



MARSHALL DAY
Acoustics 

SEAVIEW RENEWAL WORKS
CONSTRUCTION NOISE MANAGEMENT PLAN

Rp 001 r07 20210175 | 21 September 2021

Project: **SEAVIEW RENEWAL WORKS**

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Report No.: **Rp 001 r07 20210175**

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1.0 INTRODUCTION

Seaview Wharf is a critical part of the lower North Island fuel supply chain and plays a significant role for the national fuel supply serving around 20% of New Zealand’s population. The Wharf is also identified in the ‘Wellington Lifelines Group Business Case’ as the second most critical lifeline asset in the region.

The Wharf is approaching 50 years in service and suffered damage in the 2016 Kaikoura Earthquake. Major upgrade and renewal work is planned to start in late 2021 with completion expected in 2023/2024. The work will extend the operational life of the wharf, improve seismic resilience and increase performance levels in line with current international standards and requirements.

The work to be undertaken includes demolition and piling. CentrePort engaged Marshall Day Acoustics to assess the potential noise effects of the work and to prepare a Construction Noise Management Plan (CNMP) to minimise any noise effects on the local community and the marine environment.

Pursuant to the resource consents obtained for the work, all works shall be undertaken in accordance with the measures in this CNMP. It identifies the performance standards that must be complied with and sets out best practicable options (BPO) for noise mitigation and management.

Noise emissions levels from construction activities have been predicted at the closest noise sensitive receivers. These predicted noise levels have been compared with the relevant noise performance standards and this CNMP details the limitations on when works can be carried out, in order to comply with the relevant noise performance standards.

This CNMP shall be implemented throughout the Seaview renewal works. It shall be considered a ‘living document’ that is expanded and updated as the Project progresses and working conditions become clearer. It is intended to be the primary tool to inform the Project’s management of construction noise effects.

A glossary of terminology is included in Appendix A.

2.0 CONTACT DETAILS

Contact details for the relevant personnel are included in Table 1. The Project Manager is ultimately responsible for implementing this CNMP.

Table 1: Contacts

Role	Name	Organisation	Phone	Email
Consent Holder	Thomas Marchant	CentrePort Ltd	021 859 518	thomas.marchant@centreport.co.nz
CentrePort Project Manager	TBC	CentrePort Ltd		
Contractor Project Manager	Lee Griffiths	Brian Perry Civil	027 563 3053	LeeGr@fcc.co.nz
Contractor Site Manager	Helen Russell	Brian Perry Civil	027 403 2370	HelenR@fcc.co.nz
Contractor Environmental Manager	Rachel Blake	Brian Perry Civil	027 221 4699	rachelb@fcc.co.nz
Contractor H&S Manager	Adam Hunt	Brian Perry Civil	027 567 5814	adamh@fcc.co.nz

Role	Name	Organisation	Phone	Email
Acoustic Specialist	Victoria Warren	Marshall Day Acoustics	04 499 3016	victoria.warren@marshallday.co.nz
Public Enquiries / Complaints	TBC	CentrePort Ltd		

3.0 DESCRIPTION OF WORKS

The following section provides an overview of the works. For full details, refer to the Seaview Renewal Methodology, prepared by Brian Perry Civil (BPC).

3.1 Work Areas

We have broken our assessment into four different works areas. The information below has been advised by BPC. These are as follows:

Abutment works: Works here involves using a rock breaker to remove the face of the abutment, and removal from site for storage.

Approach wharf: Deck slabs cut using a track saw, floor saw or small hand breakers (over 6 months). Piling to occur at a rate 2 to 4 piles at each bent.

Main wharf: Deck slabs cut using a track saw, floor saw or small hand breakers (over 3 months). Proposal for a total of 64 piles to support the main wharf.

Compound works: The compound is the main staging area for the project. Noise generating activities which occur here would include minor fabrication works, a generator, truck (and other vehicle) movements. A 100t crawler crane is proposed which will service the works throughout. Lighting would be provided to deter theft and vandalism. A temporary staging platform would be constructed into the harbour to allow for loading of materials onto barges.

Piles would be installed using a combination of vibratory piling and impact piling. Once installed, piles would be drilled out using an auger prior to being filled with concrete. Where impact driving occurs, timber cushions are proposed to mitigate noise emissions.

3.2 Proposed Construction Hours

Seaview Wharf must remain operational throughout the construction period. For safety reasons construction activities are limited to periods when the Wharf is not being used for fuel operations. This is currently 90 to 100 days a year (typically the duration of each ship discharge is 12 to 48 hours). Weather and sea conditions may also limit construction.

Subject to these limitations, construction activities are planned to occur 0730 to 1800 Monday to Saturday. Works undertaken during the day would include pile installation, saw cutting, demolition work and hydro demolition. Deliveries would also take place during these times.

Construction activities may also occur during evening and night-time periods (1800-0730 Monday to Friday) and on Sundays/public holidays (0730-1400) if required, when noise limits are lower. Only low noise activities will occur during these times.

All construction activities must comply with noise limits, unless explicit permission has been sought from the local authority to exceed these limits (refer sections 6.3 and 6.9 of this CNMP).

