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SEISMIC SURVEYS AND RELATED GEOLOGICAL INVESTIGATIONS OF ENGINEERING PROJECTS IN THE A.C.T. FROM AUGUST 1969 TO JANUARY 1970

by

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SUMMARY

Seismic refraction surveys were carried out between August 1969 and January 1970 as an aid to the evaluation of geological conditions at the sites of six proposed engineering projects in the Australian Capital Territory. The investigations were designed to provide information on foundation and excavation conditions at the various project sites. The results of each investigation are summarized below.

Molonglo Valley Outfall Sewer

Over most of the route massive crystal tuff occurs. Scattered limestone lenses and shale beds were found along a small section of the route. Bedrock was found to be deeper than expected and blasting in order to excavate will only be necessary in areas of outcrop.

Murrumbidgee to Stromlo Gravity Main Extension

Bedrock over most of the proposed route is massive Mount Painter Porphyry. Apart from scattered areas of outcrop, generally at least 10 feet of soil, colluvium and highly weathered bedrock overlie slightly weathered to fresh bedrock.

Barry Drive

Along the proposed roadway Black Mountain Sandstone forms the bedrock. Outcrop is scarce, the sandstone being overlain by scree material. The deepest layer detected has a low seismic velocity indicating very weathered material at depth, posing no difficulties in excavating.

Sections 16 and 22, Barton

Bedrock in the area is Camp Hill Sandstone. It was found that 25 to 40 feet of soil, colluvium and highly weathered material overlie slightly weathered to fresh bedrock.

Molonglo River Bridge Site

In the immediate vicinity of the bridge site, medium- to coarse-grained welded crystal tuff with interbedded sandstone and ashstone lenses occur. The only rock encountered during diamond drilling was bedded sandstone which generally occurred at between 15 and 20 feet below the surface over most of the site.

Campbell Reservoir

Bedrock over the site is dacite. It is medium- to coarse-grained, massive, and fresh in outcrop. The seismic results indicated that bedrock with a velocity of 9,000 feet per second occurred at very shallow depths making excavations very difficult.

INTRODUCTION

Six site investigations which involved seismic refraction surveys were carried out between August 1969 and January 1970 by the Engineering Geology and Engineering Geophysics Groups of the Bureau. The surveys were carried out at the following localities:

(1) Molonglo Valley Outfall Sewer route.
(2) Murrumbidgee to Stromlo Gravity Main extension.
(3) Barry Drive, O'Connor.
(4) Sections 16 and 22, Barton.
(5) Tuggeranong Freeway, Molonglo River Bridge site.
(6) Campbell Reservoir.

The locations of the surveys are shown on Figure 1. The sites were investigated to determine soil thicknesses, or the depths to solid bedrock and likely foundation conditions.

The surveys of the Molonglo Valley Outfall Sewer, the Murrumbidgee to Stromlo Gravity Main and the Campbell Reservoir were carried out at the request of the Department of Works. The others were done at the request of the National Capital Development Commission.

The Engineering Geophysics Group, using a 24-channel refraction seismograph, carried out seismic surveys at localities 2, 3, and 5, and part of the seismic work at locality 4. Staff from the Engineering Geology Group acted as observers and assistants in these surveys. The Engineering Geology Group, using an RS 4 Recording Oscillograph and 10 geophones, carried out seismic surveys at localities 1 and 6 and one traverse at locality 4. The Engineering Geology Group undertook all the geological work involved in the six projects.

Seismic results were interpreted by means of the Reciprocal Method (Hawkins 1961). Depths to the deepest refractors were calculated at each geophone position where possible, and depths to intermediate layers were calculated at the shot points and interpolated between them.

The preliminary geological report on the Molonglo River Bridge site was written by R. Thieme; the remainder were written by D.C. Purcell.

MOLONGLO VALLEY OUTFALL SEWER

General

The proposed route follows the Molonglo River along the north bank from the suburb of Yarralumla to the junction of the Murrumbidgee and Molonglo Rivers. A treatment plant will be situated near the confluence of these two rivers. A trench 2 to 3 feet deep will be excavated to house the 5-foot diameter pipe, but tunnelling will be necessary in some areas.

In October 1969, the proposed route was walked and estimates were made of depths that can be excavated by earth-moving equipment without any blasting (Purcell, 1969(a)). For engineering purposes this layer can be regarded as soil.

To obtain better estimates of the soil thickness and at the same time to check the validity of the reconnaissance estimates twelve seismic traverses were carried out at selected sites along the proposed route. The location of traverses can be seen on Figure 2 and the seismic sections on Figures 3 and 4 (Purcell 1970(a)).

Geology

Bedrock along most of the route consists of massive, and at a few localities, bedded crystal tuff. Between traverses 6 and 8, scattered limestone lenses and associated shale beds occur. The limestone tends to be fairly impure, with very thin sandstone lenses; fossils and clastic material occur throughout. The shale which usually overlies the limestone is highly cleaved and fractured.

Crystal tuff when fresh ranks among the hardest of rocks. Near the surface its strength is reduced by weathering. In some places, with increasing depth, weathering decreases gradually to fresh rock. In other places a layer of soil and completely weathered rock abruptly rests on slightly weathered to fresh bedrock. Weathering is most active along joints resulting in the formation at some localities of residual boulders or tors of moderately weathered to fresh rock, surrounded by soil or highly to completely weathered rock.

The limestone is dense, compact and impermeable, and can weather only by solution at the surface; outcrops are fresh and hard. The limestone is thickly bedded and broadly jointed and is therefore difficult to break up.

The shale weathers fairly readily and is generally soft. As it is highly cleaved and fractured it breaks up easily.

Scattered areas that contain outcrop, mostly of crystal tuff, occur along and near the proposed route. Elsewhere there is soil cover with occasional rock fragments. Outcrops of rock form only about one percent of the length of the proposed route.

Results

Reconnaissance estimates

Estimates of soil thicknesses along the route, made during the rec nnaissance survey are shown in Table 1.

Table 1

Estimates of Soil Thicknesses

Estimated depth (feet)	Length Total ** (feet)	Percentage of Length
10 plus	5225	19
7-10	6050	22
5-7	4950	18
3-5	3025	11
0-5	8250	30

** Lengths of individual sections range from about 50 feet to several hundred feet.
The above estimates were made over a length of 27,500 feet and do not include those sections of the route where tunnels are proposed.

Seismic survey

It was proposed that 12 seismic traverses be conducted at intervals along the route; they were to be distributed equally along the sections of the route for which the four depth range estimates were made (Table 1).

The results of the seismic survey indicated that generally three layers of different velocities occur:

(i) 1,000 - 2,000 ft/sec, representing topsoil
(ii) 3,000 - 5,000 ft/sec, representing colluvium and highly weathered bedrock.
(iii) 8,000 - 20,000 ft/sec, representing moderately weathered to fresh bedrock.

The results are summarized in Table 2 which gives the estimates of thicknesses of the upper layer of soil that can be excavated without blasting, and indicates the degree of weathering of the bedrock immediately below:

Table 2

Traverse Number	Surface layer of soil that can be excavated without blasting			Velocity of layer immediately below the surface layer (ft/sec)	
	Velocity (ft/sec)	Thickness (feet) Minimum-maximum			
1	1000	2	5+	5000	(1)
2	1000 - 4500	20-	26-	8000	(2)
3	1000 - 2000	0	23-	10,000	(3)
4	1000 - 3000	22-	27-	8000	(2)
5	1000	3	5+	5000	(1)
6	1000 - 4000	14-	23-	13,000	(3)
7	1000 - 4000	15-	40-	10,000	(3)
8		NOT	SHOT		

Table 2 (Cont.)

Traverse Number	Surface layer of soil that can be excavated without blasting			Velocity of layer immediately below the surface layer (ft/sec)	
	Velocity (ft/sec)	Thickness (feet) Minimum-maximum			
9	1000 - 3500	18	23+	5000	(1)
10	1000 - 2000	5	15+	5000	(1)
11	1000 - 3500	20-	28-	8500	(2)
12	1000 - 3500	10-	16-	11,000	(3)

(1) Highly weathered bedrock
(2) Moderately weathered bedrock
(3) Slightly weathered to fresh bedrock.
\+ The plus sign next to a number indicates that it might be possible to continue to excavate, without blasting, down into the 5000 feet per second layer.
\- A minus sign next to a number indicates that excavations down to the estimated depths may not be practicable because of the possible occurrence of a thin intermediate velocity layer that was not detected in the survey.

Excavating Conditions

In this report it will be assumed that weathered bedrock that has a velocity of up to 5000 feet per second could be excavated by earth moving equipment without blasting. Weathered rock with a velocity of 5000 feet per second or greater would need to be blasted.

Table 2 shows that there are considerable depths of soil that can be removed without blasting.

Table 3 compares the Reconnaissance and Seismic estimates.

Table 3

Traverse Number	Reconnaissance estimate (feet)	Seismic Estimates (feet) Minimum	Maximum
3	0 - 5	0	23-
5		3	5+
1	3 - 5	2	5+
6		14-	23-
10		5	15+
2	5 - 7	20-	26-
7		15-	40-
		20-	28-
4	7 - 10+	22-	27-
9		18-	23+
12		10-	16-

Table 3 shows that the minimum seismic estimates for traverses 3, 5, 1, 6 and 10 are fairly similar to the corresponding reconnaissance estimates 0-5 and 3-5; the maximum figures are, however, deeper than the reconnaissance estimates suggested. The reconnaissance estimates 5-7 and 7-10+ bear very little relationship to the seismic estimates which are generally deeper than expected.

Conclusions

The seismically estimated thicknesses of soil are greater than those originally estimated in the reconnaissance survey. Rock forms outcrops over about one percent of the length of the proposed route. Also, as the reconnaissance estimates appear to be consistently too shallow, the amount of blasting necessary will not be great, even in the estimated 0 - 5 sections (which comprise about 30 percent of the length of the route).

MURRUMBIDGEE TO STROMLO GRAVITY MAIN EXTENSION

General

The Department of Works is to construct an additional water main to supplement the Canberra water supply. The pipeline has a diameter of 54 inches and the proposed route extends from the Murrumbidgee River to Stromlo Offtake. The seismic survey was carried out to provide further information on excavation conditions.

Eight seismic traverses were carried out at selected sites along the proposed water main route. The results are stated in detail by Whiteley (1970(b)) and are summarized here, with reference to geology and excavating conditions along the proposed route. (Purcell 1969(b)).

The location of the traverses can be seen on Figure 5 and the seismic sections on Figure 6.

Geology

Bedrock along most of the route consists of massive Mount Painter Porphyry. Widely scattered areas of outcrop occur along and near the proposed route; they are separated by broad areas of soil with occasional rock fragments. The seismic traverses were situated in soil covered areas.

The rock seen in outcrop appears to be mainly moderately to slightly weathered; it is fresh in some places.

Results of Seismic Survey

As the traverses are fairly randomly spaced along the route, the results are likely to be reasonably representative of conditions expected over the intervening sections of the route.

Table 4 summarizes the estimates of thickness of the upper layer of soil and weathered bedrock that can be excavated without blasting, and indicates the degree of weathering of the bedrock immediately below.

Table 4

Traverse	Surface Layer that can be excavated without blasting		Layer immediately below the surface layer	
	Velocity (feet per sec)	Thickness (feet)	Velocity (feet per sec)	Thickness (feet)
A	1000 - 3000	12 - 14	5500 (2)	12 - 32
B	2000 - 4000	16	8000 (3)	24 - 58
C	3000 - 5000	6 - 23	16000 (4)	?
D	1000 - 5000	19 - 20	8500 (3)	31 - 66
E	1000 - 2500	26 - 36	6000 (2)	12 - 40
F	1000 - 2500	21 - 22	5500 (2)	10 - 60
G	1000 - 2500	16 - 17	5500 (2)	20 - 42
H	2000 - 4500	26 - 36	15000 (4)	?

(1) Soil, colluvium and highly to completely weathered bedrock.
(2) Highly weathered bedrock.
(3) Moderately to slightly weathered bedrock.
(4) Fresh bedrock.

A feature of six of the seismic sections is a sharp change in velocities from 4500 - 6000 ft/s to velocities of 14,000 - 16,000 ft/s. This indicates a fairly sharp boundary between highly weathered bedrock (or in some cases, colluvium) and fresh bedrock with very little moderately weathered bedrock present. In traverses B and D a fairly thick layer has a velocity of 8,000 - 8,500 ft/s and thus probably represents moderately to slightly weathered bedrock. A relatively low bedrock velocity in traverse G - 10,000 ft/s - may represent either slightly weathered or fairly closely jointed bedrock.

Excavating Conditions

Table 4 shows in all traverses, except part of traverse C, a thickness of at least 12 feet for the upper layer of soil and weathered bedrock that has a velocity of 5,000 ft/s or less; this is considered to be soft enough to excavate without blasting. All eight traverses were sited on soil and rubble-covered surfaces; in the few areas where solid rock appears at the surface along the trench route, some blasting will be needed. Blasting along a short section of traverse C, where an indicated depth to a 16,000 ft/s velocity layer is 6 feet, may be necessary.

Conclusions

In all traverses except part of traverse C, the surface layer of soil and colluvium and highly weathered bedrock is at least 12 feet thick. Only in a few areas does solid bedrock exist closer to the surface; over most of the route there should be little difficulty in excavating at least the top 10 feet without blasting.

BARRY DRIVE, O'CONNOR

General

The National Capital Development Commission is considering the construction of an expressway to link Canberra City with the suburbs of Belconnen. The Commission requested that a seismic survey be carried out to determine the degree of consolidation of near-surface material.

Three seismic traverses were shot at selected sites along the proposed expressway. All were located in areas where road-cuts in the order of 15 feet in depth are required. The locations of the traverses can be seen in Figure 7 and the seismic sections in Figure 8 (Purcell 1969(c) and Whiteley 1970(c)).

Geology

Bedrock along the route consists of Black Mountain Sandstone, which at the type locality is a fine- to medium-grained quartzose sandstone. The only outcrop observed is situated in an erosion gully near traverse A; it is highly weathered. Elsewhere the route is covered with sandy soil that contains scattered sandstone fragments.

Several diamond-drill holes were sunk along the route using a light Gemco rig (Scott, W.G., Wallace & Associates Pty Ltd, 1969). Holes sunk between chainages 6750 and 6950 (along traverses A and B) encountered one foot of topsoil overlying about three to four feet of sandy clayey colluvium. Decomposed and completely weathered sandstone occured below about 5 feet. Holes sunk between chainage 7950 and 8150 (traverse C) encountered highly to completely weathered sandstone at depths ranging from seven to ten feet. This was overlain by silt and gravelly clay.

Results of Seismic Survey

Table 5 summarizes the seismic results. It can be seen that only a very small increase in velocity occurs with increasing depth.

Table 5

TRAVERSE	VELOCITY (feet per second)	THICKNESS (feet)	BEDROCK VELOCITY (feet per second)
A	2500 (1) 5000 (2)	5-11 47-102	8,500 (3)
B	2500 5000	7-15 90-110	8,500
C	5000	57-90	11,000 (4)

Following is an interpretation of the seismic velocities in terms of soil and bedrock.

SEISMIC VELOCITY (feet per second)	DESCRIPTION
2500	Soil and colluvium
5000	Saturated unconsolidated material and completely weathered rock.
8500	Moderately weathered bedrock
11,000	Slightly weathered to fresh bedrock.

It can be seen from Table 5 that there is a surface layer, interpreted as soil and colluvium which has a velocity of 2,000 feet per second. In traverse C this layer is presumably too thin to be close to the surface; the very gradual increase in velocity with depth indicates a corresponding very gradual increase in the strength and hardness of the bedrock.

Conclusions

As weathering seems fairly complete down to considerable depths no difficulties should occur in removing material from the relatively shallow depths envisaged.

SECTIONS 16 AND 22, BARTON

General

Sections 16 and 22 are suitably placed for the development of a major building complex; a preliminary site investigation was carried out to provide information for preliminary design purposes.

Four seismic traverses covering both sections were carried out. The location of the traverses can be seen on Figure 9 and the seismic sections on Figure 10. The results are stated in detail by Whiteley (1970(a)).

