COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1963/99

HERBERT RIVER SEISMIC REFRACTION SURVEYS, QUEENSLAND 1961

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SUMMARY

This Record describes a seismic refraction survey of the proposed dam sites, tunnel lines, and penstock lines on the Herbert River hydro-electric investigation, northern Queensland. The survey was requested by the Co-ordinator General's Department of Queensland. Depths to the weathered layers and to bedrock, and longitudinal seismic velocities in the rocks were measured on each site. The mean values of Poisson's ratio and Young's modulus of the bedrock were determined on the three main dam sites.

The results indicate that the bedrock on each of the dam sites is satisfactory for foundation purposes. On the geophysical evidence, the proposal to divert the water from the Kooragwin dam to the Upper Cameron Creek and then by a tunnel to the Upper Blencoe Creek dam is the most satisfactory. The Tanner penstock ridge is more suitable than the Blencoe penstock ridge.

1. INTRODUCTION

The Co-ordinator General's Department of Queensland proposes to use the waters of the Herbert River system to generate hydro-electric power in the area of the Herbert River and Blencoe Creek. The confluence of these streams is about 40 miles west of Cardwell, northern Queensland (Plate 1), at co-ordinates 472095 on the Kirrama one-mile sheet. The scheme will utilize the difference in elevation of about 1200 ft between the top of the Herbert River Falls and the confluence of Blencoe Creek and Herbert River. It has been estimated that the scheme should be able to supply 100MW of electric power at 50 percent load factor to the Cairns-Townsville area.

The Department requested that the Bureau of Mineral Resources, Geology and Geophysics, assist with the investigation by determining the depth to bedrock and the nature of the bedrock and overburden in areas where dam sites, flumes, and tunnel lines were proposed. Accordingly a seismic refraction survey was made between 4th October and 6th December 1961, by a geophysical party consisting of M. Kirton (party leader), and C.J. Braybrook and J.P. Pigott (geophysical assistants). The Department provided the topographical survey and field assistants as required. The Geological Survey of Queensland provided geological information (Wolff, 1960; 1961).

At the time of the survey, the Department's design for the Herbert River scheme was as follows (see Plate 1). The Herbert River would be dammed at the Kooragwin dam site (co-ordinates 216301 on the Cashmere one-mile sheet), and Blencoe Creek would be dammed at either the Upper Blencoe Creek dam site (co-ordinates 477156 on the Kirrama one-mile sheet) or at the Blencoe Creek dam site No. 5 (co-ordinates 459145 on the Kirrama one-mile sheet). The power station would be at the bottom of the gorge near either the confluence of the Herbert River and Blencoe Creek (co-ordinates 470096) or the confluence of the Herbert River and Tanner Creek (co-ordinates 496089, both referred to the Kirrama one-mile sheet).

To convey the water from the dams to the power stations, three possibilities were considered :

(a) a tunnel would be driven from the Kooragwin dam to the dam on whichever site on Blencoe Creek was found more suitable. From here, the combined waters of the Herbert River and the Blencoe Creek would go in a penstock down the side of the gorge to the power station. This penstock would either be on the Blencoe penstock ridge or the Tanner penstock ridge, depending on the location of the power station,

(b) a holding weir (locality referred to as 'weir site') would be built just upstream from the Herbert River Falls at map location 205092 on the Cashmere one-mile sheet. The Herbert River water would be conveyed in a flume along the 1750-ft contour level on the north side of the gorge to join the Blencoe Creek water in the Blencoe penstock,

(c) the water in the Kooragwin reservoir would be diverted into the dammed-off Cameron Creek and taken from there by a tunnel to the Blencoe dam. From here the combined water would run along one or other of the penstocks to the power station.

As time did not allow a complete survey of all the tunnel lines, flumes, and penstocks, certain representative areas were selected and surveyed. The information obtained in these places indicated the most favourable tunnelling depth and the amount of construction work that would be needed, and hence more reliable estimates of the costs of the three schemes could be made.

The line of the tunnel needed in Scheme (a) was investigated by seismic work at the following places:

	Co-ordinates	Sheet
Offside Creek	290252	Cashmere
Ring-barked area	377197	"
Middle Creek	410174	"
Showerbath Creek	428165	Kirrama
Blencoe Flats	443159	"

The traverses on the Blencoe and Tanner penstock ridges (co-ordinates 466096 and 492105 respectively on the Kirrama one-mile sheet) were located on the descent into the gorge, where the information gained was of greatest value.

To investigate Scheme (b), the weir site was surveyed and some seismic work was done at location 454128 on the Kirrama sheet. This is the area in which the flume would join the Blencoe penstock.

The proposed tunnel portal on the Cameron Creek (co-ordinates 396265 on the Cashmere sheet) and the proposed Herbert River-Cameron Creek diversion line (co-ordinates 225313 on the Cashmere sheet) were surveyed as they were the areas of greatest interest in Scheme (c).

The lengths of the seismic traverses surveyed were:

	(ft)
Kooragwin dam site	13000
Upper Blencoe dam site	7000
Blencoe dam site No. 5	6000
Weir site	10000
Blencoe penstock ridge	2000
Tanner penstock ridge	4000
Herbert River-Blencoe Creek tunnel line	6000
Flume line	2500
Cameron tunnel portal	1000
Herbert River-Cameron Creek diversion line	2000
Total	53600

The seismic refraction technique applied is known as the 'Method of Differences' (Polak and Mann, 1959a; 1959b). The instrument used was a SIE 12-channel refraction seismograph with TIC geophones of natural frequency 20 c/s. The geophone spacings were 25ft and 50ft for normal spreads, and 10ft for weathering spreads.

Two Hall-Sears three-component geophones with a natural frequency of 15 c/s were used to measure transverse wave velocities for experimental purposes.

2. GEOLOGY

The geology and geological history of the project area were described by Wolff (1960) and by White (1961). On certain traverses, the detailed geology was investigated by I.L. Skellet, engineer-in-charge of the project area, and by M. Kirton.

The project area (Plate 1) lies on the Herbert River Batholith, which is of Permian age, although it may include some Carboniferous or Lower Triassic granites. The western edge of the batholith coincides with the Burdekin River Fault Zone (White, 1961, Plate 1) which is possibly responsible for the location of the Herbert River between the Kooragwin dam site and the weir site. The granite has intruded Siluro-Devonian sediments of the Mount Garnet Formation (Wolff, 1960, p.3) in the area of the Kooragwin dam site and north of this.

The batholith was later intruded in places by Elizabeth Creek Granite and certain parts were covered by Cainozoic basalt flows.

A major fault or shear zone with an easterly strike was responsible for the formation of the Herbert River Gorge (White, 1961, Plate 1).

Geological notes referring specifically to the seismic traverses are included separately for each site.

3. KOORAGWIN DAM SITE

Geology

The area was mapped by Wolff (1960). Summarising his findings, the geology along the geophysical traverses can be described as follows (see Plate 2):

(a) from Stations WK 1 to WK 17 the surface layer is Cameron Creek Formation of unconsolidated sand, mudstone, and sandstone. It is considered to be in general, less than 20 ft thick, of Cainozoic age, and overlies Tertiary basalt,

(b) between Stations WK 17 and 26, WK 84 and 102, WK 130 and 150, and along the cross traverses WK 341-52, WK 353-64 and WK 365-76, there is Herbert River Granite. This is probably Carboniferous and has intruded the older Mount Garnet Formation and Hall's Reward Metamorphics at depth and on the surface. It was later lateritised and covered with Tertiary basalt flows, most of which have now been eroded away leaving surface outcrops of granite and granite sand. In the river bed the granite is partly covered by a thin layer of alluvial unconsolidated sand. Herbert River Granite is medium to coarse grained and jointing is well developed along three major directions, north-north-east, north-north-west and east-north-east, with nearly vertical dips. Weathering along the joint planes is moderate but tends to be more marked along those roughly parallel to the stream course,

(c) between Stations WK 36 and 84, 116 and 132, and 324 and 340 on the left bank, and Stations WK 150 and 160, 104 and 115, and 167 and 307 on the right bank, the rocks are of the Mount Garnet Formation. These rocks are of Siluro-Devonian age and consist mainly of quartzite, greywacke, hornfels, limestone, conglomerate, siltstone, slate, and shale.

The sediments are faulted against the older metamorphics to the west. They are intruded by Herbert River Granite in, and close to, the river bed, and the sediments have been metamorphosed in varying degrees to hornfels and quartzite. On the right bank the sediments are covered by unconsolidated sand and silty sand with occasional outcrops of sandstone and greywacke. On the left bank there are outcrops of quartzite, hornfels, hornfels conglomerate, and rubble derived from these rocks.

The sediments trend regionally north-north-east and are steeply tilted with dips ranging from 70 degrees to vertical. Jointing of the sediments occurs mainly in the quartzites, where the predominant directions are north-north-east to north-east, with mainly vertical dips.

Results

Plates 3 to 7 show the seismic cross-sections and the measured longitudinal velocities along the traverses. Table 1 gives the probable interpretation of the seismic velocities in terms of rock type.

TABLE 1

Seismic velocities in terms of rock types

Longitudinal seismic velocity (ft/sec)	Rock type
1000 - 2000	Soil and scree
2000 - 3000	Unconsolidated, unsaturated alluvial material; unconsolidated Cameron Creek sediments; rubble and decomposed rock; laterite
3000 - 5000	Very weathered and decomposed rock; very jointed rock with open joints; compacted clays and sands
4500	Unconsolidated Cameron Creek sediments
6000 - 8000	Very weathered to moderately weathered rock; fractured and weathered rock in a shear zone; or jointed rocks with joints partly closed and cemented
8000 - 10000	Fractured bedrock in a shear zone; slightly to moderately weathered granite and metamorphics; vesicular and slightly weathered basalt
10000 - 13000	Unweathered basalt or slightly weathered and jointed granite
14000 - 15000	Bedrock of Mount Garnet sediments
16000 and over	Slightly weathered to unweathered granite; quartzite, hornfels, or quartz porphyry

With the help of Table 1 and the available geological information, the seismic velocities shown on the cross-sections can be interpreted in geological terms. In the following discussion, bedrock is defined as the deepest seismic refractor shown on the seismic cross-sections. Generally the recorded seismic velocity in the deepest refractor exceeds 10,000 ft/sec, except in shear or contact zones. Further, only points which may lead to ambiguous interpretation will be discussed.

Between WK 5 and WK 8 (Plate 3), the 4500-ft/sec layer may be interpreted as Cameron Creek sediments overlying vesicular basalt in which the velocity is 10,000 ft/sec. West of WK 8, between WK 8 and WK 24, the 18,000 to 19,000-ft/sec velocity probably represents granite (based on geological evidence). The 8000-ft/sec velocity may indicate weathered granite.

Between WK 24 and WK 39, the bedrock is relatively deep and the average seismic velocity in it is about 14,000 ft/sec. Referring to Plate 2 this zone coincides with the contact zone between granite and the Mount Garnet Formation.

The 8000-ft/sec layer could either be a weathered granite or a weathered metamorphic rock. Depending on the type of dam to be constructed, an 8000-ft/sec layer could have the required properties to serve as a foundation rock. This should be checked by drilling.

From WK 38 to WK 81, the bedrock velocities, generally greater than 17,000 ft/sec, indicate the presence of granite or metamorphic rock. A narrow zone between WK 52 and WK 55 of lower velocities (14,000 to 15,000 ft/sec) may suggest the presence of a shear zone. The 8000-ft/sec layer continues in a westerly direction but seems to change or disappear between WK 74 and WK 79 (Plate 4). Near WK 80 the 6500-ft/sec layer represents a highly weathered rock (see Drill hole HR 3, Table 2).

In the river bed a relatively thin low-velocity layer (about 2000 ft/sec), representing unsaturated alluvial material, overlies a high-velocity bedrock (more than 16,000 ft/sec), representing unweathered granite or metamorphic rock. At certain places there may be an intermediate layer of moderately weathered rock (characterized by a velocity of 6000 to 8000 ft/sec) that is too thin to be detected.

West of the river bed, between WK 150 and WK 160, and between WK 103 and WK 112, a 7000 to 8000-ft/sec layer is present between the surface layers and the high-velocity granite or metamorphic bedrock. This layer probably represents moderately weathered granite or metamorphic rock, and again may be suitable for a foundation rock.

Between WK 171 and WK 220 (Plate 5), the normal sequence of layers for this area is present including an 8000-ft/sec layer between the surface layers and bedrock. Near WK 201, the top of the 8000-ft/sec layer is about 106 ft below the surface, i.e. at about the same elevation or level as the top of the unweathered bedrock in the river bed.

From WK 240 to WK 244 (Plate 6), the low bedrock velocity (about 9000 ft/sec) suggests the presence of a shear zone. The depth to the top of the 7000-ft/sec layer probably exceeds 90 ft.

South-west from WK 287, the bedrock dips relatively steeply towards the south-west, and the depths to the top of the 7000 to 8500-ft/sec layer range between about 76 and 95 ft.

As an experiment the transverse wave velocity was measured between WK 132 and WK 138 with three-component geophones, the measured velocity being 10,000 ft/sec. With a measured longitudinal velocity of 18,000 ft/sec (Plate 4), and an assumed rock density of 2.7 g/cm^3, the computed value of Poisson's ratio is 0.27, and Young's modulus (dynamic determination) is 6.5×10^{11} dyn/cm^2 or 9.4×10^6 lb/in.^{2} This method of determining Young's modulus usually gives values that are 10 to 20 percent higher than the corresponding static determinations.

Comparison with drilling information

After the cross-sections had been computed and plotted, they were compared with the logs of the diamond-drill holes on this site (Table 2). Where the drill holes are inclined, the depths given have been corrected for dip.

TABLE 2

Comparison of drilling and seismic results

Kooragwin dam site

Drill hole No. and position	Drill logs Depth (ft)	Drill logs Geological formation	Seismic results Depth (ft)	Seismic results Velocity (ft/sec)
HR 1, 50 ft south of WK 85, dip 45 degrees	0 - 15	Talus material		
	15 - 23	Moderately weathered pyroxene hornfels	0 - 20	2000 (including a possible 6000-ft/sec layer)
	23 - 42	Slightly weathered pyroxene hornfels	20 +	16,500
	42 +	Fresh hornfels and granite		
HR 2, 50 ft south of WK 83.5, vertical	0 - 4	Overburden	0 - 12	2000
	4 - 23	Moderately weathered hornfels conglomerate	12 - 30	6000
	23 - 52	Slightly weathered quartzite hornfels	30 +	16,500
HR 3, 70 ft south of WK 81, vertical	0 - 7	Overburden	0 - 35	2000 (including a possible 6000-ft/sec layer)
	7 - 16	Moderately weathered hornfels conglomerate		
	16 - 23	Highly weathered granite	35 +	16,500
	23 - 69	Slightly weathered conglomerate		
	69 +	Fresh conglomerate		
HR 4, 70 ft south of WK 98.5, vertical	0 - 14	Decomposed granite	0 - 24	2000
	14 - 17	Highly weathered granite	24 +	18,500
	17 +	Fresh granite		
HR 5, 50 ft south of WK 95, dip 35 degrees	0 - 6	Highly weathered granite	0 - 4	2000
	6 +	Slightly weathered granite	4 +	18,000

Drill hole No. and position	Drill logs Depth (ft)	Geological formation	Seismic results Depth (ft)	Velocity (ft/sec)
HR 6, at WK 73.3, vertical	0 - 8	Soil	0 - 4	1000
	8 - 24	Highly weathered hornfels	4 - 15	2700
			15 - 47	5000
	24 - 64	Moderately weathered hornfels	47 - 102	8000
	64 - 96	Slightly weathered hornfels	102 +	19,000
	96 +	Unweathered hornfels		
HR 7, at WK 142, dip 35 degrees	0 - 50	Slightly weathered granite	0 - 14	2000
	50 +	Unweathered granite	14 +	19,000
HR 8a, 50 ft south of WK 88, dip 35 degrees	0 - 18	Moderately weathered granite	0 - 15	2000
			15 +	16,500
	18 +	Slightly weathered granite		
HR 9, 50 ft south of WK 90, dip 30 degrees	0 - 2	Alluvium	0 - 20	2000
	2 - 4	Moderately weathered granite	20 +	16,500
	4 - 9	Slightly weathered granite		
	9 - 10	Unweathered granite		
	10 - 14	Slightly weathered granite		
	14 - 18	Unweathered granite		
HR 10, at WK 127.5 dip 35 degrees	0 - 13	Decomposed hornfels	0 - 25	2000 (and possibly a 6000-ft/sec layer)
	13 - 15	Highly weathered hornfels		
	15 - 24	Moderately weathered hornfels	25 +	18,000
	24 +	Slightly weathered hornfels conglomerate		

Drill hole No. and position	Drill logs Depth (ft)	Geological formation	Seismic results Depth (ft)	Velocity (ft/sec)
HR 11, near WK 138, dip 30 degrees	0 - 3	Decomposed granite	0 - 15	2000
	3 - 18	Slightly weathered granite	15 +	18,000
	18 +	Unweathered granite		
HR 12a, at WK 135, dip 30 degrees	0 - 6	Highly weathered granite	0 - 12	2000
	6 - 14	Slightly weathered granite and hornfels	12 +	18,000
	14 +	Unweathered hornfels		

Conclusions

In the river valley, the shallow depth to bedrock and the seismic velocity in it of greater than 15,000 ft/sec suggest that this site would be suitable for any type of dam. However, depending on the extent of the side walls, the 7000 to 8000-ft/sec layer should be further tested. Such a layer would be a suitable foundation for a gravity dam, providing it is sufficiently impermeable. Suggested drilling sites are WK 201, WK 264, and WK 296. In addition, the postulated shear zones near WK 25, WK 54, and WK 240 should be investigated.

