COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1962/67

PALOONA DAM SITE SEISMIC REFRACTION SURVEY, TASMANIA 1960

by

E.J. Polak

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ILLUSTRATIONS

SUMMARY

This Record describes a seismic refraction survey along part of the Forth River near Devonport, Tasmania. The aim of the survey, which was requested by the Hydro-Electric Commission of Tasmania, was to ascertain the depth to the bedrock and the type of bedrock on the site proposed for a dam. The plates show the results in the form of cross-sections along the traverses; a comparison between depth obtained by drilling and by the seismic survey is given.

1. INTRODUCTION

The Hydro-Electric Commission of Tasmania proposes to construct a dam and a power station on the lower reaches of the Forth River near Paloona, on the north coast of Tasmania. The purpose of the dam is to control the flow of the water in the river, in order to prevent the flooding of cultivated land by water released from proposed power stations on the Mersey and Forth Rivers. In addition, it is intended to use the fall of water across the dam for the production of electric power.

The Paloona dam site is located approximately 6 miles up-stream from the mouth of the Forth River. The approximate co-ordinates are 423917 (Devonport sheet of Australia 4-mile series).

The Commission requested the Bureau of Mineral Resources, Geology and Geophysics to investigate the site, the object of the survey being to determine the depth to the bedrock and the nature of the rocks in both bedrock and overburden.

In this report, the term 'bedrock' refers to the deepest refractor with the highest seismic wave velocity. The term 'overburden' refers to river gravel, clay, scree material, and completely or partly weathered rock.

The survey was carried out in May 1960 by a geophysical party consisting of E.J. Polak, party leader, and M.J.W. Duggin, geophysicist. The Commission provided field assistants and carried out topographical surveys.

2. GEOLOGY

The proposed site is situated in a sequence of Cambrian chert, greywacke, argillite, and siltstone on the northern limb of a south-easterly plunging fold. The beds dip eastwards at 40 degrees (Paterson, 1961).

The valley is wide with gently sloping hillsides, blanketed by terraced river gravel and scree material (see Plate 1). On the eastern abutment 40 ft of gravel (at B4 and C27) and 26 ft of scree material (at J5) were found by drilling.

Outcrops of the rocks are mostly confined to the river bed. Drilling indicates that chert underlies the scree material on the western abutment, while greywacke, argillate, and siltstone underlie the gravel and scree material on the eastern abutment.

3. METHODS AND EQUIPMENT

The seismic refraction method of exploration was used. A detailed description of this method has been given by Polak and Moss (1959).

The equipment used was a 12-channel SIE refraction seismograph with TIC geophones of natural frequency about 20 c/s.

4. RESULTS

The total length of surveyed traverses was 17,450 ft. Plate 1 shows the arrangement of the geophysical traverses, and Table 1 gives an interpretation of seismic wave velocities in terms of rock types at the Paloona dam site, as shown by drillers' logs.

TABLE 1

Seismic velocity (ft/sec)	Rock type
1000	Soil
1000 to 2500	River terrace material, talus, not water saturated.
4000 to 5500	River terrace material, talus, water saturated.
3200 to 8000	Very weathered to weathered rock.
8000 to 17,000	Weathered to unweathered bedrock.

The depth to the bedrock, the highest seismic velocity refractor, was calculated by the use of apparent velocity values obtained from weathering spreads. The depths thus calculated are plotted on Plates 2 to 6.

Cross-sections across the river (Traverses A to D, Plates 2 and 3) indicate that the thickness of the overburden increases gradually from the river in an easterly direction, reaching a maximum thickness of 132 ft near station B2. On the left (west) bank of the river the overburden is thinner, reaching a maximum of 75 ft near station B39.

As is shown in Table 1, there is an overlap in the seismic velocities in wet river-terrace material and in the weathered rock, and therefore they cannot be distinguished by seismic work. On Plates 2 to 6, velocities between 4000 ft/sec and 5500 ft/sec indicate either weathered rock or river-terrace material saturated with water.

Table 2 shows a comparison between the thickness of the overburden determined from drilling and from seismic data. The inset on Plate 6 shows a graph in which the depth to the bedrock proved in drilling is plotted against the depth calculated from seismic results.

Seismic velocities measured in the bedrock are indicated on Plate 1. The range of velocities is wide. At the westerly end of Traverse B a velocity of 9000 ft/sec was recorded, indicating a weathered and sheared zone. On the south-easterly part of the area the high velocity of 17,000 ft/sec was recorded near DDH 5854, indicating an unweathered and solid rock.

