COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF
NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1972/84

SEISMIC REFRACTION SURVEY ALONG TUGGERANONG FREEWAY STAGE II AND VILLAGE CREEK ARTERIAL, A.C.T., 1971

~~RESTRICTED~~

by

P.J. Hill

RECORD NO. 1972/84

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SUMMARY

The Bureau of Mineral Resources, Geology and Geophysics (BMR) carried out a seismic refraction survey for the National Capital Development Commission (NCDC) along the proposed routes of Tuggeranong Freeway Stage II and Village Creek Arterial, with additional seismic work along Village Creek. For the freeway, subsurface information such as nature of overburden, depth to bedrock and rippability was required at locations where major cuttings are to be excavated, and in the Village Creek area the seismic work had a more general application intended to provide information on subsurface conditions for road, bridge, and drainage works.

Contained in this Record are the results of the survey, with seismic cross-sections and an interpretation of the various velocity layers recorded.

1. INTRODUCTION

Canberra's urban growth is progressing in the form of a number of separate new towns being developed outside the inner Canberra area. A transport network planned by the NCDC will consist basically of a broad grid of peripheral freeways to link towns, and arterials within the urban areas giving access to the freeways (NCDC, 1970).

The development of the new town of Tuggeranong is soon to commence requiring the construction of Tuggeranong Freeway Stage II to connect the northern part of the town with Woden-Weston Creek at Hindmarsh Drive where Tuggeranong Freeway Stage I begins. Access to the proposed freeway from north Tuggeranong is to be provided by Village Creek Arterial.

To assist with the planning and construction of the roadworks and other associated engineering works BMR was asked by NCDC to investigate the geological conditions along proposed alignments and on adjacent areas.

In conjunction with the BMR Engineering Geology Section which investigated the geology along the route of Tuggeranong Freeway Stage II, the BMR Engineering Geophysics Group carried out seismic refraction work in the area to determine the nature of the subsurface with the purpose of predicting ease of excavation in places requiring major cuttings and the type of material on which the roadway will be founded. The work was done in July 1971 by a party consisting of P.J. Hill (geophysicist and party-leader), G.R. Pettifer (geophysicist) and S. Hall (field assistant). In November the same party, with assistance in the field of trainee draftsmen from the BMR Geophysical Drawing Office, continued the seismic refraction work in the Village Creek area.

Substantial cuttings (up to 14 m deep) may be required in construction of the freeway, but the topography in the Village Creek area is relatively flat so that major excavations should not be needed for the arterial. The seismic work was thus aimed not only at providing subsurface information for road works but also for drainage and bridge construction associated with re-alignment of the present irregular course of Village Creek.

2. GEOLOGY

A detailed investigation of soils and geology along the Tuggeranong Freeway Stage II was made by BMR geologists (Kellet & Vanden Broek, in prep.); earlier general mapping in the area had been carried out (Wilson & Newstead, 1967; Henderson & Strusz, 1971). The geology of the Village Creek area was described by Rossiter, 1971; Gardner, 1968; Strusz, 1971; Henderson & Strusz, 1971.

The bedrock in the area (of the freeway and arterial) is Upper Silurian age volcanics, an ash-flow welded tuff of rhyodacitic composition along the proposed freeway and east of the Kambah homestead, and dacitic along the upper reaches of Village Creek above the homestead.

Being on the lower slopes of Mount Taylor, the area along the proposed route of the freeway is of relatively high topographical relief, the nature of the surface material being controlled by the steepness of the slopes. Boulder outcrops are common on areas of higher elevation and the soil cover is generally thin. Augering has shown that soil, clay, and indurated slopewash overlies weathered bedrock. The Village Creek area is flat, with a thick cover of colluvial-alluvial soil, and rock exposures are virtually absent except at the bottom of the deep erosion gully incised by Village Creek where along much of its course weathered bedrock is visible. Two parallel faults have been mapped running south from about 1 km east of Kambah homestead.

3. METHOD AND EQUIPMENT

To obtain subsurface information the seismic refraction method as outlined by Dobrin (1952) was employed. The equipment used was of standard BMR type, consisting basically of a truck-mounted 24-channel SIE refraction seismograph with 20-Hz TIC geophones.

Spreads were laid with a geophone spacing of 3 m giving each spread a length of 69 m, and seismic recordings were made for shots fired at the centre, 1 m off the ends, and generally about 70 m off the ends of each spread. The energy source was gelignite in stick form buried in hand-auger holes at depths of about 40 cm; for shots at the spread, ½ to 1 stick (1 stick weighs about 130 gms) was used, while for long shots larger charges of 2 to 4 sticks were required.

Along the freeway route traverses were located on hillocks and rises where deep cuttings will be needed, while in the Village Creek area the choice of traverse positions was largely based on recommendations by NCDC. Seismic work was done on Traverses 1 to 19, the positions of which are shown in Plate 1.