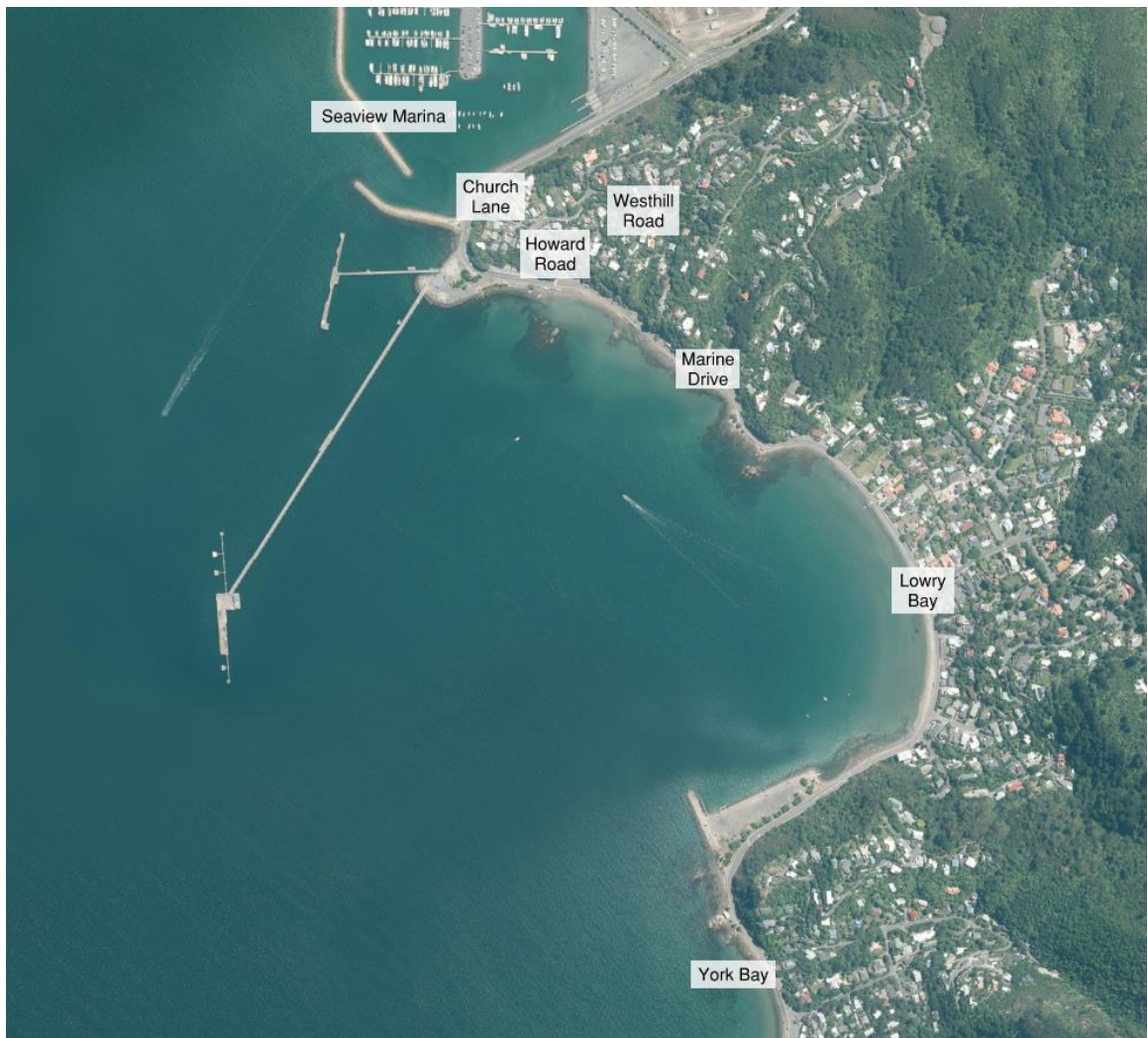
3.3 Closest Noise Sensitive Receivers

The closest receivers are summarised in Table 2 and Figure 1. Due to the number of dwellings in the area, each receiver represents a cluster of dwellings.

Table 2: Closest noise sensitive receivers

Receiver	Comment	Approximate distance from closest works
Seaview Marina	We have not been made aware if there are residents living in boats in the marina. Regardless, we have considered it as a residential location.	300 metres
Church Lane	The closest residential dwellings, which are elevated above the wharf.	100 metres
Howard Road	Majority of residents would have line of sight to some of the piling activities. Some dwellings are elevated above the wharf.	150 metres
Westhill Road	Situated further back from Howard Road.	220 metres
Marine Drive	Dwellings situated at same elevation of the wharf.	500 metres
Whiorau/Lowry Bay	Located at a greater distance from activities (when compared to other receivers). However, there are a larger number of dwellings in this location.	750 metres
York Bay	Most dwellings would have screening to majority of construction activities.	950 metres

Figure 1: Map showing closest noise sensitive locations



4.0 CONSENT CONDITIONS

The following section sets out the consent conditions which relate to noise.

Greater Wellington Regional Council

10. *The consent holder shall submit a final Construction Noise Management Plan (CNMP) to the manager for certification 20 days prior to the commencement of works. The CNMP must be prepared by a suitably qualified person. The CNMP objectives are:*

- a) *Identify and adopt the best practicable option (BPO) for the management of construction noise;*
- b) *Define the procedures to be followed when the noise standards in Condition 12 cannot be met;*
- c) *Inform the duration, frequency and timing of works to manage disruption;*
- d) *Require engagement with complainants and the timely management of complaints; and*
- e) *Manage the underwater noise levels from impact and vibratory pile driving methods to protect marine mammals and avoid adverse effects on threatened or at-risk species.*

Works shall be undertaken in accordance with the certified CNMP.

11. *The CNMP required by Condition 10 shall include:*

- a) *The relevant measures from NZS 6803:1999 “Acoustics – Construction Noise”, Annex E2 “Noise management plans”;*
- b) *Measures to minimise underwater noise effects on marine mammals, including as practicable:*
 - *Restrict in-water impact or vibration pile driving to within the start and end of Civil Twilight hours only;*
 - *Use a non-metallic ‘dolly’ or ‘cushion cap’ between the impact piling hammer and the driving helmet (e.g. plastic or plywood);*
 - *Use piling methodologies that minimise underwater noise (i.e. ‘Soft starts’ – gradually increasing the intensity of impact piling, minimising the number of strikes and/or vibro driving time per day, the consideration of alternative driving methods, and use of bubble curtains);*
 - *Establish marine mammal observation zone(s) around the construction area to minimise any risk of hearing impairment or injury to marine mammals from impact and vibration pile-driving activities. These zones shall:*
 - i. *Reflect piling method, pile size, noise mitigation method(s), and species sensitivity;*
 - ii. *Use the thresholds in the following table for management zones:*

Hearing Group	Impulsive sources (impact piling)	Non-impulsive sources (vibratory piling)
Mid-frequency cetaceans TTS (Orca, common / bottlenose dolphins)	170 dB SELcum(mf) / 224 dB Lpeak	178 dB SELcum(mf)
Low-frequency cetaceans PTS	183 dB SELcum(lf) / 219 dB Lpeak	199 dB SELcum(lf)
High-frequency cetaceans PTS (Hector's dolphin)	155 dB SELcum(hf) / 202 dB Lpeak	173 dB SELcum(hf)
Otariid pinnipeds TTS (Fur Seals)	188 dB SELcum(ow) / 226 dB Lpeak	199 dB SELcum(ow)

- iii. *Be based initially on the preliminary mammal observation zone(s) identified in Appendix B of the draft CNMP submitted with the consent application;*
- iv. *Be verified by underwater noise monitoring. The certified CNMP shall be revised and submitted to the Council for re-certification if measured levels exceed the predicted levels, or there is a change in piling method, size or type of piles to be driven which could result in larger mammal observation zone(s); and*
- v. *Cease or not commence impact or vibration piling activities if a marine mammal is observed within the marine mammal observation zone(s).*

12. *Construction noise shall be measured and assessed in accordance with 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 CNMP.*

Day	Period	dB LAeq	dB LAFmax
Weekdays	0630 – 0730	55	75
	0730 – 1800	70	85
	1800 – 2000	65	80
	2000 – 0630	45	75
Saturdays	0730 – 1800	70	85
	1800 – 0630	45	75
Sundays and public holiday	0730 – 1800	55	85
	1800 - 0630	45	75

13. *The Consent Holder shall appoint an independent consultant to monitor noise levels from the site at the following intervals:*

Interval	Day	Period	Duration of monitoring
Day 1 of commencement of works	First day of construction/demolition works	7.30 – 1800 1800 – 6.30	60 minutes per period
2 weeks following commencement of works	One weekday One Sunday (2 days total)	7.30 – 1800 1800 – 6.30	60 minutes per period
1 month following commencement of works	One weekday One Sunday (2 days total)	7.30 – 1800 1800 – 6.30	60 minutes per period
6 months following commencement of works	One weekday One Sunday (2 days total)	7.30 – 1800 1800 – 6.30	60 minutes per period
12 months following commencement of works	One weekday One Sunday (2 days total)	7.30 – 1800 1800 – 6.30	60 minutes per period
18 months following commencement of works	One weekday One Sunday (2 days total)	7.30 – 1800 1800 – 6.30	60 minutes per period
When a complaint is received, monitoring shall be undertaken the next time a comparable construction activity occurs.	When comparable construction activity is occurring.	7.30 – 1800 1800 – 6.30	60 minutes per period

Monitoring shall be undertaken in accordance with the methodology referenced in Condition 12 above. Where monitoring is undertaken in response to a noise complaint, monitoring shall trace all sources of noise emissions from the site to determine whether emissions are from landside operations, or operations within the coastal marine area.

