COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1972/7

TENNENT DAMSITE SEISMIC SURVEY, A.C.T., 1970/71

by

B.H. Dolan

Record 1972/7

TENNENT DAMSITE SEISMIC SURVEY, A.C.T., 1970/71

by

B.H. Dolan

CONTENTS

		Page
	SUMMARY	
1.	INTRODUCTION	1
2.	GEOLOGY	1
3.	METHODS AND EQUIPMENT	2
4.	RESULTS	2
5.	CONCLUSIONS	6
6.	REFERENCES	6

ILLUSTRATIONS

PLATE 1	LOCALITY MAP	
PLATE 2	LAYOUT OF TRAVERSES	
PLATE 3	Traverses L, M and N	seismic cross-sections
PLATE 4	Traverses O, Q and S	seismic cross-sections
PLATE 5	Traverses R and T	seismic cross-sections
PLATE 6	Traverse U	seismic cross-section
PLATE 7	Traverses P, V, W and X	seismic cross-sections
PLATE 8	Traverses Y, Z, α and ϕ	seismic cross-sections
PLATE 9	Traverses ϵ and Δ	seismic cross-sections
PLATE 10	Traverse Ω	seismic cross-section

SUMMARY

A seismic refraction survey was carried out as part of a detailed investigation of the Tennent Damsite on the Gudgenby River near Tharwa. The field work and interpretation were done by the Engineering Geophysics group of the Bureau of Mineral Resources, Canberra.

The site is located in pink and grey Silurian adamellite. A fault cuts the site on the east bank of the Gudgenby River.

The seismic results show deep weathering and extensive jointing over most of the site, in particular to the east of the river. The profile of the weathered section is very irregular.

1. INTRODUCTION

The Gudgenby-Naas river system is one of several in and around the Australian Capital Territory being investigated for the National Capital Development Commission. The purpose of the investigations is to permit feasibility studies and order-of-cost comparisons of several damsites in order to select the next water supply for Canberra and Queanbeyan. The most suitable location for a dam on the Gudgenby River is a gorge about three miles south of Tharwa. The site is known as the Tennent Damsite, after Mount Tennent which is nearby.

Prior to 1968, some seismic traverses were done by the Department of Works (Drawing No. CD68/1798). These are marked on Plate 2 (A, B, C, D, E, F, G, H, J, K). Two were done by BMR on the saddle. The results are described by Buchhorn (1968).

As part of the detailed investigation, more seismic refraction traverses were surveyed. The field work and interpretation were carried out by the Engineering Geophysics group of BMR.

Field work was carried out in February and March 1970 by a party consisting of E.J. Polak (party leader), P.J. Hill (Geophysicist), L. Hemphill, R. Cherry, D. Tarlington, H. Pelz, S. Hall and three field hands from the Commonwealth Department of Works. Additional traverses and extensions were completed in September 1970 and in December 1970 and January 1971 by E.J. Polak, P.J. Hill, B.H. Dolan (geophysicists), M. Dickson, S. Hall and two field hands from the Department of Works. A total of 11,125 ft of traverses were completed.

The interpretation of the field results were done by B.H. Dolan, E.J. Polak and R.J. Whiteley. The object of the seismic investigation was to determine depth to sound bedrock, thickness of overburden, and to look for indications of possible faults.

2. GEOLOGY

The geology of the Tennent Damsite is described by Buchhorn (1968).

The damsite is located on Tharwa Adamellite, which is part of the Siluro-Devonian Murrumbidgee Batholith (Snelling, 1960). The Tharwa Adamellite has an indistinct primary and metamorphic foliation. This foliation exercises a strong control over the pattern of weathering.

A fault zone cuts the east bank of the river. The extent of this zone is not known due to lack of outcrops.

3. METHODS AND EQUIPMENT

Seismic Refraction

The seismic refraction method of geophysical exploration depends on the contrast in velocity of different rock formations.

The results were interpreted using the intercept-time method (Heiland, 1940) and the reciprocal method (Hawkins, 1961). Using these methods, the number and characteristics of the layers comprising the overburden at each shot point, and the depth to bedrock at each geophone position, were calculated. A geophone spacing of 10-15 ft was employed throughout the survey. Shots were fired 5 and 200 ft from each end of the geophone spreads.

The recording equipment used was an S.I.E. 24 channel refraction seismograph with T.I.C. Geophones with a natural frequency of 20 Hz.

Laboratory Examinations

Seven core samples from three widely separated bore holes were tested by M. Idnurm (geophysicist) in the BMR Rock Testing Laboratory. The seven samples were tested for longitudinal velocity, specific gravity and hardness.

4. RESULTS

Plate 1 shows the location of the Tennent Damsite. Plate 2 shows the layout of the seismic traverses in relation to the geology.

Plates 3 to 10 show the seismic cross-sections.

Seismic Velocities

The results of the seismic velocities were interpreted as a three layer structure as described in Table 1 below.

TABLE 1

Seismic Velocity in ft/sec	Description
1,000 - 3,300	Soil, completely weathered unsaturated material.
4,800 - 5,200	Saturated completely weathered unconsolidated material.
4,800 - 17,000	Bedrock in various stages of jointing and weathering from highly weathered to fresh.

The in situ bedrock velocities are significantly lower than the laboratory measurements on much of the damsite, as can be seen from the two examples below.

Drill Hole and Depth	Rock Core Velocity	In Situ Velocity
D D 6 40'	16,700	11,000
D D 8 30'5"	17,300	12,500

The decrease in the velocity of the rock body in situ is due mainly to the presence of faults, joints, cracks and other interstices. (Onodera 1963, Polak 1968). The ratio of the square of the field measurement of longitudinal velocity (v) to the square of the laboratory measurement of longitudinal velocity (V) viz. $\frac{v^2}{V^2}$ gives the ratio of the *dynamic modulus of elasticity in situ $\mathcal{E}$ d to the modulus of rock pieces (Ed) viz. Ed). This ratio is called the "soundness" of the bedrock in situ, which can be correlated with geological diagnostic observations (Onodera, 1963), Table 2. If 17,000 ft/sec is taken to be the longitudinal velocity of a fresh core sample for the rock type in the whole of the Tennent Damsite, then the determinations of soundness can be extended to any part of the site where an in situ measurement of longitudinal velocity is made. Since the bedrock is all adamellite, this is a reasonable assumption. The velocity of 17,000 ft/sec is based on the results of 2 bore holes DD6 and DD8. The determinations of soundness for Tennent Damsite on this basis are shown in Table 2.

TABLE 2

Classification of the bedrock of Tennent Damsite

Field measured bedrock Vel. in ft/sec	Soundness (for Tennent Damsite)	Symbol	Geological Diagnostic (Onodera, 1963)
7,500	0.20	E	Weathering advanced, rock materials altered or weathered as a whole.
7,500-10,000	0.20-0.35	D	Parting is rather open and wide, which usually contained clay or muddy materials accompanied by fissure water, rock itself may be partly hard, but generally somewhat altered and jointed or cracked.
10,000-12,000	0.35-0.50	C	More or less parted by joint or crack, with or without minor amount of interstitial clayey matter, but rock itself is rather fresh with its surface weathered.
12,000-15,000	0.50-0.75	B	More or less jointed or cracked, but with only slight parting; more or less weathered only on the surface along the parting, but inner part is fresh and compact.
15,000-	0.75-	A	Fresh with no alteration; almost without joint, crack etc.

* From elastic theory the formula $E = V^2 \rho f(\sigma)$ may be derived

where E = the modulus of elasticity

V = longitudinal velocity

ρ = specific gravity

and $f(\sigma)$ is a function of Poisson's ratio (Onodera 1963).

From results of other surveys in areas of similar rock type, the value of the factor $\rho f(\sigma)$ would be expected to be about 0.02 if V is measured in metres sec -1 and E in kg cm^{-2}. This factor has also been found to be remarkably constant in an area of one rock type e.g. within 6%. Thus $\frac{V_2}{V_1}$ is a useful guide to rock soundness.

Damsite

(a) East Abutment

On traverses M and N and the western half of L, the deepest bedrock encountered can be classified into category A. Most of the bedrock on the eastern half of traverse M belongs to category D. The bedrock on traverse O belongs to category B in the southern half, and to category C in the northern half.

