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TREVALLYN BRIDGE SITE GEOPHYSICAL SURVEY, LAUNCESTON, TASMANIA 1965

by

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SUMMARY

A seismic refraction survey to determine the river detritus thickness and the position of a major fault close to a bridge-site at the mouth of Cataract Gorge, Launceston, was carried out for the Department of Mines, Tasmania.

The seismic survey confirms what was suspected from geological evidence, i.e. that the fault strikes across the mouth of the gorge about 360 ft downstream and approximately parallel to Kings Bridge. On the left (North) bank it is about 100 ft downstream of the area where possibly the bridge will be founded; on the right bank about 180 ft. Rock with seismic velocity 18,000 ft/sec suitable for foundations is covered with about 40 ft of river detritus at H1 on the left bank, but at the same level this rock probably crops out on the right bank.

Test drilling is recommended at H1, H7 and J4 on the left bank.

1. INTRODUCTION

To alleviate traffic congestion at the West Tamar outlet road from Launceston, the Public Works Department (P.W.D.) of Tasmania proposes constructing another bridge across the mouth of Cataract Gorge downstream of the existing old and narrow King's Bridge. Although the bridge design is not finalised possibly an arch structure will be used for aesthetic reasons. The approximate co-ordinates of the site is 503895 on the Launceston sheet of the Australia 1:250,000 map series.

The Department of Mines, Tasmania is carrying out the geological investigation of the bridge site for the P.W.D. The Department requested the Bureau of Mineral Resources, Geology and Geophysics, to carry out a geophysical survey to determine the depth to bedrock on the banks and in the river, and the position of a major fault close to the bridge site to assist designing a test drilling programme at the site. The work was done between the 16th and 25th February by a party consisting of P.E. Mann (party leader), J.P. Pigott (Geophysical assistant), and four field assistants supplied by the P.W.D. Survey work was carried out by surveyors from P.W.D. North East District Office, Launceston.

2. GEOLOGY

An interpretation of the major faulting and joint systems responsible for the recent development of the topography of Cataract Gorge is given by Carey (1947). Further information is given by Gill (1962). On the Launceston sheet of the 1-mile geological series published by the Department of Mines a major fault, the Trevallyn Fault, downthrown to the north-east, truncates the gorge. From the geological work foundations for the proposed bridge on the left bank are expected to be close to the edge of the fault; on the right bank the foundations can probably be sited on sound dolerite (Longman, 1965).

The South Esk river has incised a deep gorge in Jurassic dolerite and upstream of King's Bridge the gorge walls are almost sheer. Downstream, the river broadens and dolerite crops out at water level on the right bank (south) to about Traverse F (Plate 1); the left bank is covered by talus and river detritus.

In this report bedrock is defined as the highest velocity refractor recorded on normal spreads; the term overburden to material above the bedrock.

3. METHODS AND EQUIPMENT

The seismic refraction method was used. This method is described by Polak (1962a).

Three different techniques were used on this survey :

Method of differences: This method was used on Traverses A, B, C, H and K. For this method to be used charges are detonated at different distances from each end of a spread of geophones or hydrophones and in line with it. It was possible to select shot points close to the geophone at only one end of the spread on Traverses H and K to determine the velocity of the near surface material. On Traverses A, B and C small charges were detonated on the river bed beneath or within about 25' from the end hydrophones to determine the seismic velocity of the river detritus. The velocity measured was 5500 ft/sec. The same velocity was also found for water saturated detritus by detonating charges 25 ft from one end of Traverses G, H, J and K. To record refractions from the bedrock on Traverse A, B and C two shot points were used, viz. one point about 350 ft upstream from King's Bridge and centred in the gorge; the other 1550 ft downstream from the bridge adjacent to the Tamar Yacht Club floating jetty. The shot points were in line with Traverse A and approximately in line with Traverse B and C. The upstream shot point was also used for Traverse K. The geophone spacing was 25 ft for both land and water traverses.

