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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1963/150

LAKE MACKENZIE POWER DEVELOPMENT SCHEME SEISMIC SURVEYS,

TASMANIA

1962

by

P.E. MANN, E.J. POLAK, and J.T.G. ANDREW

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SUMMARY

This Record covers surveys made for the Lake Mackenzie power development scheme for the Hydro-Electric Commission of Tasmania. Surveys were carried out on a dam site, canal and flume line, tunnel, and penstock line. The depth to bedrock and the nature of the bedrock were determined.

1. INTRODUCTION

The Hydro-Electric Commission of Tasmania proposes to construct a dam at the western edge of Lake Mackenzie where the Fisher River flows out of the lake. The impounded water will be taken by canal, flume, tunnel, and penstock line to a power station on the Fisher River (Plate 1).

In response to an application from the Commission, the Bureau of Mineral Resources, Geology and Geophysics, carried out seismic surveys to determine the nature of the overburden and the bedrock, and the depth to bedrock at the dam site, canal, tunnel, and penstock lines in March, April, and May 1962. The survey of the penstock line was made by a geophysical party consisting of E.J. Polak (geophysicist and party leader), J.T.G. Andrew (geophysicist), and J.P. Pigott (geophysical assistant). The survey of the canal line was made by P.E. Mann (geophysicist and party leader), J.T.G. Andrew, and J.P. Pigott. The survey of the dam site was made by P.E. Mann and partly by J.T.G. Andrew. D. Hansen, a geologist of the Commission, assisted the party throughout the survey. The Commission provided additional field assistants and carried out the topographical survey along the traverse lines.

The total length of traverses surveyed by the seismic refraction method is shown in Table 1.

TABLE 1

Project		Length of seismic traverse (ft)
Lake Mackenzie dam site		9900
Lake Mackenzie canal and flume line		26,400
Fisher River penstock line		21,800
	Total	58,100

2. GEOLOGY

The general geology of the area (Plate 1) is shown on the Middlesex sheet of the one-mile geological series, and has been described by Ford (1957) and Mather (1956). An examination of the dam site, canal, and penstock line has been made by Mather (1962) and the results were presented on HEC sketch maps GS 27, GS 28, and GS 30. Information from these maps is incorporated in Plates 2, 5, and 8 of this Record and is discussed in later sections.

The stratigraphy of the area (after Ford, 1956 and Mather, 1956 is shown in Table 2.

TABLE 2

Age	Group	Rock Type
Recent		talus and scree material
Pleistocene		till, moraine material
Tertiary		basalt
Jurassic		dolerite
Triassic	Knocklofty Group	sandstone, shale
Permian	Ferntree Group	mudstone, conglomerate
	Woodbridge glacial formation	shale, sandstone
	Liffey Group	sandstone
	Golden Valley Group	conglomerate, mudstone
	Quamby Group	mudstone
	Conglomerate	conglomerate
Precambrian		quartzite, slate, phyllite, and schist

3. METHODS AND EQUIPMENT

A detailed description of the seismic method has been given by Polak and Moss (1959). The method of differences was used on all seismic traverses.

On the penstock-line survey, the seismic equipment used consisted of Midwestern and SIE 12-channel refraction seismographs, with Midwestern and TIC vertical geophones having natural frequencies of 8 c/s and 20 c/s respectively, and a 24-channel SIE camera.

The canal line and dam site were surveyed with the SIE seismograph and camera, an Electro-Tech 'Seismod' display unit, and TIC geophones.

4. DAM SITE

Location and geology

The Lake Macknezie dam site is at the western edge of Lake Mackenzie where the Fisher River flows out of the lake. The approximate coordinates are 434867 on the Burnie sheet of the Australia 1:250,000 map series.

At the outlet of the lake the river flows through a gently sloping area about 2300 ft wide, which forms the valley floor between outcrops of dolerite on the valley sides (Plate 2). The river has cut several feet into a cemented till that underlies part of the valley floor. Dolerite crops out at several places in the valley, but elsewhere it is covered by the cemented till. The left bank is a steep slope, partly covered by talus and scree material. The right bank has a gentler slope, the talus material is less abundant, and the scree material absent.

The valley floor is covered by dolerite blocks, mostly less than 3 ft in diameter, in a matrix of sand, clay, and dolerite fragments. The badly-sorted material overlies the cemented till, and may be considered to be either weathered till, or unconsolidated glacial material deposited later.

No test drilling has been done at the dam site. A series of test pits dug in 1922 generally stopped on the cemented till. The geological information obtained from the test pits is given in the Appendix.

The dolerite bedrock is probably jointed, as is the rest of the dolerite in this area. The steep left side of the valley is probably due to faulting.

Seismic results

Plate 2 shows the layout of the seismic traverses. Table 3 lists the interpretation of the seismic velocities in geological terms, based on the known rock types occurring and on experience from previous seismic surveys in areas with similar geology.

TABLE 3

Seismic velocity (ft/sec)	Rock type
500 - 1000	Soil, clay, silt and sand with dolerite fragments
2300 - 4750	Partly weathered, cemented till
3600	Water-saturated lake deposits
7000 - 11,500 ±	Weathered to partly weathered dolerite. Possibly cemented till around 7000 ft/sec
12,500 - 14,000	Slightly weathered dolerite in shear zone.
15,500 - 22,000	Jointed to unweathered dolerite bedrock.

The seismic velocity in the unweathered till overlaps the velocity in weathered dolerite. There is a lack of information on the seismic velocities in the near-surface layers at the dam site because the survey was suspended, owing to adverse weather conditions, before all the proposed seismic work was completed. The uncertainty in the near-surface velocity distribution decreases the accuracy of bedrock depth determination.

Plates 3 and 4 show the seismic cross-sections, which are self-explanatory. Rocks in which the seismic velocity is greater than 7000 - 8000 ft/sec are probably strong enough to serve as foundations for a gravity dam. As the depth to rock with intermediate velocities was determined at only a few localities, at many stations on the seismic traverses the depth to suitable foundation rock may be less than that indicated on the seismic profile.

On Plate 2 the velocity in the deepest refractor recorded is plotted on the seismic traverses. A low-velocity zone is shown between F35 and F38 and between G17 and G20. This is interpreted as a shear zone in the bedrock. Between G1 and G5, and F12 and F17, low velocities suggest the presence of another shear zone.

At the intersection of Traverses D and F, the velocities along D and F are 17,000 and 14,000 ft/sec respectively. Another example of velocity anisotropy occurs at the intersection of Traverse D and G.

Generally velocity anisotropy in jointed rocks is explained by assuming that the velocity in rock parallel to joint planes is greater than the velocity in a direction across the joint planes. This explanation of velocity anisotropy shown along Traverse D and F would be valid if the shearing mechanism produced joints with a predominant north-easterly strike in the shear zone.

The depth to bedrock on Traverse E is about 15 ft between E21 and E31; at E18 it is 66 ft. This step in the bedrock may be of use in the design of the dam. The low-velocity layer at the same locality is interpreted as a lake deposit.

Conclusions

To check the rock in the shear zone located between F35 and F38, and G17 and G20, drill holes are recommended at G19 and F37. To check the nature of rocks with intermediate velocities, which may still be strong enough to serve as foundations, drill holes are recommended at F12, F23, H14, and F8. Drill holes at E19 and E21 would check the structure of the bedrock in this area.

The accuracy of bedrock depth determinations in this survey is probably no better than ± 25 percent.

5. CANAL, FLUME, AND TUNNEL LINE

Location and geology

Water impounded at Lake Mackenzie will be taken by canal and flume in a direction approximately following the 3600-ft contour north of the Fisher River to PH1 (Plate 5) near the tunnel inlet portal. From here the water will be taken by tunnel to the edge of the Great Western Tiers. There is a site for a possible subsidiary dam at the southern end of Lake Yeates, which is an alternative arrangement to a canal round the north of the lake (Plate 5).

The rock types on the traverse lines consist of glacial deposits, dolerite outcrops, and talus and scree material. Near PH 422 there are small scarps adjacent to the traverse. West of Lake Yeates for about a mile the traverse is over an open, gently-sloping area of glacial deposits and scattered dolerite outcrops. Further west down to the tunnel portal the slopes are steeper and the dolerite outcrops more abundant.

Seismic results

Plate 5 shows the layout of the seismic traverses. Table 4 gives an interpretation of the velocities in geological terms, based on the known rock types occurring and previous experience in other areas.