The area classified as D is associated with the fault zone passing through that area.

(b) West Abutment

All of the bedrock of traverse P belongs to category C or D. Approximately the first 300 ft of the traverse belongs to D.

Diversion Tunnel

All of the traverses on the diversion tunnel are within the fault zone passing through the east bank of the river. Most of the deepest bedrock encountered belongs to category D.

Spillway

Most of the bedrock in this area can be classified into category C. To the western edge it is in category A. To the north in B, and in the eastern 300 ft of traverse P, it is in category D.

Rock Quarry

Most of the deepest bedrock in this area is in category B with relatively small areas of A and C.

The Overburden

This includes all layers above the deepest refractor encountered on each traverse.

Over the whole site the average thickness of the soil layer is eight ft. The average total thickness of overburden is 37 ft. Both these parameters vary considerably over the site.

The average thickness of overburden exceeds 40 ft on traverses L, O, Q, R, S, T and V. Except for V, all these traverses are in the fault zone on the east bank of the river. The average thickness of overburden is lowest in the proposed rock quarry (about 25 ft).

5. CONCLUSIONS

In the proposed diversion tunnel area, part of the abutments, and in most of the spillway area, the seismic results show considerable jointing of the bedrock. In most of the tunnel area the jointing is rather open and wide. In the same areas the depth to the deepest refractor exceeds 40 ft. The eastern extremity of the fault on the east bank was not defined by extensions of the seismic traverses in that area.

In the rock quarry area the average depth to the deepest refractor was 25 ft.

6. REFERENCES

BUCHHORN, D.A., 1968 - Geological Investigation of Tennent Damsite, Gudgenby River, A.C.T. 1966-1967. Bur. Miner. Resour. Aust. Rec. 1968/88 (unpubl.).

CLARK, S.O., Jr. (Ed) 1966 - Handbook of Physical Constants (Revised Edition). Mem. geol. Soc. Amer. 97.

HAWKINS, L.V., 1961 - The Reciprocal Method of Routine Shallow Seismic Refraction Investigations. Geophysics, 26(6), 806-819.

HEILAND, C.A., 1940 - GEOPHYSICAL EXPLORATION. N.Y., Prentice-Hall.

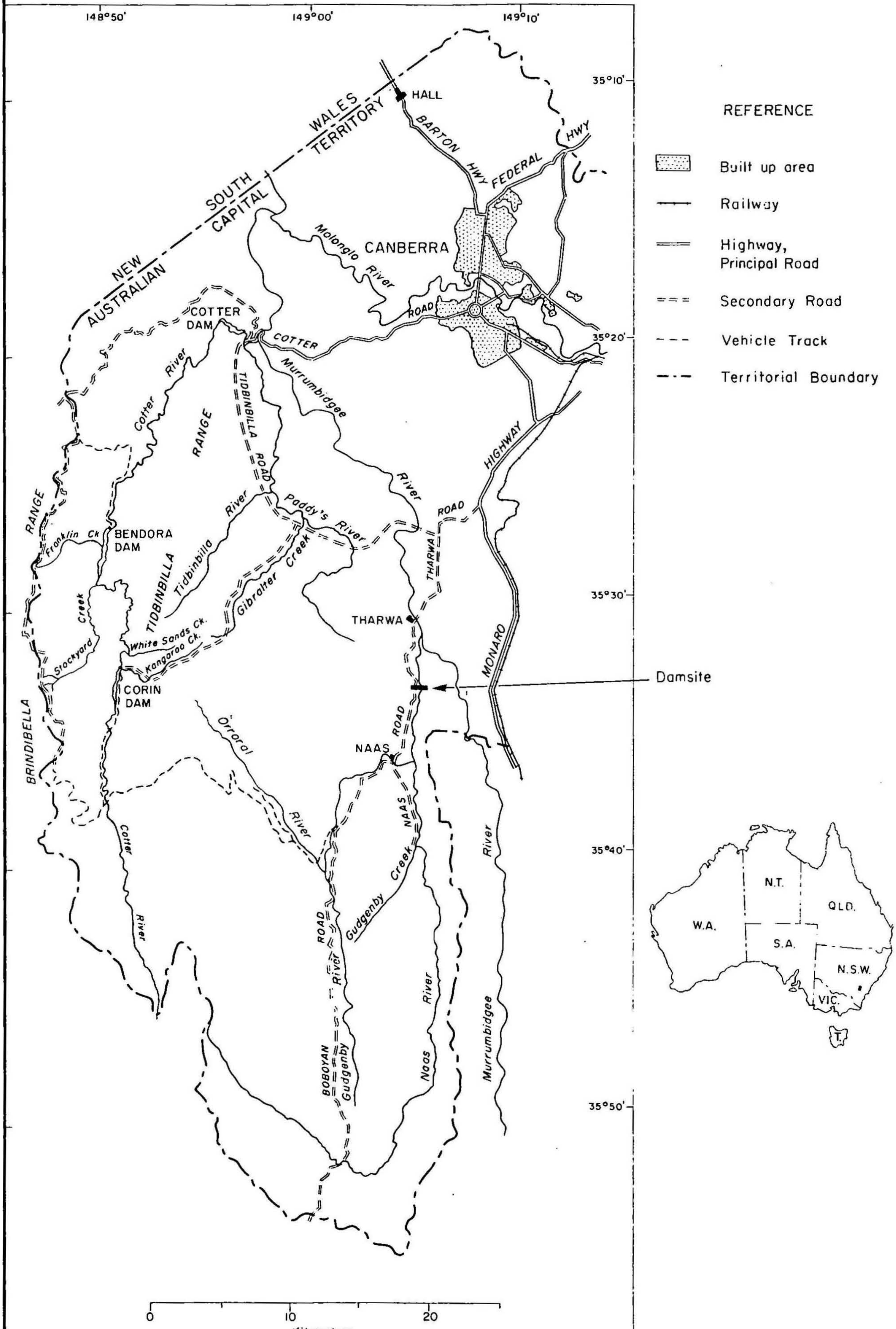
ONODERA, T.F., 1963 - Dynamic Investigation of Foundation Rocks *in situ*, Proc. Fifth Symposium Rock Mechanics, Univ. Minnesota, 1962, C. FAIRHURST (Ed). London, Pergamon.

POLAK, E.J., 1968 - The effect of Geological Environment on the properties of Foundation Rocks, Proc. Fifth Aust.-N.Z. Conf. Soil Mechanics & Foundation Engineering, 14-18.

SNELLING, N.J., 1960 - The geology and petrology of the Murrumbidgee Batholith. Quart. J. geol. Soc. Lond. 116.

