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APPENDIX F

Marshall Day Acoustic Report

MARSHALL DAY Acoustics

TE PŪWAHA, WHANGANUI NOISE ASSESSMENT

Rp 001 r03 20211001 | 9 December 2021

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Report No.: **Rp 001 r03 20211001**

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EXECUTIVE SUMMARY

Whanganui District Council has engaged Marshall Day Acoustics Limited to assess the noise effects from Te Pūwaha (the Project) at Port Whanganui, for the wharf works elements of the project. The wharf works application comprises renewing existing wharves (Wharves 2 and 3) and creation of a hardstand area for commercial activities. This report assesses the airborne and underwater noise effects from construction and operation of the redeveloped port.

Airborne construction noise

We have predicted airborne noise from all key construction activities associated with the project. The loudest sources (piling and concrete breaking) are predicted to comply with the most stringent construction noise limits in all areas except a small section of works at the eastern extent of Wharf 3. We have recommended mitigation and management measures to minimise the effects of this exceedance, which includes the use of noise barriers, and communication with the receivers.

Underwater construction noise

The primary source of underwater noise will be pile driving (sheet piling and impact and/or vibro piling of new wharf piles). Our underwater noise assessment considers the expected noise levels that will arise from these activities, and the marine mammal species that could be affected. We have developed an underwater noise model for the project location and predicted the zones within which marine wildlife could be adversely affected by noise. We have been advised that fur seals and orca are the key marine mammal species in the area, although they are infrequent visitors within the Whanganui River.

We have calculated that these marine mammal species could be physiologically affected within an area up to 155m from sheet piling activities, and up to 85m from wharf piling (vibro and impact) activities. These zones should be co-managed by the applicant/project partners during piling activities in order to appropriately manage wildlife exposure to such noise. If a marine mammal is sighted within an effects zone, piling activities should cease.

Airborne operational noise

The main operational noise source is the abrasive blasting on the hardstand. This activity would take place for several days each month.

We have predicted noise levels based on our measurements of this activity on a similar site. The predicted levels just comply with the 55 dB L_{Aeq} limit at the residential area to the north and exceed the 65 dB L_{Aeq} limit by 1 – 4 decibels at two commercial receivers to the north. We have recommended mitigation measures such as a silencer on the devices, or a noise wall, to enable compliance. We recommend carrying out measurements during the first blasting operation to confirm compliance.

Overall, we consider that ensuring the abrasive blasting complies with the relevant limits, with a margin of safety, will control noise effects to a reasonable level (i.e., comparable to traffic noise).

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1.0 INTRODUCTION

Whanganui District Council has engaged Marshall Day Acoustics Limited to assess the noise effects from construction and operation of Te Pūwaha (the Project) at Port Whanganui.

For the purpose of this assessment, this report has been prepared to inform the elements of the Te Pūwaha project addressed in the wharf works resource consent application. The construction works include renewing existing wharves and the adjoining seawall, and creation of a hardstand area for commercial activities.

Proposed site activities include boat maintenance (including abrasive blasting), vessel movements, commercial marine activities, loading/unloading operations and operation of the new wastewater treatment plant for the hardstand.

A glossary of technical terms is included in Appendix A.

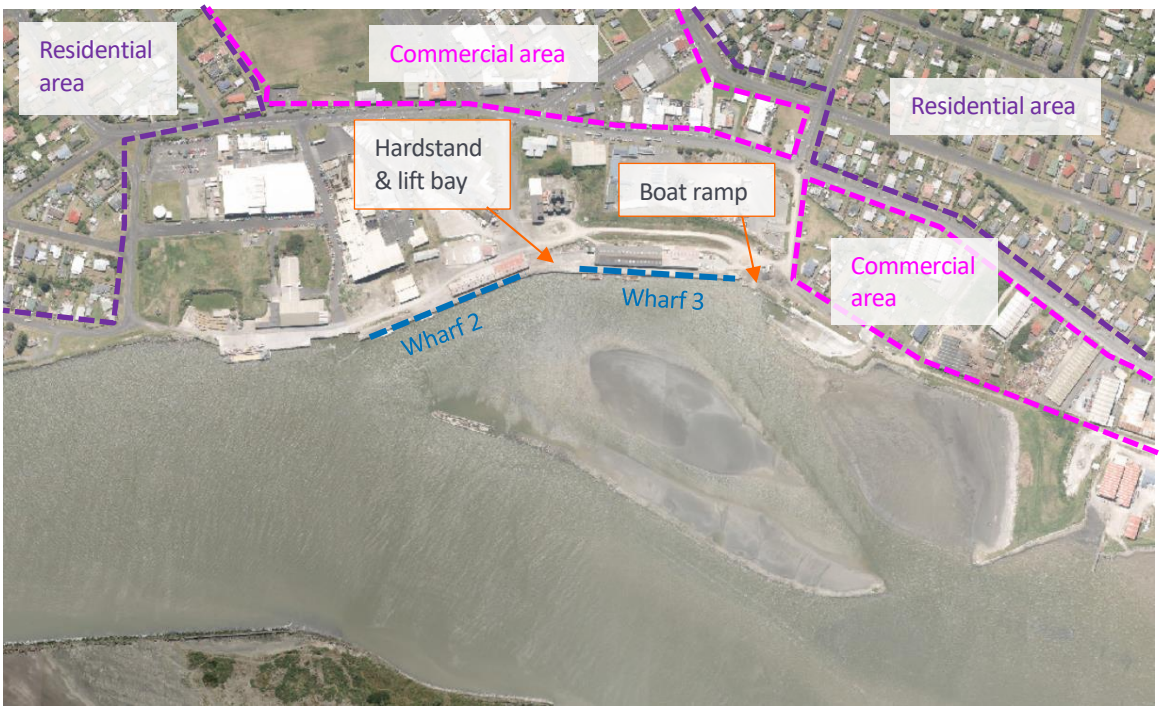
2.0 PROJECT DESCRIPTION

2.1 Overview

For the wharf works resource consent application, this Project involves several key water-based and land-based components identified in Figure 1:

- Land based works:
  - Stabilise land adjacent to the wharves with sheet piles
  - Construct a hardstand area between Wharves 2 and 3 (earthworks for stabilisation)
  - Repair wall between Wharf 3 and the boat ramp
- Marine works:
  - Replace Wharf 2 and Wharf 3 with new wharf structures and construct a boat hoist supporting structure
  - Remove abandoned marina piles

Figure 1: Map of project area



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2.2 Supporting Documentation

Our assessment is based on the following documentation:

- Mitchell Daysh 'Assessment of Environmental Effects' which provides a description of the proposed works and activities
- Department of Conservation (DOC) information on local wildlife, advised by email

2.3 Construction Activities

2.3.1 Demolition/Removal works

The following structures would be removed:

- Existing wharves (cut/break out sections and transport off site)
- Marina piles

2.3.2 Wharf Renewal

The wharf renewal works are the focus of our construction noise assessment. The new wharves will be constructed from concrete or timber. The following activities would be required:

- Earthworks and sheet piling to stabilise ground adjacent to and/or beneath the wharves.
- Impact and/or vibro-piling of new wharf piles.
- Construct new revetment wall in eroded area between the public boat ramp and Wharf 3.