TABLE 4

Seismic velocity (ft/sec)	Rock type
700 - 1400	Peaty soil, clay with dolerite boulders
2000 - 3500	Weathered glacial deposits, talus and scree material
4000 - 7500	Weathered, jointed dolerite
7500 - 13,000	Moderately weathered, jointed dolerite
13,000 - 22,000	Slightly weathered to unweathered dolerite bedrock.

The seismic results are plotted as cross-sections on Plates 6 and 7.

The depth to bedrock is less than 20 ft between PH 207 and 213, PH 200 and 203, PH 180 and 199, PH 163 and 167, PH 89 and 115, PH 67 and 71, DS 2 and 7, and DS 35 and 40. Elsewhere the bedrock is more than 20 ft deep but layers above the bedrock with intermediate velocities of 7000 to 11,000 ft/sec could possibly be used to line the canal. The places where intermediate velocities were determined are widely spaced and the interpolated depths are not reliable.

The 9000-ft/sec layer on Traverse DS may be strong enough to serve as the foundation of a gravity dam. The maximum depth determined for this layer is 29 feet near DS51.

The topography suggests a shear zone with an east-south-east strike near Traverse PY. The traverse is roughly parallel to the shear zone and the velocity in bedrock is only 12,500 ft/sec. Probably the 9000-ft/sec intermediate layer between 13 and 30 feet will be good rock for tunnelling.

Conclusions

The depth to bedrock on the Lake Mackenzie canal flume, and tunnel line is less than 20 ft on about 10 percent of the surveyed traverse.

The depth to rock that may be suitable for a dam is about 8 ft for three-quarters of the dam-site Traverse DS, and probably not more than 30 ft for the remainder of the traverse.

Test drilling to determine the nature of the layer in which the velocity is between 7500 and 13,000 ft/sec, interpreted as weathered dolerite which probably could be used for the design of canal, dam, and tunnel, is recommended at the following localities: PH 384, PH 319, PH 282, PH 233, PH 173, PH 159, PH 3, PY 68, and DS 7. Further test drilling to determine the nature of the layer in which the seismic velocity is about 4000 to 6500 ft/sec and to supply information at some points on the traverse where the seismic velocity distribution has not been determined, is recommended at the following localities: PH 422, PH 408, PH 372, PH 247, PH 204, PH 132, PH 119, PH 79, PH 52, and PH 38.

6. PENSTOCK LINE (FISHER RIVER)

Location and geology

Water from the tunnel will flow down the penstock line to a proposed power station in the Fisher valley.

The Fisher river valley is in Precambrian quartzite, schist and phyllite(Plate 8). This is overlain unconformably by flat Permian sediments, which are overlain by Jurassic dolerite. Along most of the proposed penstock line there is a cover of talus material over the solid rock (Mather, 1962).

Seismic results

The location of the seismic traverses is shown on Plate 8.

The results are shown on Plates 9 to 13. Table 5 gives an interpretation of the velocities in geological terms based on the known rock types occurring in the area and on experience from previous seismic surveys in areas with similar geology.

TABLE 5

Seismic velocity (ft/sec)	Rock type
1000 - 2000	soil
2500 - 5000	talus and scree material
6000 - 9500	weathered rock
8000 - 8500	Permian bedrock
10,000 - 12,000	jointed Jurassic dolerite
11,000 - 20,000	Precambrian bedrock

From the seismic velocities in the lowest refractor it may be inferred that on Traverse A the Precambrian extends from A 281 to A 65, and that the bedrock consists of Permian sediments from A 65 to A 97. From A 97 to A 108 the bedrock consists of Jurassic dolerite (see Plate 8).

The thickness of talus and scree material increases from zero at A 59 to 112 ft at A 94, then decreases to 30 ft at A 107.

Two alternative routes were surveyed from A1 to the river. The overburden is much deeper on the line from A 165 to A 190(Plate 13) than on the line from A 248 to A 281 (Plate 9).

Table 6 gives a comparison of drilling and seismic results. All drill holes were sited on geological evidence prior to the geophysical survey.

TABLE 6

Drillhole			Seismic		
No.	Depth (ft)	Rock type	Station	Depth (ft)	Seismic velocity (ft/sec)
5901	0-40	scree and talus material	252	0-3	1600
	40-47	weathered phyllite		3-43	3300
	47-	fresh phyllite		43-	11,500
5903	0-66	scree and talus material	99	0-80	2600
	66-	fresh dolerite		80-	12,000
5904	0-20	scree and talus material	107	0-40	3000
	20-	fresh dolerite		40-	12,000
5905	0-75	talus material	77	0-70	4000
	75-	mudstone and sandstone		70-200	6000
				200-	8500

Conclusions

Two possible routes for the penstock line from A1 have been compared. The line from A 248 to A 281 is preferred as there is less overburden along it. The upper limits of the Precambrian and Permian are at A 65 and A 97 respectively. The low velocity in the Jurassic dolerite suggests that it is strongly jointed.

7. REFERENCES

FORD, R.J.	1956	Geological report on 10 - Kiloyard Sheet 4286, Fisher River area. H.E.C. Report (unpubl.)
MATHER, R.P.	1956	Geological report on map square 4356, The Lake Mackenzie area. HEC Report 644 - 170 - 3. (unpubl.)
MATHER, R.P.	1962	Private communication.
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 (unpubl.)

APPENDIX

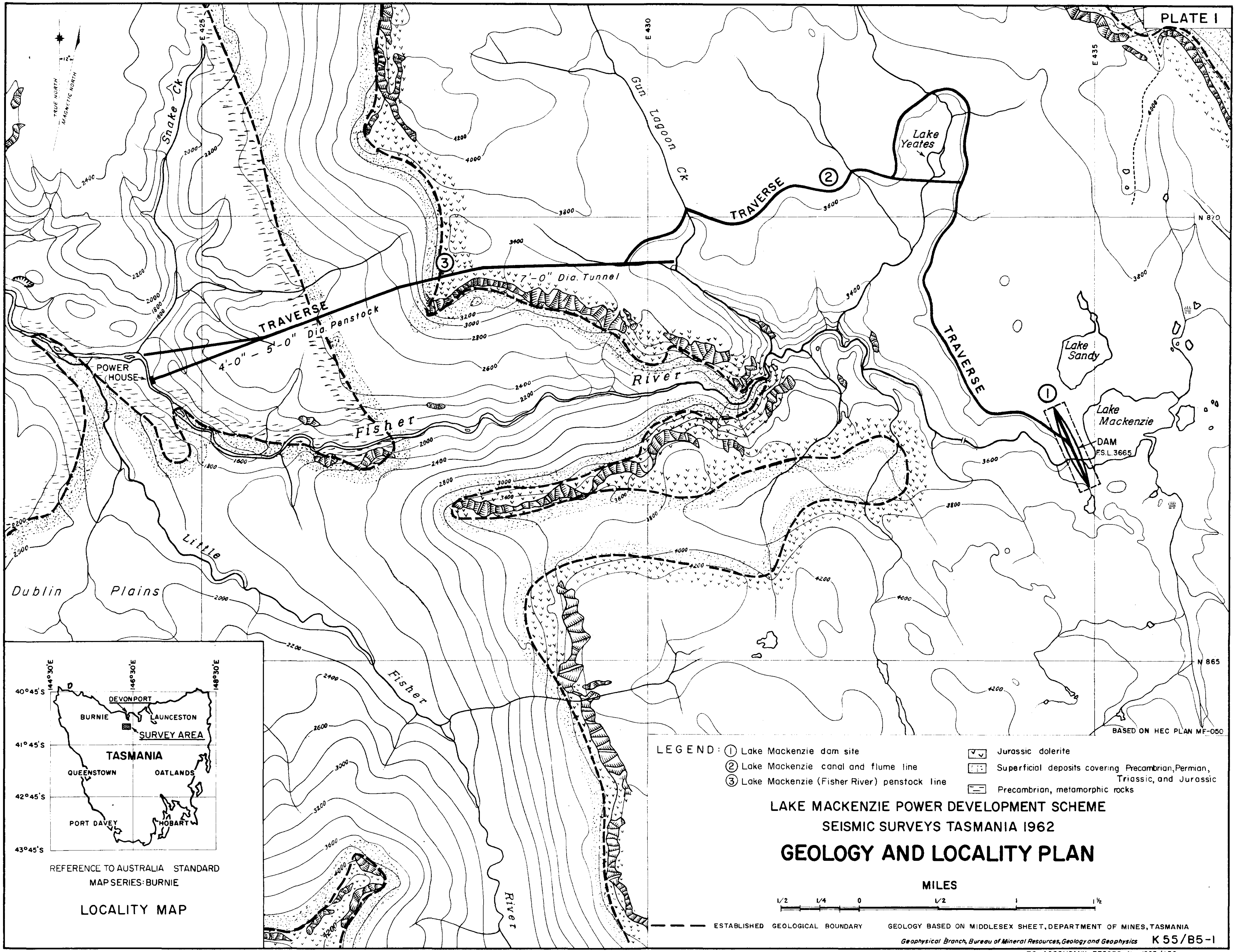
Summary of information obtained from tests pits at the Lake Mackenzie dam site

The old test pits were dug in 1922 at the time the area was mapped by Loftus Hills. The asterisks indicate information prepared in 1922. Information obtained by Mather (1956) is also included.

