BEFORE THE ENVIRONMENTAL PROTECTION AUTHORITY
AT WELLINGTON

IN THE MATTER	of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
AND	
IN THE MATTER	of a decision-making committee appointed to reconsider a marine consent application by Trans Tasman Resources Limited to undertake iron ore extraction and processing operations offshore in the South Taranaki Bight

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EXPERT EVIDENCE OF DARRAN HUMPHESON ON BEHALF OF TRANS TASMAN RESOURCES LIMITED

16 FEBRUARY 2024

HOLM | MAJUREY

Mike Holm
PO Box 1585
Shortland Street
AUCKLAND 1140

Solicitor on the record	Mike Holm	Mike.Holm@holmmajurey.nz	(09) 304 0428
Counsel	Justin Smith KC	Justin.Smith@stoutstreet.co.nz	(04) 917 1080
	Morgan Slyfield	Morgan.Slyfield@stoutstreet.co.nz	(04) 915 9277

INTRODUCTION

Qualifications and experience

1. My full name is Darran Humpheson. I am a Technical Director of Acoustics at Tonkin & Taylor Limited (**T+T**).

2. I hold a Bachelor of Science degree with Honours in Applied Physics and a Master of Science degree in Environmental Acoustics. I am a Member of the Acoustical Society of New Zealand and a Member of the United Kingdom's Institute of Acoustics. I am a New Zealand representative of the International Organisation for Standardisation (**ISO**) technical committee ISO/TC 43 SC1 "Noise", and I am also a member of the Joint Standards Australia/Standards New Zealand Committee AV-001 Acoustics.

3. I have been employed in acoustics since 1991 and have previously held positions as a consultant for international firms AECOM (Technical Director 2013-2019), Bureau Veritas (Technical Director 2012-2013), RPS Group plc (Technical Director 2002-2012) and as a UK Ministry of Defence scientist (Head of the Royal Air Force's Noise and Vibration Division 1991-2002).

4. For the past 18 years I have provided assessments and advice on a range of projects involving underwater acoustics, including work for Lyttleton Port and most recently the Interislander terminal development in Wellington Harbour. In 2013-14 I was commissioned by the EPA to review the first application Trans-Tasman Resources Ltd (**TTR**) made for ironsand mining in the South Taranaki Bight.

5. I was subsequently engaged by TTR to provide acoustics assessments in support of its second application to the EPA in 2017.

6. My evidence before the 2017 Committee comprised:

(a) A written report dated 2 May 2017 and associated noise contour map, which were provided to the DMC as Appendices 3 and 4 to the Second Supplementary Statement of Expert Evidence by Dr Simon Childerhouse dated 1 May 2017;

(b) A presentation summary of evidence dated 22 May 2017;

(c) Oral evidence on 22 May 2017 (Transcript pages 3062-3109);

(d) Written answers to requests for clarification from the 2017 DMC, dated 22 May 2017:

i. Memo to Vicki Morrison-Shaw, 1 page, Subject: *TTRL - Distance Reduction Data*;

ii. Memo to Vicki Morrison-Shaw, 2 pages, Subject: *TTRL – IMT Crawler Noise Clarification*;

(e) Written answers to questions from Forest & Bird, 3 pages, dated 22 May 2017;

(f) Written answers to questions from Ruby Haazen, by Memo to Vicki Morrison-Shaw, 3 pages, Subject: *TTRL – Questions*, dated 23 May 2017;

(g) Written answers to questions from Karen Pratt, by Memo to Vicki Morrison-Shaw, 1 page, Subject: TTRL – Responses to Questions Directed to Dr Childerhouse, dated 24 May 2017;

(h) A signed written statement dated 25 May 2017 confirming my role and my compliance with the Environment Court's Code of Conduct for Expert Witnesses.

Code of conduct

7. I confirm that I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Practice Note dated 1 January 2023. I agree to comply with this Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

8. I have completed two tasks at the request of Dr Childerhouse to update underwater sound level data that had previously been provided to the DMC in 2017 (my written report dated 2 May 2017).

