COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1962/182

UPPER PALOONA DAM SITE, SEISMIC SURVEY, TASMANIA 1962

by

E.J. Polak and J.T.C. Andrew

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SUMMARY

This Record describes a seismic refraction survey at the Upper Paloona dam site on the Forth River.

The bedrock consists of chert, in which the velocity is between 11,000 and 18,000 ft/sec. There is a general distribution of the bedrock velocity related to the direction of strike. Young's modulus for the bedrock ranges between 4.2×10^6 and 5.6×10^6 $lb/in.^2$

The overburden consists mainly of talus material, and weathered chert. The velocity in the overburden ranges from 4000 to 7000 ft/sec.

1. INTRODUCTION

The Hydro-Electric Commission of Tasmania proposes to erect a dam on the lower reaches of the Forth River, as part of the Mersey/Forth power development scheme. The Commission chose two possible sites and requested the Bureau of Mineral Resources to investigate them geophysically.

The Paloona dam site, 1000 ft upstream from the bridge on the Wilmot Highway near Paloona, was covered by a seismic refraction survey in 1960 (Polak, 1962a). The Upper Paloona dam site is situated on the Forth River 2000 ft above its junction with the Wilmot River. The approximate coordinates are 423916 on the Burnie sheet of the Australia standard 4-mile map series.

The objects of the survey described in this Record were to determine the depth to bedrock, and the nature of the bedrock and the overburden, at the proposed Upper Paloona dam site.

The survey was made in February 1962 by a geophysical party consisting of E.J. Polak (party leader), J.T.G. Andrew (geophysicist), and J.P. Pigott (geophysical assistant). The Commission provided additional assistants, and did the topographical surveying.

2. GEOLOGY

The detailed geology of the area has been described by Paterson (1961 and 1962). His summary of the geology is given below and his sketch plan included on Plate 1.

The dam site is situated on the Barrington Chert, a massive to thinly bedded formation of Cambrian age. It is on the southern limb of a broad anticline. Over most of the site there is a thick cover of talus material overlying the Barrington Chert.

At the dam site the strike of the bedding is about 50 to 60 degrees oblique to the direction of the north-flowing river, with a dip of 30 to 55 degrees towards south. The rocks are closely and strongly jointed, joint systems being well developed in three directions (see Plate 1). On the eastern bank, prominent open bedding planes appear to have behaved as minor movement planes.

As used in this Record, the term 'bedrock' refers to the deepest refractor in which was recorded the highest seismic wave velocity. The term 'overburden' refers to river gravel, talus material, and completely to partly-weathered rock.

3. METHODS AND EQUIPMENT

The seismic refraction method of exploration was used. A detailed description of this method has been given in a previous BMR Record (Polak and Moss, 1959). The 'method of differences' (Heiland, 1946) was used along Traverses D, E, F, and G which are parallel to the river. Broadside shooting was used to determine the depths on Traverses A, B, and C which are perpendicular to the river.

The equipment used was a 24-channel seismograph consisting of an SIE camera with 12 SIE amplifiers and 12 Midwestern amplifiers. TIC geophones of natural frequency 20 c/s were used to record longitudinal waves, and three-component Hall-Sears geophones were used to record longitudinal and transverse waves (Polak, 1962b).

The total length of traverse surveyed was 6000 ft.

4. RESULTS

Seismic velocities

Plate 1 shows the arrangement of the geophysical traverses, and the velocities found in the deepest refractor. Table 1 shows the seismic velocities recorded at the Upper Paloona dam site.

TABLE 1

Seismic velocity (ft/sec)	Rock type
1000 to 1600	Soil
4000 to 7000	Weathered to less-weathered rock
11,000 to 18,000	Bedrock

From the velocities that are indicated in the bedrock, three conclusions can be reached.

(a) The velocities plotted along Traverses D, E, F, and G show a zonal arrangement, e.g. a high velocity between D6 and D10 corresponds with a high velocity between E8 and E4; a high velocity between F4 and F8 corresponds with a high velocity between G5 and G10. The boundaries between the velocity zones are shown by dashed lines. The direction of the zone boundaries is roughly parallel to the strike of the beds.

(b) The lack of continuity in the velocity zones across the river suggests that there is a lateral displacement along a possible fault zone coinciding with the river bed.

(c) Low bedrock velocities in some zones on the eastern bank are due to the 'prominent open bedding planes'.

Depth determination

The depth to the highest-velocity refractor was calculated using apparent-velocity values that were determined from normal spreads and weathering spreads (Polak and Moss, 1959). The calculated depths are shown on Plates 2 and 3 with the seismic cross-sections.

The calculated depths are plotted perpendicular to the ground surface at the station. As the wave follows the path of shortest time from the bedrock to the station, an error may be introduced by this method of plotting.

Table 2, shows a comparison of the results obtained from broadside shots (Plate 2) with those calculated by the 'method of differences' (Plate 3). The average difference is 9 percent and the maximum 18 percent. Depths on Traverses A, B, and C were calculated from apparent-velocity data at their intersections with Traverses E and G. For this reason there is no difference in depth at these intersection points.