Geology

Bedrock in the area is Camp Hill Sandstone. It is covered by soil and colluvium at least 4 feet thick (Purcell 1969(d)).

During foundation investigations for Macquarie Hostel (which is sited just east of Section 22) several trenches and test bores were examined (Buckhorn, 1967). The rock exposed is bedded siltstone, which stratigraphically lies within the Camp Hill Sandstone. Beds range in thickness from 3 to 24 inches and strike north-northeast and dip 20° to 27° east. In the trenches that wereinspected in the south-eastern part of the hostel site, moderately weathered siltstone was found at a depth of from 6 to 10 feet. Light test bores revealed 1 to 4 feet of topsoil followed by completely weathered siltstone. Weathering decreased with depth and hard rock was found in six of the holes at from 3 to 11 feet. Two holes in the north-east were in clayey weathered siltstone at their completed depths of 10 and 15 feet.

Foundation investigation for the Institution of Engineers Building sited immediately to the north of section 16 revealed firm siltstone at a depth of about 10 feet, beneath about 2 feet of topsoil and about 8 feet of stiff colluvial clay and highly weathered bedrock. Depth to hard bedrock was shallowest in the south and south-east and deepest in the north and north-west. The siltstone is grey to light brown in colour with beds generally less than 12 inches thick. The siltstone beds form minor gentle folds that have a wave length of about 60 to 70 feet and plunge at 47° to the east.

Results of Seismic Survey

The seismic survey of Sections 16 and 22 indicates that the surface layer of soil and colluvium has a velocity of 1,000 to 2,500 and a thickness of from 10 to 15 feet. The soil and colluvium rests on a layer 12 to 51 feet thick which has a velocity of 4,000 to 5,000 feet per second; this probably represents highly to moderately weathered siltstone. A deeper layer which has a velocity of 7,000 to 13,000 feet per second represents slightly weathered to fresh siltstone.

Table 6 summarizes the depths and thicknesses of the refractive layers.

TABLE 6

DEPTHS AND THICKNESSES OF REFRACTORS

Traverse Number	Seismic Velocity, in feet per second		
	4,000 - 5,000		7,000 - 13,000
	Depth beneath natural surface	Thickness	Depth beneath natural surface
A	10 - 12	17 - 30	27 - 42
B	10 - 19	12 - 51	26 - 70
C	15	21 - 45	36 - 60
D	10 - 15	30 - 32	42 - 46
E	5 - 10	15 - 25	25 - 30

Foundation Conditions

In a preliminary investigation, by augering, of the site for the Institution of Engineers Building, it was concluded that foundations suitable for loadings not exceeding 10,000 p.s.i. would be obtained at from 10 to 14 feet beneath the ground surface (Coffey and Hollingsworth, 1968). The preliminary foundation design specified pier foundations at reduced levels ranging from 1843 to 1849 feet, that is, about 6 to 12 feet beneath the ground surface. Most of the 'as constructed' pier levels fell near the expected levels; a few more sunk deeper, and these occurred within the R.L. range 1835 to 1840 feet, that is 15 to 20 feet beneath the surface. These were located towards the south-western corner of the building.

The depths to the highly and moderately weathered siltstone indicated by the seismic results are similar to the 'as constructed' pier depths at the Institution of Engineers Building site, and apparently to the foundation depths at the Macquarie Hostel site.

Presumably then, foundations suitable for moderate loading will be found within this refractor, in sections 16 and 22, that is, at depths of 5 to 19 feet. Almost certainly, local variations are present in the degree of weathering throughout the sites, and these would not be detected by the method. The depths indicated by the seismic survey should be sufficiently reliable to enable a preliminary design of footings. Bedrock suitable for founding heavily loaded structures on say, bored piers, occurs at depths of 25 to 70 feet; foundations by alternative methods, say, spread footings, and piles cast in place, could be obtained at shallower depths.

Conclusions

Foundations for moderate loadings can be obtained in the refractor that has a velocity of 4,000 to 5,000 feet per second (interpreted as moderately to highly weathered siltstone). Foundations suitable for the heaviest loading would be provided by the deep refractor which has a velocity of 7,000 to 13,000 feet per second (interpreted as slightly weathered to fresh siltstone).

TUGGERANONG FREEWAY - MOLONGLO RIVER BRIDGE SITE

General

At the request of the National Capital Development Commission a number of seismic traverses were carried out by the Bureau at the proposed site for a bridge across the Molonglo River approximately 1¼ miles downstream from Scrivener Dam (Whiteley, 1971).

A fourteen-hole drilling programme, carried out by contractors to the Commission, was logged by the Bureau and the information used in the interpretation of the seismic results (Thieme, 1970). Specifications for the programme required that drilling be continued until either 3 feet or 10 feet of solid core were obtained, the length of core depending on the position of the hole. The specifications were satisfied by augering each hole until refusal and then coring for the required distance.

Locations of the seismic traverses, diamond-drill holes and proposed bridge foundations are shown on Figure 11; seismic cross-sections are shown on Figure 12. It will be noted that the drill holes are situated approximately 15 feet either side of the seismic traverses and consequently the drill logs have been projected onto the seismic cross-sections.

The seismic survey was carried out at a site originally proposed for the bridge. The site was subsequently moved 200 feet north although the original centre-line was retained. As a result the seismic traverses extend north only as far as Pier 1 but extend south 275 feet beyond Abutment B.

Geology

The rock type in the general area is predominantly a massive, medium- to coarse-grained, welded crystal tuff, previously mapped as Mount Painter Porphyry, with interbedded sandstone and ashstone lenses.

In the immediate vicinity of the bridge site outcrop is very sparse. On the southern river bank there are some small outcrops of moderately weathered, coarse-grained sandstone. In the river, about 80 feet downstream from the proposed structure there is an elongate outcrop of sandstone striking 360° and dipping 30° - 35° west. There are no outcrops on the northern bank. Some sparse river gravel occurs to the west of Abutment A.

Sandstone was encountered in each hole. This sandstone is derived from welded crystal tuff and consists predominantly of subangular quartz grains with minor amounts of feldspar and chlorite; grain size is generally less than 2 mm in diameter but with occasional grains up to 5 mm in diameter.

The sandstone is predominantly red-brown (purplish?) in colour but occasionally shows alternate pale green and red-brown banding. A vague banding is also caused by slight variations in the red-brown colour of the cement and by variations in the grain size (in parts the sandstone exhibits graded bedding). The banding is parallel to bedding and has a constant dip of 30° to 40° relative to the plane normal to the core axis. This dip is the same as that measured on the outcrop in the river and suggests that the sandstone is uniformly dipping over the whole site, viz. strike 360°, dip 30° to 40° west.

Results of Seismic Survey

The layers encountered can be classified according to their seismic velocities as follows:

TABLE 7

Layer	Seismic velocity (feet/sec)	Interpreted rock type
A	1000	Top soil, red-brown clayey sand.
B	2500	Silty sand - completely weathered sandstone.
C	4000 - 5000	Highly to moderately weathered sandstone.
D	6000 - 8000	Fresh sandstone.
E	11000 - 15000	Fresh welded crystal tuff (Mount Painter Porphyry)

The interpretation of Layers A, B and C, and of Layer D on the north bank, is based on the drilling results. Interpretation of Layer D on the south bank and Layer E on both banks is based on geological deduction.

The seismic cross-sections indicate that the top of the layer of highest seismic velocity (11000 - 15000 ft/sec) is extremely irregular which suggests that this is an old erosion surface on welded crystal tuff and that the sandstone was water-deposited in small depressions in this surface.

On the south bank all five seismic layers are present. Approximate depths to, and thicknesses of, the layers are summarized in Table 8.

TABLE 8

Layer	Description	Thickness	Depth below natural surface of top of layer
A and B	Top soil and completely weathered sandstone.	10'-20'	0'
C	Highly to moderately weathered sandstone.	10'-20'	10'-20'
D	Fresh sandstone	30'-50'	20'-30'
E	Fresh welded crystal tuff.	-	60'-80'

The following will be noted from the seismic cross-section:

(i) Both Layers A and B thin towards the northern (river) end of Traverse D.

(ii) Depth to welded crystal tuff at the western end of Traverse B is only 40 feet compared to 60-80 feet encountered elsewhere; this probably indicates that the sandstone is thinning out towards the south.

(iii) The velocities in both the sandstone and the crystal tuff decrease towards the river indicating deeper weathering as the river is approached.

(iv) Auger refusal can be correlated with the top of Layer D in all holes except Boreholes 13 and 14. The cores obtained in these two holes were highly weathered indicating that coring was commenced in the lower part of Layer C.

On the north bank only layers A, B, D and E are present. Layer C is either absent or too thin to be picked up by this seismic method. Approximate depths to, and thicknesses of, the layers are summarized in Table 9:

TABLE 9

Layer	Description	Thickness	Depth below natural surface of top of layer
A and B	Top Soil and completely weathered sandstone	10'-20'	0'
D	Slightly weathered to fresh sandstone	25'-30'	10'-20'
E	Fresh welded crystall tuff	-	40'-50'

The following will be noted from the seismic cross-sections:

In the Boreholes Nos 3 and 4 (Pier 1) positioned at the northern extremity of Traverse E, auger refusal occurred at a depth of 25 feet, that is, well into the 6000 ft/sec layer (Layer D - fresh sandstone). This is in direct contrast to the other boreholes intersecting this section (Boreholes Nos. 5-8) in which auger refusal corresponds to the top of the 6000 ft/sec layer. A possible explanation of this discrepancy is that an intermediate layer (possibly Layer C - 4000 ft/sec) is present at the northern end of Traverse E but was not distinguished in the seismic interpretation. Thickening of this intermediate layer to the north of Traverse E could also explain why auger refusal occurred at a depth of 42 feet at Abutment A - a depth far in excess of those encountered elsewhere on the site.

The reason for this deep weathering north of Traverse E is not apparent. Sparse river gravel occurs just west of Abutment A, indicating an old river terrace or channel and this could possibly be associated with deep weathering. It does not appear to have been caused by faulting as the cores from Boreholes Nos 1-4 (Abutment A and Pier 1) show that the sandstone is undisturbed.

Conclusions

The only rock type likely to be encountered in the bridge foundations is a uniform medium- to coarse-grained sandstone striking 360° and dipping; 30°-40° west.

Over the whole site, completely weathered sandstone (silty sand) occurs under a thin veneer of top soil. The intensity of weathering decreases with increasing depth and hard, moderately to slightly weathered sandstone is encountered at a depth of 15-20 feet over most of the site. However, in the vicinity of Abutment A and Pier 1 the weathering is much deeper and slightly weathered sandstone is encountered at depths of 40 feet and 25 feet respectively.

The core obtained on the north bank comes from the top of the 6000 ft/sec Layer (Layer D - fresh sandstone) and is moderately hard and strong, and only slightly weathered. Joints are iron-stained but fairly tight and have a 6-inch to 12-inch spacing. Foundations for moderate to heavy loadings can be obtained in this layer at depths corresponding to the top of the cored interval.

On the south bank the core comes from the upper part of the 8000 ft/sec layer (Layer D - slightly weathered to fresh sandstone) and is generally moderately hard and strong, and slightly weathered. However in Boreholes Nos 11-14 (Pier 5 and Abutment B) parts of the core were moderately to highly weathered with rough stained joints, stained with iron and chlorite at 3-inch to 5-inch spacing, indicating that core came from the lower part of Layer C. Foundation conditions in the lower half of this layer would thus appear to be suitable only for moderate loadings. Foundations suitable for heavily loaded structures can be found in Layer D (8000 ft/sec - fresh sandstone) at depths of 25 and 30 feet at Pier 5 and Abutment B respectively.

CAMPBELL RESERVOIR

Seismic Survey

General

On 21st January, 1970, the Department of Works requested that a seismic survey be carried out to determine the depth to solid bedrock at the proposed reservoir site, which is located on the southern slopes of Mt Ainslie (see Figure 1). A programme of drilling on a 50-foot grid system had previously been done by 'Groundtest' Australia, contractors to the Department of Works. A total of 30 holes were bored. The depths to refusal using a Gemcodril auger indicated that excavations down to and in some cases below the finished slab R.L. of 2115' would be possible using earth-moving equipment. However during early excavations hard bedrock was encountered at shallow depths. Two seismic traverses were carried out. The locations of the traverses can be seen on Figure 13 and the sections on Figure 14 (Purcell, 1970(b)).

Geology

The rock type at the site is dacite. When fresh it is a grey to light blue colour, fine to coarse-grained, massive, hard, and slightly foliated. Narrow quartz veins are common and pyrite is disseminated throughout. The surface as excavated on 22nd January, 1970 exposed bedrock over most of the site. The rock exposed was moderately weathered to fresh and fairly broadly jointed.

Results

The seismic results indicated that depths to solid bedrock of velocity 9,000 feet per second and greater, ranged from about 4 to 9 feet below the natural ground surface along traverse 1 and from 6 to 10 feet along traverse 2.

Diamond Drilling

Subsequent diamond drilling and augering was carried out to confirm the seismic results. It was shown that the auger, using a tungsten carbide bit as used in the initial augering program, was able to penetrate at least moderately to slightly weathered rock with a velocity of 9,000 feet per second. (This rock was recovered in the core of a diamond-drill hole situated a few feet away from one such auger hole). Several diamond-drill holes were drilled, most of them entered rock at shallow depths, as indicated by the seismic results. The cores were not inspected and therefore logs of them are not available.

Conclusions

Bedrock over most of the site occurs at very shallow depths and further excavations, without blasting, will be difficult.

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APPENDIX 1

DEFINITION OF DEGREES OF WEATHERING

Fresh	:	Rock shows no discolouration, loss of strength, or any other effect of weathering.
Slightly weathered	:	Rock is slightly discoloured, but not noticeably lower in strength than the fresh rock.
Moderately weathered	:	Rock is discoloured and noticeably weakened, but a 2-inch diameter drill core cannot usually be broken by hand across the rock fabric.
Highly weathered	:	Rock is usually discoloured and weakened to such an extent that 2-inch diameter cores can be broken readily by hand, across the rock fabric. Wet strength usually much lower than dry strength.
Completely weathered	:	Rock is discoloured and entirely changed to soil, but the original fabric of the rock is mostly preserved. The properties of the soil depend on the composition and structure of the parent rock.

APPENDIX 2

GEOLOGICAL LOGS OF DRILL HOLES

MOLONGLO RIVER BRIDGE SITE

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT TUGGERANONG FREEWAY: MOLONGLO RIVER BRIDGE

LOCATION 1.25 miles downstream from Scrivener Dam; RIGHT BANK.

ANGLE FROM HORIZONTAL -90° DIRECTION Vertical

COORDINATES N 1230 E 15440 R.L. 1806'

HOLE NO. 1

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC.	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	CORE BOX NO.	PHOTO CORE NO.
TOP SOIL	Red, clayey loam		0								
TUFFACEOUS SANDSTONE. Completely weathered.	Yellow-brown silty sand. Quartz grains mainly sub-angular; some felspar. Grain size: Coarse sand: 30% Medium sand: 32% Fine sand: 10% Silt and clay: 28%		10				No structure visible				
Completely weathered	As above; but color brown. Grain size: Coarse: 24% Medium: 32% Fine: 14% Silt and clay: 28%		20				Transitional boundary. No structure visible		NO WATER PRESSURE TESTING CARRIED OUT.		
Highly weathered.	As above, but color is red-brown. Grain size: Coarse: Medium: Fine: Silt and clay:		30				Transitional boundary. No structure visible				
			40				AUGER REFUSAL 42' Coring from 42'.				
Slightly weathered	Green color, medium grained, unsorted Quartz sub-angular, some felspar. Grain size upto 1mm. Rock friable.		NMLC				Soft, pale green clayey cement.				
	As above. Thin red iron staining parallel to bedding. Rock moderately hard.						Cement hard. DIP 40°. Slickensided fracture at 44'6"				
	Dark red-brown, coarse grained, unsorted. Mainly sub-angular quartz, some felspar and chlorite grainsize mostly ≤ 2mm. but upto 8mm. Rock moderately hard.		50				DIP 30°. Cement red-brown and green. DIP 40°: graded bedding - normal bedding. Red-brown iron stained cement.				
	End of hole at 52 feet.										