9. As requested by the DMC in 2017[1] my 2017 report included:

   (a) a table of sound exposure level data (Table 4 of my report) at distances of 500 m, 1000 m, 1500 m, and 2000 m from the IMV and crawler sound sources; and

   (b) a contour map (Map 1) depicting sound pressure levels ranging from 90 to 125 dB re 1µPa for the same sound sources.

10. This information was provided as un-weighted sound levels.

11. Current industry best practice is to weight sound levels based on the frequency response of five marine mammal hearing

[1] DMC Minute number 41 - 10 April 2017 - Appendix 3 Questions for marine acoustic expert.

groups (m-weightings). These weightings are documented in Southall et al 2019[2]. The five weightings are for:

(a) Low frequency cetaceans (LF)

(b) High frequency cetaceans (HF)

(c) Very high frequency cetaceans (VHF)

(d) Phocid carnivores in water (PCW)

(e) Otariid carnivores in water (OCW)

12. I have applied the appropriate weighting from Southall et al to the sound exposure data of Table 4 and Map 1. As Map 1 sound level data was unweighted, I have produced three maps to reflect the received sound levels for each cetacean hearing group. I have not produced maps for the seals as both PCW and OCW species are less sensitive to noise than cetaceans (Southall et al, criteria for Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS)).

13. My advice on those two matters is set out in an advice note dated 23 January 2024 – updated Table 4 data, which is Attachment 1 to this statement,[3] and an advice note dated 15 February 2024 – updated Map 1, which is Attachment 2 to this statement.

14. Apart from applying the m-weightings to the data, all other modelling inputs are unchanged, i.e. they are identical to the 2017 modelling data, except that I have used the latest version of the dBSea modelling software and have used a split solver algorithm rather than a single solver, which represents current best modelling practice (split solver will result in

[2] Southall et al. (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 2019, 45(2), 125-232, DOI 10.1578/AM.45.2.2019.125.

[3] For completeness, I note this advice note was also attached to Dr Childerhouse's statement of rebuttal evidence dated 23 January 2024.

marginally higher received sound levels than a single solver algorithm).

15. I have reviewed the 2017 conditions and consider that they are still relevant and appropriate from an underwater acoustics viewpoint. I defer to Dr Childerhouse whether the 120 dB threshold in Condition 17 is still relevant as Southall et al 2019 does not include a 120 dB criterion for any of the marine mammal hearing groups.

Darran Humpheson

16 February 2024

CONSULTANT'S ADVICE NOTE CAN-001

CAN Subject:	TTRL - Weighted underwater sound exposure levels		
Project/site:		Date:	23 January 2024
Client:	TTRL	TT Project No:	-
To:	Dr Simon Childerhouse		
Copy to:			

Unweighted sound exposure levels were presented in the AECOM assessment dated 2 May 2017 which was prepared by Mr Darran Humpheson. The data presented in Table 4 of the AECOM assessment were derived from underwater sound level modelling using sound source data for the crawler and integrated mining vessel (IMV)[6]. The data was presented at various distances and for a range of exposure durations ranging from 10 seconds to 24 hours. As crawler and IMV sound would be relatively constant (steady state), the sound exposure level is an accumulation of the sound level energy summed over the exposure duration.

At the request of Dr Childerhouse the data has been weighted to represent the five marine mammal hearing groups using the frequency response relationships provided in Southall et al 2019[7] (Southall weightings are the same as those in the NOAA 2018 guidance). The sound source frequency data in Table 1 of the AECOM assessment has been used. Figure A1 shows the sound source data for the crawler and IMV (unweighted) and the weighted sound source frequency data.

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6 Other sources such as the FSO were not included in the model - only those sources which operate continuously.

7 Southall B L, Finneran J J, Reichmuth C, Nachtigall P E, Ketten D R, Bowles A E, Ellison W T, Nowacek D P, Tyack P L (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 2019, 45(2), 125-232, DOI 10.1578/AM.45.2.2019.125.