TABLE 2

Intersection	Depth (ft)	Depth difference (ft)	Depth difference (%)
A/D	36/40	4	10
A/E	38/38	-	-
A/F	32/35	3	9
A/G	20/20	-	-
B/D	28/34	6	18
B/E	40/40	-	-
B/F	36/34	2	6
B/G	29/29	-	-
C/D	34/38	4	10
C/E	37/37	-	-
C/F	55/55	0	0
C/G	30/30	-	-

Six diamond-drill holes have been put down at the dam site. Drill holes 5859 and 5960 can be used to compare the depths to bedrock obtained by drilling with the depths calculated from the seismic data. The comparison is shown in Table 3.

TABLE 3

Drill hole No.	Seismic station No.	Drilling Results Rock type	Depth (ft)	Seismic Results Depth (ft)	Velocity (ft/sec)
5859	B17	Hard, massive chert weathered on closely spaced joints	0-11		
		Hard, moderately jointed, massive chert; joints slightly weathered to 52 ft,	11-52		
		moderately tight below 52 ft	52-76	49	17,000
		Hole completed 76 ft			
5860	B5	Decomposed and weathered chert	0-15		
		Hard, moderately jointed, massive chert; joints moderately tight with weathered zones at 21 ft to 24 ft 4 in. and 35 ft 9 in. to 37 ft 6 in.	15-75	32 (interpolated)	18,000
		Hole completed 75ft 6 in.			

Dynamic properties of rocks

Table 4 gives the results of the tests made at the Upper Paloona dam site to determine the dynamic properties of the rocks present. Column 1 indicates the positions of the shots and of the three-component geophones. Column 2 shows the separation between shot and the nearest three-component geophone, and between the two three-component geophones. The ratio of the longitudinal to the transverse velocity is given in Column 3. Poisson's ratio is computed from Column 3 and shown in Column 4. Column 5 gives the true longitudinal velocity, calculated from the time/distance curves. Column 6 gives the value of Young's modulus obtained from Poisson's ratio and the longitudinal velocity, assuming a value of 2.7 for the specific gravity of chert (This was measured on cores from the Lower Paloona dam site). Column 7 shows the percentage error that is introduced into the dynamic properties when the calculations are based on apparent velocities. In the computation of the apparent velocity, the distance between the shot and the geophone is divided by the time taken by the pulse to travel the distance. Hence the apparent velocity is lower than the true velocity of the refractor because the paths of the seismic pulse through the weathered layer are included in the computation. However, with a thin weathered layer the errors in the computed values do not exceed 12 percent for Poisson's ratio and 7 percent for Young's modulus. These errors are not large compared with errors usually present from other sources.

TABLE 4

No.	1 Position of: shots	1 Position of: geophones	2 Distance (ft): shot to geophone	2 Distance (ft): between geophones	3 V_t/V_l: Apparent Velocities	3 V_t/V_l: Interval Velocities	4 Poisson's ratio: Apparent Velocities	4 Poisson's ratio: Interval Velocities	5 True V_l (ft/sec)	6 Young's modulus lb/sq.in. x 10^6: Apparent Velocities	6 Young's modulus lb/sq.in. x 10^6: Interval Velocities	7 Percentage error in calculation using apparent velocities: Poisson's Ratio	7 Percentage error in calculation using apparent velocities: Young's Modulus
1	G10	B6	200	150	1.70	1.74	0.24	0.26	12,000	4.4	4.2	8	5
2	G10	A5	350		1.84		0.29			3.9		12	7
3	G14	B6	400	150	1.68	1.74	0.23	0.26	12,000	4.5	4.2	12	7
4	G14	A5	550		1.76		0.27			4.1		4	2
5	D1-250	D5	450	150	1.72	1.74	0.25	0.25	13,000	5.0	5.0	4	0
6	D1-250	D2	300		1.78		0.27			4.8		4	2
7	E1-200	E2	250	150	1.79	1.79	0.27	0.27	14,000	5.6	5.6	0	0
8	E1-200	E5	400		1.80		0.28			5.5		4	1