4. BLENCOE CREEK DAM SITE NO. 5

Geology

This site is situated in an area that was mapped by Wolff (1960) as Elizabeth Creek Granite. This granite generally crops out as large tors and rubble surrounded by decomposed granite. The granite on the hillsides is moderately weathered; in the creek the exposures are harder and less weathered. The major joints strike north to north-west, with nearly vertical dips.

Results

Plate 8 shows the layout of the traverses and Plate 9 shows the seismic cross-section and the measured longitudinal velocities. These velocities can be interpreted in geological terms by referring to Table 1. Over the whole area, the velocities in the deepest refractors recorded exceeded 15,000 ft/sec. These refractors are classified as bedrock.

From Stations WL 116 to WL 125, WL 9 to WL 33, WL 136 to WL 145, WL 159 to WL 168, and WL 30 to about WL 55 a thin layer in which the velocity is about 2000 ft/sec covers slightly weathered or slightly jointed to unweathered, unjointed granite bedrock. This 2000-ft/sec velocity is an average value along all these traverses and represents patches of soil, rubble, and unconsolidated unsaturated alluvial sand.

From Stations WL 58 to WL 68, WL 178 to WL 187, and WL 76 to WL 106, the depth of weathering increases to give, in descending order, a layer of soil and rubble, layers of decomposed and weathered rock, and granite bedrock.

The velocity of the transverse wave was measured between Stations WL 136 and WL 145 by three-component geophones, and was found to be 9000 ft/sec. The longitudinal velocity along this traverse is 17,000 ft/sec. Using these values and assuming a value of 2.7 g/cm^3 for the density of unweathered granite, the value of Poisson's ratio is 0.31. The value of Young's modulus for the bedrock is then 5.4×10^{11} dyn/cm^2, or 7.8×10^6 $lb/in.^2$.

Comparison with drilling information

Table 3* gives a comparison of the drilling information on this site with the geophysical results. For inclined drill holes, the depths have been corrected for dip.

Conclusions

In the bed of the river and on the banks, the shallow depth to bedrock and the seismic velocity in it exceeding 15,500 ft/sec suggest that this site would be suitable for any type of dam structure. However the 6500 to 7000-ft/sec layer between Stations WL 58 and WL 106 should be further investigated by drilling and water-pressure testing if the dam extends this far.

5. UPPER BLENCOE CREEK DAM SITE

Geology

The geology of this area was described by Wolff (1960) as Elizabeth Creek Granite, the characteristics of which are given in the notes on the survey of Blencoe Creek dam site No. 5. Quartz-feldspar porphyry dykes up to 40 ft wide intrude the granite. Such dykes can be observed in the river bed.

Results

Plate 10 shows the traverse layout and Plates 11 and 12 show the seismic results obtained on this site. The velocities can be interpreted by referring to Table 1.

Between Stations WU 57 and 80, WU 24 and 40, WU 88 and 117, WU 137 and 155, and WU 160 and 179 a thin layer of soil and rubble in which the seismic velocity is about 1500 ft/sec covers slightly weathered to unweathered bedrock, in which the seismic velocity is 15,500 ft/sec or greater.

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* Table 3 is on Page 11.

TABLE 3

Comparison of drilling and seismic results

Blencoe Creek dam site No. 5

Drill hole No. and position	Drill logs Depth (ft)	Geological formation	Seismic results Depth (ft)	Velocity (ft/sec)
5/B1 at WL 18, dip 30 degrees	0 - 8	Moderately weathered microgranite	0 - 11	1800
	8 - 12	Slightly weathered microgranite	11 +	16,000
	12 - 80	Bands of moderately and slightly weathered and fresh microgranite		
5/B2 20 ft east of WL 23.5 dip 35 degrees	0 - 5	Moderately weathered microgranite	0 - 7	1800
	5 - 9	Slightly weathered microgranite	7 +	17,000
	9 - 90	Bands of moderately and slightly weathered and fresh microgranite		
5/B3 at WL 26, dip 30 degrees	0 - 8	Slightly weathered microgranite	0 - 7	1800
	8 - 14	Moderately weathered microgranite	7 +	17,000
	14 - 29	Slightly weathered microgranite		
	29 - 44	Fresh microgranite		
5/B4 30 ft south of WL 183, vertical	0 - 16	Overburden	0 - 4	1000
	16 - 21	Highly weathered microgranite	4 - 18	2200
	21 - 50	Moderately weathered microgranite	18 - 52	7000
			52 +	16,500
5/B5 at WL 96, vertical	0 - 135	Decomposed and highly weathered granite	0 - 6	1000
			6 - 57	4500
	51	Standing water level for dry weather	57 - 120	7000
	135 - 146	Moderately weathered granite	120 +	15,200
	146 - 149	Slightly weathered granite		
	149 +	Fresh granite		

Between Stations WU 57 and WU 52, WU 189 and WU 199, WU 5 and WU 23, and WU 40 and WU 45 the depth to unweathered rock increases and intermediate layers of heavily and moderately weathered rock are recorded.

Between Stations WU 72 and WU 78 the transverse wave velocity was found to be 6500 ft/sec. This value, together with the longitudinal velocity of 16,000 ft/sec, gives a value of 0.40 for Poisson's ratio. Assuming the density of slightly weathered granite to 2.6 g/cm^3, Young's modulus is 2.9 x 10^{11} dyn/cm^2, or 4.2 x 10^6 lb/in.^{2}.

Comparison with drilling information

Table 4* gives a comparison of the drilling information on this site with the geophysical results. For inclined drill holes, the depths have been corrected for dip. The agreement between seismic results and drilling results is fairly good except at drill holes 2/B1 and 1/B1, where the distances from the nearest seismic stations are 50 ft or more.

Conclusions

The survey shows that on the slopes, and close to (and probably also in) the river bed, the depth to unweathered bedrock is generally less than 15 ft, and the velocity in the bedrock exceeds 15,000 ft/sec.

On the relatively flat hill tops, weathering has progressed to a much deeper level; this is indicated by the occurrence of intermediate layers in which the seismic velocity is 10,000 to 12,000 ft/sec. The maximum depths recorded to unweathered rock are 94 ft near WU 14, and 87 ft near WU 52. A rock in which the seismic velocity is 11,000 to 12,000 ft/sec is usually strong and impermeable enough to be used for foundation purposes.

6. WEIR SITE

Geology

The geology of the area was described by Wolff (1960). From the river, near Station WW 38, to about Station WW 80 there is Herbert River Granite. This is intruded in the river bed and on the bank up to Station WW 25 by a quartz porphyry dyke.

In the neighbourhood of Station WW 92 a basalt ridge commences and extends north-easterly. Between Stations WW 83 and WW 96 the seismic traverse crosses this ridge and from Station WW 103 onwards the traverse continues along the crest of the ridge. Between Stations WW 171 and WW 196 the basalt has been eroded away to form a saddle. There are thin laterite remnants over Herbert River Granite along the floor of the saddle.

The part of Traverse WB surveyed was over Herbert River Granite. On the surface this had decomposed to sandy soil.

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* Table 4 is on Page 13

TABLE 4

Comparison of drilling and seismic results

Upper Blencoe Creek dam site

Drill hole No. and Position	Drill logs Depth (ft)	Drill logs Geological formation	Seismic results Depth (ft)	Seismic results Velocity (ft/sec)
2/B1 50 ft west of WU 39, vertical	0 - 44	Moderately weathered feldspar porphyry	0 - 4	1600
			4 +	15,500
	44 - 61	Slightly weathered feldspar porphyry		
2/B2, 50 ft west of WU 35.5, dip 40 degrees	0 - 6	Moderately weathered porphyry	0 - 4	1600
	6 - 22	Slightly weathered porphyry	4 +	15,500
2/B3, 50 ft west of WU 32.5, dip 25 degrees	0 - 10	Moderately weathered granite	0 - 6	1600
	10 +	Slightly weathered granite	6 +	16,000
2/B4 at WU 20, vertical	0 - 27	Decomposed and highly weathered granite	0 - 34	Intermediate layers not known
	27 - 33	Moderately weathered granite	34 +	About 20,000
	33 - 36	Highly weathered granite		
	36 +	Slightly weathered granite		
2/B5 at WU 14.5, vertical	0 - 53	Decomposed granite	0 - 2	1200
	53 - 79	Moderately weathered granite and porphyry	2 - 12	3000
			12 - 52	6000
	79 - 86	Slightly weathered porphyry	52 - 80	8000
			80 +	15,500
1/B1 100 ft north-west of WU 174, vertical	0 - 5	Decomposed granite	0 - 2	1000
	5 - 55	Moderately weathered granite	2 - 28	12,000
	55 - 68	Moderately and slightly weathered granite	28 +	15,500
1/B2 at WU 191, vertical	0 - 5	Decomposed granite	0 - 7	1500
	5 - 10	Highly weathered granite	7 - 20	10,000 - 12,000
	10 - 33	Moderately weathered granite	20 +	17,500
1/B3 at WU 197 vertical	0 - 3	Decomposed granite	0 - 7	1500
	3 - 7	Highly weathered granite	7 - 60	10,000 to 12,000
	7 - 24	Moderately weathered granite	60 +	17,500

Results

Plates 13, 14, and 15 show the seismic cross-sections and the measured longitudinal seismic velocities on this site. Using Table 1 these velocities can be translated into geological terms.

From Station WW 67 to WW 96 (Plate 13) there is an increase in depth to the unweathered granite bedrock, suggestive of an old river valley filled with basalt. The 11,000-ft/sec layer probably represents slightly weathered basalt, over which are layers of decomposed and weathered basalt.

From Station WW 91 to WW 126 (Plate 14) along the crest of the ridge the depth is shown to an 11,000-ft/sec layer which is interpreted as slightly weathered basalt. There are indications that a higher-velocity layer exists beneath this, presumably unweathered granite.

At Station WW 166 the seismic cross-section is interpreted as layers of very weathered basaltic material over a layer of slightly weathered vesicular basalt at a depth of about 18 ft. Between Stations WW 176 and WW 196 a 13,000-ft/sec refractor is the deepest one recorded; this could represent slightly to moderately weathered granite or slightly weathered basalt. There were again indications of a high-velocity layer underneath this.

The velocity distribution along Traverse WB (Plate 15) can be interpreted as successive layers of soil and heavily, moderately, and slightly weathered granite over unweathered unjointed granite bedrock.

Conclusions

From WW 20 to WW 67 the 7000 to 8000-ft/sec layer should form a suitable foundation for a low weir. The permeability of this layer should be checked by drilling.

In the area east and north-east of WW 70, the geophysical results suggest the presence of an old river valley filled with basalt. Past experience indicates that with this type of structure, depth determinations are not better than ± 20 percent accurate. To check this area, drilling is recommended at Stations WW 81, WW 86, WW 91, and WW 121. These drill holes should also give information about the permeability of the 5000 to 6000-ft/sec layer.

A drill hole is recommended near Station WW 181 to prove the structure in the saddle area.

7. BLENCOE PENSTOCK RIDGE

Geology

The general geology of the area was described by Wolff (1960). The penstock ridge consists of granite covered by a mantle of weathered to highly weathered and decomposed granite, with scree material on the surface.

The ridge goes down to the Herbert River Gorge, which was formed on a major fault or shear zone (White, 1961, Fig. 8 and Plate 1). At the top of the ridge, near WP 3, the granite is covered by basalt. Basalt scree material is also found along the slope, down to about WP 15.

Results

The results are shown on the seismic cross-section in Plate 16. Overburden is defined as rock in which the seismic velocity is less than 7000 ft/sec. Such rock is not strong enough to support engineering structures such as penstock lines. The overburden consists of scree material, soil, and highly weathered granite, in which the seismic velocities range from 1000 to 5000 ft/sec, and weathered granite in which the velocity is about 6700 ft/sec.

In this locality, bedrock is defined as rock in which the measured seismic velocity is greater than 9000 ft/sec. At WP 4 a 12,000-ft/sec layer probably represents a basalt overlying the granite. The lateral extent of the basalt is not known.

Between WP 7 and WP 15 the calculated depth to bedrock (16,000-ft/sec velocity, probably unweathered granite) ranges from 55 to 99 ft.

Between WP 25 and WP 45 the bedrock is relatively deep; the calculated distance between the surface and the bedrock ranges from 108 to 200 ft. The seismic velocities within the bedrock range between about 13,000 ft/sec near WP 27 and 9500 ft/sec near WP 42. The 13,000-ft/sec layer probably represents slightly weathered and fractured granite. The 9500-ft/sec layer may represent moderately weathered, fractured, or sheared granite possibly belonging to the Herbert River Gorge fault zone.

Conclusions

The depth to bedrock is relatively large. Apart from the relatively high costs connected with deep foundations, the sloping ground surface and bedrock profile may cause future land slips. Hence, this locality is not recommended as a site for penstock lines.

8. TANNER PENSTOCK RIDGE

Geology

The area was mapped by Wolff (1960) as Herbert River Granite with a patch of olivine basalt covering the approximate centre of the traverse. Personal observations along the traverse defined the geology more precisely, as given below.

From Stations WT 187 to WT 195 (Plate 17) the surface cover is rubble derived from decomposed granite. Between Stations WT 195 and WT 208 and Stations WT 217 and WT 254 the granite is capped with very weathered vesicular basalt. Elsewhere the surface cover is sandy loam derived from decomposed granite.

Results

Between Stations WT 187 and WT 195 the 1000-ft/sec layer corresponds to soil, the 4000-ft/sec layer to very weathered and decomposed granite, the 9600-ft/sec layer to moderately weathered granite, and the 13,000-ft/sec layer to slightly weathered or slightly jointed granite. This layer was the deepest refractor recorded. It is possible that unweathered granite exists at a greater depth than the technique used would attain, i.e. more than 200 ft.

In the vicinity of Station P 11 the 1000-ft/sec layer corresponds to soil, the 4000-ft/sec layer to very weathered basalt, the 7700-ft/sec layer to slightly to moderately weathered vesicular basalt, and the 16,000 to 17,000-ft/sec layer to unweathered granite bedrock.

At Station WT 214, the 1000-ft/sec layer corresponds to soil, the 4700-ft/sec layer to very weathered granite, the 7000-ft/sec layer to moderately weathered granite, and the 16,000 to 18,000-ft/sec layer to unweathered granite bedrock.

Between Stations WT 214 and WT 218 the structure is complex and it is difficult to give a reliable interpretation. It is possible that there is a shear zone in the granite bedrock, in which case the inferred 18,500-ft/sec velocity would not be correct over this part of the cross-section. It is recommended that this region be investigated further before any construction work is commenced.

From Stations WT 220 to WT 234 there is a thin cover of highly weathered basalt, in which the velocity is 3000 ft/sec, over unweathered granite bedrock.

From Stations WT 234 to WT 254 there is a thin cover of highly weathered basalt over a solid unweathered basalt bedrock or a slightly weathered or jointed granite bedrock.

Between Stations WT 254 and WT 274, the 1000-ft/sec layer corresponds to soil, the 2000-ft/sec layer to soil and rubble, the 3000-ft/sec layer to very weathered decomposed granite, the 5000 to 6000-ft/sec layer to very weathered granite, and the 16,000 to 18,000-ft/sec layer to unweathered granite bedrock.

Conclusions

Although this is not an ideal site for a penstock line, it is very much better geologically than the Blencoe penstock ridge. The topography suggests that there would be little chance of an earth slip, and so layers in which the seismic velocity is 6000 ft/sec or greater would be suitable foundation rocks. However, the structure between WT 214 and WT 222 is complex and requires further investigation.

9. FLUME LINE

Geology

The area covered by the traverse was mapped by Wolff (1960) as laterite or lateritic soil overlying Tertiary basalt. The basalt in turn overlies Palaeozoic Herbert River Granite. The basalt is vesicular and porous, and closely jointed. In many places it has been eroded away, leaving granite on the surface.

Results

The seismic cross-section and measured longitudinal velocities are shown on Plate 18. Referring to Table 1, these may be interpreted as follows.

Between WF 5 and WF 25, the 5000-ft/sec layer probably represents weathered granite, but could also be weathered basalt or semi-consolidated sediments. The 3000-ft/sec layer could be laterite.

Near WF 25 the bedrock boundary shows a large step which may be a fault. The depths to bedrock shown between WF 25 and WF 35 could be as much as 40 ft too large as insufficient data were available to make accurate calculations.

From WF 25 to WF 55, the 1000-ft/sec layer corresponds to soil, the 3000 to 5000-ft/sec layer to very weathered and decomposed rock or laterite, and the 9000 to 10,000-ft/sec layer to moderately weathered granite or slightly weathered basalt.

The bedrock velocities above 15,000 ft/sec indicate a virtually unweathered, unjointed granite. Between WF 35 and WF 38, the 9000-ft/sec velocity in bedrock suggests a shear zone.

Conclusions

The 9000 to 10,000-ft/sec layer would be strong enough for the foundations of a flume line. However, the seismic cross-section should be checked by drill holes at WF 26 and WF 37.

10. TUNNEL LINE

Offside Creek area

According to Wolff (1960), the geology of this area is lateritic soil over Herbert River Granite.

The seismic cross-section and measured longitudinal velocities are shown in Plate 19. The velocities may be interpreted in terms of weathered granite with the help of Table 1. Owing to the great depth of weathering along the whole spread, it was not possible to obtain depths to bedrock except at the two ends. However, the time/distance curves plotted from the seismic records were sufficiently symmetrical to suggest that the interpolation of the layers between the ends of the spread is correct to within ± 15 percent.