Figure A1 : Sound source frequency spectra weighted and unweighted

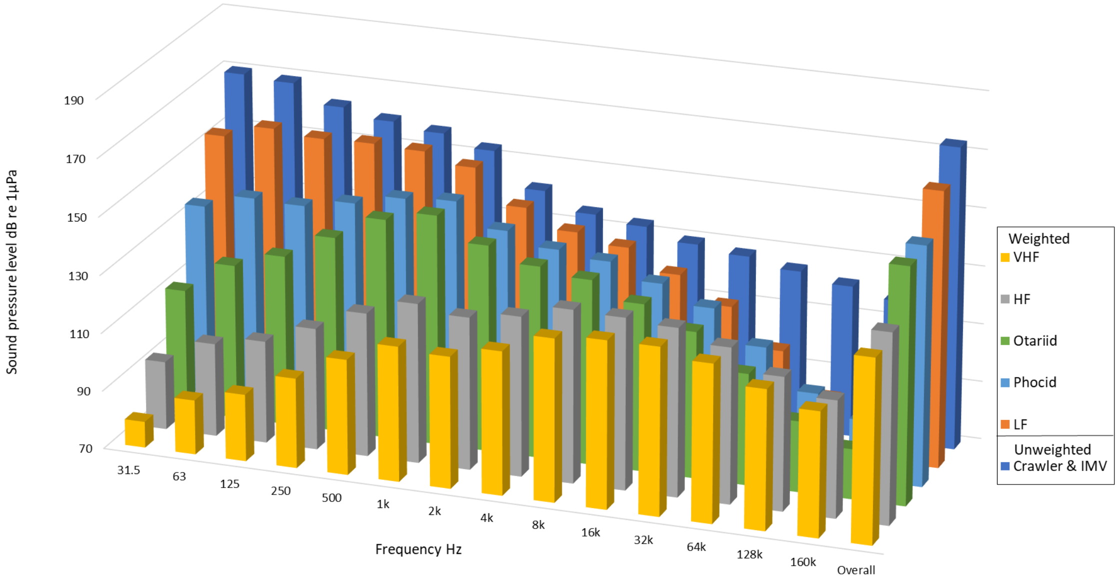

Table A1 below duplicates the Table 4 AECOM data and then provides the weighted sound pressure level and SEL data for the five marine mammal hearing groups. The weighted SEL data can then be used to compare against the relevant PTS and TTS thresholds for each marine mammal hearing group.

Table A1 – Unweighted and NOAA weighted sound exposure levels

Marine mammal hearing group	Distance m	Sound pressure level dB re 1µPa	SEL dB re 1µPa^2.s				
			10 sec	10 min	1 hr	3 hr	24 h
Unweighted – AECOM Table 4 data	**500**	135	145	163	167	170	184
	1,000	130	140	157	162	165	179
	1,500	129	139	156	161	164	178
	2,000	128	138	155	160	163	177
Weighted Low frequency cetaceans (LF)	**500**	126	136	154	158	161	175
	1,000	121	131	148	153	156	170
	1,500	120	130	147	152	155	169
	2,000	119	129	146	151	154	168
Weighted High frequency cetaceans (HF)	**500**	97	107	125	129	132	146
	1,000	92	102	119	124	127	141
	1,500	91	101	118	123	126	140
	2,000	90	100	117	122	125	139
Weighted Very high frequency cetaceans (VHF)	**500**	94	104	122	126	129	143
	1,000	89	99	116	121	124	138
	1,500	88	98	115	120	123	137
	2,000	87	97	114	119	122	136
Weighted Phocid carnivores in water (PCW)	**500**	113	123	141	145	148	162
	1,000	108	118	135	140	143	157
	1,500	107	117	134	139	142	156
	2,000	106	116	133	138	141	155
Weighted Otariid carnivores in water (OCW)	**500**	113	123	141	145	148	162
	1,000	108	118	135	140	143	157
	1,500	107	117	134	139	142	156
	2,000	106	116	133	138	141	155

