been intruded by mainly acid magmas.

Most of the terrain is hilly to undulating and covered by thin gravelly soils and outcrop; colluvium has accumulated at the base of the steeper slopes. Areas of more gentle relief have a thicker development of residual podzolic soils and earths. Alluvium occupies terraces and benches adjacent to the rivers; it is most extensive in the Molonglo flood plain in the northwest of the area near Canberra and to the east near Carwoola.

Groundwater aquifers occur in fractured rock, colluvium, and alluvium. Groundwater for stock and domestic use is obtained from fractured-rock aquifers; minor seepage problems are usually associated with the colluvial and alluvial aquifers.

The area has potential reserves of road construction materials, sand, and crushed rock.

No major constraints to urban development have been found; however, the design constraints map summarises those constraints relevant to urban planning, such as areas with steep slopes, drainage problems, rock excavation, depth of weathering, susceptibility to erosion, slope stability, and the 100-year flood level.

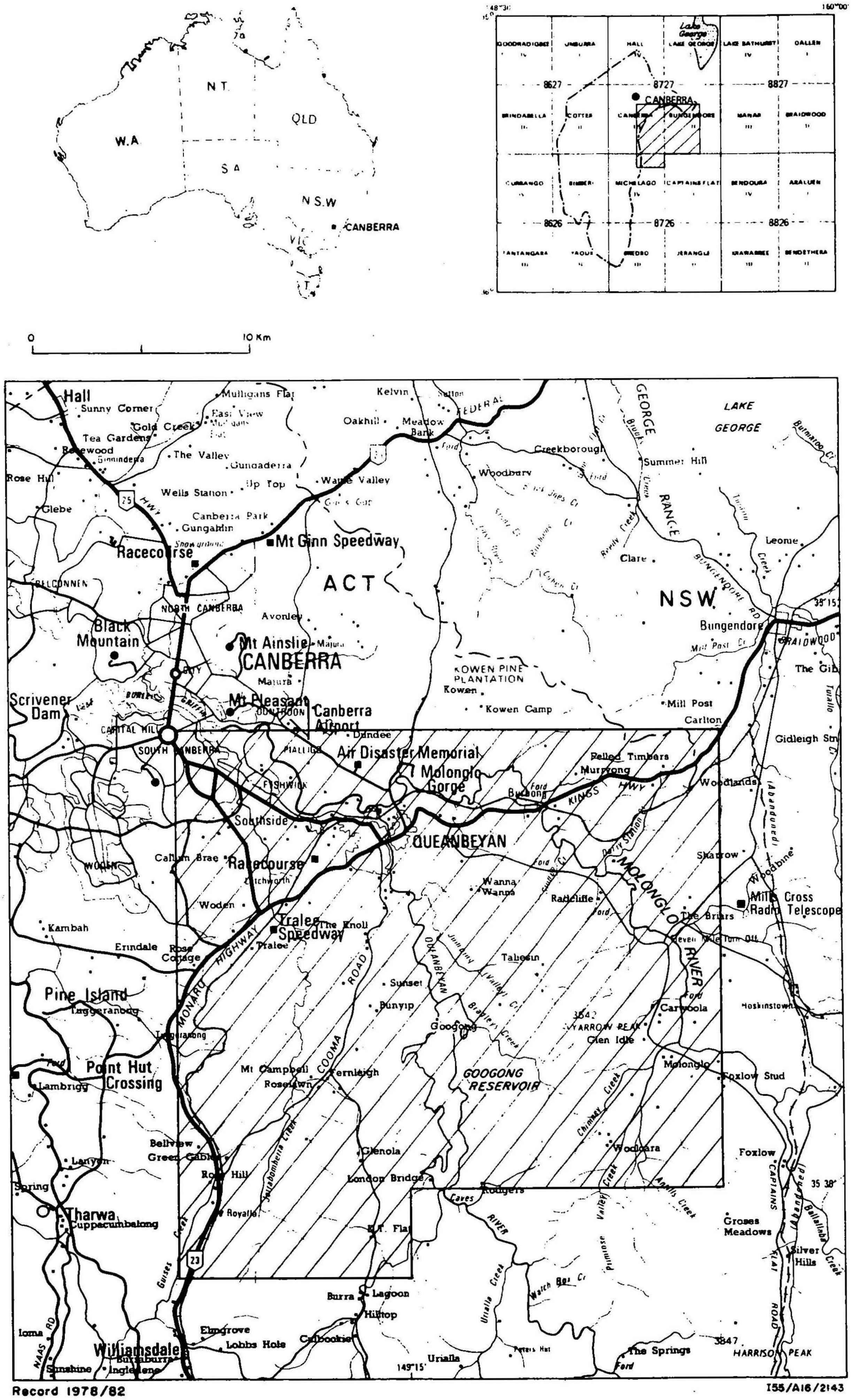

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Fig. 1 Location map

INTRODUCTION

At the request of the National Capital Development Commission (NCDC), the Bureau of Mineral Resources (BMR, 1978) started in November 1974 a review of the geology of Queanbeyan and the area to the east of the ACT, in order to identify geological factors likely to affect future development. The review formed part of the Canberra-Queanbeyan relationship study, a planning study being undertaken by the Commission in association with the Queanbeyan City Council. The study area extends eastwards from Queanbeyan to Carwoola Flats, on the Molonglo River, and south to Royalla, and also includes sections of the ACT to the north and west of Queanbeyan (Figure 1).

The geological compilation was prepared from photo-interpretation, fieldwork in the area, and reference to earlier geological mapping, with limited field mapping in the Queanbeyan city area and some drilling in the city to ascertain foundation conditions.

The general geology of the area is shown in Plate 1, the surficial geology in Plate 2, and geologic resources in Plate 3. The geological constraints affecting urban development planning are summarised in Plate 4.

Sections of the Canberra, Bungendore, and Michelago 1: 50 000 topographic series sheets were used as a base for the mapping, and all reference co-ordinates refer to this series.

Concurrently, more detailed studies were made on the geology of the Queanbeyan city area (Briscoe & Kellett, 1977) and of the soils of Mount Jerrabomberra (Kellett, in prep.).

GENERAL GEOLOGY

PHYSIOGRAPHY

The study area can be divided into four distinct physiographic units (Plate 1).

1. Cullarin Horst

The Cullarin Horst is a partly dissected plateau 600-900 m above sea level, and is bounded by the Queanbeyan and Lake George Faults. It has been uplifted and is being eroded. Thin skeletal soils occupy the slopes; some residual soils remain on the crests, and colluvium and alluvium lie at the foot of the slopes and in the depressions.

2. Carwoola Flats

The Carwoola Flats occupy the Molonglo valley east of the Lake George Fault; they occupy part of the downthrown block containing Lake George, which lies to the north-east of the study area. They consist of alluvium overlying thick clays to depths of more than 30 m; the clays are considered to be lake sediments of an earlier period when the floodplain at Carwoola was flooded.

3. Queanbeyan City and South Queanbeyan

The downthrown block to the west of the Queanbeyan Fault has a partly dissected undulating surface of deeply weathered rock with thick residual soils on the crests, and thick podzolic soils on the pediments on an alluvial flat adjacent to the Queanbeyan River, and the City has spread over the surrounding slopes and to the South Queanbeyan development area.

4. Upper Jerrabomberra Creek and Queanbeyan River catchments

The upper Jerrambomberra Creek and Queanbeyan River catchments comprise dissected hills in the south of the area and to the west of the Queanbeyan Fault.

The following sequence of events in the history of the Molonglo valley has been derived from Stauffer, Wilson, & Crook (1964).

1. Early drainage of the area by north-draining streams.
2. Headward erosion by streams flowing to the west that captured the Molonglo River; this river system was maintained until the Molonglo River occupied a mature river valley that was aligned in the general direction of the present course of the Molonglo River.
3. Movement along the Lake George Fault formed a lake in the Molonglo valley, and overflow passed along old meanders through the Cullarin Horst.
4. The lake was subsequently drained following headward erosion by the truncated Molonglo River, and the river has incised its bed into the floor of the older valley.

STRATIGRAPHY

The stratigraphy of the area is set out in Table 1, and is summarised in the reference to the generalised geological map (Plate 1), in which units of similar age and lithologies have been grouped together.

Ordovician

Ordovician sedimentary rocks - predominantly sandstone, siltstone, slate, and shale - crop out in the central part of the area, mainly in the Cullarin Horst, where rock outcrops are moderately weathered. To the east and west of the Cullarin Horst, a thicker and more deeply weathered profile is retained. The Ordovician rocks are structurally complex; they show tight folding, well-developed axial-plane cleavage, and overturned bedding, and are of low metamorphic grade.

Lower Silurian

The Ordovician rocks are unconformably overlain by the Lower Silurian State Circle Shale and Black Mountain Sandstone, which are well exposed on the road to the summit of Mount Jerrabomberra.