2.3.3 Hardstand

A hardstand area will be developed in the area between Wharf 2 and Wharf 3. The following activities will be required:

- Earthworks and land disturbance beneath the hardstand footprint to address land stability.
- Sheet piling of the quay face, which will integrate the hardstand area with sheet piling beneath Wharves 2 and 3.
- Installation of a wastewater treatment plant for water from the hardstand.
- Impact and/or vibro-piling between Wharf 2 and 3 to support new boat hoist infrastructure.

2.4 Operational Activities

2.4.1 Abrasive blasting

The key operational activity for our assessment is the proposed abrasive blasting. This high-noise activity would occur intermittently (a few days each month) and be located both outdoors and within an appropriate environmental enclosure.

The activity consists of 'blasting' the hull of a vessel with an abrasive material such as garnet (fine silicate mineral). Figure 2 shows a typical setup.

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Figure 2: Image of abrasive blasting

2.4.2 Other Activities

Other activities associated with the port would consist of vehicle movements, vessel hull washing, vessel movements, loading/unloading operations, and operation of the new wastewater treatment plant for the hardstand area.

3.0 REGULATORY FRAMEWORK

3.1 Resource Management Act

Section 16 of the Resource Management Act 1991 (**RMA**) states the following in relation to the 'Duty to Avoid Unreasonable Noise':

1. *Every occupier of land (including any premises and any coastal marine area), <u>and every person carrying out an activity in, on, or under a water body or the coastal marine area,</u> shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level.*
2. *Subsection (1) does not limit the right of any local authority or consent authority to prescribe noise emission standards in plans made, or resource consents granted, for the purposes of any of Sections 9, 12, 13, 14, 15, 15A and 15B.*

The project spans areas of land and the Whanganui River. Activities on land are controlled by the Whanganui District Plan (**WDP**). Activities in or on the Whanganui River are controlled by the Horizons Regional Plan (**HRP**).

3.2 Whanganui District Plan

Land-based activities are within sites zoned General Industrial in the WDP. The surrounding Castlecliff community to the north, east and west is primarily zoned General Residential, with small pockets of Neighbourhood Commercial to the north, and Open Space to the north and west. A coastal sandspit is located beyond the Whanganui River to the south. A Zoning map identifying the relevant Zones is included in Appendix B.

The WDP includes objectives, policies and rules relevant to airborne noise and vibration in Part 2 – General District Wide Matter – Noise. In summary:

- The objectives seek to enable noise at levels that do not have an adverse effect on human health and an acoustic environment that is compatible with the character of the area.

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- The relevant policies are:
  - P3: Ensure that noise occurs within limits that maintain and reflect the amenity values and character of the area.
  - P5: Measurement and assessment must be in accordance with relevant New Zealand Standards:
    - New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"* contains noise limits and assessment methods for construction works
    - New Zealand Standard 6809:1999 'Acoustics - Port Noise Management and Land Use Planning' is listed, but not referred to in the relevant rules for Whanganui Port. As such, NZS 6802:2008 is the default Standard relevant for assessment of operational noise.
- Standard S11, Table 2, contains noise limits for activities in the Industrial Environment received in the following Zones:

Residential Zones	7am – 7pm	55 dB L_{Aeq}
	7pm – 10pm	45 dB L_{Aeq}
	10pm – 7am	40 dB L_{Aeq} and 75 dB L_{AFmax}
Other Zones	7am – 10pm	65 dB L_{Aeq}
	10pm – 7am	55 dB L_{Aeq} and 75 dB L_{AFmax}

- We consider that Standard S5 for "commercial boating" is not relevant or appropriate for the activities proposed by this project. Such a rule is typically used to specifically assess noise from jet boats on private waterways, lakes or rivers. Nonetheless, the noise emissions from boats on the Whanganui River are specifically enabled by the HRP (refer Section 3.3 below).

There are no relevant rules for vibration. However, the earthworks section (EW) states that *"earthworks shall not … cause excessive vibration on surrounding sites"*.

3.3 Horizons Regional Plan

The Whanganui River is zoned Coastal Marine Area (**CMA**) in the HRP. The proposed activities are contained within the CMA Port Management Area shown in Appendix A.

The HRP includes objectives, policies and rules relevant to airborne and/or underwater noise in Chapters 2, 3, 8 and 18. More specifically:

- Policy 3-1 (a) (xi) identifies Port of Whanganui as infrastructure of regional or national importance. Objective 3-1 and policy 3-3 provides for the establishment, operation, maintenance and upgrading of infrastructure of regional or national importance.
- Rule 18.8.1 requires adoption of best practicable option to ensure noise does not exceed a reasonable level, "*including minimising effects on coastal birds and amenity values for people*."
- Rule 18.8.2 permits noise emissions from the normal operations of boats and ships.

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4.0 AIRBORNE CONSTRUCTION NOISE ASSESSMENT

4.1 Construction Noise Rules

Noise policy P5 of the Whanganui District Plan states that *"all sound emissions shall be measured and assessed in accordance with … 3. New Zealand Standard 6803:1999 Acoustics – Construction Noise."*

The recommended construction noise limits for long-term works in NZS 6803:1999 are summarised in Table 1. The limits apply at 1m from the façade of an occupied building. The most relevant is 70 dB L_{Aeq}, applying during the day between 7.30am and 6pm, Monday to Saturday.

Table 1: Summary of noise limits from NZS6803:1999

Time period	Weekdays		Saturdays		Sundays and Public Holidays	
	dB L_{Aeq}	dB L_{Amax}	dB L_{Aeq}	dB L_{Amax}	dB L_{Aeq}	dB L_{Amax}
6:30am – 7:30am	55	75	45	75	45	75
7:30am – 6pm	70	85	70	85	55	85
6pm – 8pm	65	80	45	75	45	75
8pm – 6:30am	45	75	45	75	45	75

We understand that all construction works would be undertaken during the day when the noise limits are more permissive and the associated effects are typically more acceptable in the community.

NZS 6803:1999 recommends implementation of a management plan to minimise effects where it is not practicable to comply with the recommended noise limits.

4.2 Predicted Noise Levels

Table 2 identifies the key noise sources for each aspect of the works and the setbacks to comply with the daytime noise limit. The information in this table informs the predicted noise levels at the closest receivers in Section 4.3.

Temporary noise barriers (Section 4.4.3) should be used where an activity is predicted to exceed the construction noise limits. They should be installed prior to works commencing and maintained throughout the works. Effective noise barriers typically reduce the predicted noise levels in Table 2 by 10 decibels, and the compliant setback is therefore also reduced (e.g. concrete cutting setback would reduce from 76m to 30m). However, temporary noise barriers are typically ineffective for screening impact and vibro pile driving because the hammer (noise source) is elevated in the air above the pile that is being driven.