APPLICABILITY

Where this Consultant's Advice Note is issued to a person who is not our Client, it is intended to assist that person in carrying out their work on the project. It is not an instruction, and it is not to be construed as relieving any party of its responsibilities.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Prepared by:

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Darran Humpheson
Technical Director, Acoustics

16-Feb-24
https://tonkintaylor-my.sharepoint.com/personal/dhumpheson_tonkintaylor_co_nz/documents/documents/weightedsel_table4data_230124.docx

15 February 2024
Job No: 1093411.0000

Trans-Tasman Resources Limited
PO Box 10571
The Terrace
Wellington 6143

Trans-Tasman Resources – Acoustic Modelling

1 Introduction

The rebuttal evidence of Dr Childerhouse[1] refers to underwater acoustic modelling of TTRL activities undertaken by Mr Humpheson in 2017[2]. Since that modelling was undertaken, the guidance on how to assess appropriate threshold criteria for marine mammals has been updated (Southall et al 2019[3]). The 2017 dBSea model calculated unweighted sound pressure levels. It is now accepted practice to assess weighted sound pressure levels for relevant marine mammal hearing groups; in this case low, high and very high frequency cetaceans (LF, HF and VHF), as well as phocid carnivores in water (PCW) and otariid carnivores in water (OCW).

This document provides weighted sound pressure level contours for LF, HF and VHF cetaceans. Comparison is made with the 2017 unweighted results and relevant PTS and TTS criteria for all five hearing groups.

2 Criteria

Southall et al. (2019) identifies sound pressure levels above which permanent threshold shift (PTS) and temporary threshold shift (TTS) are expected in each of the five marine mammal hearing groups when exposure occurs over a period of 24 hours. These threshold levels for non-impulsive noise sources are shown in Table 2.1 below.

Table 2.1: Summary of PTS and TTS onset thresholds

Hearing Group	Parameter	Onset thresholds (received level) dB re 1 µPa	
		PTS	TTS
Weighted Low frequency cetaceans (LF)	$L_{E,p,LF,24h}$	199	179
Weighted High frequency cetaceans (HF)	$L_{E,p,HF,24h}$	198	178
Weighted Very high frequency cetaceans (VHF)	$L_{E,p,VHF,24h}$	173	153
Weighted Phocid carnivores in water (PCW)	$L_{E,p,PCW,24h}$	201	181
Weighted Otariid carnivores in water (OCW)	$L_{E,p,OCW,24h}$	219	199

[1] Childerhouse, S. J. (2024). Environmental Protection Authority. *Expert rebuttal evidence of Dr Simon John Childerhouse on behalf of Trans Tasman Resources Limited.*
[2] Humpheson, D. (2017).Trans-Tasman Resources – Acoustic Modelling. Unpublished report to TTRL.
[3] Southall et al. (2019). *Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects.* Aquatic Mammals 2019, 45(2), 125-232, DOI 10.1578/AM.45.2.2019.125.

3 Modelling inputs

3.1 Sources

A central point within the TTRL's mining permit area was selected for the noise modelling, with NZTM coordinates 1696235, 5585673. The water depth at this location in the model is 34 m, i.e. similar to the 2017 modelling.

Two noise sources were modelled at this location:

1 TTR crawler – on seabed at depth of 30 m

2 IMV – integrated mining vessel at 5 m depth

Sound pressure levels for the two sources (same as 2017 assessment) are shown in Table 3.1 below.

Table 3.1: Sound pressure levels for sources in dB for each octave band (Hz)

Source levels	Level	31.5	63	125	250	500	1k	2k	4k	8k	16k	32k	64k	128k	160k
TTR Crawler	171	161	168	163	160	158	154	142	136	134	130	128	125	122	119
IMV	171	170	164	143	144	138	133	129	120	100	97*	94*	91*	88*	85*

* Data above 8 kHz assumed to drop by -3 dB per octave (conservative)

3.2 dBSea parameters

A split solver sound transmission algorithm has been used as appropriate for low / high frequencies - noise sources are low frequency biased, and generally low frequency sound propagation will dominate.

