DEPARTMENT OF MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1974/123

GEOLOGICAL AND GEOPHYSICAL INVESTIGATION OF THE CITY EAST DEVELOPMENT AREA, CANBERRA, A.C.T.

by

B.H. Dolan, G.A.M. Henderson, G. Jacobson and P.H. Vanden Broek

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SUMMARY

Investigations by seismic survey and rotary core drilling have shown that much of the proposed City East development area in Canberra is underlain by deeply weathered sedimentary rocks. The deep weathering occurs along a fault zone, 100 - 200 m wide, which extends from Ainslie in the north through City East to Lake Burley Griffin in the south. The great depth of weathering, up to 70 m, and its irregularity within the fault zone, poses problems for the design of building foundations in the area. The site for one of the major proposed buildings, the D.C.T. office building, as shown in Figure 1, has many diverse foundation conditions which would require special treatment to reduce differential settlement of the building.

INTRODUCTION

In March 1974 site investigations were undertaken by Ground Test Pty Ltd for a proposed office building for the Department of the Capital Territory (D.C.T.). The D.C.T. office building will form part of the proposed City East Ddvelopment project (for location see Figure 1). Drilling indicated completely weathered bedrock to previously unsuspected depths of up to 70 m, causing problems with foundation design for the building. BMR was asked by the National Capital Development Commission to carry out geophysical surveys and further rotary core drilling in the City East project area in order to ascertain the extent of deeply weathered rock and provide information relating to the feasibility of other proposed building construction in the area.

The project geologist was P.H. Vanden Broek in March and April, and G. Jacobson in May and June. B.H. Dolan was the project geophysicist, and G.A.M. Henderson carried out the geological mapping of the Civic Centre area.

GEOLOGY OF THE CANBERRA CITY (CIVIC CENTRE) AREA

A geological map of the Canberra City (Civic Centre) area is shown in Plate 1. It was compiled by G.A.M. Henderson in 1972 from records of mapping of excavations carried out by BMR officers over several years. Information from the current investigation in the City East area has been added to it.

GENERAL GEOLOGY

Alluvium

Alluvium of Tertiary or Quaternary age has been deposited in two valleys, which were drained by creeks flowing south into the Molonglo River. The alluvium, which is up to 5 m thick, consists of gravel, sand, and clay, and overlies Ordovician and Silurian bedrock.

Faulting in alluvium of probable Tertiary age has been observed by E.G. Wilson (pers. comm.) in the Monaro Mall excavation (Fig. 2). The faults were reverse faults dipping moderately steeply to the northeast.

Bedrock

Most of the Canberra City (Civic Centre) area is underlain by middle to late Silurian sedimentary rocks of the Canberra Group (Strusz and Henderson, 1971) which consists mainly of shale and mudstone, in part calcareous, dipping generally to the east and northeast at between 20 and

50 degrees. These rocks are separated from older, Ordovician and early Silurian, shale and mudstone to the west by a fault which has been observed in a tunnel under Liversidge Street, Acton (Opik, 1958), and which probably extends north beneath the alluvium (Plate 1).

The middle to late Silurian rocks can be divided into two units, which because of their markedly different weathering characteristics, are of particular significance for engineering works. The first unit (C on Plate 1), known in part as the City Hill Shale (Opik, 1958), crops out on City Hill and has also been mapped at Sullivan's Creek. It consists of uniform grey mudstone, much of which is calcareous, and which is relatively resistant to weathering. The mudstone is generally fresh or slightly weathered and moderately hard and strong, at a depth of less than 2 metres.

The other middle to late Silurian unit which includes parts of the Riverside Formation and Turner Mudstone (Opik, 1958) comprises mainly mudstone and shale (B on Plate 1) with thin beds of siltstone and fine-grained sandstone, and some limestone (D) and tuff (F). All of these rocks, except the limestone, are weathered to considerable depths throughout the area. The weathering profile is not known accurately but the information available indicates that moderately or highly weathered rock probably extends to a depth of at least 15 m in most places. Boulders of hard, tough, fresh limestone, set in a clay matrix, occur at shallow depths in places.

The rocks are folded, and in places are closely faulted and jointed. Fold axes are parallel to a meridional cleavage. In the City Hill Shale the plunge of folds ranges from 0 to 40 degrees and is generally to the north. A major fault, the City East Fault, has been confirmed by the present investigation. It trends northerly along a topographic lineament and has a zone, 100 - 200 m wide, of sheared and deeply weathered rocks with much clay associated with it.

FOUNDATION CONDITIONS

The conditions to be expected for excavations and building foundations depend largely on whether the underlying rock is the little-weathered mudstone or the other more deeply weathered rocks. The presence of limestone is also an important factor in a few places.

In the little-weathered mudstone (unit C) excavations for foundations of major buildings have generally encountered moderately strong rock within 2 m of the surface. For excavations deeper than 2 m a jack-pick would be needed, and extensive excavations would probably require blasting. No limestone has been recorded from the area of this partly

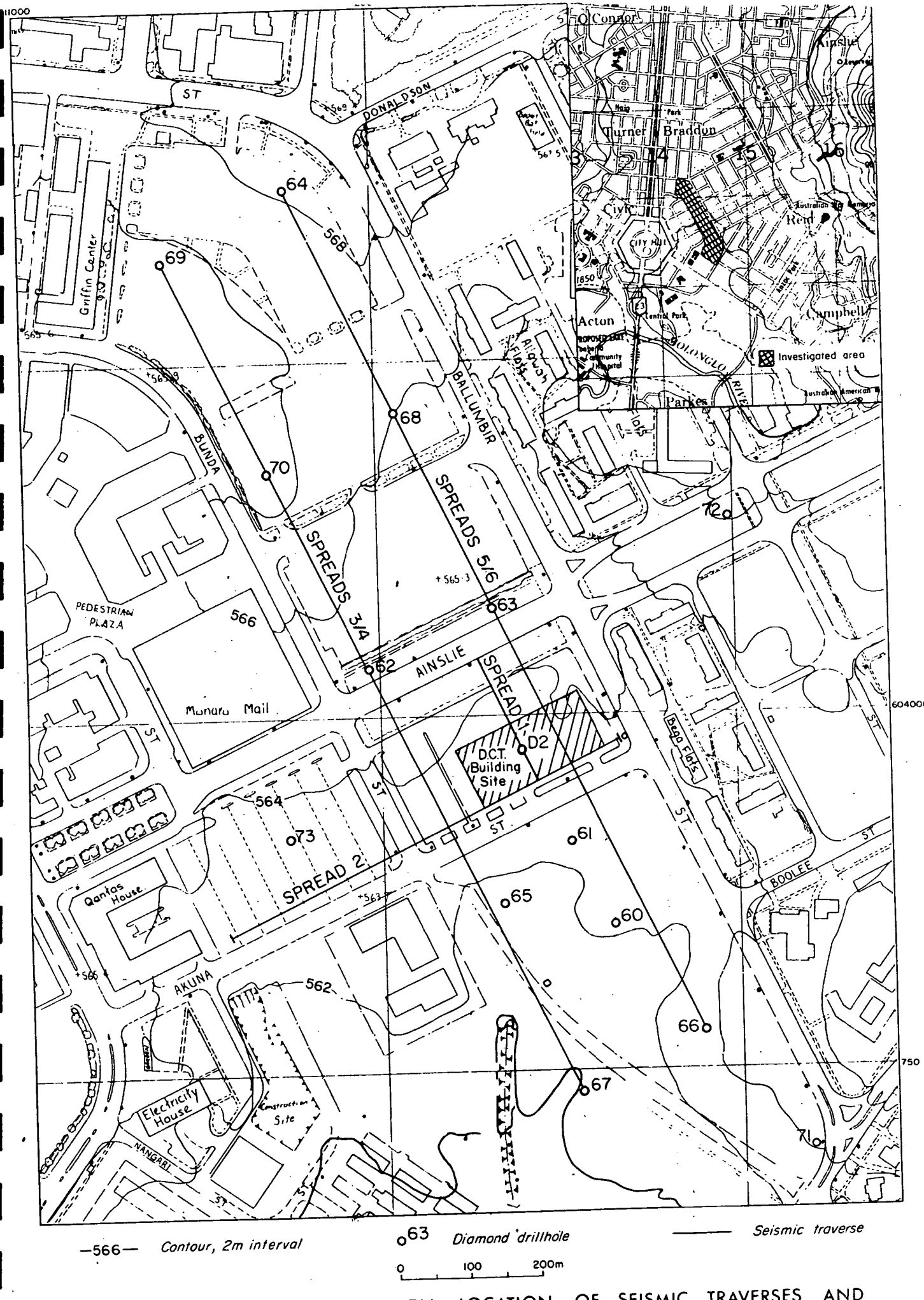
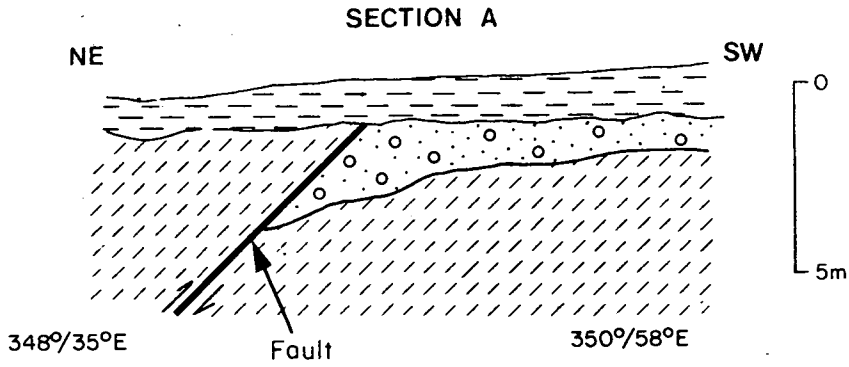
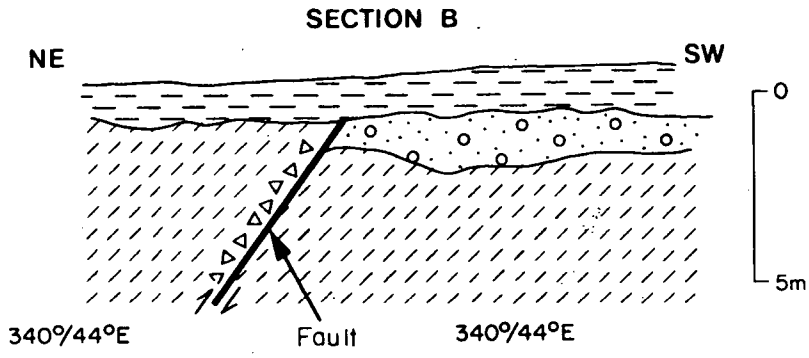