Middle to Upper Silurian sedimentary rocks

Limestone and shale of the Colinton Volcanics and the London Bridge Formation along the Queanbeyan River have been mapped as a single unit, middle to upper Silurian sediments, in Plate 1. Other Middle to upper Silurian sedimentary rocks, comprising shale, siltstone, limestone and sandstone of the Canberra and Fairbairn Groups and the Cappanama Formation, have been mapped as a single unit in the northwest of the area; similar lithologies of the Carwoola Beds and the London Bridge Formation in the east and south of the area have also been mapped as a separate unit.

Middle to Upper Silurian volcanic rocks

Formations with predominantly Silurian volcanic rocks have been grouped as one unit in Plate 1 and include rocks of the Deakin and Ainslie Volcanics, part of the Colinton Volcanics, and the Captains Flat Formation.

The Silurian rocks are tightly folded, generally with well developed foliation and are faulted. The depth of the weathered profile in the volcanics varies from place to place, and the degree of weathering is irregular and not predictable.

Late Silurian intrusive rocks

The Silurian sediments and volcanic rocks are intruded by late Silurian acid intrusives including the Mount Painter Porphyry, Barrack Creek Adamellite, Mugga Mugga Porphyry, and Googong Granite. Smaller basic intrusives are more common in the eastern half of the area.

Quaternary

Quaternary deposits of colluvium are widespread below the change of slope at the foot of hills and on gently sloping sediments. Alluvium is confined to the river beds and adjacent terraces, with some high-level alluvium remnants on benches above the terraces.

STRUCTURE

The area has been deformed a number of times; structural studies have been reported by Stauffer & Rickard (1966) and Wilson (1964). The earliest deformation (Benambran Orogeny) produced tight isoclinal folds with a well-developed cleavage in the Ordovician rocks. A later but less intensive period of folding (Bowning Orogeny) followed at the end of the Silurian, and rocks deformed in this event have a well-developed steep meridional cleavage. The development of north-south trending faults was a late stage of this deformation, and may have been associated with the emplacement of late Silurian intrusive rocks and the development of low-grade metamorphic rocks in the area. Fault movement again took place along some of these faults, namely the Lake George and Queanbeyan Faults, in mid-Tertiary to Pleistocene time: the present day areas of uplift and depression, including the Cullarin Horst, are attributed to this latest movement. Deep weathering is usually associated with faults and shear zones in the area.

SURFICIAL GEOLOGY

Plate 2 shows the distribution of the various soils. Hilly to undulating terrain is characterised by skeletal soils and rocky outcrops. Colluvial deposits accumulate at the foot of slopes and extend out onto the pediments, commonly merging with alluvial deposits in the wider valleys. Alluvium occurs along the main creeks and rivers, and on old floodplains. In areas of more gently relief, soil profiles have developed to form red and yellow earths and podzolic soils; some of these soils are residual and have developed on extremely weathered rock, and others have formed on transported material such as colluvium and high alluvial terraces.

ALLUVIUM

Recent alluvium is present along the courses of the main rivers and creeks: the Molonglo River, Jerrabomberra Creek, and to a lesser extent the Queanbeyan River. Along the Molonglo River, wide alluvial flats are pre-

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sent near Carwoola, in the southeast of the area, and also near Canberra, in the northwest. These deposits include a floodplain alluvium overlying lacustrine sediments near Carwoola, alluvial terraces and high alluvial benches, old river channels, and present-day channel deposits; they contain various amounts of sand, gravel, silt, and clay. Alluvial deposits of sand and gravel along the Queanbeyan River are restricted in area, and the sediments are poorly sorted; the alluvium beneath the commercial centre in Queanbeyan ranges in thickness to 12 m and is mostly below the water-table. Jerrabomberra Creek and other tributary creeks contain minor amounts of silt with sand and gravel which also are poorly sorted. Some windblown sand deposits have been included in the alluvial map unit; the sand is fine-grained, angular, and was originally derived from alluvial terrace deposits along the rivers.

SKELETAL SOILS

Soils developed on acid igneous rocks

The acid to intermediate igneous rocks form shallow gravelly soils with rock outcrop in areas of hilly to undulating terrain. The soil is commonly a sandy loam with fine gravel and rock fragments (SM-GC)*. Soils of this type occur in the west and southwest of the study area, and have developed on a variety of rock types. Depth of weathering of these rocks is irregular, and rock weathering is facilitated by rock defects such as joints; corestones several metres across may be surrounded by extremely weathered rock. Outcrops are rounded to blocky and often project up to several metres above the ground.

Soils developed on sedimentary rocks

The Cullarin Horst comprises a belt of folded Ordovician metasedimentary rocks; younger Silurian sedimentary rocks and interbedded volcanics occupy the eastern strip of the Cullarin Horst adjacent to the Lake George Fault.

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* See Appendix 1: Unified Soil Classification

On hilly to undulating terrain, shallow gravelly soils with extensive areas of low outcrop dominate. The soil is generally clayey sand (SC-GC) with platy rock fragments. The more resistant sandstone, greywacke, and quartzite crop out as low strike ridges, whereas the finer-grained slates and shales have only a thin soil cover and crop out less frequently, in places as flat expanses of exposed rock.

Around the Queanbeyan City area, the more deeply weathered sedimentary rocks may have a cover of podzolic soils up to 2 m thick.

COLLUVIAL SOILS

Colluvium accumulates at the foot of slopes and consists of the products of rock weathering. The weathered material gravitates downslope and is distributed by runoff. Topography, and to a lesser extent lithology, determine the type and distribution of colluvial soils.

A number of colluvial units have been delineated on the accompanying map (Plate 2).

Stony colluvium (GM-GC)

The material defined as stony colluvium is derived mainly from sedimentary rocks. It comprises an unsorted accumulation of blocky rock fragments in a silt-clay mixture. This material accumulates on the flanks of Mount Jerrabomberra and at the foot of the escarpment associated with the Queanbeyan Fault.

Pediment colluvium

The most widespread colluvial material accumulates at and below the change of slope in areas of hilly to undulating terrain, and may be extensive in small upland basins. Coarse-grained, unsorted, unoriented colluvium accumulates near the change of slope, and grades downslope into poorly stratified gravelly to sandy colluvium of the pediment slopes.

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The coarse-grained colluvium is essentially composed of blocks of rock in sand-silt (SM) gravel-sand-silt (GM) or gravel-silt-clay (GM-GC) matrix, depending on the type of upslope rock; igneous rocks tend to produce a sand-silt (SM-SC) finer-grained matrix, and sedimentary rocks a silt-sand-clay mixture (SM-CL).

The finer-grained and more extensive sandy to silty (SM-SC) colluvium of the lower pediment slopes is well graded, and contains fewer rock fragments, which have weathered since they were deposited; in places it is cemented at depth. This colluvium is thickest higher on the pediment and gradually thins out, commonly grading into or becoming interstratified with alluvium on the valley floor.

PODZOLIC SOILS AND EARTHS

Most of the podzolic soils and earths in the study area are shallow, rarely exceeding 2 m in thickness, and have been formed on older transported material and extremely weathered rock. A number of phases of erosion and soil formation are evident in the Canberra area, and it is likely that some older soils, high on the pediments, date back to the Tertiary.

The older podzolic soils (CL) are most often preserved in elevated areas. They comprise well-structured clays and are commonly grey in colour; hardpan layers of iron, calcium, or silica are common in the B2 horizon. The younger podzolic soils are generally redder in colour, and have a more earthy fabric; they range in texture from sandy to plastic clay (CL-CH).

Red and yellow-brown earths are younger soils and have developed on aeolian sands and higher river terraces.

EXPANSIVE SOILS

Numerous basic dykes and sills intrude the sedimentary rocks to the east of the area, and have weathered to produce soils containing expansive montmorillonite clays (CH).

ENGINEERING GEOLOGY

FOUNDATION AND EXCAVATION CONDITIONS

A generalised evaluation of the likely foundation and excavation conditions is given in Table 1.

SLOPE STABILITY

Slopes in many parts of the area exceed 15^{o} (Plate), which is considered the maximum slope angle for development. Removal of the natural vegetation from areas with slopes of more than 15 degrees has lead to slumping and sliding of superficial materials, and sheet erosion is common. Natural regeneration has partly rehabilitated some areas.

Two areas of potentially unstable ground are the steep slopes along the Queanbeyan Fault scarp and the flanks of Mount Jerrabomberra (Plate 4). The slopes along the Queanbeyan Fault have thick accumulations of stoney colluvium at the base, and are prone to gullying and sheet erosion.

Mount Jerrabomberra (Kellett, in prep.) has a thick mantle of stony talus on the slopes. The material consists of angular sandstone blocks with a sandy clay matrix. There is some evidence of old rock slides and of minor slumping along the scenic road, and movement of saturated ground after rainfall is likely. Removal of vegetation, trenching, and benching in such areas makes such material unstable, and increases the potential for erosion.