Ring-barked area

Wolff (1960) describes this area as laterite and lateritic soil over basalt.

The seismic cross-section and measured longitudinal velocities are shown on Plate 20. Using Table 1, the velocities can be interpreted as follows:

Velocity (ft/sec)	Geological formation
900	Soil
3000	Laterite
4100 - 5700	Weathered basalt
8000	Slightly weathered basalt or moderately weathered granite
17,000	Unweathered granite bedrock

The bedrock profile suggests that in the vicinity of WT 34 there is an old valley which has been filled with a basalt flow. This could be checked by drill holes near Stations WT 34 and WT 24.

Middle Creek area

Wolff (1960) mapped this area as Herbert River Granite. In addition, some laterite was observed on the left bank of the creek, between Stations WT 59 and WT 68.

Plate 21 shows the seismic cross-section and the measured longitudinal velocities. Using Table 1, these velocities may be interpreted as follows:

Velocity (ft/sec)	Geological formation
1000	Soil
7700 - 8000	Moderately weathered granite
14,000	Slightly weathered and slightly jointed granite bedrock
16,000 - 17,000	Unweathered granite bedrock

The 5200-ft/sec layer could be either dense laterite, or compacted alluvial sediments. This second possibility is suggested by the topography, which has the form of a river terrace. If the tunnel is planned to pass through the 8000-ft/sec layer near Station WT 63, a drill hole is recommended to clarify this point.

Showerbath Creek area

Wolff (1960) records the geology of this area as Herbert River Granite. Personal observations also revealed laterite conglomerate on the creek banks and laterite soil extending to Station WT 112.

Plate 22 shows the seismic cross-section and the measured longitudinal velocities along this traverse. These velocities may be interpreted with the aid of Table 1.

At Station WT 82, the 8500-ft/sec layer is moderately weathered granite. Elsewhere along this cross-section, the 5000-ft/sec layer could be either dense laterite or very weathered granite.

The 14,000-ft/sec velocity in bedrock indicates slightly weathered or slightly jointed granites; the 17,000-ft/sec velocity in bedrock indicates unweathered, unjointed granite.

Blencoe Flats area

This area was mapped by Wolff (1960) as laterite and weathered granite, over granite bedrock.

Plate 23 shows the seismic cross-sections and the measured longitudinal velocities. These velocities may be interpreted as follows:

Velocity (ft/sec)	Geological formation
1200	Soil
3000 - 5000	Decomposed granite or laterite
6500	Very weathered granite
8000 - 9000	Moderately weathered granite
17,000 - 20,000	Unweathered granite bedrock

It was not possible to obtain depths to bedrock between Stations WT 150 and WT 159, and between Stations WT 121 and WT 131, owing to deep weathering. However, the time/distance curve of the spread WT 150 to WT 159 was sufficiently symmetrical to permit the interpolation of the depths between the ends of the spread to a reasonable degree of certainty.

The structure between WT 121 and WT 131 was inferred from the shape of the time/distance curve. It is only approximate and should be confirmed by a drill hole.

Conclusions

In general, a slightly weathered granite or a slightly weathered to unweathered vesicular basalt in which the seismic velocity is 10,000 to 12,000 ft/sec is suitable for tunnels.

Tunnelling in rocks in which seismic velocities are less than 8000 ft/sec may be relatively expensive because of extra supports needed to keep the tunnel open.

11. CAMERON CREEK TUNNEL PORTAL

Geology

Wolff (1960) does not cover this area, but personal observation showed the rocks to be Herbert River Granite, with the remains of an old basalt flow crossing the seismic traverse between Stations WC 13 and WC 17. The surface basalt has been decomposed to small angular boulders and dark soil. Elsewhere the surface cover was the light sandy loam typical of decomposed Herbert River Granite, with occasional granite boulders.

Results

These are shown on Plate 24. At Stations WC 3 and WC 23, the velocities may be interpreted as :

Velocity (ft/sec)	Geological formation
1000	Soil
3000	Very weathered granite
6500	Weathered granite
15,000 - 20,000	Unweathered, unjointed granite.

In the vicinity of Station WC 13, the 6500-ft/sec layer could be moderately weathered basalt. The 9500 and 12,000-ft/sec bedrock velocities are either due to basalt or to fractured and sheared granite.

Conclusions

This site is not very satisfactory for a tunnel portal because of the considerable thickness of 3000-ft/sec and 6500-ft/sec material.

12. CAMERON CREEK DIVERSION

Geology

The geological information was obtained from Wolff (1960), supplemented by data from drill hole HR 15 situated near Station WD 23. The oldest rock consists of Palaeozoic Herbert River Granite. In a later stage, the eroded granite surface was covered by Tertiary basalt flows. The granite shows well-developed jointing, and in places is deeply dissected and weathered along the joints. The basalt is vesicular, porous, and closely jointed. In many places it has been removed by erosion. In this locality, the basalt and granite are covered by Cameron Creek sediments of unconsolidated sand, sandstone, and mudstone, generally less than 20 ft thick.

Results

Plate 25 shows the seismic cross-section and velocities; the latter may be interpreted as follows :

Velocity (ft/sec)	Geological formation
1000 - 2000	Soil, unconsolidated sand and clay
3000 - 4000	Water-saturated clay and sand, very weathered and decomposed granite and basalt
8000 - 9000	Moderately weathered granite, or moderately weathered vesicular basalt
14,000 - 15,000	Unweathered granite, possibly slightly jointed.

Between Stations WD 9 and WD 23 the deepest refractor recorded was a 9000-ft/sec layer, which is interpreted as basalt. The seismic data suggest the presence of a subsurface valley in the granite, some 250 ft deep and filled with basalt.

Conclusions

A drill hole between Stations WD 15 and WD 18 is recommended to confirm the structure in the suggested basalt-filled valley. However, the 8000 to 9000-ft/sec layer of slightly weathered basalt or granite should be suitable to carry a diversion channel or tunnel.

13. RECOMMENDATIONS

Of the three proposed schemes mentioned on Page 1, the geophysical results suggest that the third is the most satisfactory. Although no seismic work was done along the line of the tunnel from Upper Cameron Creek to the Upper Blencoe Creek dam, the geology of the area suggests that tunnelling conditions would be similar to those found along the Kooragwin to Blencoe Creek tunnel line. However, a more suitable site for a tunnel portal should be found on Cameron Creek.

Foundations for both dam sites on Blencoe Creek appear to be satisfactory. However, as the Tanner penstock ridge is much more suitable than the Blencoe penstock ridge, a penstock from Upper Blencoe Creek dam to a power station at the confluence of Tanner Creek and Herbert River is recommended.

As areas of deep weathering and occasional shear zones have been found throughout the investigation area, it is recommended that the total length of the tunnel line and penstock line be surveyed by geophysical methods before any construction work is commenced.

14. REFERENCES

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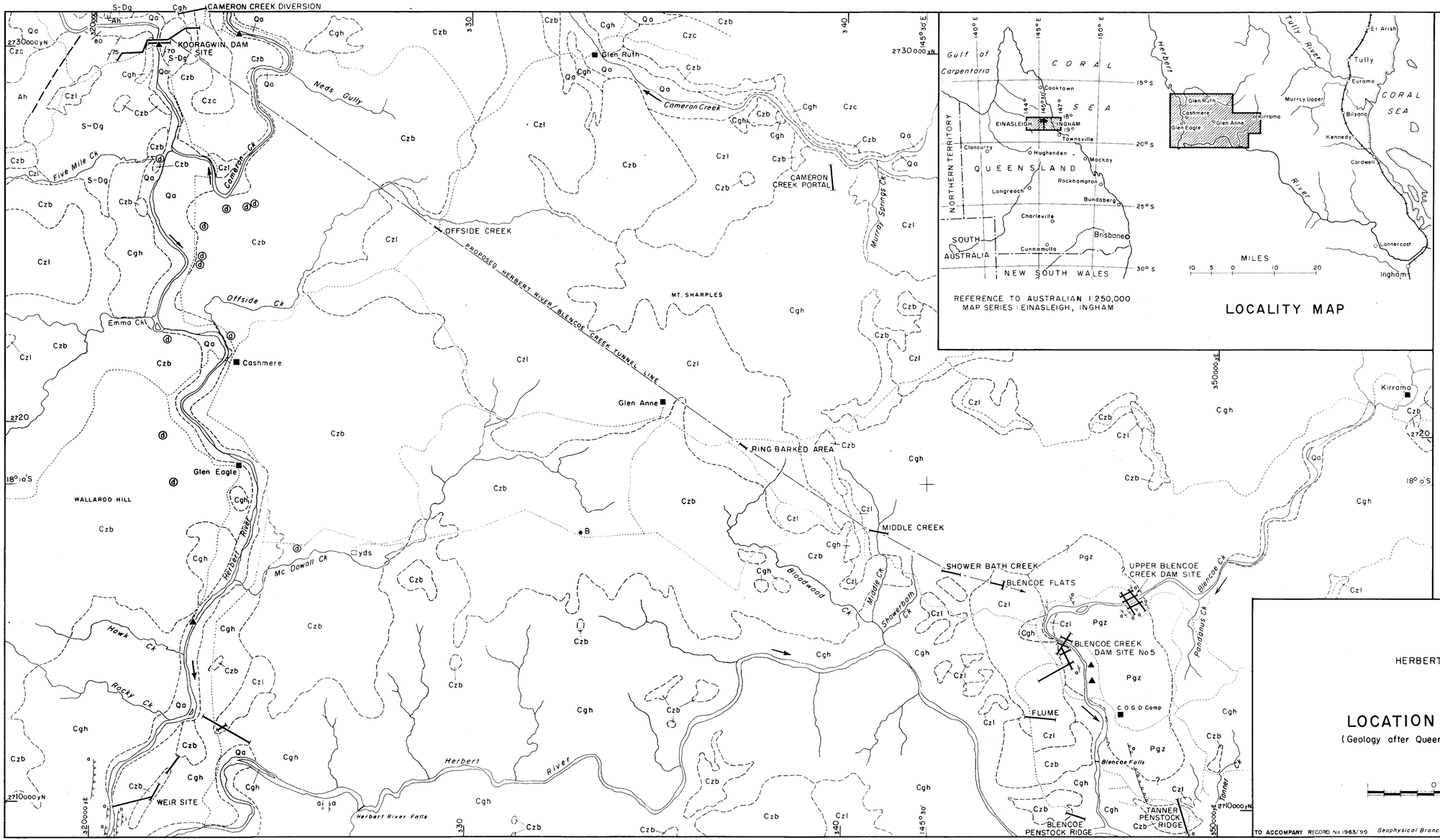
PLATE I

LEGEND

Qa		QUATERNARY	CAINOZOIC
Czc	Cameron Creek Formation	TERTIARY	CAINOZOIC
Czl	Laterite and Laterite soil	TERTIARY	CAINOZOIC
Czb	Olivine basalt	TERTIARY	CAINOZOIC
Pgz	Elizabeth Creek Granite	? PERMIAN	PALAEOZOIC
Pgt	Tiger Hill Microgranite	? PERMIAN	PALAEOZOIC
Cgh	Herbert River Granite	? CARBONIFEROUS	PALAEOZOIC
S-Dg	Mt. Garnet Formation	SILURO-DEVONIAN	PALAEOZOIC
Ah	Halls Reward Metamorphics	ARCHAEAN	PRECAMBRIAN

- Geological boundary
- 70 Strike and dip of strata
- Fault
- Diatomite deposit
- Dyke a - acid, i - intermediate
- Vehicle track
- Homestead
- B Bore
- Gauging station
- Geophysical traverse

M.N. T.N. 8°



REFERENCE TO AUSTRALIAN 1:250,000 MAP SERIES: EINASLEIGH, INGHAM

LOCALITY MAP

HERBERT RIVER HYDRO-ELECTRIC INVESTIGATION, QUEENSLAND 1961.

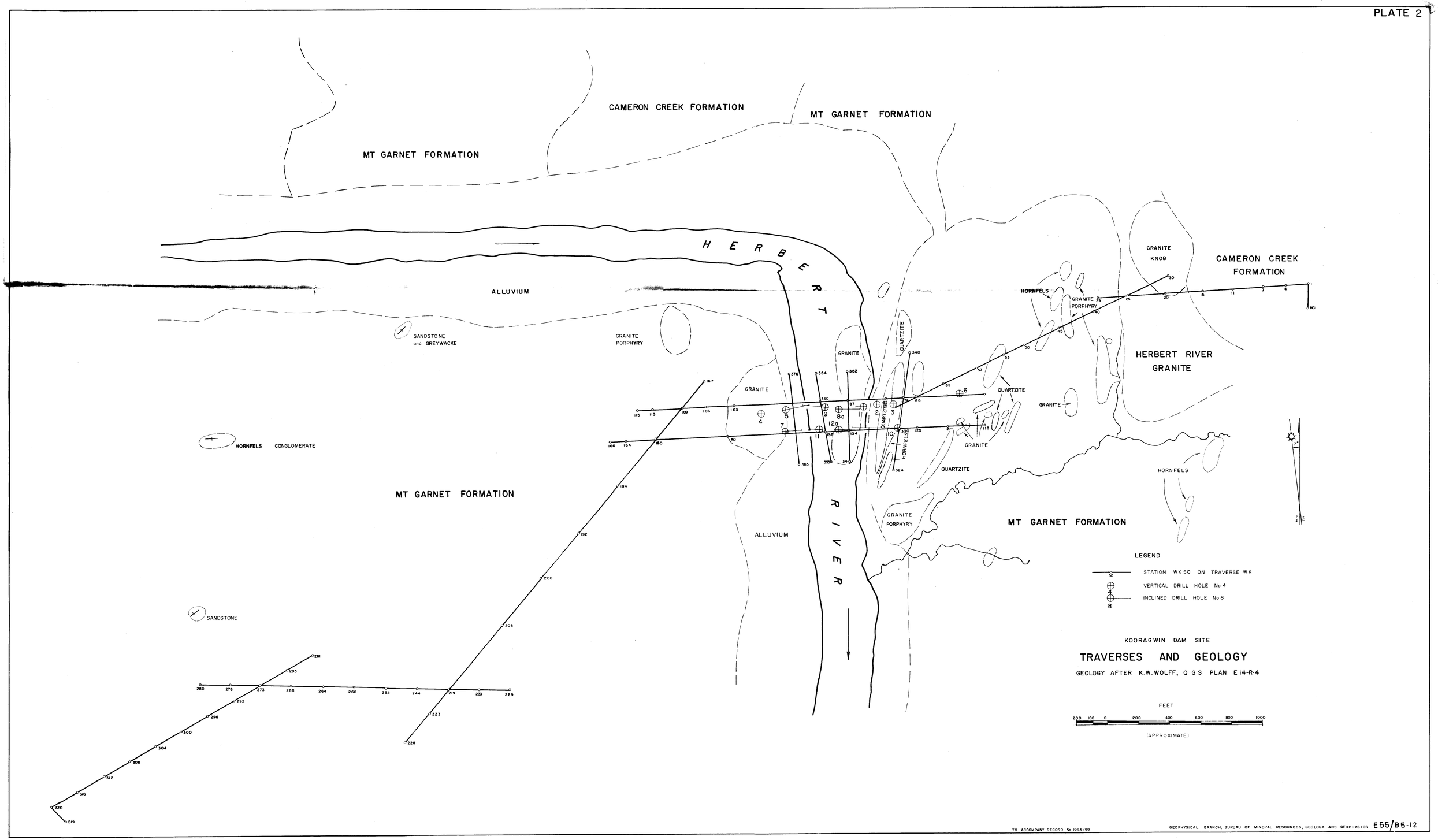
GEOLOGY AND LOCATION OF GEOPHYSICAL TRAVERSES

(Geology after Queensland Department of Development and Mines, plan E14-A-5)

MILES 1 0 1 2 3 4

TO ACCOMPANY RECORD No 1963/99 *Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics*