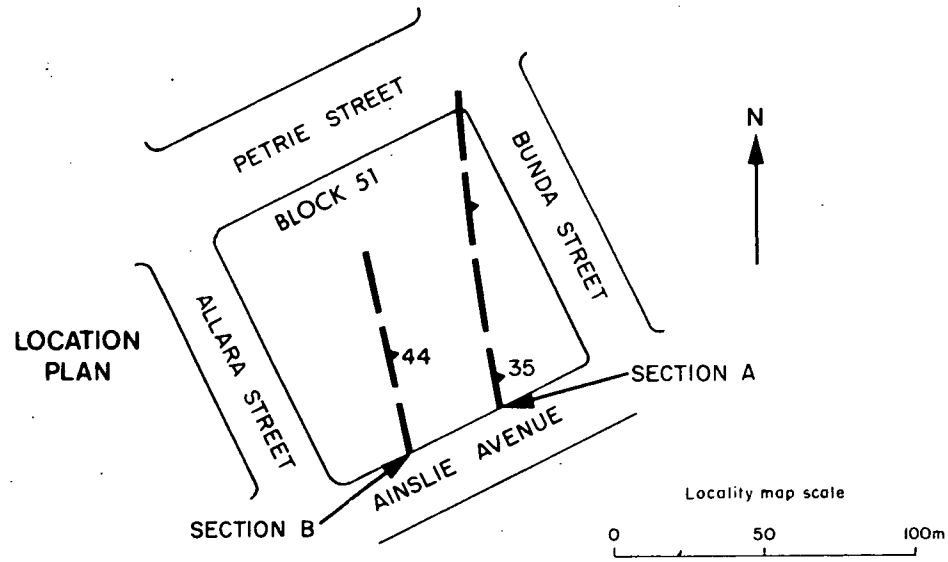
FIG. 1 CITY EAST INVESTIGATION, LOCATION OF SEISMIC TRAVERSES AND DIAMOND DRILLHOLES

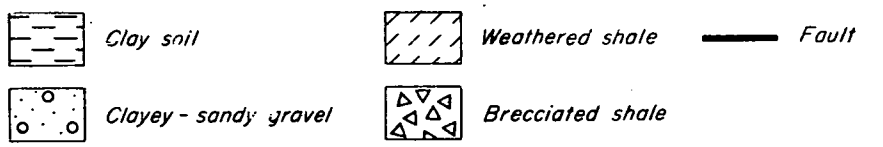
155/A16/1145

To accompany Record 1974/123









Mapped by E.G. Wilson, 1961
BMR Tech. file N/SI/55-16

FIG. 2 REVERSE FAULTS IN THE MONARO MALL EXCAVATION, CANBERRA

To accompany Record 1974/123

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calcareous rock unit C; however there is a possibility that small areas of cavernous limestone could occur.

In the other rock types (units B, D, E, F) the depth of foundations for large buildings depends on the local depth of weathering and the presence of any weaknesses such as fault zones or cavernous limestone; generally foundations need to be deeper than in the little-weathered mudstone. Owing to the deep weathering, excavation to a depth of about 15 m can probably be accomplished in most places by mechanical means (such as bulldozer and ripper, or power-shovel) without blasting. Where limestone occurs, the depth to sound rock is irregular.

GROUNDWATER

The rate of seepage of groundwater into deep excavations depends on the level of the zone of saturation and on the permeability of the rock and the superficial deposits. The information available indicates that the zone of saturation is fairly close to the surface in Canberra City and groundwater can be expected at a depth of 5 m or less in most places; on City Hill it is expected to be slightly deeper. Permeability is generally low in the bedrock, especially in the deeply weathered mudstone and shale where groundwater occurs only in fractures. Permeable lenses of alluvial sandy gravel are generally above the zone of saturation except during prolonged wet periods, but may carry perched aquifers. Highly permeable cavernous limestone has been encountered in some foundations in Canberra; however aquifers have not been intersected in excavations at any of the four known limestone localities in the Civic Centre area (Plate 1), although some seepage was encountered at the NRMA building site in Northbourne Avenue.

THE CITY EAST INVESTIGATION

The results of investigations carried out in the proposed City East development area are described below. Locations of seismic traverses and rotary drill holes in the project area are shown in Figure 1.

SEISMIC REFRACTION SURVEY

Seismic refraction surveys were carried out on 3 consecutive Sundays, 17 and 24 February, and 3 March, 1974. The field work was done by B.H. Dolan (geophysicist and party leader), M.I. McDowell, F.N. Michail (geophysicists) L. Hemphill, A. Martindale (technical officers) and three field hands. The main aim of this work was to obtain information about the structure of the area below depths of 30 m.

A previous seismic survey on the site by BMR in 1971 provided information at shallow depths only (Hill, 1972). The deepest refractor encountered had a seismic velocity of 1.6 to 2.2 km/s, and results indicated that a refractor with a higher seismic velocity (3.0 km/s) would occur at a depth greater than 28 m.

Methods and Equipment

The velocity with which a vibration is transmitted through rock varies with the nature of the rock; in general, the velocity increases with the strength of rock. In the seismic refraction method a number of ground vibration detectors (geophones) are placed a known distance apart along a line. An explosive charge is detonated along this line and the times of arrival of the longitudinal shock wave produced by this explosion are recorded from each geophone. From this information the depth to formations of different seismic velocity can be determined. The intercept method was used for interpretation (Heiland, 1946).

In order to obtain data on both shallow and deep refractors it is necessary to detonate charges close to the spread of geophones and at some distance from it. In the present investigation shots were fired up to 330 m from the end of the geophone spread. Shots were also fired directly below the end geophones to enable corrections to be made for the depth of the shot. Because the work was done in a built up area several precautions had to be taken. The charges were placed in parks or car parking areas and in drill holes 5 to 10 m deep; a number of streets and parking areas were closed; and traffic in the area was controlled by the police. Because of the distance of the long shot points from the spread up to 2 kgs of charge had to be used.

The geophones used were type GSC-20D made by the Geospace Corporation. The two sets of recording equipment used were the PSU-19 and PT-700 made by Dresser - SIE.

Six geophone spreads were recorded separately. The spacing between the geophones was 4 m on the first spread and 15 m on the other five spreads.

Results

Figure 1 shows the location of the geophone spreads and Plate 2 shows the seismic cross-sections. The seismic velocities recorded and their interpretation are shown in Table 1.

The surface layer (A) consists of a thin layer (1 to 2 m) of dry soil, clay and gravel with a seismic velocity of about 0.3 km/sec which is underlain by a layer, about 2 to

3 m thick, of partly saturated soil, clay and gravel with a velocity of about 1.0 km/sec. The average velocity of layer A is taken as 0.6 km/sec.

The second layer (B) consists mostly of saturated, completely or highly weathered mudstone with possibly some bands of moderately weathered mudstone.

TABLE 1

CORRELATION OF SEISMIC VELOCITY AND ROCK TYPE

LAYER	SEISMIC VELOCITY (km/s)	INTERPRETATION
A	0.6 (average)	Unsaturated soil, gravel and completely weathered rock.
B	1.6 - 2.1	Saturated, highly to completely weathered mudstone with possibly some interbedded layers of moderately weathered mudstone.
C	3.5 - 3.6	Moderately weathered to fresh mudstone (possibly fractured).
D	3.5 - 5.5	Moderately weathered to fresh rock of uncertain and possibly varied lithology.

The relatively high velocities (1.6 to 2.1 km/sec) for highly weathered mudstone are due to the formation being water saturated. In areas where this velocity is highest the formation probably has a greater proportion of moderately weathered fragments.

The third layer (C) is probably moderately weathered to fresh mudstone. The depth to this refractor varies over the site, from about 17 m at the northern end to about 70 m at the junction of spreads 5 and 6.

The deepest refractor encountered (D), has a variable velocity of 3.5 to 5.5 km/sec. This variability is considered to be due to different lithologies and zones of faulting. This refractor is deep (more than 50 m) over the site except at the western end of spread 2 where it is within 20 m of the surface. The velocities in excess of 5 km/sec indicate fresh or slightly weathered bedrock with tight joints.

Conclusions

The depth to bedrock, i.e. a refractor with seismic velocity of 3.5 km/sec or greater, ranges from about 20 m at the northern end of the site to about 70 m between Ainslie Avenue and Akuna Street in spread 6. The overlying material is mainly water-saturated, completely to highly weathered mudstone. Significant zones of different velocities were recorded in the deepest refractor and these could be due to lithological variations or to fault zones.

ROTARY CORE DRILLING

Although 14 rotary drillholes totalling 474 m in length were completed by BMR between February and June, 1974. The locations of the drillholes, which were numbered Canberra 60-73 inclusive, are shown in Figure 1. Drill cores are stored in the BMR Cores and Cuttings Laboratory, Fyshwick. The logs of the drill holes are given in Appendix 1 and definitions of weathering terms are given in Table 2.