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Table 2: Predicted construction noise levels and setback distances to achieve compliance (no mitigation)

Key Equipment	Sound power level (dB L_{wA})	Noise level (dB L_{Aeq}) *			Compliance setback distances (m)
		50m	200m	500m	70 dB L_{Aeq}
Wharf demolition sources					
Concrete breaker (large excavator mounted)	121	81	65	56	130m
Concrete cutting	115	75	59	50	76m
Wharf construction sources					
Impact piling with casing and dolly	121	81	65	56	130m
Vibro piling	116	76	60	51	83m
Crane mounted drill rig	111	71	55	46	52m
General sources (all works areas)					
100T excavator	114	74	58	49	69m
20T excavator	103	63	47	38	25m
Drum roller	103	63	47	38	25m
Concrete truck and pump	103	63	47	38	25m
Crawler crane	100	60	44	35	18m
Mobile crane	98	58	42	33	14m
Generator/compressor	93	53	37	28	8m

* Indicative noise levels at 1m from a building façade in accordance with NZS 6803:1999

4.3 Closest Receivers and Effects Assessment

The closest receivers to the works are at the eastern and western extents of the site. We have addressed each area separately in the following sections.

Construction works in all other areas of the site are a significant distance from nearby receivers and are predicted to comfortably comply with the recommended noise limits.

4.3.1 Eastern Project Extent

Figure 3 shows the closest receivers to the works at the eastern extent of the project, and the approximate location of the works.

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Figure 3: Closest activities at eastern project extent

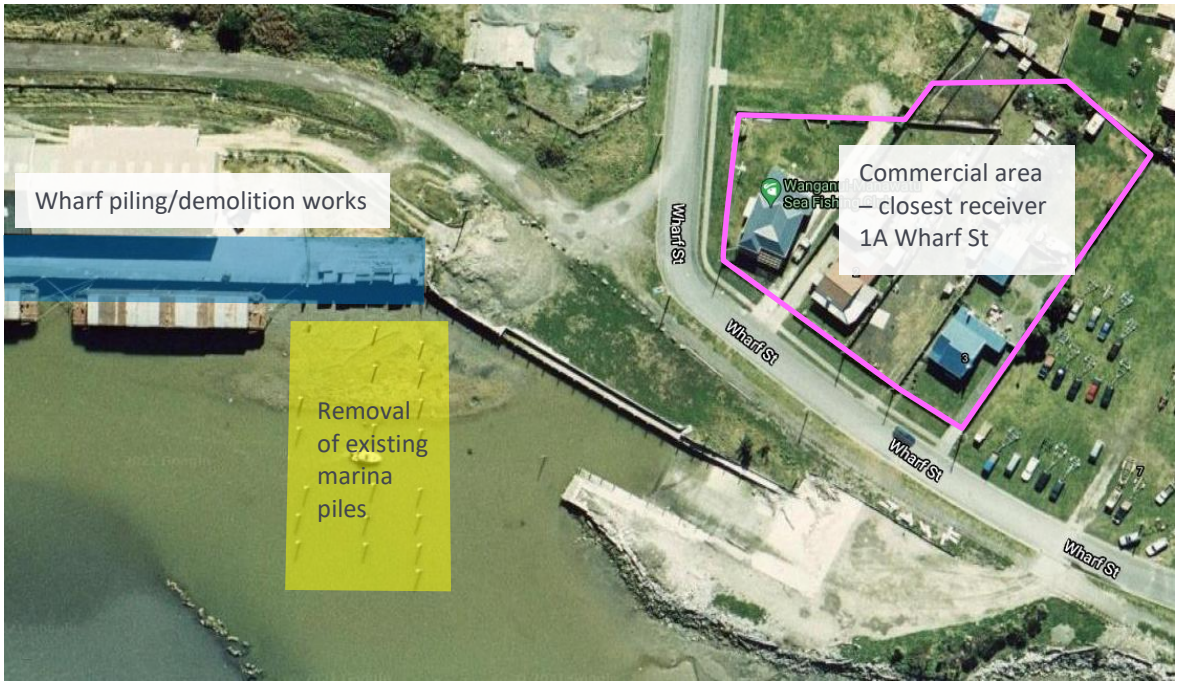

Table 3 summarises the predicted noise levels for each of the activities shown on Figure 3.

The shaded cells indicate predicted exceedances of the 70 dB L_{Aeq} construction noise limit.

Table 3: Predicted noise levels at receivers closest to eastern extent works (no mitigation)

Works area	Key activities	Source level (dB L_{WA})	Distance of closest works	Highest Predicted noise level (dB L_{Aeq})	Duration of works closest to nearby receivers
Wharf piling	Impact piling	121	70m	77	2 – 3 weeks
	Vibro piling	116	70m	72	2 – 3 weeks
Wharf demolition	Concrete breaking	121	70m	77	2 – 3 weeks
	Concrete cutting	115	70m	71	2 – 3 weeks
Removal of marina piles	Vibro piling	116	70m	67*	1 week

* Includes 5 decibels of assessment interval averaging due to the activity being 1 – 2 minutes duration

The predicted noise levels comply with the relevant limits except for piling and demolition works at the eastern end of Wharf 3.

Recommended mitigation and management measures for these short duration exceedances are provided in Section 4.4.

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4.3.2 Western Project Extent

The closest works at the western project extent would be the demolition/piling at the end of Wharf 2. These works would be over 250m from the residential receivers on Short Street and Tregenna Street.

The highest predicted noise level is 65 dB L_{Aeq}, which readily complies with the 70 dB L_{Aeq} limit.

4.4 Mitigation and Management

Mitigation and management of construction noise and vibration is essential for long-term and large-scale projects. A multi-layered approach is necessary, which will be implemented *via* a construction noise management plan (CNMP).

4.4.1 Construction Noise Management Plan

A CNMP should identify practicable noise mitigation measures and ensure effective communication between contractors and neighbours.

A CNMP should include:

- The performance standards that must, as far as practicable, be complied with;
- Predicted noise levels for relevant equipment and/or activities;
- Construction noise mitigation and management strategies;
- Noise monitoring procedures where appropriate; and
- Communication, consultation and complaints response procedures.

Specific measures that can be employed to reduce or manage the effects of underwater noise are included in Section 5.6.

The CNMP is recommended as a condition of any consent granted.

4.4.2 Plant selection

The first step towards mitigating noise and vibration levels during construction is to replace high-noise and vibration machines with quieter alternatives in accordance with the Best Practicable Option (BPO). This will not be practicable in some cases (e.g., geotechnical constraints, specialised machines etc).

The contractor should consider the following where practicable:

- Prioritise bored/screw piling methods over impact or vibrated methods;
- Prioritise electric motors over diesel engines;
- Prioritise rubber tracked equipment over steel tracked equipment;
- Ensure equipment is suitably sized for the proposed task;
- Equipment should be well maintained and fitted with exhaust silencers and engine covers;
- Avoid reversing or warning alarms that are tonal. Accepted alternatives include flashing lights, broadband audible alarms or reversing cameras inside vehicles.

4.4.3 Noise barriers

Temporary noise barriers should be used where practical when activity is predicted to exceed the construction noise limits (Section 4.2). They should be installed prior to works commencing and maintained throughout the works. Effective noise barriers typically reduce the received noise level by 10 decibels.

