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DEPARTMENT OF MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1975/148

ENGINEERING GEOLOGY OF McKELLAR, BELCONNEN, A.C.T.

by

G. BRISCOE and P. ROSENGREN

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CONTENTS

SUMMARY

The proposed suburb of McKellar, in north east Belconnen, was investigated to delineate areas with design constraints for the planning of urban development. A geological map was prepared showing areas where difficulties in development may be encountered, such as rock outcrops and poorly drained areas.

Hand and power augers were used in areas of little or no surface outcrop to examine the soil cover, and to determine the depth to and nature of the underlying rock. Soil samples were tested for plasticity parameters.

Drainage problems are present in the alluvial flats adjoining Ginninderra Creek to the east, and near the erosion gullies in the west, and the design of drainage systems will require investigation of the soil permeability.

The underlying rocks weather irregularly to variable depths, but the greater depths of weathered rock underlie the higher ground. Excavation can generally be achieved using mechanical equipment, with light blasting if rock outcrop or large boulders are encountered. The extremely weathered rock and soil should provide adequate foundation for the types of structures envisaged in the suburb.

INTRODUCTION

At the request of the National Capital Development Commission (NCDC), the geology, and its relevance to urban planning, of the proposed suburb of McKellar was investigated in June-July, 1975. The work included field mapping, airphoto-interpretation, and augering.

The accompanying plan (Plate 1) indicates areas of rock outcrop and their height above ground; the depths to moderately weathered rock in soil-covered areas; approximate geological boundaries; and drainage problem areas.

Logs of the hand auger holes are shown in Figure 1, and logs of the power auger holes, in Appendix 1.

The geology of the McKellar area was previously mapped by Strusz & Henderson (1971) and Yendall, Walraven & Doutch (1967).

PHYSIOGRAPHY

McKellar consists of undulating, cleared pasture land which is drained to the southwest, south, and east by Ginninderra Creek, now impounded to form Lake Ginninderra. A north-south-trending ridge that divides the area has steeper slopes on its western side. Two erosion gullies occur in the northwest, and swampy conditions within the gullies and downslope colluvial sediments are likely to persist for most of the year. The northeastern section slopes gently down to extensive alluvial flats along Ginninderra Creek.

GEOLOGY

The northeastern part of McKellar is overlain by thin (1 m) Quaternary alluvium adjacent to Ginninderra Creek, and thicker accumulations (2-6 m) of interstratified slopewash and alluvium underlie the gently sloping ground farther away from the creek. Investigations in this area were restricted by road construction works.

Calcareous Shale

The term 'calcareous shale' is a broad descriptive term that includes all stages of weathering of hard strongly cleaved blue-grey calcareous mudstone. During the weathering process, the carbonate cement is leached from the rock; the extremely weathered product is a soft, yellow-brown shale. The boundary between relatively soft and rippable, highly weathered shale, and hard, less weathered and non rippable calcareous mudstone is generally sharp.

The alluvium on the flats adjacent to Ginninderra Creek in the northeast of the area overlies black and blue-grey calcareous shale which was formerly exposed along the creek bed but is now covered by Lake Ginninderra. Farther from the creek, the thickness of alluvium and colluvium is generally about 5 m, and the underlying calcareous shale (drillholes G6, G7 and G8) is generally moderately weathered to fresh. For shallow excavations, mechanical removal of the extremely to highly weathered shale will be possible; however, blasting will be required where the shale is slightly weathered to fresh and retains its calcareous cement. Shale outcropping in the creek bed was slightly weathered to fresh at about 0.5 m.

Igneous Rocks

Igneous rocks underlie the remainder of the area; their ourcrop is generally sparse. They comprise an east-west band of adamellite that ranges in width from less than 50 m to 400 m, and intrude a sequence of volcanic rocks (dacite).