V_t = transverse velocity

V_l = longitudinal velocity

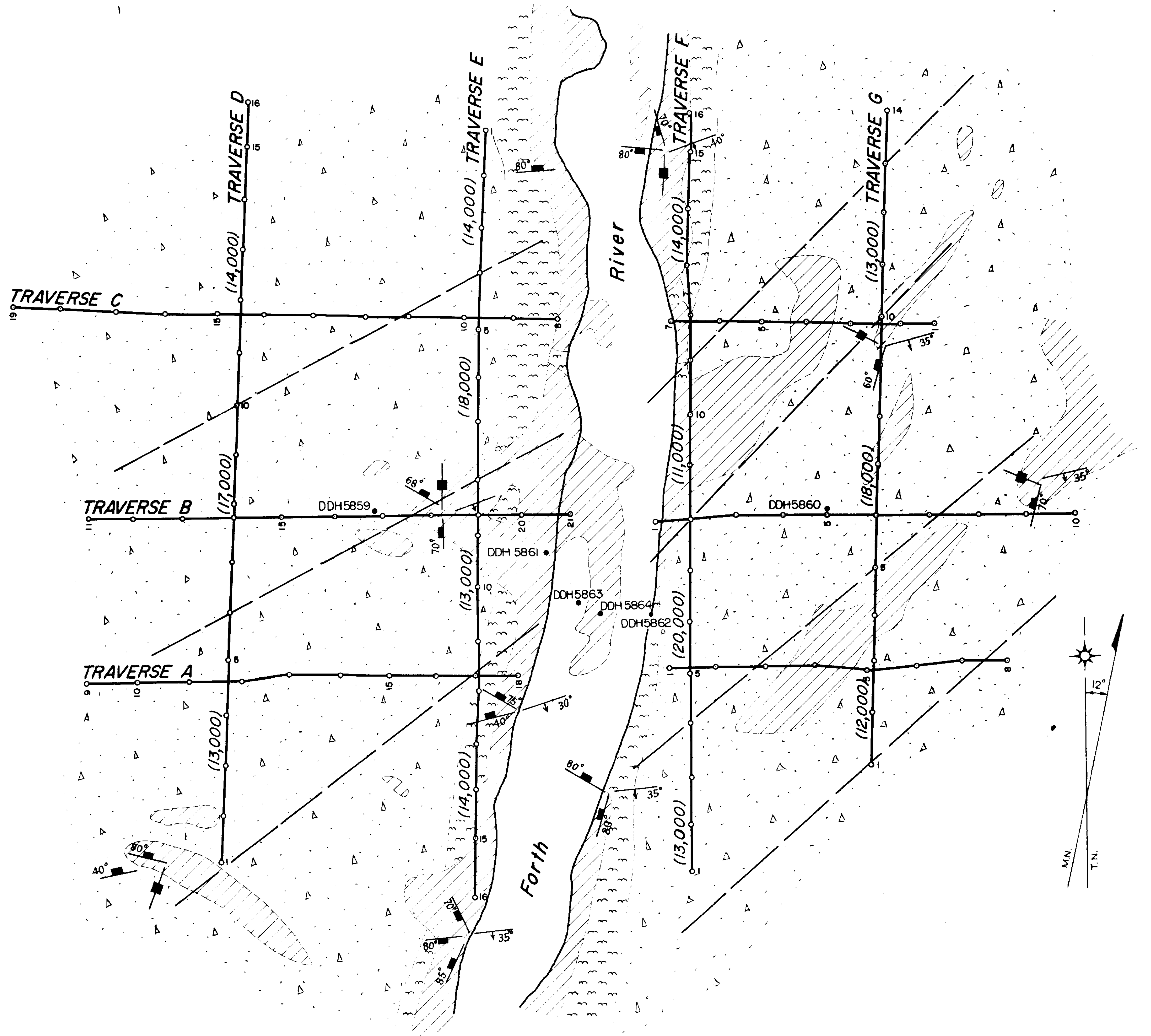
5. CONCLUSIONS

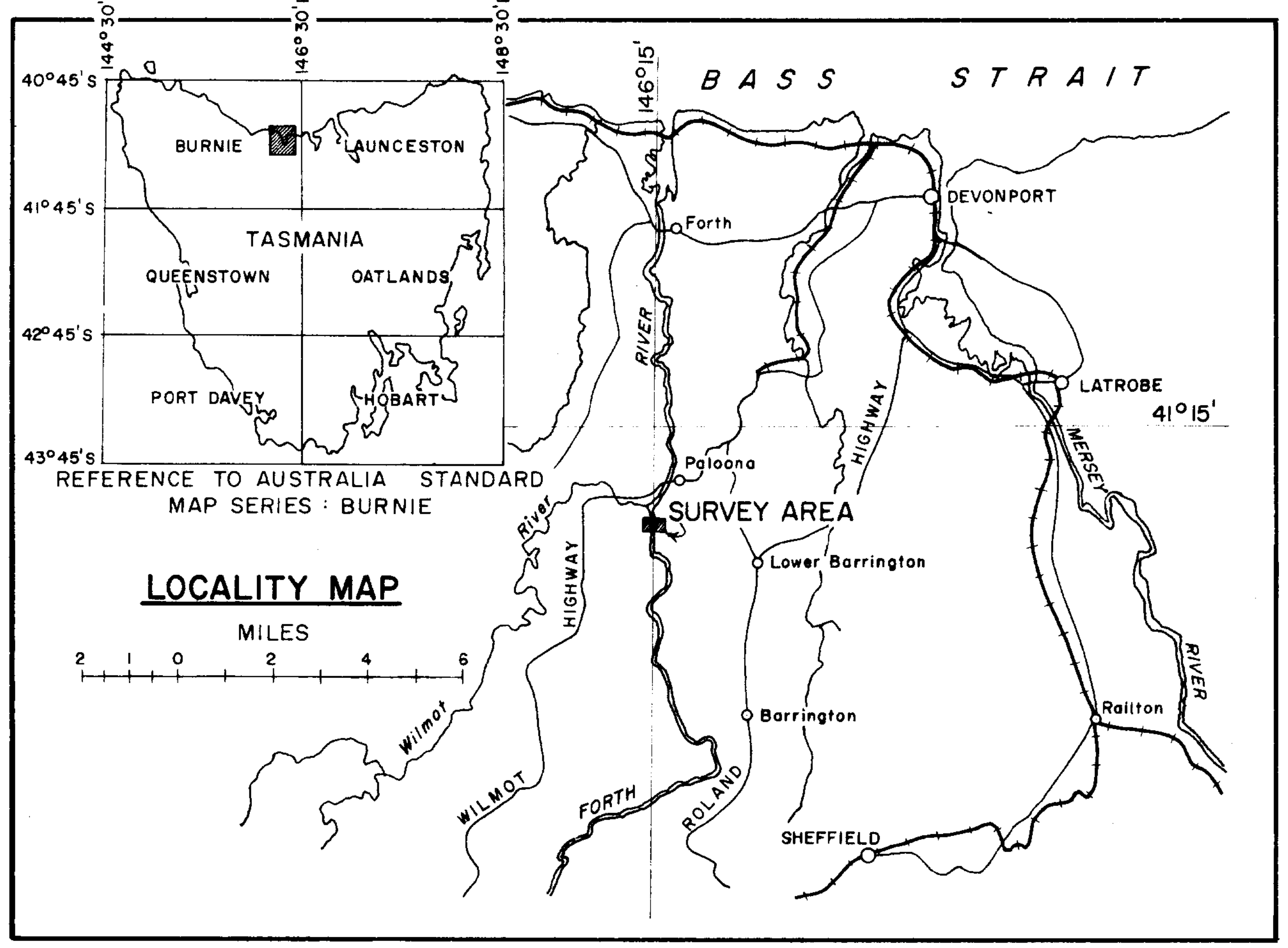
From a comparison of the results on Traverses A, B, and C it appears that the overburden is thinnest along Traverse A. Hence, this seems to be the best locality for a proposed dam site. The seismic velocities in this area indicate that the bedrock is probably suitable for a dam foundation.

6. REFERENCES

HEILAND, C.A.	1946	GEOPHYSICAL EXPLORATION New York, Prentice-Hall Inc.
PATERSON, S.J.	1961	Unpublished maps. HEC
PATERSON, S.J.	1962	Personal communication.
POLAK, E.J.	1962a	Paloona dam site seismic refraction survey, Tasmania 1960. Bur. Min. Resour. Aust. Rec. 1962/67.
POLAK, E.J.	1962b	Barrington (Devil's Gate) dam and power station site seismic refraction survey, Tasmania 1961. Bur. Min. Resour. Aust. Rec. 1962/66.
POLAK, E.J. and MOSS, F.J.	1959	Geophysical survey at the Cluny dam site, Derwent River, Tasmania. Bur. Min. Resour. Aust. Rec. 1959/87.

PLATE I





LEGEND

- Talus
- Alluvium
- Barrington Chert
- Geological boundary
- 35° Bedding
- 60° Joints, dipping
- Joints, vertical
- Geophysical traverse with station No.
- Velocity zones in bedrock
- (12,000) Seismic velocity in ft/sec
- oDDH 5860 Diamond - drill hole