DRILL TYPE Gemco

FEED Hydraulic

CORE BARREL TYPE NMLC Triple tube; inner split tube.

DRILLER Groundset

COMMENCED 18-12-69

COMPLETED 19-12-69

LOGGED BY R. Thieme

VERTICAL SCALE 1 inch: 10 feet

NOTES

FRACTURE LOG:- Number of fractures per foot of core. Zones of core loss are blacked in.

BEDDING AND JOINT PLANES:- Angles are measured relative to a plane normal to the core axis

β sheared zone showing attitude to core direction

Tuffaceous Sandstone.

To Accompany Record 1971/39

WATER PRESSURE TESTS

PACKER TYPE Not carried out.

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures. Test sections are indicated graphically by blacked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: TUGGERANONG FREEWAY: MOLONGLO RIVER BRIDGE.

LOCATION: RIGHT BANK.

ANGLE FROM HORIZONTAL: -90° DIRECTION: Vertical

COORDINATES: N 1235 E 15470 R.L. 1802'

HOLE NO. 2

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF NO CORE BOX	PHOTO REF NO CORE SAMPLE
	Red, clayey loam.		0				Transitional boundary.				
TUFFACEOUS SANDSTONE. Completely weathered.	Yellow-brown silty sand. Predominently sub-angular quartz grains; some felspar. Grain size (approx): Sand: 70% Silt and clay: 30%		10				No structure visible.				
							Transitional boundary.				
Highly weathered.	As above; but color red-brown.		20				No structure visible.				
			30				AUGER REFUSAL 33 feet. Cored from 33 feet.				
Slightly weathered.	Dark red-brown, coarse grained, (mostly ≤ 2 mm, but up to 5 mm.) unsorted. Mostly sub-angular quartz; some felspar and chlorite. Rock moderately hard and strong.		40 /9				Red-brown iron stained cement. Dip 45°. Vague banding due to color differences in cement. Graded bedding visible; normal bedding. 42', high angle 3/4" quartz vein 1" of highly weathered rock on either side of vein.				
	END OF HOLE AT 43 feet.										

DRILL TYPE: GEMCO

FEED: Hydraulic

CORE BARREL TYPE: NMLC- Triple tube.

DRILLER: Groundtest.

COMMENCED: 18-12-69

COMPLETED: 18-12-69

LOGGED BY: R. THIEME

VERTICAL SCALE: 1 inch: 10 feet.

NOTES

FRACTURE LOG :- Number of fractures per foot of core. Zones of core loss are blocked in.

BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis

/9 Quartz vein, showing attitude to core direction.

Tuffaceous Sandstone.

To Accompany Record No. 1971/39

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures. Test sections are indicated graphically by blacked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: TUGGERANONG FREEWAY; MOLONGLO RIVER BRIDGE.

LOCATION: RIGHT BANK

ANGLE FROM HORIZONTAL: -90° DIRECTION: Vertical.

COORDINATES: N 1160 E 15460 R.L. 1796'

HOLE NO. 3

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF NO. CORE BOX	PHOTO REF NO. CORE SAMPLE
	AUGER DRILLING		0 10 20				No structures visible. AUGER REFUSAL 25 feet Cored from 25 feet.		NOT WATER PRESSURE TESTED		
TUFFACEOUS SANDSTONE — Mostly slightly weathered	Dark red-brown, coarse grained, unsorted. Mainly quartz; some felspar and chlorite. Grain size generally ≤ 2 mm in diameter; some up to 5 m.m. Rock moderately hard and strong.		30				Red-brown iron stained cement. Steeply dipping quartz vein from 27'-27'6". DIP 35° (bedding). Banding due to slight color variations in the cement.				
	END OF HOLE AT 35 feet.										

DRILL TYPE: GEMCO
FEED: Hydraulic
CORE BARREL TYPE: NMLC. Triple tube.
DRILLER: Groundheat.
COMMENCED: 18-12-69
COMPLETED: 18-12-69
LOGGED BY: R. THIEME
VERTICAL SCALE: 1 inch : 10 feet.

NOTES

FRACTURE LOG:- Number of fractures per foot of core. Zones of core loss are blacked in.
BEDDING AND JOINT PLANES:- Angles are measured relative to a plane normal to the core axis

Tuffaceous sandstone.

WATER PRESSURE TESTS

PACKER TYPE:
SUPPLY LINE:
VERTICAL SCALE:
Figures given are gauge pressures
Test sections are indicated graphically by blacked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE:
COLOUR:

To Accompany Record No. 1971/39

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: TUGGERANONG FREEWAY; MOLONGLO RIVER BRIDGE.

LOCATION: RIGHT BANK.

ANGLE FROM HORIZONTAL: -90° DIRECTION: Vertical.

COORDINATES: N 1165 E 1580 R.L. 1793'

HOLE NO. 4

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, BEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF CORE	PHOTO NO CORE WAMPE
	AUGER DRILLING.		10				No structure visible				
			20				AUGER REFUSAL 22 feet. Rock cored from 22 feet.				
TUFFACEOUS SANDSTONE. Slightly weathered.	Dark red-brown, coarse grained (mainly < 2 m.m., but up to 5 m.m.) unsorted. Mainly quartz						No major structures				
	END OF HOLE AT 25 feet.										

DRILL TYPE: GEMCO

FEED: Hydraulic

CORE BARREL TYPE: NMLC. Triple tube.

DRILLER: Groundtest.

COMMENCED: 18-12-69

COMPLETED: 18-12-69

LOGGED BY: R. THIEME

VERTICAL SCALE: 1 inch : 10 feet.

NOTES

FRACTURE LOG :- Number of fractures per foot of core. Zones of core loss are blocked in.

BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis

Tuffaceous Sandstone.

To Accompany Record No. 1971/39

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures.
Test sections are indicated graphically by blocked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: TUGGERANONG FREEWAY. MOLONGLO RIVER BRIDGE.

LOCATION: RIGHT BANK.

ANGLE FROM HORIZONTAL: -90° DIRECTION: Vertical

COORDINATES: N 1035 E 15469 R.L. 1783'

HOLE NO. 5

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC.	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	CORE REF. ROLL NO.	PHOTO CORE NO.
	AUGER DRILLING		0 10				AUGER REFUSAL 12 FEET. Coring from 12 feet				
TUFFACEOUS SANDSTONE. Slightly weathered	Dark-red-brown, coarse grained (≤ 2mm mostly, but up to 5mm), unsorted. Mostly sub-angular quartz; some felspar and quartz. Red-brown iron stained cement. Rock moderately hard and strong.		20				DIP of bedding 25°-30° Banding due to slight color variations in the cement. Some graded bedding visible - normal bedding.		NOT PRESSURE TESTED.		
	END OF HOLE AT 22 FEET.										

DRILL TYPE: GEMCO

FEED: Hydraulic

CORE BARREL TYPE: NMLC. Triple tube.

DRILLER: Groundkeepers

COMMENCED: 18-12-69

COMPLETED: 18-12-69

LOGGED BY: R. THIEME

VERTICAL SCALE: 1 inch : 10 feet.

NOTES

FRACTURE LOG :- Number of fractures per foot of core. Zones of core loss are blacked in.

BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis

Tuffaceous sandstone.

To Accompany Record No. 1971/59

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures. Test sections are indicated graphically by blacked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

M(PT)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT TUGGERANONG FREEWAY. MOLONGLO RIVER BRIDGE.

LOCATION RIGHT BANK.

ANGLE FROM HORIZONTAL -90° DIRECTION Vertical

COORDINATES N 1040 E 1550 R.L. 1782'

HOLE NO. 6

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO KEY NO. CORE BOX	PHOTO KEY NO. CORE SAMPLE
	AUGER DRILLED.		0				AUGER REFUSAL 11 Feet Cored from 11 feet				
TUFFACEOUS SAND-STONE. Slightly weathered.	Dark red, coarse grained, unsorted, Banded due to color variation in matrix. Moderately hard.		10				No major structure visible.				
	END OF HOLE AT 16 FEET										

DRILL TYPE GPM&O

FEED Hydraulic

CORE BARREL TYPE NMLC. Triple tube.

DRILLER Groundtest

COMMENCED 18-12-69

COMPLETED 18-12-69

LOGGED BY R. THIAME

VERTICAL SCALE 1 inch : 10 feet

NOTES

FRACTURE LOG :- Number of fractures per foot of core. Zones of core loss are blocked in.

BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis

Tuffaceous Sandstone.

TO Accompany Record No. 1971/39

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures
Test sections are indicated graphically by blocked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: TUGGERANONG FREEWAY. MOLONGLO RIVER BRIDGE.

LOCATION: RIGHT BANK, EDGE OF RIVER.

ANGLE FROM HORIZONTAL: -90° DIRECTION: Vertical

COORDINATES: N 915 E 15490 R.L. 1770' (Approx)

HOLE NO. 7

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC.	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	* WATER PRESSURE TEST Loss in gallons per minute per foot	CORE BOX	PHOTO REF. NO. CORE
	AUGER DRILLED		0 10						NOT TESTED.		
Slightly weathered	Dark, red-brown, coarse grained, unsorted. Banded due to color variations in the cement. Occasional green bands. Rock moderately hard.		20				17'5" and 17'8", slickensided joints, normal to bedding. BEDDING DIPS 40°-45°				
	END OF HOLE AT 27 feet.										

DRILL TYPE: GEMCO

FEED: Hydraulic

CORE BARREL TYPE: NMLC. Triple tube.

DRILLER: Groundtest

COMMENCED: 18-12-69

COMPLETED: 18-12-69

LOGGED BY: R. THIEME

VERTICAL SCALE: 1 inch : 10 feet.

NOTES

FRACTURE LOG :- Number of fractures per foot of core. Zones of core loss are blocked in.

BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis

Tuffaceous Sandstone.

To Accompany Record No. 1971/39.

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures.
Test sections are indicated graphically by blocked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

M(Pt)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: TUGGERANONG FREEWAY. MOLONGLO RIVER BRIDGE.

LOCATION: RIGHT BANK, NEAR RIVER LEVEL

ANGLE FROM HORIZONTAL: -90° DIRECTION: Vertical

COORDINATES: N 915 E 1515 R.L. 1770' (Approx)

HOLE NO. 8

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, BEARS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF NO. CORE BOX / CORE
	AUGER DRILLED NO CORE RECOVERED		0							
Slightly weathered to fresh Tuffaceous Sandstone.	Purple-grey color, hard and strong. Medium to coarse grained. BEDDING 25°-30°		15				All joints ilmenite stained. 5" joint at 60° rough. 6" joint at 20° rough. 1/2" joint at 35° slightly rough.			
	END OF HOLE AT 69'									

DRILL TYPE: GEMCO

FEED: Hydraulic

CORE BARREL TYPE: NMLC. Triple tube.

DRILLER: Groundtest.

COMMENCED: 15-1-70

COMPLETED: 15-1-70

LOGGED BY: D.C. Purcell

VERTICAL SCALE: 1inch: 10 feet.

NOTES

FRACTURE LOG :- Number of fractures per foot of core. Zones of core logs are blocked in.

BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis

1' Prominent joint, showing attitude to core direction.

Tuffaceous Sandstone.

To Accompany Record No. 1971/39

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures

Test sections are indicated graphically by - blocked in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: TUGGERANONG FREEWAY. MOLONGLO RIVER BRIDGE.

LOCATION: LEFT BANK.

ANGLE FROM HORIZONTAL: -90° DIRECTION: Vertical

COORDINATES: N 775 E 15610 R.L. 1770 (Approx)

HOLE NO. 9

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF. NO. CORE LOG	PHOTO REF. NO. CORE SAMPLE
	AUGER DRILLED NO CORE		0				CORED FROM 7 FEET.				
TUFFACEOUS SANDSTONE. Slightly weathered to fresh.	Grey-purple colored, medium to coarse grained. Moderately hard and strong. BEDDING AT 40°.		10				7'6" Joints at 30° rough, iron stained. Average joint spacing 5-10". 11'-14' Joints mainly at 10°, rough, limonite stained. 15' interjecting joints at 30° and 55° rough, limonite stained. 16' Joint at 40°, rough. 16'-17' close interjecting joints.				
	END OF HOLE AT 17 feet.										

DRILL TYPE: GEMCO

FEED: Hydraulic

CORE BARREL TYPE: NMLC. Triple tube

DRILLER: Groundtest.

COMMENCED: 15-1-70

COMPLETED: 15-1-70

LOGGED BY: D.C. Purcell

VERTICAL SCALE: 1 inch: 10 feet.

NOTES

FRACTURE LOG:- Number of fractures per foot of core. Zones of core loss are blacked in.

BEDDING AND JOINT PLANES:- Angles are measured relative to a plane normal to the core axis

/j Prominent joint showing attitude to core direction.

Tuffaceous Sandstone.

To Accompany Record 1971/39

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures. Test sections are indicated graphically by blacked in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

M(Pt)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: TUGGERANONG FREEWAY. MOLONGLO RIVER BRIDGE.

LOCATION: LEFT BANK

ANGLE FROM HORIZONTAL: -90° DIRECTION: Vertical

COORDINATES: N 780 E 15540 R.L. 1770' (Approx)

HOLE NO. 10

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, BEARS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	CORE PIECES NOT IN CORE BARREL	CORE PIECES IN CORE BARREL
	AUGER DRILLED NO CORE		0				CORED FROM 8 FEET.				
TUFFACEOUS SANDSTONE. Slightly weathered to fresh.	Grey-purple colored, medium to coarse grained. Moderately hard and strong. BEDDING AT 45°		10				Joints rough, limonite stained, mostly spaced from 6"-10".				

DRILL TYPE: GEMCO

FEED: Hydraulic

CORE BARREL TYPE: NMLC. Triple tube.

DRILLER: Groundtest

COMMENCED: 15-1-70

COMPLETED: 15-1-70

LOGGED BY: D.C. PURCELL

VERTICAL SCALE: 1 inch : 10 feet.

NOTES

FRACTURE LOG :- Number of fractures per foot of core. Zones of core logs are shaded in.

BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis

Tuffaceous Sandstone.

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures. Test sections are indicated graphically by blackened in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

To Accompany Record 1971/39

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT TUGGERANONG FREEWAY. MOLONGLO RIVER BRIDGE.

LOCATION LEFT BANK.

ANGLE FROM HORIZONTAL -90° DIRECTION Vertical

COORDINATES N 650 E 15510 R.L. 1790'

HOLE NO. 11

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC.	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, BEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF. BOX CORE	PHOTO NO. CORE
	AUGER DRILLED		10				CORED FROM 16 FEET.				
TUFFACEOUS SANDSTONE Sightly weathered to fresh.	Gray colored, fine to medium grained. BEDDING ABOUT 20°-25° Moderately hard and strong.		20				Joints limonite stained, some coated with chlorite. Spaced 4"-8". 18'-19' closely jointed, some shearing.				

DRILL TYPE Gemco

FEED Hydraulic

CORE BARREL TYPE NIMLC. Triple tube.

DRILLER Groundlord.

COMMENCED 15-1-70

COMPLETED 15-1-70

LOGGED BY D.O. Purcell

VERTICAL SCALE 1 inch : 10 feet.

NOTES

FRACTURE LOG:- Number of fractures per foot of core. Zones of core logs are blocked in.

BEDDING AND JOINT PLANES:- Angles are measured relative to a plane normal to the core axis

Tuffaceous Sandstone.

To Accompany Record 1971/39

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures. Test sections are indicated graphically by blocked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

M(Pt)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT TUGGERANONG FREEWAY. MOLONGLO RIVER BRIDGE

LOCATION LEFT BANK

ANGLE FROM HORIZONTAL -90° DIRECTION Vertical

COORDINATES N 650 E 15560 R.L. 1792'

HOLE NO. 12

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Less in gallons per minute per foot	PHOTO REF NO. CORE BOX	PHOTO REF NO. CORE
	AUGER DRILLED		0 10				CORED FROM 16 FEET.				
TUFFACEOUS SANDSTONE. Slightly weathered to fresh.	Grey colored, fine to medium grained. Moderately hard and strong. BEDDING ABOUT 10°-20°		13 20				16' joint at 75°, rough, chlorite and limonite stained. Av. spacing 3-5". 17' joint at 45°, lim. stained.				