This method gives more accurate results than the other two methods used (described later) if the near surface velocities are known. Although a short shot was fired at only one end of Traverses H and K the depth to bedrock on Traverse H is considered to be more reliable than for Traverse K. On Traverse H, surveyed at low tide, the water saturated river detritus probably has a seismic velocity of about 5500 ft/sec at each end of the spread, and the apparent velocity was assumed to be constant along the spread. This is not the case on Traverse K. It was not practicable to use short weathering spreads to determine the near surface velocities on Traverse K and the apparent velocity determined at K17 was used to calculate the depth to bedrock on the traverse.

It was not possible to use this method for all the traverses because of the difficulty of locating shot points in the built up area.

Step-out time method

This method was used where it was possible to shoot at only one end of the spread i.e. on Traverses G, J and J'. The theory is given by Polak (1962b). The accuracy of this method depends on two assumptions made, viz. that the velocity of the main refractor is constant and known, and the average velocity between the main refractor and the surface remains the same throughout the spread. The second assumption is probably not valid on Traverses G, J and J', where the overburden changes along the traverses from water saturated detrital material to unsaturated material. Thus the depth to bedrock may be in error by about 20 per cent near the river, but may be higher away from the river.

Broadside method

This method was used on Traverses D, E and F where it was not possible to shoot at either end of the spread, i.e. the shot point is side on to the spread. A charge was detonated at the upstream shot point for each traverse. The same assumptions are made as with the step-out time method. Further, velocities cannot be measured but must be determined from nearby normal spreads. The assumption that the velocity of the main refractor is constant might not be completely true because of the joint system in the gorge.

The seismic equipment used was a portable 12-channel P.19 refractor seismograph manufactured by Southwestern Industrial Electronics (SIE), Houston, Texas. TIC geophones of natural frequency of about 20 c/s were used on Traverses G, H, J, J' and K. EVP-5 pressure type hydrophones, manufactured by Electro-Tech Labs., Houston, Texas, were attached to a cable floated by plastic bouys and suspended about 3 ft below the water surface on Traverses A, B, C, D, E and F.

Hydrophone spreads approximately parallel and perpendicular to the river were anchored to the banks, Kings Bridge, or mooring bouys in the river. The position of the hydrophone spread was measured wherever practicable from survey points established on both banks or positioned by surveyors. On Traverse A the positions of stations A24 to A35 were calculated from the arrival time of the direct water wave from small charges detonated at surveyed shot points.

The tidal variation of the river was recorded by visually observing a temporary tide gauge attached to a pile near the Tamar Rowing Club building. A correction was applied to the water depth contours to allow for the tide, which ranged up to 11 ft. The tide gauge was surveyed in to the survey datum.

In this survey because charges were detonated on the river bed and the hydrophones floated about 3 ft below the water surface it is necessary to refer all times used in the calculations to a reference datum. For convenience the river bed was selected as reference datum and all travel times were reduced by a small correction (Mann, 1964).

In the "U" shaped gorge a hydrophone spread close to the water surface would record refracted first arrivals from that part of the bedrock surface, which by the geometry of the "U" shaped section is closest to the spread. The refracted first arrivals could originate from either wall of the gorge (as is probable for Traverses B and C) or from some point of the unweathered bedrock beneath the river detritus (as is probable from Traverse A). However in each instance this information does not indicate the depth to bedrock but defines a minimum distance to the refractor from the hydrophone. For convenience these distances are plotted as ordinates below the datum in the form of a cross section on Plate 2.

Similarly on Traverse D, E and F refracted first arrivals from charges detonated broadside to the traverses define a minimum distance to the refractor from the hydrophone. Hydrophones at stations close to the intersection points of Traverses A, B and C and D, E, and F probably record arrivals from the same point of the refractor boundary because a common shot point was used. The minimum distance to bedrock given by broadside shooting are relative values only. This distance at one of the hydrophones must be determined either from drill hole information or by reference to a hydrophone on a normal spread. Hydrophones on Traverse A were used as reference to calculate the minimum distance of the bedrock from hydrophones on Traverses D, E and F; the results were checked at the intersection points of Traverses B, C, G and K. On Traverse D, E and F each bedrock profile is drawn as a smooth curve through a set of arcs. Each arc centred at the hydrophone represents the minimum distance to the bedrock. The minimum distance shown on the cross-sections actually represents the minimum distance between bedrock and hydrophone in three dimensions.

4. RESULTS.

Plate 1 shows the locality map and layout of the seismic traverses.

