COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1962/59

BARAMBAH CREEK 97.7M, 117.3M, AND 125.0M DAM SITES

SEISMIC REFRACTION SURVEY, QUEENSLAND 1960

by

P.E. Mann

RECORD No. 1962/59

BARAMBAH CREEK 97.7M, 117.3M, AND 125.0M DAM SITES SEISMIC REFRACTION SURVEY, QUEENSLAND 1960

by

P.E. Mann

CONTENTS

ILLUSTRATIONS

SUMMARY

This Record describes seismic refraction surveys at three dam sites on Barambah Creek, near Murgon in Queensland, made at the request of the Irrigation and Water Supply Commission of Queensland.

The seismic velocities are tentatively interpreted in geological terms, and the results are plotted in the form of cross-sections showing depth and velocity of the various layers. Special attention should be given to rocks with seismic velocities about 8000 ft/sec, which are interpreted as moderately weathered bedrock . Depending on the type of dam to be designed, these may be suitable as foundation rocks.

The seismic work suggests that fault or shear zones are present at all three dam sites.

1. INTRODUCTION

To increase the water resources available for the irrigation of farms in the Burnett Valley, the Irrigation and Water Supply Commission of Queensland is investigating dam sites on Barambah Creek, near Murgon. They requested the Bureau of Mineral Resources, Geology and Geophysics to make a geophysical survey to determine the type of bedrock and depth to bedrock at three sites on the creek. The sites selected were the 97.7M, 117.3M, and 125.0M sites; their approximate co-ordinates are respectively 505733, 515732, and 521731 on the Gympie sheet of the Australia 4-mile series.

Regional geology of the area has been described by Reid (1925). A geological investigation of the dam sites has been made by the Commission (Dunlop, 1960).

The Bureau geophysical party consisted of P.E. Mann (geophysicist and party leader), D.J. Harwood (geophysicist), and J.P. Pigott, (geophysical assistant). Four field assistants were supplied by the Commission. Field work at the three sites lasted from 31st October 1960 to 18th November 1960.

The assistance of the Commission in doing the topographical surveying of the sites and providing additional transport, gelignite, detonators, and some supplies for the party, is acknowledged. Locations on the surveyed area are indicated by referring to the traverse symbol and the station number, e.g. X7 means Traverse X, station 7.

2. METHODS AND EQUIPMENT

The seismic refraction method was used at all three sites, and resistivity traversing only at the 97.7M site. A general description of the seismic refraction method and the technique of the 'method of differences' used on this survey is outlined by Polak and Mann (1959).

The equipment used on the survey was a twelve-channel portable seismograph designed for shallow reflection and refraction methods by the Midwestern Geophysical Laboratory of Tulsa, Oklahoma. Brush geophones with a natural frequency of approximately 20 c/s were used to record the vertical motion of the ground.

The following types of geophone spread, based on the 'method of differences', were shot :

(a) Normal spreads - the geophones were spaced 50 ft apart in a straight line, and shots were fired 50 ft and 200 ft beyond each end of and in line with the spread.

(b) Weathering spreads - these spreads were used to obtain the seismic velocity and thickness of the soil and near-surface layers from which an apparent velocity (Va), for the material between the highest velocity refractor and the surface may be calculated. Va is used in calculating the depth to bedrock. The geophone interval was 10 ft and shots were fired at distances of 10, 50, and 200 ft beyond each end of and in line with the spread.

On several occasions a shot was placed in the centre of a normal spread to provide additional information on the seismic velocities and thicknesses of the near-surface layers.

Resistivity traversing (Wiebenga, 1956) with electrode spacing of 50 ft and 100 ft was used at the 97.7M dam site.