SOIL EROSION (Plate 2)

Gully and sheet erosion is common in the study area and is partly induced by the effects of grazing, the clearing of natural vegetation, and rabbit infestation. Gully erosion is common in colluvium at the foot of slopes in rolling to hilly coarse colluvium, or on the gentler slopes with a cover of thick soils, mainly podzolic soils and yellow earths.

Sheet erosion occurs in different intensities on all cleared land, it is common along vehicle tracks and disused roads, particularly where soils

TABLE 1 ENGINEERING GEOLOGY OF THE CANBERRA-QUEANBEYAN STUDY AREA (see Plate 1)

Unit	Lithology	Outcrop type/soil	Distribution	Excavation conditions*	Foundation conditions*	Groundwater/soil drainage	Resources
Alluvium	Silt, clay, sand, gravel		Along rivers and creeks	Mechanical excavation	Adequate for small structures on pad or raft footings. Piled foundations for large structures	Water table generally 2 m	Sand, gravel, topsoil
Mount Painter Porphyry Mugga Mugga Porphyry (Upper Silurian)	Porphyritic dacite and rhyodacite	MW-HW at surface	East of Queanbeyan Fault	Blasting required	Strong, MW rock is adequate to support large buildings	Well drained, water-table rages to 10 m	Crushed rock
Basic dyke rocks	Metadolerite	EW-HW outcrops weather to produce montmorillonite clays	In Cullarin Horst	Mechanical excavation to 2 m	Problems of differential settlement due to expansive clays	Poorly drained	Possible use as facing stone
Barrack Creek Adamellite Googong Granite (Upper Silurian)	Coarse-grained acid intrusive rocks	Poor outcrop; EW-HW	Along Queanbeyan River south of Queanbeyan	Mechanical excavation HW-EW rock. Blasting where silicified or MW rock close to surface	Strong MW rock is adequate to support large structures	Well drained, water-table ranges to 10 m	Source of crushed rock and road gravel
Ainslie Volcanics (Middle-Upper Silurian)	Coarse-grained rhyodacite and tuffaceous, fine-grained porphyric volcanics	Very scattered and poor (EW-HW) outcrop	Northeast of Queanbeyan	Variable depth to MW rock (2-6 m). Mechanical excavation for most purposes, blasting in deeper excavations	MW rock adequate to support large structure	Poorly drained areas are common. Water-table 3-5 m	Possible source of crushed rock but may contain pyrite
Williamsdale Volcanics (Middle-Upper Silurian)	Rhyodactic tuff	MW rock at surface; thin gravelly soil	In south of area, between Jerrabomberra Creek and Queanbeyan River	Blasting generally required	Strong MW rock adequate to support large structures	Well drained	
Colinton Volcanics (pt) (Middle-Upper Silurian)	Porphyritic rhyolite	Thin skeletal soils with low outcrops	West of Jerrabomberra Creek	Blasting generally required	Strong MW rock at 1-2 m suitable for foundation of large structures	Well drained	Possible source of crushed rock
Deakin Volcanics Captains Flat Formation Colinton Volcanics (Middle-Upper Silurian)	Acid volcanics, tuff; foliated	Thin skeletal soils with outcrops to 0.5 m	Widespread except in Culbarin Horst	MW rock at surface will need blasting. Ripping in more weathered or closely jointed areas. Stability problems probable depending on direction and intensity of foliation	MW rock suitable for foundations of large structures generally 3 m	Generally well drained with thin soils	May be suitable for crushed rock but may contain pyrite or produce unsuitable platey fragments
Colinton Volcanics (pt) London Bridge Formation (pt) (Middle-Upper Silurian)	Limestone, shale	Thin skeletal soils on limestone; shale unit more deeply weathered	Along Queanbeyan River				Limestone has been mined along Queanbeyan River, generally cleaved
London Bridge Fm (pt) Carwoola Beds (Middle-Upper Silurian)	Siltstone, sandstone		South of area, along Queanbeyan River				
Fairbairn Group Canberra Group Cappanana Form. (Middle-Upper Silurian)	Shale, siltstone, quartzose sandstone, mudstone, tuff, limestone	Poor HW scattered outcrop	In northwest of area and in south near Limestone Creek	Mechanical excavation to 2 m	Strong MW rock adequate for large structures generally 6 m. Limestone (cavernous) may cause problems	Poorly drained	

Black Mountain Sandstone (Lower Silurian)	Blocky quartzose sandstone with thin shale interbeds	Surface outcrops to 0.3 m and skeletal soil	On top of Mt Jerrabomberra	Fresh to SW rock at surface; blasting for most excavations. Slope instability in cuts where joints and bedding planes are clay-lined or unfavourably oriented	Very strong rock for foundations close to surface; steep slopes	Well drained	Used for retaining walls
State Circle Shale (Lower Silurian)	Siltstone and mudstone at base grading to siltstone with sandstone interbeds to massive sandstone	Poor scattered outcrop; HW at surface	On slopes of Mt Jerrabomberra	Mechanical excavation for EW-HW slopes in EW-MW rock often unstable	Suitable foundation on MW rock		Suitable for brick shale
Acton Shale (Middle-Upper Ordovician)	Finely laminated siliceous shale and fine-grained quartzose sandstone; tightly folded	Low outcrops or overlain by shallow gravelly soil	Outcrops to west of Queanbeyan	MW rock 2 m. Light blasting needed for most excavations	Generally good at 1 m	Minor seepages	Used in part as road aggregate, and for slate
Pittman Formation Foxlow Beds (Middle Ordovician)	Greywacke, quartzose sandstone, quartzite, chert, siltstone, phyllite. Tightly folded, overturned; well developed axial plane cleavage	In Cullarin Horst, MW-HW outcrops with thin skeletal soils. West of Queanbeyan Fault, soils to 2 m with scattered HW-MW outcrop	In Cullarin Horst, west of Queanbeyan Fault near Queanbeyan, and at Lake George Fault	Blasting needed for foundations and services except on some siltstone, phyllite, and in more weathered areas west of Queanbeyan Fault. Slopes too steep for development	Strong foundation material 2 m. Beneath alluvium MW-FR occurs at 2-12 m	Minor swampy areas developed on clay-rich weathered rock	Mudstone unit quarried on Mt Jerrabomberra for brick shale, quarry now used for refuse disposal

* For abbreviations, see Appendix 2.

are thin, and readily saturated, but is more extensive and deeper on steeper slopes. Erosion is negligible where the natural vegetation is retained and in alluvial areas. The erosion of soil in the study area is facilitated by the presence of dispersive clays, and there is generally a white efflorescent deposit of salts evaporated from groundwater on exposed areas of extremely weathered siltstones and mudstones.

Erosion has been controlled in the Jerrabomberra catchment, except for minor stream bank erosion. In the Queanbeyan catchment, erosion is confined to soils derived from sedimentary rocks. Severe erosion of similar material occurs along steeper slopes in the Molonglo valley near Burbong.

SEISMICITY

Queanbeyan is in an area of minor seismicity (Cleary, 1967). The Modified Mercalli (MM) intensities of earthquakes felt in the Canberra region since 1919 are listed in Table 2. Recent calculations by A.J. McEwin, BMR, indicate that at least one earthquake of MMV can be expected every 50 years.

Movement that initiated the now dissected scarps of the Queanbeyan and Lake George faults probably took place in Late Tertiary to Quaternary time. It has not been possible to associate earthquake epicentres with faults in this area because the seismic data covers too short a period for reliable prediction.

Buildings founded on unconsolidated material such as alluvium and colluvium are more susceptible to damage during a seismic event. Multilevel buildings should be designed according to specifications for zone A of the Standards Associations of Australia Draft Code No. DR 76100 'Draft Australian Standard Rules for the design of earthquake resistant buildings' 15 September 1976.

TABLE 2

EARTHQUAKES FELT IN THE CANBERRA REGION, 1919-1976

Earthquake	Date	Hypocentre Lat.	Hypocentre Long.	Magnitude (Richter Scale)	Max. Felt Intensity at Epicentre (Modified Mercalli Scale)	Intensity felt in ACT & environs
Kurrajong	15 Aug 1919	33.5°S	150.7°E	4.6ML	V	I-II
Murrumbateman	6 Mar 1924	34.9°S	149.0°E	5.0ML	IV	I-II
Dalton-Gunning	10 Mar 1949	34.74°S	149.20°E	5.5ML	VIII	III-IV
Rock Flat	1 Sept 1958	36.40°S	149.24°E	4.0ML	V	I-II
Berridale	18 May 1959	36.22°S	148.66°E	5.0ML	VI	III
Robertson-Bowral	21 May 1961	34.55°S	150.50°E	5.6ML	VII	III
Mt Hotham	3 May 1966	37.04°S	147.13°E	5.7ML	V	II
Dalton	3 Nov 1971	34.76°S	149.16°E	4.2ML	V	III
Picton	9 Mar 1973	34.14°S	150.29°E	5.5 ML	VI	IV
Bowning	30 June 1976	34.66°S	148.89°E	4.2ML	IV	IV
Bowning	4 July 1976	34.66°S	148.89°E	4.8ML	V	IV

GROUNDWATER

Occurrence

Groundwater occurs in fractured-rock aquifers and alluvium, with minor amounts in colluvium. Of 45 water-bores in the area (Plate 3, Table 3), 14 are believed to be producing water for stock and domestic use, mostly from fractured-rock aquifers. Seven others are for water-level observations associated with the construction of Googong Dam, and two have been abandoned.