Pit No.		Information
0		Dark peaty soil with clay and fine sand overlying brownish clay with sand and dolerite fragments up to 3 in. Fragments of cemented till on the dump.
	*	Depth 6 ft, broken rock.
1		As for Pit 0.
	*	Depth 5 ft, cemented till and pug.
2		As for Pit 0.
	*	Depth 6 ft, cemented till, gravel, and loose rocks.
3		As for Pit 0. No cemented till on the dump.
	*	Depth 2 ft, on boulder of mudstone. (The mudstone is interpreted as similar to the hardened clay found on the dump of Pit 8A).
4		Topsoil and dump removed by flooding of the river, otherwise as for Pit 0. Water at 1 ft in the pit.
	*	Depth 2 ft, cemented till (porous), mudstone.
5		As for Pit 4.
	*	Depth 3 ft, mudstone.
6		As for Pit 7.
	*	Depth 3 ft, cemented till and mudstone.
6A		Dark topsoil overlying brownish yellow clay with sub-angular weathered dolerite fragments. Dolerite gravel on the dump.
	*	Depth 3 ft, rock (?) probably cemented till.
7		Yellowish brown clay with dolerite fragments, partly consolidated. Cemented till on the dump.
	*	Depth 4 ft, cemented till, mudstone, clays, rocks.
7A		As for Pit 6A
	*	Depth 3 ft, cemented till.
8		Light brown clay, cemented till on the dump
	*	Depth 4 ft, solid rock.
9		Orange clay with dolerite fragments. Cemented till on the dump.
	*	Depth 4 ft, conglomerate
9A		Yellow fine sandy clay with dolerite fragments
	*	Depth 5 ft, cemented till

Pit No.		Information
10		As for Pit 12
	*	Depth 6 ft, solid rock
10A	*	Depth 6 ft, cemented till
11		Fragments of hardened clay (mudstone) but no cemented till seen on the dump.
	*	Depth 2 ft, clay.
12		Yellow clay with dolerite fragments. Cemented till on the dump.
	*	Depth 2 ft, solid rock.
12A		As for Pit 6A. Cemented till on the dump.
	*	Depth 3 ft, earth and clay.
13		As for Pit 17.
	*	Depth 3 ft, flat rock.
13A		As for Pit 6A. Cemented till on the dump.
	*	Depth 3 ft, cemented till?
14		As for Pit 17.
	*	Depth 3 ft, flat rock.
14A		As for Pit 6A. No cemented till seen on the dump.
	*	Depth 2 ft, clay and boulders.
15		As for Pit 17.
	*	Depth 4 ft, mudstone and cemented till.
15A		Yellow clay with dolerite fragments. No cemented till seen on the dump.
	*	Depth 6 ft.
16		As for Pit 17.
	*	Depth 3 ft, rock and clay.
16A		As for Pit 15A.
	*	Depth 3 ft, clay.
17		Dark top soil, orange and yellow clay with dolerite fragments.
	*	Depth 4 ft, clay and boulders.
17A		As for Pit 15A.
	*	Depth 3 ft.
18A		As for Pit 15A. Clay appears to be darker in colour.
	*	Depth 3 ft.
19	*	Clay and rock, solid rock.
19A		As for Pit 15A. Water stands at 2 ft in the pit.
	*	Depth 4 ft, clay.

Pit No.		Information
20		Top soil dark. Yellow clay on the dump.
	*	Depth 3 ft, earth and solid rock.
20A		Black clay. The pit is adjacent to dolerite outcrops. Water at 6 in. in the pit. No yellow clay on the dump.
	*	Depth 2 ft, rock.
21A		Yellow clay darker in part. The pit is adjacent to dolerite outcrops.
	*	Depth 4 ft, rock.



TO ACCOMPANY RECORD No 1963/150

LAKE MACKENZIE, TAS. 1962


PLATE 2
TRAVERSE B
TRAVERSE C
TRAVERSE D
TRAVERSE E
TRAVERSE F
TRAVERSE G
TRAVERSE H
Lake Mackenzie
Fisher River
HUT
BED OF LAKE
TOP BANK
(19,500)
(21,000)
(16,500)
(16,000)
(22,000)
(13,500)
(19,000)
(18,500)
(14,000)
(17,000±)
(12,500)
(20,000)
(21,000)
(14,000)
(20,500)
(19,000)
(15,500)
(16,000)
(17,000)
(18,000)
(15,500)
3595
3590
3580
3575
3570
3565
3560
LEGEND
Geophysical traverse with station number
Test pit position and identified number
Test pit approximate position and identified number
Test pit position number unknown
Dolerite
Soil overlying weathered or unconsolidated tillite
(19,000) Seismic velocity in bedrock 19,000 ft/sec
3570 Contour
Probable shear zone boundaries
Formation boundary
Joint
T.N.
M.N.
DAM SITE
SEISMIC REFRACTION SURVEY
GEOLOGY AND SEISMIC TRAVERSES
FEET
100 50 0 100 200 300
AFTER HEC PLANS S 434867, 435867, AND A4005
CONTOUR INTERVAL 5 FEET
TO ACCOMPANY RECORD No. 1963/150
GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
K55/B5-23

LEGEND

(15,000) Formation with seismic velocity of 15,000 ft/sec

—— 12' Depth to formation with different seismic velocity

I P Intersection point

—·—·— Unweathered bedrock boundary

DAM SITE

TRAVERSES F, G, and H

SEISMIC CROSS-SECTIONS

(Based on H E C Plans A 9405, 9406, 9407 and 9408)

FEET

100 50 0 100 200 300

(Horizontal and Vertical)

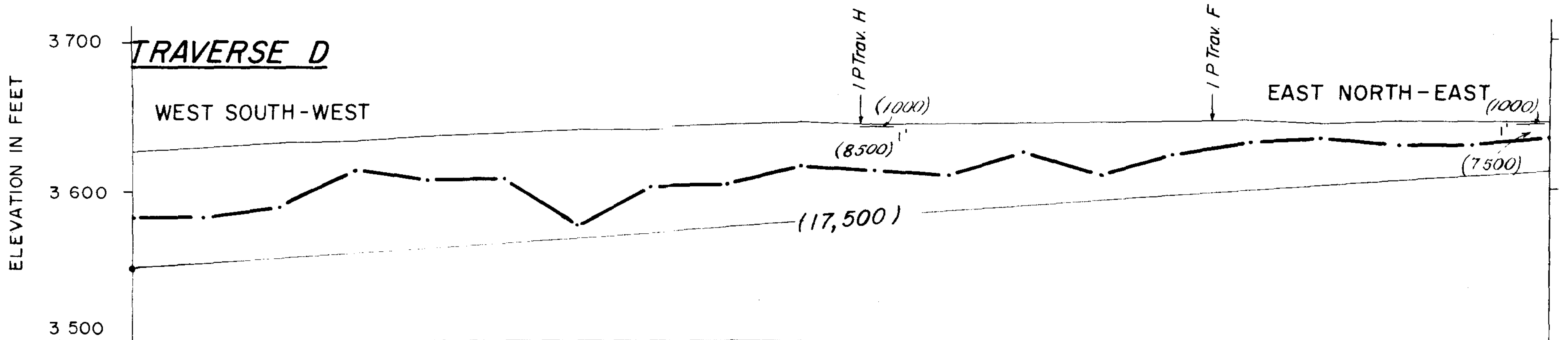
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics K 55/B5-8