PLATE I

LOCALITY MAP

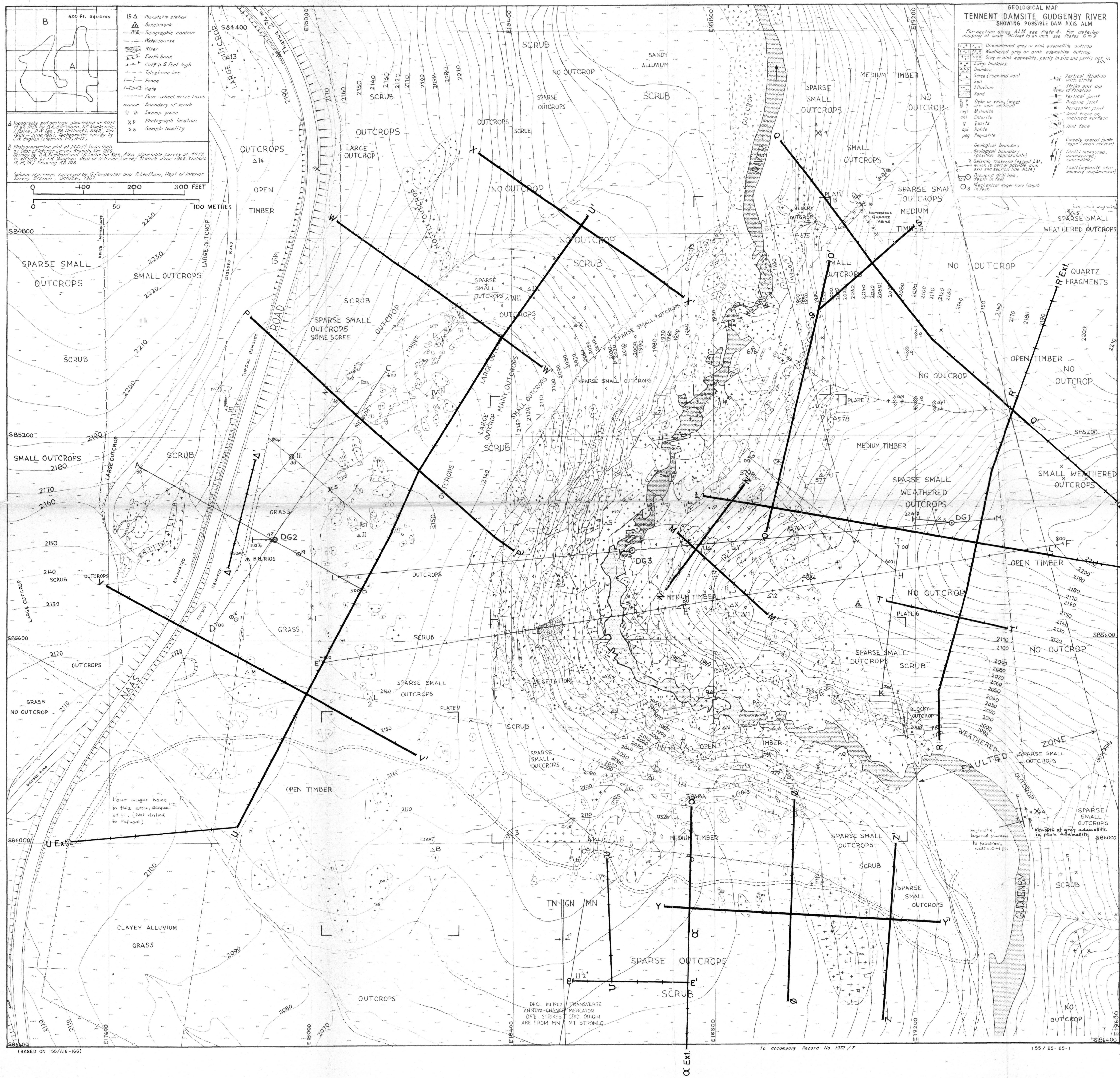


TENNENT DAMSITE

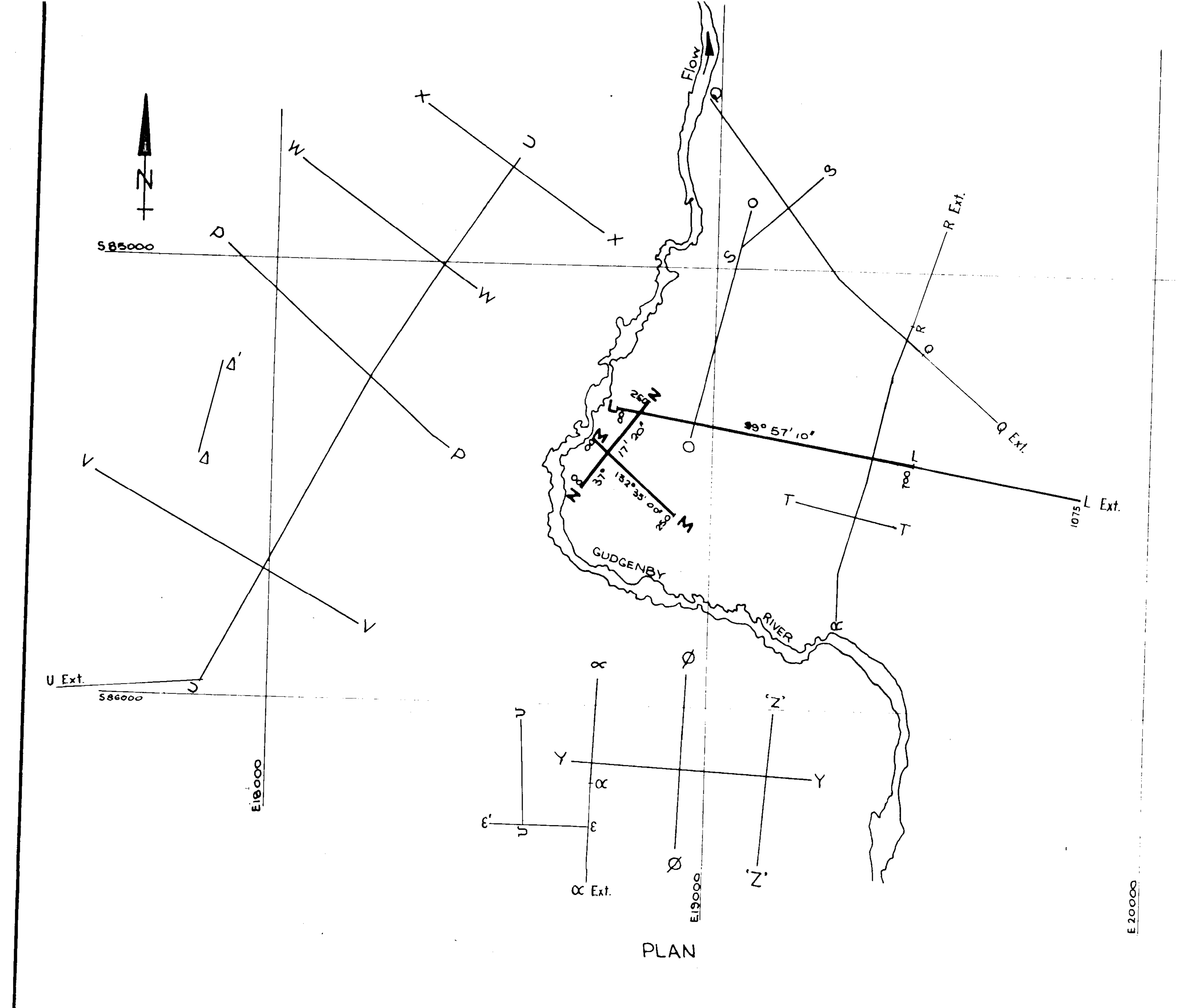
To accompany Record No. 1972/7

155/B5/125 A

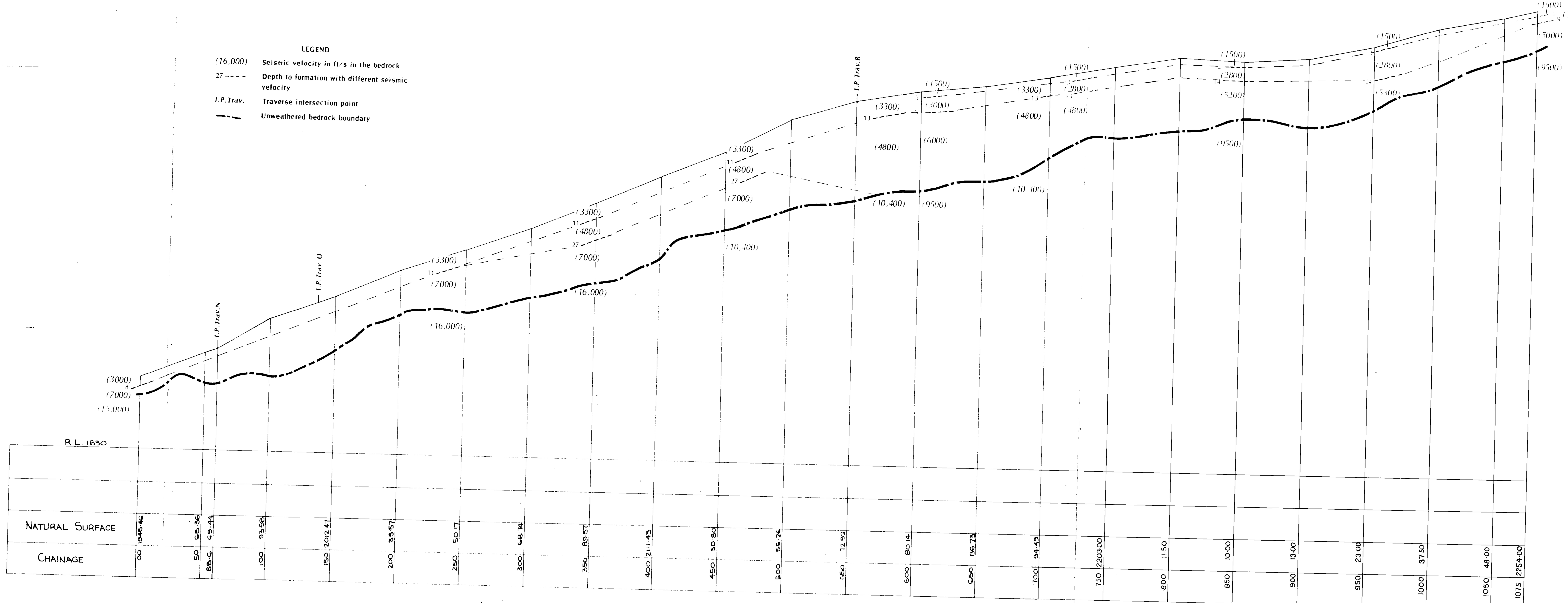
Based on 155/B0-43A



TENNENT DAMSITE SEISMIC SURVEY 1970-71