Table 1 shows the observed velocities of the longitudinal seismic waves which are characteristic for the different media

TABLE 1

Rock Type	Seismic Velocity ft/sec
Water	5000 ±
River detritus	5500
Dolerite bedrock in shear zone	10,000 to 11,000
Unweathered dolerite bedrock	18000

The seismic results are shown as cross-sections on Plate 2. On Traverses A, B, C, H, and K the bedrock is deeper at the downstream end of the traverses than upstream. On Traverses A and H the depth increases sharply near H7 and probably near A31, but on the other traverses near B3, C8 and K13 the increase in depth is gradual. The depth to the bedrock at A35 is estimated from the intercept time of the T-D curve for the charge detonated at the Yacht Club. Between stations A33 and A35 first arrivals were recorded from the bedrock for the upstream shot but not for the downstream shot.

On Traverses A and H the seismic velocity decreases markedly near A23 and H9 from about 18000 ft/sec to 11,000 ft/sec. The T-D curves for Traverses B, C and K suggest that the seismic velocity of the bedrock is lower near B2, C11 and K16, i.e. that Traverses B, C and K terminate at the edge of a shear zone. However Traverses B, C and K do not extend far enough to give the seismic velocity or width of the shear zone.

These factors indicate the presence of a shear zone accompanied by a sudden increase in the depth to the bedrock approximately along the line joining K16, C11, A23, B3 and H7. This result agrees reasonably well with the strike and position of the Trevallyn Fault interpreted from geological work.

On Traverse J the bedrock is about 40 ft deep between J1 and J4.

Between J4 and J8 there is a pronounced dip in the bedrock profile; the remainder of the bedrock profile on Traverses J and J' suggest that the depth to bedrock decreases towards J11 and J'11.

5. CONCLUSIONS

On the right bank the bedrock is shallow and will probably provide a sound foundation for a bridge. On the left bank the depth to bedrock is about 40 ft and the foundation of an arch bridge would have to be sited on bedrock close to a major fault. To check the seismic results and the quality of the bedrock test drilling is recommended near H1, H7, and J4.