DRILL TYPE Gemco

FEED Hydraulic

CORE BARREL TYPE NMLC. Triple tube.

DRILLER Graundfert.

COMMENCED 19-1-70

COMPLETED 19-1-70

LOGGED BY D.C Arrell

VERTICAL SCALE 1 inch : 10 feet.

NOTES

FRACTURE LOG - Number of fractures per foot of core. Zones of core loss and blocked in.

BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis

t/j Prominent joint showing attitude to core direction.

Tuffaceous Sandstone.

To Accompany Record 1971/39

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures. Test sections are indicated graphically by blocked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: TUGGERANONG FREEWAY. MOLONGLO RIVER BRIDGE.

LOCATION: LEFT BANK.

ANGLE FROM HORIZONTAL: -90° DIRECTION: Vertical

COORDINATES: N 550 E 15545 R.L. 1801'

HOLE NO. 13

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PACKER SET CORE	PACKER SET CASING
	AUGER DRILLED		10				CORED FROM 12 FEET.				
TUFFACEOUS SANDSTONE. Highly to moderately weathered. Completely: Moderately weathered	Purple grey colored, mainly medium to coarse grained, fine grained in places. BEDDING AT 38° Fine grained		20				Joints limonite stained, mostly parallel to bedding. 20'-21' close, interseding jointing. 24' joint at 85°-90°, smooth, planar 25'6", core fractured, clay on joint surfaces. 27'6", ½" wide sheared zone, some clay, at 30°.				

DRILL TYPE: GEMCO

FEED: Hydraulic

CORE BARREL TYPE: NMLC. Triple tube.

DRILLER: Groundtest

COMMENCED: 14-1-70

COMPLETED: 16-1-70

LOGGED BY: D.C. PURCELL

VERTICAL SCALE: 1 inch : 10 feet.

NOTES

FRACTURE LOG :- Number of fractures per foot of core. Zones of core loss are blocked in.

BEDDING AND JOINT PLANES :- Angles are measured relative to a plane normal to the core axis

/ Prominent joint showing attitude to core direction

Shear zone, showing attitude to core direction.

Tuffaceous Sandstone.

To Accompany Record 1971/39

WATER PRESSURE TESTS

PACKER TYPE:

SUPPLY LINE:

VERTICAL SCALE:

Figures given are gauge pressures. Test sections are indicated graphically by blocked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE:

COLOUR:

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT TUGGERANONG Freeway; Molonglo River Bridge.

LOCATION Left bank.

ANGLE FROM HORIZONTAL -90° DIRECTION Vertical

COORDINATES N 551 E 15575 R.L. 1802'

HOLE NO. 14

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF NO CORE BOX	PHOTO REF NO CORE SAMPLE
	AUGER DRILLED NO CORE.		0 10				AUGER REFUSAL 20 feet. Cored from 20 feet.				
TUFFACEOUS SANDSTONE. Highly weathered.	Grey colored, medium to coarse grained. Rock weak, low in strength. BEDDING AT 30°-35°		20				Joints mostly follow bedding, Some iron stained. Fragmented from 23'-23'6"		NOT TESTED		
	END OF HOLE AT 23 feet.										

DRILL TYPE GEMCO

FEED Hydraulic

CORE BARREL TYPE NMLC. Triple tube.

DRILLER Groundtest

COMMENCED 14-1-70

COMPLETED 14-1-70

LOGGED BY D.C. PURCELL

VERTICAL SCALE 1inch: 5 feet.

NOTES

FRACTURE LOG:- Number of fractures per foot of core. Zones of core loss are blacked in.

BEDDING AND JOINT PLANES:- Angles are measured relative to a plane normal to the core axis

/ Joints, showing attitude to core direction.

Tuffaceous Sandstone.

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures

Test sections are indicated graphically by blacked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

To Accompany Record No. 1971/39

M(Pf)99

APPENDIX 3

METRIC CONVERSION GRAPH

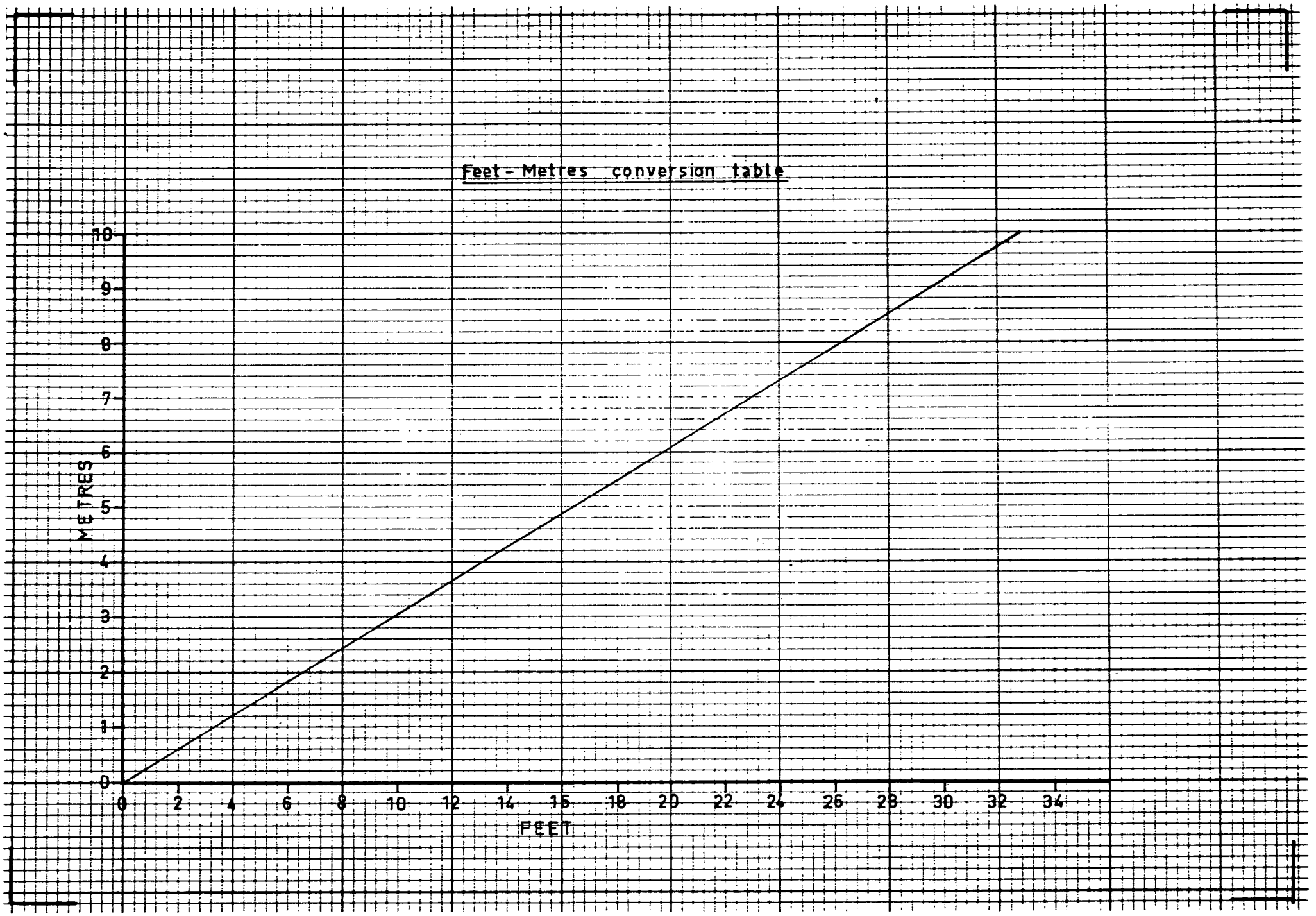
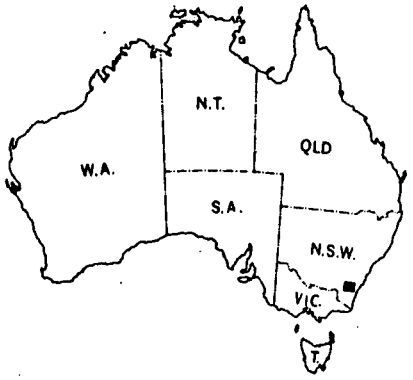
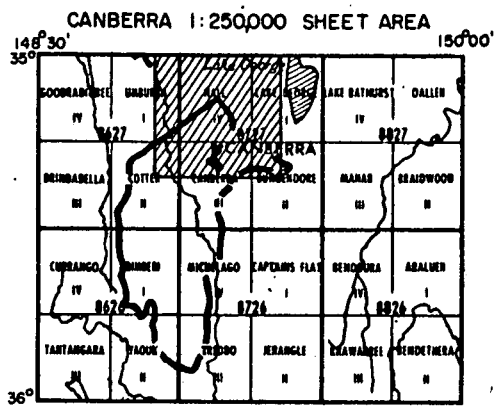
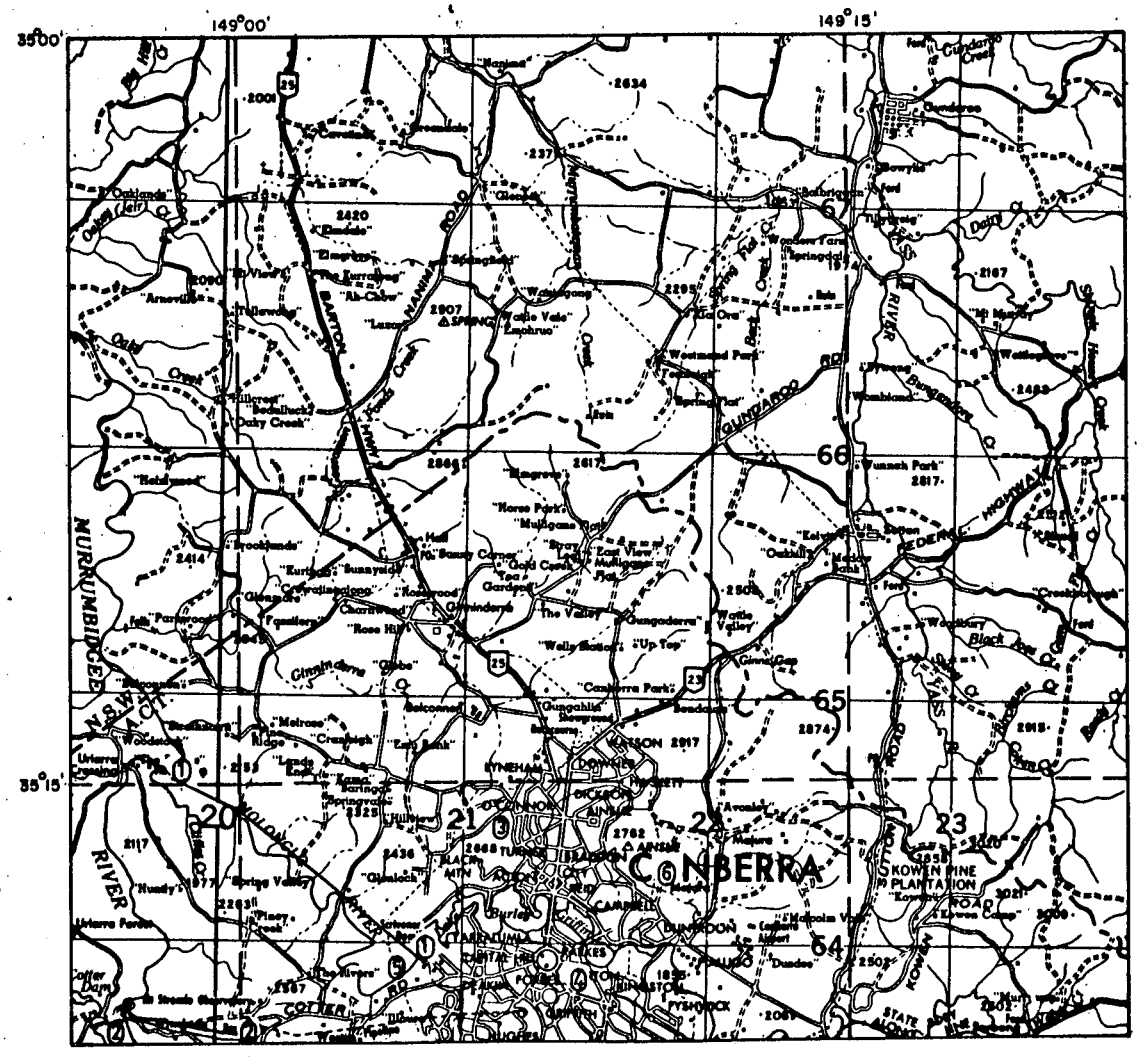

Feet - Metres conversion table
METRES
0
1
2
3
4
5
6
7
8
9
10
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
FEET

Figure 1

LOCALITY PLAN







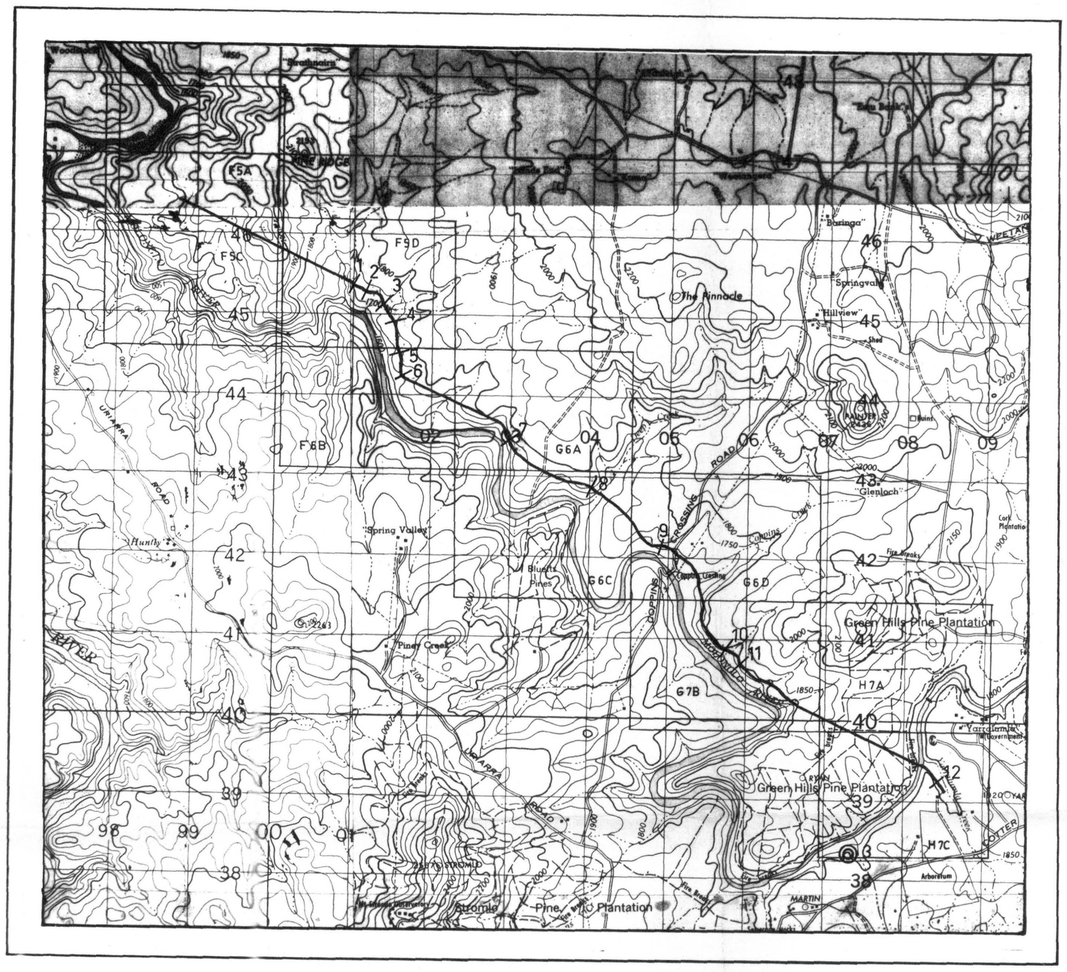
① MOLONGLO VALLEY OUTFALL SEWER
② MURRUMBIDGEE TO STROMLO GRAVITY MAIN
③ BARRY DRIVE
④ BARTON SECTIONS 16 & 22.
⑤ MOLONGLO RIVER BRIDGE SITE.
⑥ CAMPBELL RESERVOIR.