SEISMIC TRAVERSES IN RELATION TO GEOLOGY (Geology after Buchhorn 1968)

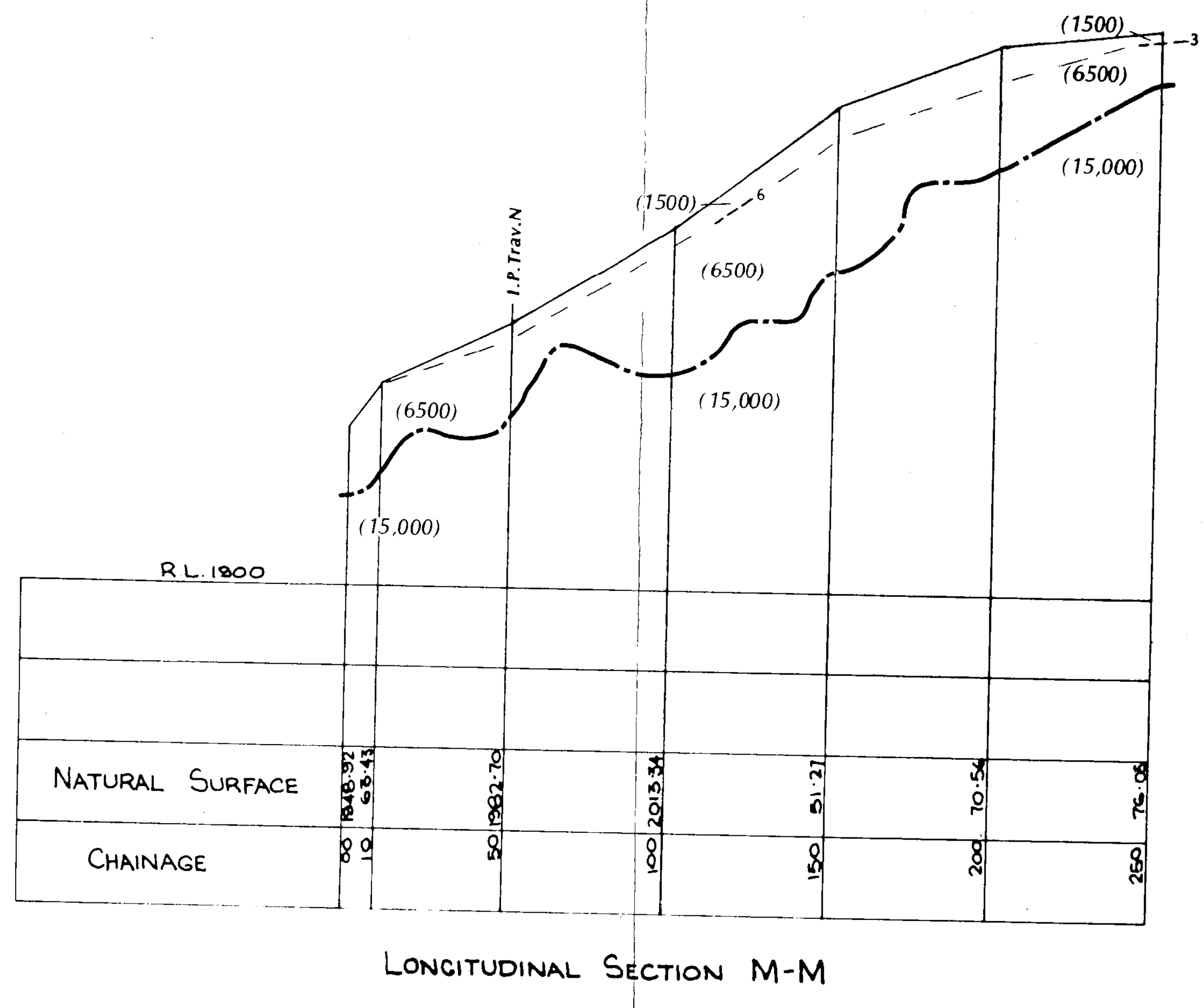


TRAVERSES L-L, M-M AND N-N.
PLAN AND LONGITUDINAL SECTIONS.

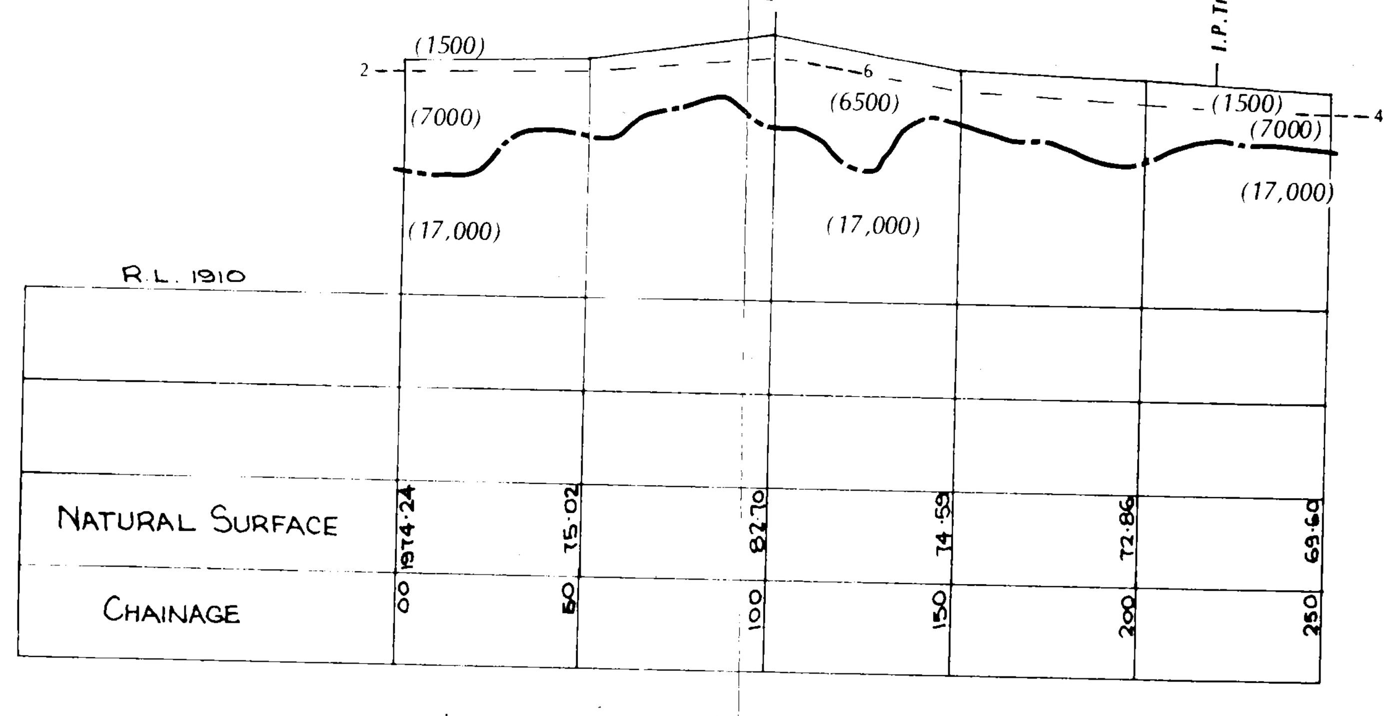


LONGITUDINAL SECTION L-L

Scale in feet (Horiz. & Vert.)