TABLE 2

DEGREES OF WEATHERING OF ROCK

DEGREE OF WEATHERING		DESCRIPTION
FRESH	:	No discolouration or loss in strength.
FRESH STAINED	:	Limonitic staining along fractures; rock otherwise fresh and shows no loss of strength.
SLIGHTLY WEATHERED	:	Rock is slightly discoloured, but not noticeably lower in strength than the fresh rock.
MODERATELY WEATHERED	:	Rock is discoloured and noticeably weakened; N-size drill core generally cannot be broken by hand across the rock fabric.
HIGHLY WEATHERED	:	Rock is discoloured and weakened; N-size drill core can generally be broken by hand across the rock fabric.
COMPLETELY WEATHERED	:	Decomposed to a soil, but the original rock fabric is mostly preserved.

Results and discussion

Rotary core drilling confirmed and extended the results of the seismic refraction survey. The investigation has defined a trough of deeply weathered bedrock beneath a blanket of alluvial fill. The deeply weathered zone probably extends from Ainslie in the north through City East to the Central Basin of Lake Burley Griffin.

The deep weathering, and the shearing and brecciation observed in several drillhole cores indicates that faulting has affected a zone 100 - 200 m wide. In the excavation for a test pit at the DCT building site, several clay-filled fault zones several centimetres wide were observed (Fig. 5). These faults strike 005°-010° and most of them dip steeply east. Elsewhere in the Civic Centre area, east dipping reverse faults have been observed in the Monaro Mall excavation (Fig. 2) and at Electricity House in London Circuit (Gardner, 1974, p. 12). It is likely that the City East fault zone consists of numerous faulted segments bounded by reverse faults which dip steeply to the east.

Contours of the depth of weathering below ground surface are shown in Plate 1. These contours have been constructed on a generalised surface of slightly weathered or fresh bedrock, based on seismic and drilling results. The depth of weathering ranges up to about 70 m in the central part of the City East project area. Drillholes 64 and 69 in the northern part of the project area intersected hard, slightly weathered mudstone at depths of about 20 m.

In detail the weathering is irregular; in some drillholes relatively hard and strong, moderately weathered rock overlies softer and weaker, highly to completely weathered rock. In general, foundations on completely weathered mudstone (clay) are likely to have some settlement, whereas highly weathered mudstone is possibly satisfactory for pad footings. On the west side of the project area, multi-storey buildings have been founded on pad footings on highly weathered mudstone, e.g. the CAGA building (Fig. 3; Coffey & Hollingsworth, 1971).

Bedrock beneath the project area is generally calcareous mudstone, which is bluish-grey where fresh and yellowish-brown where weathered. The calcareous mudstone is fossiliferous, containing brachiopods and corals which indicate a middle or late Silurian age, and probably belongs to the Canberra Group as defined on the 1:50,000 geological map of Canberra by Strusz and Henderson (1971). Sandstone was intersected in drillhole 72 in Ainslie Avenue, and interbedded siltstone and sandstone was intersected in drillhole 71 in Glebe Park; both of these drillholes are on the east side of the fault zone. Brecciated mudstone was intersected in drillholes 62 and 64.

Groundwater was intersected in several drillholes at depths of 4-6 m, and in most cases rose to a potentiometric level of 1.5 - 2 m below ground surface. The groundwater was intersected at the base of the alluvium or at the top of the fractured mudstone. In drillhole 71 in Glebe Park, water under pressure was intersected in a fault zone at 27.7 m and flowed at the surface.

SOIL TEST RESULTS

Testing of some samples of weathered mudstone was undertaken in the laboratories of BMR and the Snowy Mountains Engineering Corporation in order to determine plasticity and strength parameters.

The completely weathered mudstone is a yellowish brown or reddish brown stiff silty clay generally classified as CL or CH on the Unified Soils Classification (Appendix 2).

Samples of completely weathered mudstone from a drillhole on the DCT building site proved to be ML on the Unified Soils Classification with plasticity indices of 8-9, and an unconfined compressive strength of 1.2 kg/cm (Appendix 2).

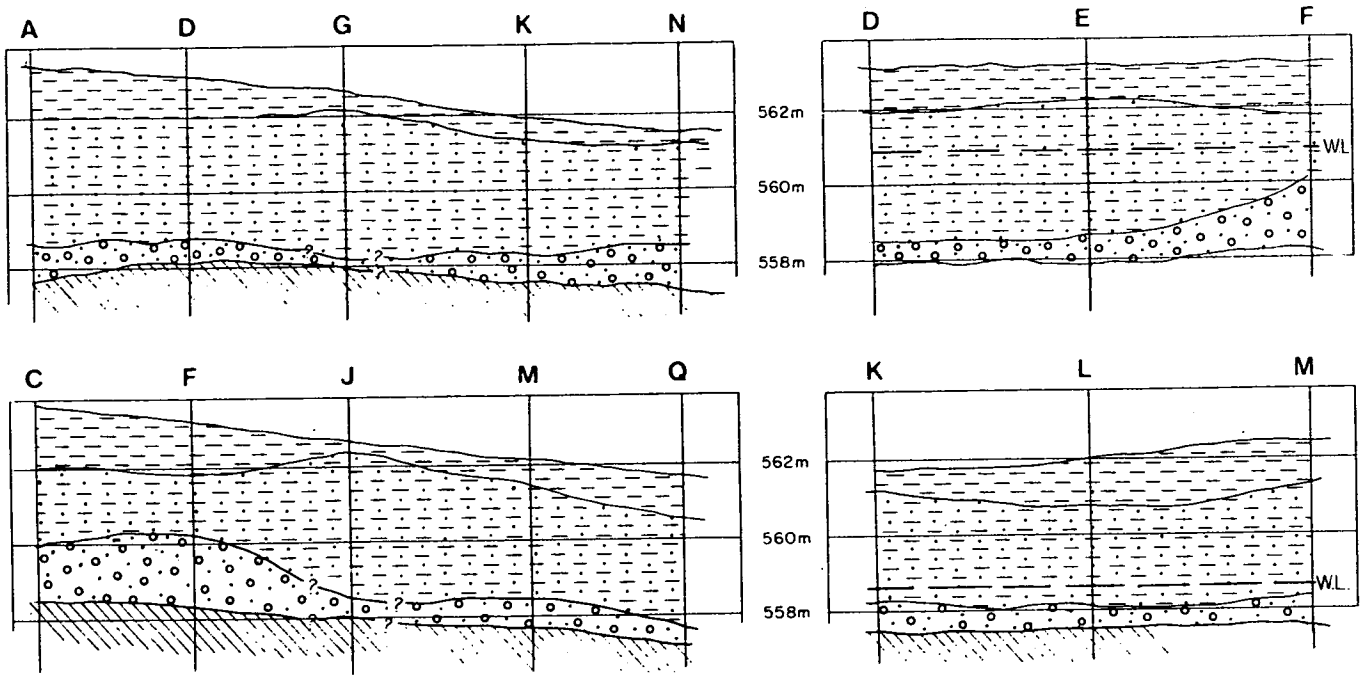
A summary of triaxial compression and consolidometer test results for samples of completely and highly weathered mudstone is given in Appendix 2.

THE D.C.T. BUILDING SITE

The D.C.T. office building is proposed to be a 13-storey structure, approximately 24 m by 73 m, with a basement excavation to a depth of approximately 5 m. Site investigations by Ground Test Pty. Ltd. (1974) have included 12 diamond drill holes, testing of soil samples, and load tests in a pit excavated to basement level.

About 4 m of gravelly alluvium overlies mudstone at the building site. The eastern half of the site is underlain by a wedge of relatively strong, moderately weathered mudstone overlying weaker, completely to highly weathered mudstone, which extends down to a depth of 70 m (Fig. 4). The western half of the site is underlain by completely to highly weathered mudstone to a depth of 70 m. The degree of weathering is irregular in detail with alternate layers of hard and soft material.

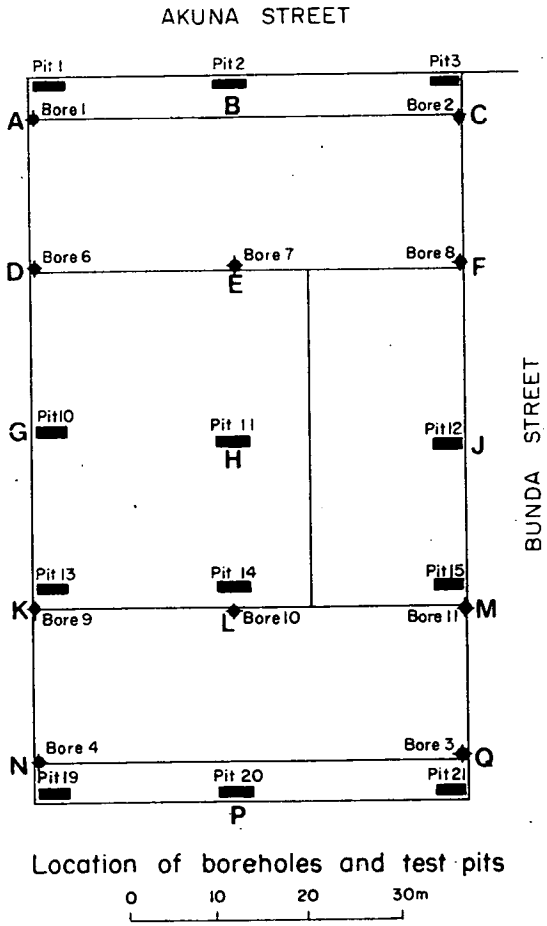
The geology of the test pit excavated at the site is shown in Figure 5. Several clay-filled fault zones up to 5 cm wide are exposed in highly weathered mudstone on the



Generalized sections through the CAGA Building site

0 10 20 30m

$\frac{V}{H} = 4$



Location of boreholes and test pits

0 10 20 30m

Clay and sandy clay of low to medium plasticity - stiff to hard, dry to moist

Clay, sandy clay and clayey sand - clay of medium to high plasticity, stiff to hard, moist, fissured.