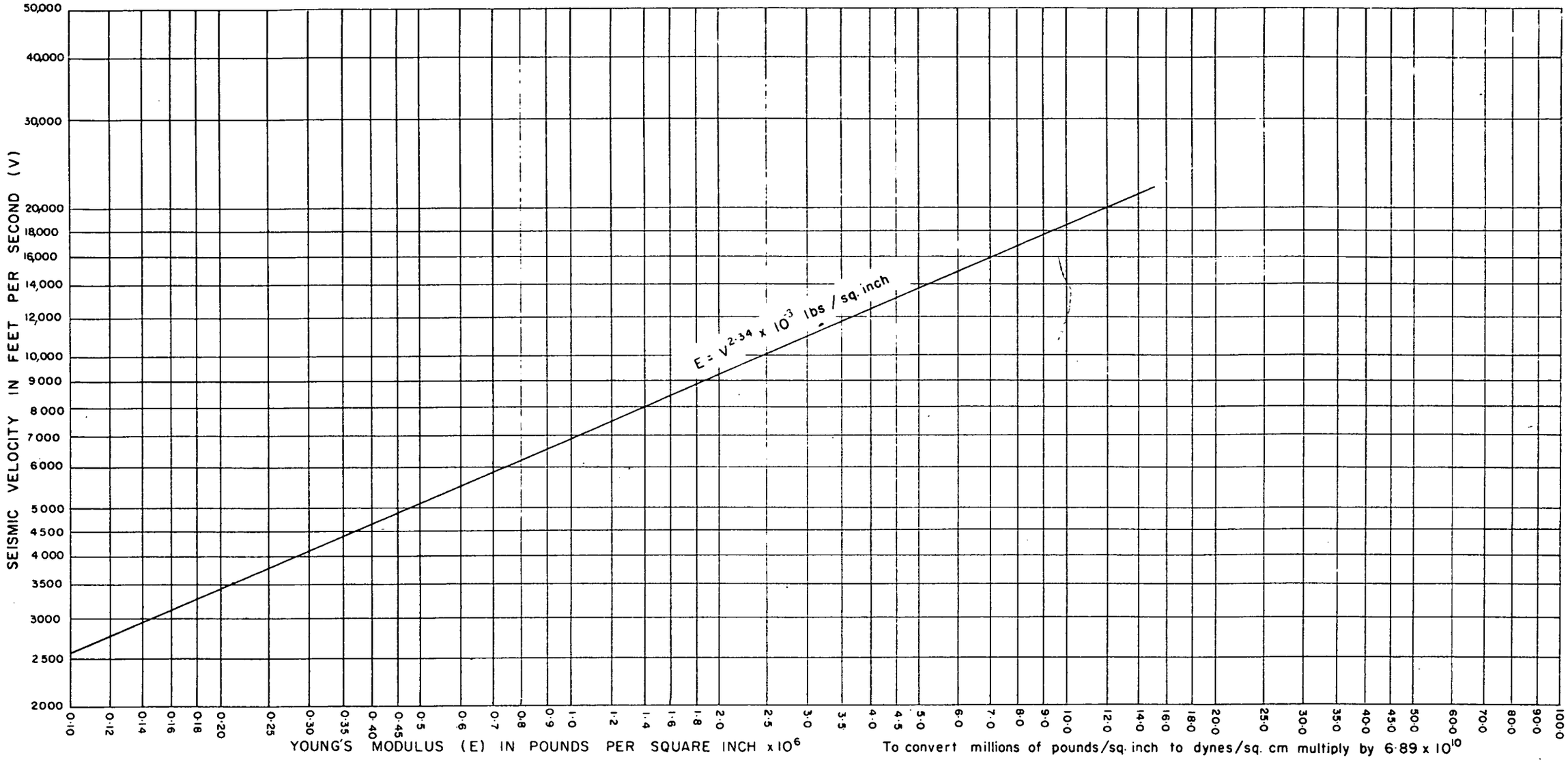
3. SEISMIC VELOCITIES

Geological formations are characterised by a discrete range of seismic velocities. Table 1 is a tentative interpretation of observed longitudinal wave velocities for the three dam sites, based on a knowledge of the exposed rocks in the area and on previous experience in other areas.

TABLE 1

Longitudinal seismic wave velocity (ft/sec)	Rock type
1000±	Soil
2000 to 4000	Eluvium or hillwash; very weathered and fractured bedrock; moist clay or silt.
4000 to 5000	Unconsolidated alluvium, predominantly sand and gravel.
5000 to 7000	Unconsolidated to semi-consolidated alluvium; sand and gravel predominant.
4000 to 8000	Very weathered to weathered bedrock, probably fractured and porous.
8000 to 11,000	Weathered to moderately weathered bedrock, probably fractured or porous.
11,000 to 14,000	Fractured to slightly fractured bedrock in fault or shear zone.
14,000 to 19,000	Slightly fractured to unfractured, unweathered bedrock.

Research by the Caterpillar Tractor Company in U.S.A. (Anon, 1959) has shown that seismic velocity can be used to indicate the ease of excavating subsurface material, i.e. whether it can be ripped or whether the use of explosives is required. This depends to some extent on the composition of the rock and size of the ripping equipment. As a general guide for rocks likely to be found in the Barambah Creek area, it is very probable that rocks with seismic velocities up to 4000 ft/sec could be easily ripped. Between 4000 and 5500 ft/sec, ripping may or may not be feasible, depending on the rock type; e.g. water-saturated sand and gravel could be ripped, but it is doubtful whether weathered bedrock with velocities in this range could be ripped. If the velocity exceeds about 5500 ft/sec explosives will probably be required.



The values of Young's Modulus may be considered to have a maximum error of ± 30 %
The above relationship is approximately correct for most rock types, other than salts

FIGURE 1. EMPIRICAL RELATION BETWEEN YOUNG'S MODULUS AND THE COMPRESSIONAL WAVE VELOCITY IN ROCKS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 263-16-3
TO ACCOMPANY RECORD No 1962/59

Experience has shown that seismic velocities can give some indication as to suitability for dam foundations. This again depends to some extent on the composition of the rocks. Though it is not possible to quote definite figures, as a general guide it may be taken that rocks with velocities below 7000 ft/sec are unsuitable as foundations; between about 7000 or 8000 and 11,000 or 12,000 ft/sec they are probably suitable for an earth dam. For a concrete dam, rocks with velocities of 11,000 or 12,000 ft/sec or higher are probably required. Seismic indications should, however, be confirmed by drilling and testing, particularly in marginal cases.

Opposite is a diagram (Fig. 1) that gives an empirical relation between Young's modulus and the compressional, or longitudinal, seismic wave velocity. Young's modulus derived from this empirical relation is accurate within about 30 per cent.

4. 97.7M DAM SITE

Geology

The geology of the dam site is described by Dunlop (1960). Outcrops are shown on Plate 2.

The bulk of the alluvium consists of unconsolidated younger alluvium, predominantly clay with some fine sand and gravel, deposited by and adjacent to the present stream. Traces of older, consolidated alluvium, consisting of hard silicified grit and sandstone, crops out at the higher parts of the right* bank, and underly younger alluvium at the base of the right bank, down-stream from the dam site.