TABLE 2

Station No.	Drillhole No.	HEC Drilling Interpretation Depth (ft)	Rock Type	Seismic Survey Depth (ft)	Seismic Velocity (ft/sec)
B4	5851	0 - 10	Scree material	1 - 27	1500
		10 - 38	River gravels	27 - 105	4000
		38 - 125	Weathered argillite	105 - 120	8000
	Total depth 165 ft	125 -	Fresh greywacke	120 -	12,000
B17	5852	0 - 10	Scree material	0 - 4	1000
		10 - 21	River gravels	4 - 25	2500
		21 - 60	Weathered greywacke	25 - 53	4000
	Total depth 96 ft	60 -	Hard argillite	53 -	17,000
B32	5853	0 - 15	Weathered chert	0 - 15	1500
	Total depth 51 ft	15 -	Chert	15 - 32	6500
				32 -	12,000
C14	5854	0 - 23	Scree material	0 - 13	1500
		23 - 80	Weathered greywacke	13 - 62	3600
	Total depth 149 ft	80 -	Argillite	62 -	13,000
B39	5855	0 - 3	Scree material	0 - 8	1500
	Total depth 80 ft	3 - 74	Weathered argillite	8 - 75	5500
		74 -	Jointed chert	75 -	11,000
C27	5856	0 - 8	Scree material	0 - 8	1500
		8 - 40	River gravels	8 - 60	3600
	Total depth 111 ft	40 - 81	Weathered greywacke	60 -	13,000
		81 -	Greywacke, argillite		
J5	5857	0 - 26	Scree material	0 - 11	1500
		26 - 83	Weathered greywacke	11 - 89	4000
	Total depth 91 ft	83 -	Greywacke	89 -	13,000

Measurements on cores from a depth of 72 ft in DDH 5852 (Fitzpatrick, 1961) gave Poisson's ratio as 0.24 and the specific gravity as 2.8. Table 3 shows a computation of Young's modulus using the measured values of Poisson's ratio and specific gravity for bedrock generally. The computed figures for Young's modulus are likely to be accurate within 20 per cent.

TABLE 3

Seismic velocity (ft/sec)	Young's modulus lb/in^2
9000	1.9×10^6
12,000	3.7×10^6
15,000	7.3×10^6
17,000	8.5×10^6

5. CONCLUSIONS

The overburden of soil and scree material is thickest along Traverse E. Close to E9 the thickness is about 138 ft. Accuracy of depth determinations is within 20 per cent of depth. Young's modulus for bedrock exceeds 1.9×10^6 lb/in^2.

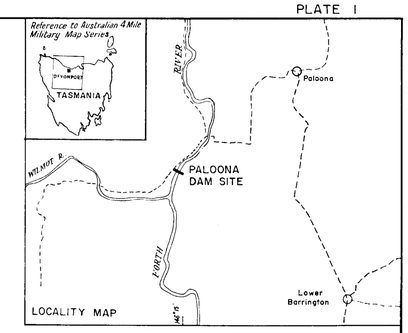
6. REFERENCES

FITZPATRICK, M. 1961 Personal Communication

PATERSON, S.J. 1961 Personal Communication

POLAK, E.J., and MOSS, F.J. 1959 Geophysical survey at the Cluny damsite, Derwent River, Tasmania. Bur. Min. Resour. Aust. Records 1959/87.

PLATE I



REFERENCE

- River Terrace Deposits
- Scree Material
- Chert
- ● D.D.H.5851 Drill Hole
- (12,000) Seismic Velocity in Bedrock 12,000 ft/sec