Adamellite

The adamellite crops out as large rounded boulders of fresh to slightly weathered rock which project up to 1.5 m above the ground. The rock is irregularly weathered, with core-stones of fresh to slightly weathered rock completely surrounded by soil or extremely weathered rock. Subsurface conditions are variable; mechanical excavation to about 2 m will be possible in most of this area, but blasting may be required for the excavation of larger boulders and massive outcrops close to the surface. The depth of weathering is generally greater on the more elevated ground; very deep weathering is not uncommon, and drillhole G3 intersected more than 23 m of soil and extremely to highly weathered rock. The weathering is facilitated by jointing and shearing, and the distribution of weathered rock is expected to be irregular at depth.

Marginal Zones

A series of acid rocks of varying composition, texture, and grainsize is closely associated with the adamellite. They have been mapped as a separate unit in Plate 1, but have engineering properties similar to the adamellite. Outcrops project up to 0.6 m above the ground and generally consist of rounded

boulders, which are commonly jointed and are, in places, foliated.

Dacite

Green-grey, coarse to medium dacite underlies the rest of the area but crops out less extensively than the adamellite. Where fresh, the rock is strong but jointed, and occurs in scattered outcrops projecting up to 1 m (average 0.3 m) above the ground surface. The weathering does not seem to be as irregular as that observed in the adamellite. Ripping to a depth of 2.0 m will probably be possible, but light blasting may be required for boulders. Augering has indicated variable depths of weathering, with the depth to moderately weathered rock ranging to more than 10 m.

QUARTZ REEFS OR VEINS

A fault striking northwest across the area contains a number of massive quartz reefs and pockets of fault breccia in low discontinuous surface outcrops. Within and adjacent to the reefs local hardening of the rocks, which is due to silicification and the injection of quartz, may cause excavation problems; however, the shearing and jointing in rock adjacent to the fault may have facilitated deep weathering and easy excavation.

SOILS

The soils in McKellar can be divided into residual soils, including red and red-brown earths, yellow podzolics, and skeletal soils; and transported soils, including alluvium and slopewash. A number of samples were tested for plasticity and shrinkage coefficients; the results are given in Table 1.

RESIDUAL SOILS

Residual red and red-brown earths are widespread with the redder soils occurring in the better drained areas. A typical residual soil comprises 5 to 30 cm of brown sandy silt (topsoil) overlying red and yellow sandy clay, which grades into weak, extremely weathered parent rock. The susceptibility of the underlying rock to weathering is responsible for variation in the profile depth. This variation, especially in the volcanics and adamellite, is con-

trolled by jointing and shearing, and in general the rocks are more deeply weathered on elevated ground. Depths to highly weathered rock in the area may range to 10 m on the dacite, and to 23 m on the adamellite.

Thin skeletal soils are present in the areas of scattered surface outcrop; they generally consist of a sandy clay with abundant coarse quartz (average size 5 mm) and rock fragments.

The erosion gullies in the northwest of the area (Plate 1) expose 2 to 3 metres of soil consisting of up to 0.4 m of grey brown earth overlying a remnant of residual podzolic soil. This podzolic soil is composed of a hard-pan of goethite-rich pisolites above a dense yellow to grey low-permeability clay, which is saturated at the base of the erosion gullies. Calcareous nodules, average size 2 cm, occur in the B2 horizon.

TRANSPORTED SOILS

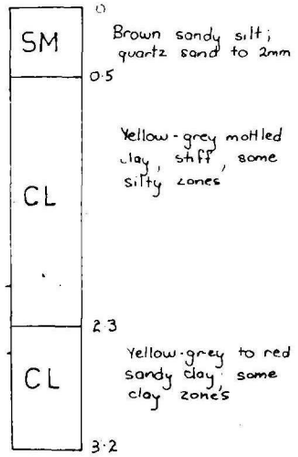
An alluvial fan spreads from the foot of the erosion gullies. Several parts of the fan contain saturated soils; however, only in the worst parts is there evidence of perennial waterlogging. The material consists of grey and black silts and clays of medium plasticity (H19 and 20 in Table 1) with minor sand and gravel.

The alluvium and slopewash in the northeast corner of McKellar consists of heavy black to dark brown organic clays grading into inorganic brown-yellow clays and silts which are of low to medium plasticity and are sandy in places. Hole G8 intersected sandy clayey gravel consisting of platy to sub-angular rock fragments generally less than 1 cm in size.