Monitoring results shall be submitted to the Manager within 5 working days of completion of each individual monitoring event.

14. *If monitoring shows that the standards defined within Condition 12 are exceeded, the consent holder shall engage a SQEP to review the CNMP and adopt the best practicable option to ensure compliance with Condition 12.*

18. *Any amendments proposed to the approved management plans (CMMP, CNMP and LBPMP) shall be confirmed in writing by the consent holder and be to the satisfaction of the Manager, Environmental Regulation, Wellington Regional Council prior to the implementation of any amendments proposed.*

19. *The consent holder shall, if requested by the Manager in response to a complaint, incident or other reasonable request that relates to managing an adverse environmental effect that is directly related to the exercise of this consent, carry out a review of any management plan required by these conditions. The consent holder shall submit the reviewed management plan to the Manager for certification that:*

- *The reason(s) for requiring the review have been appropriately addressed; and*
- *Appropriate actions and a programme for implementation are provided for if required.*

Hutt City Council

6. That the consent holder only undertake the following landside activities between the hours of 2000 – 0630:

- Crane operation
- Concrete truck deliveries

All other landside activities are limited to only occurring outside of these hours (daytime hours).

Note: Landside activities relate only to construction activities and exclude works over the Coastal Marine Area or typical operational activities that may occur at the site such as occupying offices premises on site. Crane operations may include loading and unloading barges.

8. A Construction Noise Management Plan (CNMP) must be prepared by a suitably qualified person and submitted to Hutt City Council for certification at least 20 days prior to the commencement of the works. The CNMP objectives are:

- a. Identify and adopt the best practicable option (BPO) for the management of construction noise;
- b. Define the procedures to be followed when the noise standards in Condition 7 cannot be met;
- c. Inform the duration, frequency and timing of works to manage disruption;
- d. Require engagement with complainants and the timely management of complaints; and
- e. Manage the underwater noise levels from impact and vibratory pile driving methods to protect marine mammals and avoid adverse effects on threatened or at-risk species.

9. That the Consent Holder undertakes all works onsite in accordance with the CNMP certified as per Condition 8 above.

10. That the consent holder notifies surrounding residents within 200m of the application works area for works between 0630 – 2000, or 800m of the application works area for works between 2000 – 0630, at least 24 hours prior to undertaking activities likely to generate particular noise nuisance.

Note: this notification may be provided through an online forum, website with regular updates or otherwise, provided all identified residents are provided notice and direction on how to access the web address.

11. Construction noise shall be measured and assessed in accordance with 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 CNMP.

Day	Period	dB LAeq	dB LAFmax
Weekdays	0630 – 0730	55	75
	0730 – 1800	70	85
	1800 – 2000	65	80
	2000 – 0630	45	75
Saturdays	0730 – 1800	70	85
	1800 – 0630	45	75
Sundays and public holidays	0730 – 1800	55	85
	1800 – 0630	45	75

Note: The consent holder is encouraged to engage with Council’s Environmental Health team to discuss the construction method and ways to minimise and noise disturbance to the surrounding properties.

12. *The Consent Holder shall appoint an independent consultant to monitor noise levels from the site at the following intervals:*

Interval	Day	Period	Duration of monitoring
Day 1 of commencement of works	First day of construction/demolition works	7.30 – 1800 1800 – 6.30	60 minutes per period
2 weeks following commencement of works	One weekday One Sunday (2 days total)	7.30 – 1800 1800 – 6.30	60 minutes per period
1 month following commencement of works	One weekday One Sunday (2 days total)	7.30 – 1800 1800 – 6.30	60 minutes per period
6 months following commencement of works	One weekday One Sunday (2 days total)	7.30 – 1800 1800 – 6.30	60 minutes per period
12 months following commencement of works	One weekday One Sunday (2 days total)	7.30 – 1800 1800 – 6.30	60 minutes per period
18 months following commencement of works	One weekday One Sunday (2 days total)	7.30 – 1800 1800 – 6.30	60 minutes per period
When a complaint is received, monitoring shall be undertaken the next time a comparable construction activity occurs.	When comparable construction activity is occurring.	7.30 – 1800 1800 – 6.30	60 minutes per period

This monitoring shall be undertaken in accordance with the methodology referenced in Condition 11 above. Where monitoring is undertaken in response to a noise complaint, monitoring shall trace all sources of noise emissions from the site to determine whether emissions are from landside operations, or operations within the coastal marine area.

Monitoring results shall be submitted to Council within 5 working days of completion of each individual monitoring event.

13. *If monitoring shows that the standards defined within Condition 11 are exceeded, the consent holder shall engage a suitably qualified person to review the CNMP and adopt the best practicable option to ensure compliance with Condition 11.*

14. *Any amendments proposed to the approved management plans (CTMP, CNMP) shall be confirmed in writing by the consent holder and be to the satisfaction of the Team Leader, Resource Consents, prior to the implementation of any amendments propose.*

5.0 AIRBORNE NOISE – PREDICTED LEVELS

5.1 Predicted Levels and Compliance Setback Distances

Table 3 provides construction noise levels and setback distance for activities, in order to meet the noise standards. The setback distances relate to applicable noise limits of NZS 6803:1999. The timings for each noise limit are as shown in Condition 12 (GWRC) and Condition 11 (HCC).

Table 3 should be used by the Project Manager (or nominated person) prior to construction to inform what equipment will require mitigation and/or management and when. Where there is any doubt, the Contractor should contact the Acoustic Specialist for clarification.

Table 3 should be kept up to date by the Acoustic Specialist when new information becomes apparent through noise monitoring (Section 7.0) or other means. It is the responsibility of the Contractor to advise the Acoustic Specialist when an update is required.

Table 3: Indicative noise levels at 1m from a building façade¹

Equipment	Sound Power Level (dB L _{WA})	Noise Level (dB L _{Aeq})			Setback Distances (m)			
		50 m	200 m	500 m	70 dB	65 dB	55 dB	45 dB
<u>Piling Activities</u>								
Vibro piling	116	77	65	57	110	200	630	2000
Impact piling with dolly	114	75	63	55	90	160	500	1600
Auger drilling	111	72	60	52	60	110	350	1100
<u>Other</u>								
Large breaker (rock armour)	121	82	70	62	200	350	1100	3500
Hydro Demolition	114	75	63	55	90	160	500	1600
Concrete/paver cutting	114	75	63	55	90	160	500	1600
Concrete wire cutting	103	64	52	44	25	45	140	450
Hand breaker	111	72	60	52	60	110	350	1100
Excavator (loading trucks)	103	64	52	44	25	45	140	450
Concrete pump	106	67	49	41	35	60	200	630
Grinders/Power Tools	108	69	57	49	45	80	250	800
Trucks	103	64	52	44	25	45	140	450
Mobile crane	95	56	44	36	10	20	60	180
Generator	93	54	42	34	10	15	45	140
Light tower	90	51	39	31	5	10	30	100

Table 4 shows the approximate distances between the work areas and the closest noise sensitive receivers. In all cases, the closest receivers are the dwellings on Church Lane (Table 2). Some of the work areas are large, so in some instances, a range has been provided. Table 4 can be used in conjunction with Table 3 to establish what activities can take place and at what times.