To Accompany Record 1971/39

I 55/A 16/472

MOLONGLO VALLEY OUTFALL SEWER

LOCALITY MAP 1:50,000



REFERENCE

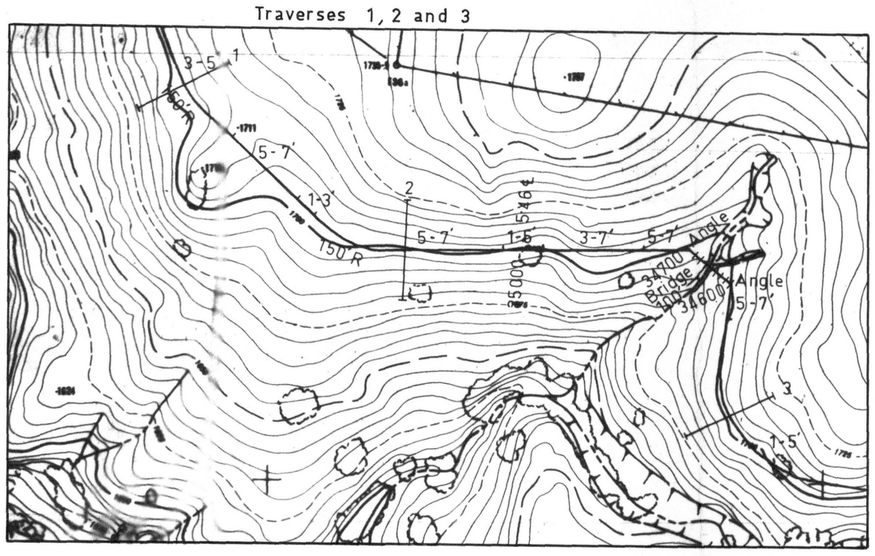
6 ——— Seismic traverse

Proposed sewer route

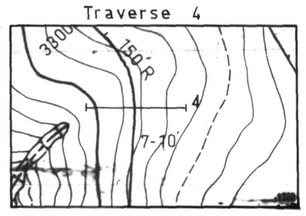
3'-7' Estimates of depth to bedrock

LOCATIONS OF SEISMIC TRAVERSES 1": 200'

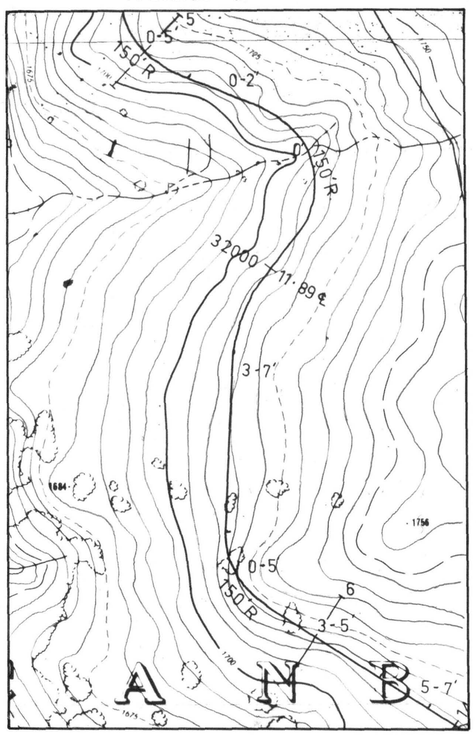
Traverses 1, 2 and 3



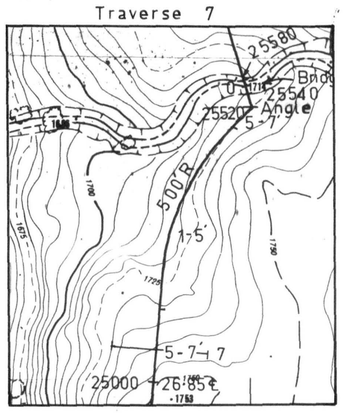
Traverse 4



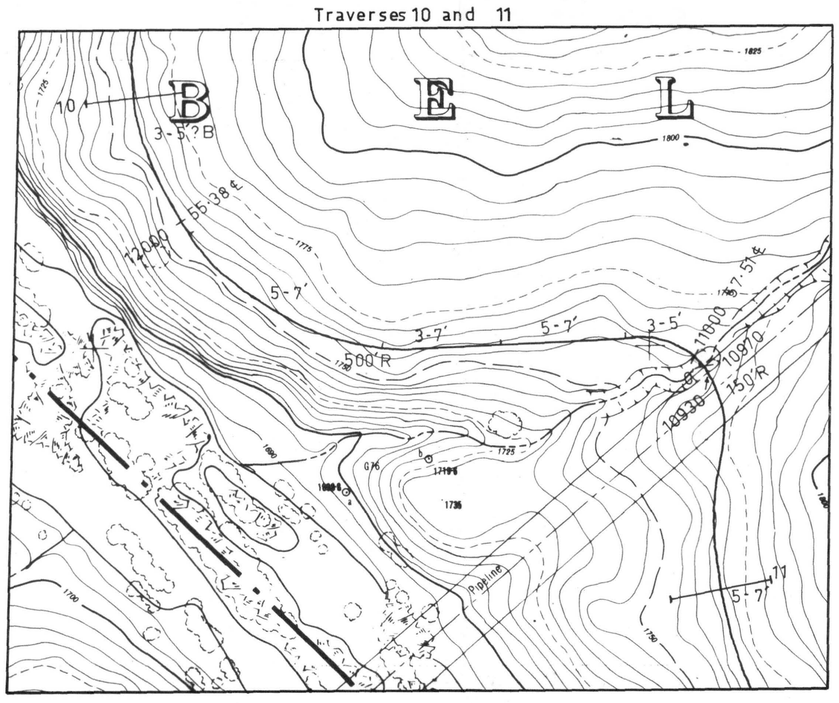
Traverse 6



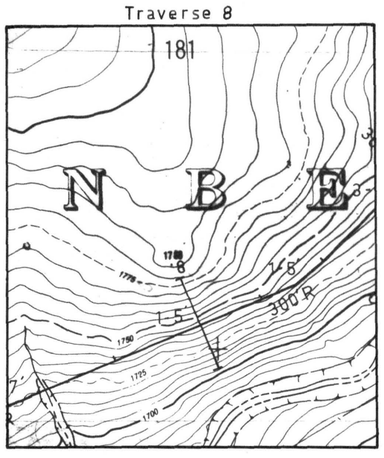
Traverse 7



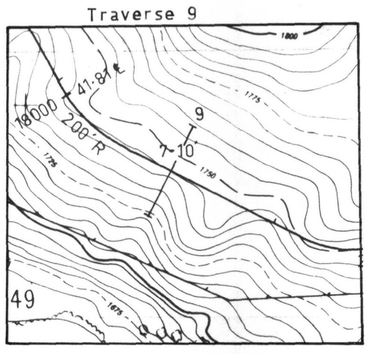
Traverses 10 and 11



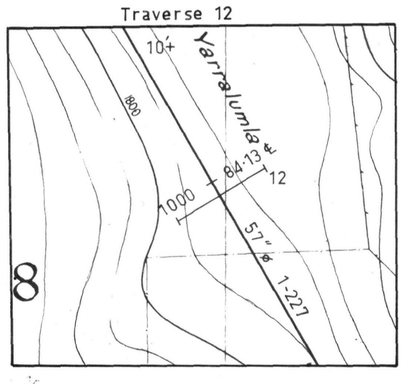
Traverse 8



Traverse 9



Traverse 12

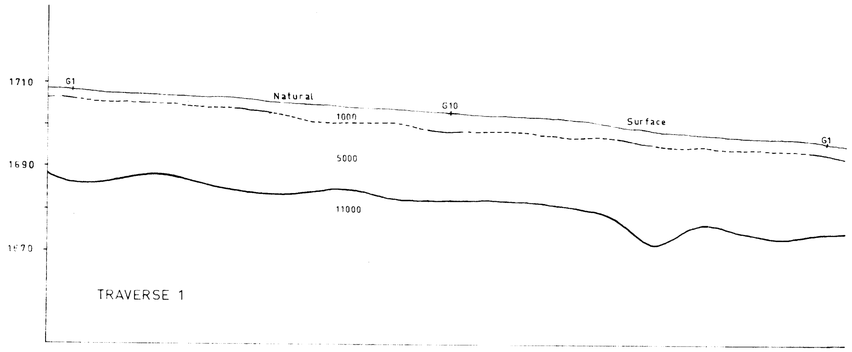


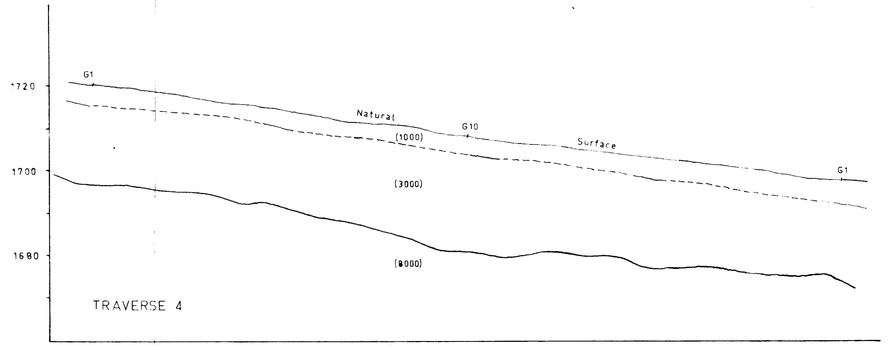
To Accompany Record No. 1971/39

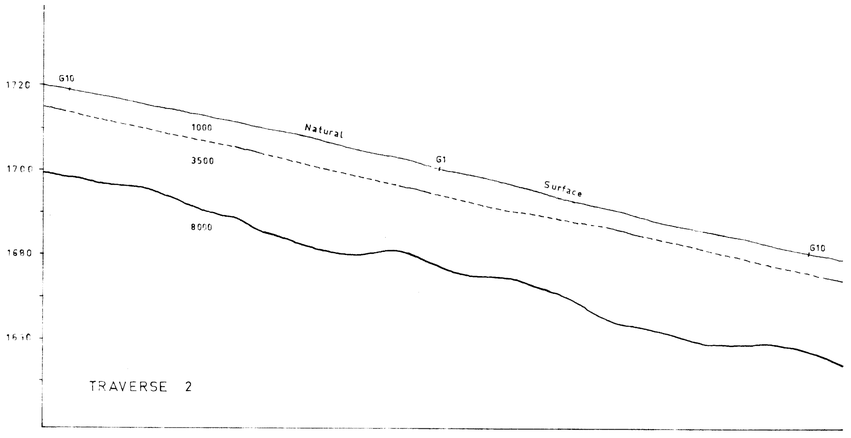
MOLONGLO VALLEY OUTFALL SEWER

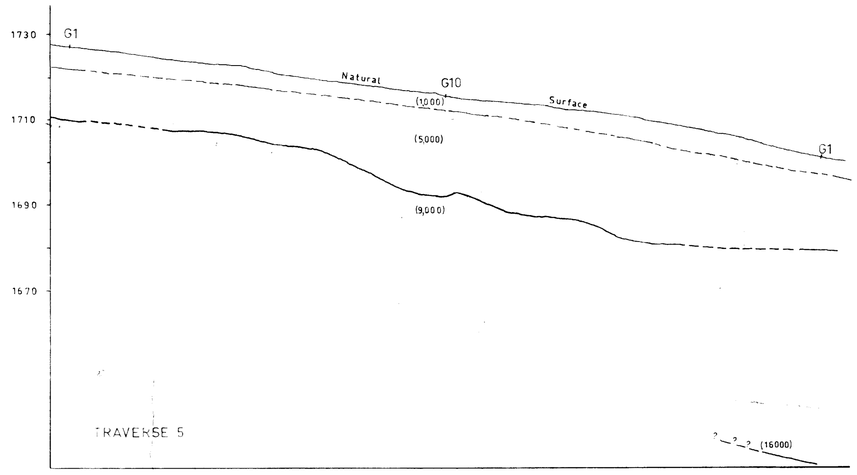
GEOPHYSICAL TRAVERSES.

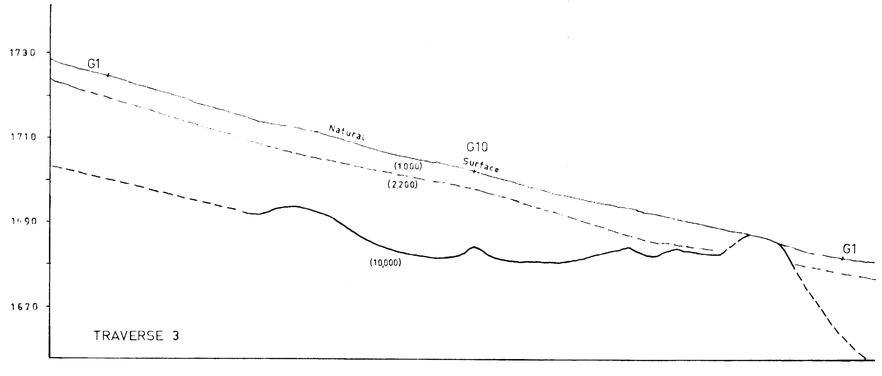
SEISMIC SECTIONS

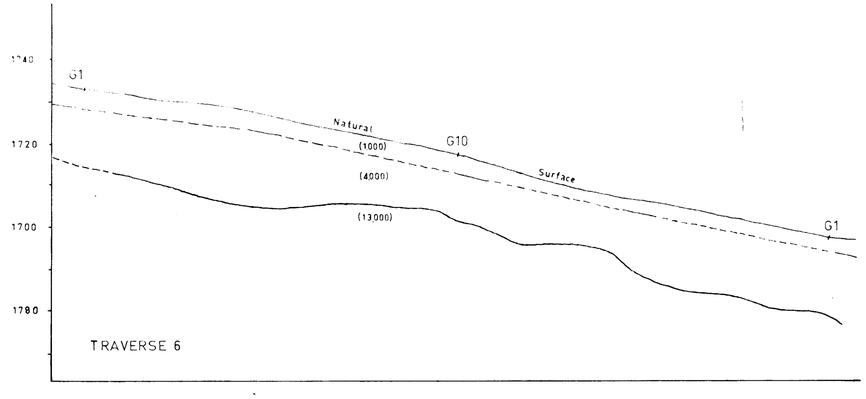












REFERENCE

G1 Geophysical station.

(5000) Velocity of layer in feet per second.

——— Boundary accurate.

------ Boundary interpolated.