UPPER PALOONA DAM SITE, TASMANIA 1961

SEISMIC REFRACTION SURVEY

GEOLOGY AND TRAVERSE LAYOUT

FEET

100 50 0 100 200 300

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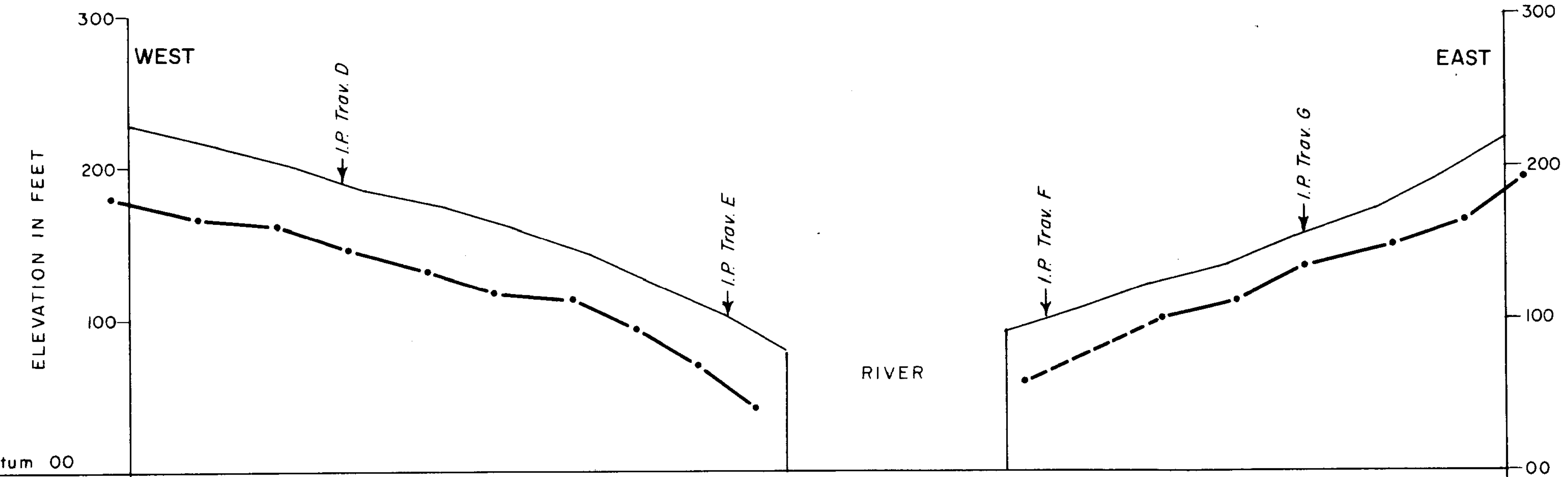
To Accompany Record No 1962/182