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Where practicable, the following guidelines should be used in designing and installing temporary noise barriers:

- The panels should have a minimum surface mass of 6.5 kg/m^2. Suitable panels include 12 mm plywood or the following proprietary 'noise curtains':
  - SealedAir 'WhisperFence 24dB' (www.sealedair.com)
  - Hushtec 'Premium Series Noise Barrier' (www.duraflex.co.nz)
  - Soundbuffer 'Performance Acoustic Curtain' (soundbuffer.co.nz)
  - Hoardfast 'Fast Wall Premium PVC partition panels' (www.ultimate-solutions.co.nz)
  - Safesmart 'Acoustic Curtain 6.5kg/m^2' (www.safesmartaccess.co.nz)
  - Alternatives will be approved by a suitably qualified and experienced acoustic specialist
- The panels should be a minimum height of 2 m, and higher if practicable to block line-of-sight
- The panels should be abutted, battened or overlapped to provide a continuous screen without gaps at the bottom or between panels
- Barriers should be positioned as close as practicable to the high-noise activity to block line-of-sight between the activity and noise sensitive receivers.

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5.0 UNDERWATER CONSTRUCTION NOISE ASSESSMENT

5.1 Underwater Noise Performance Standards

As noted in 3.1, Section 16 of the Resource Management Act 1991 (**RMA**) states that there is a 'Duty to Avoid Unreasonable Noise' "*in, on, or under a water body or the coastal marine area".*

There are no specific underwater noise rules in the HRP (Section 3.3). We therefore recommend adopting the current New Zealand best practice approach to ensure physiological hearing effects in marine species are avoided, and behavioural effects are minimised as far as practicable. This approach is expanded upon in the following sections.

5.2 Overview of Assessment Approach

Wildlife noise effects assessments are a rapidly developing area. The following precautionary approach is based on current best practice in harbour environments with relatively high levels of anthropogenic noise. However, we note that best practice may change over time due to changes in piling methods, effects thresholds, or management methods.

There are no New Zealand national guidelines for underwater noise effects. However, the US Department of Commerce National Oceanic and Atmospheric Administration (NOAA) has provided guidance for assessing the physiological impacts of anthropogenic (human-made) sound on marine mammals[1] (referred to as the 'NOAA Guidelines'). This US statute does not apply in New Zealand, but the NOAA Guidelines are used to give context to the underwater noise assessment.

The NOAA Guidelines identify the received levels above which individual marine mammals are predicted to experience changes in hearing sensitivity. These changes are either temporary ('Temporary Threshold Shift' or TTS), or permanent ('Permanent Threshold Shift' or PTS)[2]. Auditory threshold shifts can be caused from peak exposure (high-level impulsive events such as pile strikes) or from cumulative exposure (lower noise levels over an extended period such as from vibro-piling or multiple pile strikes). Based on these thresholds, zones of influence can be calculated. These zones can be managed to ensure that marine wildlife is not exposed to noise levels that can lead to changes in hearing sensitivity.

5.3 Marine Species

5.3.1 Marine mammals

The marine mammal species that visit the Whanganui River mouth area have been identified by DOC. They have advised that fur seals frequent the North Mole area all year, however they usually rest on the seaward side of the North Mole. There have been some sightings of fur seals further up the river (past the port as far as the town bridge) when chasing prey. Orca frequent the coastline and do enter the river mouth while chasing prey. We have been advised that sightings of orca are less frequent than sightings of seals.

The NOAA Guidelines provide TTS and PTS onset thresholds for impulsive (i.e., impact piling) and non-impulsive sources (i.e., vibro piling) per species group. Each species group has a specific weighting based on the frequencies of sound that they are most sensitive to. For species relevant to this assessment, orca are part of the Mid-Frequency Cetaceans hearing group, and fur seals are part of the Otariid Pinnipeds hearing group.

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[1] National Oceanic and Atmospheric Administration: *'Technical Guidance for Assessing the Effects on Anthropogenic Sound on Marine Mammal Hearing'* (April 2018).

[2] TTS in humans can be likened to the 'muffled' effect on hearing after being exposed to high noise levels such as at a concert. The effect eventually goes away, but the longer the exposure, the longer the threshold shift lasts. Eventually, the TTS becomes permanent.

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Table 4 summarises the noise thresholds and criteria at which physiological hearing effects can occur for the two species groups. The thresholds use the 'SEL_{cum}' assessment descriptor, which is the species-weighted cumulative sound exposure level over a 24-hour period.

The predicted peak noise levels from the proposed works are well below the relevant NOAA peak thresholds, so we have not detailed these criteria in this report.

Table 4. Summary of NOAA TTS and PTS thresholds[3]

Criteria	Hearing Group	Impulsive sources (impact piling)	Non-impulsive sources (vibratory piling)
TTS	Mid-frequency cetaceans (Orca)	170 dB $SEL_{cum(MF)}$	178 dB $SEL_{cum(MF)}$
	Otariid pinnipeds (Fur seals)	188 dB $SEL_{cum(OW)}$	199 dB $SEL_{cum(OW)}$
PTS	Mid-frequency cetaceans (Orca)	185 dB $SEL_{cum(MF)}$	198 dB $SEL_{cum(MF)}$
	Otariid pinnipeds (Fur seals)	203 dB $SEL_{cum(OW)}$	219 dB $SEL_{cum(OW)}$

Behavioural responses to underwater noise can vary significantly depending on species, the noise environment, and the character (temporal and frequency characteristics) of the noise. These effects can include temporary avoidance of the noisy area, disorientation, or impeded communication.

Relatively little is known about the thresholds above which behavioural impacts are likely to occur. The interim guidance from NOAA states that behavioural impacts can occur at 160 dB re. 1 μPa rms for impact piling, and as low as 120 dB re. 1 μPa rms for vibratory driven piling. As a conservative approach, the onset of behavioural effects could occur when the noise source is audible above the ambient environment.

5.4 Underwater Noise Model

The main underwater noise-producing activities in the Te Pūwaha project are impact and vibro pile driving during wharf renewal and sheet piling.

Piling includes both steel and timber driven piles. From our experience on other marine projects, timber piles generate much smaller effects zones than steel piles, so our modelling and assessment concentrates on the steel piles. Timber piles are not considered further in this assessment.

We have developed an underwater noise model using the dBSea 3D modelling software. The key inputs are as follows:

- Bathymetry from Land Information New Zealand (LINZ)
- Seafloor consisting of mud over stone
- Source spectra based on our measurements of equivalent works:
  - Impact pile driving spectra from our measurements at Half Moon Bay (a similar riverine environment).
  - Vibro pile driving spectra from our measurements at Auckland's ferry redevelopment.
  - Sheet pile vibro-driving spectra from our measurements at Auckland's Māngere Bridge.
- Piling methodology based on our experience on similar projects:
  - We have assumed that the driven steel piles have a diameter of up to 1,000mm
  - 1,000 strikes per day for impact piling (2 piles with 500 strikes each)

[3] SEL thresholds have a reference of 1 μPa^2s and L_{peak} thresholds have a reference of 1 μPa

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- 30 minutes vibro driving per day (2 piles for 15 minutes each)
- 100 minutes vibro driving of sheet piles per day (10 sheet piles for 10 minutes each)
- A dolly/cushion will be used for impact pile driving to mitigate noise emissions

- All piling was modelled at the western end of Wharf 2 in order to calculate the effects zones where propagation is least affected by the training wall.

The unweighted source levels used in the underwater noise model are shown in Table 5.

