Before the Independent Hearing Panel
Appointed by the Southland Regional Council

Under	the Resource Management Act 1991 (**RMA**)
In the matter of	an application by **South Port NZ Limited** to dredge parts of the Bluff Harbour

Statement of evidence of Dr Matthew Pine

29 March 2022

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Qualifications and experience

1 My name is **Dr Matthew Pine**. I am a principal consultant at Styles Group Acoustics and Vibration Consultants. I am an underwater noise expert with diverse experience in underwater acoustics, including acoustic modelling of anthropogenic noise sources to determine impacts on marine fauna, using sound source verification and advanced underwater noise modelling.

2 I hold a Ph.D. in Marine Science (thesis on underwater anthropogenic noise) and have completed two post-doctoral research fellowships at the Institute of Hydrobiology, Chinese Academy of Sciences in Beijing (2 years) and the Department of Biology at the University of Victoria in British Columbia, Canada (3 years). These positions were scientific research appointments that focused on current and future noise effects on marine mammals and fish due to changing environments (both acute, such as construction activities, and chronic, such as changing climates).

3 I have extensive experience in the acoustic monitoring of marine animals and modelling of anthropogenic noise sources in the coastal marine area. I have been involved in a substantial number of projects in New Zealand and internationally involving marine mammal monitoring, characterising soundscapes, verifying sound sources, passive acoustic surveys and marine mammal detection, and advanced underwater noise modelling.

4 I have worked on numerous projects around New Zealand involving the management of underwater noise effects from activities in the coastal marine area, including capital dredging, seismic surveys, pile-driving, sand extraction and open-water blasting.

5 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

6 I have been asked to prepare evidence in relation to the underwater noise effects. I prepared the Underwater Blasting and Rock Drilling Noise Effects Assessment and Advice Note - Predicted underwater noise level of rock breaker included with the application and adopt these reports as part of my evidence. My statement of evidence includes:

(a) A summary of my evidence, including the matters covered in my Underwater Noise Assessment.

(b) Response to the matters raised in the Officer's Section 42A Report.

(c) Response to the matters raised by submitters.

(d) A conclusion on the underwater noise effects.

Executive summary

7 My assessment of the potential underwater noise and the impact zones has been undertaken to inform Cawthron and e3 Scientific of the potential adverse effects on marine mammals and fish, respectively.

8 The assessment of the actual or potential effects on fish and marine mammals are contained entirely within the reports from Cawthron or e3 Scientific.

Criteria for underwater noise

9 There is no specific guidance on underwater noise effects criteria in New Zealand. I have therefore adopted overseas standards and peer-reviewed research as is commonly done in New Zealand and internationally.

10 The marine mammal acoustic technical guidance (that was revised in 2018) from the National Marine Fisheries Service of the U.S. Department of Commerce has been used extensively around New Zealand and the world for underwater noise assessments. I have therefore relied on that guidance for marine mammal species.

11 Technical guidance on the effects on fishes is scarce, with international assessments more commonly based on peer-reviewed scientific research. This is also true for New Zealand assessments.

12 I have therefore relied on overseas threshold criteria to establish the potential zones of mortality in fish. I have relied specifically on the criteria published by the Department of Fisheries and Oceans of the Canadian Government[1] and the ANSI-Accredited guidelines by Popper et al. (2014)[2].

Species of interest

[1] Wright, D.E., Hopky, G.E. (1998). Guidelines for the use of explosions in or near Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences 2107. Iv+34p.

[2] Popper, A.N., Hawkins, A.D. Fay, R.R. et al. (2014). Sound exposure guidelines for fishes and sea turtles. A technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Report No. ASA S3/SC1.4 TR-2014.