Calculation of depth to the refracting layers at the ends and centre of each spread was done using intercept times from the time-distance plots. The long shots enabled accurate bedrock seismic velocities to be determined and this assisted in the short and centre shot records in distinguishing arrivals of waves refracted through intermediate layers from those passing through bedrock.

4. SEISMIC RESULTS

The seismic cross-sections of Traverses 1 to 9 (Tuggeranong Freeway Stage II) and Traverses 10 to 19 (Village Creek) are shown in Plates 2 and 3 and Plates 4 to 7 respectively.

The following interpretation is based on surface inspection and known geology, augering (Kellet and Vanden Broek, in prep.) and results of past surveys (Hill, 1971: Hill, in prep.).

Seismic Velocity (m/s)	Material
310	soil, sand
310-1100	clays
400-700	sandy or clayey colluvium-alluvium, slightly indurated.
1100-1600	indurated slopewash
750-1400	completely weathered volcanic rock
1400-2400	highly weathered volcanic rock
2400-3500	moderately weathered volcanic rock
3500-4000	slightly weathered volcanic rock
4000-5100	fresh volcanic rock

The seismic velocity of a material gives a good indication of its degree of consolidation and thus the ease with which it can be excavated. Scraper, blade, or shovel equipment can handle material with velocity to 900 m/s, while the weathered volcanic rock and overburden with velocity less than 1500 m/s is considered rippable by bulldozers such as the D7 and D8 fitted with hydraulic rippers (Caterpillar Tractor Co., 1966; Bartlett, 1969; Hill, 1971).

Depths of rippable material on traverses as derived from the seismic cross-sections are summarized below.

Tuggeranong Freeway Stage II

Traverse No.	Average Rippable Depth (metres)
1 and 2	7
3 and 4	5
5 and 6	7.5
7 and 8	1.5 but marginal to possibly 17. Pre-blasting may be required
9	1 but marginal to possibly 22, and pre-blasting may be required

Village Creek

Traverse No.	Average Rippable Depth (metres)
10	10
11	8
12	9
13	14
14	4.5 (perhaps rippable to 12 at south end)
15	7.5
16	6 (perhaps rippable to 12 near centre)
17	4.5 (perhaps rippable to 15 on east bank of creek)
18	3
19	13

5. CONCLUSION

The seismic cross-sections which have been obtained indicate from the suggested interpretation of the different velocity layers the structure and nature of the subsurface along each traverse. Along the proposed route of Tuggeranong Freeway Stage II the typical subsurface sequence appears to be soil, clay, or indurated slopewash, weathered volcanic bedrock followed by fresh bedrock at a depth of about 20 m; in the Village Creek area it seems to be soil, sandy or clayey colluvium-alluvium (slightly indurated), weathered volcanic bedrock, then fresh bedrock again at about 20 m depth.

From the seismic velocities of the layers the most economical method of excavation can be predicted. In the survey area it is considered that material with velocities up to 1500 m/s can be ripped, and though variable from traverse to traverse and along individual traverses the material along the proposed Freeway (II) route and in the Village Creek area is rippable (with possibly some light preliminary blasting) to a depth of about 10 m.

6. REFERENCES

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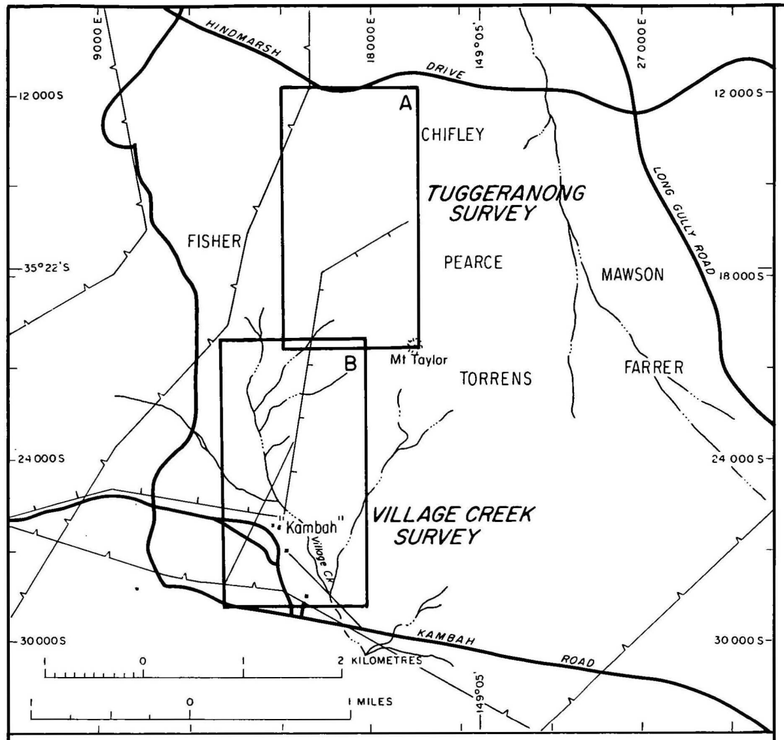