At this stage the methodology is assumed and may be subject to change. We have assumed a high number of strikes for impact piling as a worst-case.

Table 5: Predicted source levels at 1m

Piling details	Peak	RMS	$SEL_{(single\ strike)}$	SEL_{cum}
610mm diameter impact driven steel pile (top driven)	222	200	191	221
1,000mm diameter vibro driven steel pile	N/A	175	N/A	208
Vibro driven sheet piles	N/A	179	N/A	217

5.5 Underwater Noise Management Zones

5.5.1 Pile Driving TTS and PTS Zones

The predicted TTS and PTS zones for the piling methodology described in Section 5.4 are summarised in Table 6.

Table 6: Summary of NOAA Permanent Threshold Shift (PTS), Temporary Threshold Shift (TTS) & behavioural effects zones for piling activities

Activity	Hearing Group	Zone radius*		
		PTS	TTS	Behavioural
Impact piling	Mid frequency cetaceans	30m	85m	1.1 km
	Otariid pinnipeds	15m	55m	
Vibro piling	Mid frequency cetaceans	<10m	30m	1 km
	Otariid pinnipeds	<10m	<10m	
Sheet piling	Mid frequency cetaceans	25m	155m	1.5 km
	Otariid pinnipeds	<10m	50m	

*Maximum distance at which effects may occur.

The predicted zones for physiological hearing effects (PTS and TTS) should be monitored by a trained individual to reduce the likelihood of exposing wildlife to such noise. The role of the observer is discussed in section 5.6.4. The largest predicted PTS or TTS zone is 155m, which is illustrated in Figure 4. It is noted that the zones to be observed will reflect the type of activity occurring, for instance the largest 155m zone will be observed during sheet piling, and the smaller relevant zones outlined in Table 6 will be observed during other construction methods.

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Figure 4. The 155m TTS zone for mid-frequency cetaceans predicted to arise from sheet piling at the most westerly extent of piling.

5.5.2 Pile driving Behavioural Response Zones

The predicted behavioural response zones for the piling methodology described in Section 5.4 are summarised in Table 6. Piling is predicted to generate behavioural responses in marine mammals within a radius of up to 1.5km. The behavioural zones extend to, and just beyond, the river mouth into the South Taranaki Bight. While activity shut-downs are not required when marine mammals are sighted within the behavioural response zones (outside of the TTS and PTS zones), noise levels in this zone may lead to behavioural effects.

We note the following in relation to the character of each piling type:

- Impact piling generates distinct broadband impulses. These impulsive events are of a different character to the existing environment and are more likely to result in behavioural responses than continuous noise sources.
- Vibro piling generates continuous low and mid frequency noise. The continuous character is likely to be comparable to the existing environment, which is influenced by vessel traffic to and from the port and marinas.

5.6 Underwater Noise Mitigation and Management Measures

5.6.1 Changes in Methodology

Vibro pile driving should be prioritised over impact pile driving as it typically generates lower noise levels[4].

5.6.2 Dolly/Cushion for Impact Pile driving

This assessment assumes that during impact piling a wooden, polymer or nylon dolly/cushion is placed between hammer and pile/pile cap. If a dolly/cushion is not used, management zones arising from impact piling are predicted to be much larger and the injury potential heightened.

[4] This is depending on the methodology details, so advice from the Acoustic Specialist should be sought

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This measure is routinely employed by New Zealand piling contractors to reduce wear on equipment and to mitigate noise. It has been assumed in the acoustic assessment as the base case. Wooden cushions provide the greatest reduction in noise level. Polymer cushions are noticeably less effective, and nylon cushions are the least effective.

5.6.3 Pre-Start and Soft Start Procedures

Prior to the commencement of a noise-producing activity, the marine mammal zones identified in section 5.5 and surrounding waters should be monitored by a trained person for 30 minutes for the presence of marine mammals. If no marine mammals are observed during the 30 minute period, or if any sighted mammals are unlikely to enter the marine mammal zones, a soft-start procedure can commence for any impact pile driving.

Soft starts shall be used during impact piling where practicable. This mitigation measure involves gradually increasing the piling intensity (e.g. force/height of the drop hammer) over time to enable species to leave the area before full intensity pile diving commences.

To allow marine mammals adequate time to leave the area, the soft start should continue for at least 10 minutes before ramping up to full intensity.

5.6.4 Marine Mammal Observations

A key part of any mitigation is undertaking observations for marine mammals during piling operations. An education and training programme will be implemented by the project partners, with the aim to ensure that any marine mammals entering the identified marine mammal zones are promptly identified, and appropriate mitigation action is undertaken.

The training will include:

- Pre-start inspection
- Ongoing lookout
- Detect, record and report the presence of marine mammals within the wider operations area; and
- Document any mitigation measures within the marine mammal zones, including any action taken (if necessary).

5.7 Summary of Underwater Noise Assessment

The largest predicted PTS or TTS zone, which arises during sheet piling, is 155m. This zone, as well as the smaller PTS and TTS zones arising during other piling activities, should be observed during piling activities and appropriate mitigation should be enforced if a marine mammal enters an effects zone. Behavioural zones, which do not need to be observed, extend to the river mouth and into the South Taranaki Bight, up to 1.5 km from the piling sources.

Relevant mitigation and management measures for underwater noise are contained in Section 5.6.

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6.0 AIRBORNE OPERATIONAL NOISE ASSESSMENT

The key activity for our operational noise assessment is the abrasive blasting. This activity can generate noise levels which are louder than the construction works. We have addressed this activity in detail in the following sections.

Other activities associated with the redeveloped port would consist of vehicle movements, vessel movements, loading/unloading operations and travel lift operations around the lift bay. These activities are significantly lower in noise level than the abrasive blasting and are predicted to readily comply with the relevant noise limits in Section 3.2.

6.1 Abrasive Blasting Assumptions

We have included the following assumptions for the noise model to obtain a conservative envelope for assessing effects:

- Garnet blasting with a sound power level of 130 dB L_{WA}
- One unit operating for 50% of the daytime period (7.5 hours). We understand blasting would only take place several days each month
- Unit operating outdoors or in a fabric/plastic weather enclosure with negligible sound insulation

It is our opinion that the special audible character penalty in NZS 6802:2008 does not apply to this source as the received sound would not be impulsive or tonal. That said, it does have a distinctive 'hiss' character that would be audible in the community when undertaken.

6.2 Noise Limits

The relevant noise limits for this activity are 55 dB L_{Aeq} at residential zone receivers and 65 dB L_{Aeq} at commercial and industrial zone receivers. The assessment interval in NZS 6801:2008 is 15 minutes, and the daytime assessment level includes up to 5 decibels averaging of the assessment intervals.

6.3 Noise Modelling Details

We have modelled noise from the proposed construction works using SoundPLAN® environmental noise modelling software.

The following information has been incorporated in the noise model:

- Topographical contours at 1m intervals obtained from Open Topography
- Aerial maps, cadastral boundaries and buildings obtained from LINZ
- New port buildings as per the figure supplied[5]

The noise model predicts noise levels in accordance with the algorithm detailed in ISO9613-2: 1996- *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO9613) as implemented in SoundPLAN®.