Clayey sand and clayey gravel - dense, clay hard

Siltstone - extremely to highly weathered

Test pit

Borehole

WL. *Water level*

Data from a report by Coffey & Hollingsworth to Bond, James, Laron & Reid, 1971

FIG. 3 FOUNDATION EXPLORATION FOR CAGA BUILDING, CANBERRA.

To accompany Record 1974/123

155/A16/1147

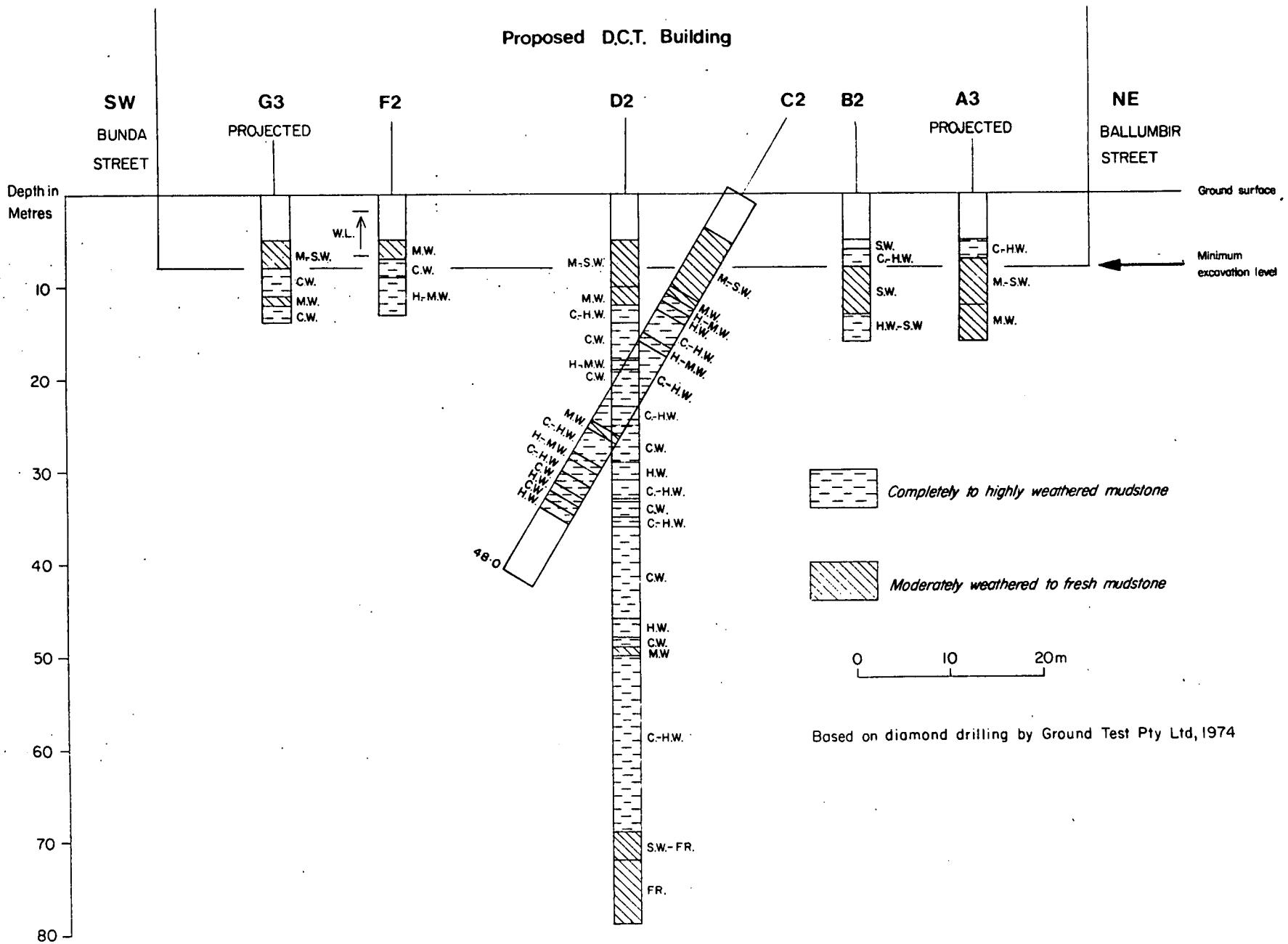


FIG. 4 CITY EAST PROJECT, GEOLOGICAL SECTION THROUGH FOUNDATION OF D.C.T. BUILDING

To accompany Record 1974/123

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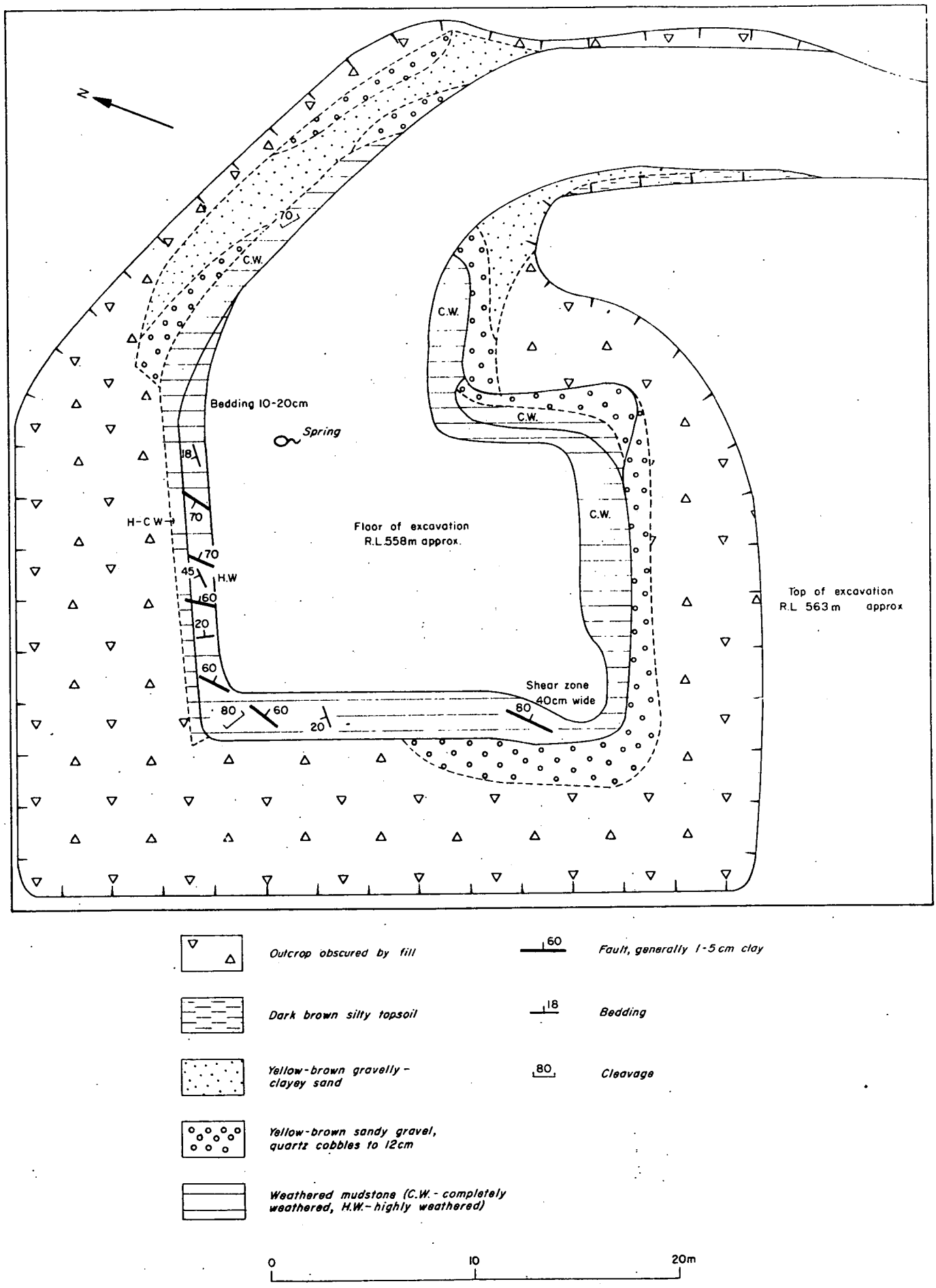

FIG. 5 GEOLOGICAL PLAN OF EXCAVATION D.C.T. BUILDING SITE, CANBERRA

western side. Measurements of bedding attitudes indicate a faulted syncline plunging 14 N, with shallow dips near the core. Dips of bedding measured in drill cores generally ranged from 20 to 40 degrees. Completely weathered mudstone is exposed on the southern side of the test pit. Problems of groundwater inflow from fractured mudstone were encountered in the excavation; a spring was exposed in the floor, and several of the test pile holes intersected groundwater.

Possible solutions to the foundation design problem have been discussed by the site investigation consultant (Ground Test Pty. Ltd., 1974). A combination of shallow footings on the northern side with friction piles over the remainder is favoured at the time of writing (June, 1974).

CONCLUSIONS

1. Seismic and drilling investigations have delineated a trough of highly to completely weathered rock, associated with a major fault zone 100-200 m wide, which trends north-south through the east side of Canberra City.

2. The hard, slightly weathered to fresh bedrock that forms the bed of the trough rises gently to the west and east of the project area and is deepest (70 m) on Section 53 which includes the proposed site for the D.C.T. building.

3. The varied degrees of weathering of the mudstone beneath D.C.T. building site provide difficult foundation conditions. The highly weathered mudstone may be satisfactory for pad footings, but the interlayered highly and completely weathered materials will settle differentially.