LEGEND

- Seismic traverse
- Telephone line
- Transmission line
- Fence line
- Stream

Contour values are in feet

Grid co-ordinates are in feet with origin at Stromlo Trig

CONVERSION TABLE

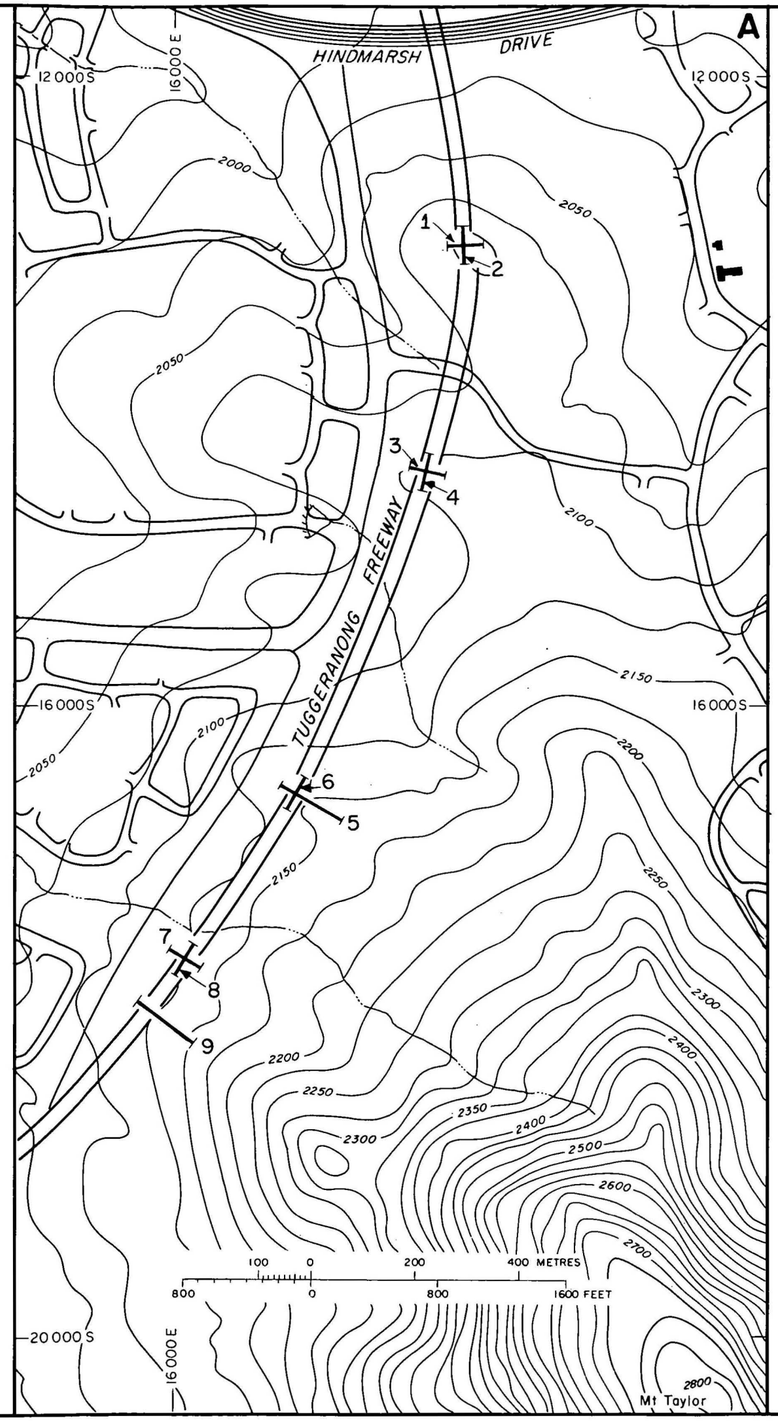
Feet	Metres
2000	609·6
2100	640·1
2200	670·6
2300	701·0
2400	731·5
2500	762·0
2600	792·5
2700	823·0
2800	853·4