A series of irregular, narrow river terraces occur up to a height of 50 ft above the water-level, between X17 and X28. The terrace material consists of dark brown surface clay and layers of sand and gravel possibly overlying old alluvium of silicified grit and sandstone.

The bedrock consists of quartzite and jasper of the Wondai Series. The strike of the quartzite beds is about 165° to 180°, and they dip almost vertically. The quartzite is closely jointed and fractured, spacing between joints being commonly less than one inch. Zones of brecciation may be present.

On the left bank three parallel, elongated outcrops of thinly bedded, jointed quartzite are aligned parallel to the strike of the beds, and nearly parallel to Traverse Z. The areas between the outcrops may represent shear or fault zones with a northerly strike.

Results

The seismic cross-sections of Plate 3 are self-explanatory and with the aid of Table 1 the seismic velocities may be used to distinguish different geological formations. This discussion will be restricted to some noteworthy points.

The comparatively flat parts in the bedrock profiles between X13 and X16, between X17 and X20, and along Traverse B, may represent the floors of river terraces.

* looking downstream

The lower bedrock velocities (11,000 to 12,000 ft/sec) between X31 and X35, C3 and C6, and C8 and C10 correspond to zones between rock outcrops (see Plate 2). The zones probably are either individual faults or shears with a northerly strike, or may form part of a larger fault or shear zone. The value of Young's modulus for the bedrock can be derived from the empirical relation shown in Figure 1.

Resistivity traversing with constant electrode spacing was done on the right bank. However, the resistivity work provided no significant additional information, and consequently the resistivity profiles are not presented in this Record.

Conclusions and recommendations

The geophysical survey gave the velocities and depths of the seismic refractors at the dam site. The intermediate layer above the bedrock is probably not ideal for dam foundations, but those parts where the velocity exceeds about 8000 ft/sec may be found satisfactory, depending on the type of dam to be used.

The bedrock, with velocities in excess of 11,000 ft/sec, is probably suitable for foundations. To check these geophysical conclusions and the depth estimates, the following sites for check drilling are suggested:

near stations X17, X11, X4, X28 (C7), C9, and X32

5. 117.3M DAM SITE

Geology

The geology of the dam site is described by Dunlop (1960). The outcrops are shown on Plate 4.

The centre line of the proposed dam coincides with the symmetry axis of a U-shaped meander of the creek. The right abutment consists of an elongated spur rising gently from a river terrace 400 to 600 ft wide. The surface material of the spur consists of silt,sand, and angular rock fragments with an area of boulders of andesitic agglomerate near X36 and X50, where bedrock possibly comes close to the surface.

On the left bank the river terrace is narrow and dissected; on the moderate hill slope are numerous outcrops and boulders of andesitic agglomerates.

The bedrock consists of the Goomeri Volcanics - andesitic agglomerate with interbedded tuff. The strike of the beds is indefinite, but may be approximately 165°, dipping east at about 45°.

A view of a large-scale topographical plan of the area of say 4 miles or 1 mile to the inch shows that most topographical features seem to line up in either a north-south or an east-west direction, suggesting a regional fault or fracture pattern.

Results

The seismic results of Plate 5 are self-explanatory, and with the aid of Table 1 of Chapter 3 the seismic velocities may be used to distinguish different geological formations. A few noteworthy points will be discussed.

The deepest refractor is interpreted as unweathered bedrock. The intermediate layer above this, ranging in velocity between 7500 and 11,000 ft/sec, is interpreted as weathered bedrock which may be used under certain conditions as a foundation rock, depending on the type of dam to be designed. Wherever possible the depth to this intermediate layer was computed from intercept times and is shown on the cross-sections. Between these observation points, the depth is interpolated and indicated by dashed lines.

The seismic velocity in the bedrock ranges between 12,000 and 18,000 ft/sec; the lower velocities are probably associated with fractured, faulted, or sheared rocks, perhaps slightly weathered on fractures and recemented. Some possible faults are indicated on Plate 4. The value of Young's modulus for the bedrock can be derived from the empirical relation shown in Figure 1.

Some percussion drilling had been completed before the seismic survey, but the logs are possibly not very reliable. The drilling information is shown on the cross-sections on Plate 5, and can be compared with the seismic data.

Conclusions and recommendations

The geophysical survey gave the velocities and depths of the seismic refractors at the dam site. These have been interpreted in geological terms. Additional drilling is recommended at B14 and B10 to confirm the step shown on the bedrock profile.

Part of the bedrock may be faulted or sheared, but the relatively high seismic velocities associated with these fault or shear zones suggest that these zones may not form a serious obstacle in dam construction.

6. 125.0M DAM SITE

Geology

The geology of the dam site is described by Dunlop (1960), and is shown on Plate 6.

The site is slightly asymmetrical in cross-section, with the steepest abutment on the right bank, and two gullies near A8 and C3. The alluvium at the centre line of the proposed dam site is approximately 400 ft wide, with the bulk of the material on the left bank. A flood channel flows through the left bank terrace. A little drilling has shown that the alluvium, consisting of sandy clay and gravelly sand with cobbles, continues to at least 12 ft below river bed level.

In a road cutting on the eastern slope of the hill that forms the right bank, weathered conglomerate, sandstone, and siltstone occur under a thin soil cover with pebbles and cobbles. An exposure of massive, coarse conglomerate, 30 to 50 ft wide and about 300 ft long, occurs adjacent to the right bank flood terrace.

