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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS.

RECORDS

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PRELIMINARY REPORT ON THE SEISMIC SURVEY OF THE
DERWENT BRIDGE SITE, HOBART, TASMANIA

by

E.J. Polak and F.J. Moss

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INTRODUCTION.

A seismic survey was made by officers of the Bureau of Mineral Resources, Geology and Geophysics, along the new centre line of a proposed bridge to cross the Derwent River at Hobart. The survey was requested by the Department of Public Works of Tasmania and its purpose was to correlate the information obtained from borings with that deduced from the seismic results and to determine variations in the thickness of silt and gravel in the river bed.

Drill holes put down by the Department of Public Works proved the existence of a layer of unconsolidated deposits, namely silt and gravel, the maximum thickness penetrated being 111 ft. in drill hole 2133. On the eastern and western banks, and under the river near both banks, dolerite crops out or underlies the unconsolidated sediments as proved by drill hole 320, and the excavation for the eastern lift span pier. It is likely that dolerite extends right across the river underlying a bedrock of Tertiary sediments (proved by drill holes) on the western, or Hobart side of the bridge site and underlying basalt towards the eastern side.

The engineers responsible for planning the bridge consider that it should be possible to anchor the piles supporting the bridge in the gravel underlying the silt, providing there are no steep dips in the underlying bedrock surface.

A seismic refraction survey was made in October, 1957. The preliminary interpretation of the results, which included an indication of the possibility of a channel in the bedrock between 600 and 800 ft. from the zero mark on the eastern bank was followed by further survey work in March, 1958.

METHODS AND EQUIPMENT.

The seismic refraction method depends on differences in the velocities of propagation of elastic waves through different media (water, silt and various rock types). When an explosive charge is fired in water, waves propagate in all directions and some of them will reach geophones also placed in the water. The signals generated by the wave arriving at the geophones are recorded on fast-moving paper simultaneous with timing lines in two milliseconds intervals. The waves may follow a few different paths, direct waves through water and silt, refracted waves along boundaries of strata, reflected waves from the surface of the water or from any discontinuity in the strata.

In this survey geophones were placed at the bottom of the river along a line at 25 ft. intervals. Shots were fired at the bottom of the river from both ends of the geophone line (spread) and in line with it. These were so called normal spreads. Broadside spreads, consisting of a geophone line, with shots fired on a line perpendicular to the geophone line were also used. The results of the normal shots were calculated by the use of the

reciprocal geophone method also referred to as the "method of differences" (Edge and Laby, 1931).

The geophysical equipment used in the survey consisted of a Midwestern shallow reflection-refraction twelve channel seismograph and T.I.C. floating underwater geophones with a natural frequency of about 20 cycles per second.

RESULTS.

Plate 1 shows the location of the seismic spreads and their relation to the drillholes and the centre line of the proposed bridge. Plate 2 shows the thickness of the unconsolidated deposits (silt and gravel) as determined by the seismic refraction method.

Reflections and refractions were obtained on normal spreads from deeper discontinuities than the bottom of the unconsolidated deposits. These results are not relevant to the immediate problem and will not be discussed here. They will be discussed in detail in the final report.

The identification of the rock types from velocities is impossible here, as the range of velocities for some rocks overlap that of other rocks. The velocities used in interpretation are as follows:

Silt and gravel	5,000 ft/sec.
Basalt	5,900 to 11,000 ft/sec.
Tertiary sediments	6,500 to 7,500 ft/sec.
Dolerite	11,000 to 21,000 ft/sec.

The velocity in water was found to be 5,000 ft/sec.

A correlation was made between recorded seismic refractors and the rocks logged in two boreholes namely DH 800 and DH 1300.

Considerable difficulty was experienced, owing to the strong currents in the river, in laying and keeping the spreads in their planned positions near the centre line of the proposed bridge. In presenting the results the depths obtained from the individual spreads have been projected onto the centre-line section. Such a projection introduces the possibility of errors in the depths shown on the centre-line although as the depths do not vary greatly from place to place this error is probably small. The spreads are numbered 5 to 26 and are shown on Plate 1. The spreads used in preparing the section are shown with the appropriate numbers on Plate 2.

The depths shown on Plate 2 are at the ends of the spreads, and bedrock is represented by a straight line joining these points. At places where significant changes occur along a spread additional depths are shown, for example on spread 5. The actual depths to bedrock at intermediate points on the spreads may differ slightly from those indicated by the straight lines but the differences are small and within the limits of experimental error.

The results of the seismic survey show:

1. The calculated thickness of silt and gravel does not vary greatly where measured along the traverses. A maximum calculated thickness of 90 ft. at 1400 ft. was observed.

2. The surface of the bedrock i.e. rock other than silt and gravel does not show any major channels with steep banks where it has been clearly recorded. The seismic results do not suggest any such channel.
3. Dolerite appears to underlie the silt and gravel at both ends of the proposed bridge line.
4. The seismic velocity of what is considered to be basalt, measured west of the 800 ft. mark is fairly low (minimum of 6,000 ft/sec.) but not unusually so for weathered basalt. For example, velocities between 5,600 ft/sec. and 12,000 ft/sec. were recorded in basalt at Wayatinah. Basalt with a seismic velocity below 7500 ft/sec. is probably in a fairly advanced stage of weathering.