LONGITUDINAL SECTION M-M



LONGITUDINAL SECTION N-N

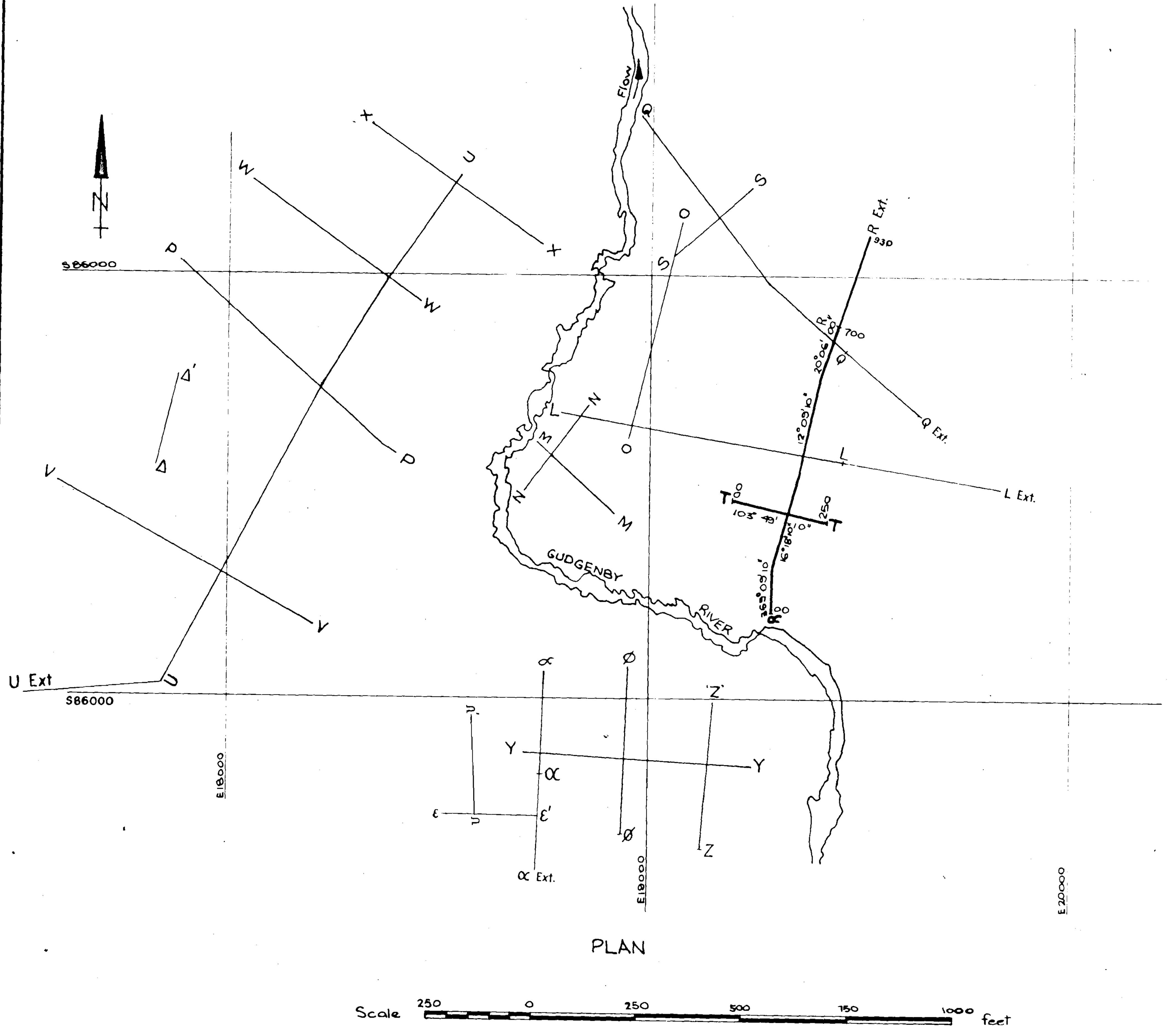
To accompany Record No. 1972/7

155/B5-72-2

TRAVERSES O-O, Q-Q AND S-S
PLAN AND LONGITUDINAL SECTIONS

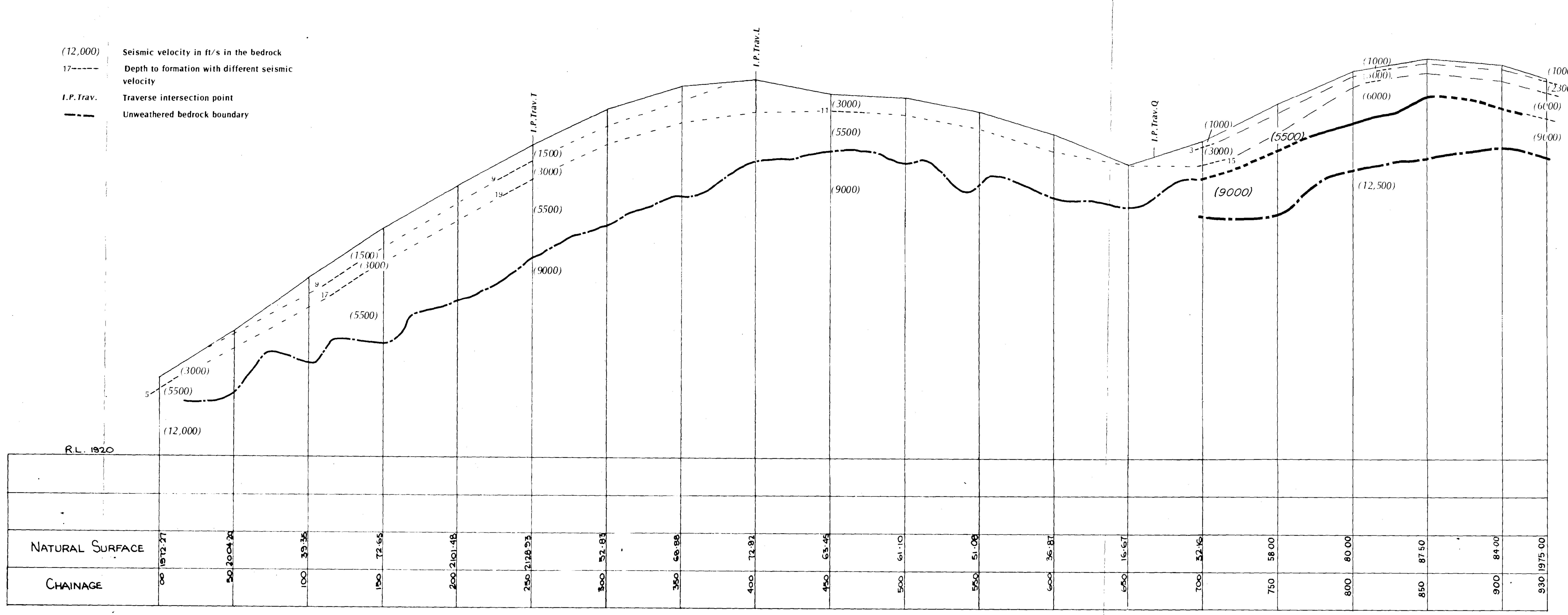
To accompany Record No 1972/7

155/B5-77-1

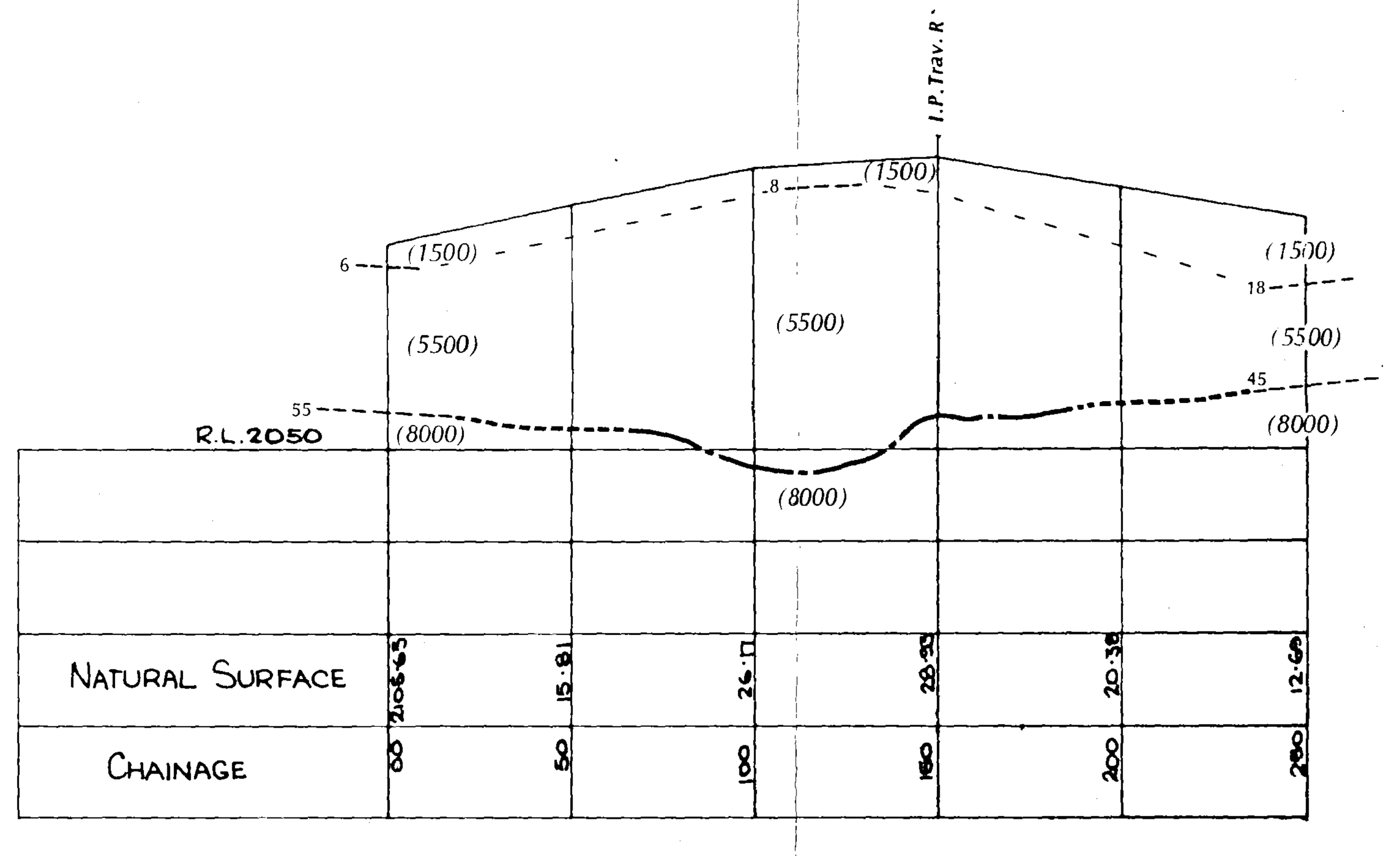


PLAN

TRAVERSES R–R AND T–T
PLAN AND LONGITUDINAL SECTIONS



Longitudinal Section R-R



Longitudinal Section T-T

Scale in feet (Horiz. + Vert.) 50 0 50 100 150

To accompany Record No. 1972/7

I55/B5-73-1

TRAVERSE U-U
PLAN AND LONGITUDINAL SECTION

To accompany Record No. 1972/7