6. REFERENCES

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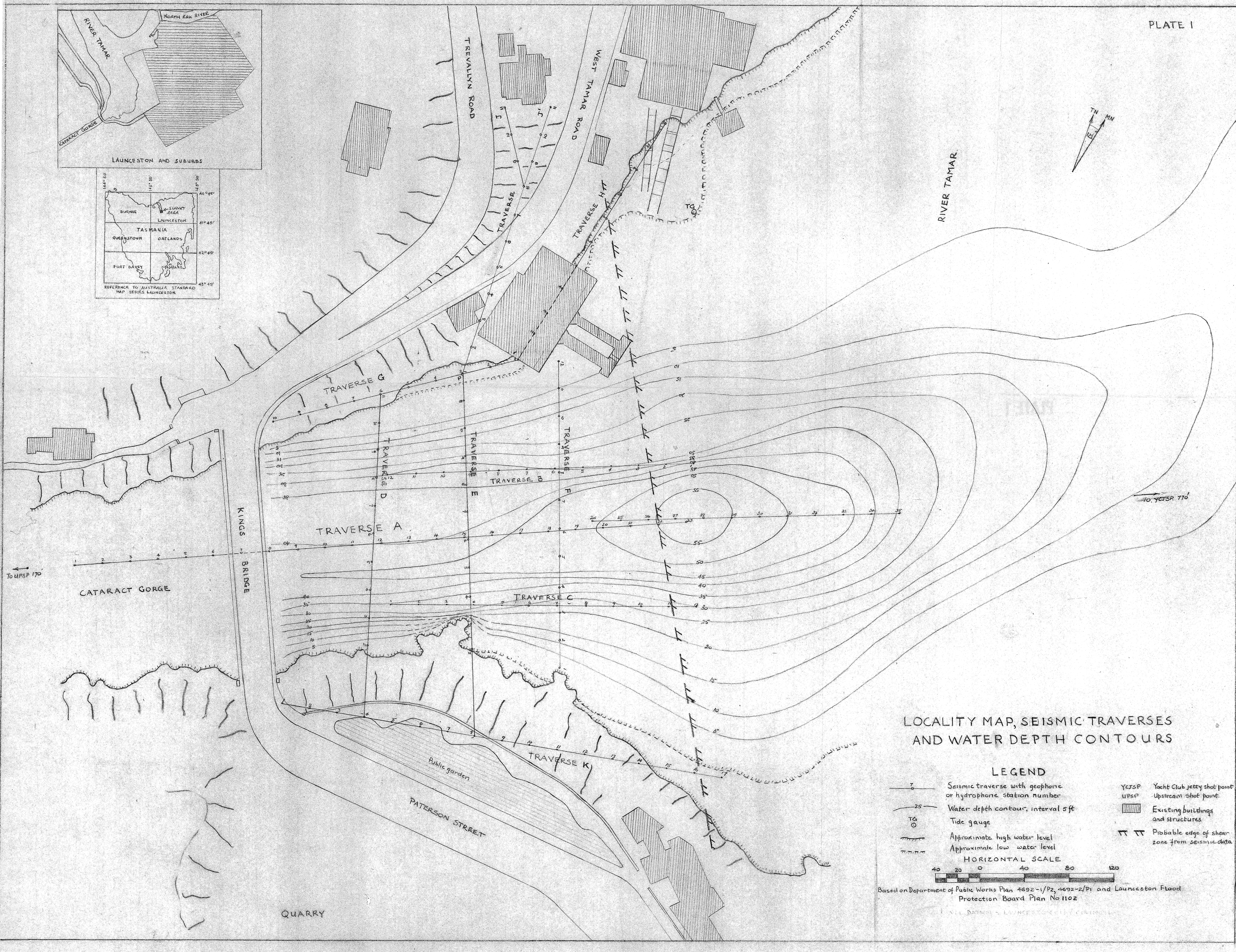
PLATE I
LOCALITY MAP, SEISMIC TRAVERSES AND WATER DEPTH CONTOURS
LEGEND
Seismic traverse with geophone or hydrophone station number
Water depth contour, interval 5 ft
Tide gauge
Approximate high water level
Approximate low water level
YCJSP Yacht Club jetty shot point
UPSP Upstream shot point
Existing buildings and structures
Probable edge of shear zone from seismic data
HORIZONTAL SCALE
40 20 0 40 80 120
Based on Department of Public Works Plan 4692-1/P2, 4692-2/P1 and Launceston Flood Protection Board Plan No 1102
RIVER TAMAR
NORTH ESK RIVER
CATARACT GORGE
LAUNCESTON AND SUBURBS
BURNIE
SURVEY AREA
LAUNCESTON
TASMANIA
QUEENSTOWN
OATLANDS
PORT DAVEY
HOBART
REFERENCE TO AUSTRALIA STANDARD MAP SERIES LAUNCESTON
TREVALLYN ROAD
WEST TAMAR ROAD
TRAVERSE J
TRAVERSE H
TN
MN
TG
TRAVERSE G
TRAVERSE D
TRAVERSE E
TRAVERSE F
TRAVERSE B
TRAVERSE A
TRAVERSE C
TRAVERSE K
TO YCJSP 770'
TO UPSP 170'
KINGS BRIDGE
CATARACT GORGE
Public garden
PATERSON STREET
QUARRY

Traverse G

STATION NUMBER	10	9	8	7	6	5	4	3	2	1
STATION ELEVATION	20	19	14	13	8	7	6	7	8	8
DEPTH TO BEDROCK	3	18	21	18	26	6	21	35	44	41

Traverse H

1	2	3	4	5	6	7	8	9	10	11
8	7	6	8	8	6	6	7	8	8	9
41	35	41	38	35		35	49	67	87	85

Traverse J

1	2	3	4	5	6	7	8	9	10	11
7	12	18	24	28	(26)	25	33	39	42	45
35	44	41	38	58	84	64	68	70	73	47

Traverse J'

1	2	3	4	5	6	7	8	9	10	11
7	12	18	24	28	(26)	25	33	29	26	26
35	44	41	38	58	84	64	68	70	73	47

Traverse K

STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
STATION ELEVATION	40	39	41	41	41	44	43	41	40	33	22	18	17	12	7	5	3
DEPTH TO BEDROCK			9	17	14	19	10	6	10	10	20		29		44	46	41