ISO9613 considers a range of frequency dependent attenuation factors, including spherical divergence, atmospheric absorption, ground effect, acoustic screening and directivity effects. It assumes meteorological conditions favourable to propagation from sources (downwind at wind speeds 1 – 5m/s in all directions), and as such, calculates slightly conservative noise levels.

The noise contours are obtained by computer interpolation between calculated grid points at 5m intervals, 1.5m above ground level.

Figure 5 presents noise contours based on the scenario described in Section 6.1.

[5] '*WM_WDC_Q-West_OCEL_20211024.jpg*', provided on 8 November 2021 by Philip Wardale

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Figure 5: Predicted noise contours from garnet blasting

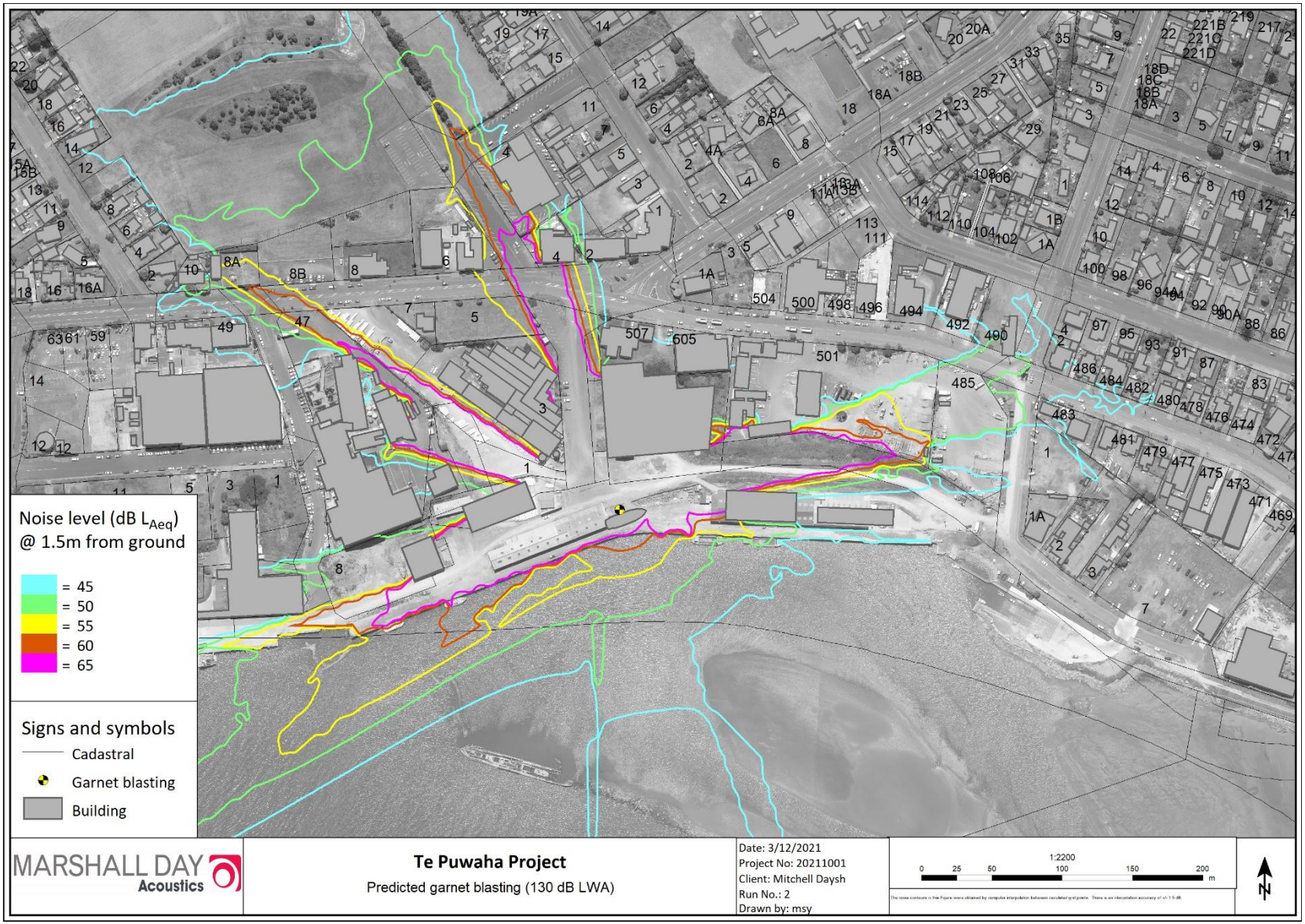

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Figure 5 shows that noise from the abrasive blasting just complies with the 55 dB L_{Aeq} limit at the most affected residential zone receiver (10 Bryce Street).

Noise levels at the closest commercial receivers are predicted to be 69 dB L_{Aeq} (4 Bryce Street – The Type Warehouse) and 66 dB L_{Aeq} (4 Thatcher Street – Castlecliff Club restaurant). This exceeds the 65 dB L_{Aeq} noise limit by 1 – 4 decibels. These receivers have general line of sight to the hardstand.

6.4 Recommended Mitigation Measures

Mitigation is necessary to enable compliance at the closest commercial receivers, and to ensure compliance is comfortably achieved at the closest residential receivers.

We recommend the following measures are considered:

- Monitoring be undertaken during the first abrasive blasting operation to verify the predicted noise levels and effectiveness of the mitigation
- Choice of machinery including consideration for the use of a silencer on the abrasive guns such as the Snakebite[6]. The literature for this product states a 16-decibel noise reduction, which is considerably more than is needed to comply with the relative limits. We recommend verification measurements be undertaken to confirm the onsite reduction in noise level
- Construct a noise barrier/noise wall to block line of sight to the hardstand (see mark-up in Appendix C). A reduction in received level in the order of 10 decibels would be achievable with this mitigation. The noise barrier should be lined with acoustic absorption on the side facing the awa to minimise noise propagation to the south.

We predict compliance can be readily achieved such mitigation measures.

6.5 Assessment of Operational Noise Effects

6.5.1 Residential Receivers

The highest noise level modelled at a residential receiver is 54 dB L_{Aeq} at 10 Bryce Street. This is at the upper end of acceptable levels in a sub-urban environment. We note that this receiver is adjacent to Bryce Street and likely experiences relatively high traffic noise levels, but the abrasive blasting would be of a different character (high frequency and variable level) so would be noticeable between traffic movements.

Reducing noise levels using the mitigation measures described above would have a noticeable improvement. Noise levels would be below 50 dB L_{Aeq} and would likely only be occasionally noticeable above the ambient traffic noise.

6.5.2 Commercial Receivers

Noise levels 66 - 69 dB L_{Aeq} at commercial receivers would likely result in reduced speech intelligibility outdoors and annoyance indoors for office/restaurant activities if windows and doors are open.

Reducing levels by 10 decibels as per the mitigation measures above would reduce effects to acceptable levels and minimise disturbance both indoors and outdoors.