Yields of the producing bores are generally low because most bores are less than 25 m in depth. Little data on water quality are available. Groundwater could provide a secondary water source for stock in most parts of the area, and well-sited bores to greater depths would generally increase the yield.

Seasonal fluctuations of the water-levels in two bores (Fig. 2) illustrate the water-level recovery in late 1973 at the end of the drought; however, the seasonal fluctuations of 1.5 m in bore 159 and 1 m in bore 214 with a maximum in the month of November is the general pattern of normal years.

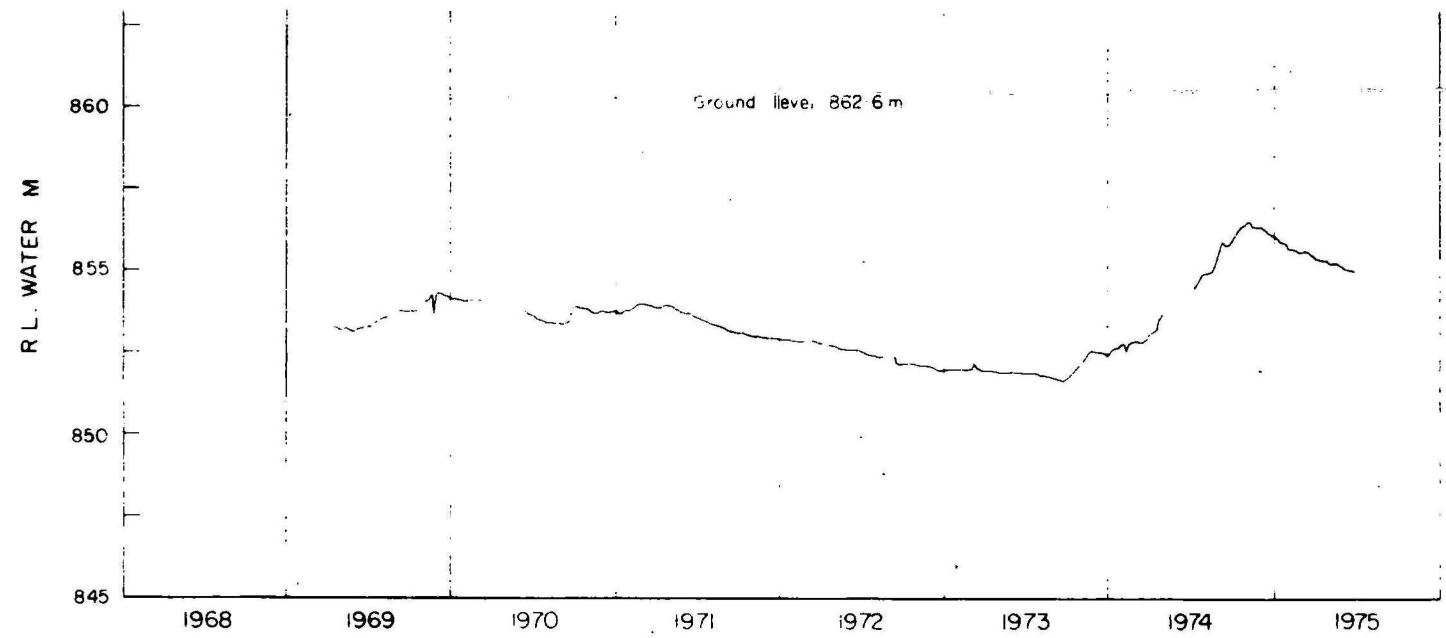
Drainage problem areas (Plate 4)

Before urban development proceeds, remedial drains will have to be installed in several minor perched basins in the upper valley of Jerrabomberra Creek, where groundwater in colluvium is confined by low permeability clay soils and groundwater outflow is restricted; a high potentiometric surface is common in such conditions.

Water-tables are also perennially high in small alluvial fills of Jerrabomberra Creek and its tributaries. In these areas the alluvium is a very fine-grained stratified sequence containing organic soils of low vertical permeability, and the creek bed is generally not well defined.

The main areas of intermittent seepage problems are shown in Plate 4. Most of these seeps occur at the change of slope in outwash fans derived from volcanic and intrusive rocks, and less commonly from metasedimentary

GROUNDWATER OBSERVATION BORE 214 (BUNGENDORE 318283)



GROUNDWATER OBSERVATION BORE 159 (BUNGENDORE 329384)

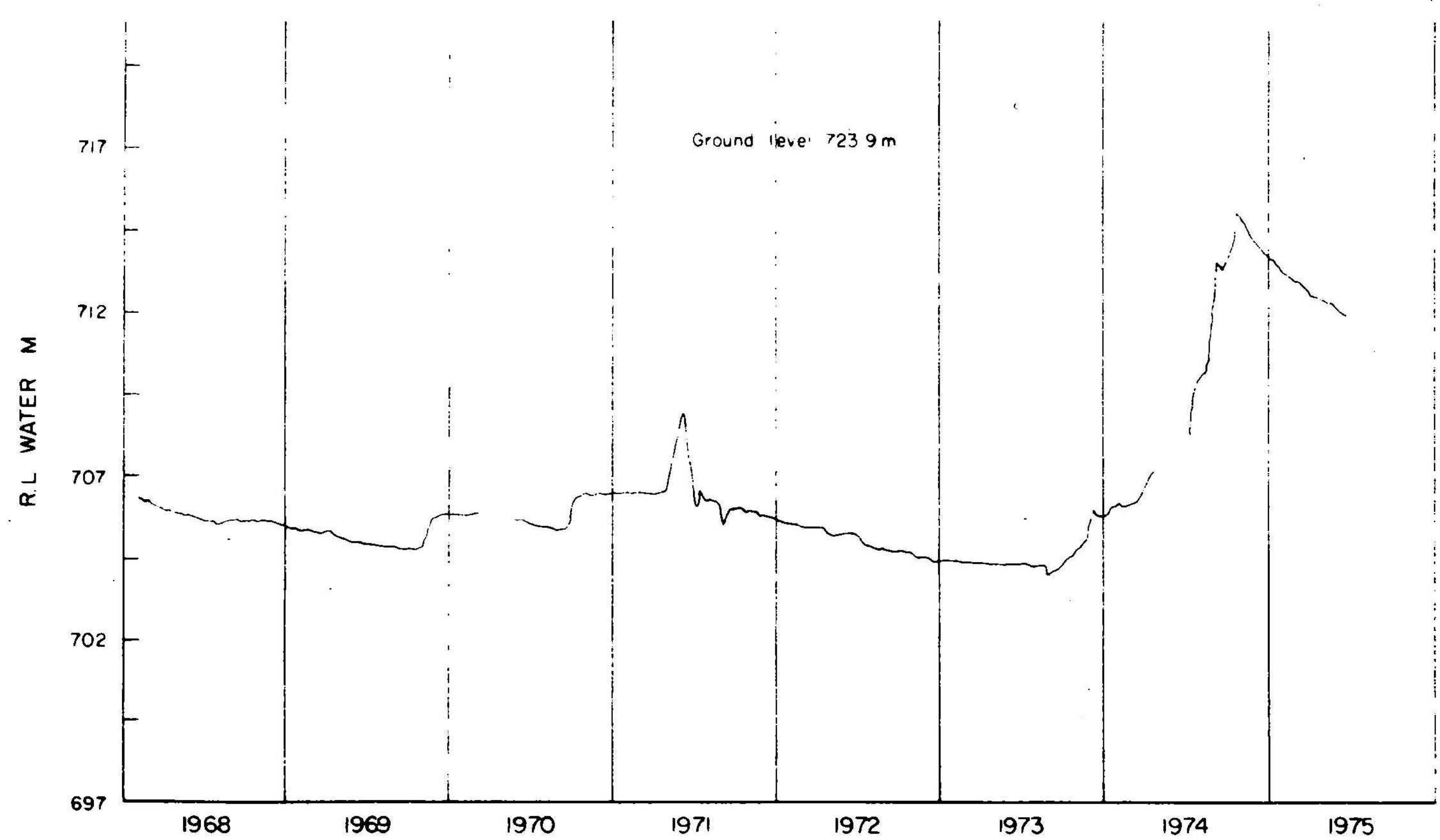


Fig. 2 Groundwater-levels in observation bores, Queanbeyan area, 1968-75.