4. Foundation conditions for a large structure would be better in the northwest part of the City East development area where hard, slightly weathered rock has been encountered at depths of about 20 m.

5. The properties of the weathered rock are so varied within the City East development area that detailed site investigations will be required for every proposed structure.

6. Confined groundwater occurs in the fractured mudstone, and groundwater inflow in excavations is likely.

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APPENDIX 1

CITY EAST INVESTIGATION, CANBERRA

LOGS OF DIAMOND DRILL HOLES

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO 60

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE				5m						
MUDSTONE S.W.- M.W.	Yellow - brown			100 100							
NO	CORE				10m						
MUDSTONE M.W.				20							
NO	CORE										
MUDSTONE M.W.- H.W.				50							
NO	CORE										
MUDSTONE M.W.- H.W.				100							
M.W.				85	15m						
H.W.				100							
MUDSTONE C.W.				100					Sheared zone		
NO	CORE										
MUDSTONE M.W.- H.W.				50							
S.W.- M.W.											
NO	CORE				20m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed MARCH 74

Logged by P. VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE ALSO NUMBERED C.E.P. 1

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED

S.W. SLIGHTLY WEATHERED

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION

LOCATION

HOLE NO. 60

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
					20m						
MUDSTONE H.W.-C.W.				100							
M.W.				100							
NO CORE											
MUDSTONE SW-M.W.				50	23m						
NO CORE	NO CORE RECOVERED IN THE INTERVAL 23·0 – 82·0 m. BLUISH GREY CALCAREOUS MUDSTONE WAS INTERSECTED AT 75·0 m. CORE RECOVERY RESUMED AT 82·0 m.										
CALCAREOUS MUDSTONE H.W.-S.W.	Bluish grey			30	82m				Some S.W. fragments		
END	OF HOLE 83·3 m.				83m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed MARCH 74

Logged by P. VANDEN BRAEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED

S.W. SLIGHTLY WEATHERED

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1·55/A16/1176

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

HOLE NO. 61

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE										
MUDSTONE H.W.- M.W.	Yellow brown			100	5m				Iron and manganese stained joints. Fossiliferous (brachiopods)		
MUDSTONE M.W.	Yellow - brown moderately hard and strong.			100					Bedding 50°		
NO	CORE										
MUDSTONE M.W.	Yellow brown moderately hard and strong			80	10m				Manganese stained joints, some slickensided - vugs (etched out fossils) to 3cm at 30-45° Core in 10-20 cm pieces. Brachiopods on bedding planes which dip 45°-55°		
NO	CORE										
MUDSTONE M.W.	Yellowish - pinkish brown, moderately strong, but fragmented.			100					Core broken to 10 cm pieces. Manganese stained and clay filled joints, shear zone at 14 m, steeply dipping.		
NO	CORE										
MUDSTONE M.W.	Yellowish pinkish brown.			85	15m				} Broken and crushed		
H.W.											
NO	CORE										
MUDSTONE H.W.- C.W.	Pinkish - brown fragmented, weak.			90					Broken and crushed (brecciated)		
NO	CORE				20m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed MARCH 1974

Logged by P.V.B., G.J.

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE ALSO NUMBERED C.E.P. 7.

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1177

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 61

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18)	RQD	Defect Frequency — Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
MUDSTONE C.W.	Soft, fragmented pinkish-greyish brown. weak			75	20m				Broken and crushed (bracciated)		
NO CORE											
MUDSTONE C.W.– H.W.	Yellowish-pinkish brown, weak			100					Brecciated		
MUDSTONE C.W.– M.W.	Pinkish-brown, some moderately strong pieces.			100	25m				Closely jointed - joints are manganese stained or clay filled. Some broken core.		
NO CORE											
MUDSTONE H.W.– M.W.	Pinkish brown, some moderately strong fragments			80	30m				Joints manganese stained, some slickensided. Some broken and crushed core..		
NO CORE											
END OF HOLE 30.5 m.											

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed MARCH 1974

Logged by P.V.B., G.J.

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE ALSO NUMBERED C.E.P. 7

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

L-55/A16/1177

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT ...CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 62

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 1 OF 2.

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE										
MUDSTONE C.W. - H.W.	Buff			100	5m				Manganese stained joints. 3-10 cm spacing		
C.W. - H.W.	Pinkish brown weak rock - stiff clay			100					Broken core		
MUDSTONE C.W.	Pinkish brown firm -stiff clay			100	10m						
MUDSTONE C.W.	Orange - brown stiff clay			100							
NO	CORE			30	15m						
C.W.	Stiff clay										
NO	CORE										
MUDSTONE C.W. - H.W.	Yellow - pinkish brown, mostly stiff clay.			100							
MUDSTONE C.W.	Reddish - brown stiff clay			100	20m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed APRIL 1974

Logged by P.V.B., G.S.

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (sheers, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE ALSO NUMBERED C.E.P. 11

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1178

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 62

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log 0 6 12 18+	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
					20m						
MUDSTONE C.W.	Reddish-brown stiff clay			80							
NO	CORE										
C.W.	Reddish brown			75							
MUDSTONE H.W.	Reddish brown			90							
NO	CORE										
MUDSTONE C.W.– H.W.	Reddish brown weak, friable			45	25m						
NO	CORE										
MUDSTONE BRECCIA H.W. – C.W.	Reddish brown, weak			80					Brecciated		
NO	CORE										
MUDSTONE BRECCIA H.W.-C.W.	Reddish brown			50					Brecciated		
NO	CORE				30m						
END OF HOLE 30·5 m.											

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed APRIL 1974

Logged by P.V.B., G.I.

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 63

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION

COORDINATES R.L. OF COLLAR

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE				10m						
MUDSTONE S.W.				40							
MUDSTONE C.W.				100							
MUDSTONE S.W.	Yellow - brown			100	15m						
M.W. - H.W.											
MUDSTONE H.W. - C.W.				60							
C.W.											
MUDSTONE H.W.				100	20m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed MARCH, 1974

Logged by P. VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE ALSO NUMBERED C.E.P. 4.

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED

S.W. SLIGHTLY WEATHERED

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 63

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
H.W.					20m						
MUDSTONE H.W.				70							
MUDSTONE M.W.				80							
END OF HOLE 24.4m (80ft 6 ins)					25m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed MARCH 1974

Logged by T. VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO 64

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION

COORDINATES R.L OF COLLAR

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE				10m						
MUDSTONE C.W.	Some breccia			100					C.W.-H.W. fragments in clay matrix		
MUDSTONE BRECCIA C.W.				100							
MUDSTONE BRECCIA H.W.-C.W.				100	15m						
BRECCIA H.W.-C.W.				100					Angular M.W. fragments 1-3 cm in clay matrix		
BRECCIA				100	20m						

Drill type IFOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed MARCH 1974

Logged by P. VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE ALSO NUMBERED C.E.P. 5.

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1180

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO 64

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
MUDSTONE S.W. - M.W.				100	20m						
MUDSTONE S.W. - M.W.				100					2-12 cm pieces		
S.W.				100					Steeply dipping iron & manganese stained joints		
S.W.				100							
S.W.				100							
MUDSTONE S.W.					25m				vugs 1-2 cm diameter at 23.87 m.		
S.W.											
MUDSTONE S.W.											
	END OF HOLE 26.8 m (88 feet)										

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed MARCH, 1974

Logged by P.VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

M.W. MODERATELY WEATHERED

S.W. SLIGHTLY WEATHERED

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1180

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

HOLE NO. 65

SHEET 1 OF 2.

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE										
MUDSTONE M.W.	Yellow - brown								Iron and manganese stained joints		
M.W.											
MUDSTONE H.W.– M.W.					10m						
H.W.–C.W.											
MUDSTONE H.W.– C.W.											
M.W.											
MUDSTONE M.W.					15m						
H.W.– C.W.											
M.W.											
MUDSTONE H.W.–C.W.											
H.W.											
MUDSTONE H.W.–C.W.											
MUDSTONE M.W.											
M.W.					20m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed

Logged by P. VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth.

▽ Level in completed hole on specified date.

HOLE ALSO NUMBERED C.E.P. 6

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT CITY EAST INVESTIGATION, CANBERRA
LOCATION
ANGLE FROM HORIZONTAL (θ) 90° DIRECTION
COORDINATES R.L. OF COLLAR

HOLE NO. G5
SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency — Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
MUDSTONE H.W-M.W.				100	20m						
M.W											
MUDSTONE H.W				100							
H.W. — C.W.											
MUDSTONE H.W											
MUDSTONE M.W				100							
MUDSTONE M.W.				90	25m						
MUDSTONE M.W				100							
MUDSTONE H.W.				100							
MUDSTONE H.W.					30m						
MUDSTONE H.W.— C.W.											
END HOLE 32 m (105 feet)											

Drill type FOX
Feed HYDRAULIC
Core barrel type TRIPLE TUBE
Driller B.M.R.
Commenced
Completed
Logged by P. VANDEN BROEK
Vertical scale 1:100
Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

C.W. COMPLETELY WEATHERED.
H.W. HIGHLY WEATHERED
M.W. MODERATELY WEATHERED.