E 55/ B 5-11

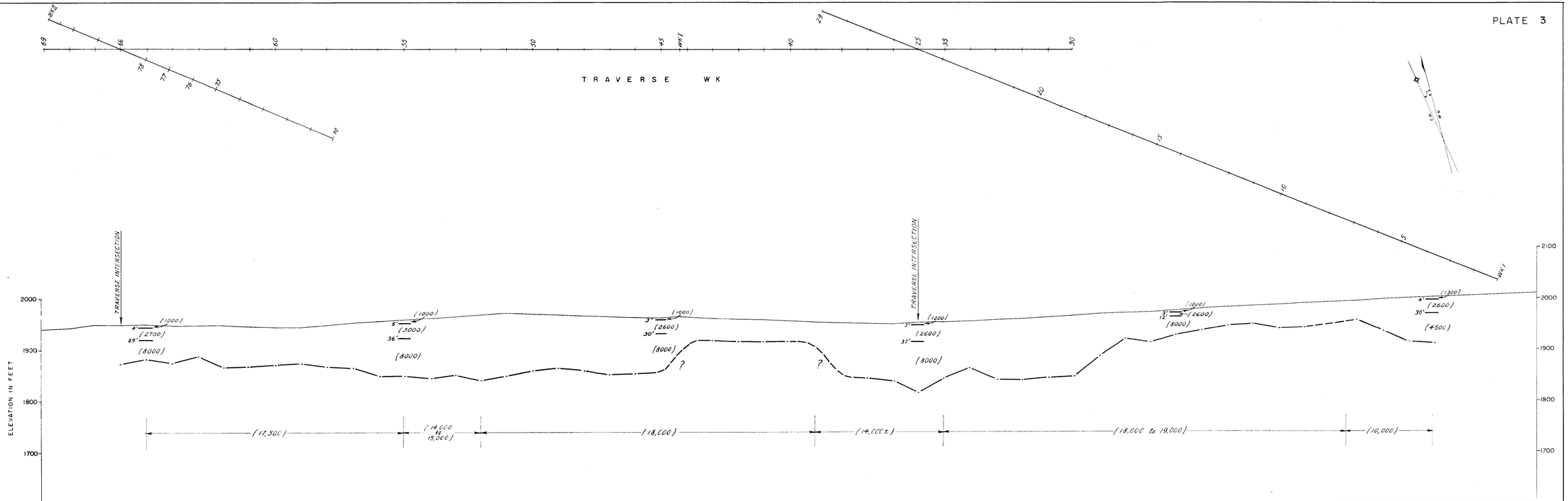


TO ACCOMPANY RECORD No 1963/99

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS E55/B5-12

HERBERT RIVER QLD 1962

PLATE 3



STATION NUMBER	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	WK1 44	43	42	41	40	39	38	37	36	35	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	WK1
STATION ELEVATION	1945	1950	1950	1950	1950	1950	1949	1950	1947	1947	1944	1949	1935	1953	1951	1961	1963	1965	1969	1973	1974	1972	1970	1968	1967	1966	1964	1963	1962	1962	1962	1958	1957	1957	1955	1959	1957	1956	1956	1958	1959	1962	1964	1966	1970	1970	1973	1976	1977	1980	1983	1986	1988	1988	1991	1992	1995	1997	1999	2002	2003	2005	2006	2010	2011
DEPTH TO BEDROCK				(15)	66	72	58	82	78	73	69	86	56	106	108	171	113	127	122	110	103	103	112	108	108	145	41	42	42	(39)	(39)	(108)	103	112	135	108	49	115	118	115	115	79	48	57	46	42	35	35	44	46		37	59	85	96					

LEGEND

50 — Geophysical traverse with station number

(2000) — Formation with seismic velocity of 2000 ft/sec

15′ — Depth to formation with different seismic velocity

— · — Bedrock boundary

HORIZONTAL AND VERTICAL SCALES IN FEET

100 50 0 100 200 300

LEVELS TO STATE DATUM

NOTE: Topography from Coordinator General's Department Plans H1093 and H1094

TO ACCOMPANY RECORD No 1963/99

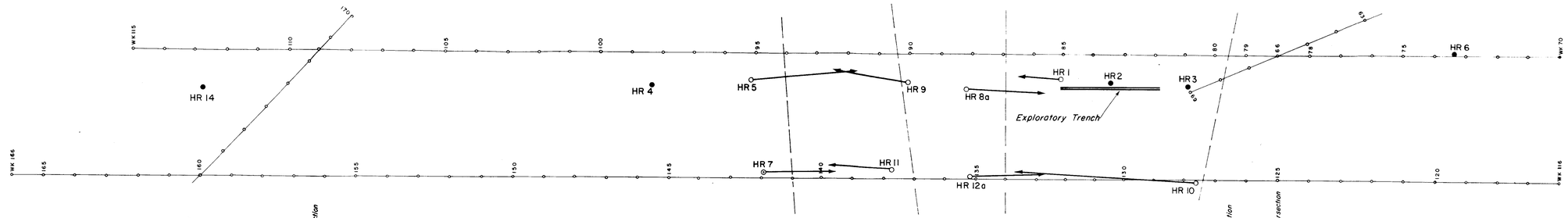
KOORAGWIN DAM SITE

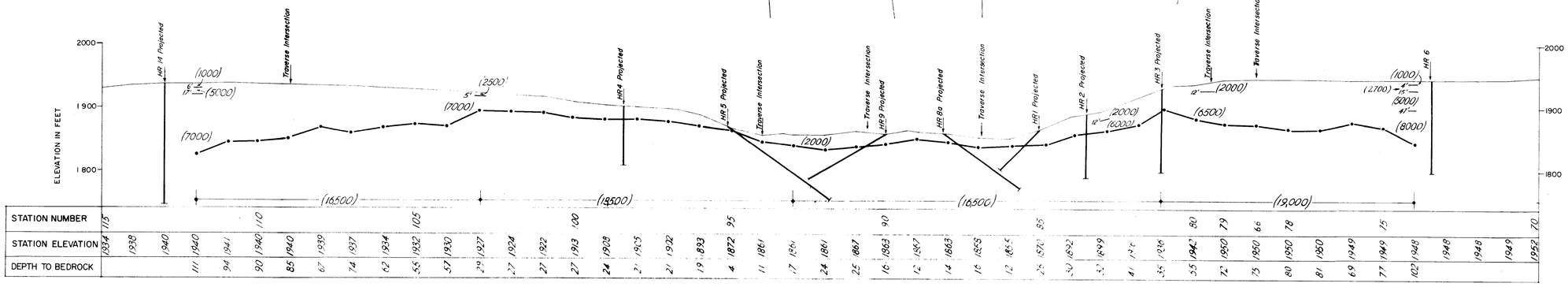
LAYOUT OF TRAVERSES AND SEISMIC CROSS-SECTION

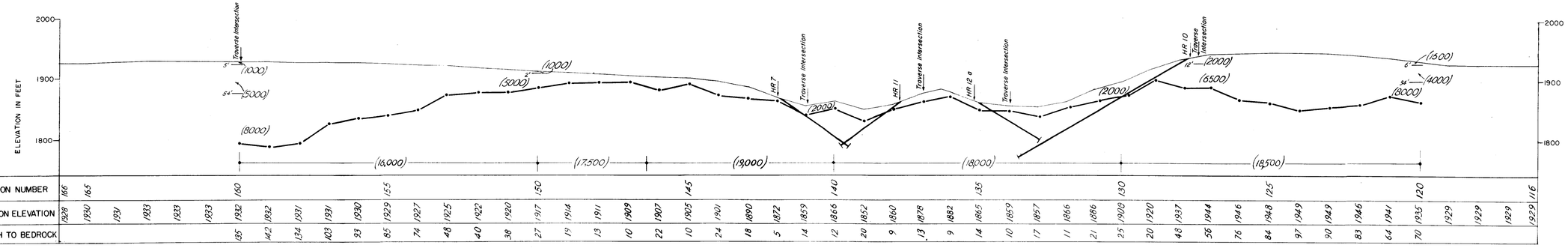
BETWEEN STATIONS WK 1 & WK 69

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E 55/B5-13

HERBERT RIVER, N.Q. QLD







LEGEND

- Geophysical traverse with station number
- (2000) Formation with seismic velocity of 2000 ft/sec
- 15' Depth to formation with different seismic velocity
- Bedrock boundary
- Diamond drill hole (vertical)
- " " " (depressed)

Based on COG Drawing H1095, H1096, H1097

FEET

100 0 100 200

(Horizontal and Vertical)

Level Datum: Station 311. R.L. 1879' (State Datum)

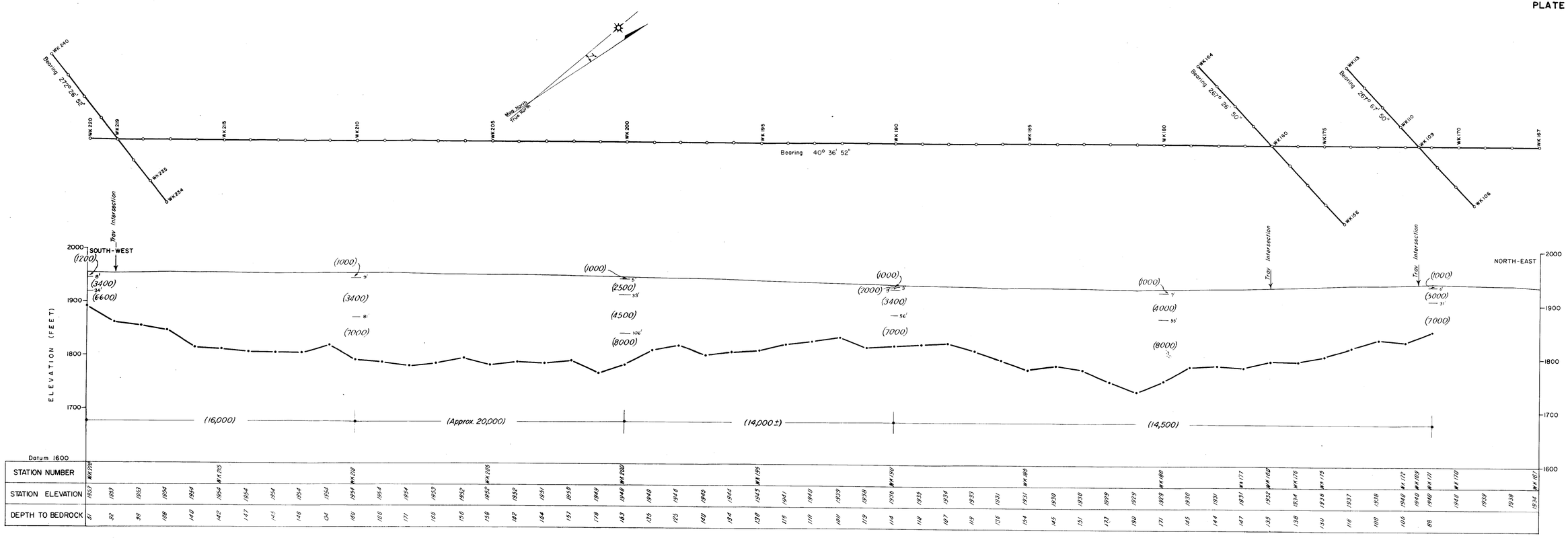
KOORAGWIN DAM SITE

LAYOUT OF TRAVERSES AND SEISMIC CROSS-SECTIONS BETWEEN STATIONS WK 70 AND WK 166

HERBERT RIVER DAM SITES QUEENSLAND 1962

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B5-14

To accompany Record No. 1963/99



FEET

100 50 0 100 200 300

Levels to State Datum

WK 123 — Geophysical traverse with station number

(2000) — Formation with seismic velocity of 2000 ft/sec

31' — Depth to formation with different seismic velocity

Bedrock boundary

Based on C O G Drawing H 1098

KOORAGWIN DAM SITE

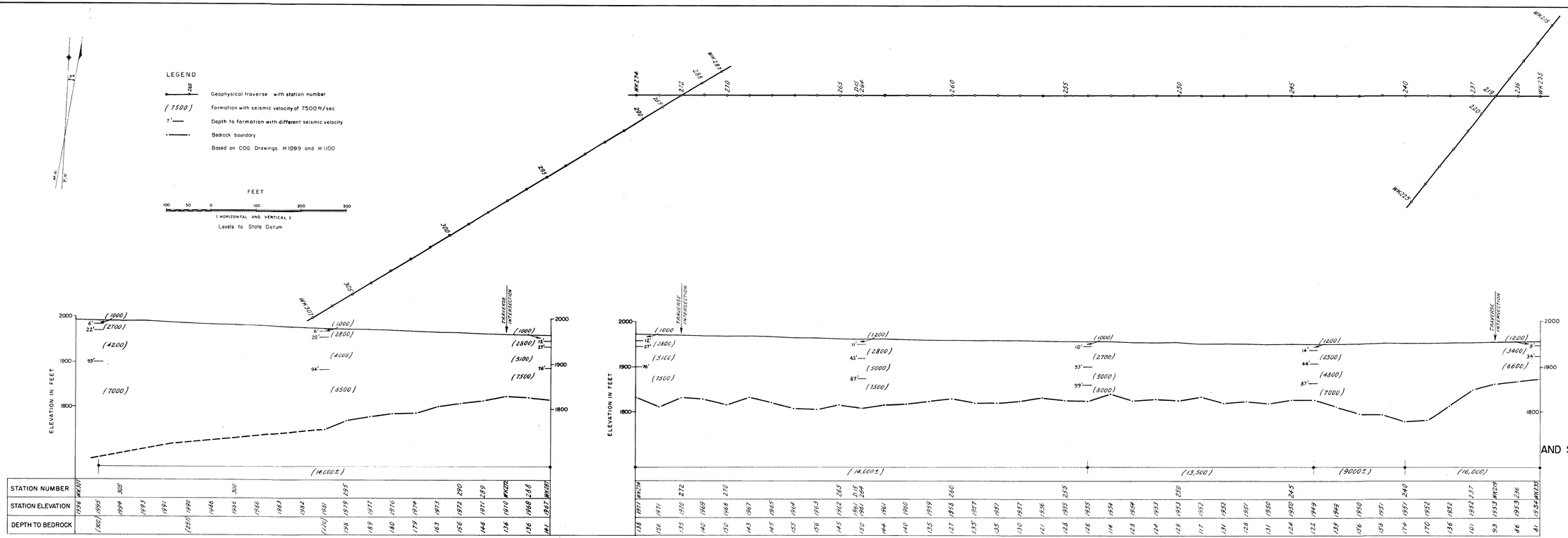
LAYOUT OF TRAVERSES AND SEISMIC CROSS-SECTION

BETWEEN STATIONS WK 167 & WK 220

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics **E55/B5-15**

HERBERT RIVER, QLD 1962



KOORAGWIN DAM SITE

LAYOUT OF TRAVERSES AND SEISMIC CROSS-SECTIONS BETWEEN STATIONS WK 235 AND WK 307

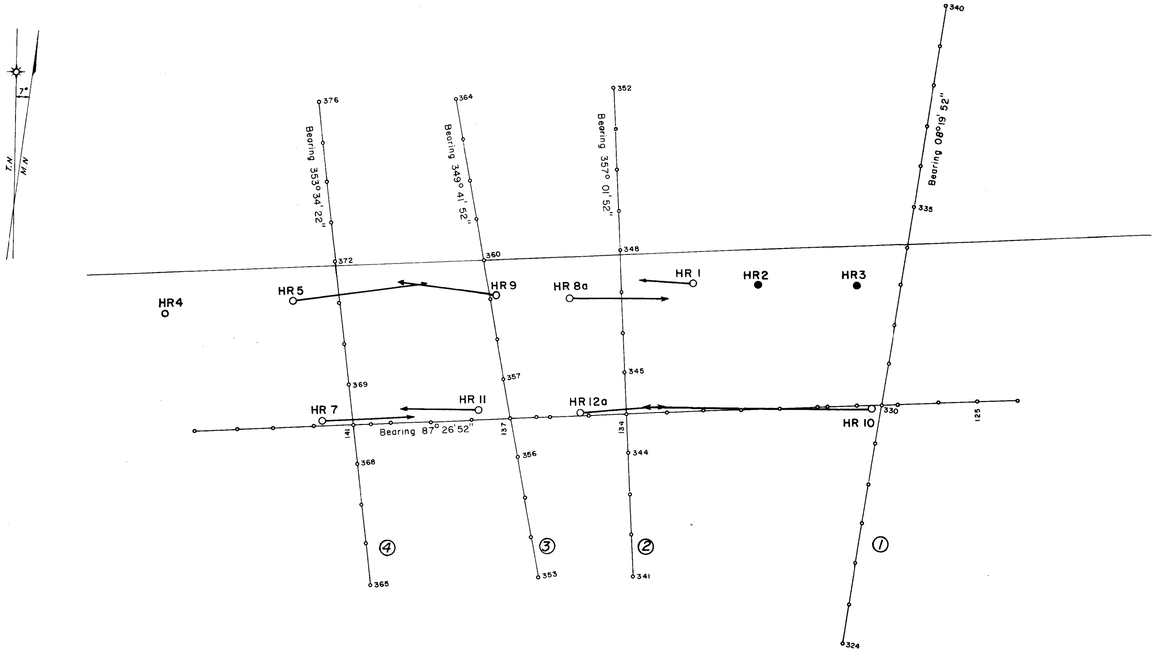
TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E 55/B5-16

KOORAGWIN DAM SITE, QLD 1961

KOORAGWIN DAM SITE

LAYOUT OF TRAVERSES AND SEISMIC CROSS-SECTIONS BETWEEN STATIONS WK 324 AND WK 376



LEGEND

- 125 — Geophysical traverse with station number
- (2000) — Formation with seismic velocity of 2000 ft/sec
- 12' — Depth to formation with different seismic velocity
- Bedrock boundary
- Diamond drill hole (vertical)
- " " " (depressed)

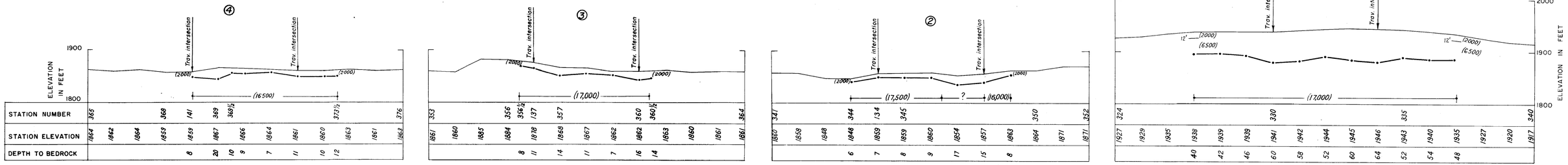
Based on COG Drawing H 1097

FEET

100 0 100 200 300

(Horizontal and Vertical)