The bedrock consists predominantly of andesitic conglomerate with sandstone and siltstone. The strike of the beds is approximately south-east, dipping north-east at approximately 20°.

Results

The results shown in cross-section on Plate 7 are self-explanatory. As explained in Chapter 3 the seismic velocities at the dam site (Traveres A, B, C and X) and spillway site (Traverses AA and XX) may be interpreted in geological terms.

Near A7, B4, and C3, the bedrock velocities are lower than the general velocities along the traverses. These localities line up with the two gullies near C3 and A7 and probably indicate the presence of a shear or fault as indicated on Plate 6. Near AA11 and XX12 also the bedrock velocities are lower than is general along the traverses. These low velocities probably indicate a shear zone, which may be a continuation of the shear zone that crosses Traverses A, B, and C (Plate 7); however, this is by no means certain.

The value of Young's modulus for the bedrock can be derived from the empirical relation shown in Figure 1.

Some percussion drilling had been completed before the seismic survey, and the results are shown on the cross-section of Traverse X, Plate 7, for comparison with the seismic data.

The intermediate layer with a velocity about 6000 ft/sec is not likely to be satisfactory for dam foundations.

Conclusions and recommendations

The geophysical survey gave the velocities and depths of the different seismic refractors at the dam site, and these were interpreted in geological terms.

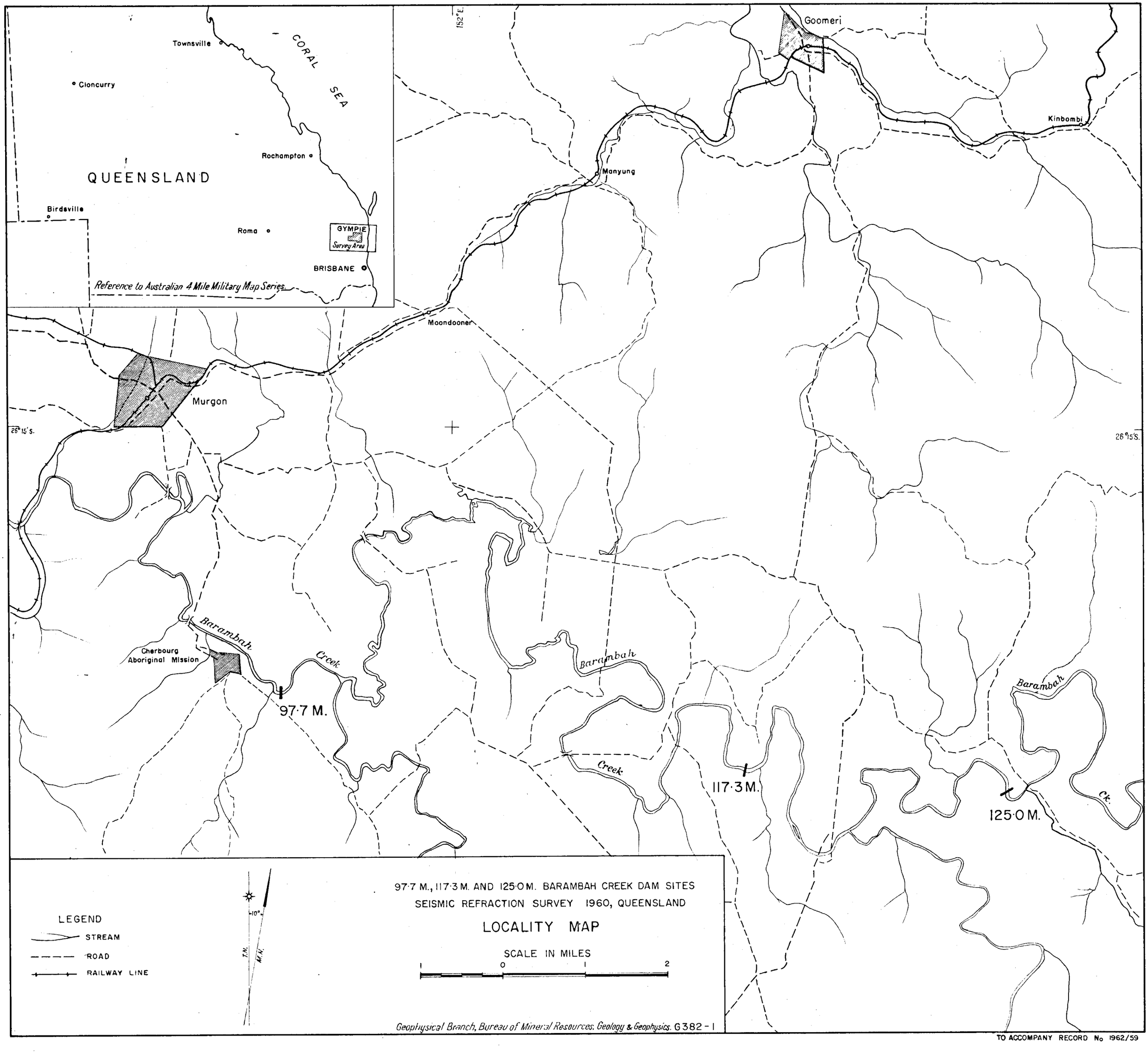
To check the presence of the fault or shear zone and the quality of the rock, additional drill holes are recommended near A7, C3, and XX11.

7. REFERENCES

ANONYMOUS 1959 Seismic analysis aids in overburden removal. Mining Engineering 11, 803.