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION

COORDINATES R.L. OF COLLAR

HOLE NO. 66

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE				5m						
MUDSTONE M.W. - S.W.	Yellow-brown			100					Manganese stained joints, some slickensided		
MUDSTONE M.W. - S.W.	Yellow - brown			100	10m				Core broken along 80° fault, 9.1 - 10.0 m and 10.2 - 11.6 m. manganese stained pieces.		
MUDSTONE M.W. - S.W.	Yellow - brown moderately strong			100					Manganese stained joints, 2-20 cm spacing vugs to 1cm where fossils etched out.		
MUDSTONE S.W.	Yellow - brown to pale yellow - green			100					Shears at 13.1 and 14.3 m		
MUDSTONE S.W.	Yellow - brown strong			90	15m				Manganese stained joints 3-20 cm spacing generally with rough or slickensided surfaces.		
MUDSTONE M.W. - S.W.	Yellow - brown			90					Some broken core		
					20m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed 23-3-74

Logged by P. VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE ALSO NUMBERED C.E.P. 8

M.W. MODERATELY WEATHERED

S.W. SLIGHTLY WEATHERED

Water Pressure Tests

* Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1·55/A16/1182

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 66

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
MUDSTONE M.W.	Yellow - brown				20m	0 6 12 18+			← shear, 10cm C.W. crushed closely jointed - manganese stained & clay filled		
MUDSTONE H.W.	Yellowish - pinkish brown.								some broken core		
MUDSTONE M.W. - C.W.	Yellow - brown generally weak, some moderately strong pieces				25m				crushed zone, 25cm, with plastic clay, at 25.0 m. manganese stained joints		
MUDSTONE C.W. - M.W.	Yellow - brown								sheared, much broken core.		
MUDSTONE C.W.	Pinkish - brown stiff clay				30m				} Brecciated		
END OF HOLE 30.5 m (100 feet)											

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed 28-3-74

Logged by P.VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE ALSO NUMBERED C.E.P. 8

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1182

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 67

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency — Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE				5m						
MUDSTONE H.W.	Yellow brown			100					Iron + manganese stained joints		
MUDSTONE H.W.- C.W.	Yellow - orange - brown			80	10m				Broken core		
MUDSTONE M.W. - H.W.	Yellow - brown some moderately strong pieces			100					Manganese stained joints. Much broken core.		
MUDSTONE M.W.	Yellow brown			100					20 cm sheared at 14.0 m.		
MUDSTONE M.W.	Yellow brown			100	15m				Closely jointed (2cm - 15 cm)		
MUDSTONE M.W. - H.W.	Yellow brown			100					Broken core		
H.W. - C.W.					20m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed APRIL 1974

Logged by P. VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE ALSO NUMBERED C.E.P. 9.

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED.

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1183

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

HOLE NO. 67

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
				20m						
MUDSTONE H.W.-C.W.	Yellow-brown, mostly stiff clay		100							
MUDSTONE C.W.	Yellow brown stiff clay		100							
MUDSTONE H.W.-C.W.	Yellow brown stiff clay.		100							
MUDSTONE C.W.	Red brown plastic clay			25m				Brecciated		
MUDSTONE H.W.	Yellow brown		100							
MUDSTONE H.W.-C.W.	Yellow-orange brown		100					Sheared		
MUDSTONE H.W.-C.W.	Yellow-orange brown		100					Iron and manganese stained joints		
MUDSTONE H.W.-C.W.	Yellow-brown weak, some moderately strong pieces		100	30m				Some broken & crushed		
END OF HOLE 32 m (105 feet).										

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller BMR

Commenced

Completed APRIL 1974

Logged by P. VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1183

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 68

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency — Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE										
FINE SANDSTONE C.W.	Yellow brown, weak			100	5m				Broken core		
NO	CORE										
FINE SANDSTONE C.W.	Yellow brown, weak			15							
NO	CORE				10m						
MUDSTONE H.W. - C.W.	Yellow, weak			85					Broken core		
NO	CORE										
MUDSTONE C.W.				50							
NO	CORE				15m						
MUDSTONE C.W.				30					Broken core		
NO	CORE										
MUDSTONE H.W - C.W.	Weak, yellow brown			20							
NO	CORE				20m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed APRIL 1974

Logged by P.VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (sheors, joints, fractures) per 25cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE IS ALSO NUMBERED C.E.P. 10
C.W. COMPLETELY WEATHERED
H.W. HIGHLY WEATHERED

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1184

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 68

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE				20m						
SILTSTONE H.W.	Micaceous, sandy			60					Closely fractured, Broken core.		
NO	CORE										
SILTSTONE H.W - C.W.	Micaceous, sandy				25m						
MUDSTONE H.W. - C.W.	Yellow-brown weak			80							
NO	CORE										
MUDSTONE H.W. - C.W.	Yellow brown								Much broken core		
NO	CORE				30m						
END	END OF HOLE 30·5 m (100 feet)										

Drill type FOR

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed APRIL 1974

Logged by P. VANDEN BROEK

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth. ▼ Level in completed hole on specified date.

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

Water Pressure Tests

* Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO 69

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L OF COLLAR

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressu Test Losse (Lugeons) *
NO	CORE										
MUDSTONE C.W. M.W. MUDSTONE C.W.-H.W. M.W.	Pink, stiff clay to weak rock			100	5m				Manganese stained joints, some crushed zones.		
NO	CORE										
MUDSTONE C.W.-M.W.	Pink, stiff clay to weak rock			50	10m				Broken and crushed sections. Iron and manganese stained joints		
NO	CORE										
MUDSTONE C.W.-M.W.	Pink, stiff clay to weak rock			45	15m				Broken and crushed sections Manganese stained joints		
NO	CORE										
MUDSTONE S.W.	Grey-brown, hard strong rock			100					Iron stained & clay-filled joints Fossiliferous		
MUDSTONE, S.W.					20m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed 22-4-74

Logged by G. JACOBSON

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE IS ALSO NUMBERED C.E.P. 12

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED

S.W. SLIGHTLY WEATHERED

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1185

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO 69

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
MUDSTONE S.W.	Grey, hard, strong			100	20m				3-30 cm pieces, iron stained and clay filled joint		
MUDSTONE S.W.	Grey, hard, strong			100					Slickensided vertical fault plane from 22.0 - 23.8 m 20 cm crushed at 24.1 m.		
S.W. MUDSTONE C.W. - H.W.	Weak, some strong pieces.			100	25m				Crushed and broken, probably steeply dipping fault plane		
MUDSTONE S.W.	Grey, hard, strong										
MUDSTONE FRESH STAINED	Bluish grey, hard strong			100	30m				2-40 cm pieces steeply dipping, iron stained joints bedding dip 60°		
END OF HOLE 30.5 m (100 feet)											

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed 22-4-74

Logged by G. JACOBSON

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

S.W. SLIGHTLY WEATHERED

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT LOCATION CITY EAST INVESTIGATIONS, CANBERRA

HOLE NO. 70

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE										
MUDSTONE C.W. (CLAY)	Red-brown Firm-stiff CLAY.			100	5m						
NO	CORE										
MUDSTONE C.W. (CLAY)	Red-brown stiff CLAY			70	10m						
NO	CORE										
MUDSTONE C.W. (CLAY)	Red-brown, firm to stiff clay			100	15m						
NO	CORE										
MUDSTONE C.W.-H.W.	Red-brown stiff clay to weak rock			80	20m				Some broken and crushed.		

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed 26-4-74

Logged by G. JACOBSON

Vertical scale 1:100

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

HOLE ALSO NUMBERED C.E.P. 13

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 70

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION -

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log 0 6 12 18+	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
MUDSTONE C.W. - H.W.	Red - brown				20m						
NO	CORE										
MUDSTONE H.W.	Red - brown weak rock			100					Bedding dips 70°		
NO	CORE										
MUDSTONE C.W. - H.W.	Red - brown stiff clay with some rock bands			75	25m				Sheared zones Joints, clay filled, iron and manganese stained		
NO	CORE										
MUDSTONE C.W. - H.W.	Red - brown stiff clay with some rock bands			90	30m				Sheared		
END	OF HOLE 30.5 m (100 feet)										

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed 26-4-74

Logged by G. JACOBSON

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

C.W. COMPLETELY WEATHERED
H.W. HIGHLY WEATHERED

Water Pressure Tests

* Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1186

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION CORNER BALLUMBIR / CORRANDERRK STS. CANBERRA CITY

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES — R.L. OF COLLAR —

HOLE NO 71

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
					0 6 12 18						
NO	CORE										
SANDSTONE C.W.	yellowish brown stiff sandy clay			90	5m						
SANDSTONE H.W.	yellowish brown weak rock			100					bedding 25°-40° widely spaced joints with chlorite and liminite infillings		
				100	10m						
SANDSTONE C.W.	yellowish brown soft - stiff sandy clay										
SANDSTONE H.W.	yellowish brown weak rock - interbedded sandstone / siltstone 0.5cm - 2 cm.			100					bedding 30° ironstained joints		
				100	15m						
MUDSTONE C.W.	brown firm - stiff clay										
SANDSTONE - SILTSTONE H.W.	yellowish brown weak rock.			100	20m						

Drill type EOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced 17-5-74

Completed 23-5-74

Logged by G. JACOBSON

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 71

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
MUDSTONE H.W. – C.W.	mostly dry, some weak rock, yellowish - brown				20m						
NO	CORE										
SANDSTONE / SILTSTONE H.W.	interbedded laminated, yellowish brown			80					iron stained bedding planes 20°		
NO	CORE										
MUDSTONE M.W.	dark grey, weak rock			80	25m				broken core		
SILTSTONE M.W. – S.W.	dark grey, moderately strong rock, some sandstone beds			55					bedding 2-4cm. dip 40°		
NO	CORE			20					sand only recovered -probable fault zone with artesian water		
MUDSTONE H.W. – M.W.	Yellow brown & dark grey				30m						
END OF HOLE 30·5 m (100 feet)											

Drill type

Feed

Core barrel type

Driller

Commenced

Completed

Logged by

Vertical scale

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

Water struck at 27·7 m - rose and overflowed casing at night.