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M(W)15

TABLE 3

WATER-BORES IN THE QUEANBEYAN AREA

Reg. no.	Location	Grid. ref.	Depth (m) Total	Depth (m) Aquifer	Supply m^3/hr	Salinity	Strata	Remarks
33	Canberra	162356						
34	Canberra	162344						
46	Canberra	201288	19.2					
47	Canberra	178302	24.69					
56	Canberra	155235	25.9		0.5	412		Used as observation bore, now pumped
58	Canberra	222621	20.4					
59	Canberra	221217	19.8					
60	Canberra	209216	19.5					
61	Canberra	214211	28.0					
68	Canberra	238283	24.1	11,18	6.60		Limestone	
88	Canberra	191495	154		9.0			Observation
120	Canberra	209309	21.3		1.36			
121	Canberra	205308	23.5		1.36			
122	Canberra	206309						
124	Canberra	237232	21.3	5-10			Shale, quartzite	
125	Canberra	246255	23.9			1540		
126	Canberra	237237	20.7			595		
145	Bungendore	393279	27.43					
149	Bungendore	391234	32.31		2.9		Shale	
159	Bungendore	329384		15-21	0.09		Sandstone	Observation K2
171	Canberra	237181						Abandoned, insufficient supply
189	Canberra	155282						
190	Canberra	255350						Abandoned, poor quality
198	Canberra	142273						
209	Canberra	196392	16.15		0.[illegible]			
210	Canberra	195392						
211	Canberra	192393	19.51					
213	Canberra	172179	45.7		2.71		Volcanic rocks	
214	Bungendore	318283	44.5	17,27,42	9.05	1050		Observation K3
222	Canberra	188270						
224	Canberra	142366	30.18				Volcanic rocks	
268	Bungendore	276266	53.0	0-53			Dacite	Observation, Googong damsite
269	Bungendore	267265	53.0	0-53			Dacite	Observation, Googong damsite
270	Bungendore	263247	34.1	14-16,26-29			Dacite	Observation, Googong damsite
271	Bungendore	228267	29.0	10-41	2.71		Dacite	Observation, Googong damsite
272	Bungendore	284270	53.0	44-53	little			
343	Bungendore	393253						
344	Bungendore	408297						
345	Bungendore	397233						
346	Bungendore	418338						
347	Bungendore	387226						
348	Bungendore	398277						
349	Bungendore	405274						
350	Bungendore	413241						
351	Bungendore	389252						

rocks. Joints in most rocks in the area promotes infiltration on the higher ground and seepage into and through colluvium at the foot of the slope. Ephemeral springs emerge on the slopes of Mount Jerrabomberra and along the foot of the Queanbeyan Fault scarp.

Details of rainfall in the Queanbeyan area have been given by Gunn & others (1969).

The hydrology of the Queanbeyan River has been documented by the Commonwealth Department of Works (1968) in connection with the Googong water supply project.

FLOODING

Flooding of the low-lying commercial centre of the city has been recurrent throughout Queanbeyan's history (Lea-Scarlett, 1968); the earliest recorded flood was in 1852. The highest recorded flood, in 1925, wrecked the suspension bridge and inundated the lower parts of Monaro and Macquoid Streets.

The 100-year flood levels for the Queanbeyan River below the Googong damsite are shown in Plate 4. Googong Dam is expected to reduce the incidence of flooding in the lower parts of Queanbeyan.

RESOURCES

The study area has potential resources of crushed rock and gravel, with lesser reserves of sand (Plate 3).

METALLIC MINERALS

No significant metallic mineral prospects are known in the area, although the now abandoned Captains Flat mine is located within the upper catchment of the Molonglo River. According to information supplied by the Geological Survey of New South Wales, small base-metal deposits occur at The Briars homestead, and south of Queanbeyan at the Valley Creek, Googong, and London Bridge prospects. Several exploration licences are current in the Googong prospect which is of some interest.

Minor amounts of alluvial gold have been won from a few creeks and from the Queanbeyan River. Quartz reefs in the area are generally barren.

CONSTRUCTION MATERIALS

Crushed rock

The crushed rock requirements for Canberra and Queanbeyan are being met by the Mugga, Readymix (RMC), and BMI quarries; the Readymix Cooma Road quarry is the only major quarry in the study area. Rock suitable for crushing is confined to the volcanic rocks to the southwest of the area, and has been delineated in Plate 3. Large reserves, should be available from sites screened from residential areas, but the thick mantle of weathered rock that is still retained on the higher areas will reduce the value of many potential quarry sites.

The area east of Royalla extending south to Williamsdale is of particular interest because porphyritic acid intrusive rocks crop out extensively in the hills; however, much of the rock is strongly foliated and the quality of the rock for aggregate would vary greatly.

Adamellite, with minor hornfelsed greywacke, limestone and dolomite is supplied from the RMC quarry on the Cooma Road. Other potential sources of crushed rock are to the north and south of the railway siding at Tuggeranong, and around Pemberton Trig and Enchanted Hill.

Limestone and interbedded volcanic rocks within the Colinton, Ainslie and Deakin Volcanics, and the Captains Flat and London Bridge Formations, may also provide rock suitable for crushing; the limestone locations have been shown in Plate 3, but most of them are too small for a major quarrying operation. Rocks to the east of Jerrabomberra Creek are strongly foliated, and tend to produce angular fragments; some of the volcanics contain disseminated pyrite and/or devitrified silica.

Numerous metarhyodacite and metadolerite dykes occur in the eastern part of the Cullarin Horst; some may prove suitable for aggregate but reserves could be limited as their extent and form is most irregular, and proving such deposits would require close drilling and careful exploration.

23

Road-making aggregate (plastic and non-plastic gravels)*

Material suitable for use as road base and for similar construction purposes can be obtained from extremely and highly weathered jointed volcanic and sedimentary rock.

Plastic gravels derived from deeply weathered adamellite (Barrack Creek Adamellite)have been supplied from a number of pits along the Cooma Road (Plate 3). The rock is coarse-grained, of quartz-feldspar composition, and breaks down to form a low-plasticity gravel consisting of subrounded quartz grains and kaolinite. The Colinton Volcanics also produce plastic and semi-plastic gravels in areas of deep weathering and steeper slopes.

Slopewash deposits adjacent to weathered granitic rocks in the southwest of the study area produce gravels of low plasticity that have been worked near the Monaro Highway; their average thickness is 2-3 m.

Scree and slopewash accumulations at the base of the dissected scarp along the Queanbeyan Fault produce a gravel that contains much clay. Thick slopewash on the lower slopes of Mount Jerrabomberra contains cobbles and pebbles of quartzite in a fine-grained matrix of silt and clay. These materials have been used in road-making in the past, but would not meet modern specifications for road materials.

Sand and gravel

Stratified alluvial deposits of silt, sand, and gravel occur along the Queanbeyan and Molonglo Rivers and Jerrabomberra Creek.

Sand and gravel for aggregate have been exploited along the Queanbeyan River; deposits are generally of limited extent and non-uniform in composition; access may be difficult. Organic silt suitable for use as topsoil occurs along small creeks and on meander flood plains adjoining the river, but the deposits are limited in extent.

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* 'Non plastic gravel' is used as a surface course beneath a seal and its PI must not exceed 6, and maximum particle size should not exceed 3.8 cm. 'Plastic gravel' should have a higher percentage of fines than non-plastic gravel.

Gravel, sand, and silt deposits are present along the Molonglo River in the present river channel, in old river channels, and on alluvial flats and terraces. The extensive flood plain adjacent to the Molonglo River near Carwoola may contain some reserves of sand and gravel, but distance from the existing market excludes their use at present, and the reserves have yet to be determined.

Closer to Canberra, the area to the east of Lake Burley Griffin contains large reserves of sand, gravel, and silty material suitable for topsoil. Before the site of Lake Burley Griffin was filled with water, topsoil was removed from much of the East Basin, and substantial reserves of sand and gravel still remain on the bed of the East Basin.

Jerrabomberra Creek has small poorly graded deposits of silt, sand, and gravel.

Fine windblown sand used in the building industry as plaster sand, is widely distributed in the Molonglo valley east of Canberra. Deposits in the Pialligo area have been extensively worked, and lesser quantities are being extracted to the south of Burbong. The sand is a remnant of fixed dunes, and the development of a soil profile has produced a clayey B horizon and zones of ironstone pisolites (hardpan) that are rejected during extraction for use as plaster sand.

Stone

The following rock types have been used as rough stone for retaining walls and rough flagging, rubble walls, and foundation facings.

1. Sandstone and siltstone of the State Circle Shale,
2. Sandstone from the Black Mountain Sandstone,
3. Sandstone of the Pittman Formation,
4. Igneous rocks such as dacite and rhyodacite, from the Ainslie, Deakin, and Colinton volcanics, and
5. Metamorphic rocks such as metadolerite and metarhyodacite that crop out in the south and east of the area.