PALOONA DAM SITE, TASMANIA

SEISMIC REFRACTION SURVEY 1960

GEOLOGY AND TRAVERSE LAYOUT

GEOLOGY AFTER S.J. PATERSON

SCALE IN FEET

100 0 100 200 300

After H.E.C. Map A 7632

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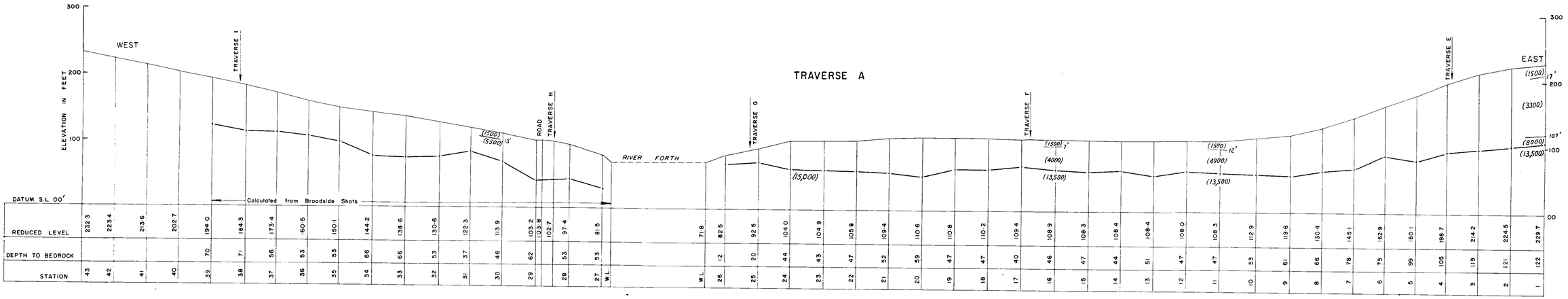
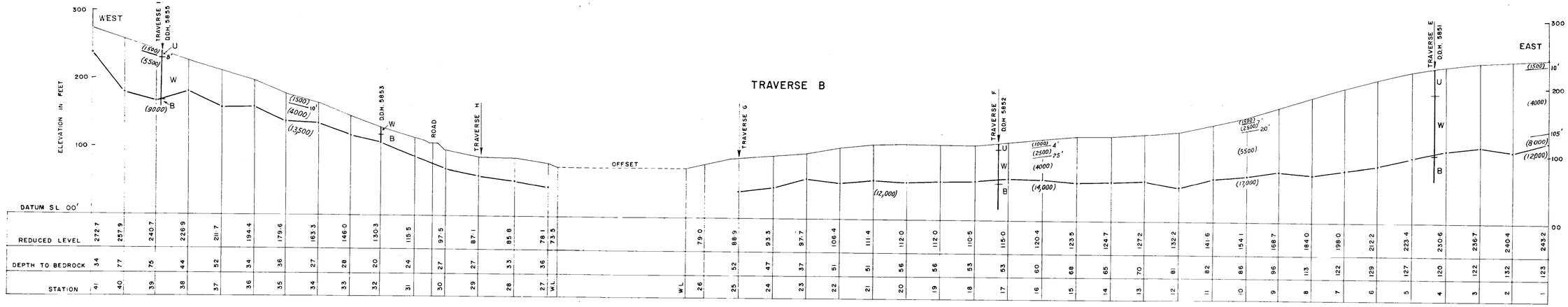
PLATE 2





LEGEND

- BEDROCK
- (12,000) SEISMIC VELOCITY (ft/sec)
- 12' DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY
- DRILL HOLE SECTION
  - U UNCONSOLIDATED
  - W WEATHERED ROCK
  - B BEDROCK