UPPER PALOONA DAM SITE TAS. 1961

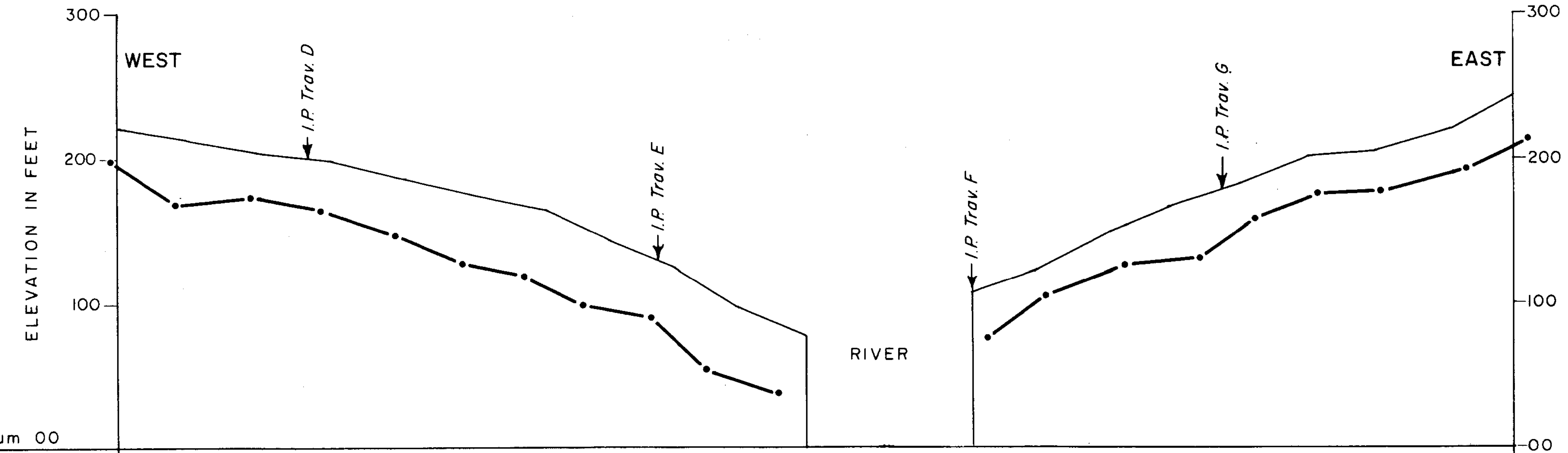
PLATE 2

TRAVERSE A



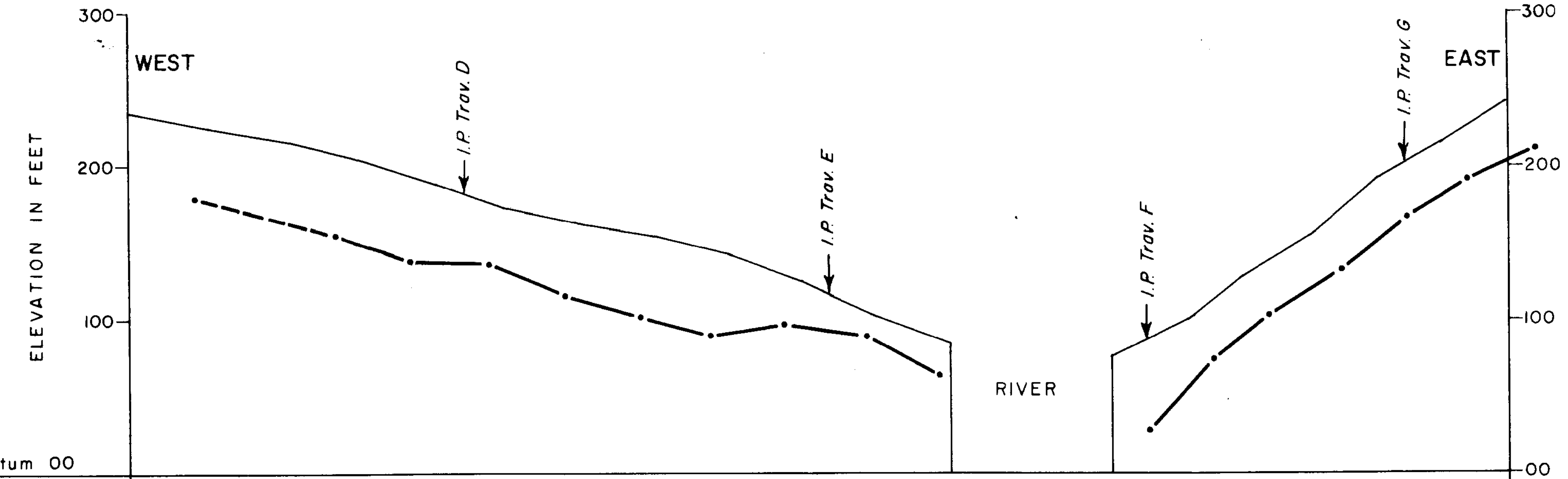
STATION NUMBER	9	10					15			18	1				5			8
STATION ELEVATION	228	213	200	186	173	160	143	123	102	78	91	107	122	135	152	171	195	217
DEPTH TO BEDROCK	50	50	40	40	43	43	31	31	38	41	35		23	23	20	28	33	28

TRAVERSE B



STATION NUMBER	11				15					20	21	2			5					10
STATION ELEVATION	222	214	205	199	188	175	166	143	124	99	77	107	121	149	167	182	200	203	220	243
DEPTH TO BEDROCK	22	46	31	34	40	49	49	49	39	49	44	34	19	24	41	29	26	29	29	32

TRAVERSE C



STATION NUMBER	19				16					10		8	7		5				1
STATION ELEVATION	236	227	217	205	189	173	163	154	143	126	102	86	78	101	129	158	192	217	242
DEPTH TO BEDROCK		46		51	51	38	48	53	53	31	13	22	55	30	30	30	30	30	37

LEGEND

Depths calculated from broadside shots, and plotted approximately perpendicular to surface