Table 3.2: Summary of dBSea parameters

Bathymetry	250 m resolution sourced from NIWA
Grid resolution	Set to map resolution, approx. 250 m
Frequencies	31.5 Hz to 128 kHz
Solver	Split, dBSeaModes (normal modes) to 125 Hz, dBSeaRay (ray tracing) for >250 Hz
Water properties	Temperature 18 °C, Salinity 35 ppt, pH 8
Seafloor properties	Sand extending infinitely

4 Results

Sound level contours are shown in Appendix A with the maximum sound pressure level at all depths projected to the surface. HF and VHF contours are at a different scale due to the high transmission loss of high frequency sound compared to low frequencies.

Appendix B shows the 2017 contours for comparison.

Assuming 24 h exposure the calculated distances for PTS and TTS criteria are shown below. N/A denotes that the relevant criteria is not achieved.

Hearing Group	PTS / metres	TTS / metres
Weighted Low frequency cetaceans (LF)	N/A	250
Weighted High frequency cetaceans (HF)	N/A	<10
Weighted Very high frequency cetaceans (VHF)	N/A	100
Weighted Phocid carnivores in water (PCW)	N/A	<10
Weighted Otariid carnivores in water (OCW)	N/A	N/A

5 Applicability

This report has been prepared for the exclusive use of our client Trans-Tasman Resources Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Prepared by:

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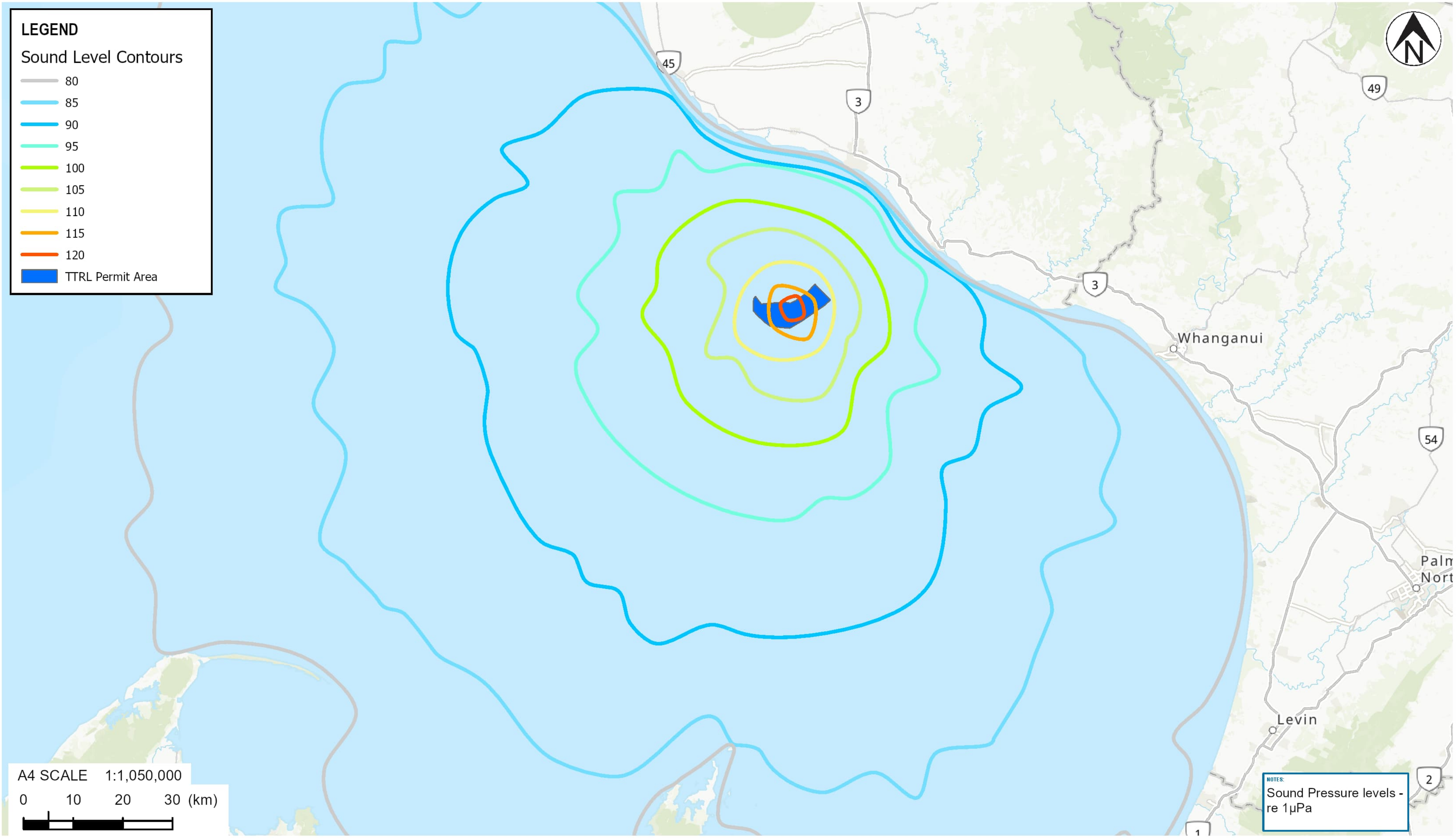
Darran Humpheson
Technical Director - Acoustics