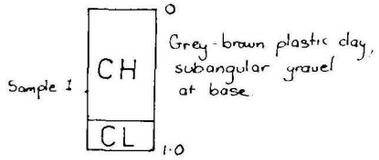
TABLE 1. SOIL TEST DATA

Hole	Depth in metres	Sample	Liquid Limit	Plastic limit	Plasticity index	Linear Shrinkage
H1	2.0	4	33	18	15	11.45
H1	2.5	5	39	15	24	11.4
H6	0.7	2	24	18	6	4.0
H6	0.4	1	24	22	2	2.0
H17	0.2	1	26	25	1	0.6
H19	0.9	3	48	22	26	11.2

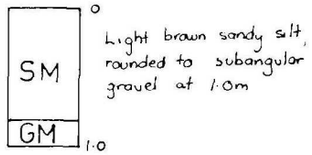
H1 (582·5) (Residual soil on dacite)



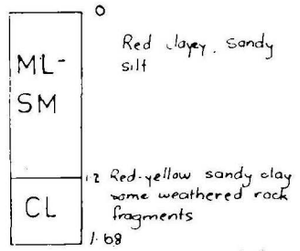
H2 (577·5) (Alluvial/colluvial soil on calcareous shale)



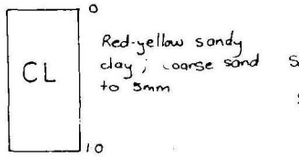
H3 (584) (Residual soil on dacite)



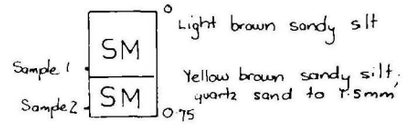
H4 (588) (Residual soil on adamellite)



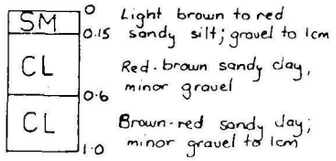
H5 (595) (Residual soil on adamellite)



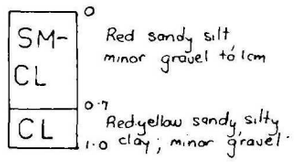
H6 (592) (Residual soil on dacite)



H7 (596) (Residual soil on dacite)

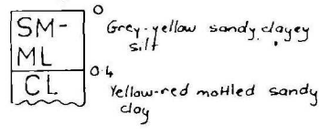


H8 (610) (Residual soil on volcanics)

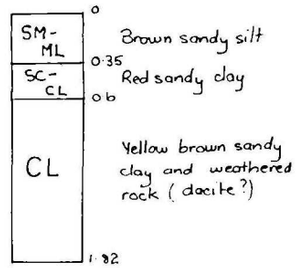


H9 (601·5) (Residual soil on volcanics)

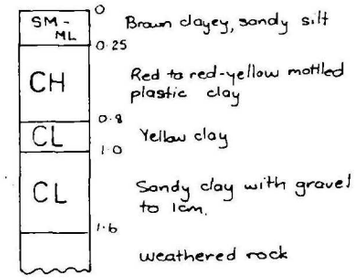
H10 (594) (Residual soil on dacite)



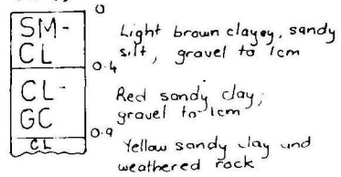
H11 (603) (Residual soil on dacite)



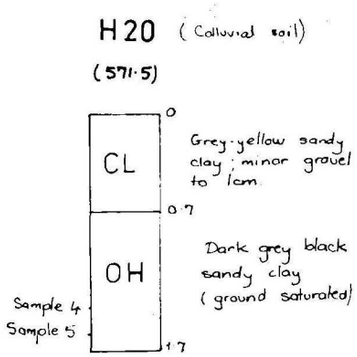
H12 (605·5) (Residual soil on dacite)



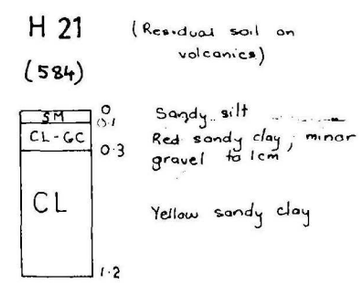
H15 (604) (Residual soil on adamellite)