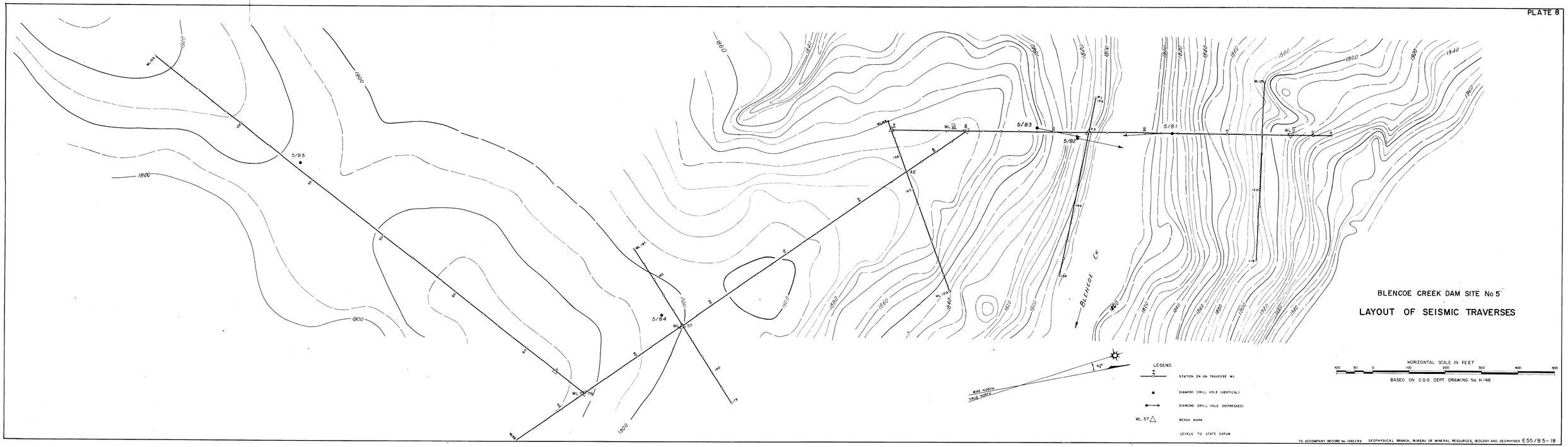
Level Datum: Station 311. R.L. 1879' (State Datum)



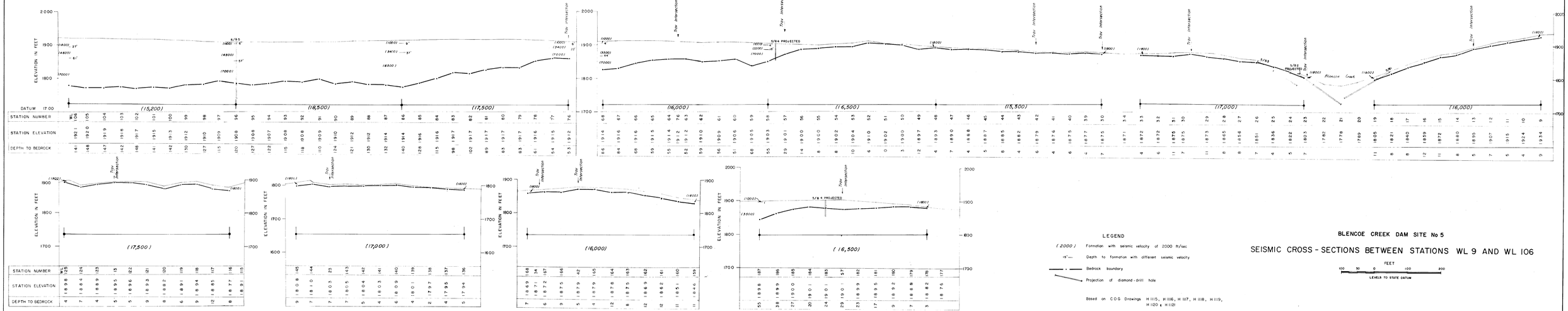
TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. E 55/B5-17

HERBERT RIVER:- KOORAGWIN, QLD, 1961



BLENCOE DAM SITE No 5 QLD 1962



LEGEND

(2000) Formation with seismic velocity of 2000 ft/sec

15'— Depth to formation with different seismic velocity

Bedrock boundary

Projection of diamond-drill hole

Based on C.O.G. Drawings H 1115, H 1116, H 1117, H 1118, H 1119, H 1120 & H 1121

BLENCOE CREEK DAM SITE No 5

SEISMIC CROSS-SECTIONS BETWEEN STATIONS WL 9 AND WL 106

FEET

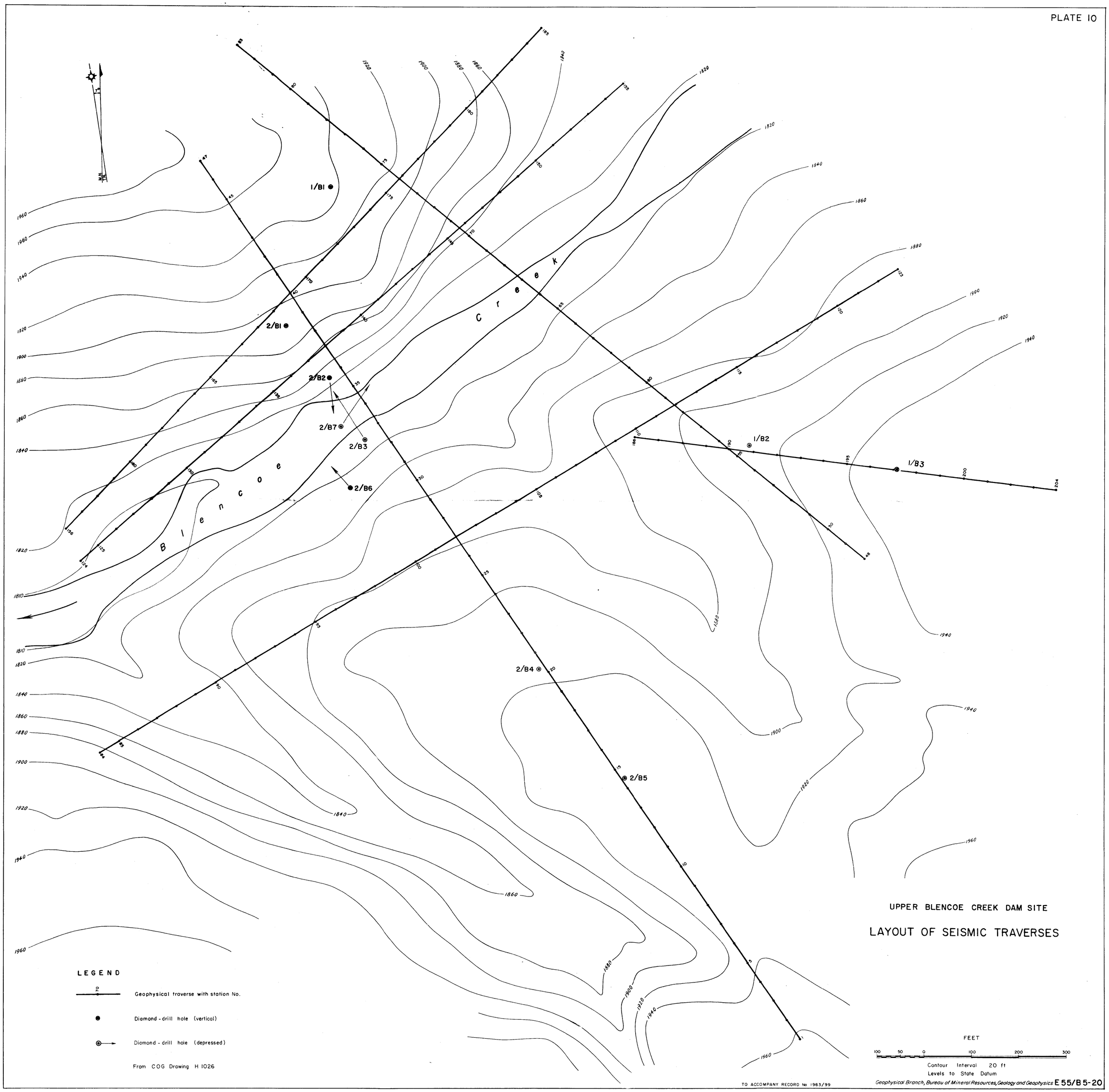
100 50 0 100 200

LEVELS TO STATE DATUM

TO ACCOMPANY RECORD No 1963/59

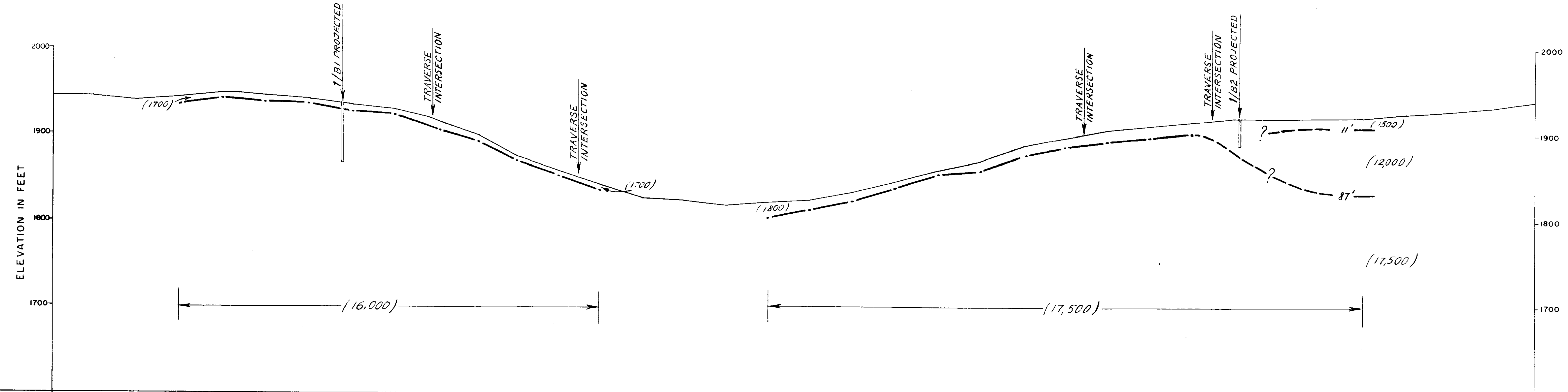
GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS E55/B5-19

BLENCOE DAM SITE No 5 QLD 1962

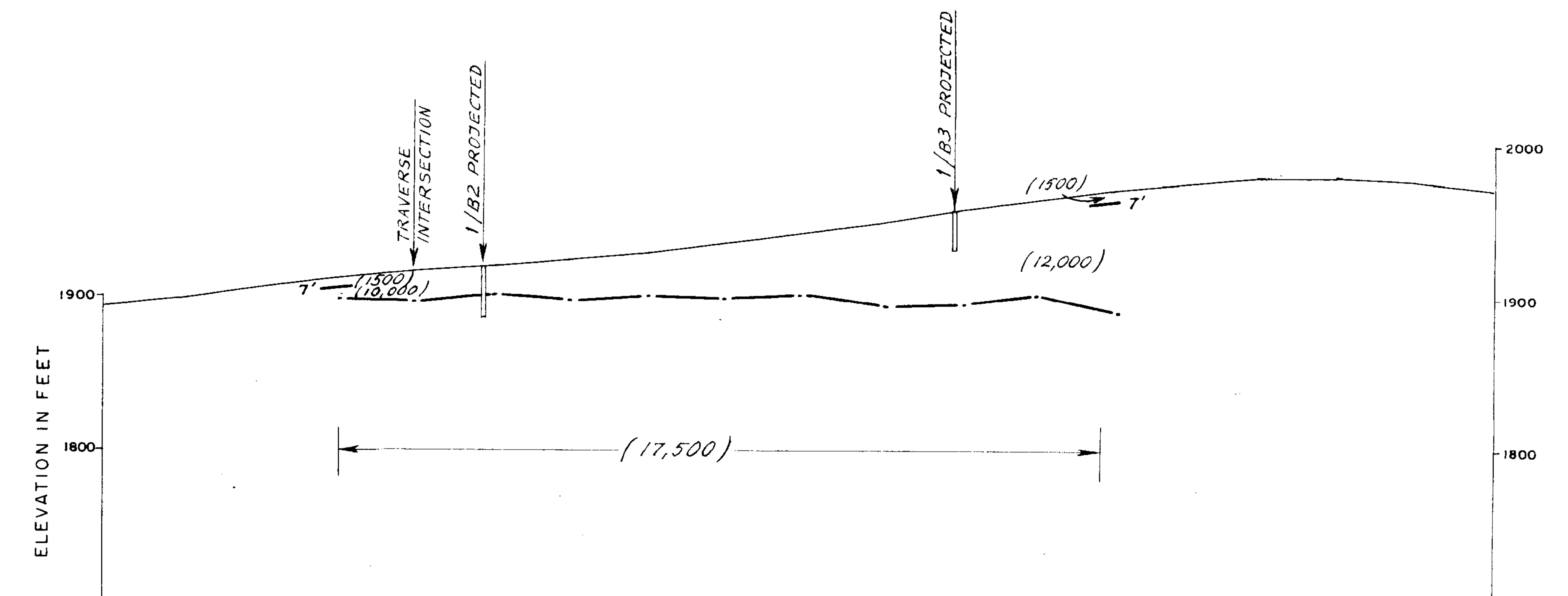


Herbert River" Qld 1961

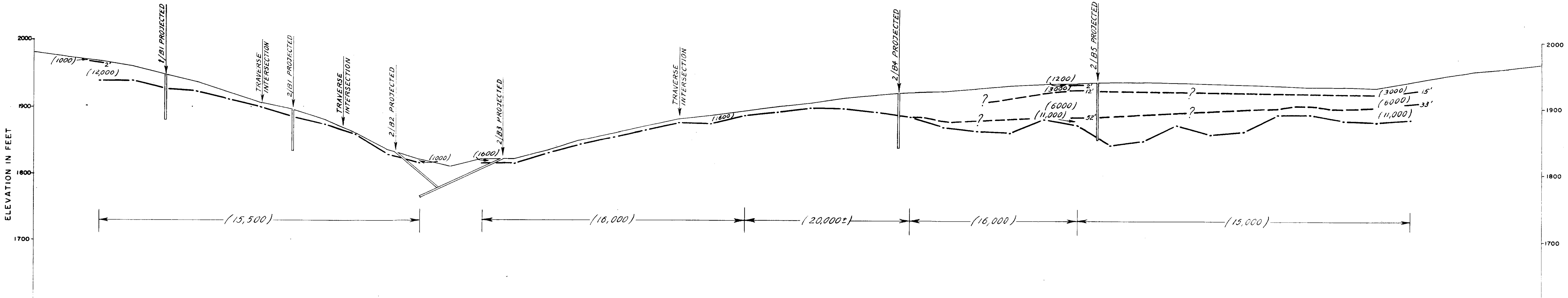
PLATE 11



STATION NUMBER	WU83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	WU48
STATION ELEVATION	1944	1944	1938	1943	1948	1945	1940	1933	1928	1915	1899	1875	1858	1842	1827	1823	1819	1822	1824	1834	1846	1860	1869	1886	1897	1905	1910	1915	1919	1919	1919	1919	1924	1928	1932	1938
DEPTH TO BEDROCK				7	6	7	5	7	5	10	5	4	4	5				17	9	8	7	4	10	9	11	12	14	13				87				



STATION NUMBER	WU186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	WU204
STATION ELEVATION	1893	1900	1907	1913	1918	1921	1926	1931	1938	1944	1951	1959	1966	1972	1977	1981	1981	1979	1974
DEPTH TO BEDROCK				14	20	18	26	28	35	40	54	60	61	79					



STATION NUMBER	WU47	46	45	44	43	42	41	40	39	38	37	36	35	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	WU1
STATION ELEVATION	1980	1974	1968	1959	1948	1937	1921	1905	1895	1880	1861	1835	1821	1811	1823	1823	1837	1852	1861	1872	1884	1890	1899	1904	1909	1917	1921	1925	1928	1932	1935	1938	1939	1940	1940	1940	1938	1936	1935	1933	1933	1931	1940	1950	1956	1961	1967
DEPTH TO BEDROCK			28	21	21	12	8	3	8	4	1	5	4		6	6	4	6	6	6	7	13	8	8	7	17	27	37	54	66	72	53	65	94	88	63	76	70	45	44	52	53	57				

LEGEND

(1000)	Formation with seismic velocity of 1000 ft/sec
15'	Depth to formation with different seismic velocity
—·—	Bedrock boundary
╥	Projection of diamond-drill hole