[6] https://www.blastone.co.nz/snakebite-xq/

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7.0 RECOMMENDED CONDITIONS OF CONSENT

The following relevant conditions are recommended for any consent granted by Horizons Regional Council for the wharf works resource consent application:

1. *Construction noise shall be measured and assessed in accordance with the provisions of New Zealand Standard NZS 6803:1999 "Acoustics - Construction Noise" and comply with the following Project Standards at any occupied building, unless otherwise provided for in the Construction Noise and Vibration Management Plan (CNVMP) (refer condition 3).*

Day	***Time***	***dB $L_{Aeq\ (30min)}$***	***dB L_{AFmax}***
Monday to Friday	*0630 – 0730*	*55*	*75*
	0730 – 1800	*70*	*85*
	1800 – 2000	*65*	*80*
Saturday	*0730 – 1800*	*70*	*85*
Sunday	*0730 – 1800*	*55*	*85*
All other times (night-time)		*45*	*75*

Construction Noise Management Plan

2. *A Construction Noise Management Plan (CNMP) shall be prepared by the consent holder. The CNMP must be implemented throughout the Project.*

   The objectives of the CNMP are:

   - *Identify and adopt the Best Practicable Option (BPO) for the management of construction noise;*
   - *Define the procedures to be followed when the noise standards in Condition 1 cannot be met;*
   - *Inform the duration, frequency and timing of works to manage disruption;*
   - *Require engagement with affected receivers and timely management of complaints;*
   - *Establish construction management protocols and methodologies with consideration to the underwater noise levels of impact and vibration piling to protect marine mammals.*

We recommend that the following condition is included in any operational management plan for the port and hard stand:

3. *Noise for activities generated within the Whanganui Port site shall comply with the following noise limits at receivers:*

   - *Residential Zones* — *7am – 7pm* — *55 dB L_{Aeq}*
     7pm – 10pm — *45 dB L_{Aeq}*
     10pm – 7am — *40 dB L_{Aeq} and 75 dB L_{AFmax}*
   - *Other Zones* — *7am – 10pm* — *65 dB L_{Aeq}*
     10pm – 7am — *55 dB L_{Aeq} and 75 dB L_{AFmax}*

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Noise shall be measured in accordance with New Zealand Standard NZS 6801:2008 Acoustics – Measurement of environmental sound and assessed in accordance with New Zealand Standard NZS 6802:2008 Acoustics - Environmental Noise.

4. *Noise measurements shall be undertaken for the first abrasive blasting operation to demonstrate compliance with the noise limits in Condition 3.*

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APPENDIX A GLOSSARY OF TERMINOLOGY

Noise	A sound that is unwanted by, or distracting to, the receiver.
dB	Decibel (dB) is the unit of sound level. Expressed as a logarithmic ratio of sound pressure (P) relative to a reference pressure (Pr), where dB = 20 x log(P/Pr). The convention is a reference pressure of Pr = 20 μPa in air.
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear. A-weighting is used in airborne acoustics.
$L_{Aeq\,(t)}$	The equivalent continuous (time-averaged) A-weighted sound level commonly referred to as the average level. The suffix (t) represents the period, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{AFmax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
NZS 6803:1999	New Zealand Standard NZS 6803: 1999 "Acoustics - Construction Noise"
Underwater noise	A sound that is unwanted by, or distracting to, the receiver underwater.
L_{peak}	The peak instantaneous pressure level (un-weighted).
RMS	Root Mean Square (RMS) is the equivalent continuous (time-averaged) sound level commonly referred to as the average level (period matches the event duration).
SEL	Sound exposure level (SEL) is the total sound energy of an event, normalised to an average sound level over one second. It is the time-integrated, sound-pressure-squared level. SEL is typically used to compare transient sound events having different time durations, pressure levels and temporal characteristics.
SEL_{cum}	The SEL_{cum} is the 'cumulative' sound energy of all events in a 24-hour period, normalised to an average sound level over one second.
TTS	Temporary Threshold Shift (TTS) is the temporary loss of hearing caused by sound exposure. The duration of TTS varies depending on the nature of the stimulus, but there is generally recovery of full hearing over time. TTS in humans can be likened to the 'muffled' effect on hearing after being exposed to high noise levels such as at a concert. The effect eventually goes away, but the longer the exposure, the longer the threshold shift lasts. Eventually, the TTS becomes permanent (PTS).
PTS	Permanent Threshold Shift (PTS) is the permanent loss of hearing caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear.