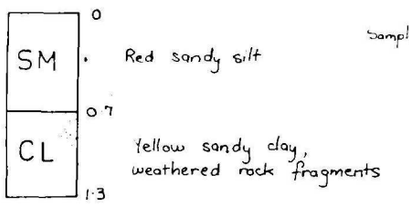
H20 (571·5) (Colluvial soil)



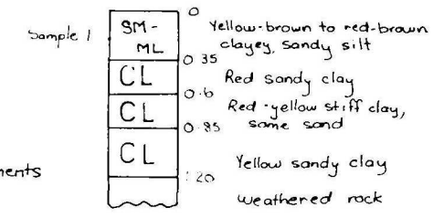
H21 (584) (Residual soil on volcanics)



H16 (604) (Residual soil on adamellite)

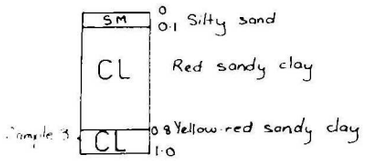


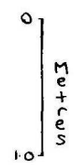
H17 (599) (Residual soil on dacite)



H18 (592·5) (Residual soil on volcanics)

H19 (572) (Colluvial soil)





(571·5) Reduced level of ground surface in metres

Auger refusal

For key to letter symbols, see figure 2

FIG 1: LOGS OF HAND AUGER HOLES McKELLAR

UNIFIED SOIL CLASSIFICATION SYSTEM FIGURE 2

CLASSIFICATION CHART

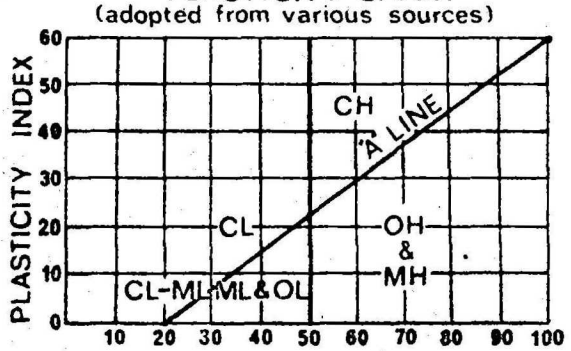
MAJOR DIVISIONS		SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 1/2 of soil > No 200 sieve size)	GRAVELS (More than 1/2 of coarse fraction > no 4 U.S. sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines*
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixture
		GC	Clayey gravels, gravel-sand-clay mixture
	SANDS (More than 1/2 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	Grain Size in Millimetres
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76·2
GRAVEL		
coarse	3" to No. 4 / 3" to 3/4"	76·2 to 4·76 / 76·2 to 19·1
fine	3/4" to No 4	19·1 to 4·76
SAND		
coarse	No. 4 to No. 200 / No. 4 to No. 10	4·76 to 0·074 / 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)



H20	1.4	4	33	16	17	3.39
H20	1.6	5	39	14	25	11.62
H2	0.5	1	65	25	40	10.8
G7	2.5	1	40	15	29	12.4
G6	2.0	1	40	14	26	13.7
G8	2.5	1	32	13	17	8.3

1. Liquid limit AS A89-1966 (Test 2A)
2. Plastic limit AS A89-1966 (Test 3A)
3. Plasticity index AS A89-1966 (Test 4A)
4. Linear shrinkage AS A89-1966 (Test 5A)

DRAINAGE

Two areas with soil drainage problems have been noted during field investigations; they are the alluvial fan and nearby erosion gullies to the west, and the alluvial flats to the northeast. High rainfall during the winter of 1975 combined with the low permeability of the clays has water logged the soils in extensive areas and accentuated the soil drainage problem.

ALLUVIAL FAN AND EROSION GULLIES

The alluvial fan at the foot of the erosion gullies was saturated when inspected in July 1975; the heavy black clays and coarse grasses indicate that saturation in parts of the fan is perennial, and not seasonal.