TO ACCOMPANY RECORD No. 1963/150

LAKE MACKENZIE DAMSITE, TASMANIA 1962

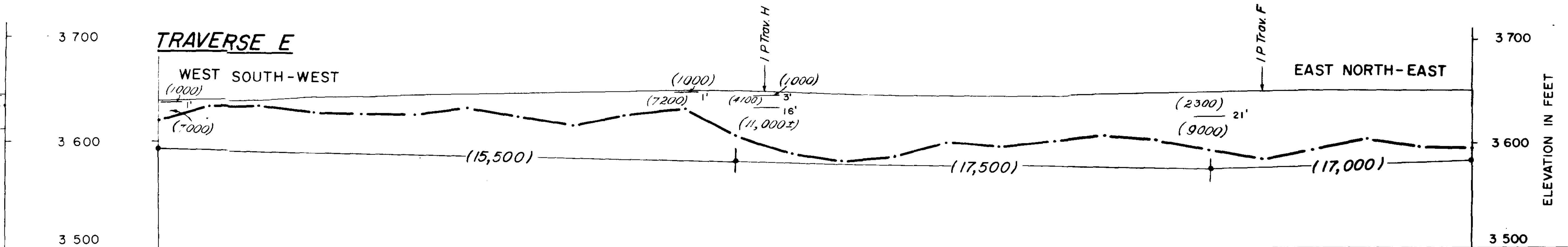
PLATE 4

TRAVERSE D



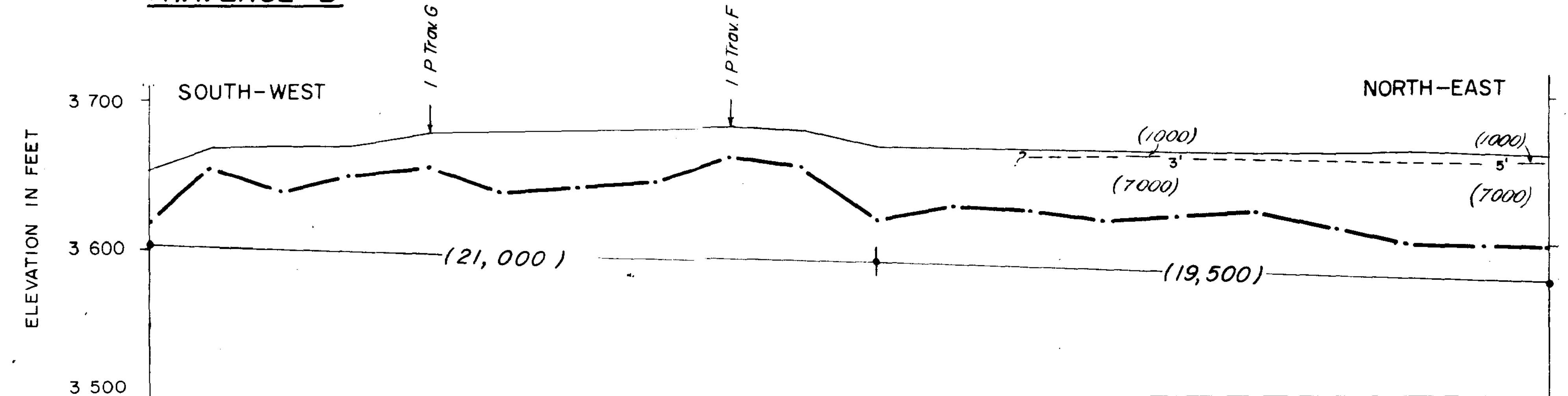
STATION NUMBER	20					15					10					5				1
STATION ELEVATION	3625	29	32	33	37	38	41	41	42	44	3643	43	43	44	44	44	42	44	44	3644
DEPTH TO BEDROCK	44	49	44	20	32	32	64	38	41	32	32	35	20	35	23	15	10	17	17	12

TRAVERSE E



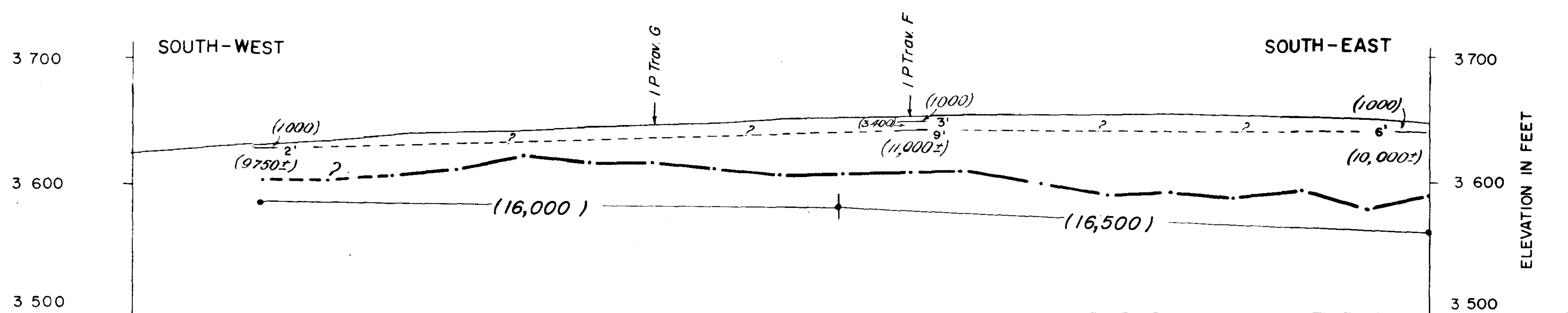
STATION NUMBER	31	30					25					20					15					10				6
STATION ELEVATION	3639	40	41	43	45	47	48	49	50	50	51	51	50	48	45	44	45	44	46	47	48	49	50	49	50	3650
DEPTH TO BEDROCK	18	6	6	15	18	21	15	24	33	24	18	46	60	66	58	44	50	44	42	46	57	64	57	46	53	55

TRAVERSE B



STATION NUMBER	18			15	G 33				F 51		10					5				1
STATION ELEVATION	3652	65	67	67	76	77	78	78	79	77	3666	65	65	64	63	63	65	64	61	3660
DEPTH TO BEDROCK	33	13	31	19	23	41	38	36	18	25	48	38	41	46	43	38	51	61	61	59

TRAVERSE C



STATION NUMBER	21	20					15					10					5				1
STATION ELEVATION	3625	29	33	35	39	42	44	46	48	49	51	3652	53	54	54	55	55	54	52	51	3647
DEPTH TO BEDROCK			27	30	30	27	18	27	27	33	42	42	42	42	51	63	60	63	57	69	57

LEGEND

(15,500) Formation with seismic velocity of 15,500 ft/sec

—— 12' Depth to formation with different seismic velocity

I P Intersection point

—·—·— Unweathered bedrock boundary

DAM SITE

TRAVERSES B, C, D, and E

SEISMIC CROSS-SECTIONS

(Based on H E C Plan A 9409 and 9410)

FEET

100 50 0 100 200 300

(Horizontal and Vertical)

LAKE MACKENZIE DAM SITE . TASMANIA 1962.

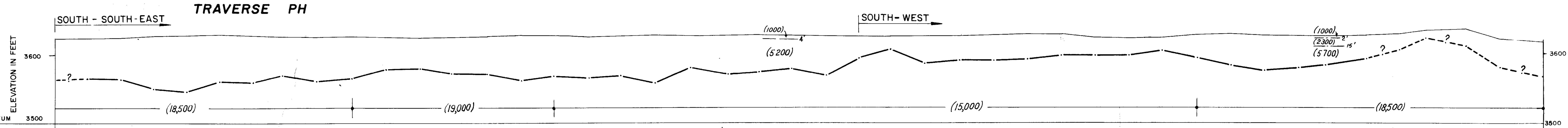
PLATE 5

CANAL AND FLUME LINE

GEOLOGY AND SEISMIC TRAVERSES

LAKE MACKENZIE CANAL & FLUME LINE, TAS. 1962

TRAVERSE PH



STATION NUMBER	STATION ELEVATION	DEPTH TO BEDROCK
385	3625	
	3626	59
	3627	62
	3631	78
	3631	84
390	3633	68
	3631	71
	3630	59
	3629	67
	3630	63
395	3628	47
	3627	46
	3628	54
	3629	56
	3631	66
400	3630	60
	3629	59
	3630	57
	3631	71
	3630	46
405	3631	56
	3631	53
	3630	47
	3629	57
	3629	32
410	3629	17
	3629	38
	3630	34
	3632	35
	3633	35
415	3631	30
	3629	25
	3627	23
	3628	17
	3632	33
420	3634	45
	3632	49
	3630	45
	3631	42
	3632	33
425	3633	23
	3638	6
	3641	23
	3626	40
429	3621	49

Depths calculated from Broadside shots (stations 412–419)

Depths calculated from Broad-side shots (stations 424–429)

