COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1966/168

DEVONPORT AND LAUNCESTON "SONAR BOOMER" SURVEYS,

TASMANIA 1966

by

J.S. MILSOM

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SUMMARY

Three low-power "Sonar Boomer" surveys were made in northern Tasmania during March 1966 at the request of the Department of Mines. Two of the surveys were in Devonport - one in the outer harbour area and the other at the proposed site of a new bridge intended to replace the Victoria Bridge across the Mersey River. The third survey was in the Trevallyn Gorge, Launceston, also the proposed site of a new bridge.

The survey at the Victoria Bridge site delineated layers of sediment within a V-shaped channel. Drilling results show that this channel is cut partly through unweathered dolerite bedrock and partly through clay formed by the decomposition of the dolerite. It was not possible to differentiate between these rock types on the "Sonar Boomer" records.

In the outer harbour area at Devonport a number of sub-bottom layers were noted. As no drilling information was available, these layers could not be definitely correlated with geological formations.

The work in Launceston was of an experimental nature. It was hoped that the "Sonar Boomer" equipment could be used successfully despite the narrowness of the gorge at the bridge site, but with the present omni-directional pulse this proved not to be so.

1. INTRODUCTION

As part of the programme for the improvement of the Bass Highway, the Public Works Department (P.W.D.) of Tasmania is to construct a new bridge across the Mersey River at Devonport, downstream from the existing bridge (Plate 1). A geological investigation of the proposed bridge site is being made by the Department of Mines, Tasmania, and a number of holes have been drilled from a floating platform. The Department requested a "Sonar Boomer" survey of the submerged part of this site by the Bureau of Mineral Resources, Geology and Geophysics (BMR), to determine the depth to bedrock in the river channel.

Also at Devonport, the Marine Board of Devonport is proposing to extend the harbour works beyond the present mouth of the Mersey River by the building of new breakwaters and the reclamation of some land. The Department of Mines acts as geological consultant in this work also and requested a "Sonar Boomer" survey of the area.

The surveys were made on the 9th and 10th of March by J. Milsom and A. Radeski. A boat and crew were provided by the Marine Board and positional markers and control were supplied by the P.W.D. and by the Marine Board.

Prior to its arrival in Devonport, the survey party was working in the Trevallyn Gorge, Launceston, where a seismic refraction survey of a new bridge site had previously been made by the BMR (Mann, 1966). It was hoped that the difficulties inherent in using seismic methods in a narrow, high walled, gorge might be minimised by use of the "Sonar Boomer" equipment. The results of this work are also given in this Record.

2. EQUIPMENT AND METHOD USED

Equipment

The "Sonar Boomer" equipment used in the surveys at Devonport and Launceston has been developed by Edgerton, Germeshausen, and Grier, Inc. of Boston, Massachusetts, mainly for deep marine seismic work. The system can be operated at power ratings of up to 13,000 watt-seconds, but for the shallow investigations the minimum number of components was used, at a rating of only 500 watt-seconds. Current was supplied by an Onan petrol generator at a nominal 110 volts and 60 c/s.

The power pack unit (model 232) can be operated at either 110 or 220 volts. It supplies charging current at 4000 volts to the triggered capacitor bank (model 231), which contains ten 16-microforad capacitors (only five of which are used at 500 watt-seconds operation) and a trigger circuit. The trigger circuit initiates discharge of the capacitors through the coil of a transducer in response to an external pulse. The transducer (model 236) consists of an aluminum plate, normally held flat against the epoxy-cased coil by a heavy spring. Discharge of the capacitors through the coil induces eddy currents in the disc and drives it away from the coil to the limit of its travel against the spring (about $\frac{3}{4}$ inch), producing a pressure wave in the water.

Pressure changes in the water were detected by a hydrophone, originally manufactured for the Royal Australian Air Force by Sparton Electronics. Signals from the hydrophone were amplified, filtered, and then recorded on an "Alden" wet paper, helical wire recorder. Discharge of the capacitors was triggered by a pulse from the recorder at the start of every fifth sweep (rotation) of the helix. Only the first sweep of each five was printed.

In addition to the instruments supplied by the BMR, the boat used in Devonport was fitted with a Kelvin-Hughes echo sounder by the Devonport Marine Board.

Survey method

The hydrophone and transducer were suspended amidships from opposite sides of the boat, at a horizontal separation of about twelve feet. The transducer was approximately four feet and the hydrophone six feet below the surface, but these depths fluctuated considerably in the rough conditionsencountered beyond the present harbour works at Devonport. The boat speed was very low and the hydrophone and transducer hung almost vertically below their suspension points.

The traverses were indicated by pairs of markers erected on shore, these being in line when the boat was on course. Position along the traverses was determined by noting the transits (coincidences) of other pairs of markers. At the Victoria Bridge site and in Devonport, markers were specially set up for this purpose, but in Devomport harbour area, beacons and other permanent features were used. When two markers were in transit, the event mark button on the recorder panel was depreseed, causing a vertical line to be printed on the record (Plate 3).

Each run was repeated at least twice, usually with different filter settings. The records were little affected by alterations of the filter settings above 2000 c/s.

Survey records

A sample record is reproduced in Plate 3. The horizontal lines are timing lines impressed on the record at 10-millisecond intervals. On the time scales in Plates 3, 4, and 5, this interval is shown as 5 milliseconds, this being the one-way travel time of the pulse. The one-way travel time to a boundary is often termed the 'time-depth' of that boundary. The vertical lines are event marks impressed at will on the record by the operator, indicating the start and end of the run and the transiting of pairs of event markers. Darkening of the record indicates the arrival of pressure waves at the hydrophone, either directly from the hydrophone, or after reflection at an interface, or from random sources such as the boat's propellor. Since this last group of waves is not synchronised with the sweeps of the helix, they do not give rise to continuous traces on the record. Continuous traces arise when pulses from the transducer are reflected from a continuous interface. Strong horizontal traces near the top of the record usually arise from direct waves, or from waves reflected only at the upper surface of the water.

If the velocity of sound is known, or can be estimated, for all layers above a given boundary, the wave reflection depth can be calculated. For water, or water-saturated sediments, the velocity is close to 5 feet/millisecond, so that the depth equivalent to the time-line interval is about 25 feet. For harder or more compacted material, the equivalent depth will be greater.

Repititions and multiples

A serious disadvantage of the equipment as used in Devonport and Launceston arises from the repetition on the record of continuous traces that correspond to a single boundary. This may be due to two causes. In the first place, the initial pulse is not pure, but has three main peaks (Hersey, Edgerton, Raymond, and Hayward, 1960). The first and largest of these is the pulse due to movement of the transducer plates. About three milliseconds after this (the actual delay depending on the depth of suspension of the transducer), comes the pulse reflected from the water surface. This is followed after a further three milliseconds by the cavitation pulse, believed to be caused by the collapse of cavitation bubbles generated by the sudden motion of the plate. The amplitude of the reflected pulse is commonly about two-thirds, and of the cavitation pulse about half, that of the initial pulse. Each of these pulses, after reflection from a boundary, will give rise to two pulses to the hydrophone, one direct and one reflected from the water surface. Alternatively, repetitions may be caused by 'rattle' or ringing of the filter stage in the recorder.