15-Feb-24
t:\christchurch\tt projects\1093411\workingmaterial\ttrl modelling letter.docx

Appendix A Sound pressure level contour plots

C:\Users\shyu\Documents\ArcGIS\Projects\TTRL\TTRL.aprx Layout: TTRL Underwater LF map 2024-Feb-15 4:30 pm Drawn by SHYU



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NOTES:	REVISIONS	NO.	BY	PROJECT No.	1234567.1000	
NZ Topographic - Basemap Only: Eagle, LINZ, StatsNZ, OSM. NZ Topographic - Reference Labels: Eagle, OSM	First version (DD/MM/YY)	0	SHYU	DESIGNED	SHYU	FEB.24
				DRAWN	SHYU	FEB.24
				CHECKED	DAHU	FEB.24
				APPROVED	DATE	

CLIENT **TRANS-TASMAN RESOURCES LTD**

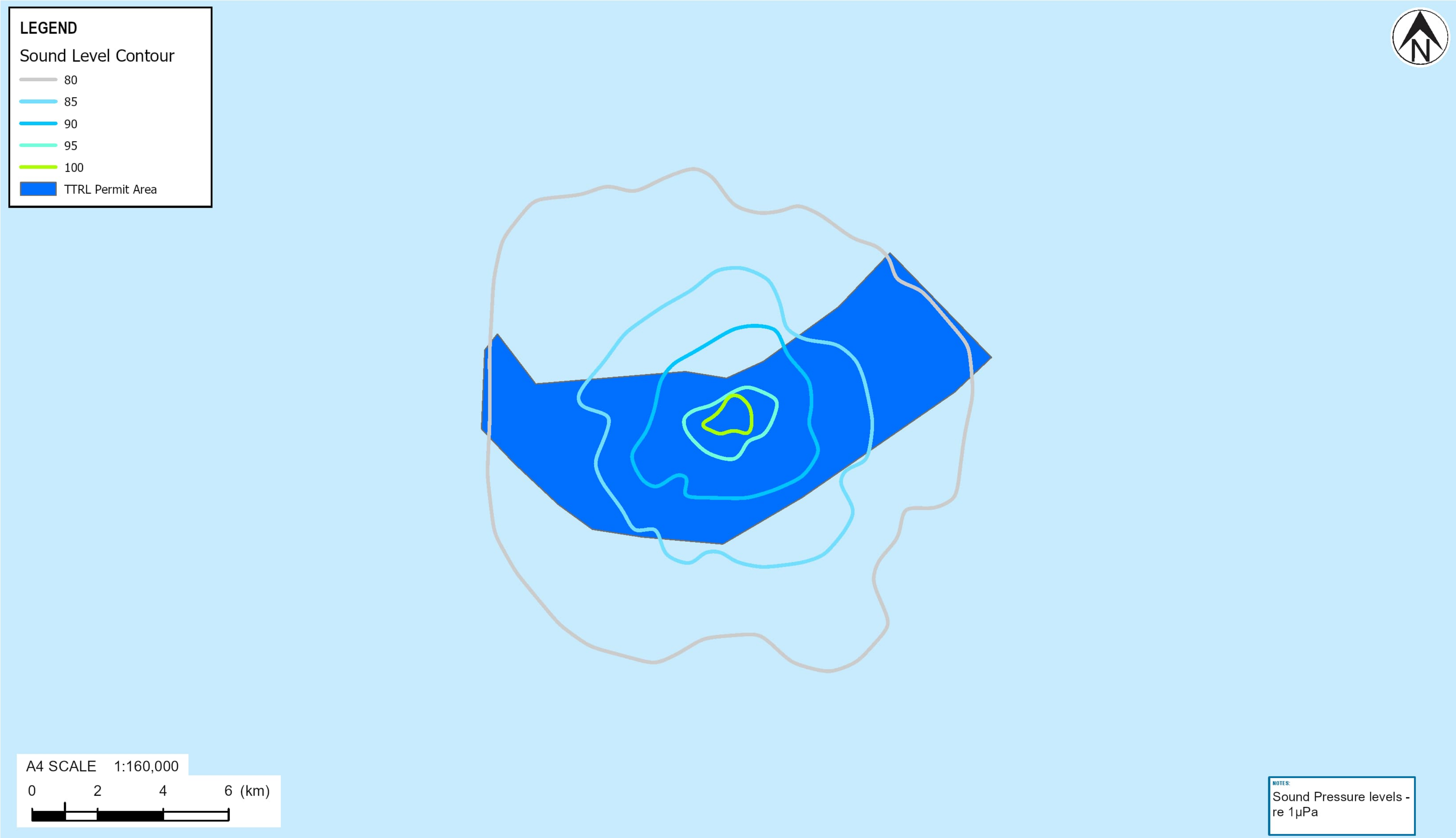
PROJECT **UNDERWATER ACOUSTIC MODELLING**

TITLE LOW FREQUENCY HEARING GROUP CONTOURS

SCALE (A4) 1:1,050,000 FIG No. FIGURE 1. REV 0

COPYRIGHT ON THIS FIGURE IS RESERVED DO NOT SCALE FROM THIS FIGURE.

C:\Users\shyu\Documents\ArcGIS\Projects\TTRL\TTRL.aprx Layout: TTRL HF 2024-Feb-15 4:30 pm Drawn by SHYU



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PROJECT **UNDERWATER ACOUSTIC MODELLING**

TITLE HIGH FREQUENCY HEARING GROUP CONTOURS

SCALE (A4) 1:160,000 FIG No. FIGURE 2. REV 0

C:\Users\shyu\Documents\ArcGIS\Projects\TTRL\TTRL.aprx Layout: VHF Map 2024-Feb-15 4:30 pm Drawn by SHYU