25

Brick shale and clay

Bricks have been made with shale from various sites within and near Queanbeyan from an early time. Up until 1973, about half of the brick shale requirements of the Commonwealth Brickworks was met by the quarry on the northeast slope of Mount Jerrabomberra. This quarry is now abandoned, and is used for refuse disposal by the Queanbeyan City Council.

The two brickworks within the Queanbeyan town area, Clifton and Multibrick, derive their clay from Bungendore, Sutton, Braidwood, and Windellama, all of which are outside the study area. Shale has been quarried at the Multibrick quarry site but produced poor quality bricks, discoloured by the presence of iron oxides.

Minor clay and shale deposits occur near Googong and Mahons Hill (calcareous), and in the east larger deposits are located near Bungendore and Hoskinstown. Many of the deposits are unworked; samples taken by the Geological Survey of New South Wales have proved satisfactory, but further testing will be needed to determine depth and extent of the deposits. Lacustrine clay underlies the alluvium near Carwoola.

Slate has been obtained from a small quarry in Acton Shale to the east of the brick shale quarry on Mount Jerrabomberra.

No deposits of kaolin or refractory* clay are known in the area.

Limestone

Limestone lenses are interbedded with the volcanic rocks of the Colinton and Deakin Volcanics, and the London Bridge Formation. They are mostly found in the Queanbeyan River valley and to the southeast in Primrose Valley near Woolcara homestead; the deposits are generally too small or structurally complex to be worked economically. Limestone has been extracted south of Queanbeyan on the western banks of the Queanbeyan River, but most of the rock is thinly bedded and not suitable for crushing. Farther south at

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* Clay with high silica and/or high alumina.

grid ref 274272 a sizeable deposit of limestone and dolomite is associated with phyllitic shale, sheared volcanics, and greywacke; the deposit is not large enough for a major quarrying operation, and the site lies within a proposed urban development area.

CONCLUSIONS: GEOLOGICAL CONSTRAINTS ON PLANNING

1. There are no major constraints to urban development in the area, although steep slopes will restrict development in places.
2. The Ordovician rocks of the Cullarin Horst are slightly to moderately weathered and have a thin cover of soil; excavation services will require regular blasting.
3. Poorly drained soils provide minor drainage problems, mainly in the valley of Jerrabomberra Creek.
4. Some soils are susceptible to erosion, and the design of road cuts and service installations should cause a minimum of disturbance to the land surface, and measures to prevent erosion should be adopted.
5. The area contains resources suitable for construction.
6. The alluvium beneath central Queanbeyan ranges in depth to 12 m; multistorey buildings will probably require piled foundations, and excavations below the water-table will have to cope with large groundwater inflows.
7. Low-lying areas close to the Queanbeyan River will be less prone to flooding now that the Googong Dam is completed.
8. The area is one of minor seismic activity, and buildings founded on unconsolidated materials such as alluvium or colluvium are more susceptible to damage during a seismic event.
9. Multilevel buildings should be designed according to specifications for Zone A of the Standards Association of Australia Draft Code No DR76100 'Draft Australian Standard Rules for the design of Earthquake-Resistant buildings' 15 September 1976.

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APPENDIX I

UNIFIED SOIL CLASSIFICATION SYSTEM

CLASSIFICATION CHART

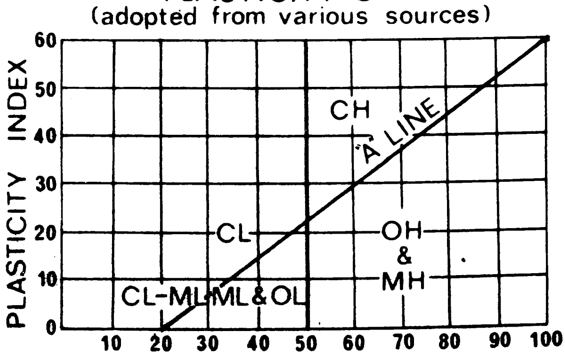
MAJOR DIVISIONS		SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 1/2 of soil > No 200 sieve size)	GRAVELS (More than ½ of coarse fraction > no. 4 U.S. sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines*
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixture
		GC	Clayey gravels, gravel-sand-clay mixture
	SANDS (More than ½ of coarse fraction > no 4 U.S sieve size)	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand silt-mixtures
		SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS (More than 1/2 of soil < No. 200 sieve size)	SILTS AND CLAYS Liquid limit > 50	ML	Inorganic silt and very fine sands, rock flour, silty or clayey fine sands or clayey silts with low plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticty
	SILTS AND CLAYS Liquid limit > 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils

*fines - portion of a soil finer than a no. 200 sieve

GRAIN SIZE CHART

Classification	Range of grain size: U.S. Standard Sieve Size	Range of grain size: Grain Size in Millimetres
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76·2
GRAVEL	3" to No. 4	76·2 to 4·76
coarse	3" to 3/4"	76·2 to 19·1
fine	3/4" to No 4	19·1 to 4·76
SAND	No. 4 to No. 200	4·76 to 0·074
coarse	No. 4 to No. 10	4·76 to 2·00
medium	No. 10 to No. 40	2·00 to 0·420
fine	No. 40 to No. 200	0·420 to 0·074
SILT & CLAY	Below No. 200	Below 0·074

PLASTICITY CHART
(adopted from various sources)



APPENDIX 2

DEGREES OF WEATHERING

Fresh (FR)	No discolouration or loss in strength.
Fresh stained (FRST)	Limonitic staining along fractures; rock otherwise fresh and shows no loss of strength.
Slightly weathered (SW)	Rock is slightly discoloured, but not noticeably lower in strength than the fresh rock.
Moderately weathered (MW)	Rock is discoloured and noticeably weakened; N-size drill core generally cannot be broken by hand ac-oss the rock fabric.
Highly weathered (HW)	Rock is discoloured and weakened; N-size drill core can generally be broken by hand across the rock fabric.
Extremely weathered (EW)	Rock is decomposed to a soil, but the original rock fabric is mostly preserved.

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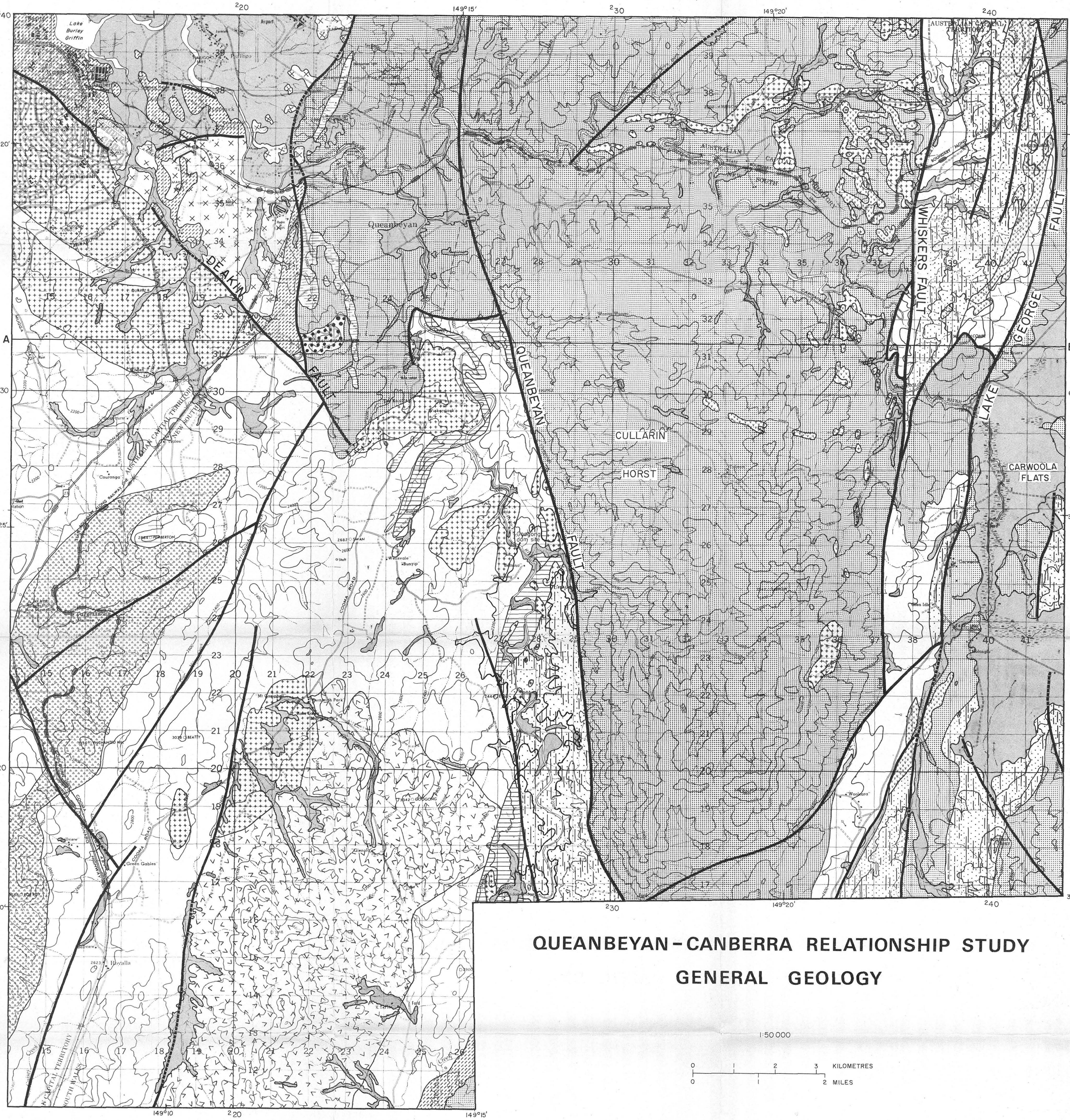
PLATE 1