PROFILES A AND B

SCALE IN FEET

100 0 100 200 300

After H.E.C. Dwgs. A 7718 and A 7719

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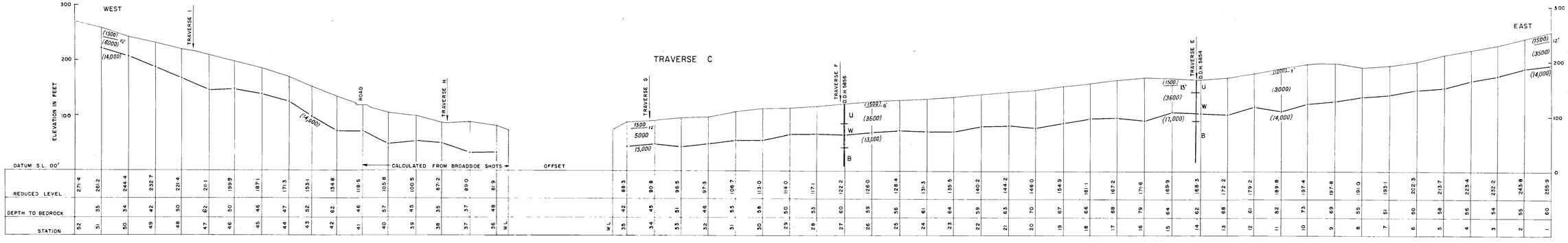
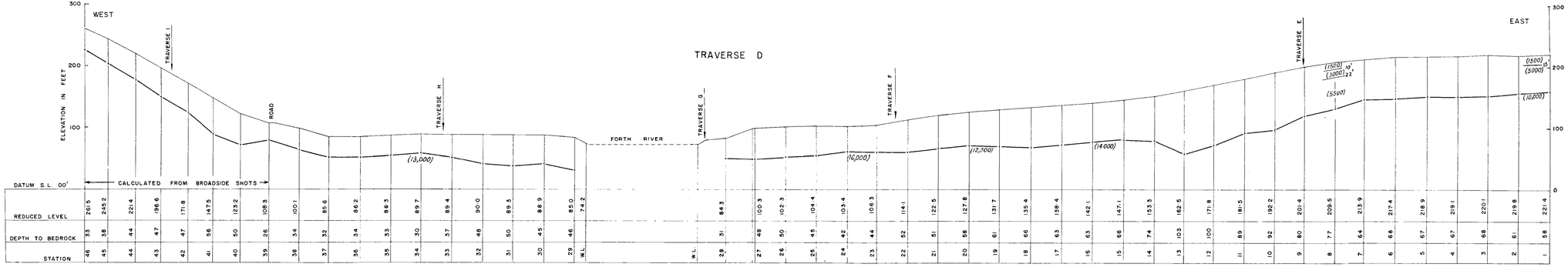
PALOONA D-SITE TAS. 1960

PLATE 3





LEGEND

BEDROCK

(10,000) SEISMIC VELOCITY (ft/sec.)

8' DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY

DRILL HOLE SECTION
U Unconsolidated
W Weathered
B Bedrock

PROFILES C AND D

SCALE IN FEET

100 0 100 200 300

After H.E.C. Dwgs. A 7721 & A 7739

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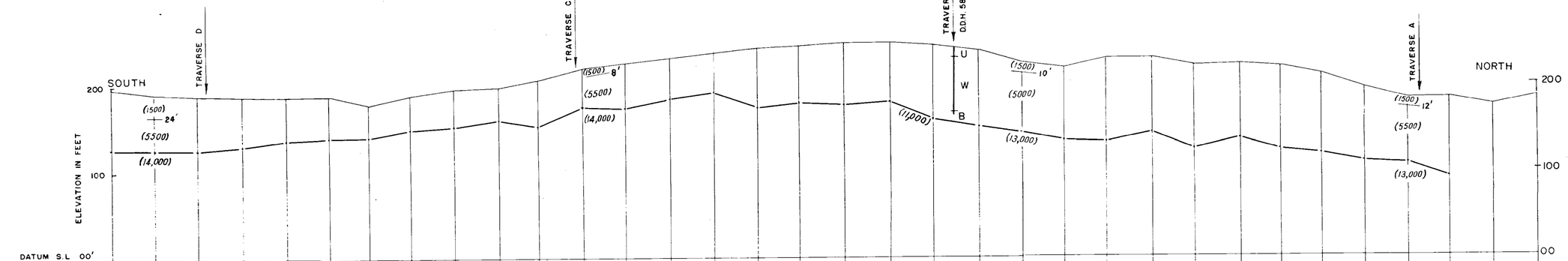
PALOMA D-SITE TAS. 1960

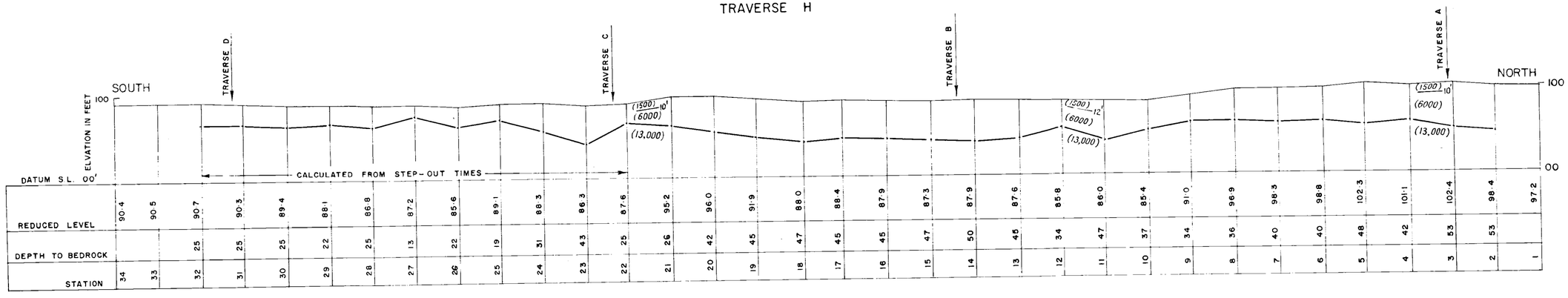
TRAVERSE I



DATUM S.L. 00'

STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
REDUCED LEVEL	195.7	190.4	187.5	186.1	186.0	187.0	176.6	187.3	194.5	196.6	205.6	218.3	224.0	230.4	235.9	241.5	244.6	246.7	247.0	244.2	237.6	224.2	218.1	229.5	228.7	220.2	222.0	219.5	210.6	194.6	182.3	182.7	173.8	183.8
DEPTH TO BEDROCK	67	68	64	54	50	47	37	36	43	34	53	47	51	50	45	68	65	72	70	84	69	81	85	96	88	97	87	95	94	82	75	92	53	34

TRAVERSE H



DATUM S.L. 00'

STATION	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
REDUCED LEVEL	90.4	90.5	90.7	90.3	89.4	88.1	86.8	87.2	85.6	89.1	88.3	86.3	87.6	95.2	96.0	91.9	88.0	88.4	87.9	87.3	87.9	87.6	85.8	86.0	85.4	91.0	96.9	98.3	98.8	102.3	101.1	102.4	98.4	97.2
DEPTH TO BEDROCK			25	25	25	22	25	13	22	19	31	43	25	26	42	45	47	45	45	47	50	45	34	47	37	34	36	40	40	48	42	53	53	

LEGEND

- BEDROCK
- (12,000) SEISMIC VELOCITY (ft/sec.)
- 10' DEPTH TO FORMATION WITH DIFFRENT SEISMIC VELOCITY

DRILL HOLE SECTION

- U UNCONSOLIDATED
- W WEATHERED
- B BEDROCK

PROFILES I AND H

SCALE IN FEET

100 0 100 200 300

AFTER H.E.C. DWGS. A7746 & A7744

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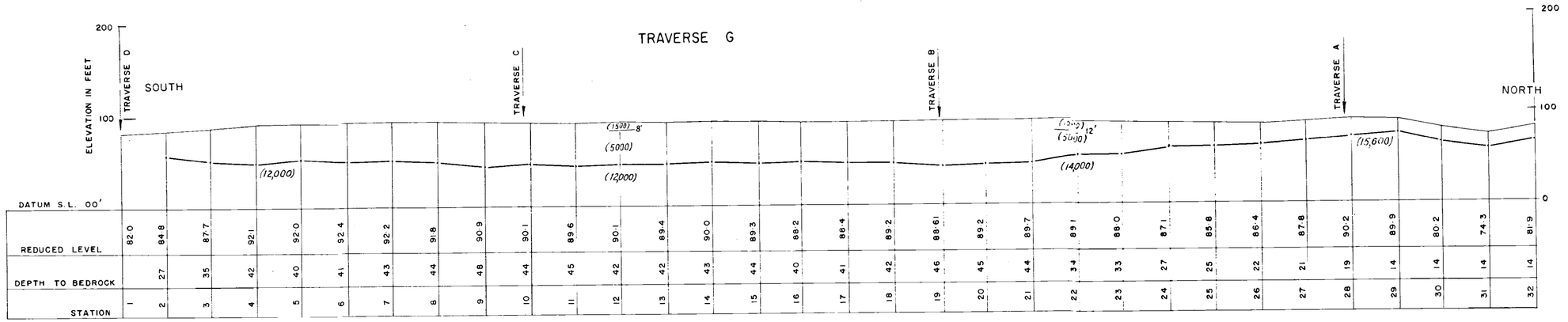
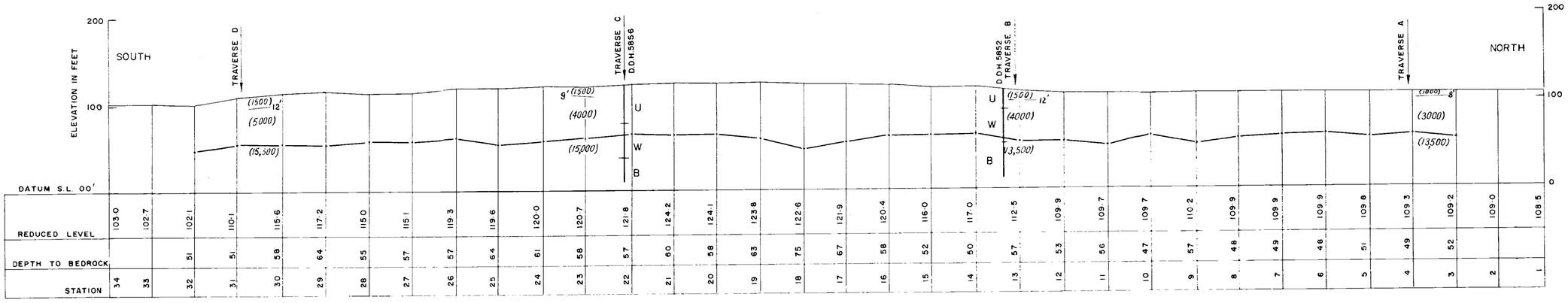
PALOONA D SITE, TAS., 1960