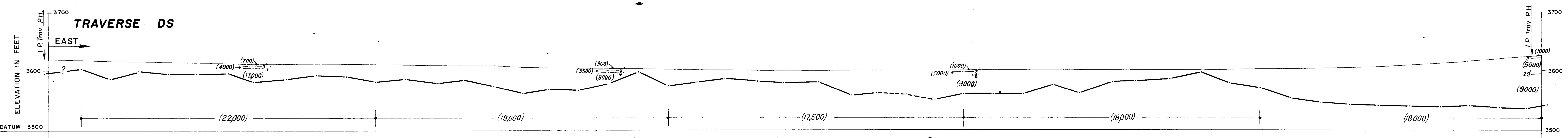
TRAVERSE PH

STATION NUMBER	STATION ELEVATION	DEPTH TO BEDROCK
303	3629	33
	3628	31
305	3628	26
	3629	59
	3628	55
	3627	36
	3627	48
310	3627	55
	3626	41
	3627	66
	3627	65
	3626	73
315	3626	70
	3627	93
	3627	63
	3627	77
	3628	97
320	3629	88
	3629	73
	3630	74
	3631	75
	3629	67
325	3628	45
	3626	77
	3625	74
	3625	64
	3625	56
330	3626	64
	3625	57
	3628	66
	3630	74
	3632	65
335	3630	74
	3629	68
	3628	53
	3627	49
	3626	47
340	3627	37
	3626	36
	3627	43
	3628	43
	3629	48
345	3628	47
	3627	55
	3626	59
	3627	53
	3628	58
350	3627	66
	3627	70
	3627	54
	3627	48
	3627	56
355	3627	45
	3627	49
	3629	49
	3630	31
	3630	32
360	3632	38
	3631	28
	3630	23
	3630	40
	3628	45
365	3629	63
	3629	67
	3629	52
	3628	48
	3629	56
370	3629	54
	3628	56
	3628	61
	3628	47
	3629	44
375	3629	38
	3629	53
	3629	64
	3630	68
	3630	77
380	3631	75
	3632	75
	3632	84
	3631	77
	3629	69
385	3625	

TRAVERSE PH

STATION NUMBER	STATION ELEVATION	DEPTH TO BEDROCK
222	3623	23
	3624	8
	3624	17
225	3625	34
	3625	38
	3625	28
	3624	20
	3625	29
230	3624	26
	3623	25
	3624	29
	3623	27
	3623	30
235	3624	36
	3624	30
	3625	30
	3625	33
	3625	26
240	3625	25
	3625	35
	3625	7
	3624	14
	3624	24
245	3624	41
	3624	39
	3623	65
	3623	50
	3622	42
250	3624	42
	3623	42
	3624	34
	3625	52
	3626	55
255	3627	42
	3627	56
	3628	58
	3628	48
	3629	42
260	3629	39
	3629	35
	3629	32
	3629	25
	3628	25
265	3628	21
	3627	21
	3626	21
	3624	8
	3623	22
270	3623	22
	3624	22
	3624	28
	3625	42
	3625	45
275	3625	37
	3625	64
	3626	62
	3627	66
	3626	82
280	3627	77
	3627	82
	3627	98
	3626	96
	3627	85
285	3627	47
	3625	53
	3626	46
	3626	45
	3626	41
290	3625	24
	3626	49
	3626	43
	3627	28
	3624	39
295	3625	38
	3625	29
	3625	36
	3625	34
	3625	28
300	3627	35
	3627	39
	3628	37
303	3629	33

TRAVERSE DS



STATION NUMBER	STATION ELEVATION	DEPTH TO BEDROCK
00	3627	
1	3620	14
	3619	29
	3619	17
	3617	19
5	3616	19
	3615	17
	3614	31
	3614	26
	3614	20
10	3613	22
	3613	30
	3612	25
	3611	31
	3612	26
15	3611	36
	3608	44
	3607	37
	3607	38
	3606	27
20	3605	6
	3604	28
	3603	22
	3603	14
	3602	20
25	3600	21
	3603	21
	3603	43
	3602	39
	3603	
30	3602	51
	3603	42
	3603	42
	3603	42
	3603	26
35	3603	39
	3602	19
	3603	19
	3603	16
	3603	3
40	3604	23
	3604	32
	3605	49
	3606	58
	3606	63
45	3608	66
	3611	69
	3614	74
	3618	77
	3623	84
50	3626	88
51	3628	85

LEGEND

(18000)	Formation with seismic velocity of 18000 ft/sec
6'	Depth to formation with different seismic velocity
IP	Intersection point
—·—	Unweathered bedrock boundary
	Based on HEC dwgs A9491, A9492, A9493, and A9497

LAKE MACKENZIE CANAL AND FLUME LINE
TRAVERSES PH AND DS
SEISMIC CROSS-SECTIONS

FEET
100 0 100 200 300
(Horizontal and Vertical)

TO ACCOMPANY RECORD No 1963 / 150

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. K55/B5-2

LAKE MACKENZIE CANAL AND FLUME LINE

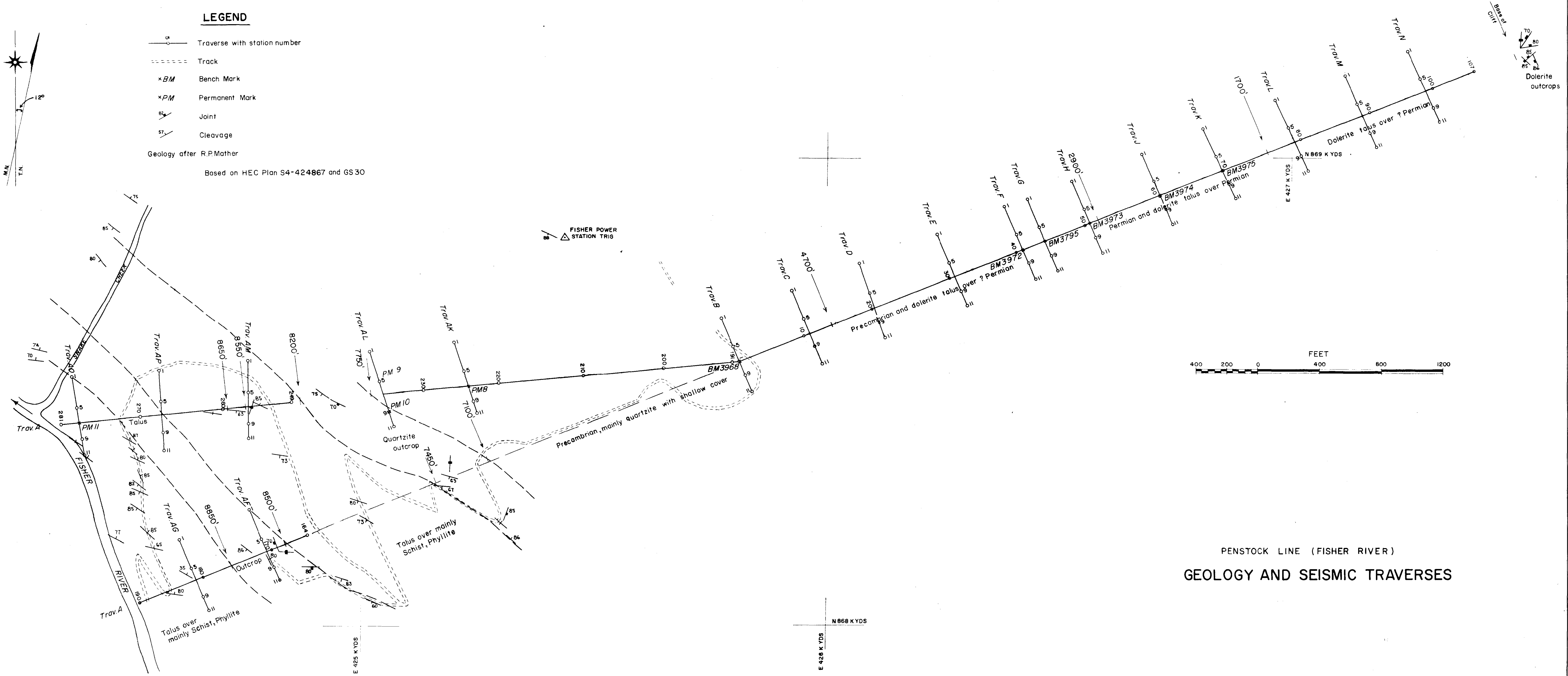
TRAVERSES PH, U, S, R, AND PY

SEISMIC CROSS-SECTIONS

TO ACCOMPANY RECORD No 1963/150

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics. K 55/B5-3

PLATE 8



PENSTOCK LINE (FISHER RIVER)