I.P. Intersection point

Unweathered bedrock boundary

DDH589 Diamond – drill hole

TRAVERSES A, B, and C

SEISMIC CROSS—SECTIONS

FEET

100 50 0 100 200 300

(Horizontal and Vertical)
Based on HEC Plan A9216

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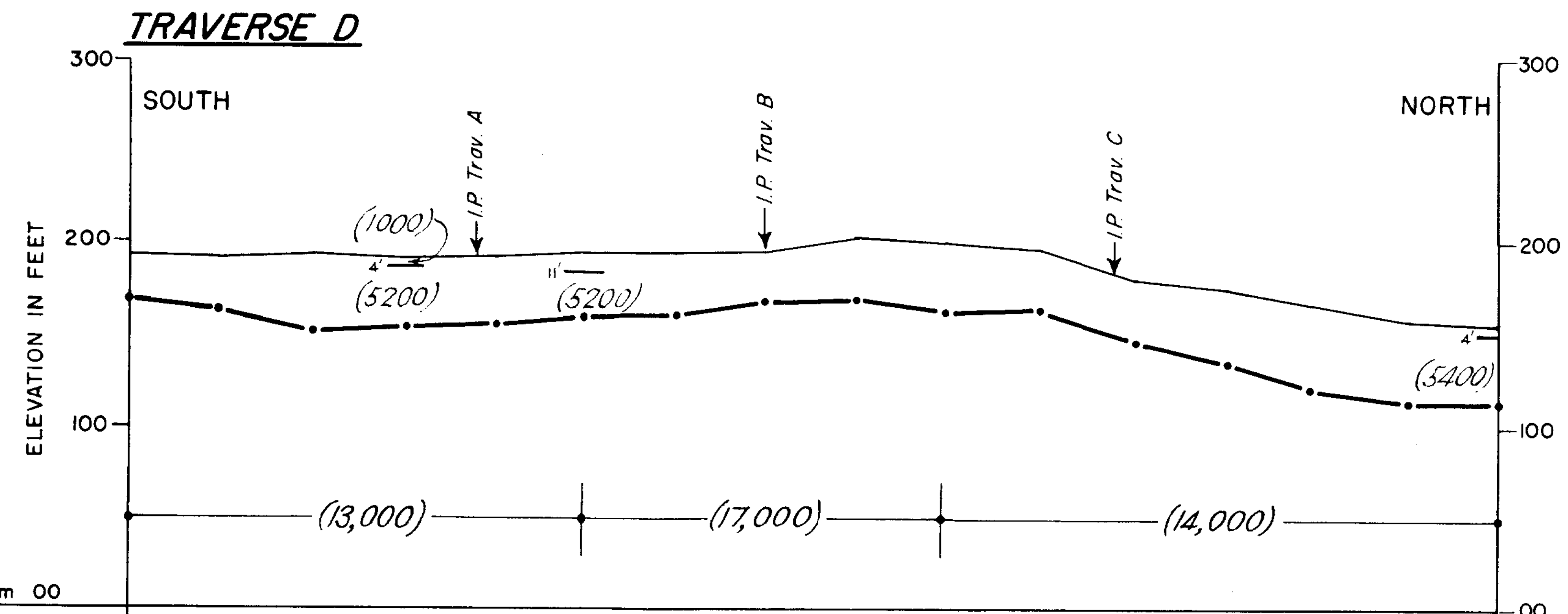
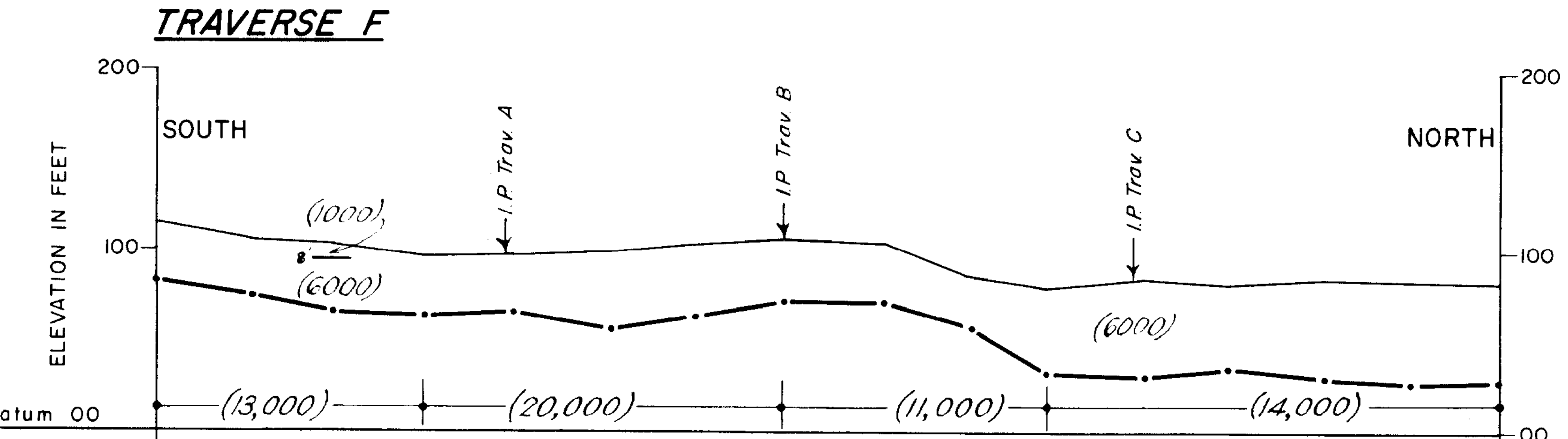
TRAVERSE D



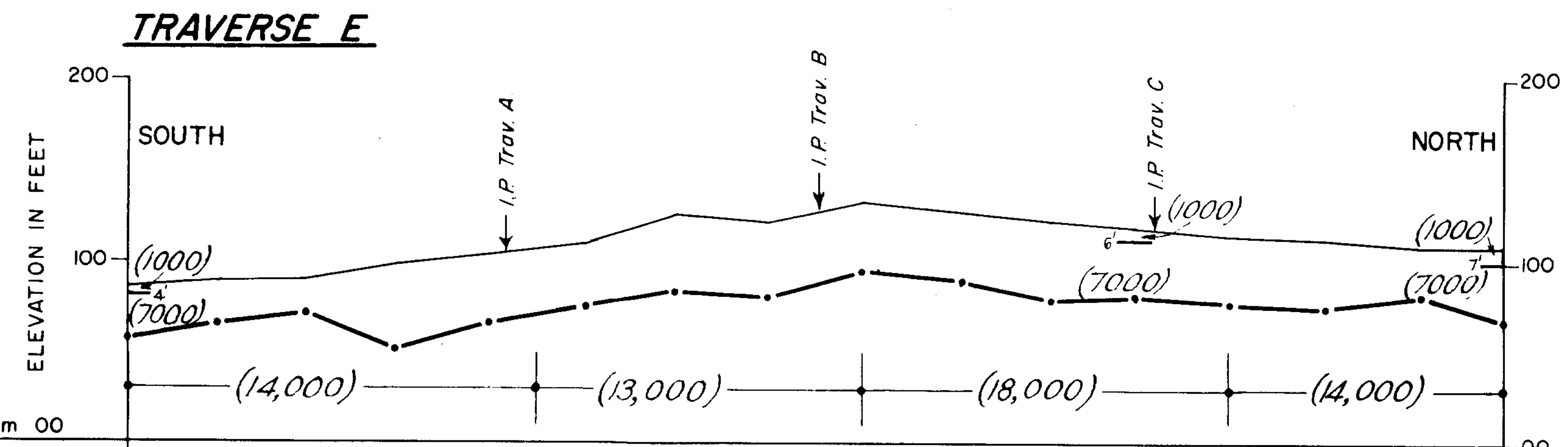
STATION NUMBER	1				5					10					15	16
STATION ELEVATION	194	192	194	191	191	194	194	195	202	200	197	180	175	168	159	157
DEPTH TO BEDROCK	27	29	42	36	36	34	34	28	33	38	34	34	41	48	46	43