Whatever the cause of the repetitions their effect is to conceal a boundary when it is less than a certain depth below another. The actual 'hidden depth' depends on the velocity and density contrasts of the reflected waves. In some cases it proved possible to follow the repetition of a trace when the initial trace from that boundary was obscured by repetitions from a shallower one. Where this has been done the fact is noted.

Repetitions should not be confused with the multiples caused by the waves that have undergone more than one reflection. The most common multiple traces are those due to the reflection of a wave from a boundary to the water surface, back to the boundary, and then to the hydrophone, and those due to the wave reflected once from the boundary and once from the water bottom. Multiples are normally easily recognised, but may also obscure true first reflections.

Errors

The error in reading the time-depth of a given trace would not be more than a quarter of a millisecond, half a millisecond being the maximum thickness of trace observed. Larger errors, of the order of one and a half milliseconds, will arise if a first repetition is mistaken for an initial trace. Where continuous monitoring of the boat's path is not possible, there will also be errors in depth due to errors in position. These errors will be important where there is considerable sub-surface relief, as at the Victoria Bridge, or where the distance between event marks is large. Rough conditions, leading to fluctuations in boat speed, as in the Devonport outer harbour survey, will aggravate this. The magnitude of such errors can be reduced and their effect minimised by re-running the traverses.

Errors also arise when estimates of velocity are made and depths are calculated from these estimates. Consider a layer of thickness W = vt, where t is the one-way travel time across the layer, and v is the velocity of seismic waves in it. Then the error dW in W is given by :

$$\frac{dW}{W} = \frac{dv}{v} + \frac{dt}{t}$$

That is, the percentage error in W is equal to the sums of the percentage errors in v and t. As noted above, dt, for a layer defined by two boundaries, will be one millisecond.

For unconsolidated, water-saturated sediments a velocity of 5 feet/millisecond is commonly used. In practice, this velocity ranges from 4.8 to 5.3 feet/millisecond, with occasional higher values, and a 6% error may be introduced. Velocity estimates can be made if drill hole information is available, the errors in this case depending on the number of drill holes, the degree of correlation obtained, and the uncertainty in the boat's position.

More commonly, the depth D to a given horiaon is required, rather than the thickness of a layer. The error dD in this estimate is the sum of the errors in the widths of the layers above the horizon. The errors in layer widths are not, of course, completely independent quantities, since an overestimate of the time-depth of an intermediate horizon will increase the estimated thickness of the layer above it and decrease that below it. If the velocity differences are small, the percentage error due to errors in time-depth estimates is simply the percentage error in the time-depth of the horizon in question. The percentage error introduced by velocity errors is less simple, being a function of the widths of the various layers. The error dD in the depth to the top of the nth layer is approximately given by :

$$dD_n = W_o \frac{dv_o}{v_o} + \ldots W_{n-1} \frac{dv_{n-1}}{v_{n-1}} + D_n \frac{dt_n}{t_n}$$

In the special case where all velocity estimates are in error by approximately the same percentage, this reduces to a formula similar to that already obtained for the width of a layer :

$$\frac{dD_n}{D_n} = \frac{dv}{v} + \frac{dt_n}{t_n}$$

If traces on the "Sonar Boomer" chart have been correctly identified with horizons intersected in drilling, and if a reasonable number of runs have been made along each traverse, errors in velocity should not be more than four or five percent. The error in t is usually smaller than this except for very shallow horizons and the total error in D might be expected to be of the order of six to eight percent. Unfortunately the nature of the "Sonar Boomer" records at shallow depths, where there is considerable confusion caused by multiple reflections and by repetitions, is such that much larger errors may arise. This is particularly the case where little or no drilling control is available.

The depth errors due to errors in position must be added to any other errors. Position errors will also affect estimates unless the drill holes are at event mark points. This is therefore very desirable. The error in D, if velocities have been correctly estimated, is equal to the error in position multiplied by the sine of the dip angle of the horizon in question. This may be the largest source of error in river surveys.

3. RESULTS AND CONCLUSIONS, VICTORIA BRIDGE SITE

A number of drill holes have been completed at the Victoria Bridge site, mainly on the proposed centre line of the new bridge (Plate 2). Only one of these holes reached unweathered dolerite bedrock. Many of the others were bottomed in clay, which in some cases has an igneous texture and is believed to be the end product of weathering of the dolerite. Overlying the clay is a layer of gravel, and above this is a layer of sand. In the central parts of the river channel the sand graduates into the gravel through a muddy transition zone.

Three "Sonar Boomer" traverses were made along lines selected by the P.W.D. One of these was the proposed centre line of the bridge, a second was 42 feet upstream of this and the third 40 feet downstream. Although the separations between the lines are small, there are noticeable differences in the records.

Because of the strong tidal currents at the site and the necessity for maintaining a very slow speed along the traverse, the bows of the boat had to be pointed almost directly upstream. Under these conditions, departures from the desired line were unavoidable, and the mid-point of the transducer-hydrophone may at times have deviated by as much as 20 feet. Larger deviations and considerable fluctuations in speed probably occurred at the start of each run. The traverses were repeated at least twice, the cross-sections in Plate 3 being tracings from the record of one run along each line, interpreted with reference to other runs along the same line. The vertical scale on the cross-section is in milliseconds. For water or soft, water-saturated sediments, one millisecond on the time scale is equivalent to approximately five feet in depth.

On all records there is a short trace, apparently from a deep reflector, near the third event mark. On the centre traverse it is at an equivalent depth of between 31 and 34 milliseconds. The trace is very sharp and shows no signs of the attenuation that would be expected at such a depth. This suggests that it is probably caused by side reflections from a body in the river and does not represent a sub-bottom feature. The variation in depth of the reflector between adjacent lines is consistent with a reflection from an object about 160 feet downstream and close to the line of the third event markers.

The cross-sections show a roughly V-shaped valley with various higher traces indicating sedimentary infilling. The best correlation with drilling results is obtained if it is assumed that the seismic velocity in the layers above the V-shaped reflector is about 5 feet/millisecond. The uppermost trace corresponds to the river bottom as shown by the echo sounder. Drilling logs show that this is the upper surface of a layer of sand. The lowest reflector (i.e. the V-shaped reflector) is probably the top of either clay or dolerite. There is no noticeable change in the trace between points where it is thought to represent the top of the clay and those where it indicates fresh or slightly weathered dolerite rock. In places where a layer of clay was detected in the drill holes, there is no indication of a deeper trace corresponding to the top of the hard rock. This suggests either that the clay graduates into the dolerite through an extensive transition zone with no sharp discontinuities, or that the absorption of seismic waves in the clay is so large that no significant amount of energy reaches the hydrophone after reflection from the dolerite. Both these effects may be present.

The two intermediate traces probably represent the upper and lower boundaries of the muddy transition layer. Where this zone is missing, only a single trace is seen, and this arises from the sand-gravel interface.