13 There are 14 marine mammal species have been identified as potentially occurring inside and around the Bluff Channel. These have been summarised in the below Table 1 below:

Table 1: Species of interested in and around Bluff Harbour specifically considered in the underwater noise assessment

Common Name	Species Name	NZ Threat Classification	Residency Category in Bluff Harbour	Functional Hearing Group
New Zealand fur seal	*Arctocephalus forsteri*	Not Threatened	Year-round resident	Otariid pinnipeds (OW)
New Zealand sea lion	*Phocarctos hookeri*	Nationally vulnerable	Year-round resident	Otariid pinnipeds (OW)
Hector's dolphin	*Cephalorhynchus hectori*	Nationally vulnerable	Year-round resident	High frequency cetacean (HF)
Bottlenose dolphin	*Tursiops truncatus*	Nationally endangered	Seasonal to semi-resident	Mid-frequency cetacean (MF)
Long-finned pilot whale	*Globicephala melas*	Not threatened	Potential Offshore Semi-Resident	Mid-frequency cetacean (MF)
Sperm whale	*Physeter macrocephalus*	Data deficient	Potential Offshore Visitor	Mid-frequency cetacean (MF)
Beaked whale	*Ziphiidae sp.*	Data deficient	Potential Rare Offshore Visitors	Mid-frequency cetacean (MF)
Southern right whale	*Eubalaena australis*	At risk – recovering	Seasonal Migrant	Low-frequency cetacean (LF)
Humpback whale	*Megaptera novaeangliae*	Migrant	Seasonal Migrant	Low-frequency cetacean (LF)
Dusky dolphin	*Lagenorhynchus obscurus*	Not threatened	Seasonal Visitor	Mid-frequency cetacean (MF)
Common dolphin	*Delphinus delphis*	Not threatened	Seasonal Visitor	Mid-frequency cetacean (MF)
Killer whale	*Orcinus orca*	Nationally critical	Seasonal to Infrequent Visitor	Mid-frequency cetacean (MF)
Sei whale	*Balaenoptera borealis*	Not threatened	Seasonal to Infrequent Visitor	Low-frequency cetacean (LF)
Blue whale	*Balaenoptera musculus*	Data deficient	Seasonal to Infrequent Visitor	Low-frequency cetacean (LF)

14 All species are represented by four functional hearing groups: low-frequency (LF), mid-frequency (MF), or high-frequency (HF) cetaceans and Otariid pinnipeds (OW).

15 Fish species are highly diverse in the area and my assessment considered all species generally rather than any specific species. This follows the above-stated technical guidance for fishes.

16 One consideration to note concerning fishes is that lethality of shock waves from blasting can be related to the size of the fish. However, the above-stated technical guidance for fishes do not provide size-dependent thresholds and therefore the thresholds are more general in nature.

Assessment methodology

17 I predicted noise emissions and determined the impact zones for injury (permanent threshold shift, PTS[3]) and temporary threshold shifts (TTS[4]) for marine mammals and mortality for fishes.

18 These effects were chosen because of their biological significance. The biological significance of the sound exposure relates to whether the animal experiences an adverse effect in its life, i.e., will the invasive sound likely cause significant physical, chemical, or biological responses that have real consequences for the net fitness[5] of the individual or population.

19 For marine mammals and fish, it is known that hearing loss, even temporarily, can potentially lead to consequences for the net fitness of an individual or population. This is because marine animals are highly in-tune to their acoustic environment and use sound in nearly all aspects of their lives, such as to coordinate behaviours when navigating, foraging, reproducing, etc.

20 The relationship between noise exposure and PTS/TTS effects in marine mammals is relatively well understood, and therefore criteria for those effects exists and are widely used. For fishes, however, the relationship between noise exposure from blasting, drilling or rock breaking and the severity of many biologically significant effects, including PTS/TTS, is very

[3] PTS refers to injury where hearing sensitivities do not return to normal following noise exposure.

[4] TTS refers to injury where hearing sensitivities do return to pre-exposure thresholds after a period of time following noise exposure.

[5] The success of an individual reproducing.

data deficient. More understood is the relationship between energy and mortality in fishes, and mortality is, of course, a very real consequence for the net fitness of the individual, if not a population.

21 Mortality was therefore assessed for fishes, while the more severe effects expected from the proposal, being PTS/TTS, were assessed for marine mammals.

22 My assessment on drilling and blasting noise was presented in a report dated 20 November 2020, while my assessment on rock breaking noise is presented in the consulting advice note dated 27 August 2021.