Table 4: Distance between work areas and closest sensitive receivers

Works Area	Approximate distance from works area to closest receiver
Compound works	20 metres – 100 metres
Abutment works	100 metres
Approach wharf (north)	100 metres – 400 metres
Approach wharf (south)	400 metres – 700 metres
Main wharf	750 metres

¹ In accordance with the requirements of NZS 6803: 1999 (inclusive of 3 decibels façade reflection)

5.2 Work Hours When Noisy Activities Can Comply

Table 5 shows the time periods where unmitigated noise levels (except where noted) are predicted to comply with the noise standards of Condition 12 (GWRC) and Condition 11 (HCC). These predictions are slightly conservative in that we have assumed all noisy activities occur simultaneously.

Table 5: Work hours to comply with NZS 6803:1999 noise standards

Works Area	Monday to Friday				Saturday		Sunday/public holiday	
	0630 to 0730	0730 to 1800	1800 to 2000	2000 to 0630	0730 to 1800	1800 to 0730	0730 to 1800	1800 to 0730
Compound works		✓			✓			
Abutment works*		✓			✓			
Approach wharf (north)		✓			✓			
Approach wharf (south)		✓	✓		✓			
Main wharf	✓	✓	✓		✓		✓	

* Assumes noise mitigation of rock breaker (e.g. temporary screens)

Table 5 shows that during the night-time and morning/evening shoulder periods, and on Sundays/public holidays (except in regard to the Main Wharf works), works will not be able to proceed without additional noise mitigation measures.

5.3 Construction Activities and Little Blue Penguins

We have also calculated airborne noise emissions that may be received by Little Blue Penguins/Kororā that have been detected in the rock revetment in the area. A full Kororā management plan has been prepared by Boffa Miskell², per requirements of the resource consent, and we summarise the noise information here.

Based on our research for a similar construction project, certified by Auckland Council³, penguin hearing damage can occur at levels exceeding 90 – 95 dBA SPL in-air. Behavioural responses to sound are likely to occur at 80 dB $L_{Aeq(1\text{ sec})}$, but could occur at lower levels which are not clearly defined.

Airborne noise from rock breaking has the potential to cause penguin hearing damage if a penguin is within 6m of the activity, but the hearing damage threshold for all other activities has set-back distances of 4m or less. Table 6 shows the set-back distances predicted for the penguin behavioural threshold of 80 dB $L_{Aeq(1\text{ sec})}$ for the loudest activities documented in Table 3.

Given the uncertainty around behavioural effects thresholds for Kororā, all practicable noise mitigation measures shall be utilised to reduce noise at the burrows. The primary mitigation measures are noise barriers, operator care to avoid unnecessary noise and ensuring equipment is well maintained. Refer Section 6.0 for a detailed description of the mitigation recommendations.

² 'Draft BM19572A Little Penguin Management Plan, 20210505', dated 6 August 2021

³ 'RP 002 r04 2016226A VW (Little Blue Penguins and Construction Noise)', by Marshall Day Acoustics, dated 19 August 2021, available from <https://ouruckland.aucklandcouncil.govt.nz/media/ivfd2jke/cst60082321-c24a-mda-acoustic-report-certified.pdf>

The positioning of noise barriers near the burrows shall be carried out under the guidance of Boffa Miskell to minimise disturbance to the Kororā.

Table 6. Set-back distances to achieve 80 dB L_{Aeq} (penguin behavioural threshold) for loudest activities

Activity	Sound Power Level (dB L_{wA})	Set-back distance to achieve 80 dB $L_{Aeq(1sec)}$
Large breaker (rock armour)	121	20 m
Vibro piling	116	11 m
Hydro demolition	114	10 m
Concrete/paver cutting	114	10 m
Impact piling with dolly	114	10 m
Auger drilling	111	6 m
Hand breaker	111	6 m
Grinders/Power Tools	108	4 m
Concrete Pump	106	4 m

6.0 AIRBORNE NOISE – MITIGATION AND MANAGEMENT

The following section sets out options for the mitigation and management of noise.

6.1 Staff Training

All staff will participate in an induction training session prior to the start of construction, with attention given to the following matters:

- Construction noise limits (Section 4.0)
- Activities with the potential to generate high levels of noise (Section 5.1)
- Noise mitigation and management procedures (Section 6.0)
- The sensitivity of receivers and any operational requirements and constraints identified through communication and consultation (Section 8.0)
- Inform workers of the sensitivity of the marine environment, and be aware of the potential for marine mammals in the area

Awareness of current noise matters on, or near active worksites, will be addressed during regular site meetings and/or 'toolbox' training sessions.

6.2 General Measures

Noise disturbance or nuisance can arise whether or not noise levels comply with the project limits. To minimise disturbance, general mitigation and management measures include, but are not limited to, the following:

- Avoid unnecessary noise, such as shouting, the use of horns, loud site radios, rough handling of material and equipment, and banging or shaking excavator buckets
- Avoid high engine revs through appropriate equipment selection and turn engines off when idle
- Maintain site accessways to avoid pot holes and corrugations

- Mitigate track squeal from tracked equipment, such as excavators (may include tensioning and watering or lubricating the tracks regularly)
- Minimise the construction duration near sensitive receivers
- Stationary equipment (e.g. generators) should be located away from noise sensitive receivers and site buildings, with material stores or temporary noise barriers used to screen them
- Reversing alarms on vehicles must only be of a broadband type when used at night time (2200 - 0700) or on Sundays/public holidays.
- Implement specialised mitigation measures for concrete cutting (Section 6.7), concrete or rock breaking (Section 6.8), piling (Section 6.6), and underwater noise (Section 10.0)
- Ensure advanced communication is complete (Section 8.0) prior to commencing activities that are predicted to exceed the noise performance standards (Section 4.0)
- Undertake monitoring as appropriate (Section 7.0)

Note that people tend to be less disturbed by continuous engine noise compared with intermittent noise or activities with special audible character (e.g. reversing beepers, whistling, banging tailgates or shouting).

6.3 Scheduling

Where practicable, avoid night works.

Where night works do occur, noise levels will need to comply with the limits of Condition 12 (GWRC) and Condition 11 (HCC), unless explicit permission has been sought from the local authority to exceed these limits. Refer section 6.9.

6.4 Equipment Selection

When selecting construction equipment, the following will be implemented where practicable:

- Equipment shall be suitably sized for the proposed task
- Equipment shall be maintained and fitted with exhaust silencers and engine covers
- Tonal reversing or warning alarms (suitable alternatives may include flashing lights, broadband audible alarms or reversing cameras inside vehicles) should be avoided. However, in some instances, this may be unavoidable due to safety reasons

The above measures have assumed to be implemented in Table 3 of this report.

6.5 Noise Barriers and Enclosures

6.5.1 Temporary Noise Barriers

Temporary noise barriers will be used where an activity is predicted to exceed the construction noise limits (Section 5.0), unless they are ineffective (e.g. where a receiver is elevated and would look over the barrier). They will be installed prior to works commencing and maintained throughout the works.

Effective noise barriers typically reduce the received noise level by 10 decibels.

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

- The panels will have a minimum surface mass of 6.5 kg/m². 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/m²' (www.safesmartaccess.co.nz)
- Alternatives will be approved by a suitably qualified and experienced acoustic specialist
- The panels will be a minimum height of 2 m, and higher if practicable to block line-of-sight
- The panels will be abutted, battened or overlapped to provide a continuous screen without gaps at the bottom or between panels
- Barriers will be positioned as close as practicable to the high-noise activity to block line-of-sight between the activity and noise sensitive receivers. A site hoarding at the boundary may not be effective for all receivers. Add extra barriers close to high-noise activities to ensure effective mitigation for sensitive receivers on upper floors.