Because of the considerable subsurface relief and the uncertainty in position noted above, errors are probably larger than would normally be the case. Time-depths in repeated runs along a traverse vary usually by seven or eight percent and will result in a similar error in velocity estimates. An overall error of fifteen percent is therefore probable.

4. RESULTS AND CONCLUSIONS, DEVONPORT OUTER HARBOUR

Work has not yet been started on the harbour extensions at Devonport and, apart from the bottom soundings made with the Kelvin Hughes echo sounder, the "Sonar Boomer" survey is the first investigation of the area. There are no drill holes from which reflecting horizons can be identified or velocities calculated, and the results of the survey must therefore be presented in tentative form. Tertiary basalt crops out along the shore at the mouth of the Mersey River (Plate 1). It is assumed in the following discussion that this can be regarded as bedrock, but it should be remembered that the basalt may not be very thick, and may overlie softer rocks.

The profiles in Plate 5 are taken directly from the "Sonar Boomer" records and show all the coherent traces noted. No adjustments have been made to the horizontal scale, which therefore varies widely with the speed of the boat. The position of the numbered event marks may be found by reference to Plate 4, which also shows the profiles at reduced and adjusted scale. The best record obtained on each traverse was used to obtain the profiles, interpretation being made with reference to the other records obtained on that traverse and by comparison with records from the adjacent traverses. A repetition of a trace from a continuous horizon could often be followed when the trace itself was obscured by repetitions from a shallower horizon or repetitions of the direct wave. Where this has been done the fact is noted in Plate 5.

Certain features are common to all five traverses. The uppermost layer appears to consist of loose silt with a seismic velocity little different from that of water. Its upper surface coincides with the sea bottom as recorded by the echo sounder but it gives rise to only a weak trace on the "Sonar Boomer" records. Except in the deeper parts of the traverse the trace is obscured by repetitions of the direct wave. Where shown, the top of the layer is denoted in Plate 5 by the letter A. Thicknesses of this layer are given in feet in the following description, assuming a seismic velocity of 5000 ft/s. All other depths and thicknesses are in milliseconds.

At the bottom of the silt there is a boundary, the B horizon, which usually gives rise to strong first traces and repetitions. This indicates a significant change in seismic velocity and density and must correspond to the top of a much harder layer. Below this boundary it is possible to trace other reflectors, but these are often obscured or confused by repetitions of the B horizon. Letters have also been assigned to these traces, denoting tentative correlations. Traces at times greater than 15 milliseconds are very weak and there are no traces at all at times greater than 20 milliseconds. This suggests that there are no strong reflectors for some distance below this level, although absorption of energy in the first forty feet of sea bottom is probably large.

The individual profiles are discussed below, in order from the west. In all cases the line is regarded as starting at the near shore (southern end), although the record of line MB5 traced in Plate 5 was taken on a run with the boat heading towards the shore. In addition to the "Sonar Boomer" cross-sections, the profiles taken from the echo sounder charts are shown at the same scale in Plate 4, as dotted lines. The dotted line is raised very slightly where it coincides with a "Sonar Boomer" horizon.

Line MB5

Horizon A can be traced in about the last third of the record, where it coincides with the echo sounder profile. Horizon B is below this profile over the whole length of the line. Below the B trace there are two other traces, each extending for less than half the record and not overlapping. These traces were denoted by the symbols C' and C". Their possible relation to each other and to the traces observed on line MB4 is discussed below.

Line MB4

Horizon A scarcely appears on the record, being generally obscured by repetitions of the direct wave. Where seen, it coincides with the echo sounder profile. Horizon B extends over the whole of the record, but is broken by a fault or slump before the second event mark. Below this is a further trace, horizon C, which can also be followed over the whole length of the record. The trace is similar in character to C' and C" on line MB5, suggesting that these traces may mark a continuous horizon, possibly rising to the level of the B horizon in the vicinity of event mark 3. Alternatively, a thin layer between B and C may exist only on line MB5 and reflections from C' may mask reflections from C" if this horizon continues beneath it. In view of the apparent continuity of the B horizon on MB5 the first of these explanations seems the most likely. Where C" does appear it is confused by repetitions of the B trace and possibly only a repetition has been followed. The trace marked D is very faint on line MB4 and would possibly not have been included in this report but for the appearance of a similar horizon at shallower depths on succeeding records.

Line MB3

Although little of horizon A can be seen, horizon B can be traced across the entire length of the record without reference to repetitions. There is a C horizon, which can almost certainly be identified with the C horizon of line MB4. Below the C trace a lower trace defines a layer wedging out seawards. This layer may also be wedging out eastwards, the D trace being too weak to be seen on line MB5 and faint but visible on line MB4.

Line MB2

This is the most complex of the profiles and appears to mark a transition between the three western profiles (which have many similar characteristics) and line MB1, which is difficult to relate to the others. The seaward end of line MB2 is generally similar to line MB3. The C horizon falls very suddenly in the vicinity of event mark 8, and between event marks 7 and 8 it cannot be followed through the repetitions of the B horizon. The layer between C and D appears to wedge out finally in this region.

There is a lateral change between event marks 5 and 7, and the C trace at the beginning of the record apparently represents a different boundary from that at the end. The record is very confused at the start of the line, where the B trace is concealed by repetitions of the direct wave. Large fluctuations in depth are shown by traces which may be either continuations of the C trace or repetitions of the B trace. The cross-section in Plate 4 shows the simplest explanation, but other interpretations are possible. The indications of a strong downthrow to the south from the domal structure near the start of the record may be connected with the boundary between rock outcrop and sand on the nearby beach.

Line MB1

This is the only record on which a part of the B horizon coincides with the sea bottom as shown by the echo sounder. This occurs close to the shore and to outcropping basalt, strongly suggesting that, on this trace at least, the B horizon is the upper surface of the bedrock. A second difference is the absence on line MB1 of any strong reflectors below the B horizon. The traces F, F', and E shown in the cross-sections are all very faint. Trace E, the faintest of these, may be a continuation of either trace F or F' but any connection is masked by the strong 50-c/s interference that was always encountered in the middle of the line. Because of the faintness of these lower traces they are not considered to arise from either the C or D horizons, which produce much stronger reflections on the other lines.

The presumed silty layer (between the dashed line and trace B) appears in the middle of MB1 and is about seven feet thick at the north end of the line, where the A horizon can be seen on the "Sonar Boomer" records.

Conclusions

No firm identification of the various layers detected can be made with the information at present available. In most of the area surveyed a layer of soft silt between five and ten feet thick overlies much harder material. Although, as noted above, this harder material appears to be bedrock on line MB1, it is not safe to assume that this is so on the other lines, where the horizons denoted by the letters C and D appear. Either of these or horizon B might be the top of bedrock or decomposed bedrock. Alternatively bedrock might lie still deeper; In this case, since no traces are observed at times greater than 20 milliseconds, and since bedrock is expected to be a strong reflector, the depth to bedrock is likely to be large. It should also be noted that in the work at the Victoria Bridge site, where drilling information is available, it was not found possible to distinguish between fresh and extensively decomposed bedrock on the "Sonar Boomer" charts. A limited number of drill holes would solve most of the problems connected with interpretation of the harbour survey. Suggested sites for drilling are shown in Plate 4 (DH1 to DH6). Drilling should preferably be carried out on the survey lines and near to event mark points.