QUATERNARY	Colluvium Alluvium	Clay, silt, sand, gravel
UPPER SILURIAN	Mount Painter Porphyry Mugga Mugga Porphyry Barrack Creek Adamellite Googong Granite	Porphyritic dacite and rhyodacite; acid intrusive rocks
		Basic dyke rocks
MIDDLE-UPPER SILURIAN	Ainslie Volcanics	Dacite, andesite
	Williamsdale Volcanics	Rhyodacitic tuff
	Colinton Volcanics (part)	Porphyritic rhyolite
	Deakin Volcanics Captains Flat Formation Colinton Volcanics (part)	Acid volcanic rocks, tuff
	Colinton Volcanics (part) London Bridge Fmn (part)	Limestone, shale, tuff
	London Bridge Fmn (part) Carwoola Beds	Siltstone, sandstone
	Fairbairn Group Canberra Group Cappannama Formation	Shale, siltstone
LOWER SILURIAN	Black Mountain Sandstone State Circle Shale	Dominantly sandstone with interbedded siltstone. Siltstone & mudstone at base grading to siltstone with sandstone interbeds to massive sandstone.
MIDDLE-UPPER ORDOVICIAN	Acton Shale	Siliceous shale and slate
MIDDLE ORDOVICIAN	Pittman Formation Foxlow Beds	Dominantly sandstone, shale, siltstone with some chert, phyllite

Fault or major lineament

Fault or major lineament, concealed

Geological boundary

Geological boundary, concealed

Contour interval 200 feet

Reservoir margin

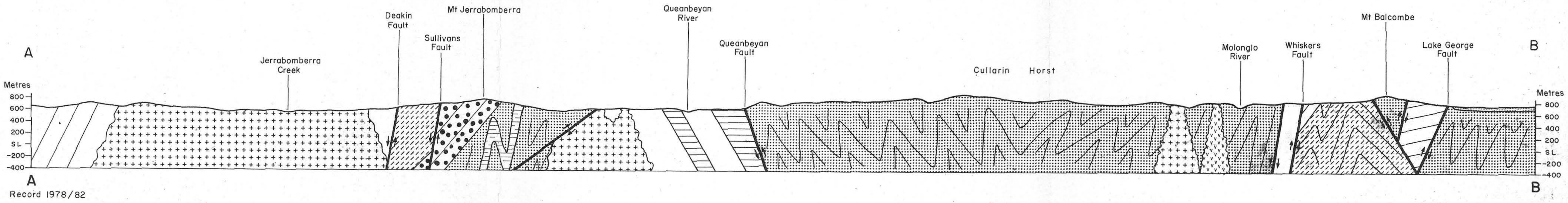
Quarry outline

QUEANBEYAN - CANBERRA RELATIONSHIP STUDY
GENERAL GEOLOGY

1:50 000

0 1 2 3 KILOMETRES

0 1 2 MILES



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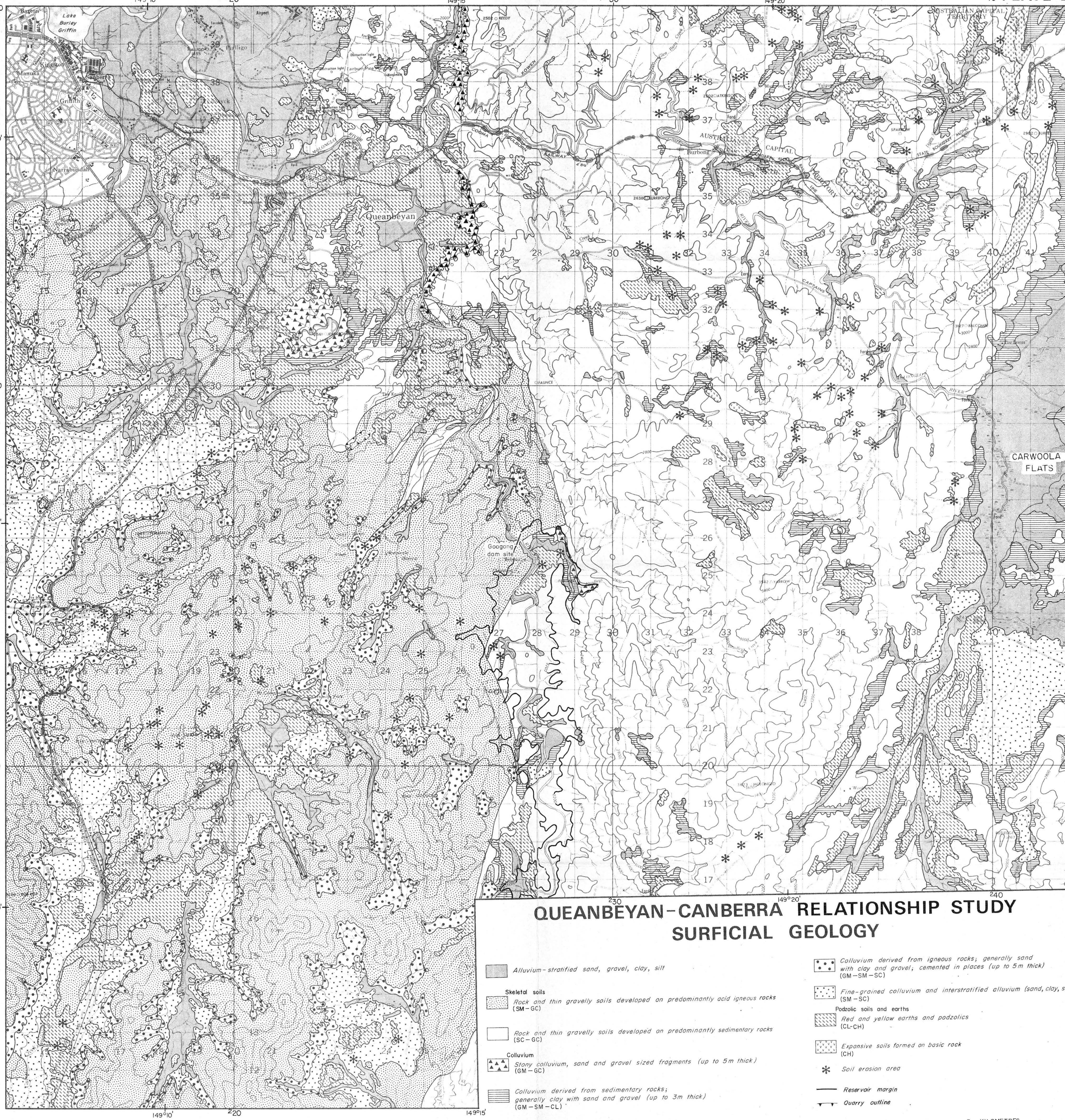
155/A16/1559



QUEANBEYAN–CANBERRA RELATIONSHIP STUDY
SURFICIAL GEOLOGY

Alluvium – stratified sand, gravel, clay, silt

Skeletal soils

Rock and thin gravelly soils developed on predominantly acid igneous rocks (SM – GC)

Rock and thin gravelly soils developed on predominantly sedimentary rocks (SC – GC)

Colluvium

Stony colluvium, sand and gravel sized fragments (up to 5m thick) (GM – GC)

Colluvium derived from sedimentary rocks; generally clay with sand and gravel (up to 3m thick) (GM – SM – CL)

Colluvium derived from igneous rocks; generally sand with clay and gravel; cemented in places (up to 5m thick) (GM – SM – SC)

Fine-grained colluvium and interstratified alluvium (sand, clay, silt) (SM – SC)

Podzolic soils and earths

Red and yellow earths and podzolics (CL – CH)

Expansive soils formed on basic rock (CH)