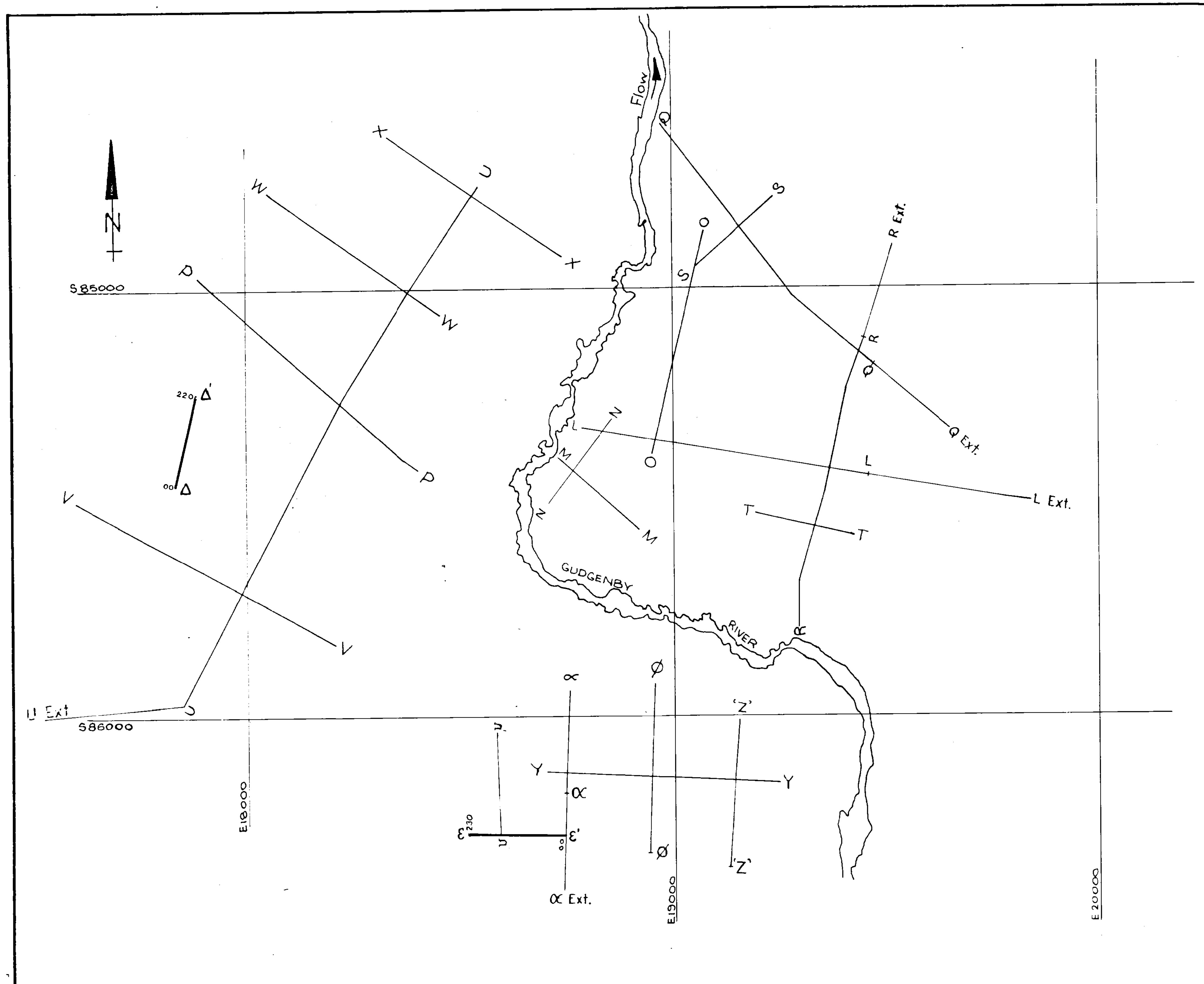
155/B5-74-1

PLATE 7
(15,000) Seismic velocity in ft/s in the bedrock
10 Depth to formation with different seismic velocity
I.P. Trav. Traverse intersection point
Unweathered bedrock boundary
WEST
EAST
R.L. 2075
NATURAL SURFACE
CHAINAGE
LONGITUDINAL SECTION V-V
R.L. 2020
LONGITUDINAL SECTION W-W
R.L. 2060
LONGITUDINAL SECTION P-P
R.L. 1900
LONGITUDINAL SECTION X-X
GUDGENBY RIVER
Flow
U Ext.
PLAN
Scale in feet
TRAVERSES P-P, V-V, W-W AND X-X
PLAN AND LONGITUDINAL SECTIONS
Scale in feet (Horiz.&Vert.)
To accompany Record No. 1972/7
I55/B5-75