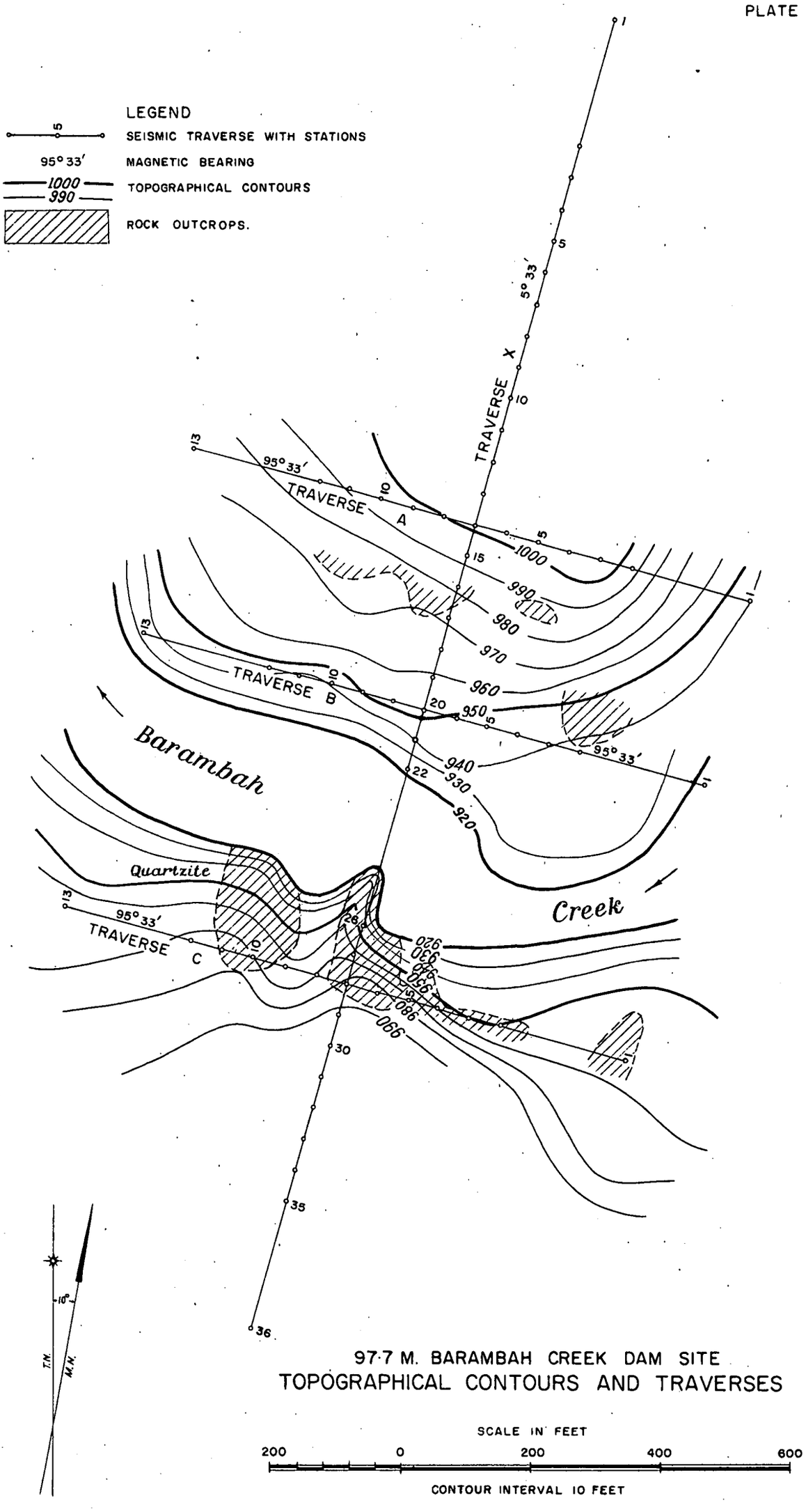
DUNLOP, R.A. 1960 Geology of Barambah Creek dam sites, Memorandum to the Senior Planning Engineer, Irrigation and Water Supply Commission, Queensland (unpublished).

POLAK, E.J. and MANN, P.E.	1959	A seismic refraction survey at the Moogerah dam site near Kalbar, Queensland. Bur. Min. Resour. Aust. Rec. 1959/62 (unpubl.).
REID, J.H.	1925	The Murgon Goomeri districts. Queensland Govt. Mining J., 26, 87.
WIEBENGA, W.A.	1956	Geophysical investigation of water deposits, Western Australia. Bur. Min. Resour. Aust. Bull. 30.



TO ACCOMPANY RECORD No 1962/59

PLATE 2



97·7 M. BARAMBAH CREEK DAM SITE
TOPOGRAPHICAL CONTOURS AND TRAVERSES

SCALE IN FEET

200 0 200 400 600

CONTOUR INTERVAL 10 FEET

ELEVATION DATUM; STATE.