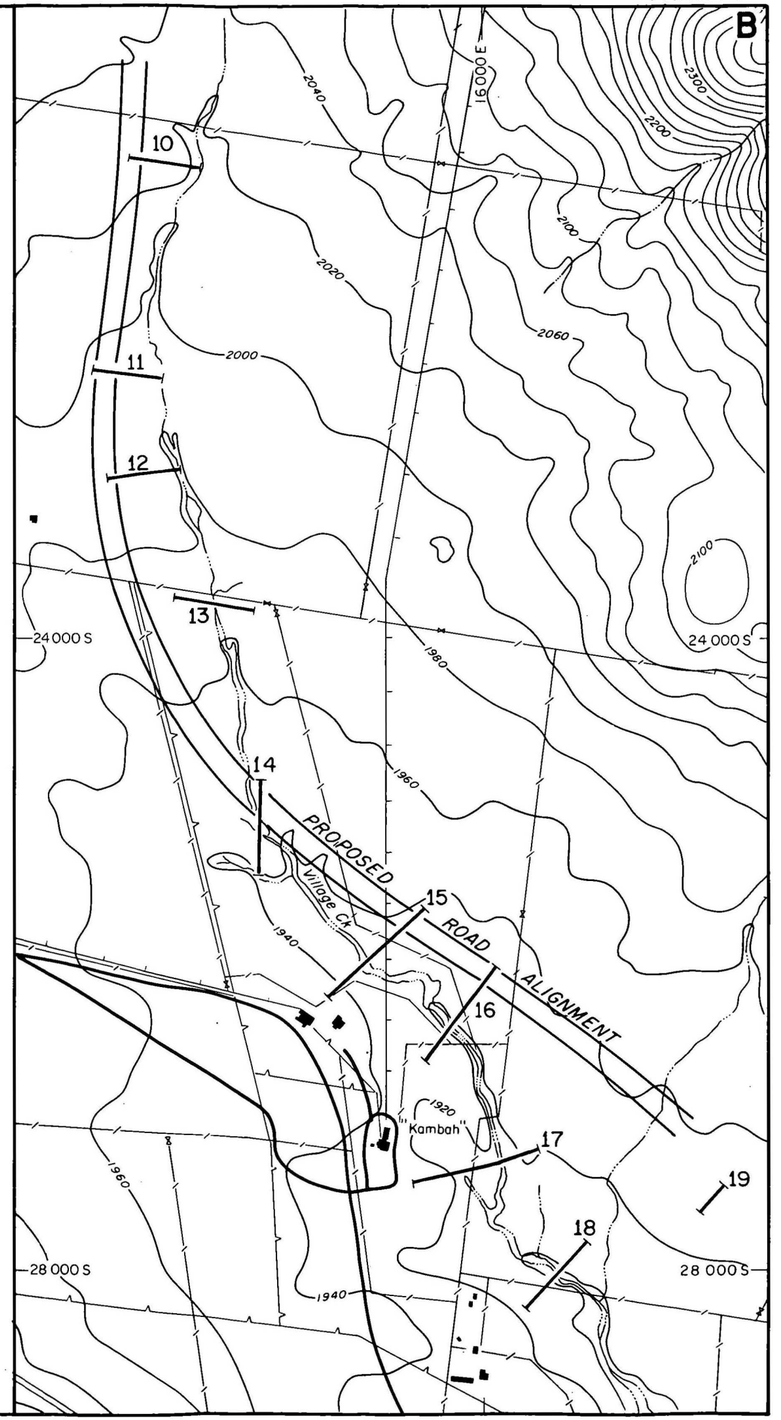
TUGGERANONG FREEWAY AND VILLAGE CREEK SURVEYS