Scale (feet)

20 0 20 40

Bureau of Mineral Resources, January 1970

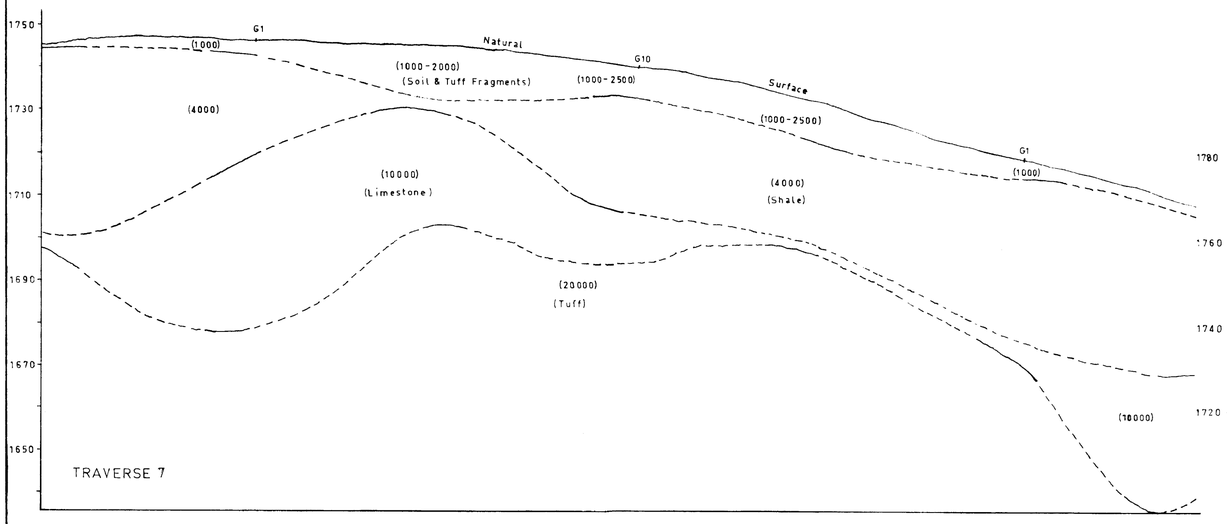
To Accompany Record No. 1971/39

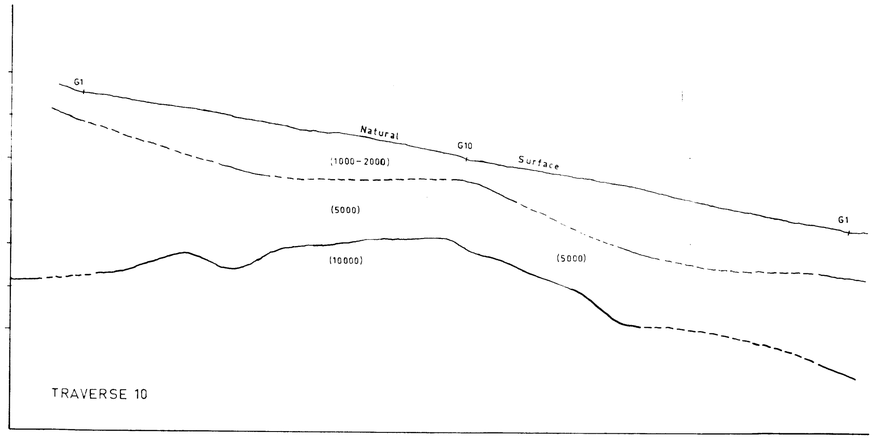
155/A16/770

MOLONGLO VALLEY OUTFALL SEWER

GEOPHYSICAL TRAVERSES.

SEISMIC SECTIONS.





REFERENCE

G1 Geophysical station.

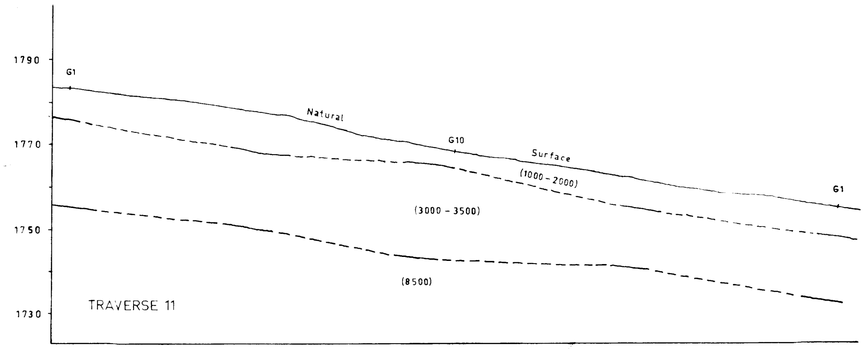
(5000) Velocity of layer in feet per second.

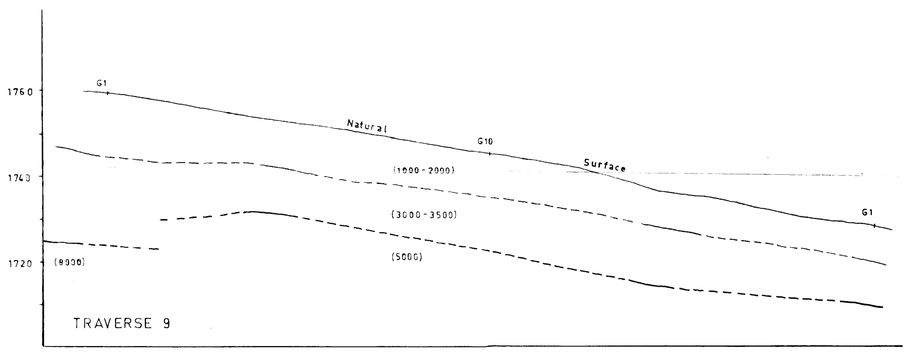
——— Boundary accurate.

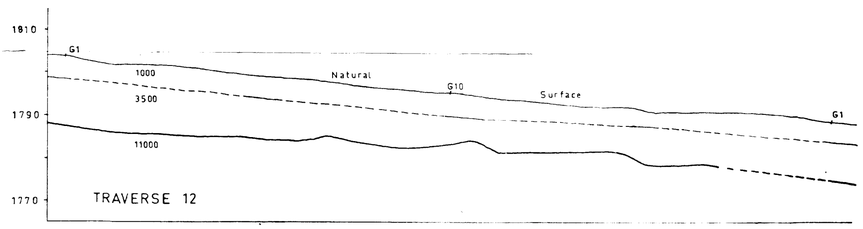
------ Boundary interpolated.

SCALE (feet)

20 0 20 40



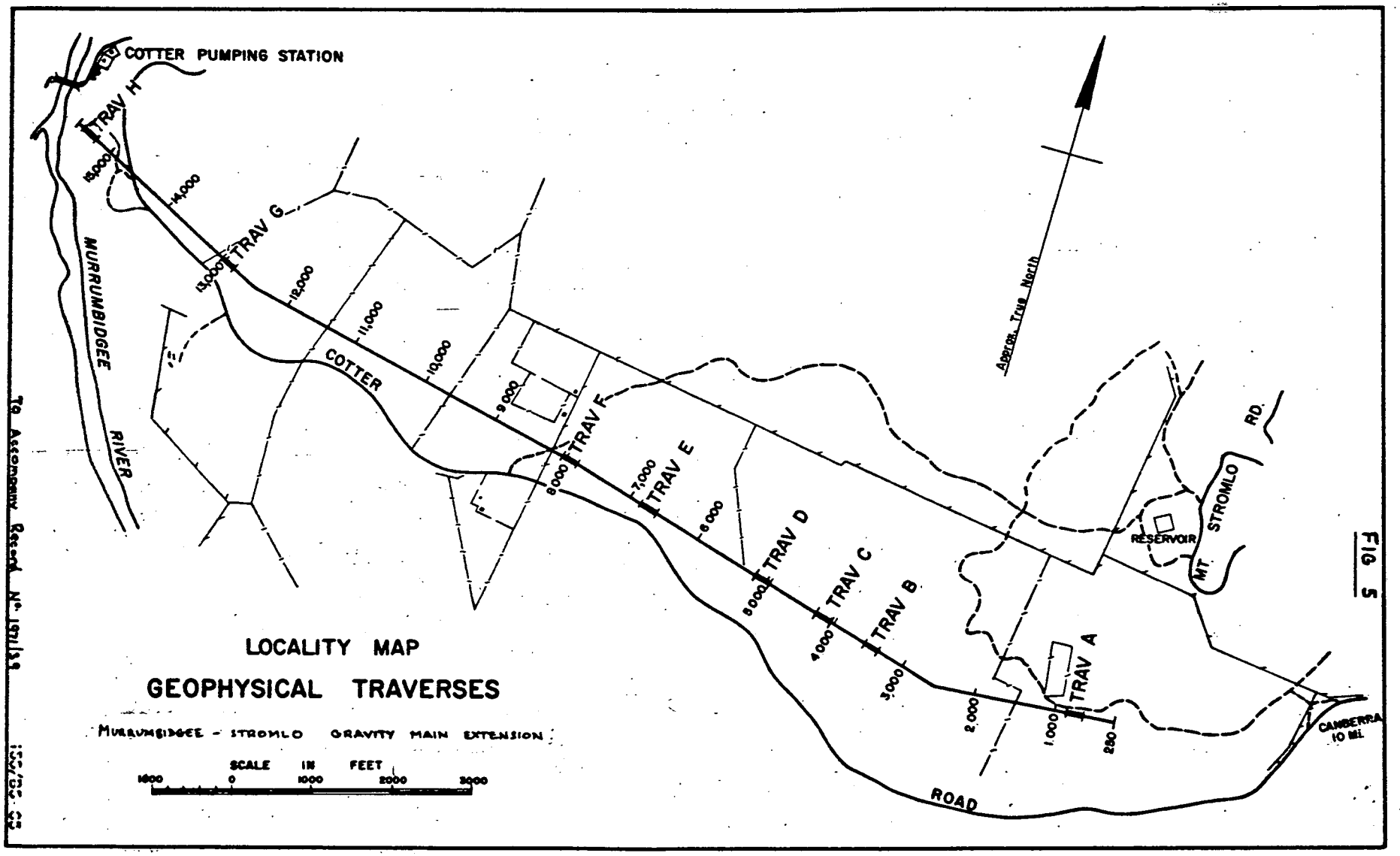




155/A16/772

To Accompany Record No. 1971/39

Bureau of Mineral Resources, January 1970


COTTER PUMPING STATION
TRAV H
15,000
14,000
TRAV G
13,000
12,000
11,000
10,000
9,000
TRAV F
8,000
7,000
TRAV E
6,000
TRAV D
5,000
TRAV C
4,000
TRAV B
3,000
2,000
1,000
TRAV A
250
MURRUMBIDGEE RIVER
COTTER
Approx. True North
RESERVOIR
MT STROMLO
RD.
CANBERRA 10 MI.
ROAD
LOCALITY MAP
GEOPHYSICAL TRAVERSES
MURRUMBIDGEE - STROMLO GRAVITY MAIN EXTENSION
SCALE IN FEET
1000 0 1000 2000 3000
FIG 5
To Accompany Record No. 1961/33

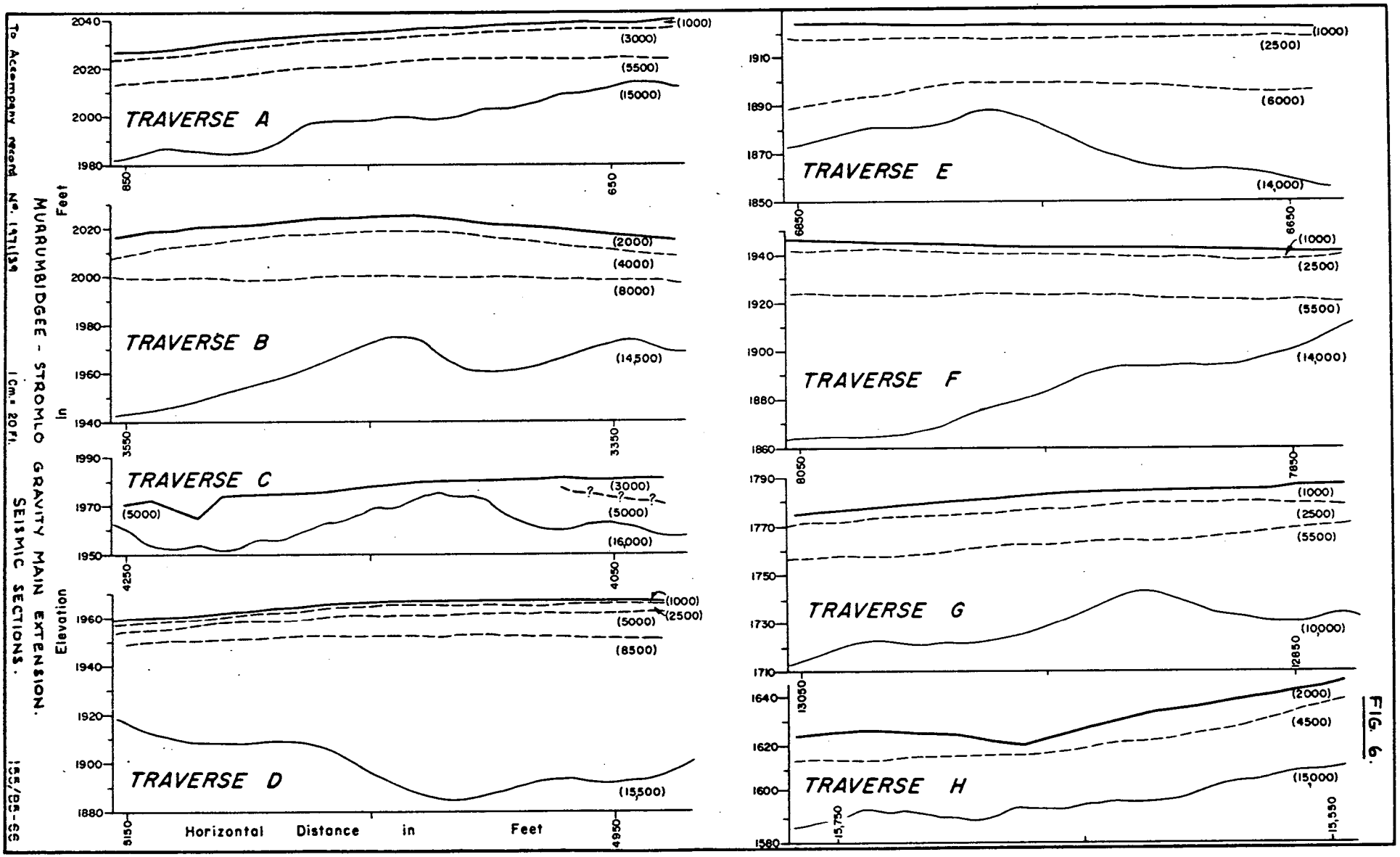

MURRUMBIDGEE - STROMLO GRAVITY MAIN EXTENSION.
SEISMIC SECTIONS.
To Accompany Record No. 1971/39
1 Cm. = 20 ft.
155/65-66
Elevation in Feet
TRAVERSE A
(1000)
(3000)
(5500)
(15000)
2040
2020
2000
1980
850
650
TRAVERSE B
(2000)
(4000)
(8000)
(14,500)
2020
2000
1980
1960
1940
3550
3350
TRAVERSE C
(3000)
(5000)
(5000)
(16,000)
1990
1970
1950
4250
4050
TRAVERSE D
(1000)
(2500)
(5000)
(8500)
(15,500)
1960
1940
1920
1900
1880
5150
4950
Horizontal Distance in Feet
TRAVERSE E
(1000)
(2500)
(6000)
(14,000)
1910
1890
1870
1850
6850
6650
TRAVERSE F
(1000)
(2500)
(5500)
(14,000)
1940
1920
1900
1880
1860
8050
7850
TRAVERSE G
(1000)
(2500)
(5500)
(10000)
1790
1770
1750
1730
1710
12850
TRAVERSE H
(2000)
(4500)
(15000)
1640
1620
1600
1580
13050
15,750
15,550

FIG. 6.