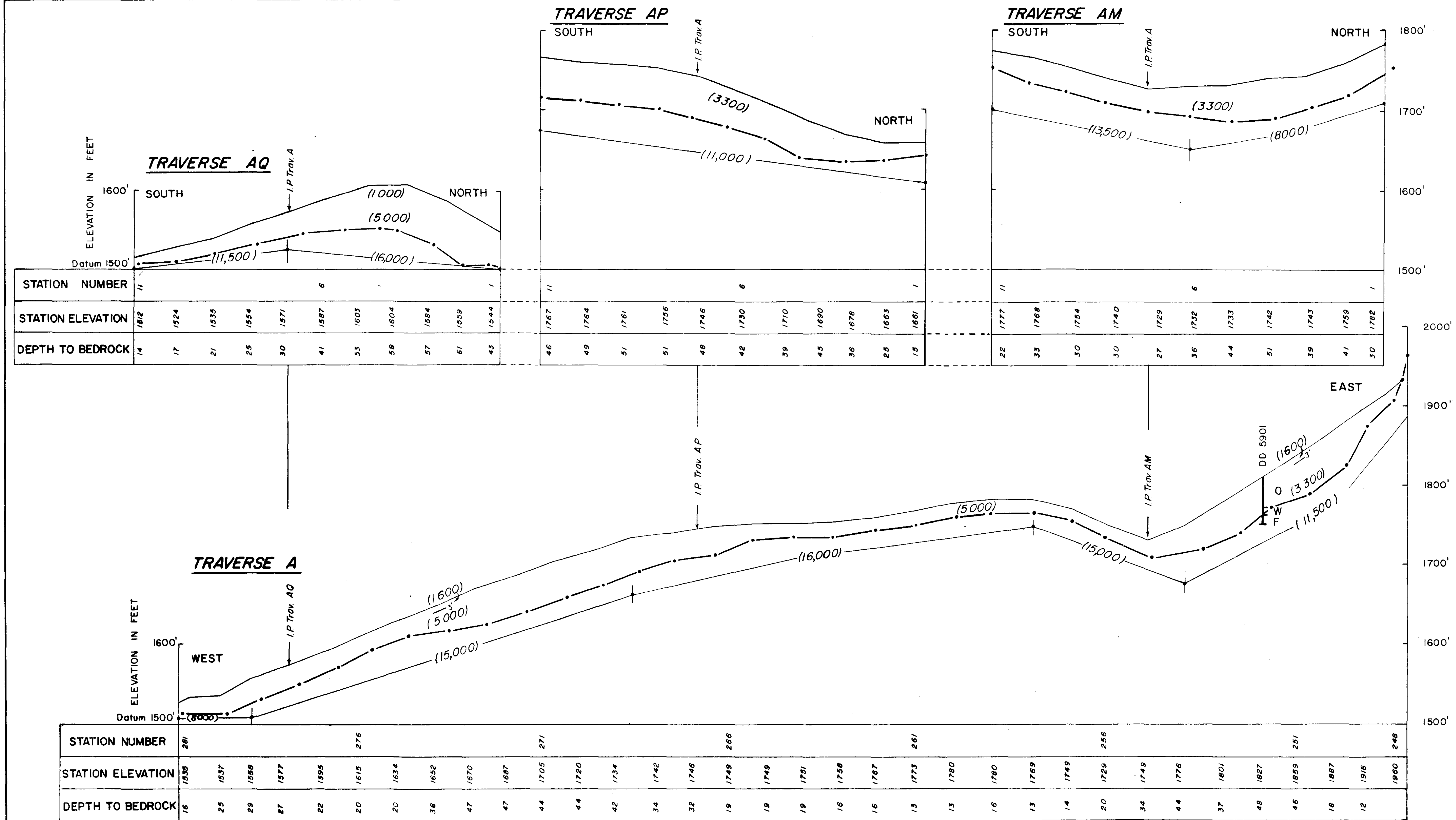
GEOLOGY AND SEISMIC TRAVERSES

LAKE MACKENZIE (FISHER RIVER) PENSTOCK LINE
SEISMIC REFRACTION SURVEY, 1962

TO ACCOMPANY RECORD No 1963/150

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

K55/B5-19



Traverse AQ

STATION NUMBER	11					6					1
STATION ELEVATION	1512	1524	1535	1554	1571	1587	1603	1604	1584	1559	1544
DEPTH TO BEDROCK	14	17	21	25	30	41	53	58	57	61	43

Traverse AP

STATION NUMBER	11					6					1
STATION ELEVATION	1767	1764	1761	1756	1746	1730	1710	1690	1678	1663	1661
DEPTH TO BEDROCK	46	49	51	51	48	42	39	45	36	25	15

Traverse AM

STATION NUMBER	11					6					1
STATION ELEVATION	1777	1768	1754	1740	1729	1732	1733	1742	1743	1759	1782
DEPTH TO BEDROCK	22	33	30	30	27	36	44	51	39	41	30

Traverse A

STATION NUMBER	281					276					271					266	
STATION ELEVATION	1535	1537	1558	1577	1595	1615	1634	1652	1670	1687	1705	1720	1734	1742	1746	1749	1749
DEPTH TO BEDROCK	16	25	29	27	22	20	20	36	47	47	44	44	42	34	32	19	19

STATION NUMBER					261					256					251		248
STATION ELEVATION	1751	1758	1767	1773	1780	1780	1769	1749	1729	1749	1776	1801	1827	1859	1887	1918	1960
DEPTH TO BEDROCK	19	16	16	13	13	16	13	14	20	34	44	37	48	46	18	12	

LEGEND

(7,000) Formation with seismic velocity of 7000 ft/sec

—3' Depth to formation with different seismic velocity

I.P. Intersection point

•——• Unweathered bedrock boundary

Based on HEC Plans A9314 and A9320

FEET

100 50 0 100 200 300

(Horizontal and Vertical)

Drill-hole data

O Overburden

W Weathered bedrock

F Fresh

PENSTOCK LINE (FISHER RIVER)
TRAVERSES A (Stations 248-281),
AM, AP, and AQ

SEISMIC CROSS-SECTIONS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics **K55/B5-13**