UPPER BLENCOE CREEK DAM SITE

SEISMIC CROSS – SECTIONS

BETWEEN STATIONS WU 1 & WU 83, & STATIONS WU185 & WU 204

HORIZONTAL AND VERTICAL SCALES IN FEET

100 50 0 100 200 300

LEVELS TO STATE DATUM

From COG Drawings H 1106, H 1107, and H 1122

TO ACCOMPANY RECORD No 1963/99

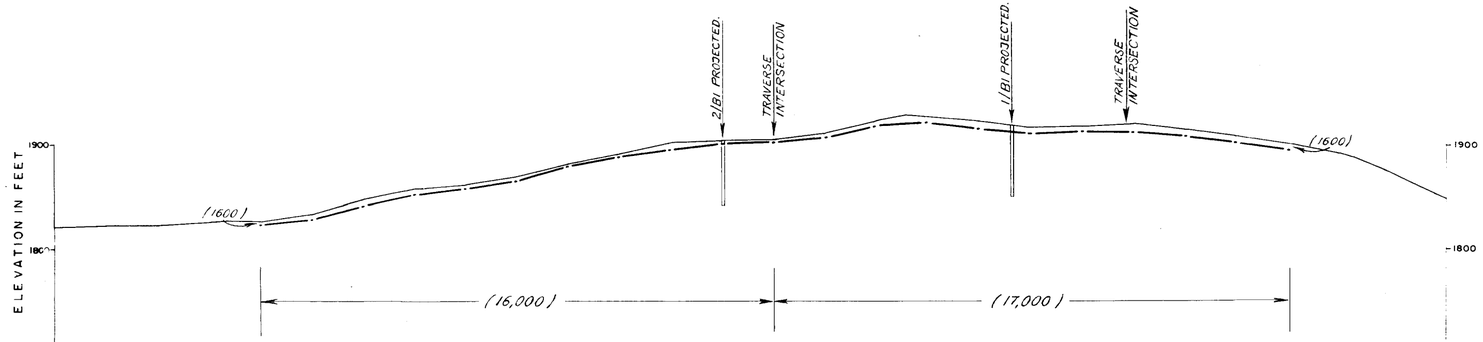
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics F55/B5-21

UPPER BLENCOE, 1961 QLD

UPPER BLENCOE CREEK DAM SITE

SEISMIC CROSS-SECTIONS

BETWEEN STATIONS WU 84 & WU185



STATION NUMBER	WU185	157	158	159	160	161	162	163	164	165	166	167	168	169	WU140	170	171	172	173	174	175	176	177	178	179	180	181	182
STATION ELEVATION	1820	1822	1822	1826	1826	1833	1847	1855	1861	1869	1882	1892	1901	1904	1905	1911	1923	1928	1922	1918	1918	1921	1915	1908	1901	1892	1877	1853
DEPTH TO BEDROCK					2	3	5	5	2	2	1	2	6	2	2	3	4	6	6	5	3	7	6	7	6			

LEGEND

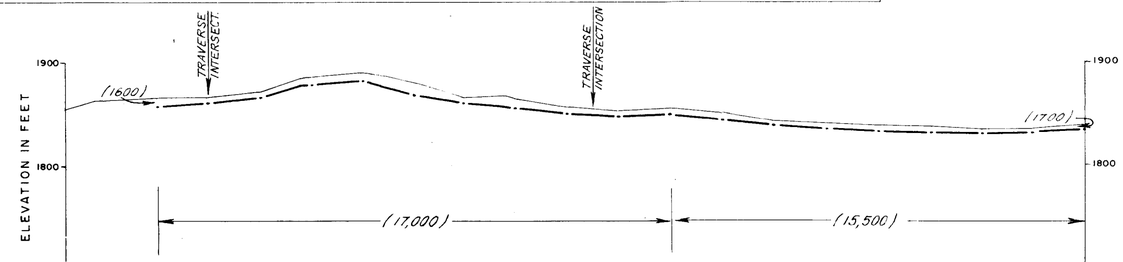
(16,000) Formation with seismic velocity of 16,000 ft/sec

Bedrock boundary

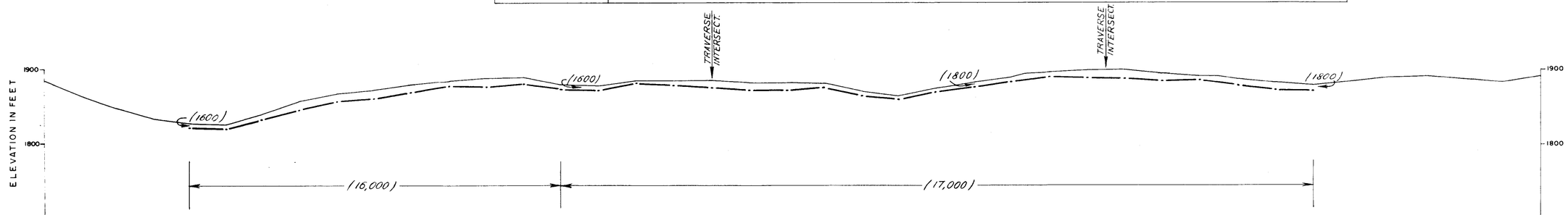
HORIZONTAL AND VERTICAL SCALES IN FEET

100 50 0 100 200 300

LEVELS TO STATE DATUM



STATION NUMBER	WU137	WU136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155
STATION ELEVATION	1862	1862	1865	1864	1870	1883	1888	1878	1865	1862	1854	1850	1853	1849	1841	1839	1837	1836	1833	1834	1838
DEPTH TO BEDROCK			8	6	5	8	7	10	5	6	5	4	5	6	3	4	5	6	5	3	7



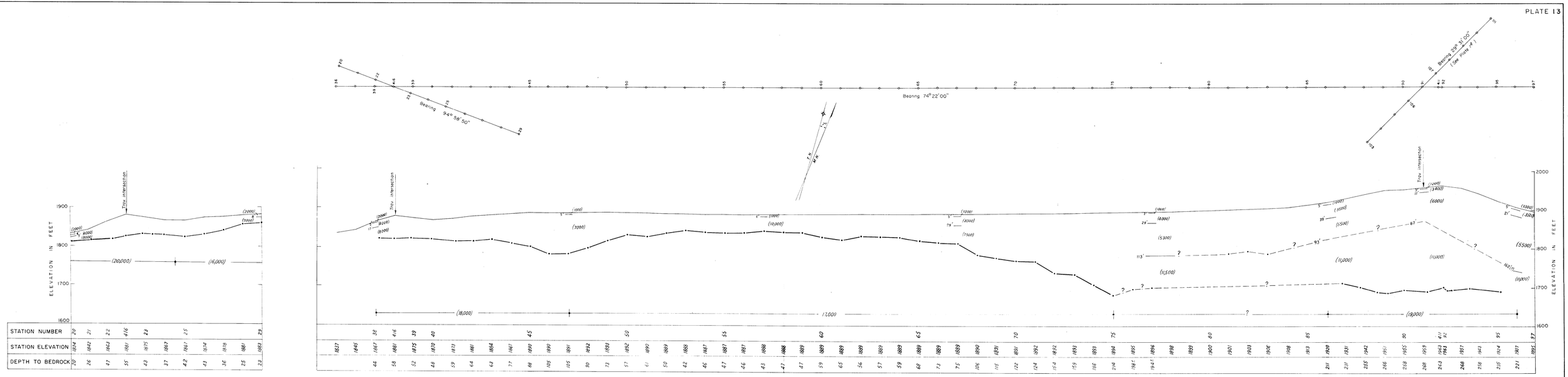
STATION NUMBER	WU84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	WU27	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123
STATION ELEVATION	1883	1866	1849	1837	1831	1828	1841	1859	1869	1874	1881	1886	1890	1891	1881	1818	1886	1884	1884	1881	1883	1881	1870	1864	1875	1882	1890	1895	1899	1900	1894	1890	1886	1883	1878	1882	1888	1890	1885	1881	1889
DEPTH TO BEDROCK					6	6	7	10	9	10	10	7	10	8	7	4	2	4	8	9	8	5	5	3	4	7	6	6	9	10	11	5	7	9	6						

From COG Drawings H 1110, H 1109, H 1108

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B5522

UPPER BLENCOE, 1981 QLD



LEGEND

- Geophysical traverse with station number
- (7000) Formation with seismic velocity of 7000 ft/sec
- 8 Depth to formation with different seismic velocity
- Bedrock boundary

Based on COG Drawings H 1127 and H 1128

FEET

100 0 100 200 300

(Horizontal and Vertical)

LEVELS TO STATE DATUM

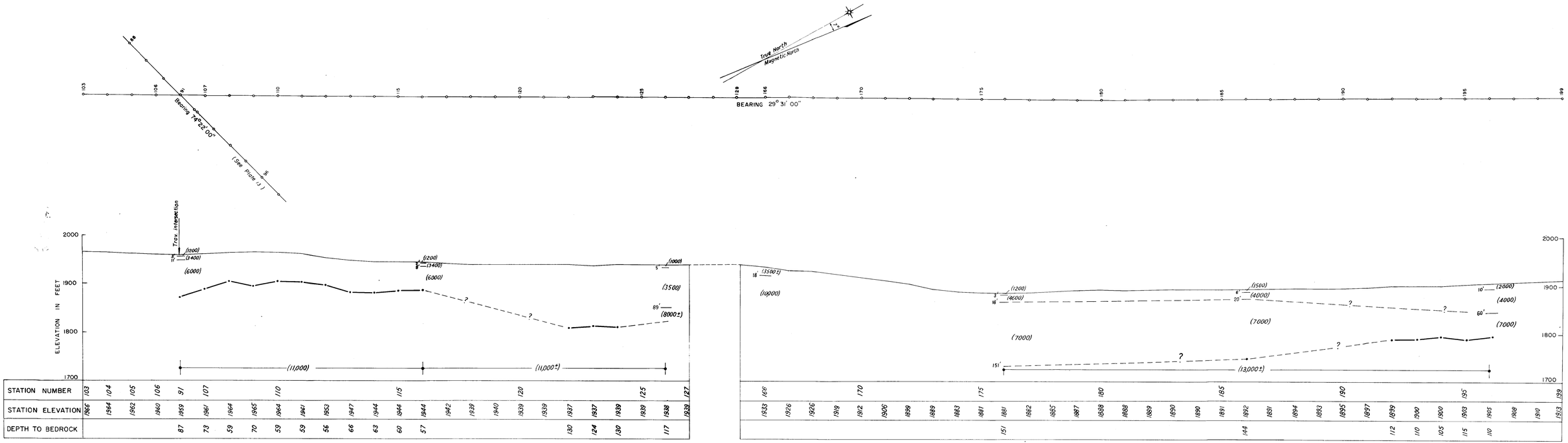
WEIR SITE

LAYOUT OF TRAVERSES AND SEISMIC CROSS-SECTIONS

BETWEEN STATIONS W W 20 & W W 29, AND STATIONS WW 36 & WW97

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B5-23



LEGEND

- Geophysical traverse with station number
- (7000) Formation with seismic velocity of 7000 ft/sec
- 8' Depth to formation with different seismic velocity
- Bedrock boundary

Based on COG Drawings H 1140 and H 1141

FEET
100 0 100 200 300
(Horizontal and Vertical)

Level Datum: Station 311. R.L. 1879' (State Datum)

WEIR SITE

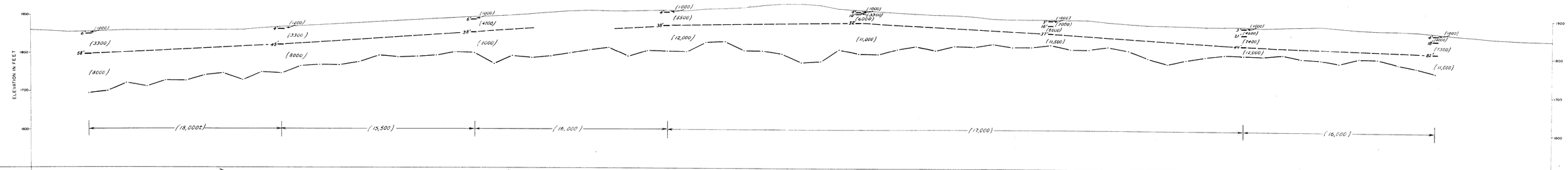
LAYOUT OF TRAVERSES AND SEISMIC CROSS-SECTIONS

BETWEEN STATIONS W W 103 & W W 127, & STATIONS W W 166 & W W 199

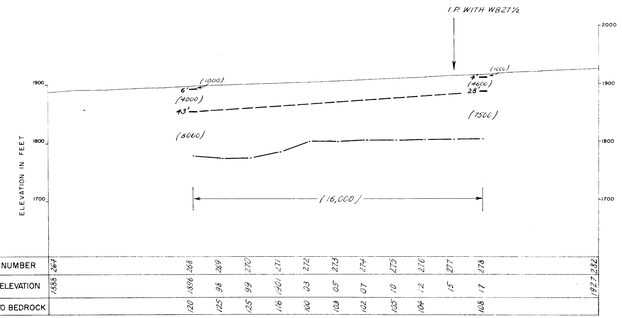
TO ACCOMPANY RECORD 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics. E 55/B5-24

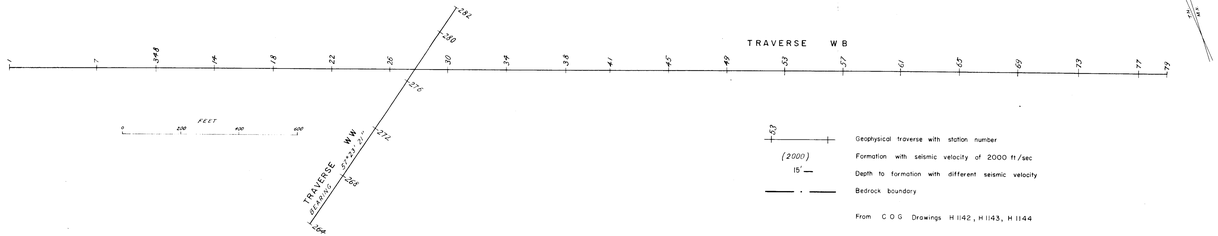
HERBERT RIVER, QLD. 1961



STATION NUMBER	1	4	5	6	7	8	9	10	348	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74
STATION ELEVATION	1664	161	162	166	166	166	165	164	163	163	169	169	172	175	178	181	182	186	188	189	193	193	196	1602	194	198	192	198	196	195	195	192	192	191	191	192	194	194	194	192	192	191	191	192	192	192	194	194	194	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	1664
DEPTH TO BEDROCK		161	156	137	146	130	132	118	113	129	115	120	103	101	108	101	86	86	93	93	85	90	122	101	114	112	108	101	95	115	122	105	105	87	37	112	119	129	152	146	107	114	112	96	85	92	75	73	73	65	72	71	67	76	76	63	63	67	94	89	77	72	75	73	70	96	73	70	73	73	57	90	102



STATION NUMBER	264	265	269	270	271	272	273	274	275	276	277	278	282
STATION ELEVATION	1688	1696	98	96	100	93	90	80	87	90	95	97	1737
DEPTH TO BEDROCK		120	125	125	116	120	90	80	102	100	100	108	



63 — Geophysical traverse with station number

(2000) — Formation with seismic velocity of 2000 ft/sec

15' — Depth to formation with different seismic velocity

Bedrock boundary

From C O G Drawings H 1142, H 1143, H 1144

WEIR SITE

LAYOUT OF TRAVERSES AND SEISMIC CROSS-SECTIONS

BETWEEN STATIONS W W 268 & W W 278, & STATIONS WB 4 & WB 73

HORIZONTAL AND VERTICAL SCALES IN FEET

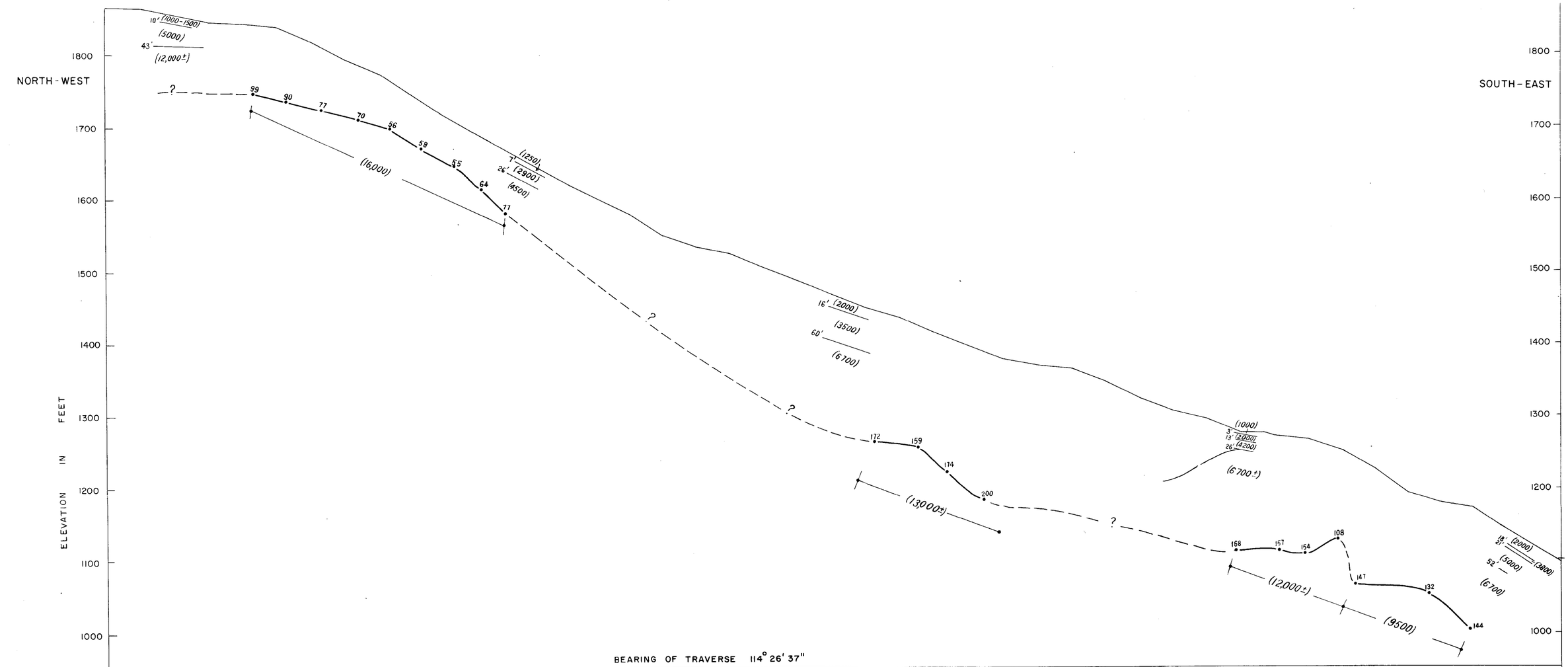
100 50 0 100 200 300

Levels to State Datum

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B5-25

HERBERT RIVER, 1961 QLD



STATION NUMBER	2	3	G31	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	35	36	37	38	39	40	41	42	43	44	45	46
STATION ELEVATION	1866	1865	1864	1856	1846	1843	1839	1819	1795	1773	1747	1720	1633	1669	1644	1620	1599	1578	1550	1533	1523	1506	1486	1467	1448	1434	1415	1397	1377	1368	1364	1345	1322	1305	1294	1275	1271	1264	1248	1223	1191	1176	1169	1144	1119	1095