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1187

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 72

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE										
MUDSTONE C.W.	Stiff clay, brown			95	5m						
NO	CORE			0							
MUDSTONE C.W.				20							
NO	CORE										
				100							
NO	CORE			10							
MUDSTONE C.W.	Yellow-brown, stiff clay.			100	10m				laminated, bedding dips 20°.		
NO	CORE										
MUDSTONE C.W.	Yellow-brown, stiff clay			40							
NO	CORE										
SANDSTONE C.W.	Yellow-brown, sandy clay			75							
NO	CORE										
SANDSTONE C.W.	Yellow-brown, sandy clay.			60	20m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.A.

Commenced 24-5-74

Completed 30-5-74

Logged by G. JACOBSON

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

C.W. COMPLETELY WEATHERED

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 72

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION -

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
MUDSTONE C.W.	Stiff clay				20m	0 6 12 18+					
NO	CORE			60							
MUDSTONE C.W.	Yellow-brown stiff clay			100							
MUDSTONE C.W.	Yellow-brown stiff clay			90	25m						
SANDSTONE H.W.	Brown weak rock			100							
SANDSTONE M.W.	light greyish brown moderately strong			100	30m				laminated - bedding dips 20°, ironstained joints, some broken core		
SANDSTONE M.W.	light greyish brown			100					broken core		
SANDSTONE S.W.	light greyish brown			100	35m						

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed

Logged by R.JACOBSON

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth. ▽ *Level in completed hole on specified date.*

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1188

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 73

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) DIRECTION

COORDINATES R.L. OF COLLAR

SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
NO	CORE										
MUDSTONE H.W.-C.W.	Yellow-brown weak rock				5m						
MUDSTONE M.W.	reddish brown - purple moderately strong rock								Clay filled joints core pieces 4-20 cm		
C.W.	stiff clay										
NO	CORE										
MUDSTONE M.W.	purple				10m						
H.W.											
NO	CORE										
MUDSTONE M.W.	reddish brown										
H.W.											
H.W.											
NO	CORE										
MUDSTONE C.W.-H.W.	reddish brown				15m						
MUDSTONE H.W.-M.W.	purple								} sheared		
MUDSTONE M.W.	purple-grey moderately strong rock								bedding 40°, some broken core. vugs are weathered out		
MUDSTONE S.W.	bluish grey, strong rock				20m						

Drill type EOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced 31-5-74

Completed 5-6-74

Logged by G. JACOBSON

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

C.W. COMPLETELY WEATHERED

H.W. HIGHLY WEATHERED

M.W. MODERATELY WEATHERED

S.W. SLIGHTLY WEATHERED

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

1-55/A16/1189

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

PROJECT CITY EAST INVESTIGATION, CANBERRA

LOCATION

HOLE NO. 73

GEOLOGICAL LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL (θ) 90° DIRECTION —

COORDINATES R.L. OF COLLAR

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
MUDSTONE S.W - FRST	bluish grey				20m				some ironstained joints. Fossiliferous		
MUDSTONE FRESH	bluish grey				25m				bedding 35°-40°		

Drill type FOX

Feed HYDRAULIC

Core barrel type TRIPLE TUBE

Driller B.M.R.

Commenced

Completed

Logged by G. JACOBSON

Vertical scale 1:100

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

S.W. SLIGHTLY WEATHERED

FRST FRESH STAINED

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

APPENDIX 2

SOIL TEST RESULTS

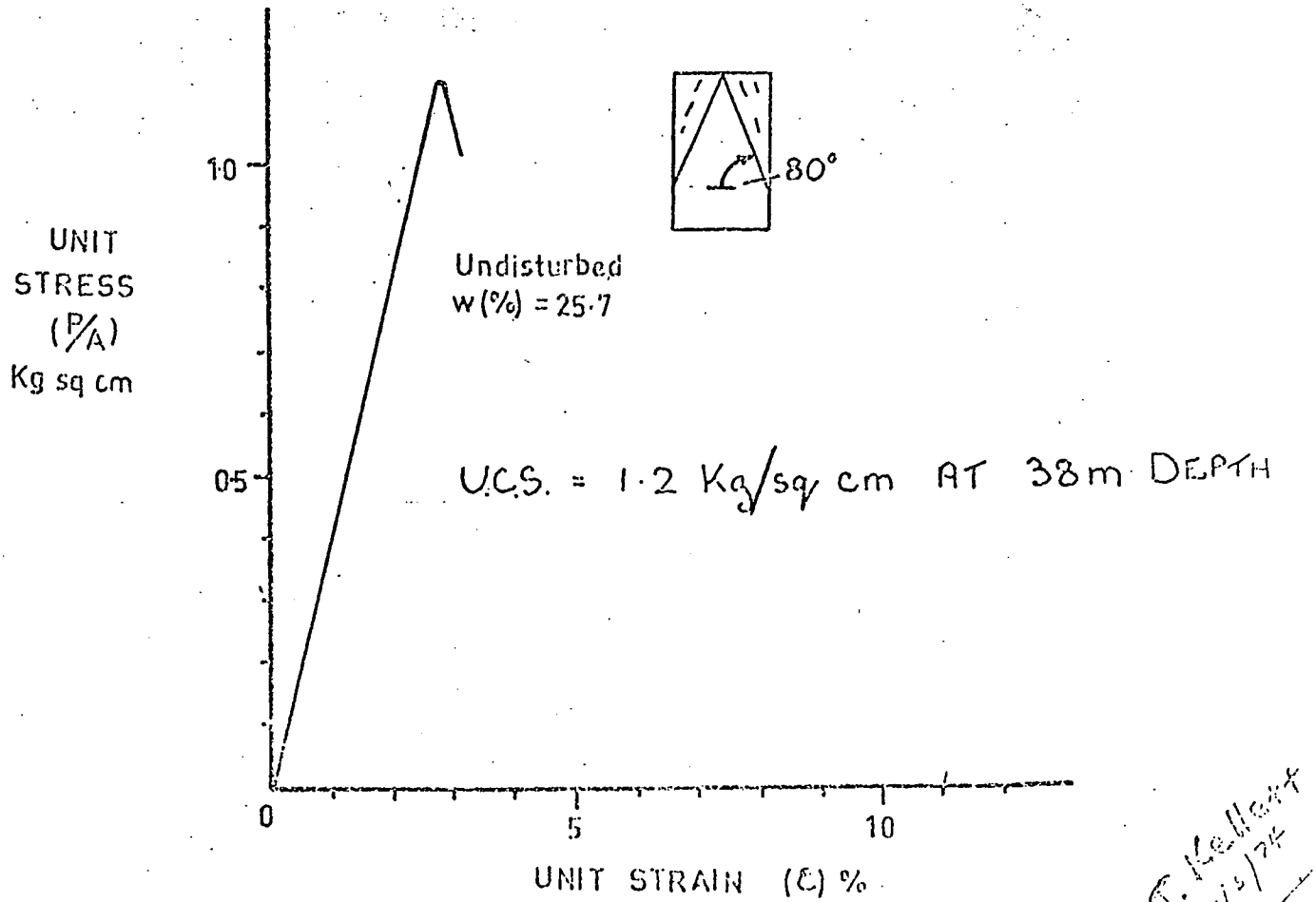
COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF MINERALS AND ENERGY — BUREAU OF MINERAL RESOURCES
ACT ENGINEERING GEOLOGY

TEST RESULT SHEET

Investigation: CITY EAST PROJECT
Location: CIVIC CENTRE AKUNA STREET
Sample Description(s): COMPLETELY WEATHERED MUDSTONE

Bore No.	D2	D2	D2					
Depth	50 m	49·9m	22 m					
Sample No.	1	2	3					

Lower Liquid Limit	40	34	38					
Lower Plastic Limit	31	26	29					
Plasticity Index	9	8	9					
Linear Shrinkage	4·5	4·3	5·1					
Unified Classification	M.L.	M.L.	M.L.					
U.S.P.R.A. Classification	A-4(8)	A-4(8)	A-4(8)					



S. Lellock 4/9/74

To accompany Record 1974/123

I-55/A16/1190

TRIAXIAL COMPRESSION TEST RESULTS

Saturated, consolidated, undrained, three stage tests on undisturbed samples, 5 cm diameter.

Drillhole	Depth (m)	Description	Cohesion (kPa)	Friction angle (degrees)
Groundtest B2	18	Completely weathered mudstone	46	29.4
Groundtest C1	30	Completely weathered mudstone	55	25.7
BMR 64	16	Highly weathered mudstone	143	23.8
BMR 64	25	Highly weathered brecciated mudstone	95	28.2
BMR 65	18	Highly-completely weathered mudstone	86	25.1

Tests by Snowy Mountains Engineering Corporation (1974)

SUMMARY OF CONSOLIDOMETER RESULTS

Consolidometer tests were done on three samples of highly to completely weathered mudstone from BMR drill hole 65, depth 20-30 m.