DH1 and DH2 are positioned to determine the nature of horizons B, C', and C". Both should be drilled to 50 feet below sea bottom or shallower bedrock. DH3 on line MB3 will test the foundation for the proposed breakwater and, if continued to about seventy feet below sea bottom it should give information on the nature of horizon D; this also applies to DH6 on line MB2. DH4 and DH5, which could probably be terminated before forty feet below sea bottom, would give information on the possible fault near the start of line MB2.

No holes have been recommended on MB4, since it lies along one side of the shipping channel; the "Sonar Boomer" records could probably be interpreted using DH1, DH2, and DH3. However, the advantages of drilling in the shelter of the existing breakwater may outweigh these considerations. Two holes near line MB4 and in the sheltered part of the harbour would provide much useful information and might be more easily drilled than those recommended above. No holes can be recommended on MB1 until more subsurface information is available.

5. RESULTS, TREVALLYN BRIDGE SITE

The "Sonar Boomer" equipment was also used in further investigations of the site of the new Trevallyn Bridge over the South Esk river at Launceston. A boat was provided for this work by the Launceston Marine Board. At the request of the P.W.D. the site was previously investigated by Mann (1966) using conventional seismic refraction techniques, but some difficulties were encountered owing to refractions along the very steep sides of the gorge. It was thought that additional information might be obtained using the "Sonar Boomer".

It was intended that "Sonar Boomer" traverses should be made on three lines across the gorge and two along it, these lines coinciding with the previous geophone spreads of the refraction survey. The three cross-lines were each about 180 feet long. For such a short distance the "Sonar Boomer" record obtained is less than one inch long and does not allow continuous horizons to be identified, more especially as the reflections obtained at the start and finish of the lines will be from the banks and not from the bottom.

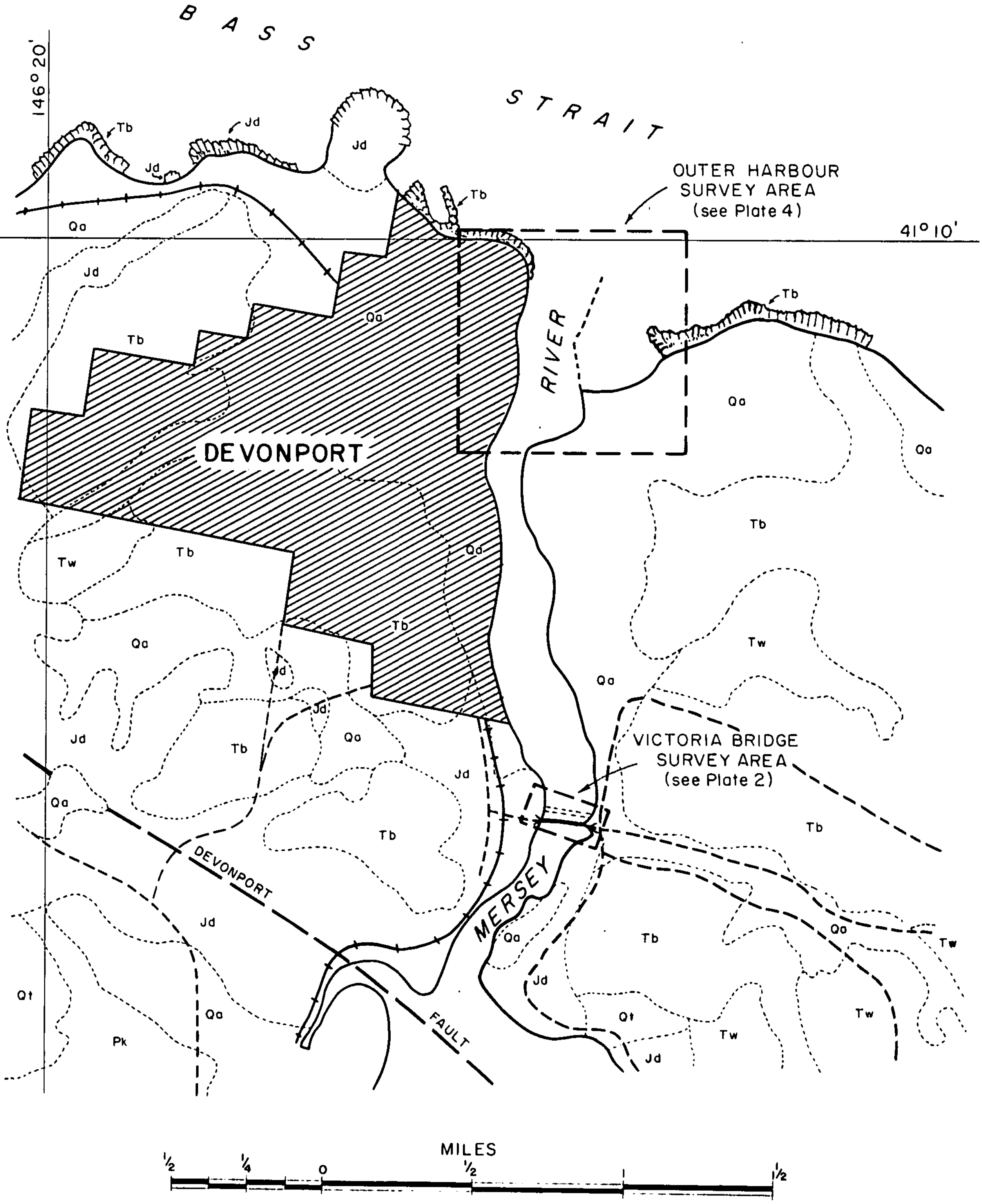
In the case of the lines at right angles to the proposed bridge it was found that, while reasonable records could be obtained some distance away in the open harbour, on approaching the gorge the record became very confused and no continuous horizons could be identified. This is attributed in part to the effect of nearby vertical or near-vertical rock faces, but may also be due to the existence of a shatter zone in the gorge.

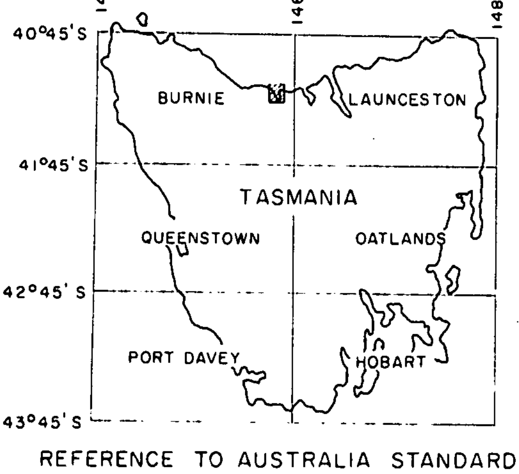
6. REFERENCES

HERSEY, J., EDGERTON, H., RAYMOND, S., and HAYWARD, G. 1960 Sonar uses in oceanography. <u>Preprint 21.60, Fall Instrument-Automation Conference, Instrument Society of America.</u>

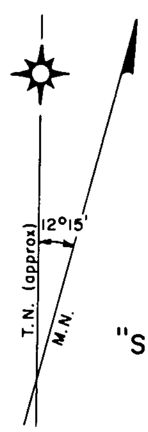
MANN, P.E. 1966 Trevallyn Bridge site geophysical survey, Launceston, Tasmania 1965. <u>Bur. Min. Resour. Aust. Rec.</u> 1966/85.