LEGEND

(6700) Formation with seismic velocity of 6700 ft/sec

3' 70 56 Depth to formation with different seismic velocity
Bedrock boundary, with depths in feet

Based on COG Drawing H 1111

FEET
100 0 100 200 300
(Horizontal and Vertical)

Level Datum: Station 311. R.L. 1879' (State Datum)

BLENCOE PENSTOCK RIDGE

SEISMIC CROSS-SECTION

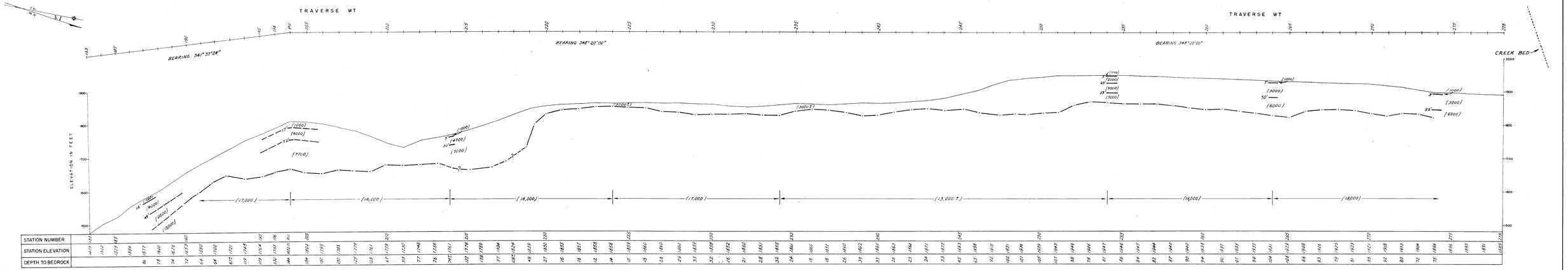
BETWEEN STATIONS WP 3 & WP 46

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. E55/B5-26

HERBERT RIVER, QLD. 1961, PENSTOCK BLENCOE

PLATE 17



LEGEND

- 245 — Geophysical traverse with station number
- (2000) — Formation with seismic velocity of 2000 ft/sec
- 6' — Depth to formation with different seismic velocity
- Bedrock boundary

From COG Drawings H1150, H1151, H1152

TANNER PENSTOCK RIDGE

LAYOUT OF TRAVERSE AND SEISMIC CROSS-SECTION

BETWEEN STATIONS WT187 AND WT 274

HORIZONTAL AND VERTICAL SCALES IN FEET

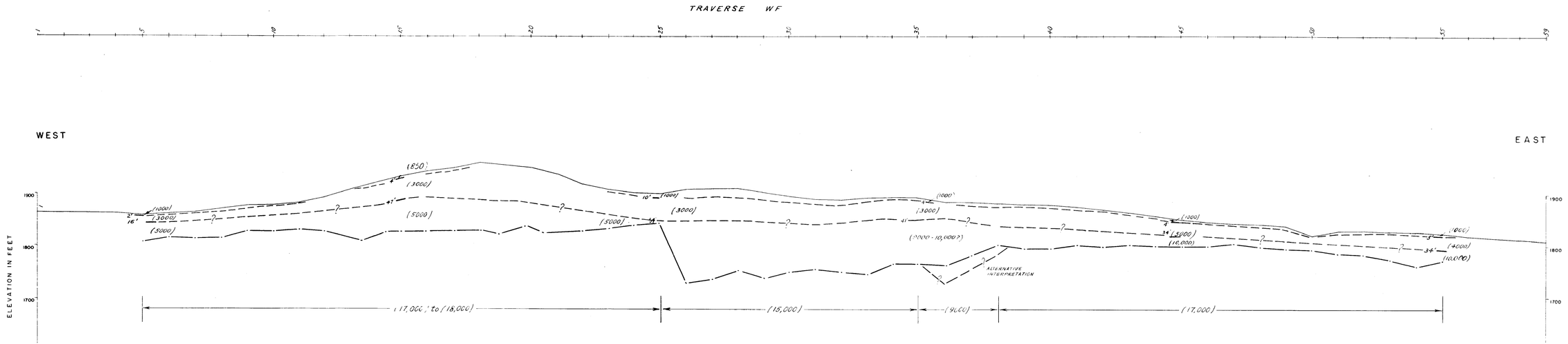
100 50 0 100 200 300 400

Levels to State Datum

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E 55/B5-27

HERBERT RIVER, 1961 QLD



STATION NUMBER	1		5			10				15				20				25				30				35				40				45				50				55		59
STATION ELEVATION	1864	1862	1859	1861	1866	1873	1880	1880	1885	1886	1912	1925	1938	1946	1953	1953	1959	1959	1952	1942	1933	1912	1885	1864	1912	1913	1914	1905	1900	1892	1892	1892	1898	1899	1897	1897	1888	1888	1885	1882	1882	1879	1873	1865	1859	1852	1845	1846	1843	1839	1821	1829	1832	1828	1827	1824	1819		1810
DEPTH TO BEDROCK			51	45	51	56	50	51	51	66	90	96	101	115	120	129	130	110	113	92	75	61	56	180	172	158	161	144	132	131	146	127	125	118	99	79	93	83	83	71	71	60	58	51	44	41	44	44	28	44	46	55	64	53			

LEGEND

- Geophysical traverse with station number
- (1000) Formation with seismic velocity of 1000 ft/sec
- 4' Depth to formation with different seismic velocity
- Bedrock boundary

From COG drawing H1153-4

BLENCOE FLUME LINE

LAYOUT OF TRAVERSE AND SEISMIC CROSS-SECTION

BETWEEN STATIONS WF 5 & WF55

HORIZONTAL AND VERTICAL SCALES IN FEET

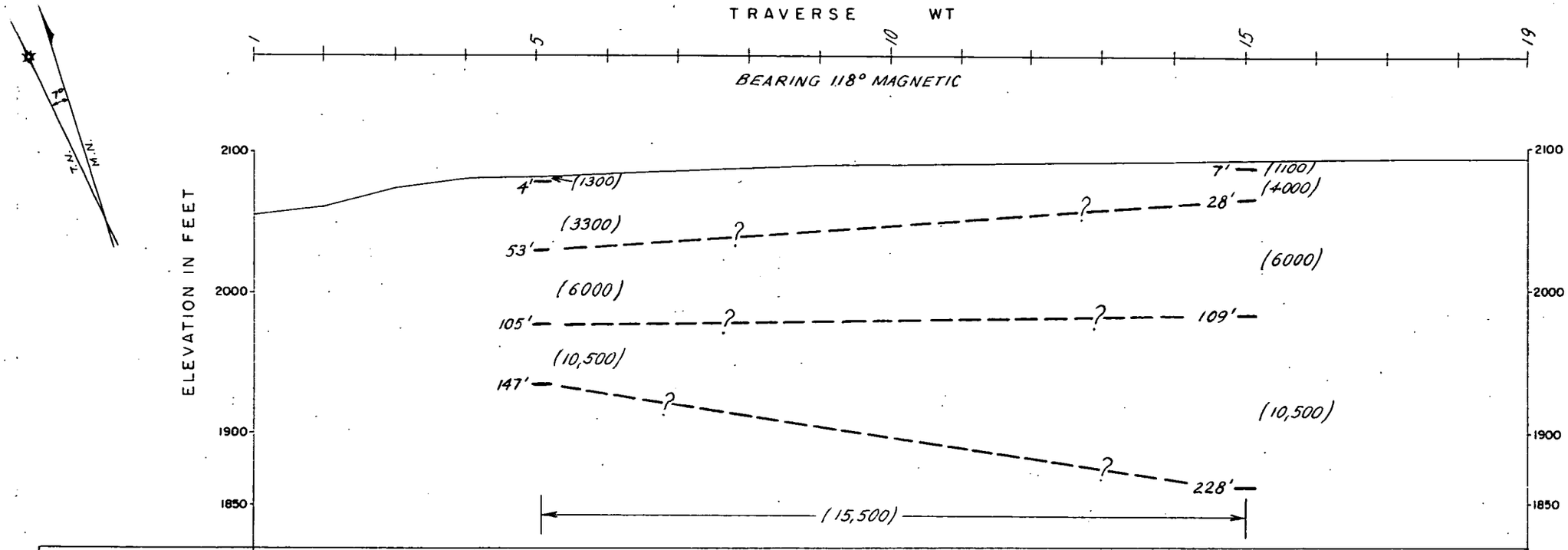
100 50 0 100 200 300 400

LEVELS TO STATE DATUM

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B5-28

HERBERT RIVER, 1961 QLD



STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
STATION ELEVATION	2054	2060	2073	2079	2081	2084	2086	2089	2090	2090	2091	2091	2092	2092	2093				2095
DEPTH TO BEDROCK					147'										228'				

LEGEND

5 — Geophysical traverse with station number

(6000) — Formation with seismic velocity of 6000 ft /sec

— —53'— — Depth to formation with different seismic velocity

FROM C.O.G. PLAN H-1133

TUNNEL LINE-OFFSIDE CREEK AREA
LAYOUT OF TRAVERSE AND SEISMIC CROSS-SECTION
BETWEEN STATIONS WT 52 WT 15

HORIZONTAL AND VERTICAL SCALES IN FEET

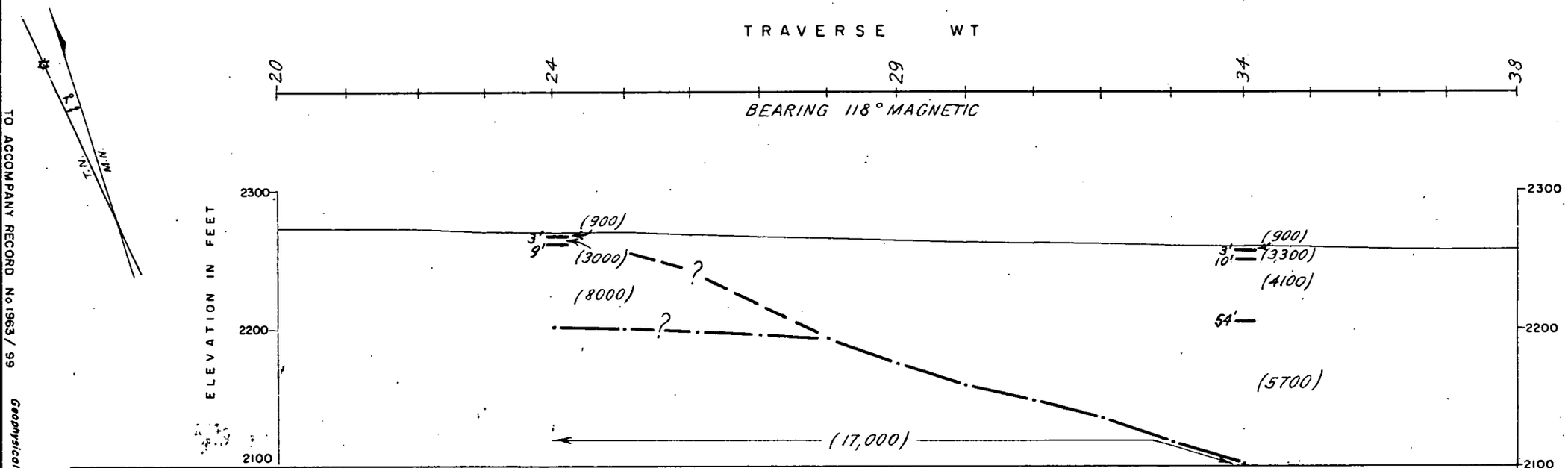
100 50 0 100 200

LEVELS TO STATE DATUM

PLATE 19

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B5-29



STATION NUMBER	20	24	25	26	27	28	29	30	31	32	33	34	35
STATION ELEVATION	2271	2269	2268	2267	2266	2264	2263	2262	2261	2260	2260	2259	2258
DEPTH TO BEDROCK		67	68	70	71	73	87	102	112	125	140	157	

LEGEND

20 — Geophysical traverse with station number

(3000) — Formation with seismic velocity of 3000 ft/sec

3' — Depth to formation with different seismic velocity

—·—·— Bedrock boundary

FROM C.O.G. PLAN H 1135

TUNNEL LINE RING-BARK AREA
LAYOUT OF TRAVERSE AND SEISMIC CROSS-SECTION BETWEEN STATIONS
WT 24 AND WT 34

HORIZONTAL AND VERTICAL SCALES IN FEET

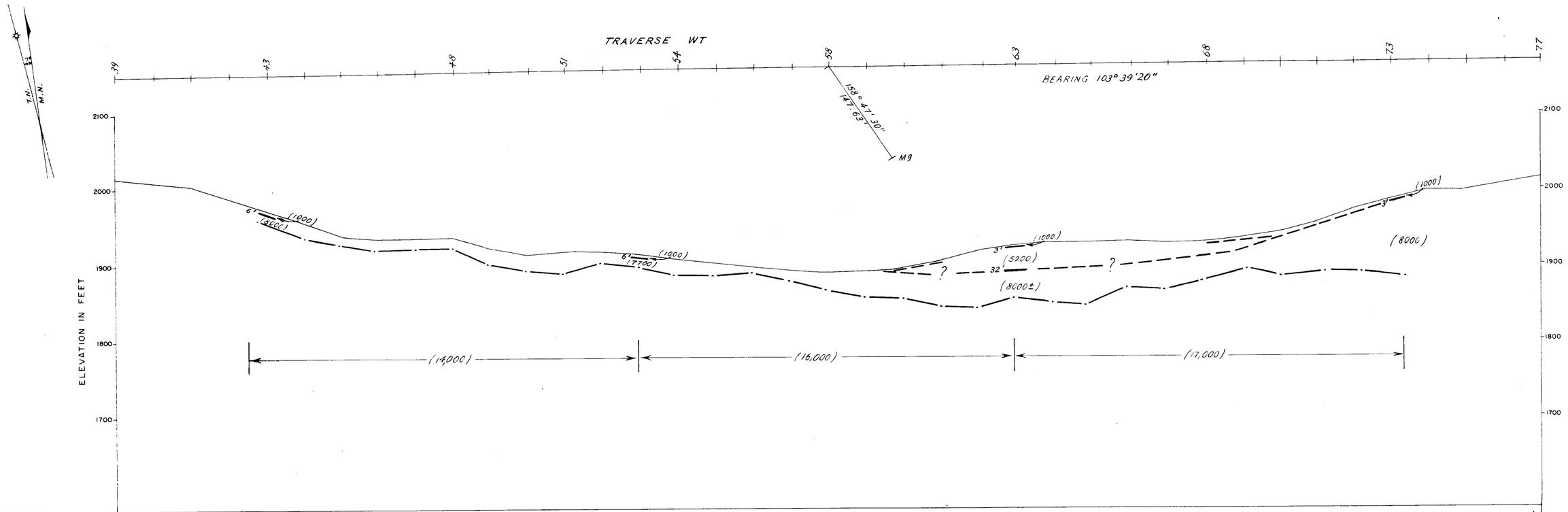
100 50 0 100 200

LEVELS TO STATE DATUM

PLATE 20

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch Bureau of Mineral Resources, Geology and Geophysics E55/B5-30



STATION NUMBER	39	43	48	51	54	58	63	68	73	77
STATION ELEVATION	2014	1974	1956	1938	1935	1937	1931	1924	1914	1918
DEPTH TO BEDROCK		18	20	12	16	16	17	24	24	31

STATION NUMBER	39	43	48	51	54	58	63	68	73	77
STATION ELEVATION	1917	1913	1908	1902	1895	1890	1887	1881	1893	1904
DEPTH TO BEDROCK	18	20	23	18	10	15	24	34	39	57

STATION NUMBER	39	43	48	51	54	58	63	68	73	77
STATION ELEVATION	1916	1923	1926	1926	1927	1925	1927	1930	1938	1948
DEPTH TO BEDROCK	75	69	78	83	61	62	50	38	57	63

STATION NUMBER	39	43	48	51	54	58	63	68	73	77
STATION ELEVATION	1966	1979	1989	1991						
DEPTH TO BEDROCK	81	102								

LEGEND

- 43 — Geophysical traverse with station number
- (2000) — Formation with seismic velocity of 2000 ft/sec
- 6' — Depth to formation with different seismic velocity
- —·— Bedrock boundary