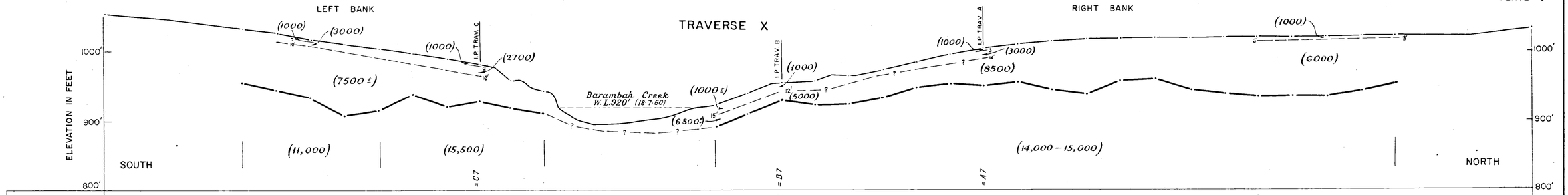
AZIMUTH DATUM; MAGNETIC.

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 382-2

TO ACCOMPANY RECORD No 1962/59

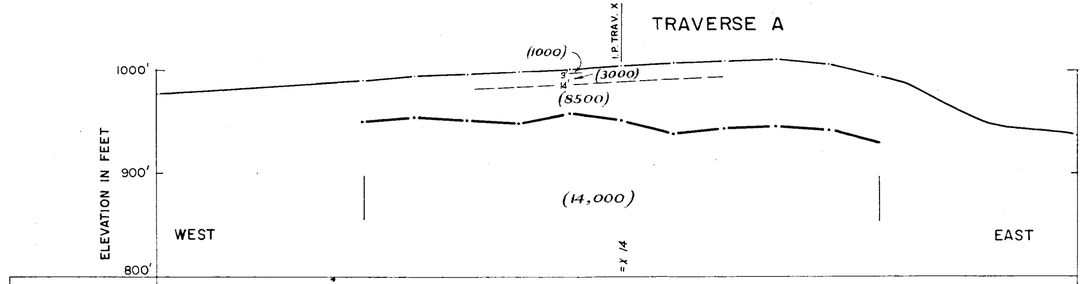
PLATE 3

TRAVERSE X



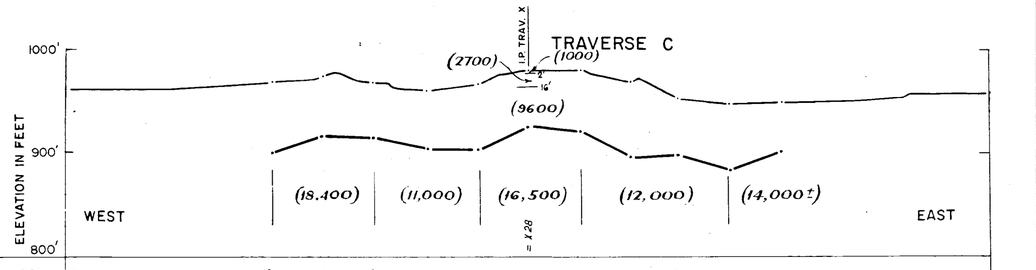
STATION NUMBER	36		35	34	33	32	31	30	29	28	27	26		22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2		1
STATION ELEVATION	1056		1034	1027	1019	1011	1005	998	991	982	958	943		923	941	956	958	966	974	985	985	1004	1011	1016	1019	1020	1020	1020	1021	1022	1022	1022	1023	1023		1034
DEPTH TO BEDROCK			78	82	85	104	90	60	70	53	40	33		33	30	28	35	42	40	37	40	53	53	70	78	60	58	73	80	85	83	85	78	68		

TRAVERSE A



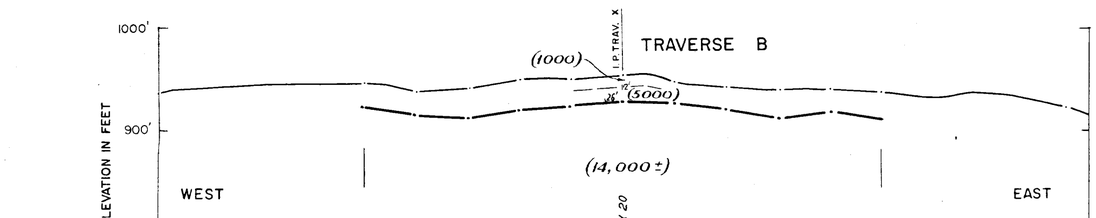
STATION NUMBER	13		12	11	10	9	8	7	6	5	4	3	2		1
STATION ELEVATION	975		988	994	995	997	1001	1004	1006	1007	1009	1005	993		936
DEPTH TO BEDROCK			40	40	45	50	43	53	68	65	65	63	65		

TRAVERSE C



STATION NUMBER	13		12	11	10	9	8	7	6	5	4	3	2		1
STATION ELEVATION	963		970	976	970	962	969	982	982	971	953	948	949		957
DEPTH TO BEDROCK			69	59	53	56	63	83	59	73	53	63	46		

TRAVERSE B



STATION NUMBER	13		12	11	10	9	8	7	6	5	4	3	2		1
STATION ELEVATION	937		947	939	943	951	952	956	949	943	940	941	937		922 913
DEPTH TO BEDROCK			25	23	29	29	25	26	21	22	27	22	26		

97·7 M. BARAMBAH CREEK DAM SITE

TRAVERSES A, B, C, AND X
CROSS-SECTIONS

LEGEND

(12000)	FORMATION WITH SEISMIC VELOCITY 12,000 FT/SEC.
23'	DEPTH OF FORMATION WITH DIFFERENT SEISMIC VELOCITY.
(25')	INTERPOLATED DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY
I.P. TRAV. X.	INTERSECTION POINT
———	UNWEATHERED BEDROCK
——?——?	BEDROCK BOUNDARY WITH SEISMIC VELOCITY ABOUT 10,000 FT/SEC