PLATE 1





REFERENCE TO AUSTRALIA STANDARD 1:250,000 MAP SERIES: BURNIE



GEOLOGY

Qa	Alluvium and beach deposits
Qt	Dolerite talus
Tw	Wesley Vale sand
Tb	Tertiary basalt
Pk	Kelcey Tier mudstone
Jd	Jurassic dolerite

DEVONPORT, TASMANIA

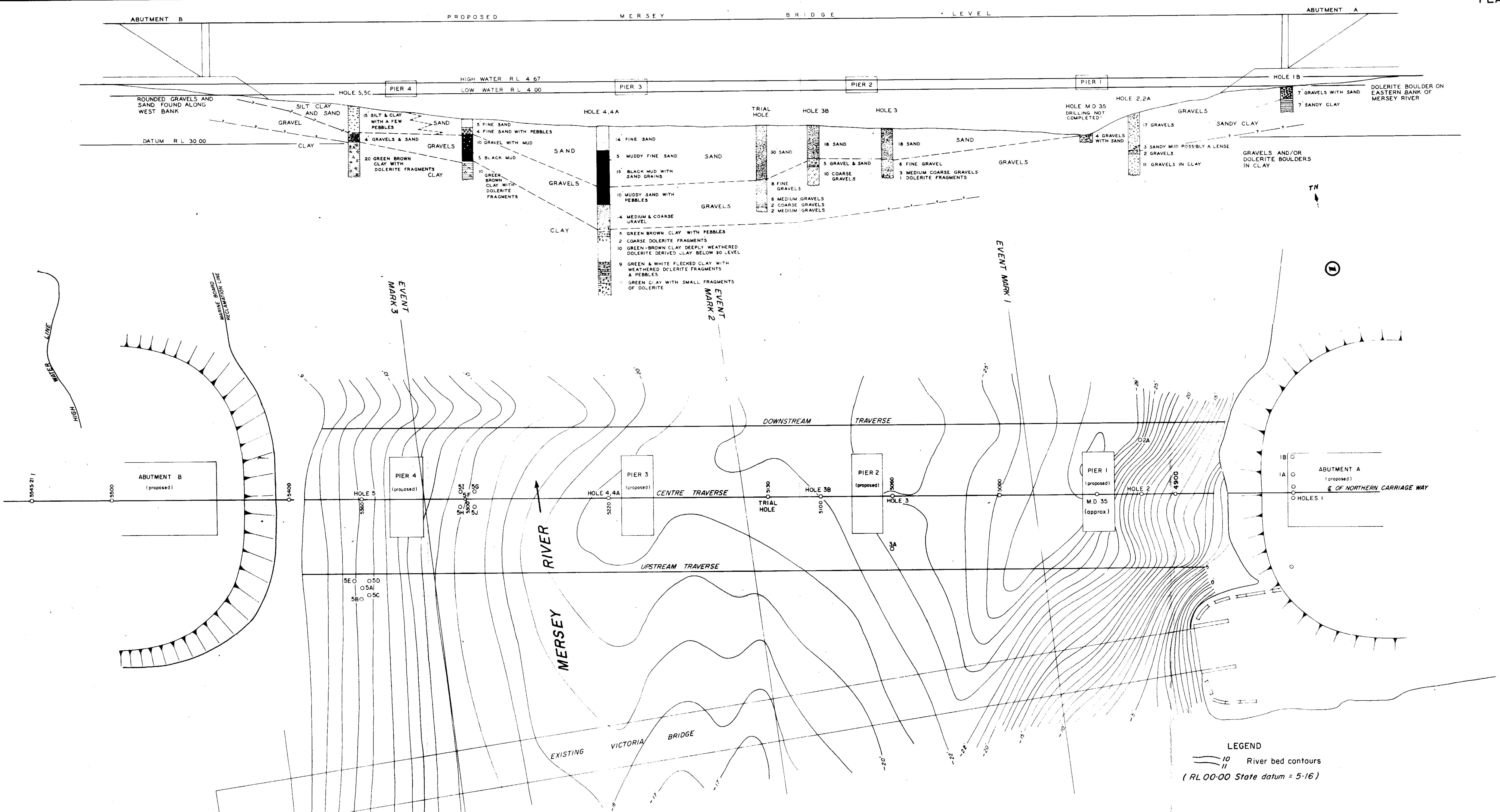
"SONAR BOOMER" SURVEYS, 1966

LOCATION PLAN AND GEOLOGY

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

K55/B5-104