During the second phase of the work larger charges were used than in the initial survey and clearer records were obtained. Following this a re-interpretation of the earlier work was carried out. The base of the silt and gravel determined by clearly recorded refractions is shown on Plate 2 by a continuous line with the calculated depths shown at the ends of the spreads. Such depths determinations are likely to have an error of $\pm 15\%$. That determined by weakly recorded refractions or secondary waves is shown by a broken line. The likely error in these determinations may be larger, possibly $\pm 20\%$.

REFERENCES.

- Edge, Broughton A. & Laby, T.M. - The Principles and Practice of Geophysical Surveying
Cambridge University Press.

SCALE IN MILES
0 50 100 150

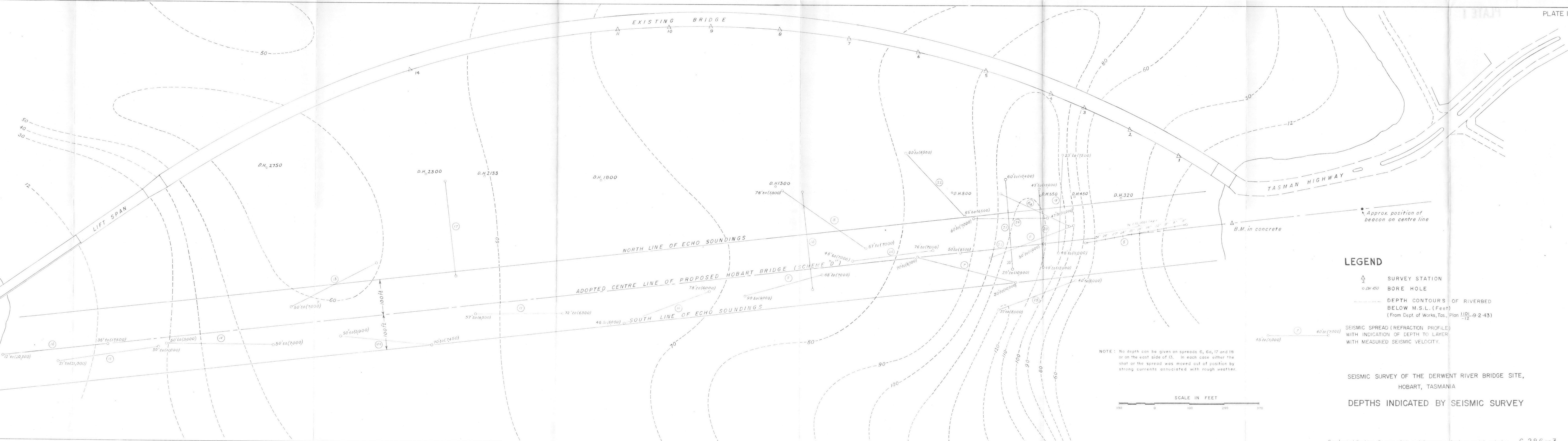


REFERENCE TO AUSTRALIAN
4 MILE MILITARY MAP SERIES

True North
Magnetic North
12° 15'

Approx. position
of beacon on
centre line.

T.G.R. MAIN LINE



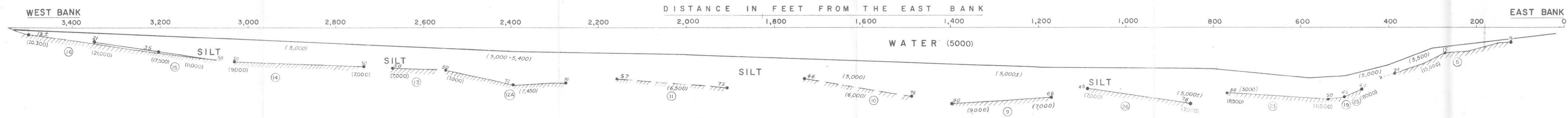
NOTE: No depth can be given on spreads 6, 6a, 17 and 19 or on the east side of 13. In each case either the shot or the spread was moved out of position by strong currents associated with rough weather.

SCALE IN FEET
0 100 200 300

LEGEND

- SURVEY STATION
- BORE HOLE
- DEPTH CONTOURS OF RIVERBED BELOW M.S.L. (Feet)
(From Dept. of Works, Tas., Plan L101-9-2-43)
- SEISMIC SPREAD (REFRACTION PROFILE) WITH INDICATION OF DEPTH TO LAYER WITH MEASURED SEISMIC VELOCITY.

SEISMIC SURVEY OF THE DERWENT RIVER BRIDGE SITE,
HOBART, TASMANIA
DEPTHS INDICATED BY SEISMIC SURVEY



LEGEND

- 46 ——— DEPTH DISCONTINUITY IN FEET BELOW RIVER BOTTOM
- (6,500) ——— HORIZONTAL SEISMIC VELOCITY (REFRACTION) IN Ft./Sec.
- PROBABLE SURFACE OF BEDROCK BASED ON CLEARLY RECORDED REFRACTED SEISMIC WAVES
- " " " " " " WEAKLY " " " "
- (16) ——— NUMBER OF SPREAD

NOTE: DEPTHS SHOWN ARE THOSE DETERMINED ALONG SEISMIC SPREADS.
THESE HAVE BEEN PROJECTED ONTO THE CENTRELINE OF THE PROPOSED BRIDGE IN ORDER TO CONSTRUCT THIS SECTION.

**SECTION ALONG PROPOSED CENTRE LINE
OF NEW HOBART BRIDGE**
(FROM SEISMIC REFRACTION)