TO ACCOMPANY RECORD No. 1963/150

Seismic Refraction Survey

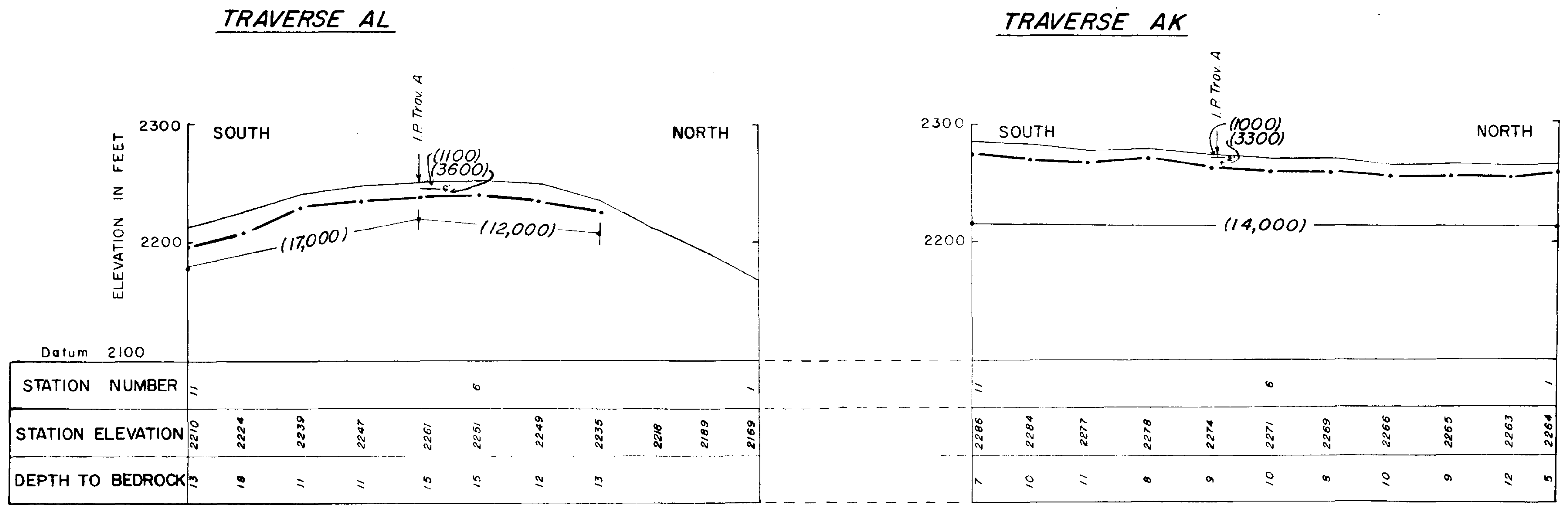
PLATE 10

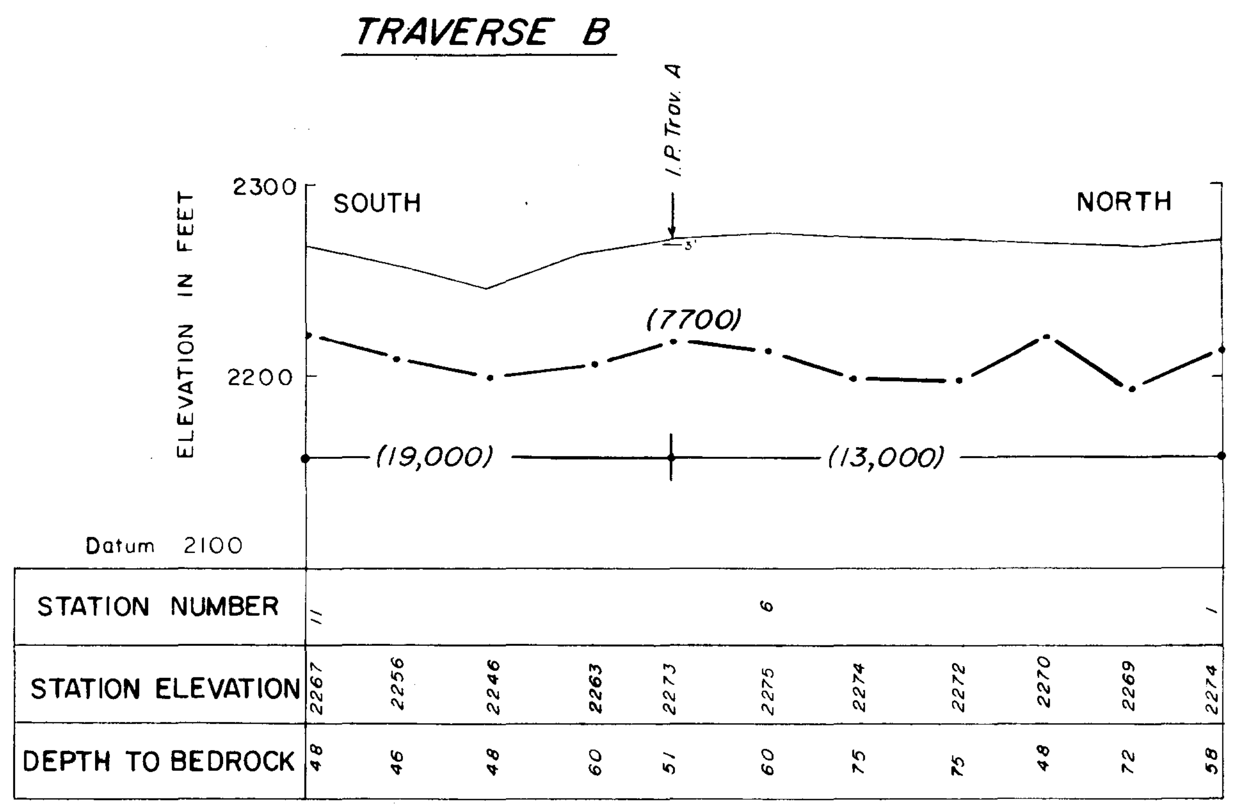
PENSTOCK LINE (FISHER RIVER)

TRAVERSES A (Stations 1, 191-238),

AL, AK, and B

SEISMIC CROSS-SECTIONS





LEGEND

(7700) Formation with seismic velocity of 7700 ft/sec

Depth to formation with different seismic velocity

I.P. intersection point

Unweathered bedrock boundary

Based on HEC Plans A9313, A9314, A9315, and A9319

FEET

100 50 0 100 200 300

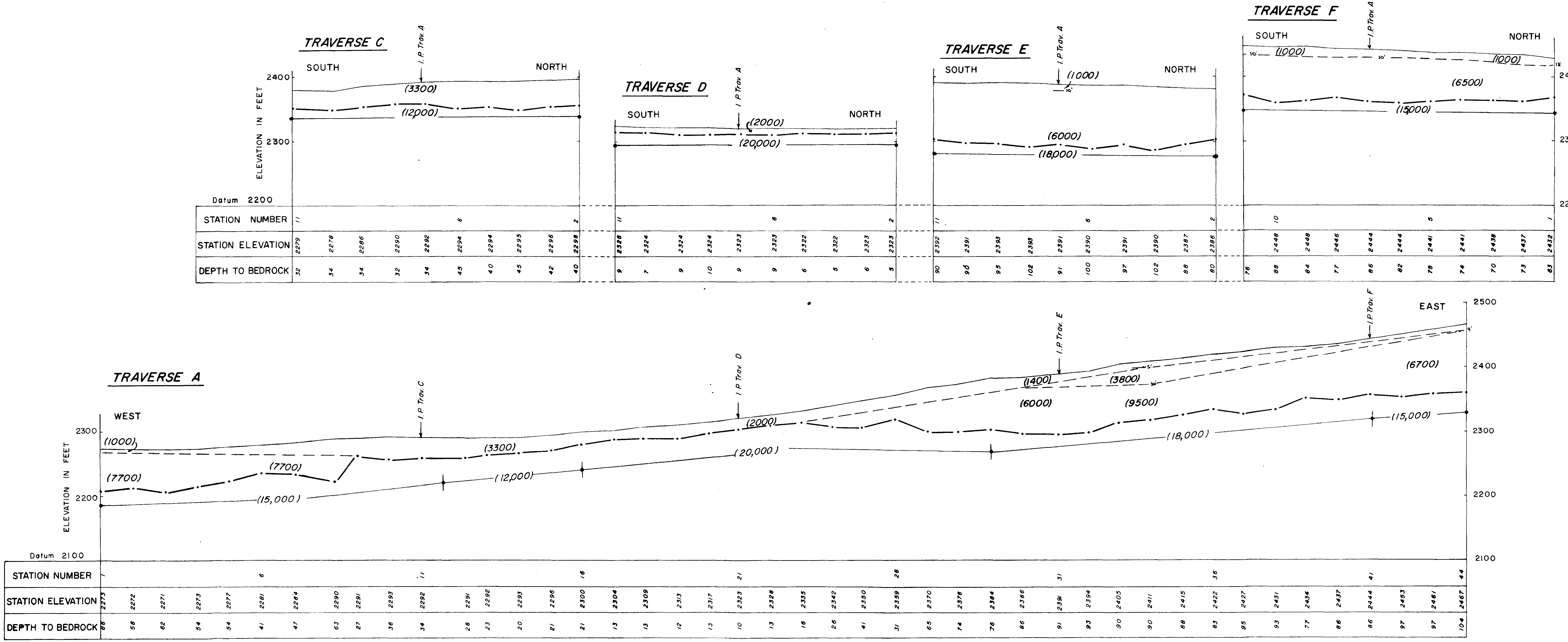
(Horizontal and Vertical)

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics K55/B5-14

TO ACCOMPANY RECORD No. 1963/150

LAKE MACKENZIE (FISHER RIVER) PENSTOCK LINE

PLATE 11



LEGEND

(7700) Formation with seismic velocity of 7700 ft/sec

10' — Depth to formation with different seismic velocity

I.P. Intersection point

—·—·— Unweathered bedrock boundary

Based on HEC Plans A9310 and A9316

FEET

100 50 0 100 200 300

(Horizontal and Vertical)

PENSTOCK LINE (FISHER RIVER)

TRAVERSES A (Stations 1-44), C, D, E, and F

SEISMIC CROSS-SECTIONS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics K55/B5-15

TO ACCOMPANY RECORD No. 1963/150

PENSTOCK LINE (FISHER RIVER)