Very low permeability clays were in a saturated state in the erosion gullies and on adjacent hillslopes; in the more variable materials in the alluvial fan, low permeability clays are associated with perched water-tables. Seepages were noted along the sides of the northern gully and water was observed to be slowly discharging over a rock bar in the southern erosion gully. Hole G9 intersected two saturated clayey sands up to 10 cm thick.

The alluvial fan will have to be drained if it is planned as a site for buildings or recreation. The materials of the alluvial fan should be investigated, so that the location and depths of drains will dewater the permeable beds in the fan. Remedial work will also be needed to contain gully erosion and to drain the clays in the gullies.

NORTHEAST ALLUVIAL FLAT

Extensive areas of perennially saturated clay soils are indicated by the vegetation on the alluvial flat. The plans for development indicate that much of this area is to be built up with spoil. Much of the spoil will have a low permeability after consolidation and it is expected that the lower 0.5 m of the spoil will be in an almost permanently saturated condition. Investigation of the soil conditions in the poorly drained areas would seem appropriate before the area is covered with fill, and a foundation investigation should be regarded as essential to the design of structures on the areas of fill.

CONCLUSIONS

1. No major problems in the development of McKellar are anticipated.

2. Excavations for most services and buildings can probably be achieved with mechanical equipment, but the scattered surface outcrops and irregular weathering in the adamellite and dacite indicate that some light blasting will be required, particularly on the steeper slopes to the west.

3. Highly to moderately weathered rock is found at depths ranging to 23 m, and foundation investigations will be required for major buildings; suitable foundation material will occur at greater depths on the rises.

4. The erosion gullies and alluvial fan in the west will have to be drained if the area is to be used perennially.

5. Drainage of the alluvial soils in the northeast does not appear to be a prerequisite for development; however, an investigation to assess groundwater conditions and the cause of poor drainage before the area is covered with spoil would prove useful when planning major earthworks or structures in this area.

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APPENDIX 1

LOGS OF GEMCO AUGER HOLES, McKELLAR

Logs of Gemco Auger Holes : McKellar

Hole G1

Depth in metres	Description
0 - 0.46	Brown clayey sandy silt, low plasticity
0.46- 1.52	Reddish brown sandy clay, high plasticity
1.52- 3.66	Yellow sandy clay with rock fragments
3.66- 4.57	Extremely to highly weathered rock in plastic sandy clay
4.57- 6.10	Orange-yellow sandy clay and extremely weathered rock
6.10- 6.55	Yellow-fawn highly to moderately weathered dacite
6.55- 7.93	Sandy clay and extremely weathered dacite
7.93- 8.08	Greyish yellow plastic clay
8.08-11.43	Extremely to highly weathered dacite, and weak clay seams

Hole G2

0 - 0.31	Brown silty sandy clay
0.31- 0.76	Red sandy clay, medium plasticity
0.76- 1.22	Yellow sandy clay, medium plasticity
1.22- 5.94	Sandy clay with rock fragments
5.94- 6.71	Extremely to highly weathered dacite

Hole G3

0 - 0.61	Dark brown to reddish brown silty sandy clay
0.61- 1.83	Yellow to reddish yellow mottled sandy clay
1.83-17.98	Sandy clay and extremely to highly weathered rock containing quartz and altered feldspar
17.98-18.13	Extremely to highly weathered fragments of porphyritic rhyolite
18.13-18.79	No recovery
18.79-19.35	Extremely to highly weathered rhyolite
19.35-23.42	No recovery
23.42-23.62	Highly weathered rhyolite, fractured

Hole G4

0 -0.15	Brown sandy clay
0.15- 0.61	Red sandy stiff clay

Hole G4 (cont.)

