Darran Humpheson

22 May 2017

Response to Forest and Birds Written Questions (date 19 May 2017)

1. Can you please provide detail of the exact method used to calculate the crawler and IMV octave band source spectra shown in Table 1 and Fig. 1 of your report?

First, some background information.

I was involved in the 2014 hearing acting on behalf of the EPA. The De Beers IMT reports were made available to the experts post discussion of the Hegley report, in which Nevil Hegley converted in air source measurements of dredging noise to underwater noise levels. Hegley proposed a source level of 172 dB. At the time I was in agreement that a source level of 172 dB was realistic, even after reviewing the IMT reports. During expert conferencing a source level of 188 dB was also considered for sea bed crawlers, which I considered to be the upper of the likely range of source levels. During the 2014 hearing, no detailed predictions of receiver levels were undertaken and hence no detailed spectral data was produced or used in any calculations.

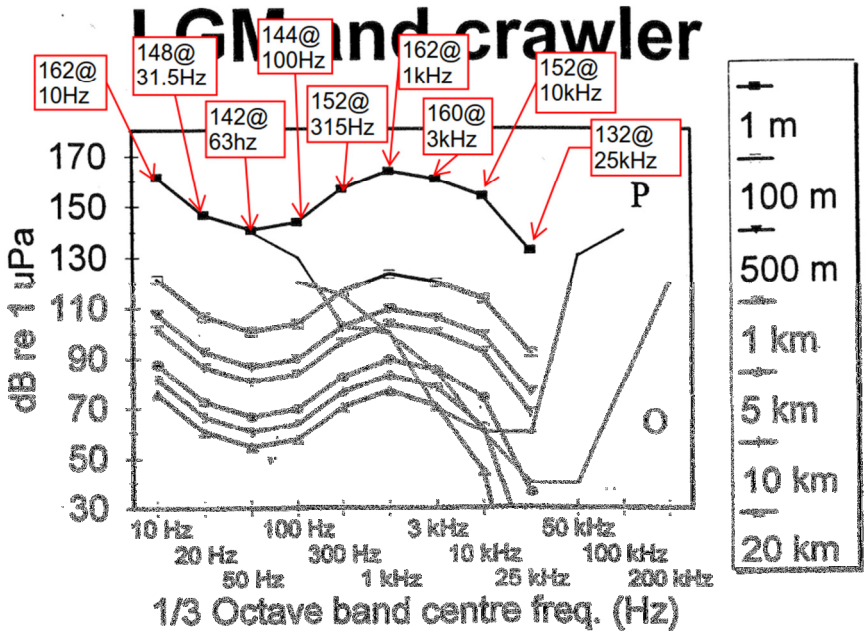
In April, I was engaged by TTRL to undertake detailed noise modelling of TTRL's proposed activities. I have made my own judgement on the likely source levels of the Crawler and IMV based on the available information. No new information was made available to me apart from a University of Cape Town report.

My spectrum is based in part on Figure 1 of the IMT report, which it would appear from the Curtin review to have been transposed from the Grand Banks drilling vessel data, which was then duplicated in the later IMT report. I considered the data within the University of Cape Town report (Specialised Study #10, The impact of diamond mining noise on marine mammal fauna off Southern Namibia, Dr K P Findlay, Oceanography Department, University of Cape Town, June 1996). In the report is Figure A-2 which reports 1/3 octave band data from the Louis G Murray FPSO and crawler. I have used this data in my analyses and have separated out the sources using professional opinion on the contribution from each.

We do not have actual source data or similar projects which can be used. Therefore a proxy has to be used which is based on a combination of empirical data and likely source levels.

I have used a similar level of 172 dB to that discussed at the 2014 hearing based on the above data sources, taking into account a 1dB reduction in source levels due to a combination of technological improvements and the fact that high frequency noise levels would be lower due to the reduced particle size being transported up the riser pipe.

I consider the data to be representative of the likely source levels that will be encountered.



2. **Referring to Table 2, what does the 171 dB re 1 uPa @ 1m source level to obtain a received level of 135 dB re 1 uPa at 500m relate to? i.e. is this the source level of a single operating source (either the IMV or the crawler), the source level of each of the two sources operating simultaneously and assumed the same, or the equivalent source level of the two sources combined in some way? Please can you provide details?**

The 171 dB SL is the overall combined level that would be required for all sources. All sources refers to the IMV operating as well as the crawler. It does not include the separate contribution from sources of different depths.

3. **What were the geoacoustic properties used for the " sand seabed to a depth of 15 m", and what was the terminating condition at 15 m?**

A sand depth from 0 to 15 m was used in the assessment. Beyond that depth, dBSea extends the geoacoustics properties using similar attenuation and speed of sound properties. Whilst dBSea can accommodate multi layers, I did not vary the sea bed conditions across the whole of the study area, but rather kept them uniform across the whole of the 120km radius study area.

4. **What was the range of frequencies included in the transmission loss modelling and received level calculations for each source, and was the normal mode model used for all these frequencies?**

dBSea is able to calculate over a varied frequency range from low to high. A large bandwith is computationally very intensive. A bandwidth from 31.5 Hz to 3150 Hz was used for the dBSea normal modes solver. A cross over was not used between two different dBSea solvers, ie a low and high frequency.

I did a comparison of the different solvers – dBSeaModes whilst not the most conservative was certainly the most appropriate, which has been noted by the Curtin reivew.

5. **Is the normal mode solution used in dBSea range dependent, and if so, does it use an adiabatic or coupled mode solution?**

The normal modes are calculated for each water depth, based on the sediment properties and water sound speed profile. The sound field is calculated based on coupling between the calculated modes across the interfaces between different depths. The calculation is of the adiabatic, single forward scattering type. The overlying space is modelled as a vacuum. dBSeaModes is suitable where the frequency is low and/or the water depth is shallow. The sediment layer is extended down well below the depth of the water column, with the attenuation rapidly increasing at the lowest depths. In this way, there are no modes where energy is reflected from the very bottom of the sediment layer (the space underneath the bottom of the sediment is also a vacuum).

6. **Did you model the depth dependence of the sound field at 500m range, and if so, how much variation was there compared to the 10m depth value given in the report?**

   The data I have presented is the max level across all depths. For 500 m from the operations, the water depth was 42m – the max variation across the depths at this location using 10 transects grid depth points was less than 2-3dB.

7. **Do you accept there were errors in the way in which you calculated, as set out in the report from Erbe et al, attached to Mr van Helden's third supplementary brief of evidence.**

As I have stated the source levels, are based on IMT data any my professional opinion. I acknowledge that the Curtin report has identified a transposition of drilling data to crawler data. Notwithstanding this observation, I do not believe there are any errors in my assessment. The Curtin report considers that the Transmission Loss calculations, (Normal modes) seems appropriate.

8. **Do you agree that this is likely that you have underestimated the source level of noise by approximately 10 dB?**

No. Regardless, the back calculation I have done does demonstrate that a combined Source Level of 171 would be required to achieve Condition 12 as worded.

9. **If the noise was underestimated by approximately 10 dB, do you agree that the limits in Condition 12 would not be met?**

Regardless of the Source Level starting point, it will be a requirement of TTRL to achieve the project's noise limit. The crawler and IMV will have to be designed to meet the noise limit. TTRL will need to commit resources to ensure that the acoustic emissions of their proposed activities achieve the project's noise limits.