HORIZONTAL AND VERTICAL SCALES IN FEET

100 0 100 200 300

ELEVATION DATUM – STATE

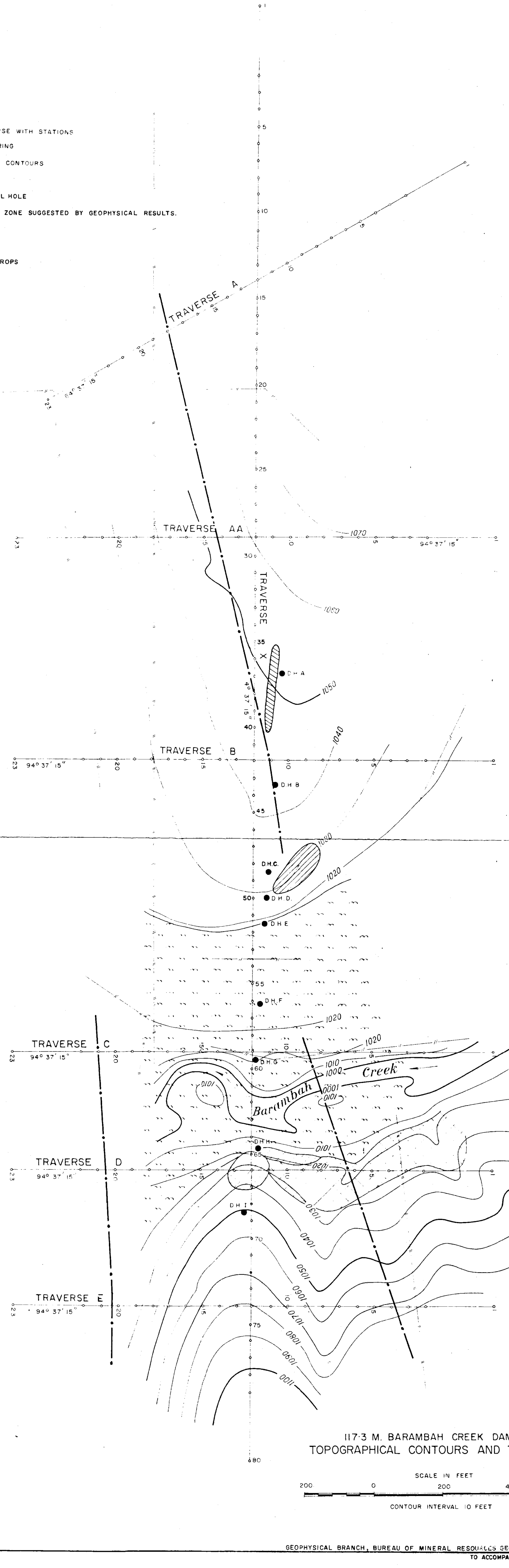
Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics. G 382-3

TO ACCOMPANY RECORD No. 1962/59

A.L.D. 1960.

LEGEND

- SEISMIC TRAVERSE WITH STATIONS
- 4° 37' 15" MAGNETIC BEARING
- 1010 / 1000 TOPOGRAPHICAL CONTOURS
- FENCE
- ● D.H. B PERCUSSION DRILL HOLE
- FAULT OR SHEAR ZONE SUGGESTED BY GEOPHYSICAL RESULTS.
- ALLUVIUM
- HILLWASH
- BOULDERY OUTCROPS



117·3 M. BARAMBAH CREEK DAM SITE
TOPOGRAPHICAL CONTOURS AND TRAVERSES

SCALE IN FEET
200 0 200 400 600

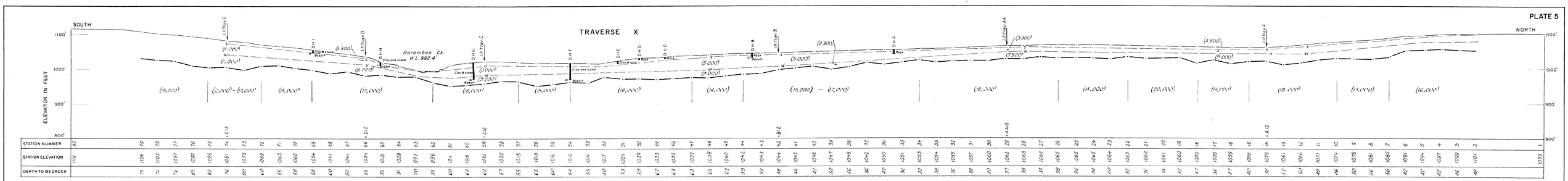
CONTOUR INTERVAL 10 FEET

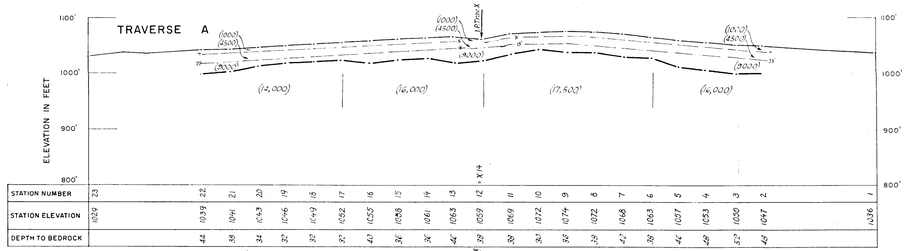
ELEVATION DATUM, STATE
AZIMUTH DATUM MAGNETIC

