UNDERWATER ACOUSTIC NOISE LEVELS IN LAKE CETHANA

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This paper describes the noise measurements made in Lake Cethana, Northern Tasmania, as the first step in establishing the suitability of this lake as a possible site for a proposed towed array test facility and gives the noise spectrum results obtained. The results are compared with typical ambient noise data for Australian waters.

1. INTRODUCTION

Lake Cethana is a long deep artificial lake which is managed by the Hydro-Electric Commission (HEC) of Tasmania as part of the State's hydro-electric generating network. The lake, situated approximately 80 km west of Launceston, is one of the sites used by the Australian National Underwater Training Centre Ltd (ANUTC), a company established to train surface supported air and mixed-gas divers.

Lake Cethana is being investigated as a potential site for a towed array testing facility under an Australian Maritime Engineering Cooperative Research Centre (AMECRC) project. As a first step in assessing the suitability of the lake for this role, underwater acoustic noise measurements have been carried out with and without the HEC generators in operation. Depth soundings of the lake have also been made. A map of the northern end of Lake Cethana is included.

This paper outlines the equipment and measurement techniques used to obtain these noise data and gives noise spectral density curves for the lake.

2. UNDERWATER ACOUSTIC NOISE MEASUREMENTS

2.1 Equipment and Measurement Techniques

An ITC 1042 hydrophone with a 9m lead was used, either directly connected to a 20 Hz to 22 kHz digital tape (DAT) recorder or via a 90m long coaxial cable system suspended by floats. A FET voltmeter was also used to record noise voltage readings and headphones were used to monitor the signals being recorded.

The hydrophone was lowered into the water to a depth of approximately 7.5m when directly attached to the DAT recorder. The full 9m hydrophone cable length was used when the 90m coaxial cable was added in line with the hydrophone. The latter arrangement was used to minimise the noise generated by waves lapping against the 18 foot aluminium outboard boat used, however most measurements were made with the hydrophone directly connected to the recorder as this method provided the best sensitivity.

The recorded acoustic noise was analysed by a Rockland System/90 Signal Analysis Workstation. The FFT spectrum was computed from this using the sum fast average function. This required the least processing time enabling analysis to be made between the periods when the sound of waves was acting on the boat. Uniform weighting was used in accordance with the Rockland recommendation for the analysis of acoustic noise measurements.

2.2 The Noise Spectrum Level

This section shows graphs of the sound spectrum level in the lake with and without the HEC generators in operation. Figure 1 shows the spectrum level at different positions in the lake with the generators running. Refer to the map in Figure 2 for the location of the various measurement positions.

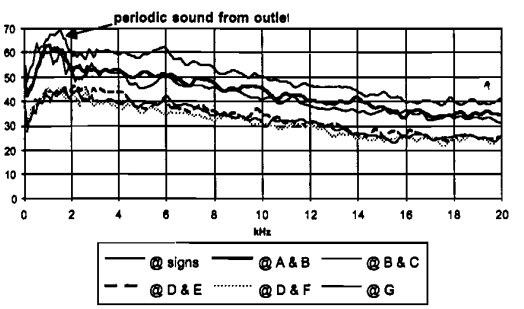

Figure 1 : Spectrum level for Lake Cethana with generators in operation

The arrow points to the water intake's periodic 'roar' sound, the energy of which is mostly below 2 kHz. The spectrum level increases in magnitude as the hydrophone is moved towards the dam wall. In the absence of the 'roar' sound, the spectrum at the warning signs, between points A and B and between points B and C is a similar shape to that between points D and E. The rapid decrease in the ambient noise levels below 1 kHz in the above results is because the measurements were made with the hydrophone directly connected to the DAT recorder. The low input impedance of the DAT acts, with the sum of the hydrophone and cable capacitance, to produce a lower cutoff frequency of about 1kHz with a low-frequency roll off of 20dB per decade.

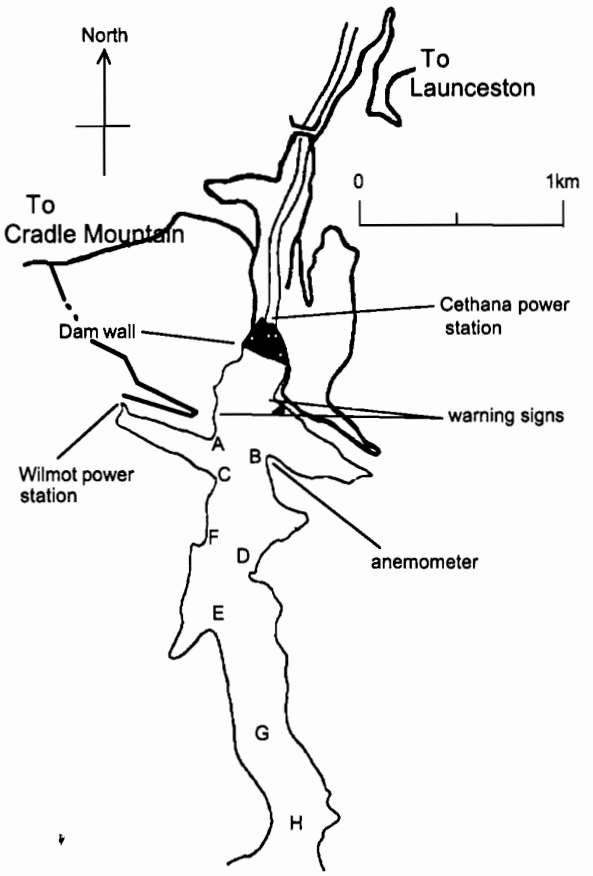

Figure 2. Map of Lake Cethana

Figure 3 contains the spectrum levels with and without the generators running. The top curve is for measurements made between the warning signs near the dam wall. This particular spectra shows the 'roar' from the water inlet. The combination of curves, for the case where the generators were not running, is shown for measurements made from the dam wall (between the signs) to point G.