6.5.2 Permanent Noise Barriers

Upgrading an existing boundary fence (or constructing a new one) can provide effective construction noise mitigation. Its construction should be more durable than a temporary barrier (minimum surface mass of 10 kg/m², such as 18 mm plywood or 20 mm pine). Other guidelines for permanent barriers are the same as for temporary barriers (Section 6.5.1).

6.5.3 Noise Enclosures

Noise enclosures surround the source on more than one side and have a roof (an example is included as Figure B.3 in NZS 6803: 1999). How effective an enclosure is depends on how well the noise source can be enclosed without constraining its operation (e.g. mobility, heat, dust, lighting).

Where practicable, the following guidelines will be used in designing and installing enclosures:

- Enclosures will be considered where a noise barrier can't achieve compliance noise limits, particularly for stationary plant such as compressors, pumps, generators, air tools and paver cutting stations
- Enclosures can be made from the noise curtains listed above, or the following proprietary options are available:
 - Echo Barrier 'Cutting Station' (www.supplyforce.co.nz)
 - Soundbuffer 'Cutting Enclosure' (soundbuffer.co.nz)
 - Hushtec 'Acoustic Tent' (www.duraflex.co.nz)

If a custom enclosure is needed, a suitably qualified and experienced acoustic specialist, such as a Member of the Acoustical Society of New Zealand (MASNZ), will be involved in its design.

6.6 Piling Mitigation

- A non-metallic 'dolly' or 'cushion cap' shall be used between the impact piling hammer and the driving helmet (e.g. plastic or plywood). This reduces both airborne and underwater noise emissions
- Use an enclosed impact piling driving system that shrouds the point of impact where practicable
- Avoid shaking the auger to remove spoil where practicable. Shaking the kelly bit connection can result in very loud banging that often results in noise complaints. If spoil does not fall off the auger easily, use tools to scrape the auger clean if necessary. If shaking is required due to Health and Safety constraints, ensure bushes are well maintained to avoid steel on steel contact.

6.7 Concrete Cutting

Where practicable:

- Minimise the cutting period and, the number of cutting periods (e.g. complete all cutting in one extended period rather than two shorter periods with the same overall duration)
- Use a unit fitted with a blade shroud and a 'quiet' blade type (tooth design)

6.8 Concrete Breaking and Rock Breaking

Where practicable:

- Minimise the duration of breaking (e.g. small rocks should be excavated directly and larger basalt boulders removed by truck for breaking offsite), and, the number of breaking periods (e.g. complete all breaking in one extended period rather than two shorter periods with the same overall duration)
- Match the size of breaker to the scale of the works (i.e. large enough to undertake the works efficiently, but avoiding oversized units)
- Match the chisel/tip type to the material and use a dampened bit to avoid ringing
- Avoid 'blank' firing by engaging the material before commencing and stopping before it fires through the material
- For concrete breaking, an initial perimeter saw cut should be made at the perimeter to reduce vibration transfer to nearby buildings

6.9 Exceeding Noise Limits/Night Works

The contractor has expressed that night-works may be necessary at some point during the construction period. However, the noisiest activities (rock breaking, impact piling) would not occur.

Where activity noise levels are predicted to exceed the night-time noise limits (see Section 5.0), the contractor must seek explicit permission from the local authority to exceed the limits and carry out a Best Practicable Option (BPO) assessment. The BPO assessment shall include, but not be limited to:

- The reasons why works cannot take place during the standard hours
- Reasons why a quieter method, to achieve the same objective, cannot be implemented
- What mitigation measures are proposed to reduce the noise from activities
- Stakeholder engagement/notification of potentially affected parties, including the local authority
- Noise monitoring protocols

In accordance with Condition 14 (GWRC) and Condition 13 (HCC), the BPO assessment shall be provided to the local authority, prior to works taking place. This CNMP shall then be updated to include this BPO assessment.

7.0 AIRBORNE NOISE – MONITORING

Construction noise levels shall be monitored:

- Periodically, at the intervals set out Condition 12 (HCC) and Condition 13 (GWRC)
- During the first occurrence of any activities that are predicted to exceed the noise limits (Section 4.0), and
- In response to a reasonable noise complaint

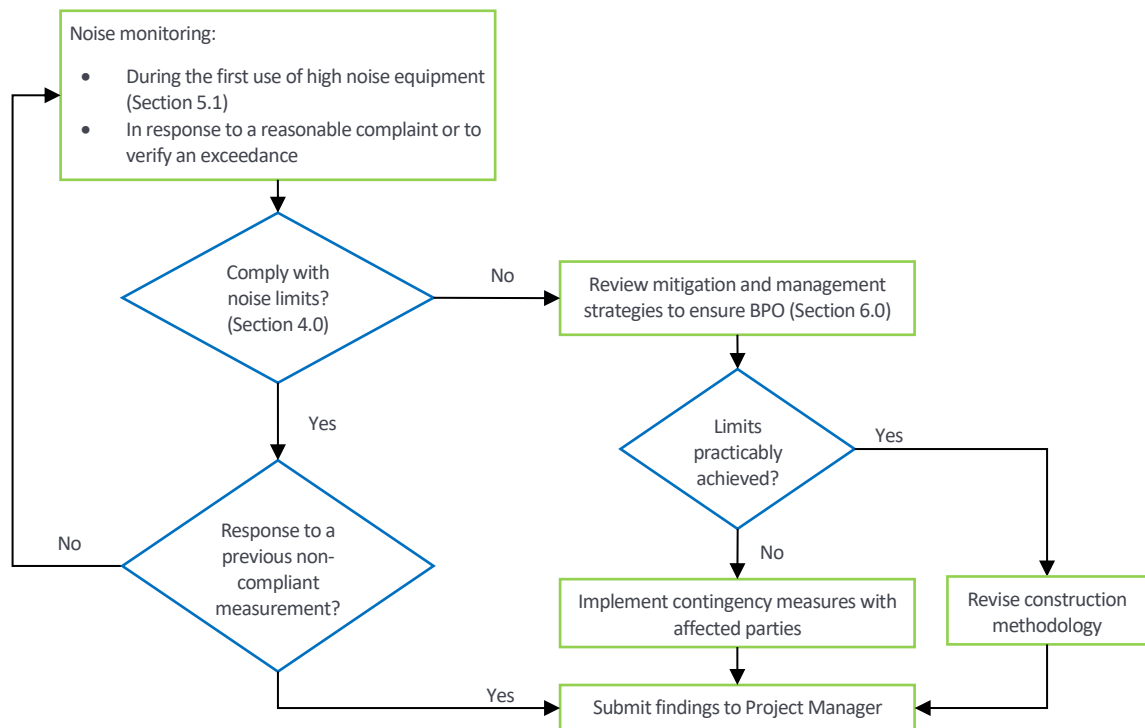
The following sets out the procedures for carrying out noise monitoring:

- At 1m from the most affected building façade, or proxy position and adjusted for distance and façade reflections where appropriate
- By a suitably qualified and experienced specialist (e.g. Member of the Acoustical Society of New Zealand) in accordance with the requirements of New Zealand Standard NZS 6803: 1999 “Acoustics - Construction Noise”
- For a representative duration, reported with the measured level (e.g. 65 dB $L_{Aeq}(30min)$)
- The results should be used to update Section 5.0 if appropriate

Spot checks of noise levels may be carried out by a member of the construction team who is trained in noise monitoring.