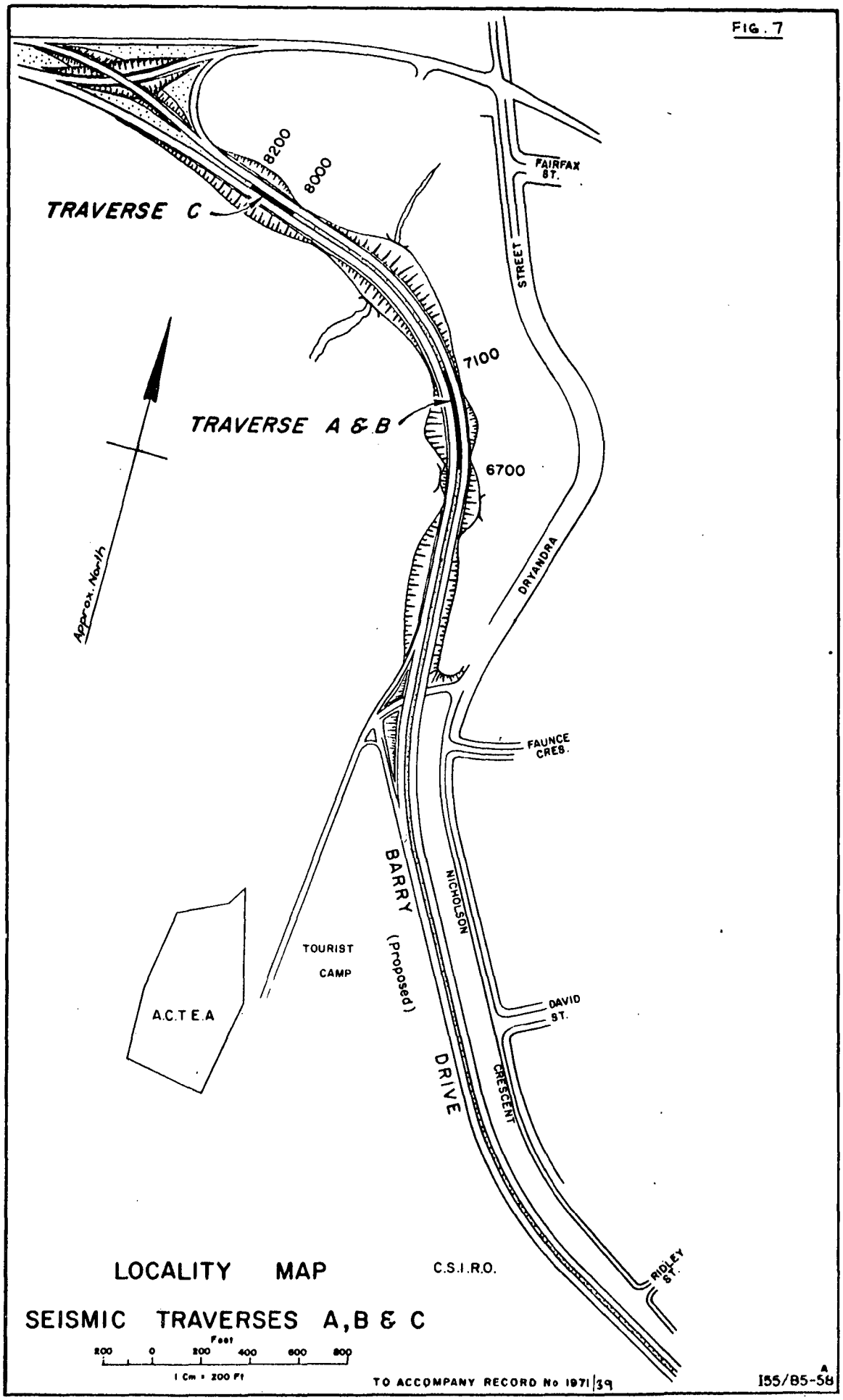


FIG. 7
8200
8000
TRAVERSE C
FAIRFAX ST.
STREET
7100
TRAVERSE A & B
6700
Approx. North
DRYANDRA
FAUNCE CRES.
BARRY (Proposed)
NICHOLSON
TOURIST CAMP
A.C.T.E.A
DAVID ST.
DRIVE
CRESCENT
RIDLEY ST.
LOCALITY MAP
C.S.I.R.O.
SEISMIC TRAVERSES A, B & C
Feet
200 0 200 400 600 800
1 Cm = 200 Ft
TO ACCOMPANY RECORD No 1971/39
A
155/85-58

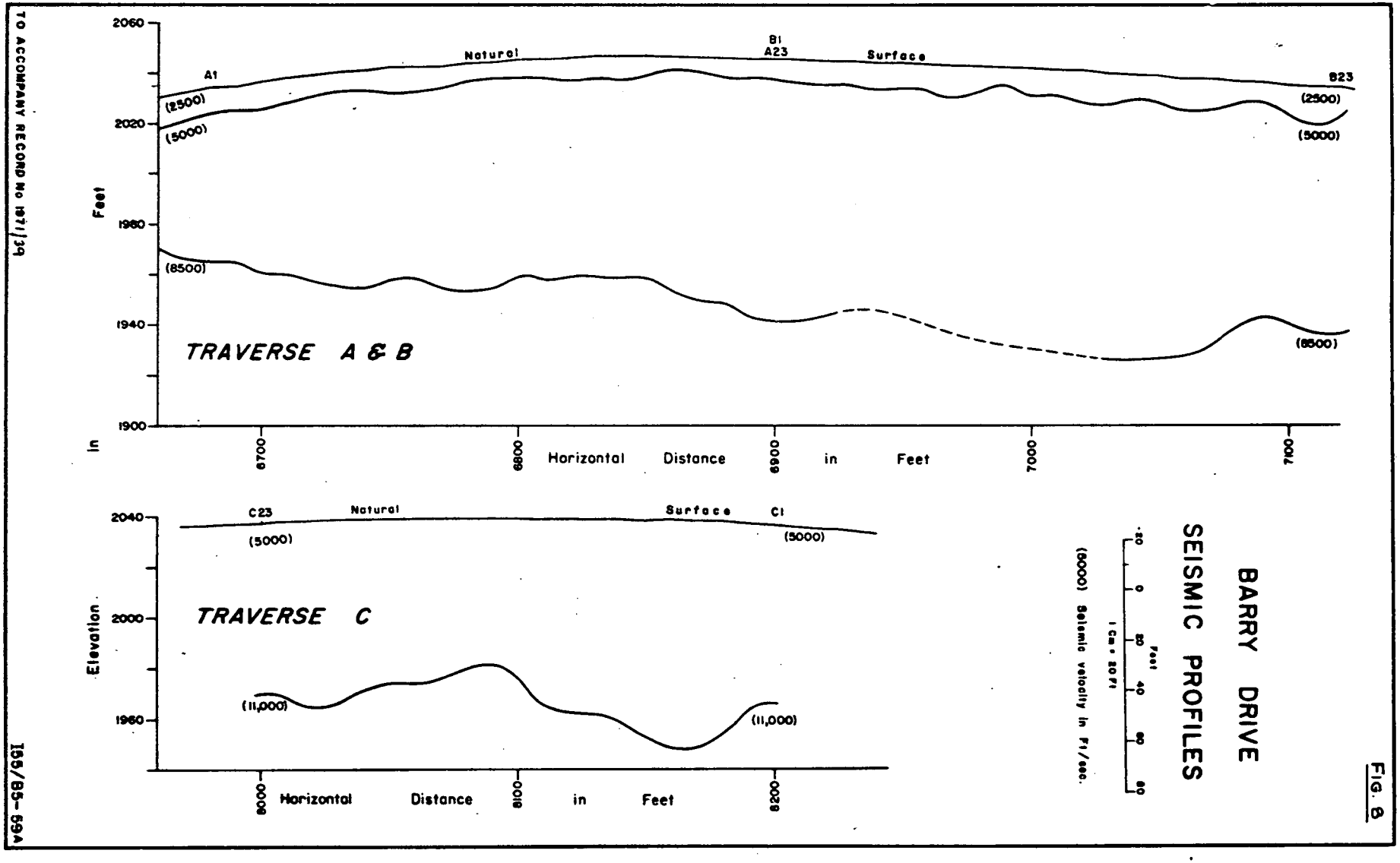
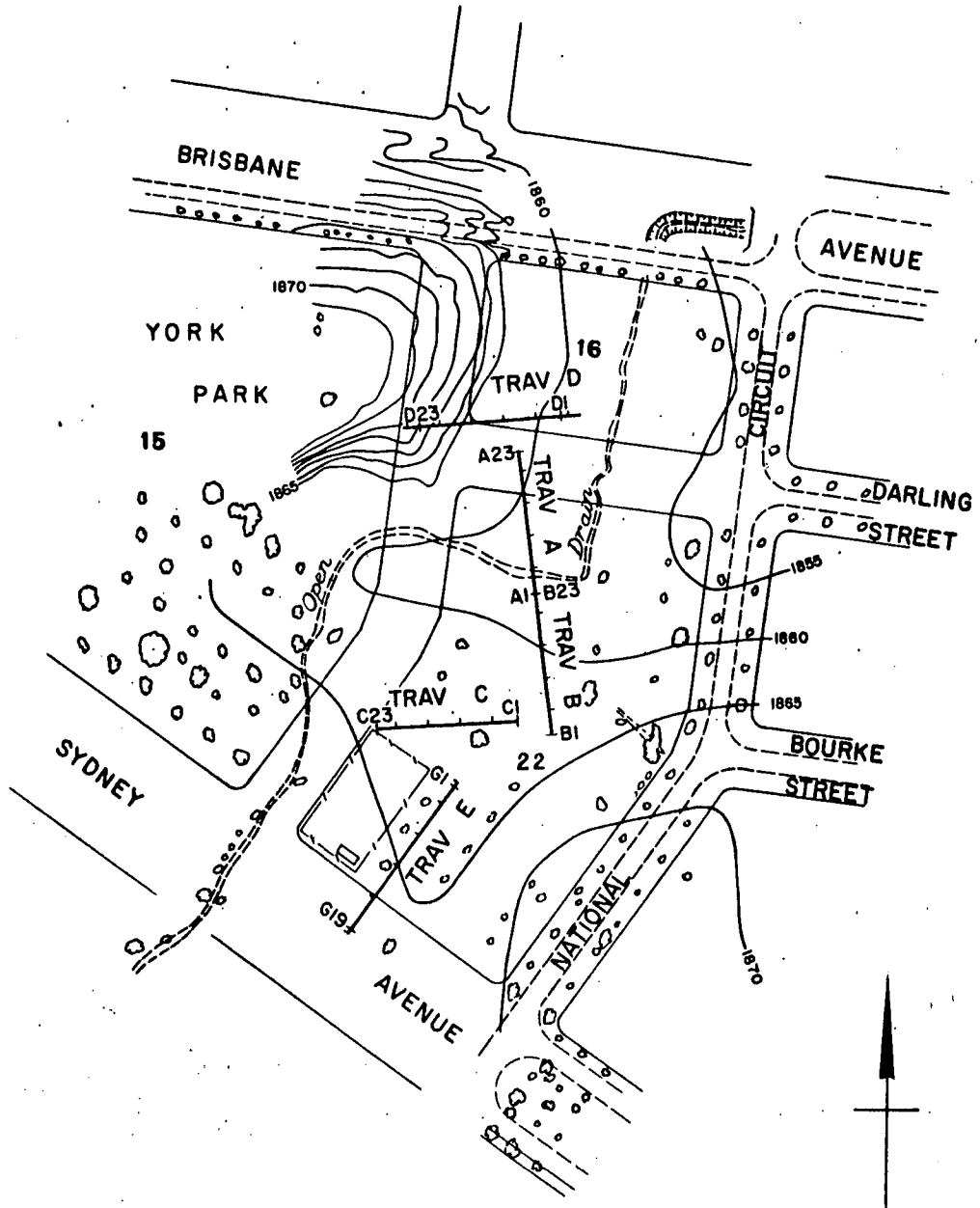

TO ACCOMPANY RECORD No 1971/39
2060
2020
1980
1940
1900
Feet
A1
(2500)
(5000)
Natural
B1
A23
Surface
B23
(2500)
(5000)
(8500)
TRAVERSE A & B
(8500)
In
6700
6800
Horizontal Distance in Feet
6900
7000
7100
2040
2000
1960
Elevation
C23
Natural
Surface
C1
(5000)
(5000)
TRAVERSE C
(11,000)
(11,000)
8000
8100
Horizontal Distance in Feet
8200
BARRY DRIVE
SEISMIC PROFILES
(5000) Seismic velocity in Ft/sec.
Feet
155/85-69A

FIG. 8

FIG 9



BARTON GEOPHYSICAL TRAVERSES
SECTIONS 16 & 22

A1 A10 A20 Geophysical traverses and stations

SCALE IN FEET
100 0 100 200 300 400
1 Cm = 100 Ft

TO ACCOMPANY RECORD NO 1971/39

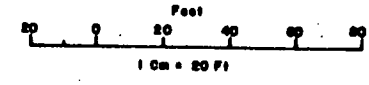
135/B3 60

Barton Seismic. Canberra 9-10-69

FIG 10

BARTON SEISMIC PROFILES

SECTIONS 16 & 22



(2000) Seismic Velocity in Ft/sec.

TO ACCOMPANY RECORD NO 1971/39

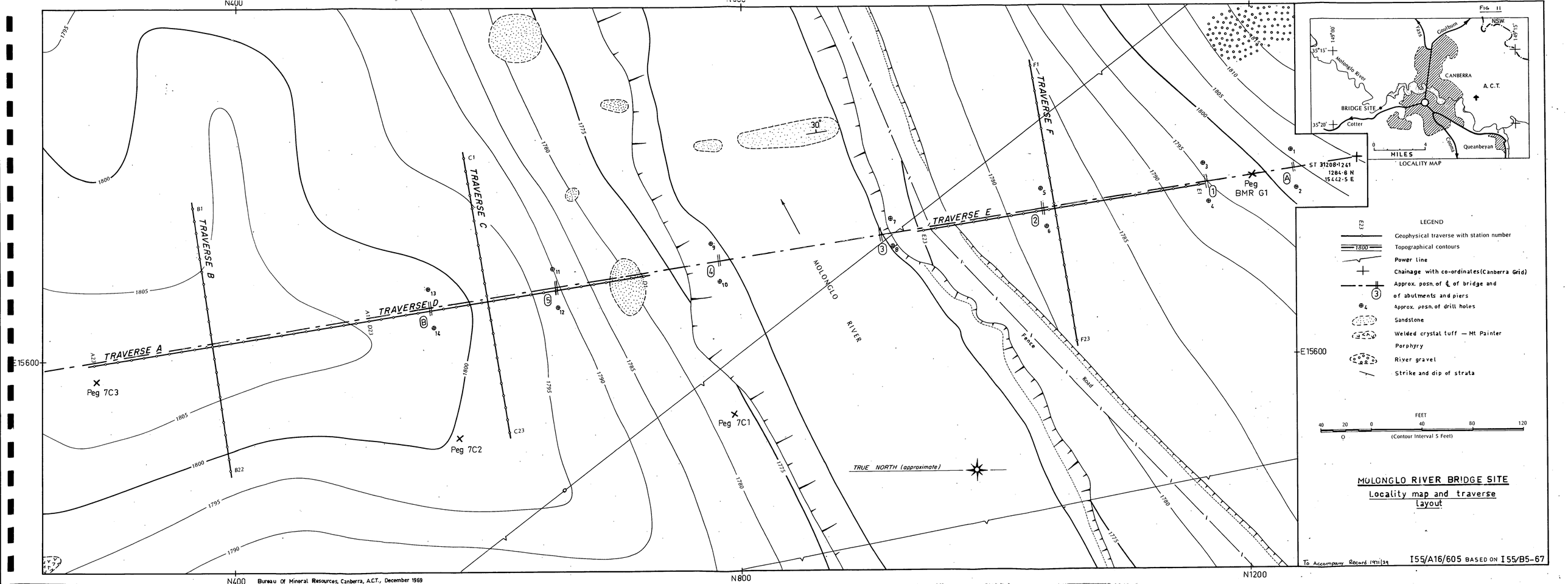
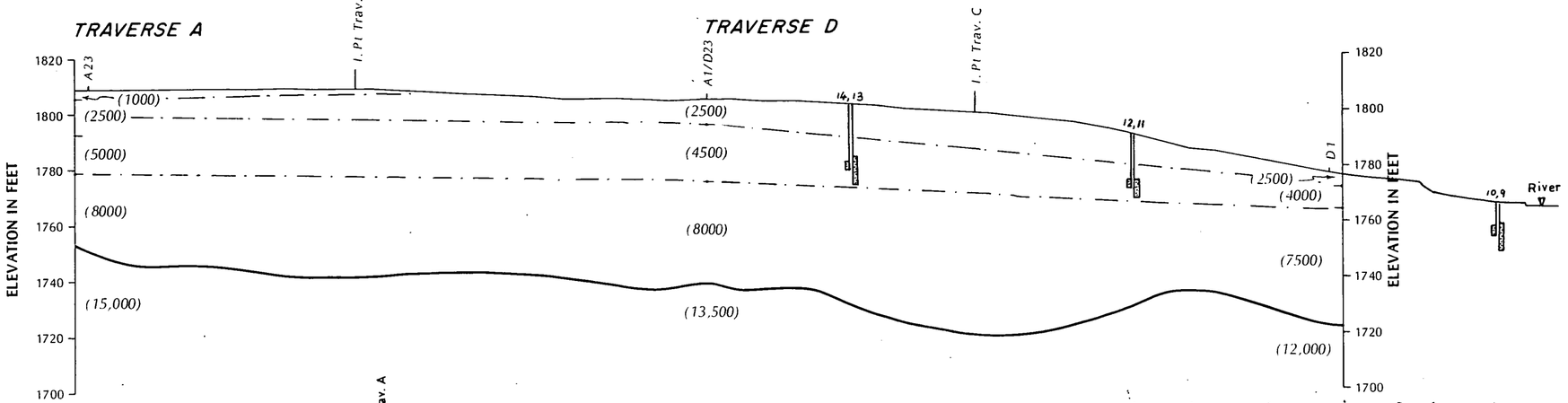


FIG 11
NSW
Goulburn
149°00'
35°15'S
149°15'
35°15'
Molonglo River
CANBERRA
A.C.T.
BRIDGE SITE
35°20'
Cotter
Queanbeyan
Cooma
0
4
MILES
LOCALITY MAP
N400
N800
N1200
E15600
TRAVERSE A
TRAVERSE B
TRAVERSE C
TRAVERSE D
TRAVERSE E
TRAVERSE F
A23
A1
D23
B1
B22
C1
C23
E1
E23
F1
F23
Peg 7C1
Peg 7C2
Peg 7C3
Peg BMR G1
ST 31208-1241
1284·8 N
15442·5 E
MOLONGLO RIVER
Fence
Road
TRUE NORTH (approximate)
30°
1795
1800
1805
1810
1775
1780
1785
1790
LEGEND
Geophysical traverse with station number
Topographical contours
Power line
Chainage with co-ordinates(Canberra Grid)
Approx. posn. of ℄ of bridge and of abutments and piers
Approx. posn. of drill holes
Sandstone
Welded crystal tuff — Mt Painter Porphyry
River gravel
Strike and dip of strata
FEET
40 20 0 40 80 120
0
(Contour Interval 5 Feet)
MOLONGLO RIVER BRIDGE SITE
Locality map and traverse layout
To Accompany Record 1971/39
I55/A16/605 BASED ON I55/B5-67
Bureau Of Mineral Resources, Canberra, A.C.T., December 1969

FIG.12



LEGEND

(13,000) Seismic velocity in ft/s. in the bedrock.