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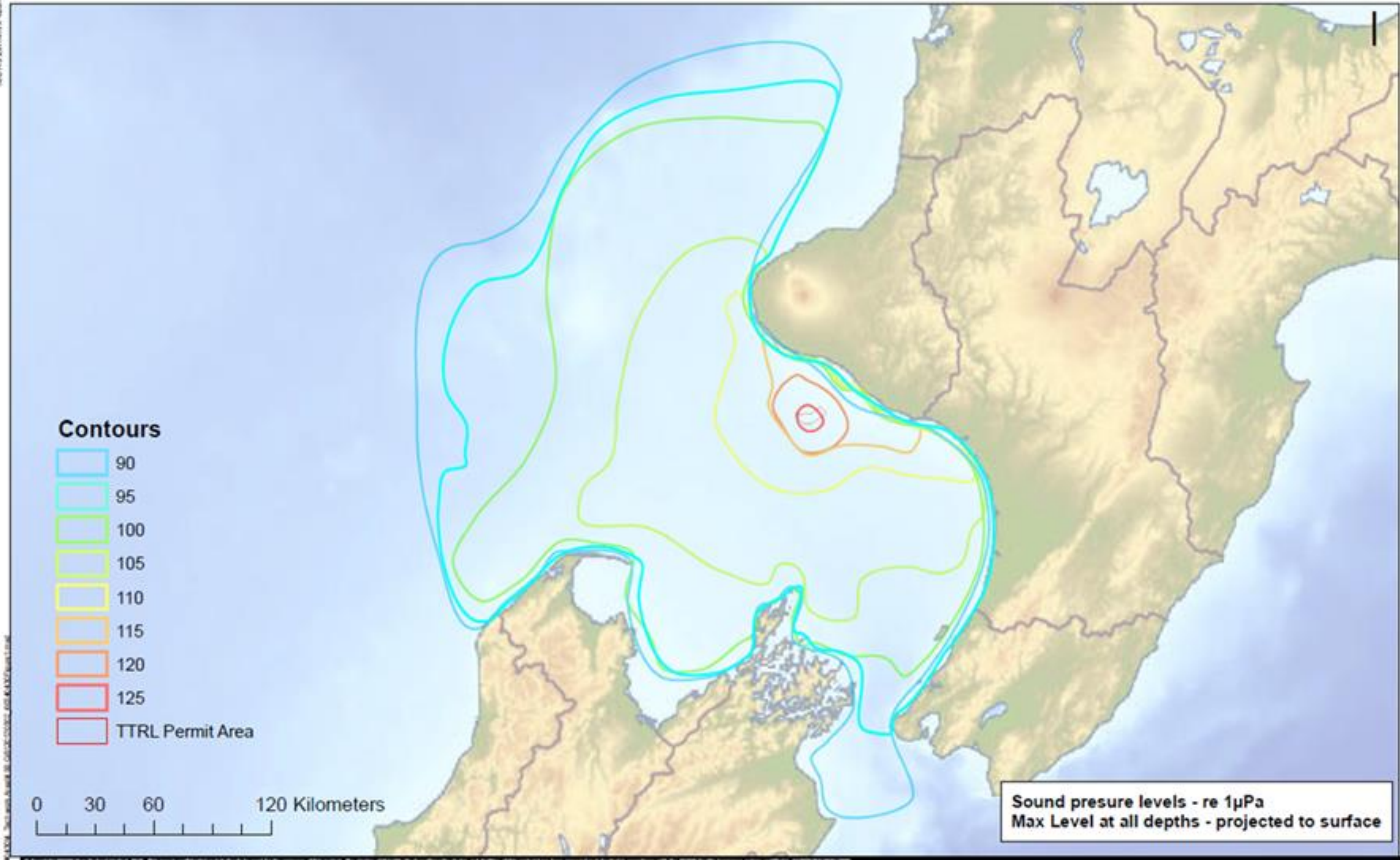
APPROVED		DATE

CLIENT **TRANS-TASMAN RESOURCES LTD**
PROJECT **UNDERWATER ACOUSTIC MODELLING**
TITLE VERY HIGH FREQUENCY HEARING GROUP CONTOURS
SCALE (A4) 1:160,000 FIG No. FIGURE 3. REV 0

Appendix B 2017 Model results



AECOM

AECOM New Zealand Limited
2 Hazeldean Road, Addington
Christchurch 8024
+64 3 966 6113
www.aecom.com

PROJECT
TTRL - Underwater noise

CLIENT
Trans-Tasman Resources Limited

PROJECT MANAGEMENT

ISSUE/REVISION

PROJECT NUMBER
60540430

SHEET TITLE
Sound presure levels
Crawler + IMV

MAP NUMBER
1