A noise monitoring flowchart is presented in Figure 2.

Figure 2: Noise Monitoring Flow Chart



8.0 AIRBORNE NOISE – ENGAGEMENT WITH NEIGHBOURS

8.1 Communication

Written communication prior to the works (e.g. newsletter, website, emails etc.) shall:

- Be provided to occupiers of buildings within 200 metres of works (or 800 metres where night-works are proposed)
- Be provided at least 2 weeks prior to the Project commencing
- Acknowledge that some activities are predicted to generate high noise levels that may result in disturbance for short periods.
- Include details of the overall works, its timing, duration and contact details where enquiries and complaints should be directed.

Written communication during the works:

- Public site signage shall include contact details of the project manager
- Regular project updates shall be provided via communication channels. This shall include details of impending activities that may result in disturbance, including concrete cutting, rock breaking and piling.
- It shall include scheduled timing and duration of noisy activities and contact details where complaints and enquiries should be directed.
- Any night works, outside of low noise activities, shall be advised (separately) at least 5 days prior to the works commencing.

8.2 Complaints Response

All construction noise complaints should be recorded in a complaints file that is available to Council on request. For each complaint, an investigation should be undertaken involving the following steps as soon as practicable:

- Acknowledge receipt of the concern or complaint within 24 hours and record:
 - o Time and date the complaint was received and who received it
 - o Time and date of the activity subject to the complaint (estimated where not known)
 - o The name, address and contact details of the complainant (unless they elect not to provide)
 - o The complainant's description of the activity and its resulting effects
 - o Any relief sought by the complainant (e.g. scheduling of the activity)
- Identify the relevant activity and the nature of the works at the time of the complaint
- Review the activity noise levels (Section 5.1) to determine if the activity is predicted to comply with the relevant noise performance standards at the complainants building. Undertake noise monitoring to verify noise levels.
- Review the mitigation and management measures in to ensure the activity represents the BPO (Section 6.0). Review the relief sought by the complainant. Adopt further mitigation and management measures as appropriate.
- Report the findings and recommendations to the Project Manager, implement changes and update this CNMP as appropriate.
- Report the outcomes of the investigation to the complainant, identifying where the relief sought by the complainant has been adopted or the reason(s) otherwise.

In most cases, ceasing the activity would provide immediate relief. In some cases, this may not be practicable for safety or other reasons. The complainant shall be kept updated regularly during the time it takes to resolve the matter.

9.0 UNDERWATER PILING NOISE – PREDICTED ZONES

9.1 Overview

We have predicted underwater noise levels from the planned piling works and calculated marine mammal observation zones (MMOZ). The following sections contain the effect thresholds, piling methodology, source levels and zones.

The main purpose of this section of the plan is to summarise the key parameters which go into calculating the MMOZs. These details will be updated when the Acoustic Specialist completes on-site monitoring as part of the verification process (see Section 11.0), and updated zones will be calculated. The updated MMOZs will be included in the Marine Mammal Management Plan (MMMP)⁴ which is used by the Marine Mammal Observers (MMO) during piling works.

9.2 Effect Thresholds

These criteria inform the effects zones in the following sections.

The relevant NOAA⁵ PTS and TTS thresholds⁶ from Consent Condition 11b (GWRC) are summarised in Table 7. The MMOZ are based on these criteria.

The predicted peak noise levels from the planned piling works are well below the peak thresholds in Consent Condition 11b (GWRC), so we have not included this criteria.

Table 7: Summary of TTS and PTS criteria

Criteria	Hearing Group	Impulsive sources (impact piling)	Non-impulsive sources (vibratory piling)
TTS thresholds	Mid-frequency cetaceans (Orca, common/bottlenose/dusky dolphins)	170 dB SEL _{cum(mf)}	178 dB SEL _{cum(mf)}
	High-frequency cetaceans (Hectors/Maui dolphin)	140 dB SEL _{cum(hf)} 146 dB SEL _{ss (unweighted)}	153 dB SEL _{cum(hf)}
	Otariid pinnipeds (Fur Seals)	188 dB SEL _{cum(ow)}	199 dB SEL _{cum(ow)}
	Low frequency cetaceans (baleen whales)	168 dB SEL _{cum(LF)}	179 dB SEL _{cum(LF)}
PTS thresholds	Mid-frequency cetaceans (Orca, common/bottlenose/dusky dolphins)	185 dB SEL _{cum(mf)}	198 dB SEL _{cum(mf)}
	High-frequency cetaceans (Hectors/Maui dolphin)	155 dB SEL _{cum(hf)}	173 dB SEL _{cum(hf)}
	Otariid pinnipeds (Fur Seals)	203 dB SEL _{cum(ow)}	219 dB SEL _{cum(ow)}
	Low frequency cetaceans (baleen whales)	183 dB SEL _{cum(LF)}	199 dB SEL _{cum(LF)}

⁴ Cawthron Report 3650, Marine Mammal Management Plan (MMMP)

⁵ National Oceanic and Atmospheric Administration: 'Technical Guidance for Assessing the Effects on Anthropogenic Sound on Marine Mammal Hearing' (April 2018).

⁶ Temporary threshold shift (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 which is referred to as permanent threshold shift (PTS).

9.3 Piling Methodology

The piling methodology inputs to calculate the MMOZ are summarised in Table 8⁷.

The methodology will be validated during on site monitoring (refer Section 11.0).

Table 8: Piling Methodology

Stage	Pile Size	Number of Piles per day	Piling Method	Strikes/Minutes
Approach Wharf	1200mm	2	Impact	1000 strikes
			Vibro	60 minutes
Compound Staging	710mm	2	Impact	1000 strikes
			Vibro	45 minutes
Main Wharf	750mm	4	Impact	500 strikes
			Vibro	30 minutes
	1050mm	2	Impact	500 strikes
			Vibro	45 minutes
1200mm	2	Impact	1000 strikes	
		Vibro	60 minutes	
1500mm	1	Impact	1500 strikes	
		Vibro	90 minutes	

9.4 Underwater Piling Source Levels

The source levels for the planned piling works are presented in Table 9. These levels will be validated through monitoring.

Table 9: Predicted piling source levels at 1m from the pile^{8 9}

Piling details	Peak	RMS	SEL _(single strike)	SEL _{cum}
Approach wharf 1,200mm impact	222	200	191	223
Approach wharf 1,200mm vibro	N/A	175	N/A	214
Compound staging 710mm impact	215	199	188	221
Compound staging 710mm vibro	N/A	184	N/A	221
Main wharf 750mm impact	215	199	188	221
Main wharf 750mm vibro	N/A	175	N/A	223
Main wharf 1,050mm impact	222	200	191	221

⁷ Email from Lee Griffiths (FCC), 23 February 2021

⁸ SEL thresholds have a reference of 1 $\mu\text{Pa}^2\text{s}$ and L_{peak} /RMS thresholds have a reference of 1 μPa

⁹ Source levels have been predicted using a '15log(distance)' approximation of the distance attenuation between the measurement position and the pile.

Piling details	Peak	RMS	SEL _(single strike)	SEL _{cum}
Main wharf 1,050mm vibro	N/A	175	N/A	212
Main wharf 1,200mm impact	222	200	191	223
Main wharf 1,200mm vibro	N/A	175	N/A	214
Main wharf 1,500mm impact	222	200	191	222
Main wharf 1,500mm vibro	N/A	175	N/A	212

9.5 Marine Mammal Observation Zones

The predicted TTS and PTS zones are summarised in Table 10 and Table 11, with and without a bubble curtain, respectively.