* Soil erosion area

Reservoir margin

Quarry outline

0 1 2 3 KILOMETRES
0 1 2 MILES
1:50 000

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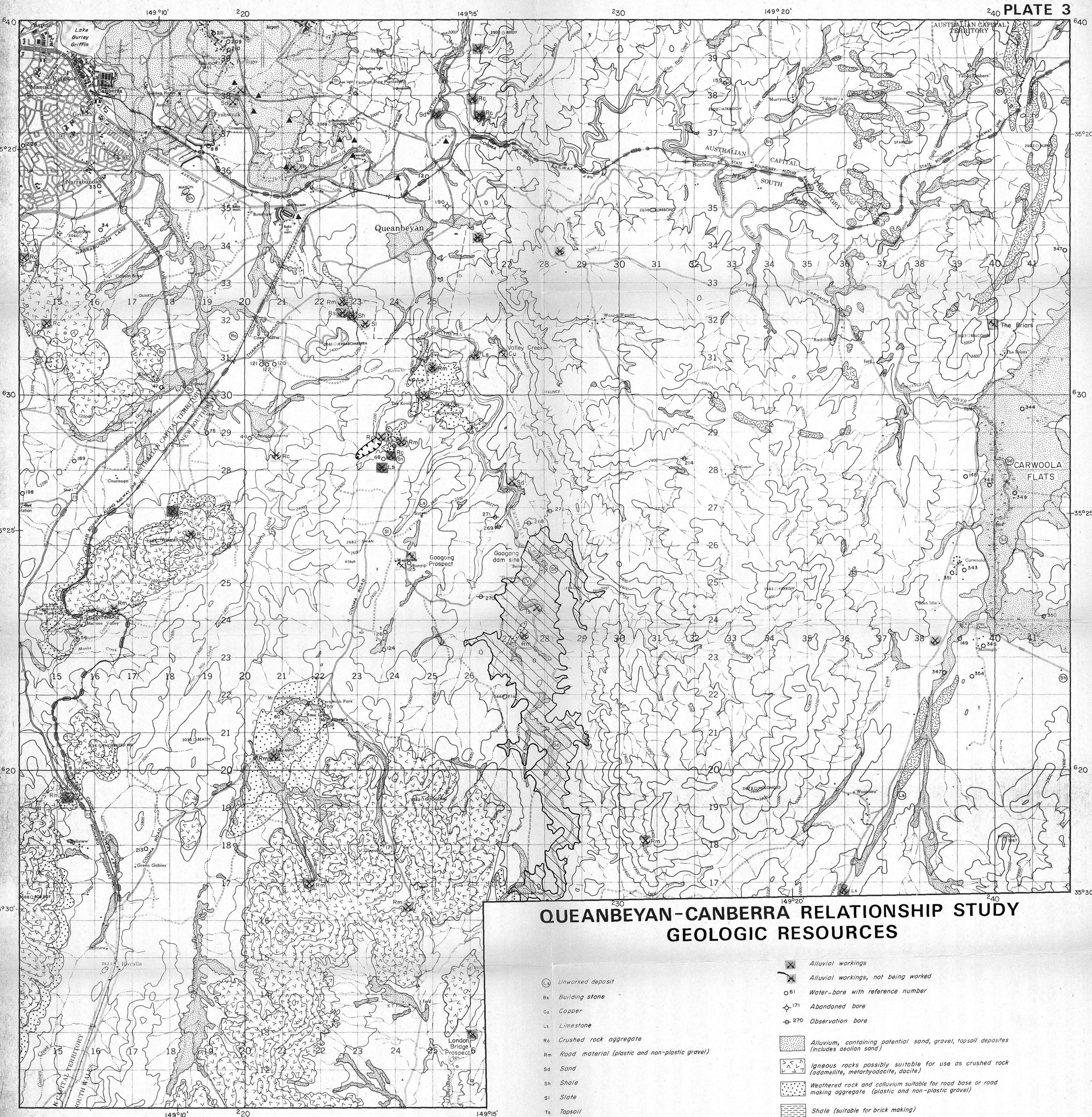


QUEANBEYAN-CANBERRA RELATIONSHIP STUDY
GEOLOGIC RESOURCES

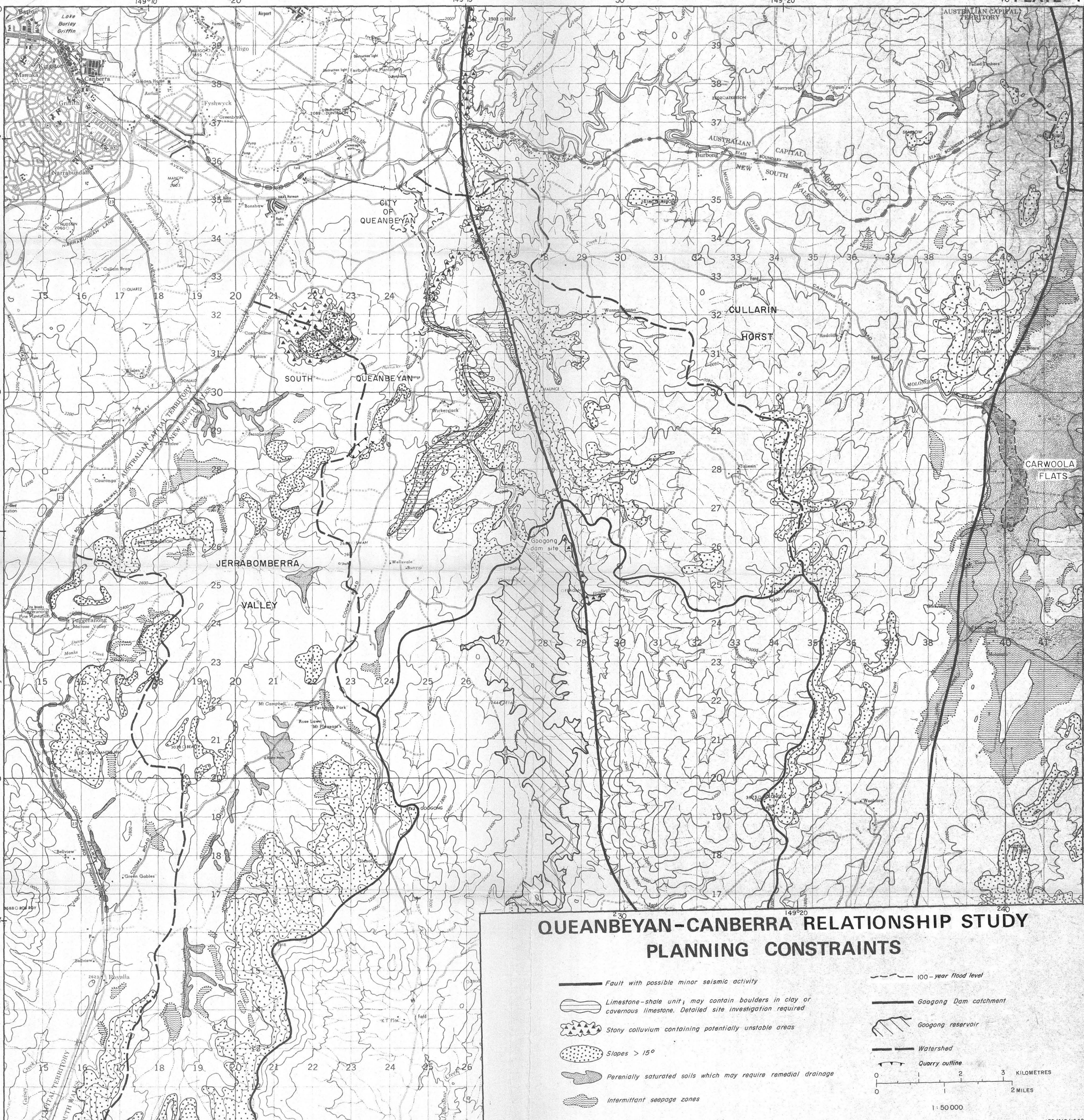
- (Ls) Unworked deposit
- Bs Building stone
- Cu Copper
- Ls Limestone
- Rc Crushed rock aggregate
- Rm Road material (plastic and non-plastic gravel)
- Sd Sand
- Sh Shale
- Sl Slate
- Ts Topsoil
- ▲ Aeolian sand
- Prospect - little or no production
- Mine
- Mine, not being worked
- Quarry or pit
- Quarry or pit, not being worked
- Alluvial workings
- Alluvial workings, not being worked
- ○61 Water-bore with reference number
- 171 Abandoned bore
- 270 Observation bore
- Alluvium, containing potential sand, gravel, topsoil deposites (includes aeolian sand)
- Igneous rocks possibly suitable for use as crushed rock (adamellite, metarhyodacite, dacite)
- Weathered rock and colluvium suitable for road base or road making aggregate (plastic and non-plastic gravel)
- Shale (suitable for brick making)
- Basic rocks possibly suitable for crushed rock
- Reservoir
- Quarry outline

0 1 2 3 KILOMETRES
0 1 2 MILES

1 : 50 000

Record 1978/82

155/A16/1541



QUEANBEYAN-CANBERRA RELATIONSHIP STUDY
PLANNING CONSTRAINTS

Record 1978/82

155/A16/1542