COEFFICIENT OF CONSOLIDATION, Cv (m^2/year)

	Pressure increments (k Pa)					
Sample	0-55	55-109	109-219	219-438	438-875	875-1313
A	-	-	-	-	-	14
B	47	42	31	21	16	15
C	-	-	-	34	54	13

COEFFICIENT OF COMPRESSIBILITY, Mv (m^2/kN x 10^{-6})

	Pressure increments (k Pa)					
Sample	0-55	55-109	109-219	219-438	438-875	875-1313
A	7	4	4	3	7	7
B	82	57	120	49	34	23
C	8	6	4	7	14	10

Tests by Snowy Mountains Engineering Corporation (1974)

UNIFIED SOIL CLASSIFICATION SYSTEM

CLASSIFICATION CHART

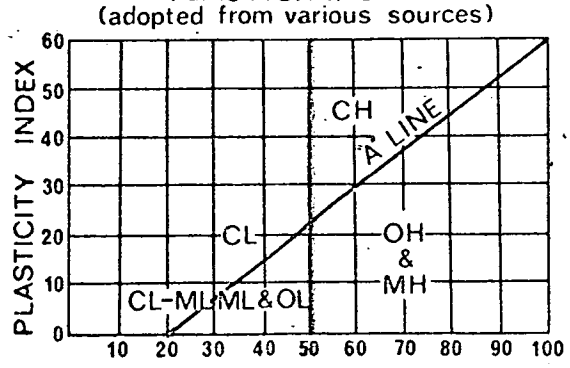
MAJOR DIVISIONS		SYMBOLS		TYPICAL NAMES
COARSE GRAINED SOILS More than 1/2 of soil > No 200 sieve size	GRAVELS (More than 1/2 of coarse fraction > no. 4 U.S. sieve size)	GW		Well graded gravels or gravel-sand mixtures, little or no fines*
		GP		Poorly graded gravels or gravel-sand mixtures, little or 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	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)



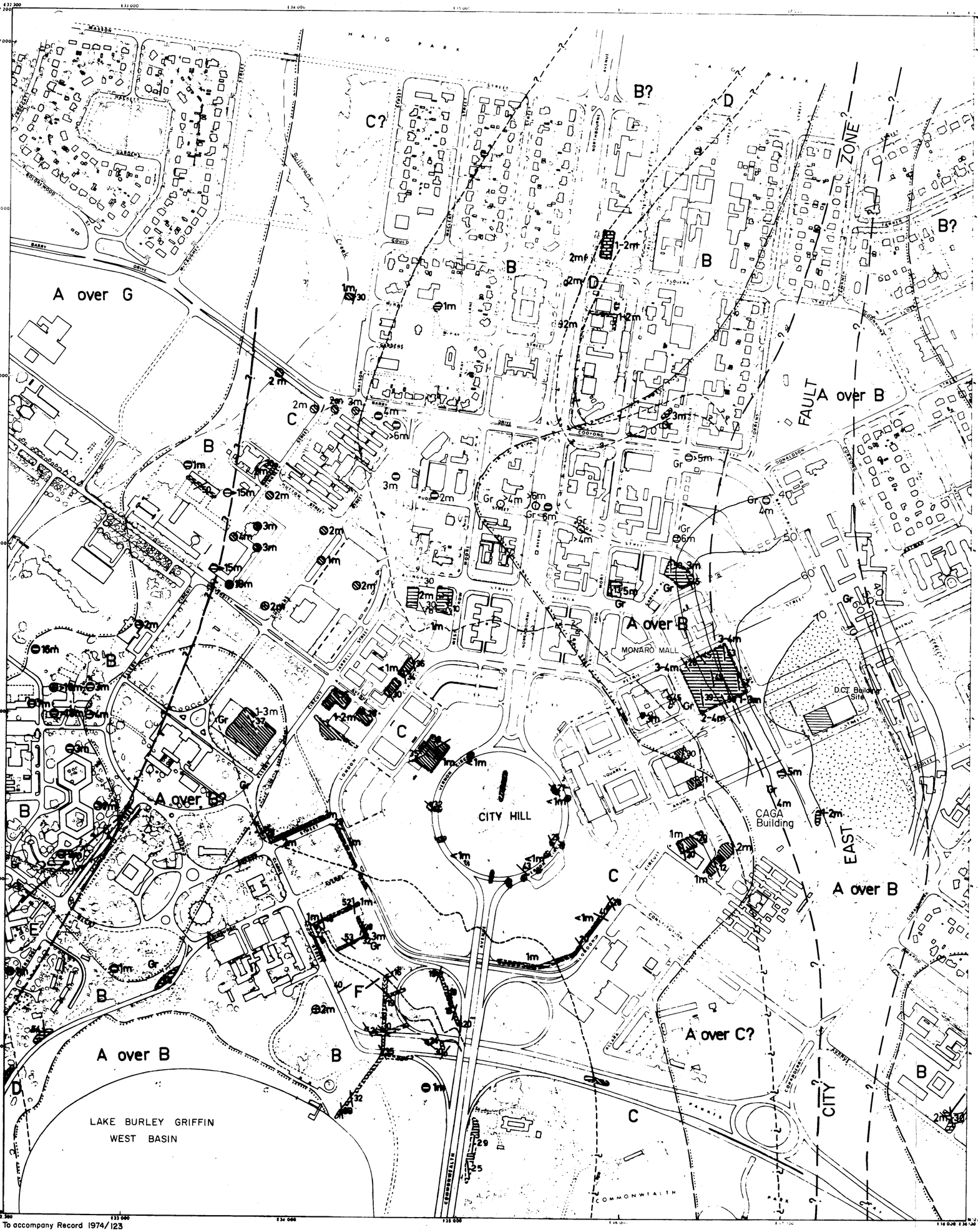
Pt.8

PLATE 1

GEOLOGICAL MAP OF THE CIVIC CENTRE AREA, CANBERRA

SCALE

0 100 200 300 400 500 600 m.



Note: Pattern shown where data available from excavations.

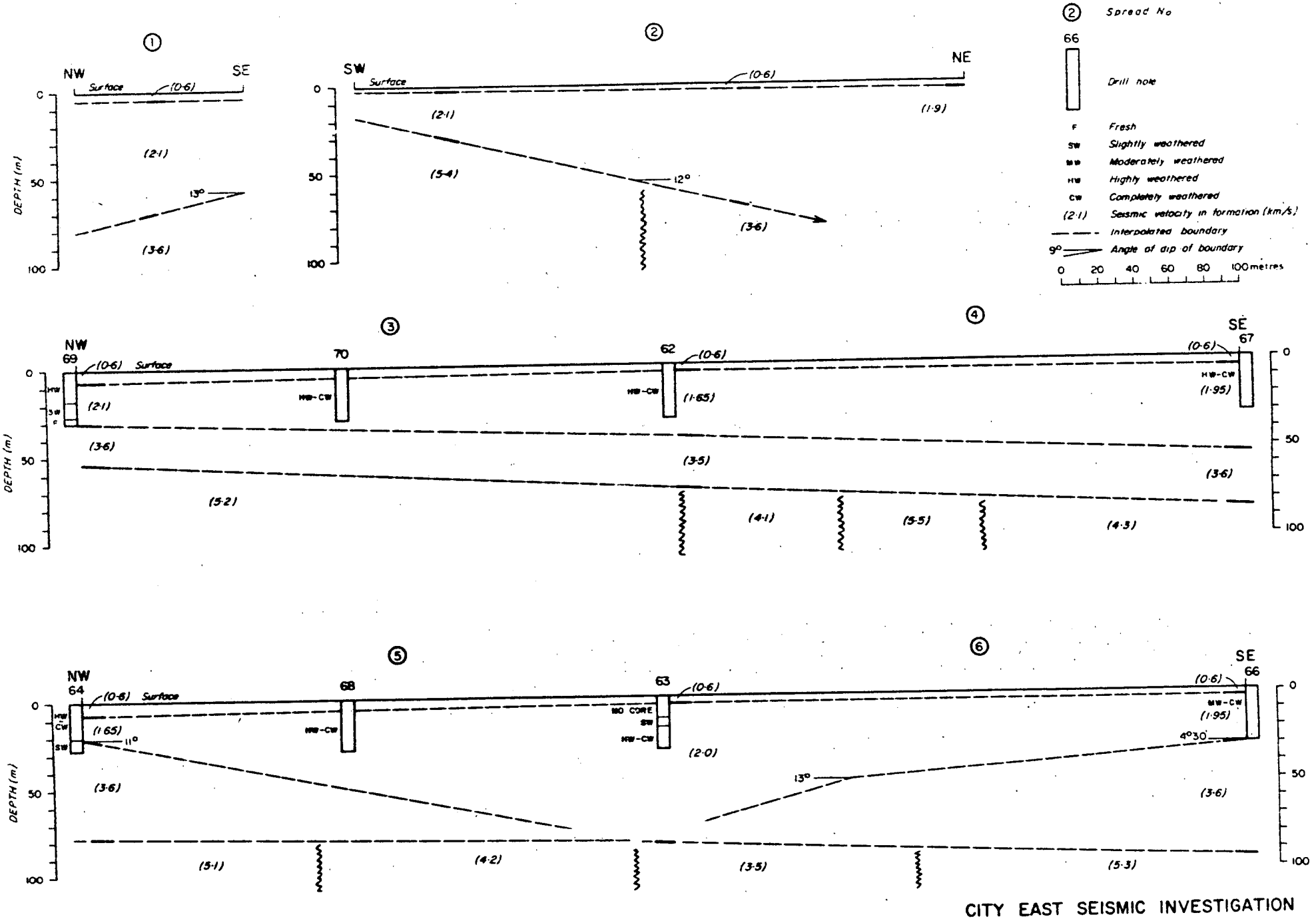
REFERENCE

- B — Mudstone, shale, siltstone – deeply weathered
- C — Mudstone, shale – shallow weathered
- D — Limestone – irregularly weathered
- E — Siliceous shale – shallow weathered
- F — Coarse tuff – deeply weathered
- G — Underlying rock type unknown
- ——— Geological boundary, position accurate
- – – – Geological boundary, position approximate
- –?–?– Geological boundary, position inferred
- ——— Fault, position accurate
- — — Fault, position approximate
- —?— Fault, position inferred
- 39 — Dip and strike of bedding
- ⊖2m — Auger or diamond drill hole showing rock type met and depth to moderately weathered rock
- 2m — Depth to moderately weathered rock in excavation
- Gr — Gravel locality; gravel generally as lenses immediately overlying bedrock and covered by younger alluvium or soil
- (A) — Area covered by unconsolidated alluvial deposits, generally 3-5m thick, boundaries approximate
- GN MN — Contours of depth to slightly weathered or fresh rock, 10m interval, based on seismic surveys and diamond drilling
- Area where depth of weathering greater than 70m

To accompany Record 1974/123

155/A16/1150

PLATE 2



CITY EAST SEISMIC INVESTIGATION

155/85-226

To accompany Record 1974/123