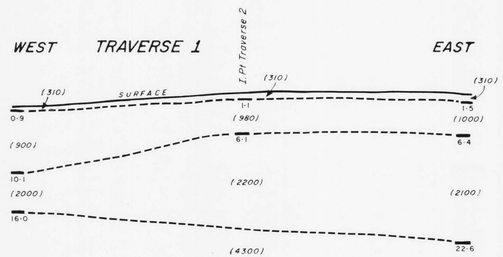
LOCALITY MAP AND TRAVERSE PLAN

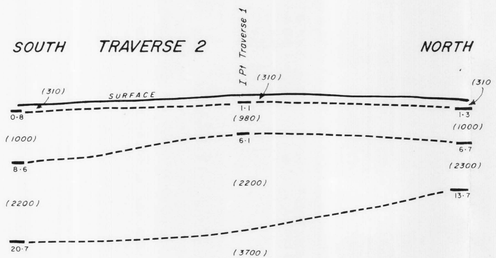
To accompany Record No 1972/84

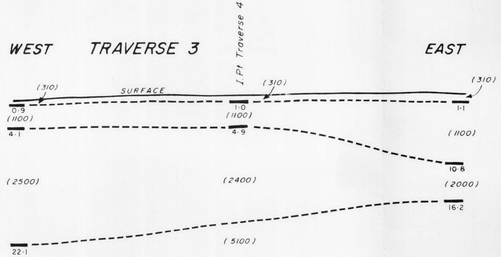
I55/B5-157

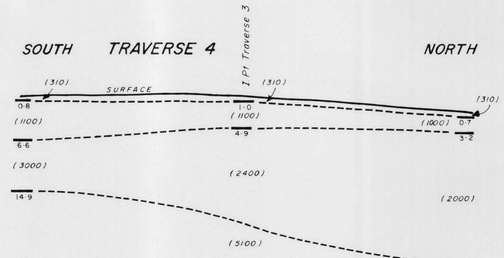


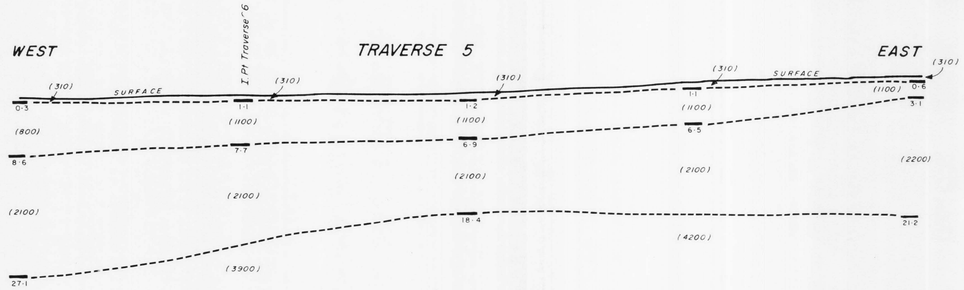


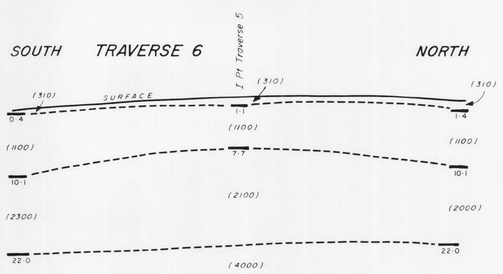












LEGEND

10·1 — Depth to refractor (metres)

Interpolated boundary

(2100) — Seismic velocity in formation (metres/second)