TO ACCOMPANY RECORD No. 1966/168



DRILL LOGS AND TRAVERSE POSITIONS

Adopted from PWD site investigation plan 225MB

Geology and bore logs due to Dept of Mines, Tasmania

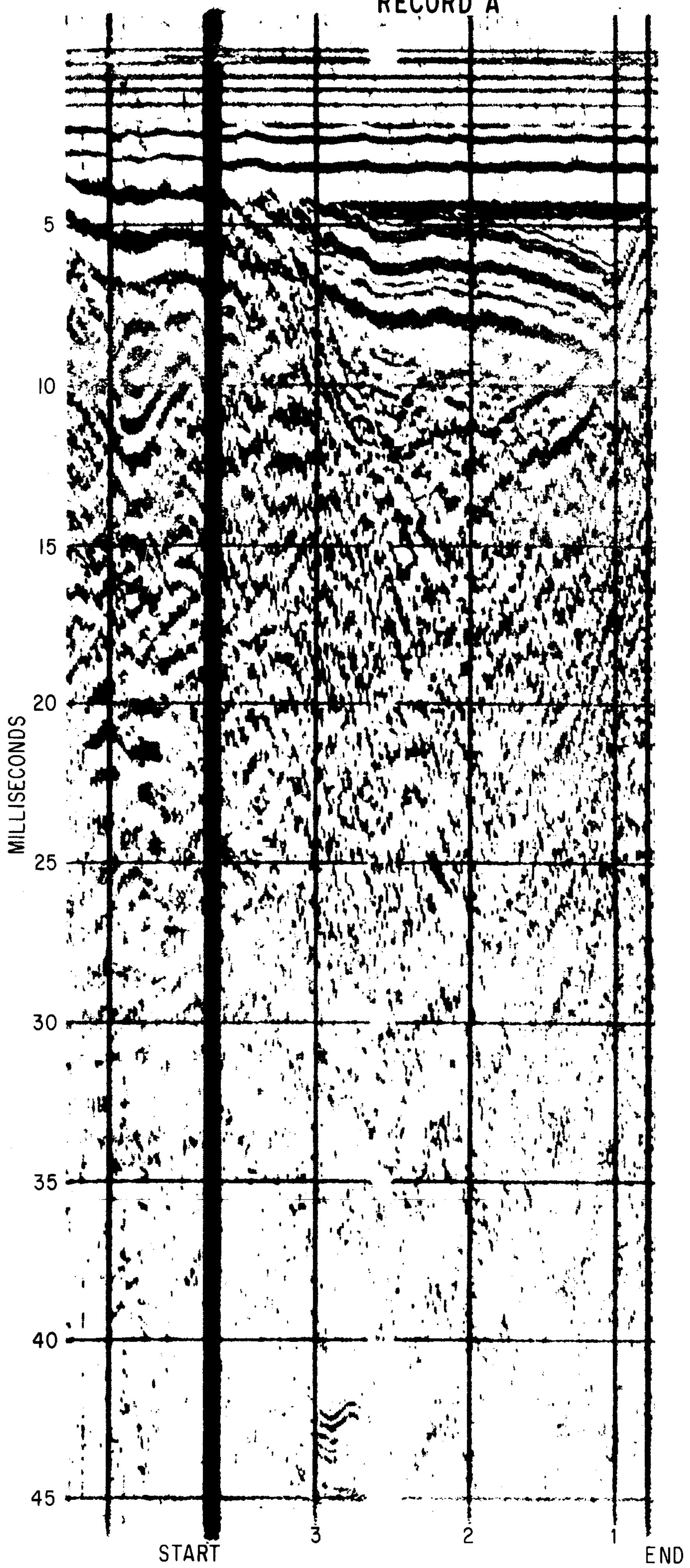
TO ACCOMPANY RECORD No. 1966/168

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

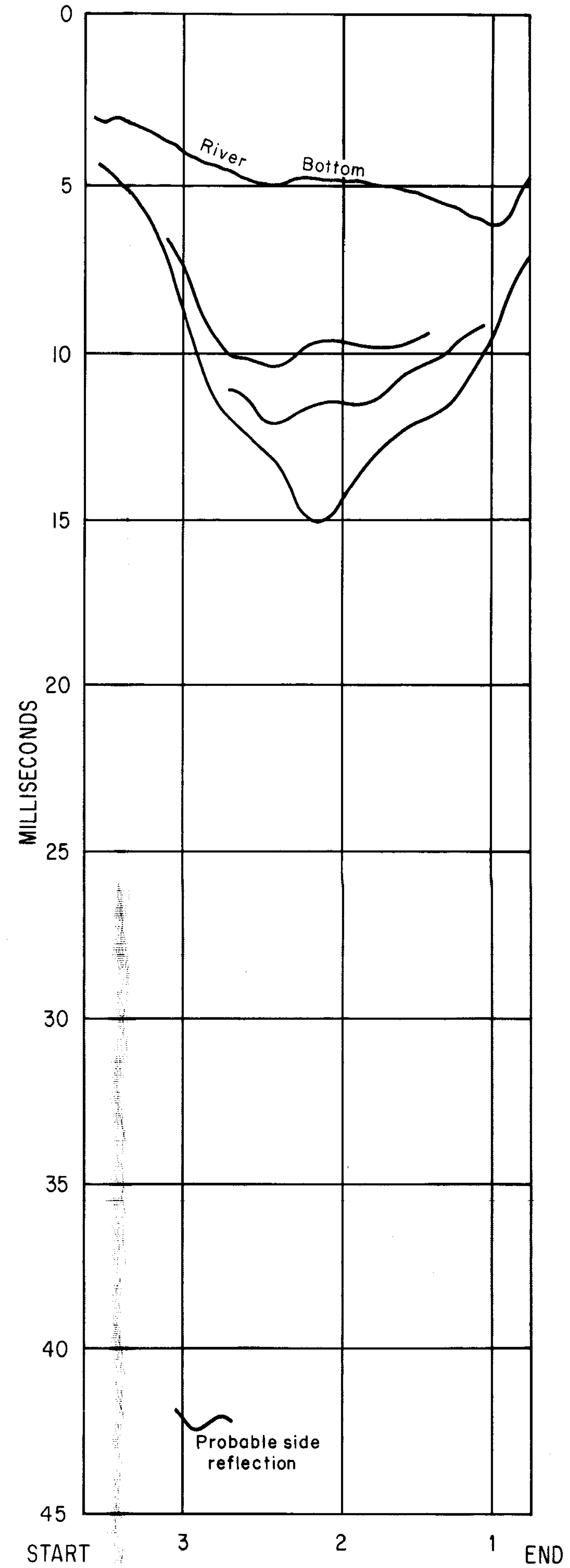
K55/B5-107

PLATE 3

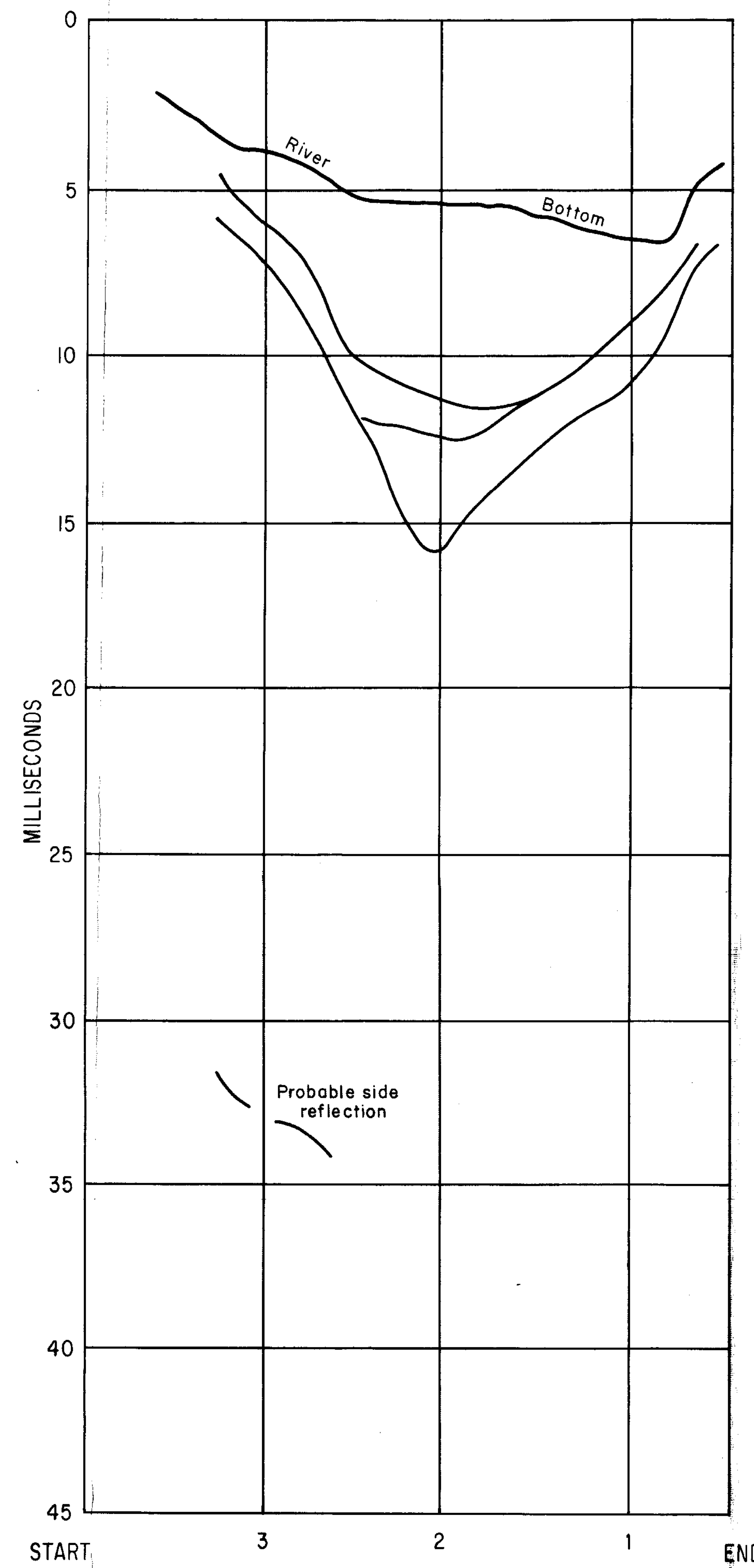
UPSTREAM TRAVERSE
RECORD "A"