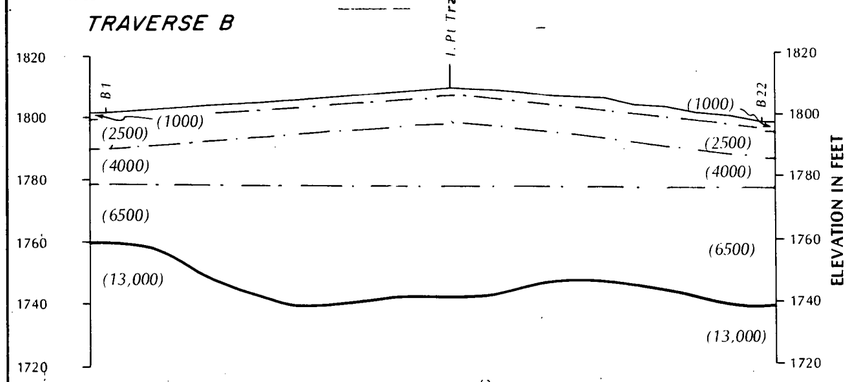
Depth to formation with different seismic velocity.

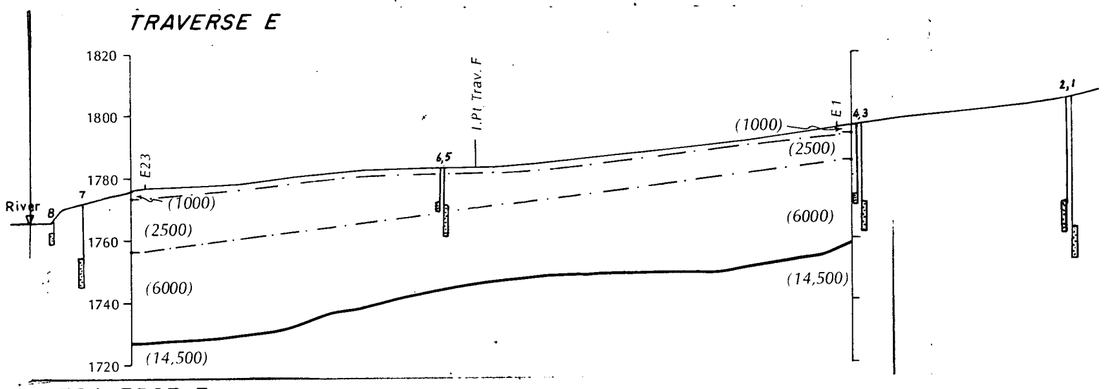
I.Pt Trav. Traverse intersection point.

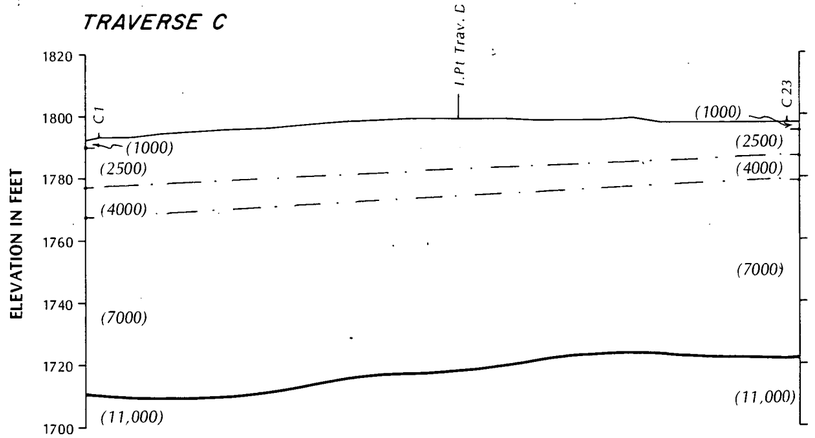
Unweathered bedrock boundary.

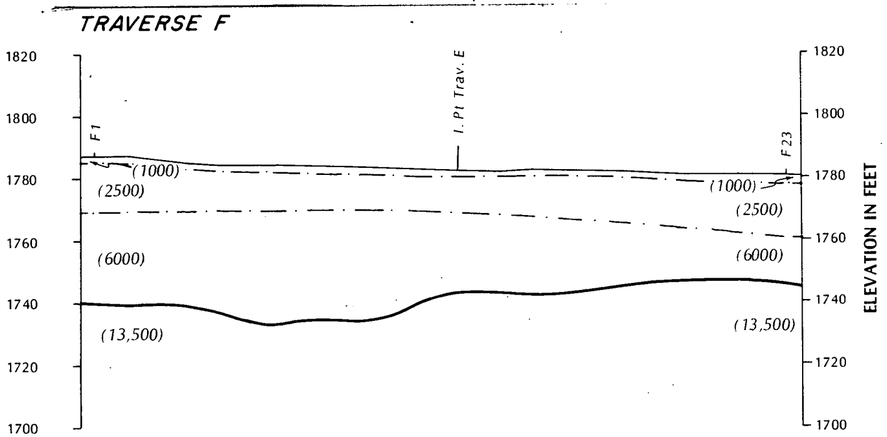
Approx. position of boundaries between layers of different seismic velocities — Interpolated between ends of traverses.

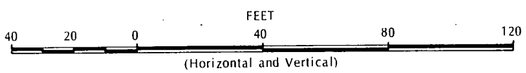
3 Combination auger and diamond drillhole — cored section stipled.











MOLOKAI BRIDGE SITE, ALT

SEISMIC CROSS-SECTIONS

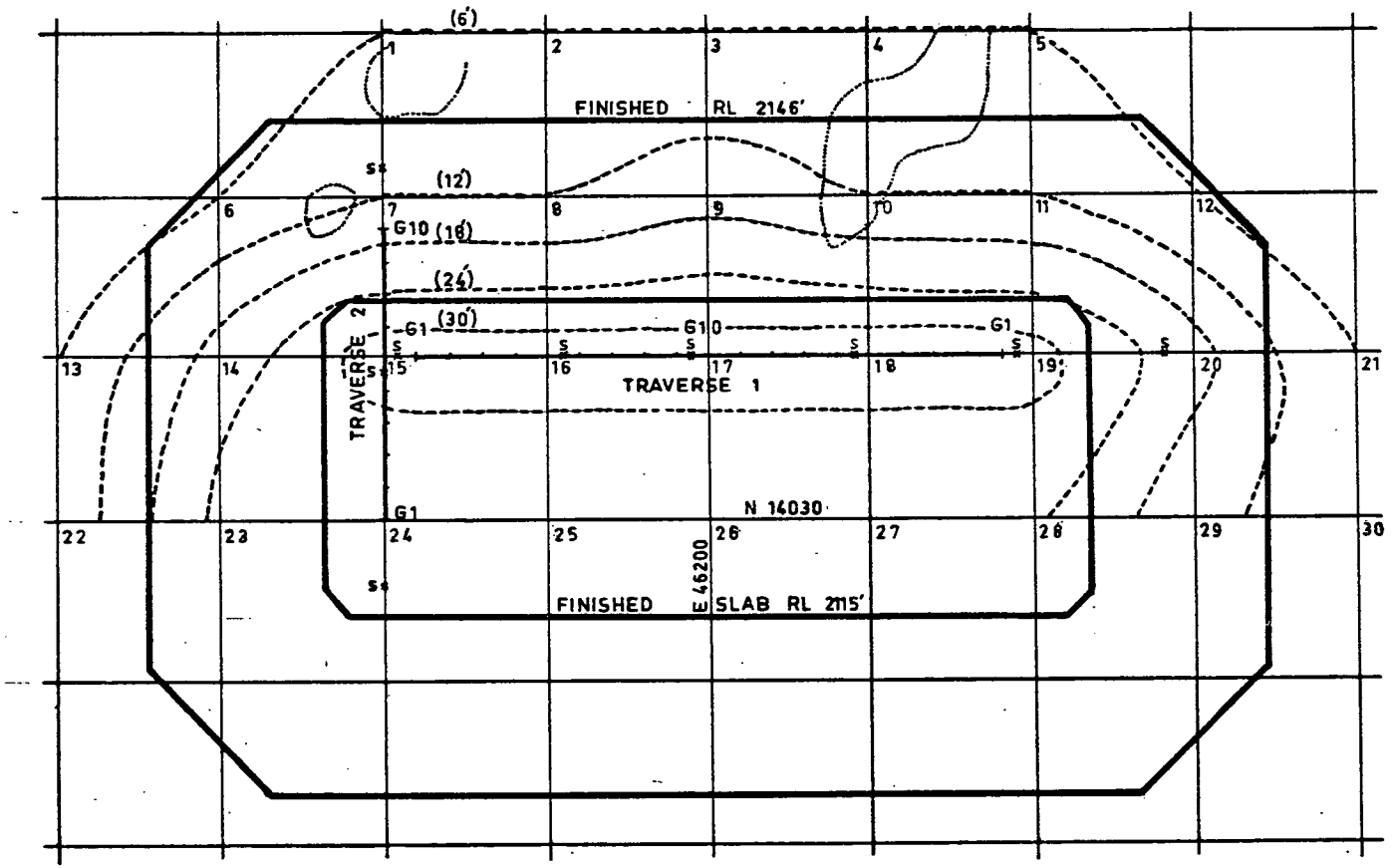
(See Figure 1 for locations of traverses.)

To Accompany Record No. 1971|39

I55/B5-68

FIG. 13

PLAN OF PROPOSED CAMPBELL RESERVOIR



REFERENCE

- Number and position of bore hole.
- Outline of the reservoir.
- (6') Contour of surface of bedrock according to bore hole refusal depth. Number refers to depth below natural surface.
- G1 Seismic traverse line showing position of geophone stations. (Stations 2 to 9 not numbered.)
- Shot point.
- Rock outcrop.

SCALE (in feet)

0 50 100

155/A16/768

To Accompany Record No. 1971/39

Bureau of Mineral Resources Geology and Geophysics January 1970. (After Dept. of Works drawing.)

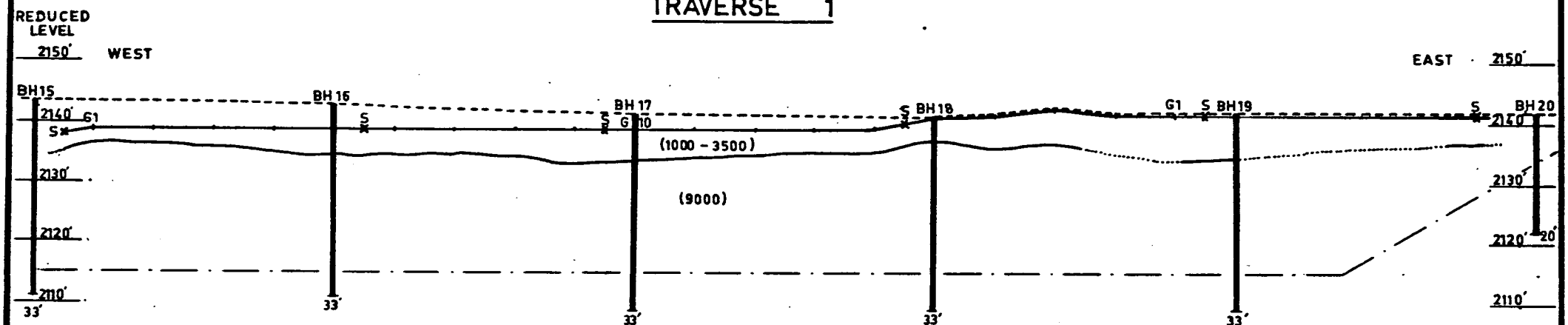
PROPOSED CAMPBELL RESERVOIR.

FIG. 14

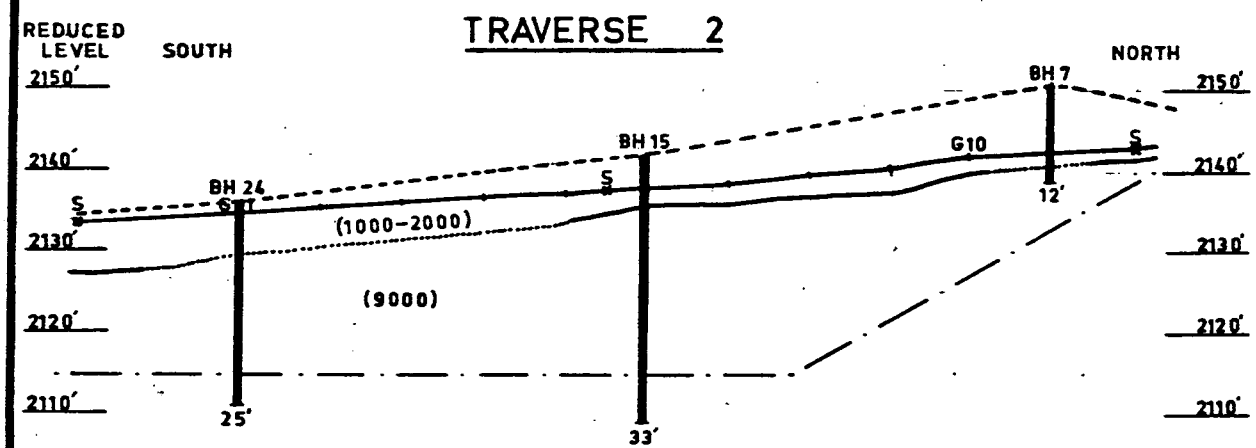
GEOPHYSICAL TRAVERSES.

SEISMIC SECTIONS.

TRAVERSE 1



TRAVERSE 2



REFERENCE

- Natural surface.
- Excavated surface (as on 22/1/70)
- Seismic boundary accurate.
- Seismic boundary interpolated.
- Proposed limit of excavation.
- (9000) Velocity of layer in feet per second.
- G10 Geophysical station. (Stations 2 to 9 not numbered.)
- S Shot point.
- BH 7 / 12' Bore hole showing depth.

SCALE (in feet)

0 10 20 40

To Accompany Record No. 1971/39

Bureau of Mineral Resources Geology and Geophysics January 1970

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