The largest zones are shown graphically in Appendix B.

The key marine mammal observation zones (MMOZ) are shaded yellow and grey. Zones shaded yellow indicate areas exceeding the 500m range of a single Marine Mammal Observer, while the grey zones are able to be monitored by a single marine mammal observer. Zones which are less than 50m do not require an observer.

Refer to the Marine Mammal Management Plan (MMMP)² for information and procedures for marine mammal observers.

Table 10: Summary of TTS and PTS zones (without bubble curtain). Yellow cells indicate areas >500m, and grey cells are able to be monitored by a single marine mammal observer.

Hearing Group		Compound Staging		Approach Wharf		Main Wharf							
		710mm diameter steel		1200mm diameter steel		1500mm diameter steel		1200mm diameter steel		1050mm diameter steel		750mm diameter steel	
		Vibro Piling	Impact Piling	Vibro Piling	Impact Piling	Vibro Piling	Impact Piling	Vibro Piling	Impact Piling	Vibro Piling	Impact Piling	Vibro Piling	Impact Piling
Low-Frequency Cetaceans (LF)	TTS cumulative	900m	1km	225m	3.5km	190m	3.1km	225m	3.5km	160m	2.6km	1.1km	1.0km
	PTS cumulative	100m	165m	<50m	750m	N/A	650m	<50m	750m	40m	535m	100m	165m
Mid-Frequency Cetaceans (MF)	TTS cumulative	N/A	105m	N/A	220m	N/A	190m	N/A	220m	N/A	160m	165m	100m
	PTS cumulative	N/A	N/A	N/A	<50m	N/A	<50m	N/A	<50m	N/A	<50m	N/A	N/A
High-Frequency Cetaceans (HF)	TTS cumulative	1.4km	1.5km	210m	2.4km	335m	2.2km	210m	2.4km	155m	1.9km	1.5km	1.5km
	PTS cumulative	<50m	450m	N/A	650m	50m	570m	N/A	650m	N/A	480m	225m	450m
Otariid Pinnipeds (OW)	TTS cumulative	N/A	<50	N/A	220m	N/A	190m	N/A	220m	N/A	160m	<50m	<50m
	PTS cumulative	N/A	<50m	N/A	<50m	N/A	<50m	N/A	<50m	N/A	<50m	N/A	<10m

Note: cells that contain N/A indicate that there is no zone – the source level is below the relevant thresholds

Table 11: Summary of key TTS and PTS zones (with bubble curtain). Yellow cells indicate areas >500m, and grey cells are able to be monitored by a single marine mammal observer.

Hearing Group		Compound Staging	Approach Wharf	Main Wharf			
		710mm diameter steel	1200mm diameter steel	1500mm diameter steel	1200mm diameter steel	1050mm diameter steel	750mm diameter steel
		Impact Piling	Impact Piling	Impact Piling	Impact Piling	Impact Piling	Impact Piling
Low-Frequency Cetaceans (LF)	TTS cumulative	500m	750m	670m	750m	540m	500m
	PTS cumulative	<50m	120m	100m	120m	90m	<50m
Mid-Frequency Cetaceans (MF)	TTS cumulative	<10m	55m	<50m	55m	<50m	<10m
	PTS cumulative	<10m	<10m	<10m	<10m	<10m	<10m
High-Frequency Cetaceans (HF)	TTS cumulative	650m	700m	650m	700m	565m	650m
	PTS cumulative	200m	185m	160m	185m	155m	200m

Note: cells that contain N/A indicate that there is no zone – the source level is below the relevant thresholds.

10.0 UNDERWATER NOISE – MITIGATION AND MANAGEMENT

10.1 Hours of Operation

Piling shall be restricted to within the start and end of civil twilight hours as per condition 14 b). This is because it is not possible to identify marine mammals in the MMOZs without sufficient light.

Piling times are primarily controlled by the airborne noise limits, which restrict high-noise activities to 0730 – 1800, Monday to Saturday. However, during winter the civil twilight hours will restrict piling works in the evening.

Table 12 shows the civil twilight hours based on Civil Aviation guidance¹⁰. The red text indicates where these hours are more restrictive than the 0730 – 1800 piling construction hours.

Table 12: Summary of civil twilight hours. Red text indicates where twilight hours are more restrictive than the 0730 – 1800 construction hours

		NZDT times (in 24 hour time)			
		7th	14th	21st	28th
Jan	Morning	527	535	545	554
	Evening	2126	2124	2120	2114
Feb	Morning	607	617	626	635
	Evening	2104	2053	2043	2031
Mar	Morning	645	653	701	710
	Evening	2019	2006	1954	1943
Apr	Morning	620	628	635	643
	Evening	1827	1815	1805	1756
May	Morning	651	657	704	710
	Evening	1746	1739	1733	1729
Jun	Morning	717	721	723	724
	Evening	1726	1725	1726	1728
Jul	Morning	722	719	715	709
	Evening	1733	1738	1742	1749
Aug	Morning	700	651	641	629
	Evening	1757	1803	1810	1817
Sep	Morning	613	601	549	636
	Evening	1827	1833	1840	1948
Oct	Morning	621	610	558	549
	Evening	1957	2005	2014	2026
Nov	Morning	534	526	520	515
	Evening	2036	2046	2055	2104
Dec	Morning	512	513	514	517
	Evening	2113	2122	2124	2126

¹⁰ <https://www.aip.net.nz/>

10.2 Underwater Noise Mitigation Measures

10.2.1 Maintenance of Equipment

Conduct regular maintenance on equipment to reduce the production of noise. Ensure that all noise suppression equipment (such as barriers and baffles) is maintained in good working order.

10.2.2 Dolly/Cushion for Impact Piling

A wooden, polymer or nylon dolly/cushion shall be placed between hammer and pile/pile cap to reduce the injury potential of impact piles from impulsive signals.

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.

10.2.3 Pre-Start and Soft Start Procedures

Prior to the commencement of a noise-producing activity, MMOZs and surrounding waters are monitored for 30 minutes for the presence of marine mammals. If no marine mammal have been observed during the 30 minute period, or if any sighted mammals are unlikely to enter the MMOZs, a soft-start procedure can commence.

Soft starts shall be used 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 piling 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.

10.2.4 Changes in Methodology

Low noise methods of pile driving such as bored/screw piling shall always be prioritised over vibro/impact piling where practicable. Vibro piling should also be prioritised over impact piling as it typically generates lower noise levels¹¹.

If it is discovered through underwater noise monitoring that the marine mammal observation zones (MMOZ) are too large to effectively monitor for the marine mammal observer(s), then the methodology will need to be revised. This could involve:

- Limiting the number of piles installed per day
- Limiting the number of impact strikes per pile by prioritising vibro piling
- Minimising both vibro and impact piling by drilling out the pile to depth once a seal has been achieved

The Acoustic Specialist shall be involved in this process to calculate the required methodology to reduce the zone to an appropriate size and validate the new zones through underwater noise measurements (refer to Section 11.0).

10.2.5 Bubble Curtains

We understand that this mitigation is an effective, relatively simple and low-cost method of significantly reducing piling noise emissions. Bubble curtains are commonly implemented overseas. Our calculations involving this mitigation are based on the spectral data from Figure 3 of 'Overview of existing noise mitigation systems for reducing pile driving noise' (Bellman, 2014). The mitigation

¹¹ This is depending on the methodology details, so advice from the Acoustic Specialist should be sought

provides the greatest reduction at high frequencies, so is highly beneficial for species such as Hector's dolphins.