Rock drilling and blasting noise

23 Rock drilling is required to create the bore holes that will contain the charges.

24 Three blasting scenarios were considered[6], all of which were based on the use of trinitrotoluene (TNT) explosive[7]. These were:

(a) 50 x 10kg charges loaded 2.5m below the seabed (referred to as Scenario 1);

(b) 60 x 15kg charges loaded 3.5m below the seabed (referred to as Scenario 2); and

(c) 10 x 25kg charges loaded 5.0m below the seabed and 20 15kg charges loaded 3.5m below the seabed (referred to as Scenario 3).

25 For all scenarios, the charges were set along lines of up to 12 charges per line. Detonation between charges along each line were delayed 20ms with a 70ms delay between lines. I refer to the detonation of all charges within each scenario as a blasting event.

Risk for marine mammal species

26 My assessment demonstrates that both PTS and TTS risk for all marine mammal species exists within a limited range from the site of each blasting event. The specific ranges (in metres) within which that risk exists are reproduced in Table 1 below:

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[6] Each scenario was confirmed by Red Bull Powder and a range of scenarios were run because the actual blasting regime is yet to be confirmed.

[7] I have been told by Nick Bastow from Red Bull Powder Company that TNT is more powerful than the bulk emulsion explosive that will be used for this project.

Table 1: Ranges for the potential onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) for the four functional hearing groups of marine mammals, from the blasting only.

The yellow highlighted cells show the maximum distance of the two metrics (L_{pk} and L_E), which is the distance to be used as stipulated in the NMFS (2018) guidance.

Scenario	Functional Hearing Group	Impact			
		Peak Pressure ($L_{pk,flat}$)		Cumulative Sound Exposure Level ($L_{E,M\text{-}weighted,24h}$)	
		PTS	TTS	PTS	TTS
1	LF	191m	257m	**427m**	**1632m**
	MF	68m	170m	**263m**	**1096m**
	HF	**790m**	**1405m**	188m	787m
	OW	17m	31m	**67m**	**467m**
2	LF	248m	323m	**430m**	**1704m**
	MF	110m	204m	**345m**	**1607m**
	HF	**830m**	**1449m**	202m	1002m
	OW	63m	183m	**107m**	**711m**
3	LF	259m	355m	**639m**	**2001m**
	MF	152m	222m	**286m**	**1246m**
	HF	**841m**	**1470m**	275m	1405m
	OW	75m	166m	**80m**	**599m**

27 For marine mammals, my assessment demonstrates that the rock drilling is not expected to induce PTS or TTS beyond a metre from the source of

the noise. This is because the cumulative sound exposure levels are below the required noise criteria.

Risk for fish species

28 The substantial overpressure near the confined blasting is expected to be lethal to fishes inside a limited range. Those ranges are:

(a) 16 to 77m for Scenario 1;

(b) 20 to 82m for Scenario 2; and

(c) 26 to 85m for Scenario 3.

These are based on peak pressures from each blasting event exceeding the lowest mortality thresholds[8].

29 The variation in these distances within each Scenario is because of the different calculation methods between the American and Canadian guidelines. Both methods were used to establish this range to provide e3 Scientific with a comprehensive assessment of the possible impact zones.

30 My assessment demonstrates that mortality of fishes from the rock drilling is not expected due to the noise levels being below the threshold criteria.

Rock breaking noise

31 I assessed the rock breaking noise based on the following assumptions:

(a) A S-70 IHC hydrohammer with a Hitachi CX 1800 crane on a 40m × 15m flat construction barge;

(b) 70 kJ per blow with 50 blows per minute, imparting 3500 kJ per minute;

(c) 0.18m^3 of rock to be broken per breaker position, requiring 1412.1 kJ;

(d) At 70 kJ per blow, it would take 20.2 blows to impart 1412.1 kJ, or 24 seconds of operation;

(e) 30 seconds to lift the breaker head and slew it into a new position. Therefore, a total of 1 minute per breaker position;

[8] The 100 kPa threshold as set out in the Canadian guidelines.

(f) 12 hr shifts per day, which is 10 hrs of possible operation. Therefore, 10hrs = 600min = 600 breaker positions; and

(g) 600 breaker positions equate to 15,000 seconds of rock breaking and therefore 12,000 blows per day.

32 The operator of the rock breaker expects that the energy required to break 0.18m^3 of rock could be 1/3 to 1/5 less than the 1412.1 kJ assumed in my assessment. However, I chose to maintain the 1412.1 kJ assumption because a set energy level could not be guaranteed by the operator at the time.