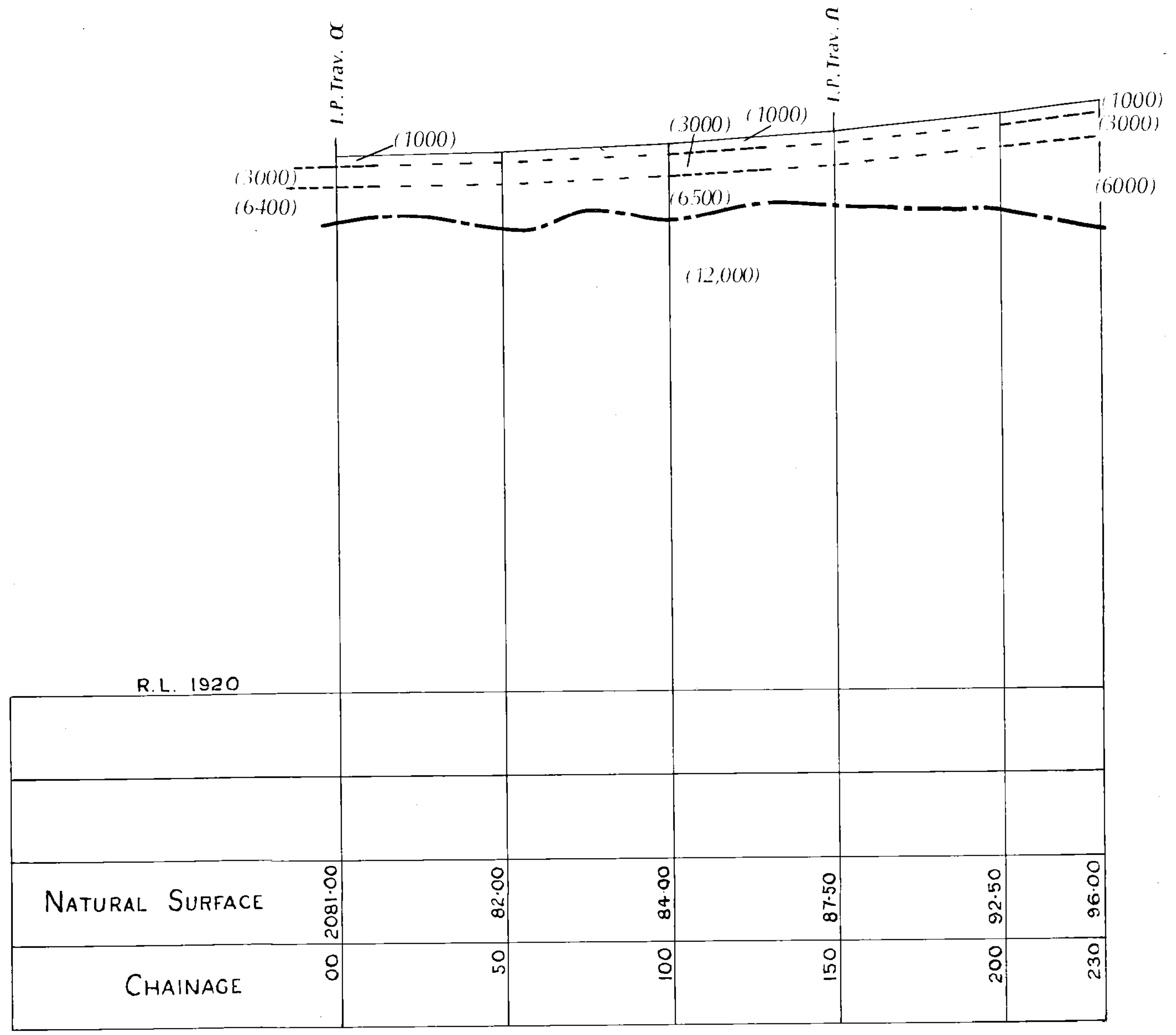
PLATE 8

To accompany Record No. 1972/7

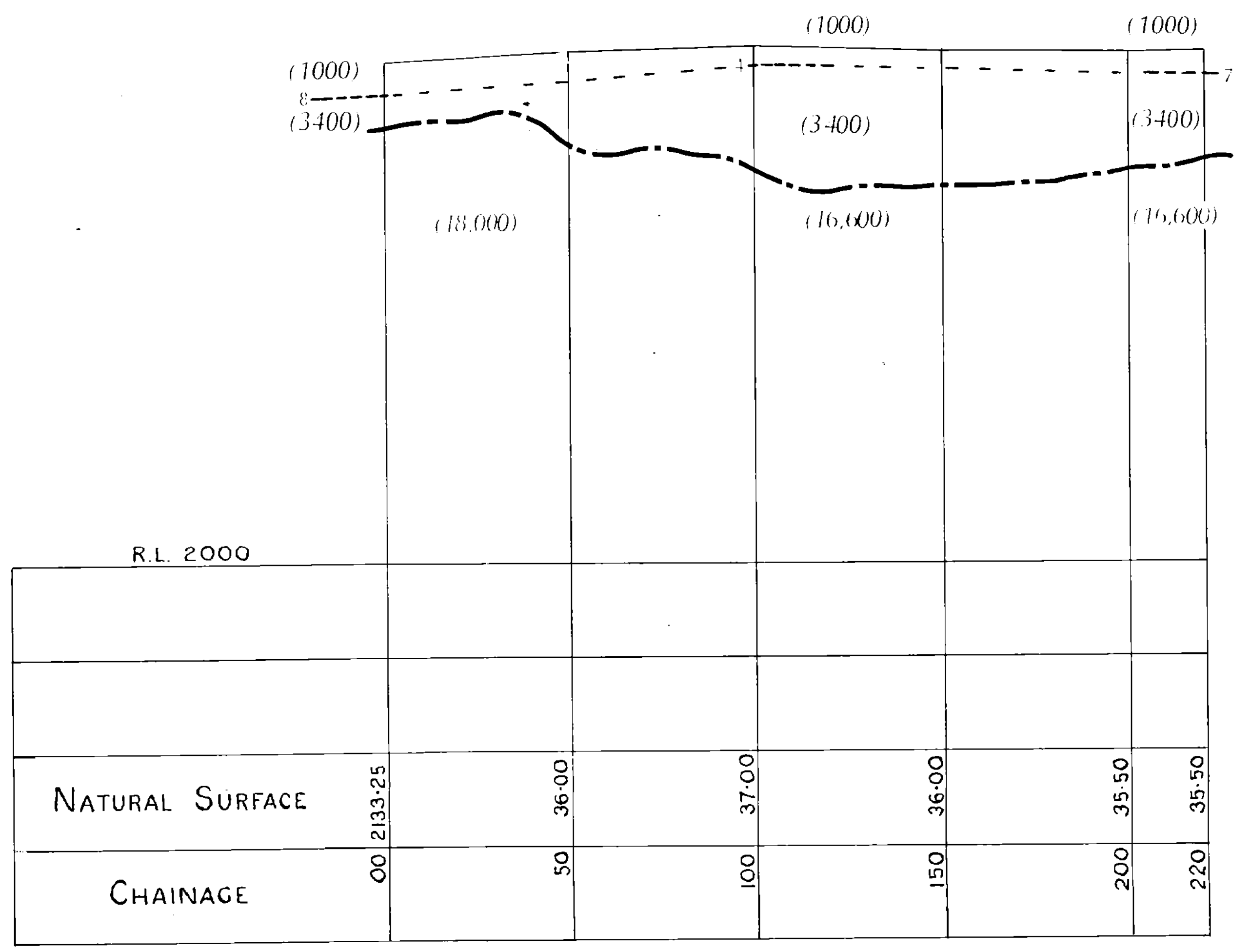
155/B5-76-2



TRAVERSES ε'-ε AND Δ-Δ'
PLAN AND LONGITUDINAL SECTIONS



Longitudinal Section ε'-ε

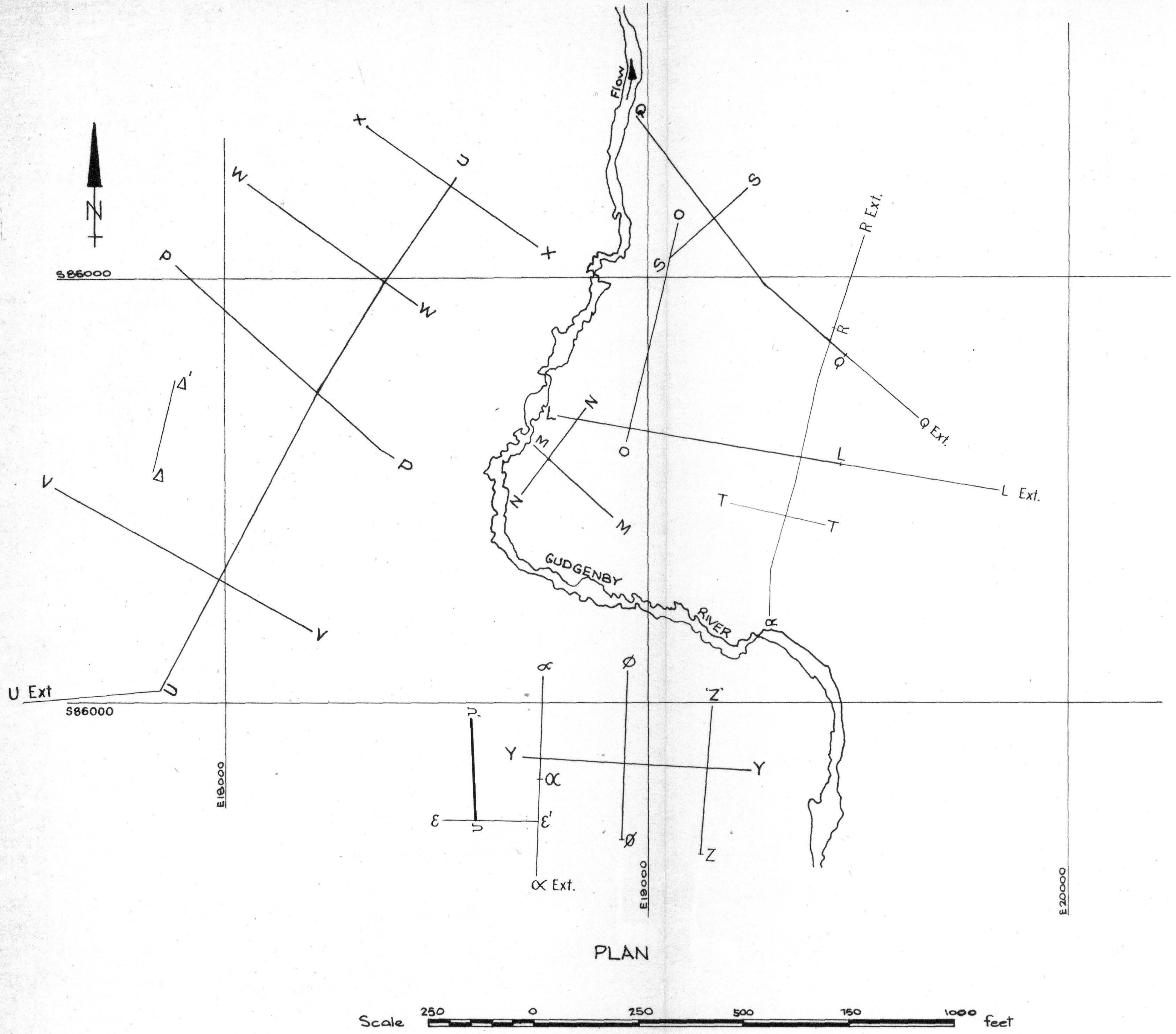


Longitudinal Section Δ-Δ'

Scale in feet. (Horiz. & Vert.) 50 0 50 100 150