The bubble curtains typically reduce the zones to around one-third of the original size. However, the attenuation is frequency dependant, and therefore varies with source spectrum, distance from the pile and species being considered.

10.3 Marine Mammal Observer (MMO) Roles and Procedures

A key part of any mitigation is undertaking observations for marine mammals during piling operations. The aim of observations is to ensure that any marine mammals entering the MMOZ are promptly identified, and appropriate mitigation action is undertaken.

The MMO has two general duties:

- Detect, record and report the presence of marine mammals within the wider operations area; and
- Enforce mitigation measures within the MMOZ, including documenting any action taken (if necessary).

Refer to the Marine Mammal Management Plan for the required qualifications, roles and procedures for the MMO(s).

11.0 UNDERWATER NOISE – VALIDATION OF MMOZS

Underwater construction noise levels and the MMOZ shall be verified through noise monitoring during the first occurrence of impact and vibro driven steel piles for representative pile types, sizes and locations. Noise monitoring shall be undertaken by the acoustic specialist.

Monitoring shall be undertaken for a representative duration to characterise the noise produced by the various activities – e.g., the installation of two piles of a given size and methodology.

Further monitoring shall be undertaken if there is a change in methodology that is predicted to result in larger zones.

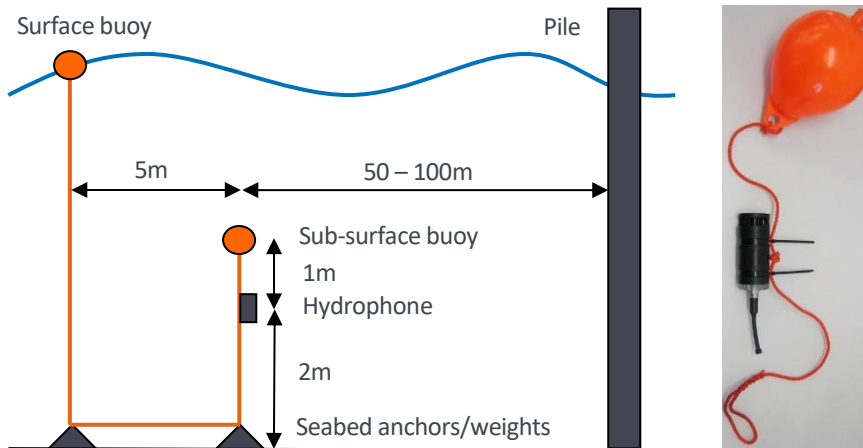
The results will be used to update the relevant Marine Mammal Observer Zones (MMOZ).

The underwater noise measurements will be undertaken using a compact self-contained hydrophone (underwater sound recording units). Measurements will be taken either off the wharf, or from a boat.

Calm sea state is required for good acoustic measurement conditions.

The generic setup for each hydrophone unit would be as shown in Figure 3.

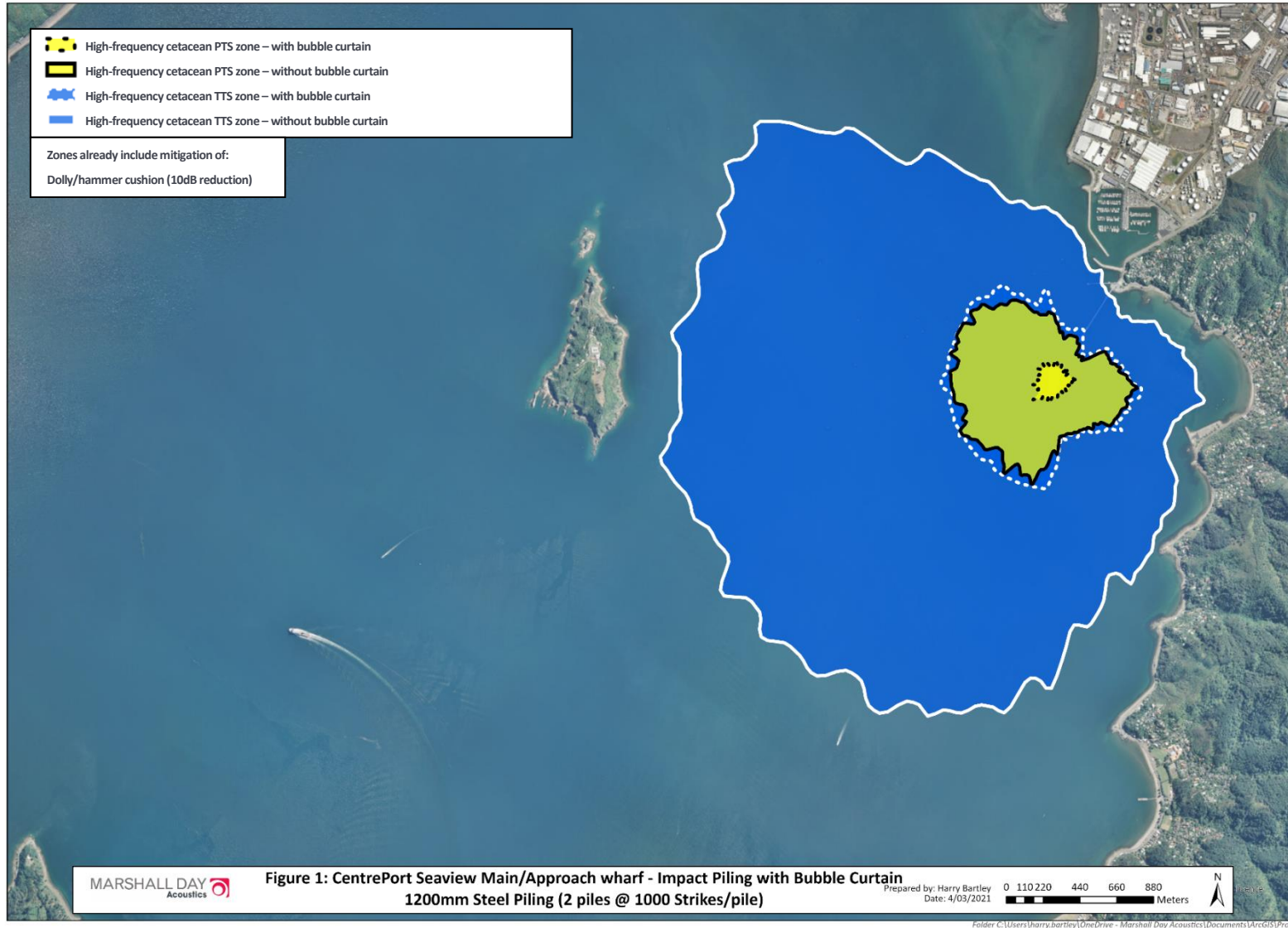
Figure 3: Hydrophones indicative setup (not to scale)



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 $dB = 20 \times \log(P/Pr)$. The convention is a reference pressure of $Pr = 20 \mu Pa$ in air and $Pr = 1 \mu Pa$ underwater.
dB(A)	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.
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.

APPENDIX B EXAMPLE OF HIGH-FREQUENCY CETACEAN MANAGEMENT ZONES – WITH AND WITHOUT BUBBLE CURTAIN



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