Risk for marine mammal species

33 Both PTS and TTS risk for all marine mammal species is likely within a small distance from the operating rock breaker. The specific ranges (in metres) within which that risk exists are reproduced in Table 2 below:

Table 2: Ranges (m) for the potential onset of permanent and temporary threshold shift (PTS/TTS) for the four functional hearing groups of marine mammals.

The levels are based on cumulative sound exposure ($L_{E\text{-}M\text{-}weighted,24h}$) and NMFS (2018) thresholds.

Functional hearing group	PTS	TTS
Low-frequency cetaceans	181m	1050m
Mid-frequency cetaceans	19m	65m
High-frequency cetaceans	175m	1080m
Otariid pinnipeds in water	11m	28m

Risk for fish species

34 The threshold for mortality in fishes from rock breaking are different to that of blasting and drilling. While there is no specific guidance for noise effects on fishes exposed to rock breaking, the acoustic waveform is expected to be similar to small piling operations driving steel casings through rock. We

have therefore applied the same thresholds as for percussive piling from the ASNI-Accredited guidelines by Popper et al. (2014).

35 Based on those guidelines, there exists a risk for mortality within 10m of the operating rock breaker for fishes that use swim bladders for hearing. For fish without swim bladders or smaller swim bladders that are not involved in hearing (i.e., hearing is primarily through particle motion detection), no mortality risk was found at any range from the operating rock breaker.

Officer's Report

36 I have reviewed the relevant sections of the Officer's Report relating to adverse ecological effects, including the risk of underwater noise effects prepared by Hamish Peacock.

37 Mr Peacock concurred that there exists a real risk of both injury (PTS) and TTS effects for marine mammals and mortality for fishes. The specific points raised regarding the mitigation of these risks relates to the use of MMOs and their ability to confidently detect species inside the shutdown zones. Those concerns are addressed in Dr Childerhouse's evidence.

38 I have reviewed the proposed conditions and support them. I note particularly in relation to the new condition proposed at p52 of the Officer's Report that the validation of underwater noise modelling is appropriate. Given the assumptions made for the confined blasting (including environmental conditions such as seabed composition and water chemistry), and the severity of the impacts (TTS in marine mammals), validation is important to ensure confidence that the protections in place are sufficient. However, a period of 2 weeks is required to allow enough time for processing of the data, and reconstructing the scenario for validations.

Submissions

39 I have reviewed the submissions from the Forest & Bird Protection Society of New Zealand and the Department of Conservation that relate to underwater noise effects and/or marine mammals, fish and seabirds.

40 The Department of Conservation's submission raised concerns relating to marine mammals and not specifically underwater noise effects. Those concerns are therefore addressed in Dr Childerhouse's evidence.

41 The submission of Forest & Bird raises concerns relating to fish, marine mammals and birds and not specifically the underwater noise effects. Those concerns are therefore addressed in Dr Childerhouse's and Dr Stephenson's evidence.

42 Notwithstanding, as I have outlined above, there is a risk for injury (through PTS) and TTS effects for marine mammals and mortality for fishes inside a limited range from the blasting or rock breaking.

Conclusion

43 In summary, my assessment identified:

(a) The proposed rock drilling to create the bore holes for the explosives are not predicted to induce PTS or TTS effects in marine mammals and no mortality in fishes;

(b) The proposed blasting events will pose a risk of PTS and TTS effects within a finite range from the source for all three blasting scenarios. The furthest range for which PTS effects may occur in any marine mammal species was 841m (high-frequency cetaceans, which include Hector's dolphins). The furthest range for which TTS effects may occur was 2001m for low-frequency cetaceans, which include humpback and southern right whales;

(c) There is a risk of mortality for fishes inside maximum radiuses between 16 – 77m (Scenario 1); 20 – 82m (Scenario 2); and 26 – 85m (Scenario 3);

(d) Mortality from the rock drilling is not expected to occur;

(e) The rock breaking will pose a risk of both PTS and TTS effects in marine mammals within a maximum range of 1008m; and

(f) There is a risk of mortality in some fishes when exposed to rock breaking noise inside 10m of the source.

Dr Matthew Pine

29 March 2022