TRAVERSE G



STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
REDUCED LEVEL	82.0	84.8	87.7	92.1	92.0	92.4	92.2	91.8	90.9	90.1	89.6	90.1	89.4	90.0	89.3	88.2	88.4	89.2	88.61	89.2	89.7	89.1	88.0	87.1	85.8	86.4	87.8	90.2	89.9	80.2	74.3	81.9
DEPTH TO BEDROCK		27	35	42	40	41	43	44	48	44	45	42	42	43	44	40	41	42	46	45	44	34	33	27	25	22	21	19	14	14	14	14

TRAVERSE F



STATION	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
REDUCED LEVEL	103.0	102.7	102.1	110.1	115.6	117.2	115.0	115.1	119.3	119.6	120.0	120.7	121.8	124.2	124.1	123.6	122.6	121.9	120.4	116.0	117.0	112.5	109.9	109.7	109.7	110.2	109.9	109.9	109.9	109.8	109.3	109.2	109.0	108.5
DEPTH TO BEDROCK			51	51	58	64	55	57	57	64	61	58	57	60	58	63	75	67	58	52	50	57	53	56	47	57	48	49	48	51	49	52		

LEGEND

- BEDROCK
- (15,000) SEISMIC VELOCITY (ft/sec.)
- 12' DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY
- DRILL HOLE SECTION
  - U UNCONSOLIDATED
  - W WEATHERED
  - B BEDROCK