I. Pt — Intersection point

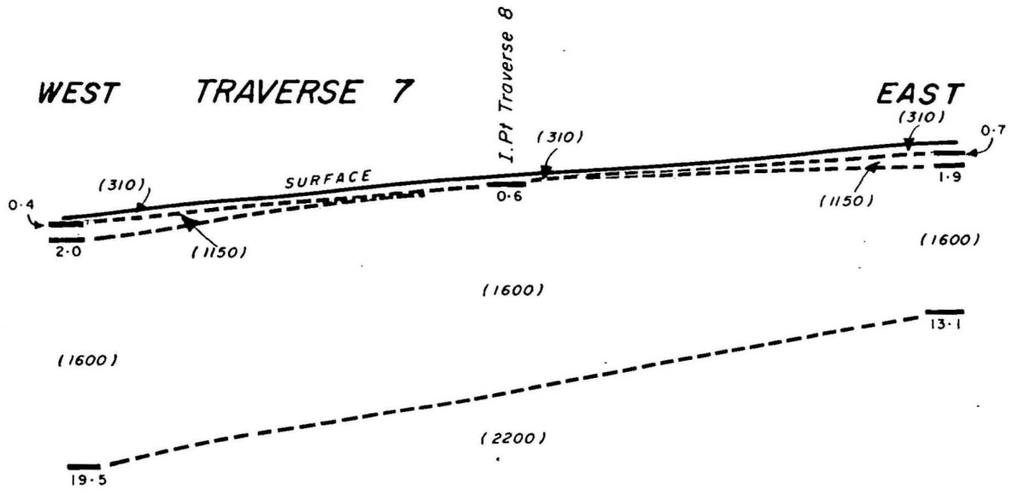
HORIZONTAL AND VERTICAL SCALE

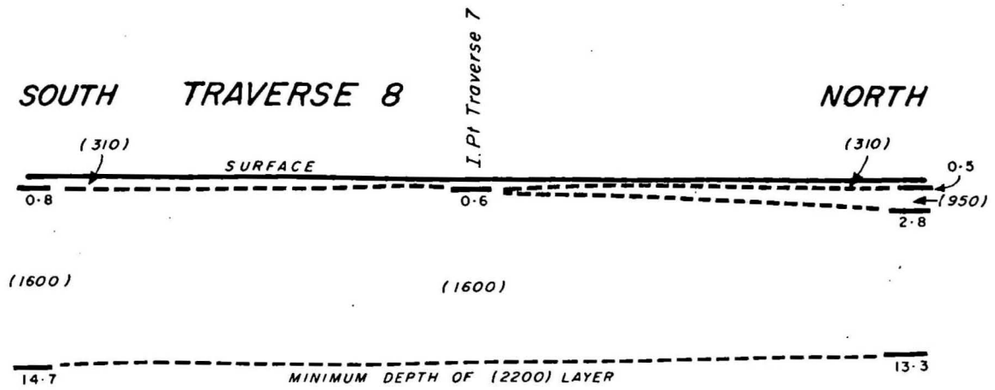
5 0 5 10 15 20 25 METRES

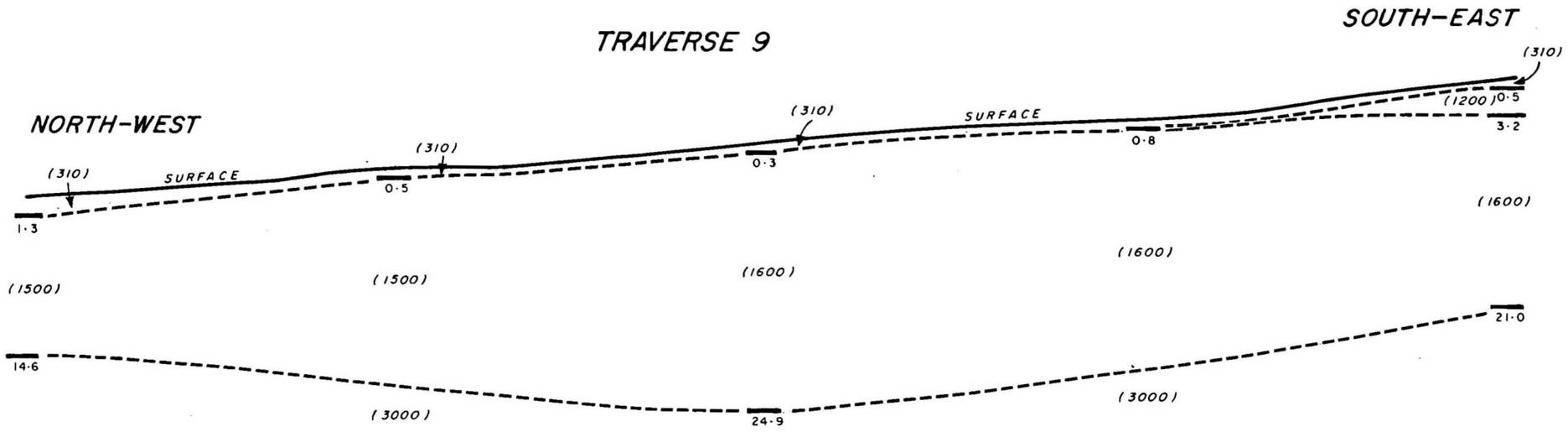
TUGGERANONG FREEWAY STAGE 2
SEISMIC CROSS-SECTIONS
TRAVERSES 1, 2, 3, 4, 5 and 6

To accompany Record No 1972/84

I55/B5-128







LEGEND

14·6 — Depth to refractor (metres)

------ Interpolated boundary

I.Pt — Intersection point

(3000) — Seismic velocity in formation (metres/second)