TUNNEL LINE - MIDDLE CREEK AREA

LAYOUT OF TRAVERSE AND SEISMIC CROSS-SECTION

BETWEEN STATIONS WT 43 & WT73

From C.O.G. Plan H 1135

HORIZONTAL AND VERTICAL SCALES IN FEET

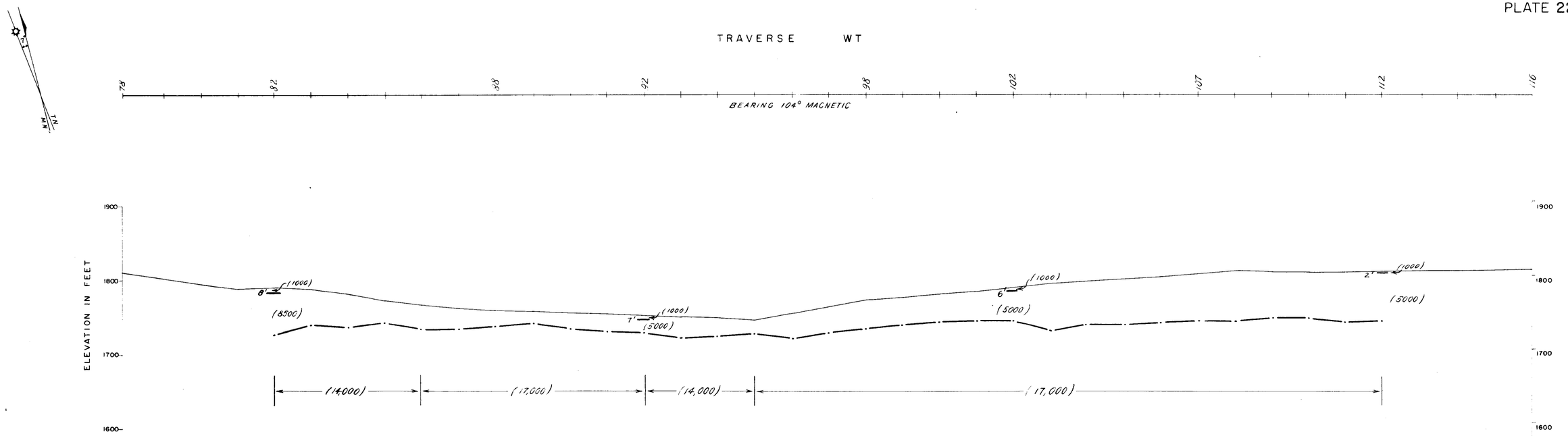
100 50 0 100 200 300

LEVELS TO STATE DATUM

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B 5 - 31

HERBERT RIVER, 1961 Q.D



STATION NUMBER	78	82					88				92									98					102					107						112			116
STATION ELEVATION	1809	1790	1787	1781	1771	1765	1762	1758	1758	1756	1755	1753	1751	1749	1745	1755	1765	1771	1775	1779	1782	1787	1791	1796	1799	1803	1807	1808	1808	1807	1808	1808	1808	1809		1808
DEPTH TO BEDROCK		65	50	47	31	34	30	22	11	22	25	26	30	27	18	34	36	39	37	39	40	46	63	58	61	63	65	68	64	65	70	69				

LEGEND

- 82 — Geophysical traverse with station numbers
- (1000) — Formation with seismic velocity of 1000 ft/sec
- 7' — Depth to formation with different seismic velocity
- Bedrock boundary

NOTE: From C O G Plan H-1136

TUNNEL LINE - SHOWERBATH CREEK AREA

SEISMIC CROSS - SECTION

BETWEEN STATIONS WT82 & WT112

HORIZONTAL AND VERTICAL SCALES IN FEET

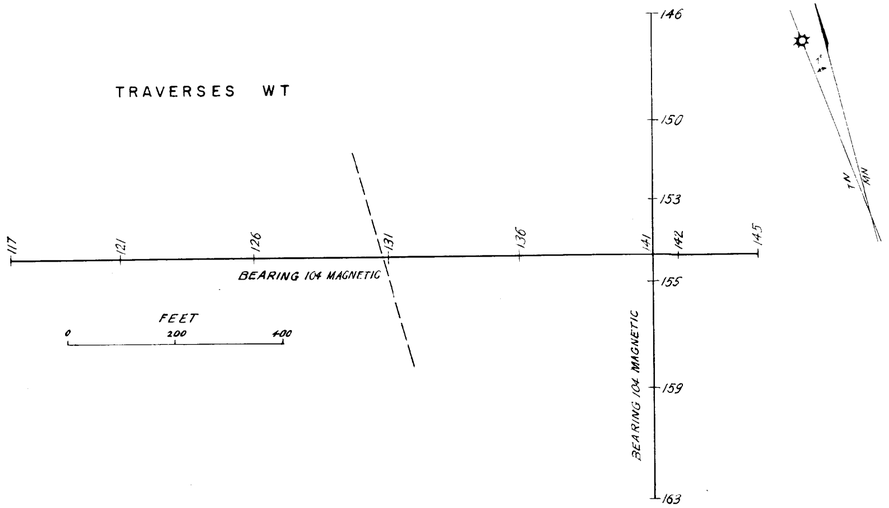
100 50 0 100 200 300

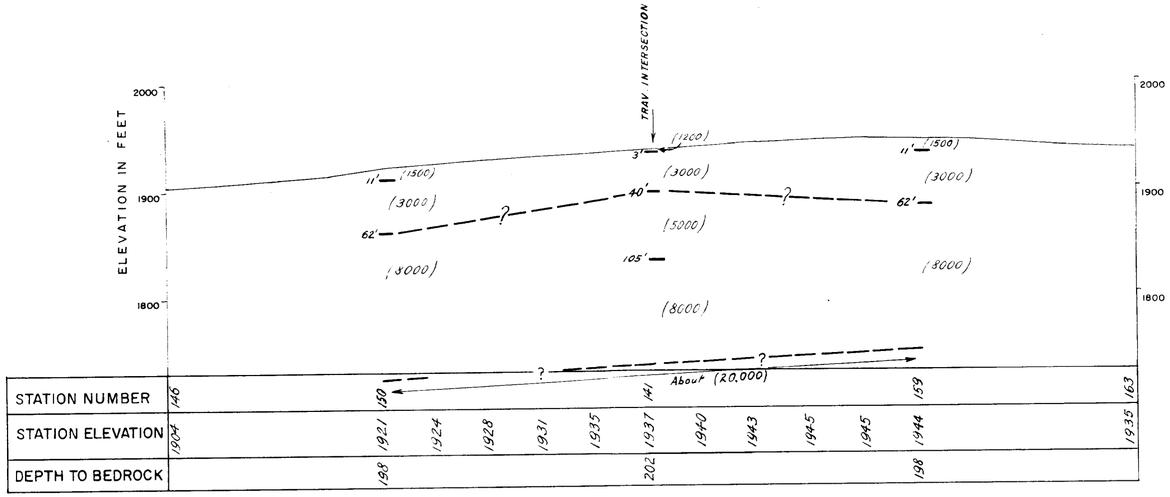
LEVELS TO STATE DATUM

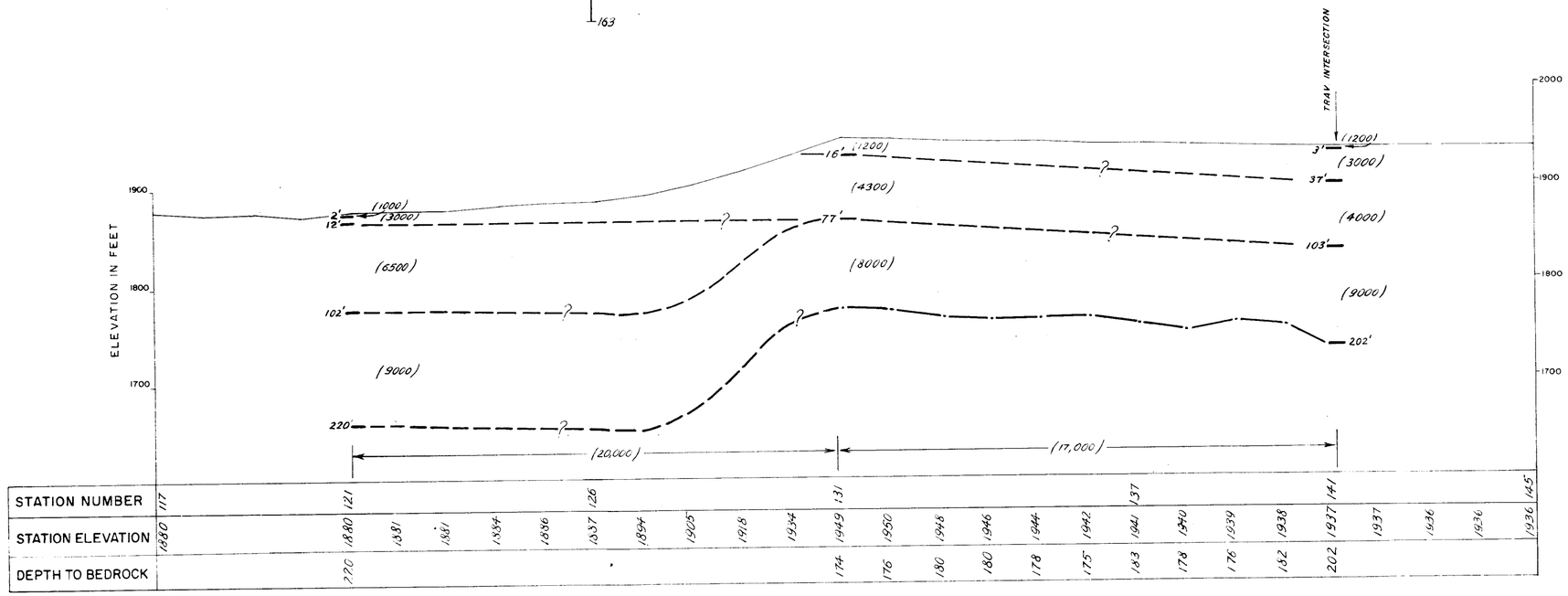
TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B5-32

HERBERT RIVER, 1961 QLD







LEGEND

- 136 — Geophysical traverse with station number
- (2000) Formation with seismic velocity of 2000 ft/sec
- 16' Depth to formation with different seismic velocity
- Bedrock boundary

TUNNEL LINE – BLENCOE FLATS AREA

SEISMIC CROSS-SECTIONS

BETWEEN STATIONS WT 121 & WT 159

HORIZONTAL AND VERTICAL SCALES IN FEET

100 50 0 100 200 300

LEVELS TO STATE DATUM

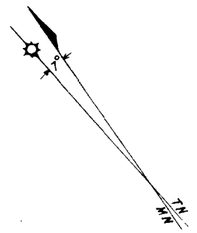
From C O G Plans H 1137 and 1138

TO ACCOMPANY RECORD No 1963/99

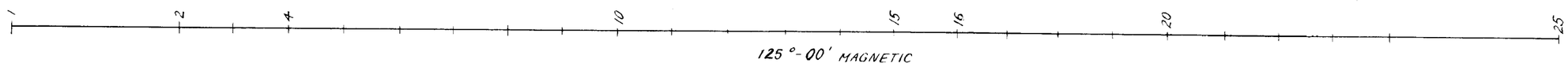
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/ B5-33

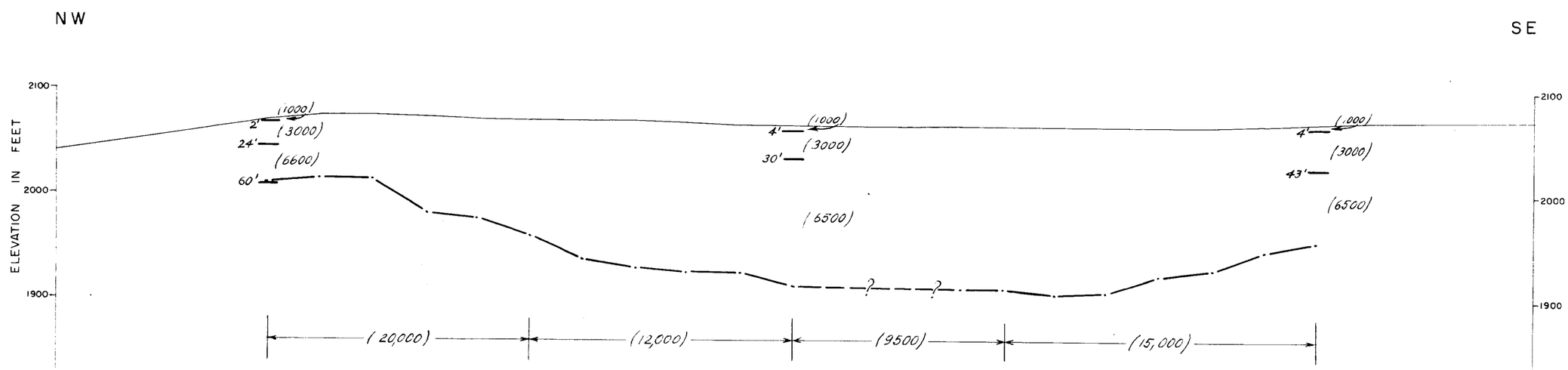
HERBERT RIVER, 1961 QLD

PLATE 24



TRAVERSE WC





STATION NUMBER	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
STATION ELEVATION	2043	2066	2074	2078	2079	2077	2075	2074	2073	2073	2072	2070	2071	2070	2070	2070	2070	2070	2070	2070	2070	2072	2073	2074	2077
DEPTH TO BEDROCK			60	60	60	91	94	108	128	138	141	141	153			156	156	163	162	144	139	120	110		

LEGEND

- 4 — Geophysical traverse with station number
- (1000) — Formation with seismic velocity of 1000 ft/sec
- 24' — Depth to formation with different seismic velocity
- Bedrock boundary

From C O G Plan H 1178

CAMERON CREEK TUNNEL PORTAL

LAYOUT OF TRAVERSE AND SEISMIC CROSS-SECTION

BETWEEN STATIONS WC3 & WC23

HORIZONTAL AND VERTICAL SCALES IN FEET

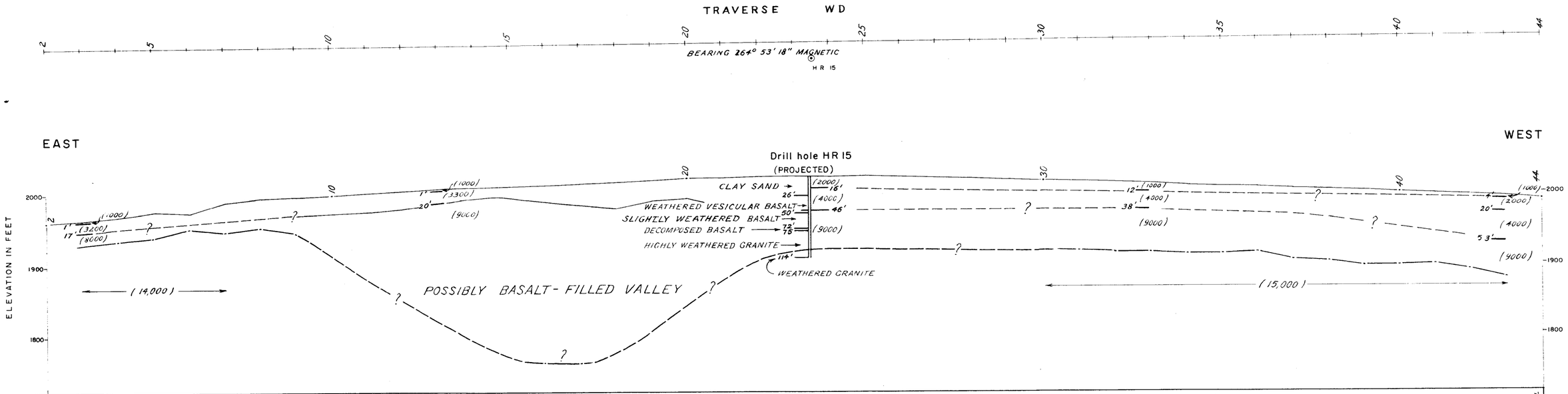
100 50 0 100 200

LEVELS TO STATE DATUM

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B5-34

HERBERT RIVER, 1961 QLD



STATION NUMBER	2		5					10					15					20					25					30					35					40					44
STATION ELEVATION	1964	1969	1977	1974	1989	1985	1997	1999	2002	2004	2006	2008	2009	2011	2013	2016	2018	2020	2021	2022	2022	2022	2021	2020	2019	2018	2016	2015	2014	2012	2011	2009	2008	2006	2004	2003	2001	1999	1997	1995	1991	1988
DEPTH TO BEDROCK	33	35	37	23	41	41	(24)	(27)	(28)	(26)	(20)	(14)	(14)	(21)	(31)	(39)	(29)	(30)	(40)	(40)	98	94	92	102	98	84	94	102	96	96	96	98	96	92	100	100	106	102	100	106	114	

DEPTH TO (9000) LAYER — DEPTH ESTIMATED

LEGEND

- 5 — Geophysical traverse with station number
- (2000) — Formation with seismic velocity of 2000 ft/sec
- 15' — Depth to formation with different seismic velocity
- Bedrock boundary

From Co-ordinator General's Dept. Plan No. H 1155

CAMERON CREEK DIVERSION

SEISMIC CROSS-SECTION

BETWEEN STATIONS WD2 & WD44

HORIZONTAL AND VERTICAL SCALES IN FEET

100 50 0 100 200 300

LEVELS TO STATE DATUM

TO ACCOMPANY RECORD No 1963/99

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B5-35