TRAVERSES A (Stations 44-107), H, J, K, L, M, and N

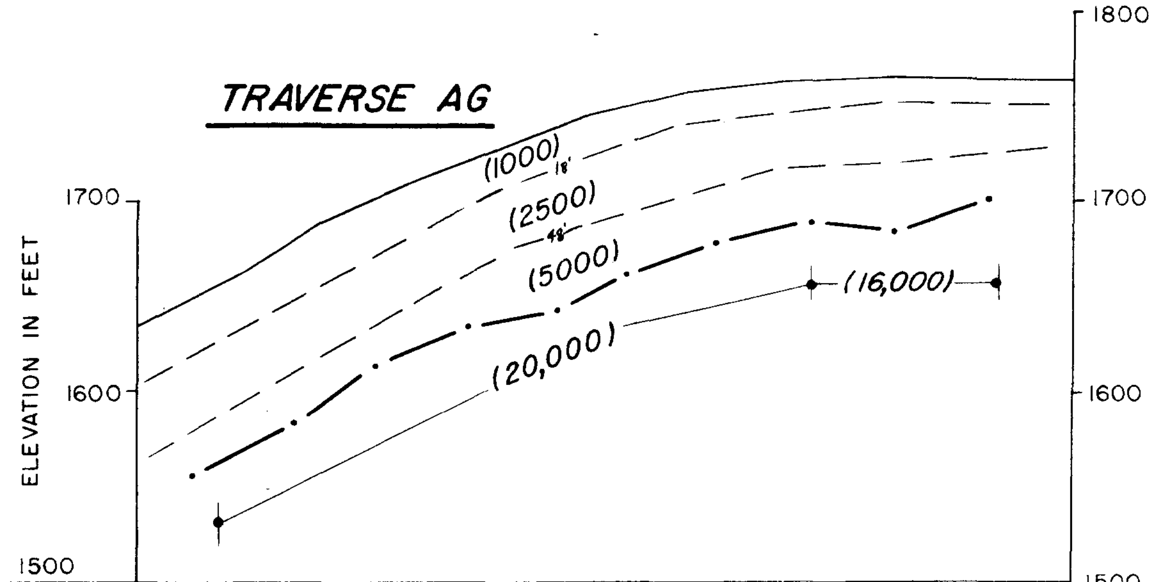
SEISMIC CROSS-SECTIONS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

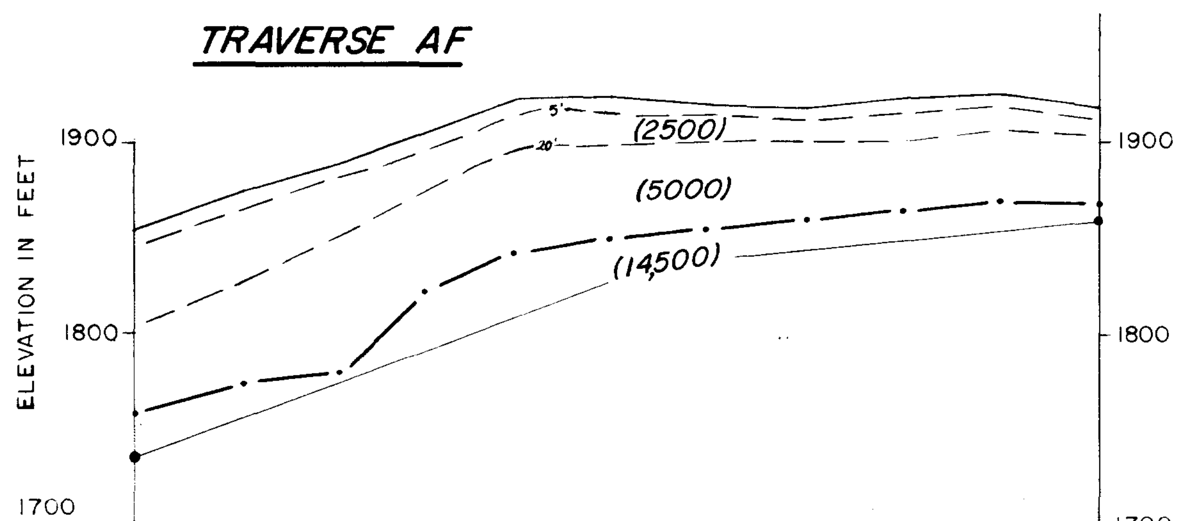
K55/B5-16

TO ACCOMPANY RECORD No.1963/150

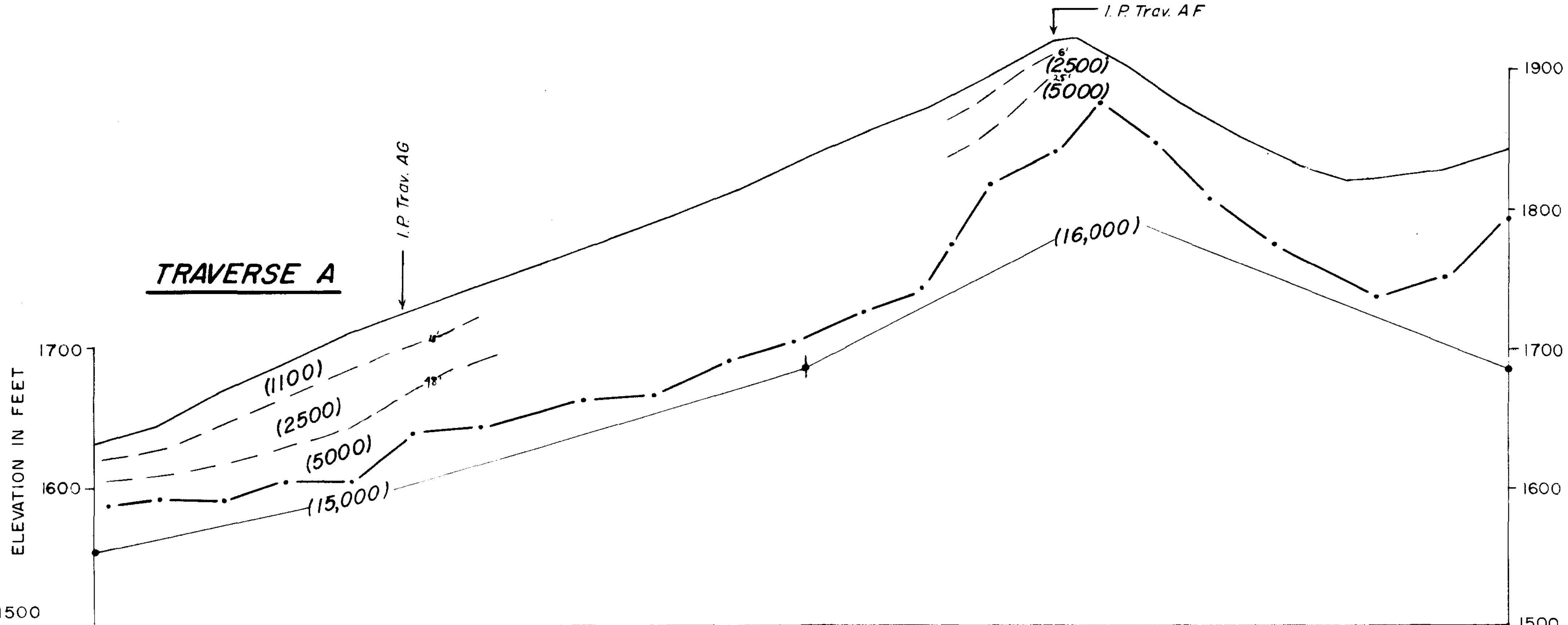
PLATE 13



STATION NUMBER	11					6					1
STATION ELEVATION	1635	1664	1688	1708	1728	1745	1756	1761	1763	1762	1761
DEPTH TO BEDROCK	80	82	82	80	86	84	78	72	80	60	



STATION NUMBER	11					6					1
STATION ELEVATION	1854	1873	1887	1905	1921	1922	1919	1917	1922	1924	1919
DEPTH TO BEDROCK	96	100	106	80	77	74	62	58	58	55	49



STATION NUMBER	186					181					176					171					166		164
STATION ELEVATION	1632	1644	1669	1689	1709	1728	1744	1762	1777	1795	1815	1836	1856	1873	1896	1921	1904	1879	1853	1832	1822	1829	1844
DEPTH TO BEDROCK	49	53	78	84	96	86	98	98	112	108	114	106	114	96	74	80	31	31	45	58	80	74	45

LEGEND

(5000) Formation with seismic velocity of 5000 ft/sec

6' — Depth to formation with different seismic velocity

I.P. Intersection point

•——• Unweathered bedrock boundary

Based on HEC Plans A9312 and A9318

FEET

100 50 0 100 200 300

(Horizontal and Vertical)

PENSTOCK LINE (FISHER RIVER)

TRAVERSES A, AF, AG

SEISMIC CROSS-SECTIONS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

K55/B5-17

TO ACCOMPANY RECORD No. 1963 / 150

LAKE MACKENZIE (FISHER RIVER) PENSTOCK LINE