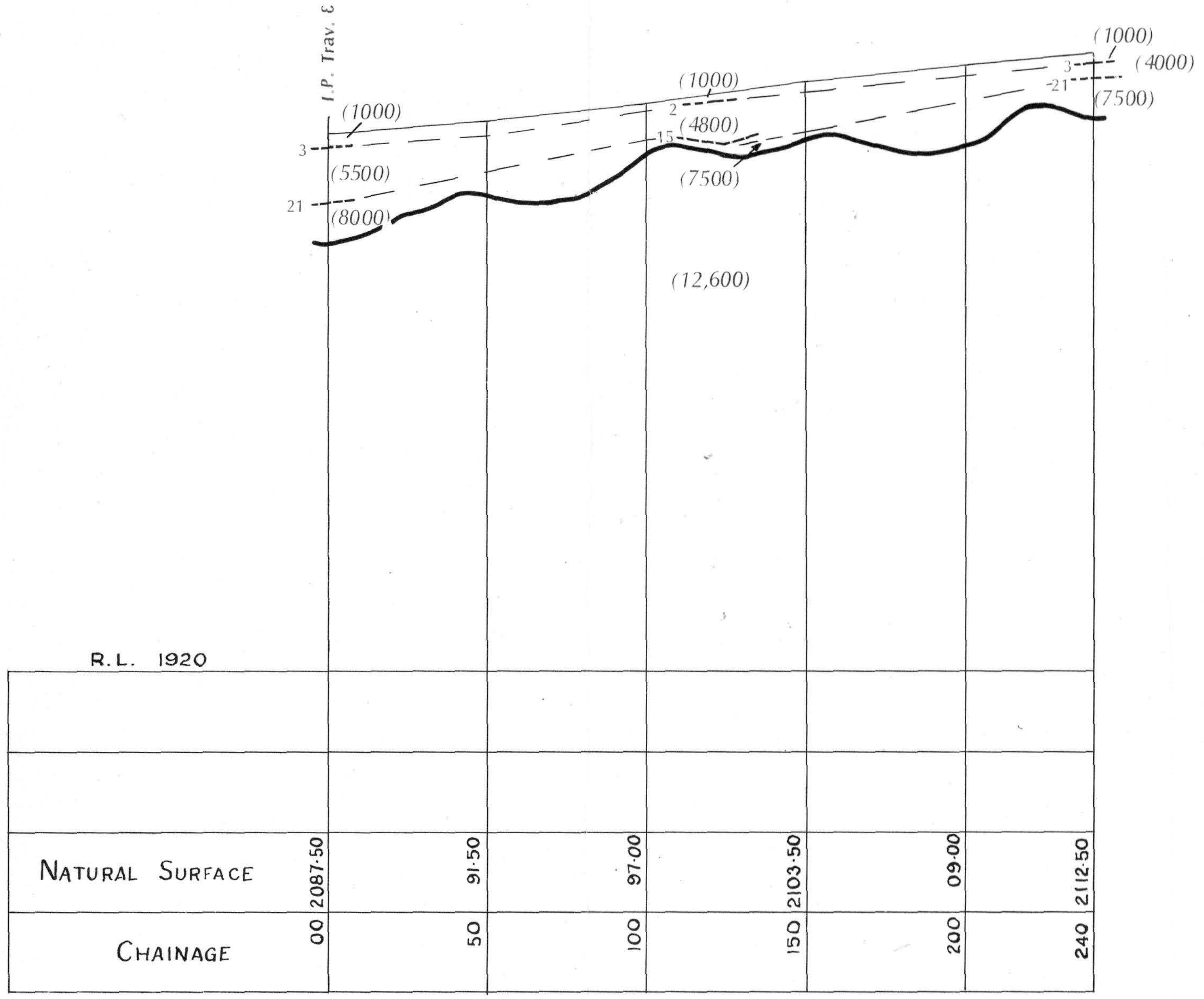
To accompany Record No. 1972/7

155/B5-86



LEGEND

(12,600)	Seismic velocity in ft/s in the bedrock
21	Depth to formation with different seismic velocity
I.P. Trav.	Traverse intersection point



LONGITUDINAL SECTION Ω - Ω'

TRAVERSE Ω-Ω'
PLAN AND LONGITUDINAL SECTION