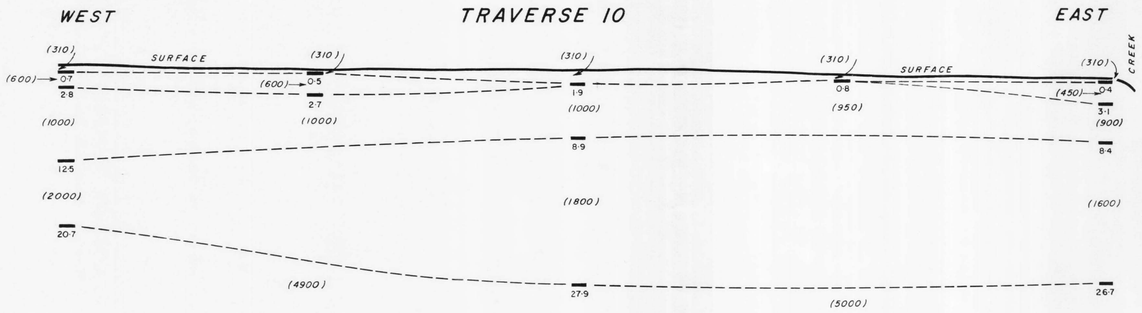
HORIZONTAL AND VERTICAL SCALE

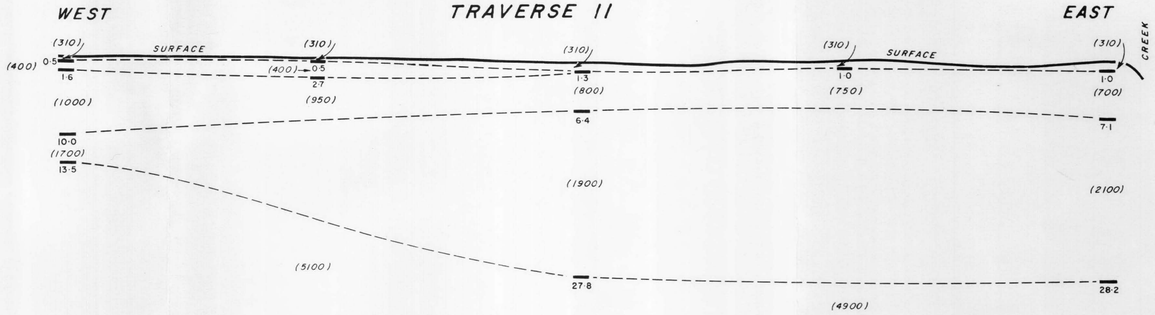
5 0 5 10 15 20 25 METRES

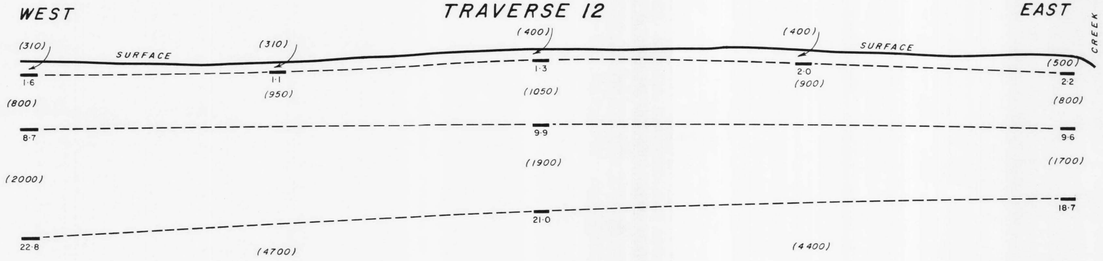
TUGGERANONG FREEWAY STAGE 2
SEISMIC CROSS-SECTIONS
TRAVERSES 7, 8 and 9

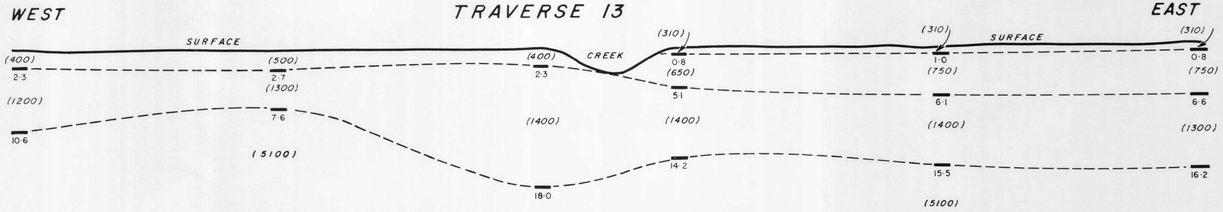
To accompany Record No 1972/84

I55/B5-129









HORIZONTAL AND VERTICAL SCALE

5 0 5 10 15 20 25 METRES

LEGEND

2·7 — Depth to refractor (metres)

– – – – Interpolated boundary

(5000) Seismic velocity in formation (metres/second)

VILLAGE CREEK SEISMIC CROSS-SECTIONS
TRAVERSES 10, 11, 12 and 13

To accompany Record No 1972/84

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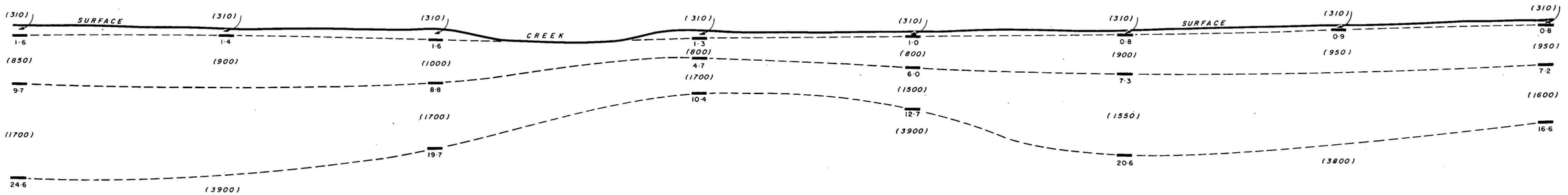
TRAVERSE 14

TRAVERSE 15



LEGEND

7·3 — Depth to refractor (metres)

– – – – Interpolated boundary

(3800) Seismic velocity in formation (metres/second)