0.61-12.95	Yellow sandy clay with extremely to highly weathered rock, weak
12.95-13.11	Fawn extremely to highly weathered dacite

Hole G5

0 - 0.15	Brown sandy silt
0.15- 0.91	Red and yellow mottled stiff clay
0.91- 1.52	Yellow sandy clay
1.52- 1.83	Extremely weathered rock, weak
1.83- 2.28	Yellow sandy clay
2.28- 2.58	Extremely weathered rock
2.58- 3.05	Yellow sandy clay
3.05-10.36	Extremely weathered rock and sandy clay
10.36-11.28	Fawn extremely to highly weathered dacite

Hole G6

0 - 0.15	Light brown sandy clay
0.15- .31	Brownish red to red silty clay
.31- 2.28	Red stiff clay with minor yellow mottling
2.28- 2.74	Reddish yellow to yellow clay
2.74- 4.88	Yellow-brown clay and mottled brown-yellow clay
4.88- 5.02	Core loss
5.02- 6.70	Grey-black highly to moderately weathered shale core pieces 0.5 cm to 6.0 cm. Fractured;yellow clay on joints

Hole G7

0 - 0.25	Light brown silty clay
0.25- 0.38	Dark brown silty clay
0.38- 3.19	Yellowish brown mottled and yellow clay, sticky
3.19- 3.66	Black shale, core broken into pieces 0.5-5.0 cm
3.66- 5.33	Black extremely to moderately weathered shale becoming slightly weathered, some clay and weak rock seams

Hole G8

0 - 0.15	Brown silty clay
0.15- 1.22	Reddish brown to red stiff clay, sandy clay layers
1.22- 3.05	Yellow clay and yellow sandy clay
3.05- 4.42	Sandy clay and platy subangular to subrounded gravel (5 mm - 3 cm) layers

Hole G8 (cont.)

4.42- 5.48	Black highly to moderately weathered shale, steeply dipping joints. Clay and Fe on joints

Hole G9

0 - 0.31	Brown clayey silt
0.31- 0.46	Brown sand grading down to clayey sand
0.46- 1.54	Brownish red to red stiff clay
1.54- 9.45	Yellow sandy clay and extremely weathered rock fragments (to 2.0 cm) containing quartz and altered feldspar
9.45- 9.82	Brown clayey sand, saturated
9.82-10.06	Yellow sandy clay
10.06-11.58	Moderately to extremely weathered green-grey dacite

Hole G10

0 - 0.20	Brown sandy clay and clayey sand
0.20- 0.60	Pebbles angular to subrounded Moderately weathered adamellite
0.60- 3.00	Highly to moderately weathered adamellite Core length 1 cm - 10 cm. Jointed at high angle, and fractured at bottom of hole - recemented with quartz. Some iron staining on joints

Hole G11

0 - 0.5	Brown to reddish brown silty, sandy clay
0.5 - 1.5	Yellow to reddish yellow mottled sandy clay
1.5 -16.5	Fawn to yellow sandy clay and extremely to highly weathered adamellite
16.5-21.4	Highly weathered adamellite

GEOLOGY OF McKELLAR

Metres 0 50 100

- Alluvium: Clay, minor sand, gravel overlying calcareous shale
- Alluvium & slopewash: Clay, sand, minor gravel
- Adamellite - scattered outcrop
- Adamellite - marginal zone - scattered outcrop
- Dacite - scattered outcrop
- Quartz
- Fault
- Lithological boundary
- Spring, seepage
- Erosion gully
- Alluvial fan
- Trees
- Boundary of investigation area
- Transmission line
- Boundary of alluvial fan
- +0.5 Height outcrop projects above ground in metres
- OH3 / 2.0 Hand auger hole location with depth to refusal in metres
- G3 / 23.6 Gemco auger hole location with depth to moderately weathered rock in metres
- 366 Observation bore and number
- Cross section
- 600 Contour, 2.5m intervals

LAKE GINNINDERRA

GINNINDERRA CREEK

GINNINDERRA DRIVE

WILLIAM WEBB DRIVE

Line of trees

Alluvial fan

TNMN

590 600 610 580

A A'

205000E 205500E 206000E 206500E 207000E

80500N 81000N 81500N 61000N 61500N

GEOLOGICAL CROSS SECTION AA'

V/H = 2

Ginninderra Creek; H20 (proj); H19(proj); G10; fault; H18(proj); H17(proj); G2(proj); G4(proj); G8; Alluvium & slopewash; Alluvium; Ginninderra Creek

Adamellite; Adamellite Marginal zone; Dacite; Residual soil; Grey and black calcareous shale

Record 1975/148

1:5000/A16/1491