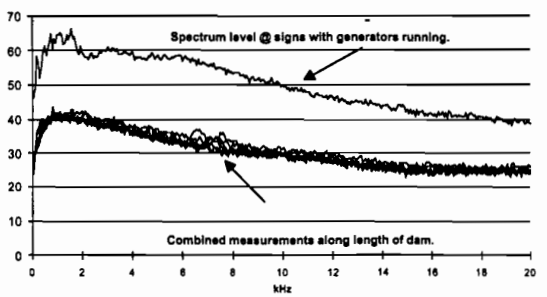

Figure 3. A combination of spectra with and without the generators in operation

Figure 4 shows the noise level at point G with and without the generators running. Between the frequencies of 2 kHz and 13 kHz there is approximately 5 dB difference between the two levels. For comparison, the two upper curves show typical ambient noise data for Australian waters for the wind speeds shown. These data have been taken from Figure 1 of a paper by D Cato [1].

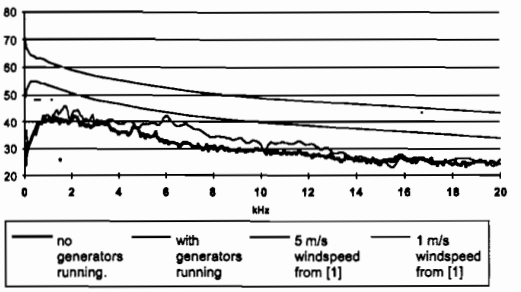

Figure 4. Measurements made at point G with and without the generators running

2.3 Wind speed recorded during measurements

As the wind speed over a body of water affects the ambient sound level in water an anemometer was used, in combination with a data logger, to record wind speeds when noise measurements were being recorded.

It was not feasible to mount the anemometer on the boat so this was placed in the position indicated on the map of Lake Cethana. While this location was generally clear of vegetation, it was felt that the wind speed on the water was marginally greater than the figures recorded in this location. For the measurements made the wind was found to be from a northerly direction. In general the size of the waves were greater further away from the dam wall.

The wind speed was averaged over a 5 minute period before being recorded.

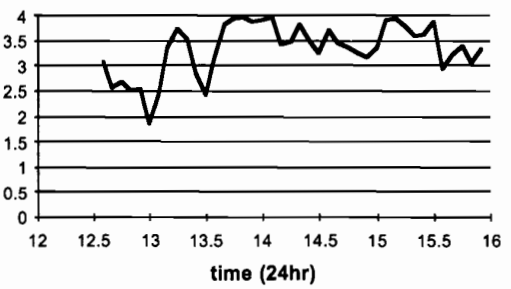

Figure 5. Wind speed measurements taken on 24 March 1994 when the generators were off

Figure 5 shows that the wind speed for measurements made when the generators were off was 3± 1 m/s.

3. DEPTH SOUNDINGS

Depth soundings of the lake were made with a narrow beam echo sounder along the approximate centre line of the lake from the dam wall to point H. The water level in the lake was then approximately 2m below the dam spillway. The deepest recording was 90m at a point between the signs in front of the dam wall. The lake depth varies mainly between 60 and 80m

with the shallowest point being 52m approximately between points D and E as shown on the map in Figure 2.

4. DISCUSSION OF RESULTS

The reason for the rapid decrease in the measured ambient noise levels below 1 kHz has been explained previously. For frequencies above 1 kHz the ambient noise levels are encouraging. The recorded Cethana measurements are significantly less than the typical results for Australian oceanic waters at similar wind speeds, and similar in level to those recorded in Woronora Dam [2], which is used by the DSTO Aeronautical and Maritime Research Laboratory for acoustic experimentation.

5. SUMMARY

Lake Cethana is a long deep lake which is acoustically quiet when the HEC generators are not running. With the generators in operation, the lake spectrum noise level between points D and E and at point G are marginally increased compared to the case when the generators are not running. Lake Cethana is one of the sites used by the ANUTC and a 22m x 11m barge carrying diving support gear is already in place at the dam wall end of the lake which could be used as a winch platform for a towed array test facility. Basic accommodation is available at the old HEC camp at Gowrie Park which is a 20 minute drive from the lake site. It now needs to be established whether or not there is sufficient interest in developing such a facility at Lake Cethana.

6. ACKNOWLEDGMENTS

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7. REFERENCES

1. Cato, D.H., Review Of Ambient Noise In The Ocean: Non Biological Sources, *Bulletin of Australian Acoustical Society*, Volume 6, 1978
2. Cato, D.H., Private Communication