TRAVERSE F



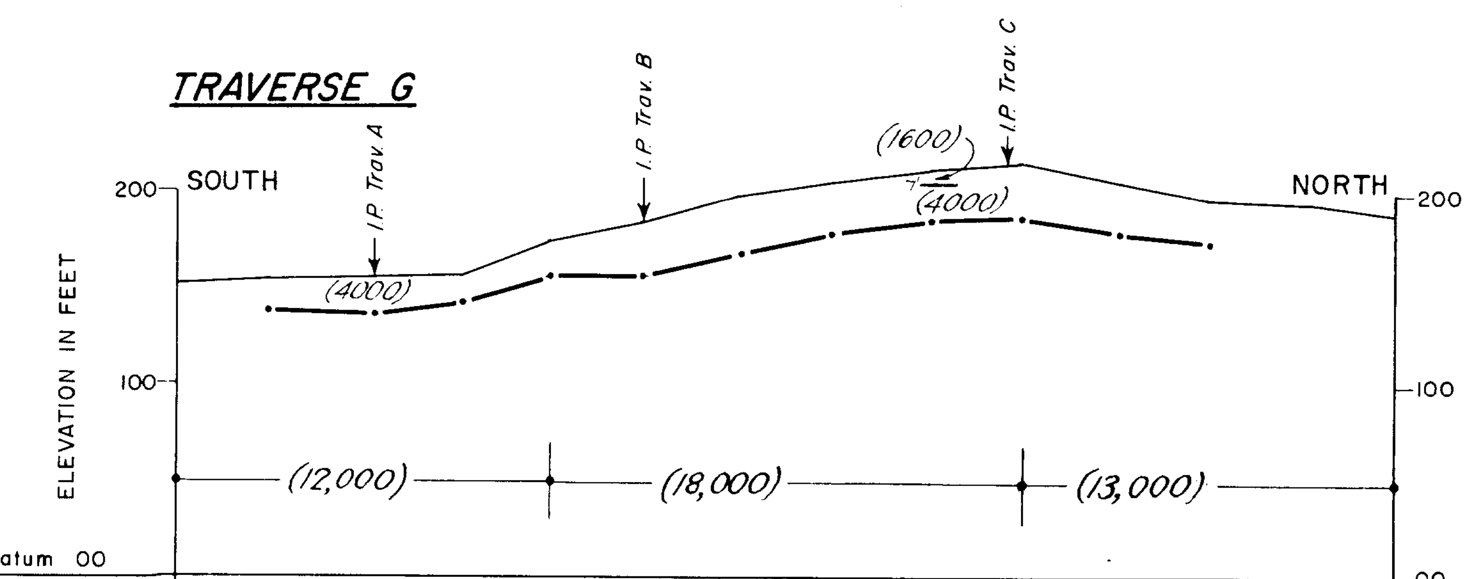
STATION NUMBER	1				5					10					15	16
STATION ELEVATION	113	107	102	97	98	99	102	107	104	86	80	86	82	86	84	83
DEPTH TO BEDROCK	32	32	38	34	32	43	40	36	32	30	48	55	47	55	57	55

TRAVERSE E



STATION NUMBER	16	15					10					5				1
STATION ELEVATION	85	89	90	98	102	110	126	120	131	127	121	118	113	111	108	107
DEPTH TO BEDROCK	28	24	19	47	38	35	42	40	39	39	43	37	36	37	26	40

TRAVERSE G

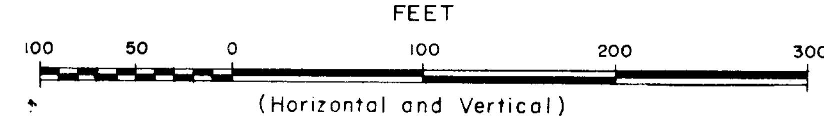


STATION NUMBER	1				5					10				14
STATION ELEVATION	151	154	156	157	174	185	199	206	212	217	206	197	194	190
DEPTH TO BEDROCK		17	20	15	19	29	30	27	27	30	27	23		

LEGEND

(7000)	Formation with seismic velocity of 7000 ft/sec
6' —	Depth to formation with different seismic velocity
I.P.	Intersection point
•——•	Unweathered bedrock boundary

TRAVERSES D, E, F, and G
SEISMIC CROSS – SECTIONS



(Horizontal and Vertical)

Based on HEC Plans A 9251 and B 6394

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