HORIZONTAL AND VERTICAL SCALE

5 0 5 10 15 20 25 METRES

VILLAGE CREEK SEISMIC CROSS-SECTIONS
TRAVERSES 14 and 15

To accompany Record No 1972/84

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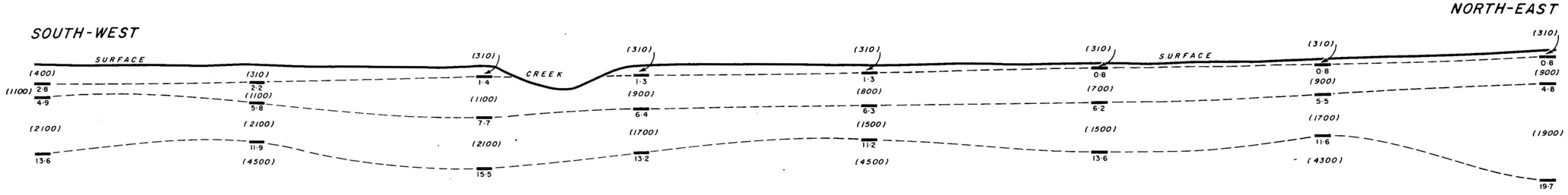
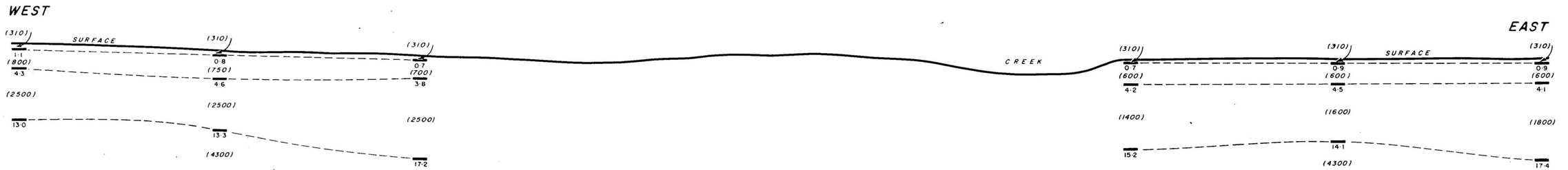
TRAVERSE 16



TRAVERSE 17



HORIZONTAL AND VERTICAL SCALE

5 0 5 10 15 20 25 METRES

LEGEND

5·8 — Depth to refractor (metres)

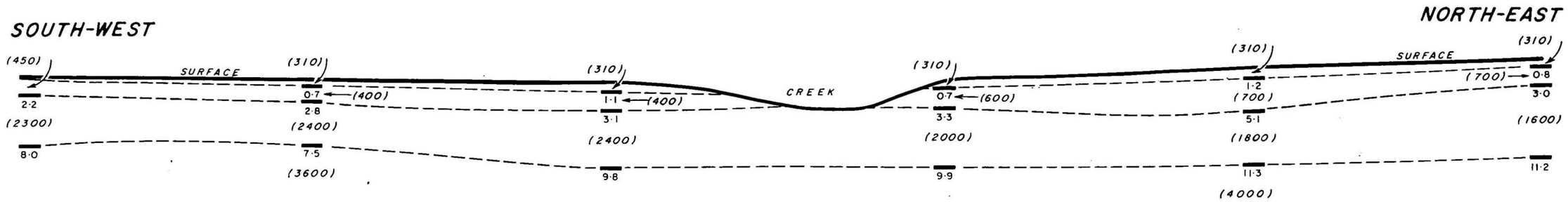
– – – – – Interpolated boundary

(2100) Seismic velocity in formation (metres/second)

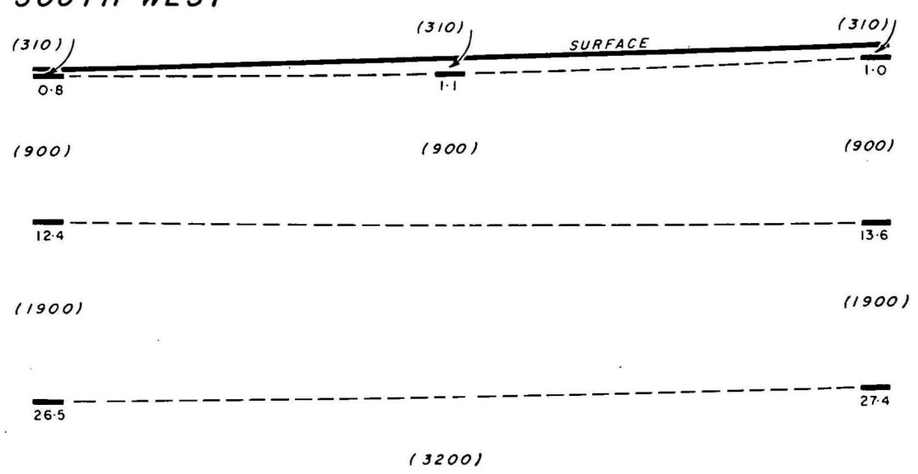
VILLAGE CREEK SEISMIC CROSS-SECTIONS
TRAVERSES 16 and 17

To accompany Record No 1972/84

TRAVERSE 18



TRAVERSE 19



LEGEND

7·5 — Depth to refractor (metres)

— — — Interpolated boundary

(2400) Seismic velocity in formation (metres/second)

HORIZONTAL AND VERTICAL SCALE

5 0 5 10 15 20 25 METRES

VILLAGE CREEK SEISMIC CROSS – SECTIONS
TRAVERSES 18 and 19

To accompany Record No 1972/84

I55/B5-156