PROFILES G AND F

SCALE IN FEET

100 0 100 200 300

AFTER H.E.C. DWGS. A7743 & A7742

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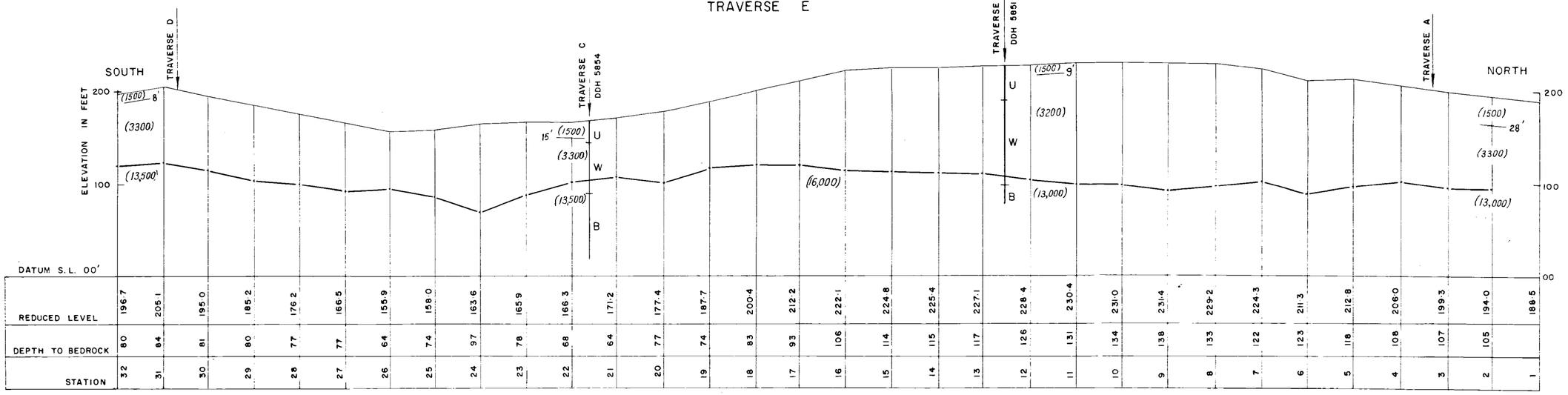
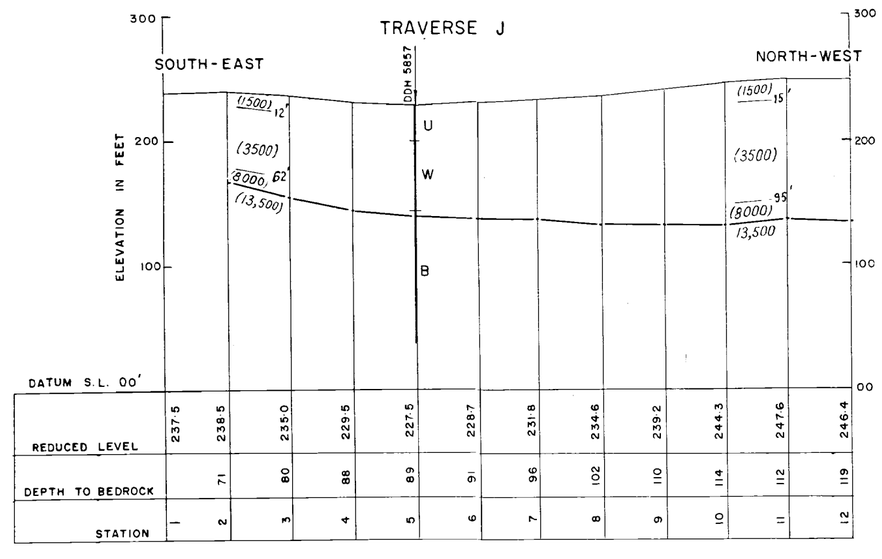
PALOONA DAMSITE, TAS., 1960

TRAVERSE E

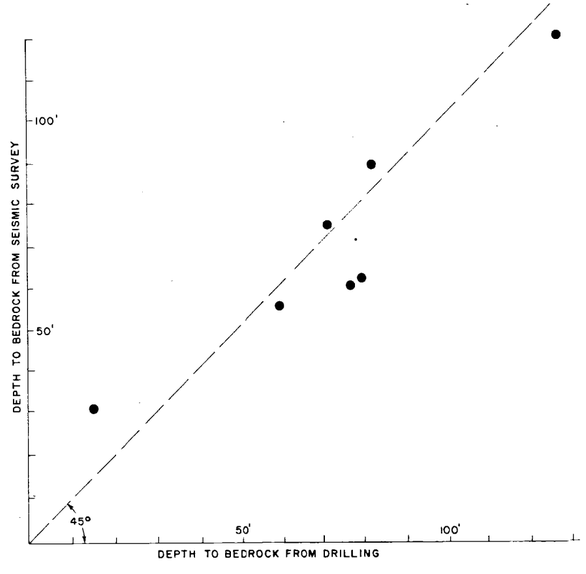


STATION	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
REDUCED LEVEL	196.7	205.1	195.0	185.2	176.2	166.5	155.9	158.0	163.6	165.9	166.3	171.2	177.4	187.7	200.4	212.2	222.1	224.8	225.4	227.1	228.4	230.4	231.0	231.4	229.2	224.3	211.3	212.8	206.0	199.3	194.0	188.5
DEPTH TO BEDROCK	80	84	81	80	77	77	64	74	97	78	68	64	77	74	83	93	106	114	115	117	126	131	134	138	133	122	123	118	108	107	105	

TRAVERSE J



STATION	1	2	3	4	5	6	7	8	9	10	11	12
REDUCED LEVEL	237.5	238.5	235.0	229.5	227.5	228.7	231.8	234.6	239.2	244.3	247.6	246.4
DEPTH TO BEDROCK		71	80	88	89	91	96	102	110	114	112	119



COMPARISON OF DRILLING AND SEISMIC DATA

LEGEND

- BEDROCK
- (13,000) SEISMIC VELOCITY (ft/sec.)
- 9' DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY

DRILL HOLE SECTION

- U UNCONSOLIDATED
- W WEATHERED
- B BEDROCK

PROFILES E AND J

SCALE IN FEET

100 0 100 200 300

AFTER H.E.C. DWGS. A7741 & A7748

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PALOOWA O-SITE, TAS, 1960