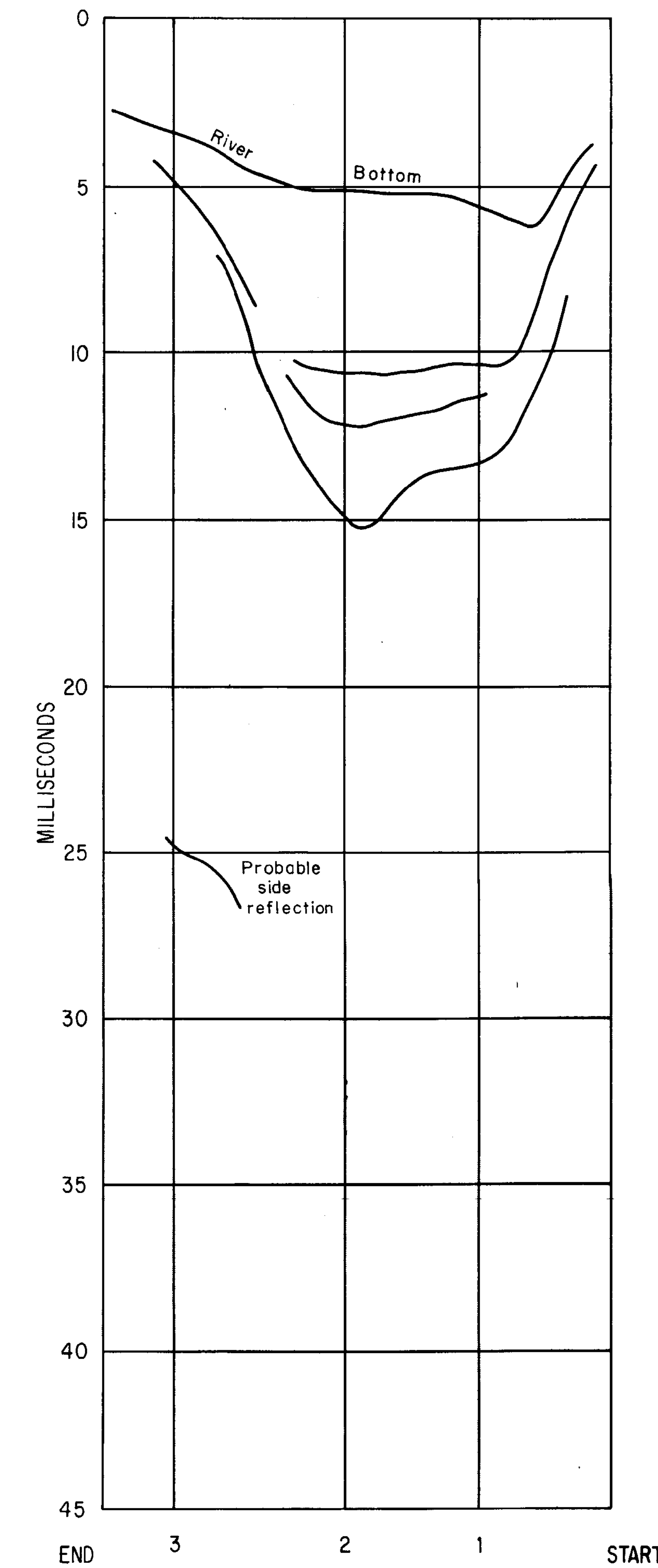
UPSTREAM TRAVERSE
(FROM RECORD "A")



CENTRE TRAVERSE
(FROM RECORD "B")



DOWNSTREAM TRAVERSE
(FROM RECORD "C")



TRACINGS OF "SONAR BOOMER" RECORDS AND SAMPLE RECORD

VICTORIA BRIDGE, TAS.