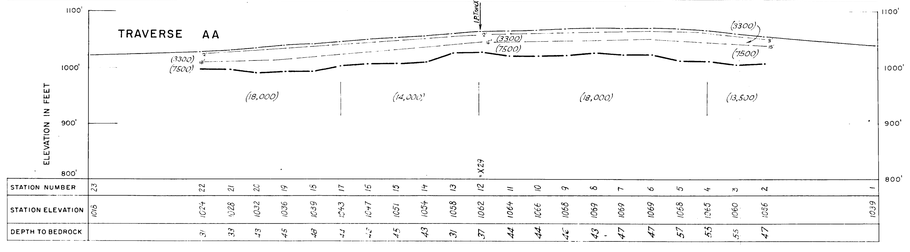
G382-4

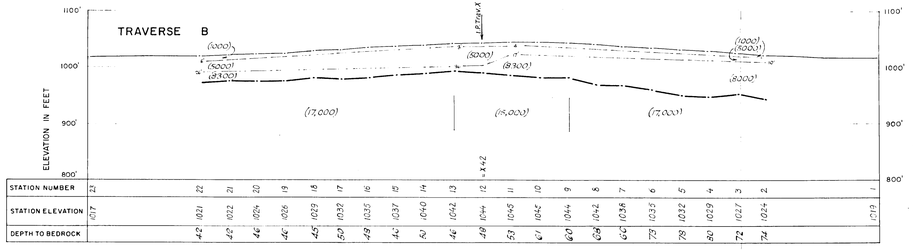
GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES GEOLOGY & GEOPHYSICS
TO ACCOMPANY RECORD No 1962/59

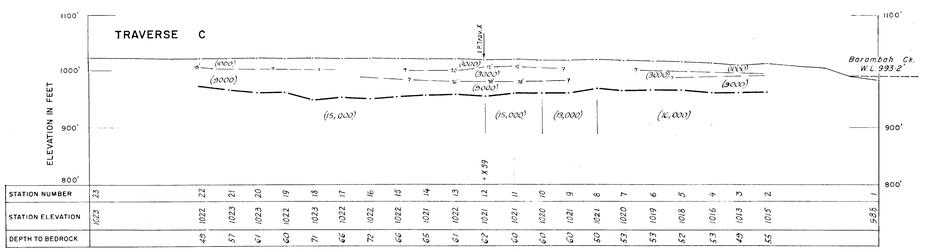
PLATE 5

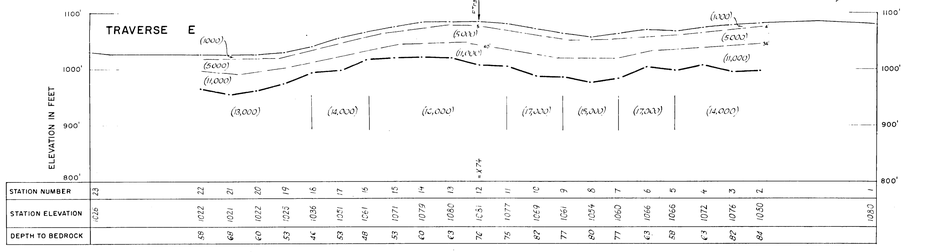












LEGEND

(15000) FORMATION WITH SEISMIC VELOCITY 15000 ft /sec

——— 20' DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY

I.P.Trav.E INTERSECTION POINT

UNWEATHERED BEDROCK BOUNDARY

DH 10 Rock Basalt DRILL HOLE B

117·3 M BARAMBAH CREEK DAM SITE

TRAVERSES A,AA, B,C,D,E, AND X

CROSS – SECTIONS

HORIZONTAL AND VERTICAL SCALES IN FEET

100 50 0 100 200 300 400

ELEVATION DATUM-STATE

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 382-5

TO ACCOMPANY RECORD No. 1962/59

LEGEND

- SEISMIC TRAVERSE WITH STATIONS
- 97°42′ MAGNETIC BEARING
- 1050 / 1040 TOPOGRAPHICAL CONTOURS
- D.H. F PERCUSSION DRILL HOLE F
- SHEAR OR FAULT SUGGESTED BY GEOPHYSICAL RESULTS
- ALLUVIUM
- BOULDERY OUTCROPS

T.N. M.N. 10°

Barambah Creek

TRAVERSE A
TRAVERSE B
TRAVERSE C
TRAVERSE X
TRAVERSE AA
TRAVERSE XX

D.H. A
D.H. B
D.H. C
D.H. D
D.H. E
D.H. F
D.H. G
D.H. H

1047.8′ 164° 30′
392.8′ 155° 10′ 30″
97° 42′
57° 15′
147° 15′

ELEVATION DATUM; STATE.
AZIMUTH DATUM; MAGNETIC.

125·0 M. BARAMBAH CREEK DAM SITE

TOPOGRAPHICAL CONTOURS AND TRAVERSES

SCALE IN FEET
200 0 200 400 600

CONTOUR INTERVAL 10 FEET

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 382-6
To accompany Record No 1962/59

125·0 M. BARAMBAH CREEK DAM SITE

TRAVERSES A, B, C, X, XX, AND AA CROSS-SECTIONS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 382-7
TO ACCOMPANY RECORD No. 1962/59

QLD. 1960