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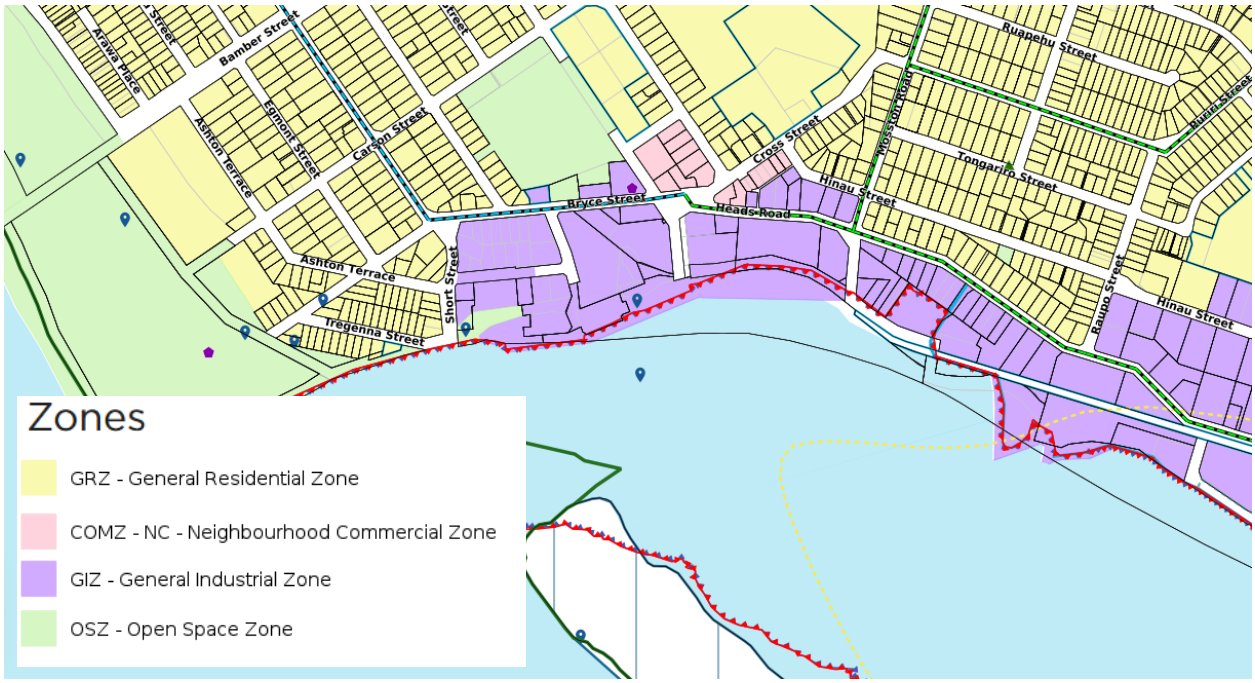
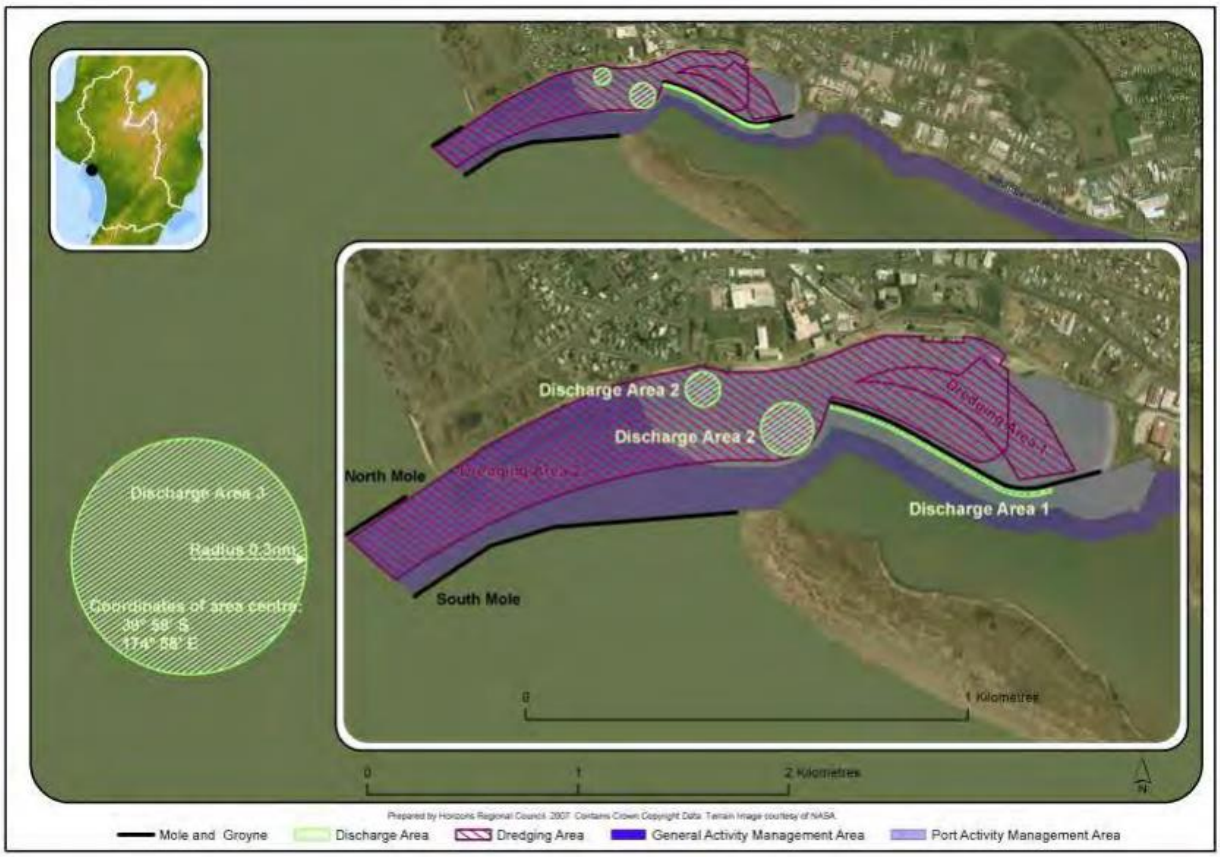
APPENDIX B SITE ZONING

Whanganui District Plan



Horizons Regional Plan

Figure I:10 Port Activity Management Area



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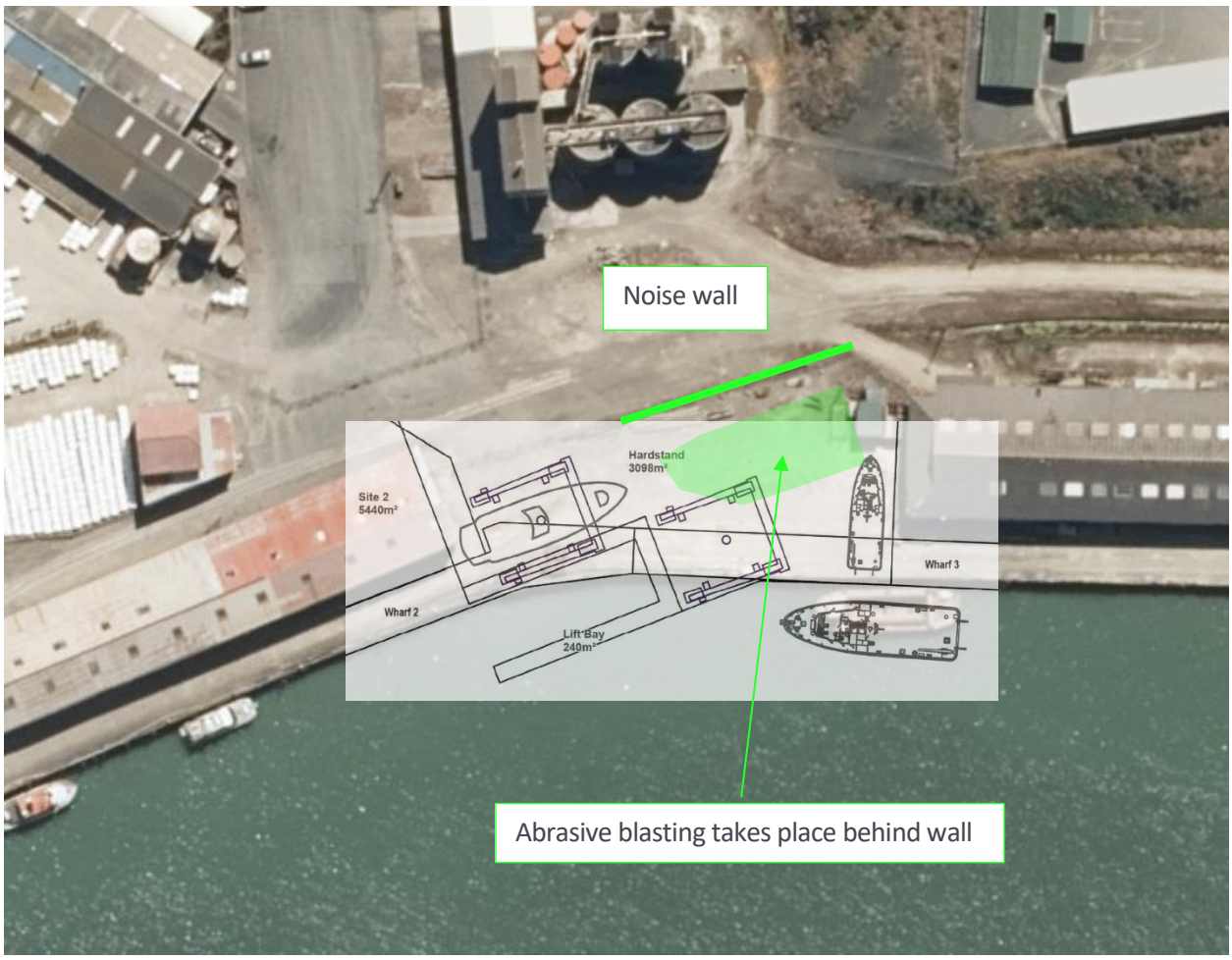
APPENDIX C POTENTIAL HARDSTAND NOISE BARRIER



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