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS K55/B5-105

TO ACCOMPANY RECORD NO. 1966/168

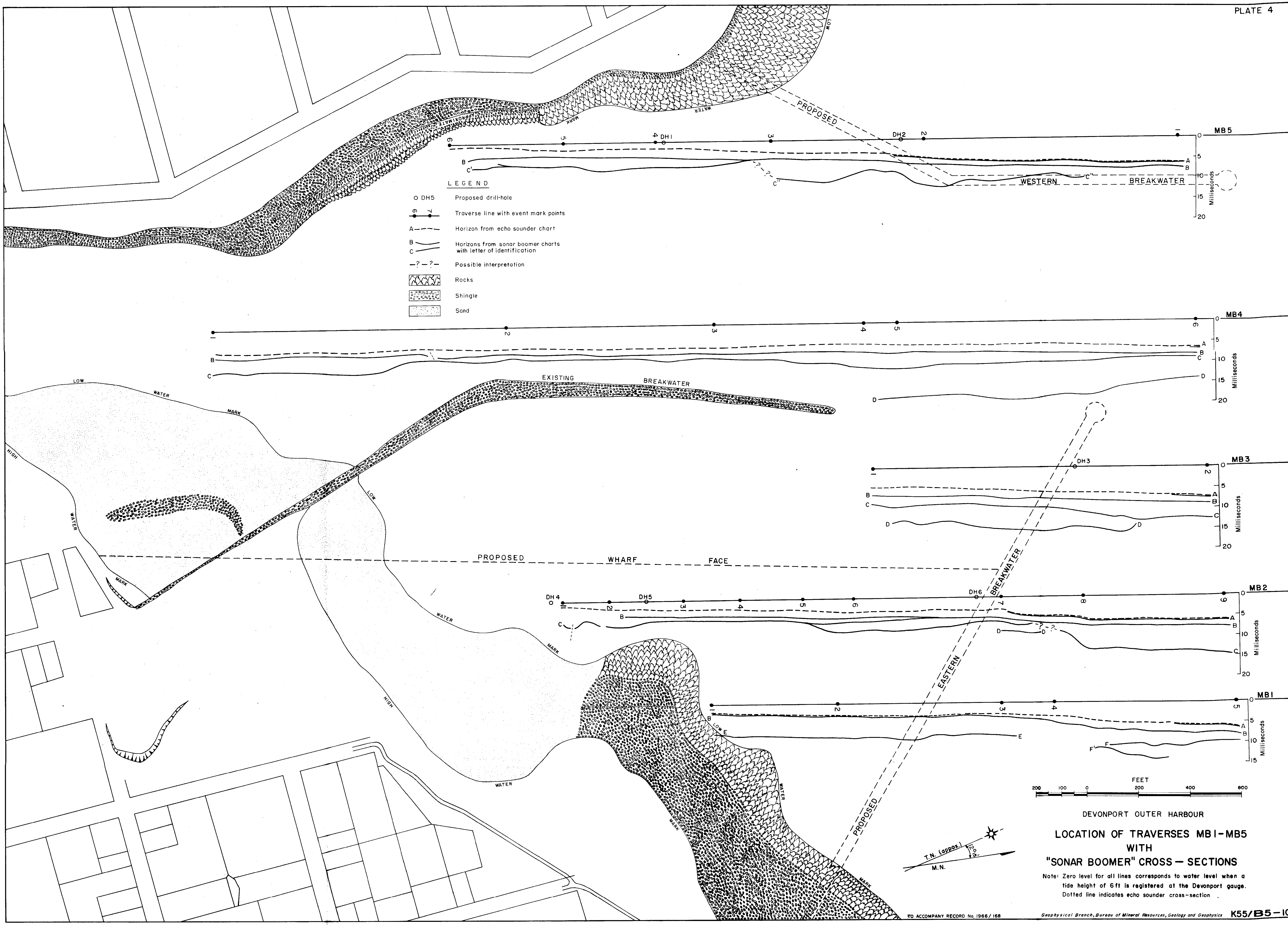
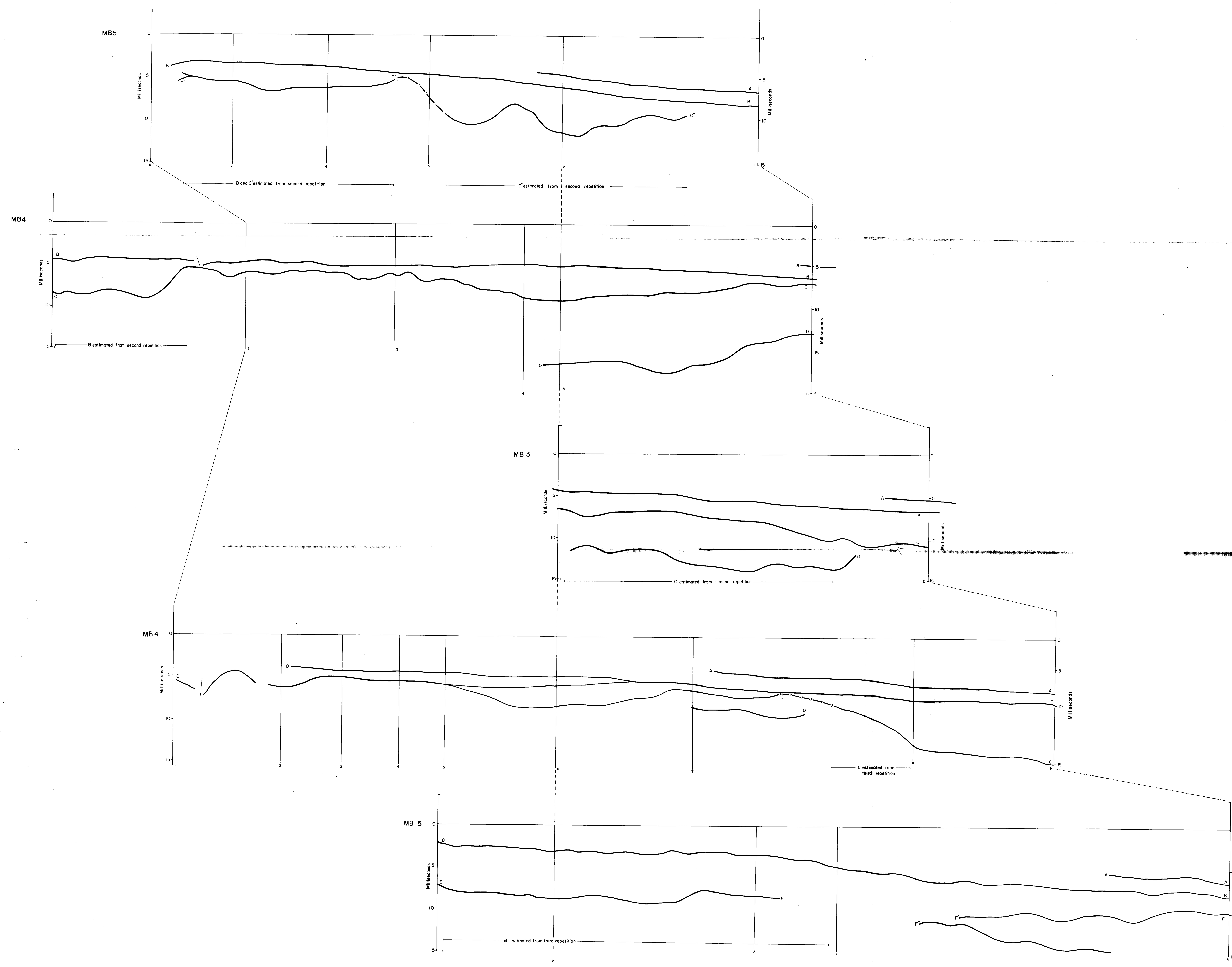


PLATE 4
MB5
MB4
MB3
MB2
MB1
DH1
DH2
DH3
DH4
DH5
DH6
PROPOSED
WESTERN
BREAKWATER
EXISTING
BREAKWATER
PROPOSED
WHARF
FACE
EASTERN
BREAKWATER
PROPOSED
LOW
WATER
MARK
HIGH
WATER
MARK
Milliseconds
LEGEND
DH5 Proposed drill-hole
Traverse line with event mark points
A Horizon from echo sounder chart
B C Horizons from sonar boomer charts with letter of identification
-?-?- Possible interpretation
Rocks
Shingle
Sand
FEET
200 100 0 200 400 600
T.N. (appox.)
M.N.
DEVONPORT OUTER HARBOUR
LOCATION OF TRAVERSES MB1-MB5
WITH
"SONAR BOOMER" CROSS — SECTIONS
Note: Zero level for all lines corresponds to water level when a tide height of 6ft is registered at the Devonport gauge.
Dotted line indicates echo sounder cross-section.
TO ACCOMPANY RECORD No. 1966/168
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics
K55/B5-103



LEGEND

B — Horizons from sonar boomer charts
C — with letter of identification

TRACINGS OF "SONAR BOOMER" RECORDS

NOTE: Event marks indicating the transit of the same pair of markers on different traverses are joined by dotted lines.

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics K55/B5—106

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